African Forest Forum

A platform for stakeholders in African forestry

Forests and Climate Change Mitigation

A COMPENDIUM FOR PROFESSIONAL TRAINING IN AFRICAN FORESTRY

12

African Forest Forum

A platform for stakeholders in African forestry

Forests and Climate Change Mitigation

COMPENDIUM FOR PROFESSIONAL TRAINING IN AFRICAN FORESTRY

Correct citation: African Forest Forum. 2022. Forests and Climate Change Mitigation: A Compendium for Professional Training in African Forestry

African Forest Forum
United Nations Avenue, Gigiri
PO Box 30677-00100
Nairobi, Kenya

Tel: +254 20 722 4203
Fax: +254 20 722 4001
Website: www.afforum.org

Front cover photos: View from Umbrella Rock in the Yilo Krobo District, outside of Accra, Ghana. Credit: Felix Lipov (left); Fever tree forest, Kruger National Park, South Africa. Credit: Jo-anne Hounsom (middle); Ekom Waterfall deep in the tropical rain forest of Cameroon. Credit: Fabian Plock (right).

Back cover photo: Quiver tree forest landscape. Kokerbooms in Namibia (Credit: JayS).

Design & layout: Conrad Mudibo, Ecomedia

Acknowledgements
We want to appreciate the valuable inputs from all AFF stakeholders who contributed in drafting of the outline and those who reviewed the initial draft of the document. This work could not have been completed without the input of the AFF Secretariat. Funding for the assignment was through the The African Forest Forum's (AFF) project on "African forests, people and climate change".

Contents

Abbreviations and Acronyms

AD	Activity D
AF	Adaptation Fund
AFOLU	Agriculture, Forestry and Other Land Uses
AFR100	African Forest Landscape Restoration Initiative
APAF	Association for the Promotion of Fertiliser Trees and Agroforestry
BURs	Biennial Update Reports
CBD	Convention on Biological Diversity
CCM	Climate Change Mitigation
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CH_4	Methane
Ci-Dev	Carbon Initiative for Development
CIF	Climate Investment Fund
CMA	COP serving as the Meeting of the Parties to the Paris Agreement
CMP	COP Serving as the Meeting of Parties to the KP
CO_2	Carbon dioxide
COP	Conference of Parties
CSOs	Civil Society Organisations
EbA	Ecosystem based Adaptation
EbM	Ecosystem based Mitigation
EF	Emission Factor
ERU	Emission Reduction Unit
ESF	Environmental and Social Framework
ESMF	Environmental and Social Management Framework
ESS	Environmental and Social Standard
ETF	Enhanced Transparency Framework
ETS	Emissions Trading Scheme
FCPF	Forest Carbon Partnership Facility
FIP	Forest Investment Programme
FPIC	Free Prior Informed Consent
FREL	Forest Reference Emission Level
FRL	Forest Reference Level
GCF	Green Climate Fund
GEF	Global Environment Facility
GGW	Great Green Wall
GHG	Greenhouse Gas
GS	Grameen Shakti

GST	Global Stocktake
GWP	Global Warming Potential
HFCs	Hydrofluorocarbons
IPCC	Intergovernmental Panel on Climate Change
IPP	Indigenous People Plan
ITMO	Internationally Transferred Mitigation Outcomes
JI	Joint Implementation
KP	Kyoto Protocol
LT-LEDS	Long-Term Low GHG Emission Development Strategies
LULUCF	Land Use, Land Use Change and Forestry
M&E	Monitoring & Evaluation
MERVC	Monitoring, Evaluation, Reporting, Verification, and Certification
MRV	Monitoring, Reporting and Verification
N_2O	Nitrous Oxide
NAMAs	Nationally Appropriate Mitigation Actions
NDCs	Nationally Determined Contributions
NFMS	National Forest Monitoring Systems
NGOs	Non-Governmental Organisations
NTFPs	Non Timber Forest products
PDD	Project Design Document
PES	Payment for Ecosystem Services
PFCs	Perfluorocarbons
PIN	Project Idea Note
ppm	Parts Per Million
RED	Reducing Emissions from Deforestation
REDD	Reducing Emissions from Deforestation and forest Degradation
REDD+	Reducing Emissions from Deforestation, forest Degradation, Conservation of Forests, Sustainable Management of Forests and Enhancement of Forest Carbon Stocks
REL	Reference Emission Level
RMU	Removal Unit
SADC	Southern African Development Community
SBSTA	Subsidiary Body for Scientific and Technological Advice
SCCF	Special Climate Change Fund
SCF	Standardised Crediting Framework
SDGs	Sustainable Development Goals
SDM	Sustainable Development mechanism
SESA	Strategic Environmental and Social Assessment
SF_6	Sulphur Hexafluoride
SFM	Sustainable Forest Management

SIS	Safeguard Information System
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNDRIP	United Nations Declaration on the Rights of Indigenous Peoples
UNFCCC	United Nations Framework Convention on Climate Change
UNFI	United Nations Forest Instrument
UNSPF	United Nations Strategic Plan on Forests
VCS	Verified Carbon Standards

Preface

African forests and trees support the key sectors of the economies of many African countries, including crop and livestock agriculture, energy, wildlife and tourism, water resources and livelihoods. They are central to maintaining the quality of the environment throughout the continent, while providing international public goods and services. Forests and trees provide the bulk of the energy used in Africa. Forests and trees are therefore at the centre of socio-economic development and environmental protection of the continent.

Forests and trees outside forests in Africa are in many ways impacted by climate change, and they in turn influence climate. Hence, African forests and trees are increasingly becoming very strategic in addressing climate change, as captured in African countries' Nationally Determined Contributions (NDCs). The great diversity of forest types and conditions in Africa is at the same time the strength and the weakness of the continent in devising optimal forest-based responses to climate change. In this regard, given the role of forests and trees to socio-economic development and environmental protection, actions employed to address climate change in Africa must simultaneously enhance livelihoods of forest dependent populations and improve the quality of the environment. It is therefore necessary for Africa to understand how climate change affects the inter-relationships between food, agriculture, energy use and sources, natural resources (including forests and woodlands) and people in Africa, and in the context of the macro-economic policies and political systems that define the environment in which they all operate. Much as this is extremely complex, the understanding of how climate change affects these inter-relationships is paramount in influencing the process, pace, magnitude and direction of development necessary for enhancing people's welfare and the environment in which they live.

At the forestry sector level, climate affects forests but forests also affect climate. For example, carbon sequestration increases in growing forests, a process that positively influences the reduction in the level of greenhouse gases in the atmosphere, which, in turn, may reduce global warming. In other words, the forests, by regulating the carbon cycle, play vital roles in climatic change and variability. For example, the Intergovernmental Panel on Climate Change (IPCC) special report of 2018 on the impacts of global warming of 1.5 °C above pre-industrial levels underscores the significance of afforestation and reforestation, land restoration and soil carbon sequestration in carbon dioxide removal. Specifically, in pathways limiting global warming to 1.5 °C, agriculture, forestry and land-use (AFOLU) are projected with medium confidence to remove 0-5, 1-11 and 1-5 GtCO2 yr-1 in 2030, 2050 and 2100, respectively. There are also co-benefits associated with AFOLU-related carbon dioxide removal measures such as biodiversity conservation, improved soil quality and local food security. Climate, on the other hand, affects the function and structure of forests. It is important to understand adequately the dynamics of this interaction to be able to design and implement appropriate mitigation and adaptation strategies for the forest sector.

In the period between 2009 and 2011, the African Forest Forum (AFF) sought to understand these relationships by putting together the scientific information it could gather in the form of a book that addressed climate change in the context of African forests, trees, and wildlife resources. This work, which was financed by the Swedish International Development Cooperation Agency (Sida), unearthed considerable gaps on Africa's understanding of climate change in forestry, how to handle the challenges and opportunities presented by it and the capacity to do so.

The most glaring constraint for Africa to respond to climate change was identified as the lack of capacity to do so. AFF recognizes that establishment and operationalization of human capacities are essential for an effective approach to various issues related to climate change, as well as to improve the quality

of knowledge transfer. For example, civil society organisations, extension agents and local communities are stakeholders in implementing adaptation and mitigation activities implicit in many climate change strategies. In addition, civil society organisations and extension agents are more likely to widely disseminate relevant research results to local communities, who are and will be affected by the adverse effects of climate change. It is therefore crucial that all levels of society are aware of mechanisms to reduce poverty through their contribution to solving environmental problems. Training and updating knowledge of civil society organisations, extension service agents and local communities is one of the logical approaches to this. Also, professional and technical staff in forestry and related areas would require updated knowledge and skills in these relatively new but highly dynamic areas of work.

It was on this basis that AFF organized a workshop on capacity building and skills development in forest-based climate change adaptation and mitigation in Nairobi, Kenya, in November 2012 that drew participants from selected academic, research and civil society institutions, as well as from the private sector. The workshop identified the training needs on climate change for forestry related educational and research institutions at professional and technical levels, as well as the training needs for civil society groups and extension agents that interact with local communities and also private sector on these issues. The training needs identified through the workshop focused on four main areas, namely: Science of Climate Change, Forests and Climate Change Adaptation, Forests and Climate Change Mitigation, and Carbon Markets and Trade. This formed the basis for the workshop participants to develop training modules for professional and technical training, and for short courses for extension agents and civil society groups. The development of the training modules involved 115 scientists from across Africa. The training modules provide guidance on how training could be organized but do not include the text for training; a need that was presented to AFF by the training institutions and relevant agents.

Between 2015 and 2018, AFF brought together 50 African scientists to develop eight compendiums in a pedagogical manner, namely:

1. Basic Science of Climate Change: A Compendium for Professional Training in African Forestry 01- https://afforum.org/publication/basic-science-of-climate-change-a-compendium-for-professional-training-in-african-forestry-01/
2. Basic Science of Climate Change: A Compendium for Technical Training in African Forestry 02- https://afforum.org/publication/basic-science-of-climate-change-a-compendium-for-technical-training-in-african-forestry-02/
3. Basic Science of Climate Change: A Compendium for Short Courses in African Forestry 03- https://afforum.org/publication/basic-science-of-climate-change-a-compendium-for-short-courses-in-african-forestry/
4. Carbon Markets and Trade: A Compendium for Professional Training In African Forestry 04- https://afforum.org/publication/carbon-markets-and-trade-a-compendium-for-professional-training-in-african-forestry/
5. Carbon Markets and Trade: A Compendium for Technical Training in African Forestry 05- https://afforum.org/publication/carbon-markets-and-trade-a-compendium-for-technical-training-in-african-forestry/
6. Carbon Markets and Trade: A Compendium for Short Courses in African Forestry 06- https://afforum.org/publication/carbon-markets-and-trade-a-compendium-for-short-courses-in-african-forestry/
7. Climate Modelling and Scenario Development: A Compendium for Professional Training in African Forestry 07- https://afforum.org/publication/climate-modelling-and-scenario-development-a-compendium-for-professional-training-in-african-forestry-07/

8. International Dialogues, Processes and Mechanisms on Climate Change: A Compendium for Professional and Technical Training in African Forestry 08- https://afforum.org/publication/international-dialogues-processes-and-mechanisms-on-climate-change-a-compendium-for-professional-and-technical-training-in-african-forestry-08/

From 2019 to 2022, AFF mobilized 75 African forestry stakeholders to continue the development of the compendiums including updating, strengthening and contextualizing them with case studies, new and emerging issues in forestry and climate change in order to produce six new compendiums as follows:

1. Forests and climate change adaptation: a compendium for professional training in African forestry
2. Forests and climate change adaptation: a compendium for technical training in African forestry
3. Forests and climate change adaptation: a compendium for short course in African forestry
4. Forests and climate change mitigation: a compendium for professional training in African forestry
5. Forests and climate change mitigation: a compendium for technical training in African forestry
6. Forests and climate change mitigation: a compendium for short course in African forestry

These compendiums are being translated into French for the benefit of the Francophone African forestry stakeholders.

Another notable contribution during the period 2011-2018 was the use of the training module on "Carbon markets and trade" in building the capacity of 574 trainers from 16 African countries on rapid forest carbon assessment (RaCSA), development of a Project Idea Note (PIN) and a Project Design Document (PDD), exposure to trade and markets for forest carbon, and carbon financing, among others. The countries that benefited from the training are: Burkina Faso (35), Côte d'Ivoire (31), Ethiopia (35), Guinea Conakry (40), Kenya (54), Liberia (39), Madagascar (42), Niger (34), Nigeria (52), Sierra Leone (35), Sudan (34), Swaziland (30), Tanzania (29), Togo (33), Zambia (21) and Zimbabwe (30). In addition, the same module has been used to equip African forest-based small-medium enterprises (SMEs) with skills and knowledge on how to develop and engage on forest carbon business. In this regard, 63 trainers of trainers were trained on RaCSA from the following African countries: Angola, Benin, Burkina Faso, Cameroon, Chad, Côte d'Ivoire, Democratic Republic of Congo, Ethiopia, Kenya, Gabon, Gambia, Ghana, Guinea Conakry, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Niger, Nigeria, Republic of Congo, Senegal, South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda, Zambia and Zimbabwe.

In 2021 and 2022, the validated training compendiums on "Forests and climate change mitigation: a compendium for short courses in African forestry" and on "Forests and climate change adaptation: a compendium for short course in African forestry" were used to train 165 African forestry stakeholders from forestry administrations, private sectors, civil society and community based organizations from 29 African countries including 10 from Francophone (Algeria, Benin, Burkina Faso, Chad, Mali, Mauritania, Niger, Tunisia, Togo and Senegal); 15 from Anglophone (Botswana, Egypt, Ethiopia, Kenya, Gambia, Lesotho, Liberia, Malawi, Namibia, Nigeria, Rwanda, Uganda, Tanzania, Zambia, Zimbabwe) and 2 from Lusophone Africa (Angola and Mozambique).

An evaluation undertaken by AFF has confirmed that many trainees on RaCSA are already making good use of the knowledge and skills gained in various ways, including in developing bankable forest carbon projects. Also, many stakeholders have already made use of the training modules and the compendiums to improve the curricula at their institutions and the way climate change education and training is delivered. In the same vein, an evaluation done at the end of the training workshops using the compendiums for short courses indicate that the skills gained, and experiences shared were relevant to improve the capacity of trainees in developing and implementing activities, projects, programmes and policies related to forest and tree-based mitigation and adaptation in their national contexts.

These compendiums and training workshops were largely financed by the Swiss Agency for Development and Cooperation (SDC) and with some contribution from the Swedish International Development Cooperation Agency (Sida).

The development of the compendiums is therefore an evolutionary process that has seen the gradual building of the capacity of many African scientists in developing teaching and training materials for their institutions and the public at large. In a way this has cultivated interest within the African forestry fraternity to gradually build the capacity to develop such texts and eventually books in areas of interest to the continent, as a way of supplementing information otherwise available from various sources, with the ultimate objective of improving the understanding of such issues as well as to better prepare present and future generations in addressing the same.

We therefore encourage the wide use of these compendiums, not only for educational and training purposes but also to increase the understanding of climate change aspects in African forestry by the general public.

Macarthy Oyebo
Président du Conseil d'administration du AFF

Godwin Kowero
Secrétaire exécutif du AFF

Executive Summary

The rise in greenhouse gas (GHG) emissions especially Carbon dioxide (CO2) has led to the recognition of forests as important agents for climate change mitigation (CCM) through the process of Carbon sequestration. The role of trees and forests in CCM is achieved by increasing forest area and density through afforestation, reforestation and forest restoration resulting in increased absorption of CO2 from the atmosphere. Additional measures will be through the substitution of forest products for fossil fuels or use of products requiring fossil fuels in their production. The contribution of forests to CCM is been recognised as a cornerstone of the post-2012 climate change agenda with the decision on the Reducing Emissions from Deforestation and forest Degradation, Conservation of Forests, Sustainable Management of Forests and Enhancement of Forest Carbon Stocks (REDD+) adopted by Conference of Parties (COP) 16 of United Nations Framework Convention on Climate Change (UNFCCC). REDD+ includes policy approaches and positive incentives on issues relating to reducing emissions from deforestation and forest degradation in developing countries, and recognises the contribution of conservation, sustainable management of forests and enhancement of forest Carbon stocks in achieving REDD+ objectives. This compendium introduces learners to the concepts of CCM, forest-based mitigation measures/strategies, clean development mechanism (CDM), REDD+ and other international initiatives, non-forest-based mitigation measures of climate change, monitoring and evaluation.

Chapter one of the compendium explores the concept of CCM. It provides a definition of the concept in the context of climate change and forestry and explores pathways for mitigation approaches and actions. The concepts of GHG sources and sinks as well as Carbon sequestration are also ascertained. Safeguard Information Systems (SIS) and key CCM policies and legislations are also explored, as well as the relationship between adaptation and mitigation.

Chapter 2 focuses on forest-based mitigation initiatives. The role of forests in CCM is discussed, as well as approaches for managing forests for CCM. The legislations, policies and initiatives on CCM are captured as well as the financial mechanisms for CCM. Some forest-based CCM initiatives are discussed, including forest protection and conservation, sustainable forest management (SFM), agroforestry and on-farm tree planting, afforestation and reforestation, urban forestry and management of forest reserves as well as Nationally Appropriate Mitigation Actions (NAMAs).

Chapter 3 deals with CDM, REDD+ and other forest-based approaches for mitigating climate change with focus on the definition, evolution, implementation, governance and financing of these international CCM mechanisms.

Chapter 4 explores non-forest CCM initiatives and other approaches. A range of sectoral mitigation measures and non-extractive use of forests (e.g. ecotourism, beekeeping) including climate smart Agriculture are discussed.

Chapter 5 discusses monitoring, reporting and evaluation of CCM initiatives and other approaches, with focus on concepts, purpose, types of evaluation, reporting processes and some specific monitoring and evaluation (M&E) frameworks performance indicators.

Compendium aim

The aim of this compendium is to enable learners acquire knowledge on the concepts and principles of forest-based and non forest-based CCM strategies and practices.

Learning outcomes

At the end of this compendium, the learners will be able to:

- Define forest and non-forest-based CCM;
- Describe concepts of CCM;
- Analyse CCM financing mechanisms;
- Explain forest based and non-forest-based CCM strategies;
- Relate CDM and REDD+ and other mechanisms to CCM; and
- Design appropriate M&E tools for CCM projects and practices.

Chapitre 1 : Le Concept D'atténuation Du Changement Climatique

1.1 Présentation du Chapitre

Climate change is defined as the long-term shift in climate patterns mainly caused by increased concentration of GHGs in the atmosphere, resulting in the trapping of heat by the earth's atmosphere, driving global warming. Climate change is identified as a variability in climate properties that persists for an extended period of time. It can be caused by natural internal processes or by external forces, such as volcanic eruptions or persistent anthropogenic actions (UNICEF, 2020). This chapter introduces the concept of CCM and explores national strategies and actions aimed at CCM and the inter-relationships between adaptation and mitigation. It covers an understanding of climate change options, mitigation approaches and actions, GHGs, Carbon sequestration, SIS, CCM policies and legislation. The chapter concludes by explaining the relationship between CCM and adaptation.

Learning outcomes

By the end of this chapter, the learners should be able to:

i. Define CCM;
ii. Explain the concept of CCM and the relationship between adaptation and mitigation; and
iii. Describe policy framework, strategies or actions in CCM.

1.2 Definition of mitigation in the context of climate change and forestry

CCM includes all efforts to reduce or prevent emission of GHGs into the atmosphere and to reduce the current concentration of CO2 in the atmosphere by enhancing Carbon sinks. The reduction of GHG emissions can be in the form of new technologies, improving efficiency of older equipment and machinery, retrofitting buildings to make them more energy efficient; adopting the use of renewable energy sources such as wind, solar, and hydro-power; helping cities to develop more sustainable transport systems such as electric vehicles, rapid bus transit, etc.; promoting more sustainable uses of land and forests or a change in management practices and consumer behaviour (GEF, 2022).

The enhancement of Carbon sink can be achieved for example by growing more trees, increasing the area of forests and limiting deforestation. UNEP and IUCN (2021) showed the importance of nature-based solutions to climate change. In nature-based solutions, ecosystems and their services form the basis for responding to the various challenges facing societies. This approach may also include ecosystem-based mitigation (EbM) (UNICEF, 2020).

The UNFCCC (2011) encouraged developing country Parties to contribute to mitigation actions in the forest sector by undertaking appropriate activities, in accordance with their respective capabilities and national circumstances including the following:

i. Reducing emissions from deforestation;
ii. Reducing emissions from forest degradation;
iii. Conservation of forest Carbon stocks;
iv. Sustainable management of forests; and
v. Enhancing forest Carbon stocks.

Activity 3.1 (Brainstorming) (10 minutes)

Explain some of the mitigation approaches applied in your country.

1.3 Green House Gases sources and sinks

The GHGs that are mainly defined by the Kyoto protocol (KP) include; CO2, Nitrous oxide (N2O), and Methane (CH4) together with fluorinated gases such as Hydrofluorocarbons (HFCs), Sulphur hexafluoride (SF6) and Perfluorocarbons (PFCs) (UNFCCC, 2008; 2009a). The main sources of GHG emissions are natural systems and human activities. In 2019, total Global anthropogenic GHG emissions were 52.4 Gt CO2e and annual anthropogenic GHG emissions increased by 59% since 1990 (PBL Netherlands Environmental Assessment Agency, 2020).

The most abundant GHG is CO2 (IPCC, 2014), with about 76% of the C02 is emitted into the atmosphere through the combustion of fossil fuels for energy, industrial processes, biomass burning, forestry and land use change (Figure 1).

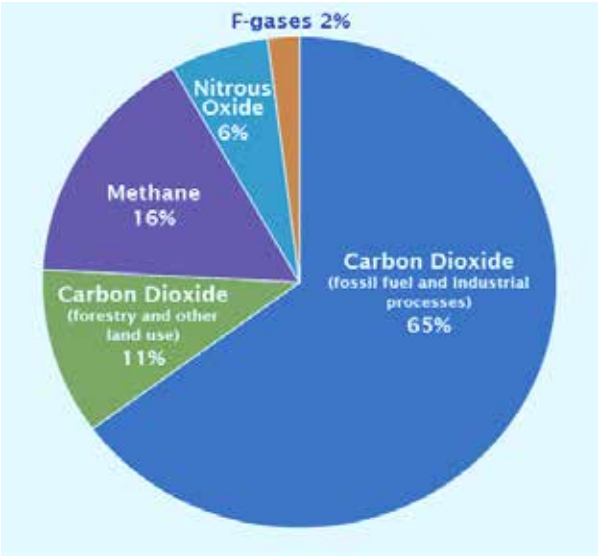


Figure 1: The global proportional scale of GHGs (Source: IPCC, 2014)

The World Meteorological Organisation showed that the global averaged concentrations of CO2 reached 405.5 parts per million (ppm) in 2017, up from 403.3 ppm in 2016 and 400.1 ppm in 2015 (WMO, 2018). By 2019, total GHG emissions amounted to 58.1 GtCO2e, of which 51.5 GtCO2 was from sectors outside land use change (i.e. fossil CO2 emissions from energy production and industrial activities). In the same year, emissions from land-use change were 6.6 GtCO2 (UNEP, 2021). Fossil CO2 emissions reached a record 37.9 GtCO2 in 2019, but dropped to 36.0 GtCO2 in 2020. CH4 is another significant GHG whose emission rate increased by 1.7% in 2018 compared to an annual increase of 1.3% over the past decade. N2O emissions are mainly influenced by agricultural and industrial activities, increased by 0.8% in 2018 relative to a 1% annual increase over the past decade. Fluorinated gases however, increased significantly by 6.1% during 2018 compared to a 4.6% annual increase over the previous decade (UNEP, 2019).

Prior to COVID-19, related emission declines in total global GHG emissions between 2011 and 2019, fossil-based and land-use-related CO2 emissions increased by approximately 1.4 GtCO2 per year with lower atmospheric accumulation of CO2 in 2021 driven by La Niña conditions that help enhance the land Carbon sink. The Pacific Ocean shifts from El Niño to La Niña every five or six years (Carbon Brief Ltd, 2021).

Box 1.1: Climate change impacts on plantations of Teak in Ivory Coast
Growth of Teak in managed and non-managed plantations showed slower growth in unmanaged stands than areas that were thinned regularly. Sea-surface temperature anomalies affected tree growth and Teak growth was assumed to be additionally linked to El Niño events (Dié et al., 2015).

The Intergovernmental Panel on Climate Change (IPCC) special report on global warming showed that anthropogenic activities caused a global warming increase of about 1.0°C above the pre-industrial level, with a range of 0.8 and 1.2°C. It is estimated that global warming will reach 1.5°C between 2030 and 2052 if the current emission rates continue (IPCC, 2018). Figure 2 shows GHG from all sources between 1970 and 2020 (UNEP, 2021).
UNEP (2020) stated that emissions could be reduced by 25% from pre-COVID-19 predictions, significantly increasing the possibility of limiting warming to below 2°C above preindustrial level; though 1.5°C would remain out of reach by 2030. Activities to achieve this include initiating global green recovery, reducing fossil fuel subsidies, using zero-emissions technologies and infrastructure, no new opening of coal power plants, and using nature-based-solutions.

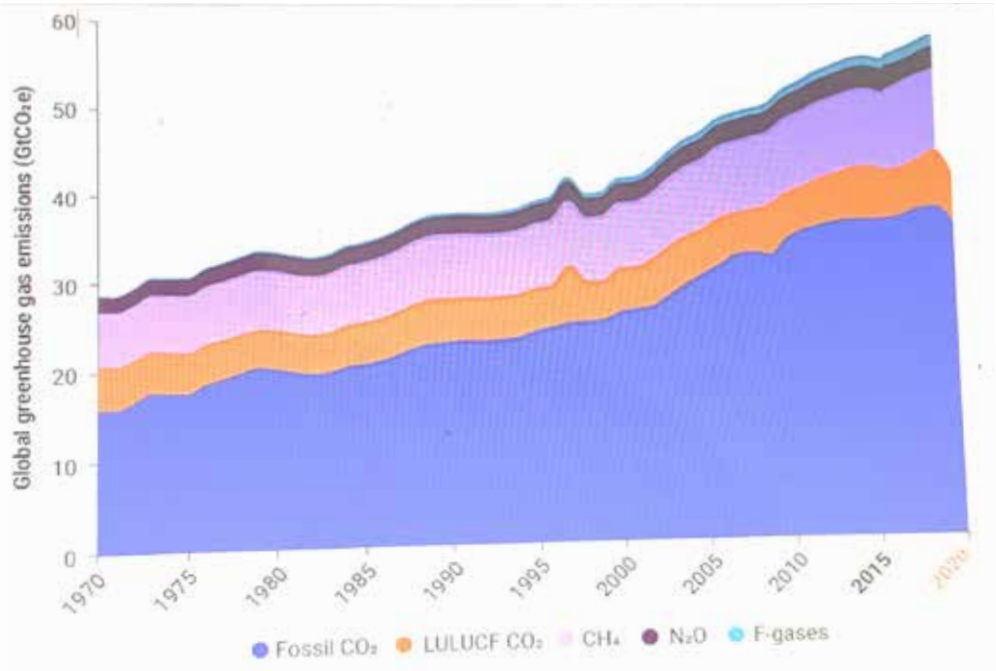


Figure 2: GHG emission from 1970-2020 (UNEP, 2021)

The main GHG sinks are oceans and terrestrial biosphere. GHG sink varies with the type of land use. Land use categories with great potential for absorbing CO2 gas include oceans, forest land, and agroforestry systems. GHG can then be captured through forest based mitigation actions. This makes forests and trees important in climate change actions as they are able to absorb some of the atmospheric CO2 through photosynthesis although they are also affected by climate impacts (e.g. Box 1.1).

Box 1.1: Climate change impacts on plantations of Teak in Ivory Coast

Growth of Teak in managed and non-managed plantations showed slower growth in unmanaged stands than areas that were thinned regularly. Sea-surface temperature anomalies affected tree growth and Teak growth was assumed to be additionally linked to El Niño events (Dié et al., 2015).

1.4 Concepts and definition of Carbon sequestration

Carbon sequestration is the capture and storage of Carbon from the atmosphere in Carbon sinks (such as oceans, forests and soils) through physical and biological processes such as photosynthesis. Carbon sequestration increases the long-term storage of Carbon in a reservoir other than the atmosphere, from the atmosphere as well as directly from the emission source. It is therefore necessary to distinguish the notion of "Carbon storage in the plant or soil" (which is the organic Carbon coming among others, from atmospheric CO2) from the notion of "Carbon sequestration" which is the complete balance expressed in C-CO2 equivalent, of all GHG fluxes, including the storage of C from atmospheric CO2, in addition to CH4 and NO2 fluxes (Bernoux et al., 2006). One of the most obvious methods for Carbon sequestration is the removal of CO2 from the atmosphere using biological means. Land use changes and forestry have the potential to remove large quantities of CO2 from the atmosphere through photosynthesis. This Carbon is stored as biomass, but the CO2 can be released when these species decompose or through burning. Strategies to increase the uptake of CO2 from the atmosphere through plants include reforestation/re-vegetation, improved agricultural practices e.g. agroforestry and some natural regeneration practices. Figure 3 illustrates the sources of Carbon sequestration and emissions.

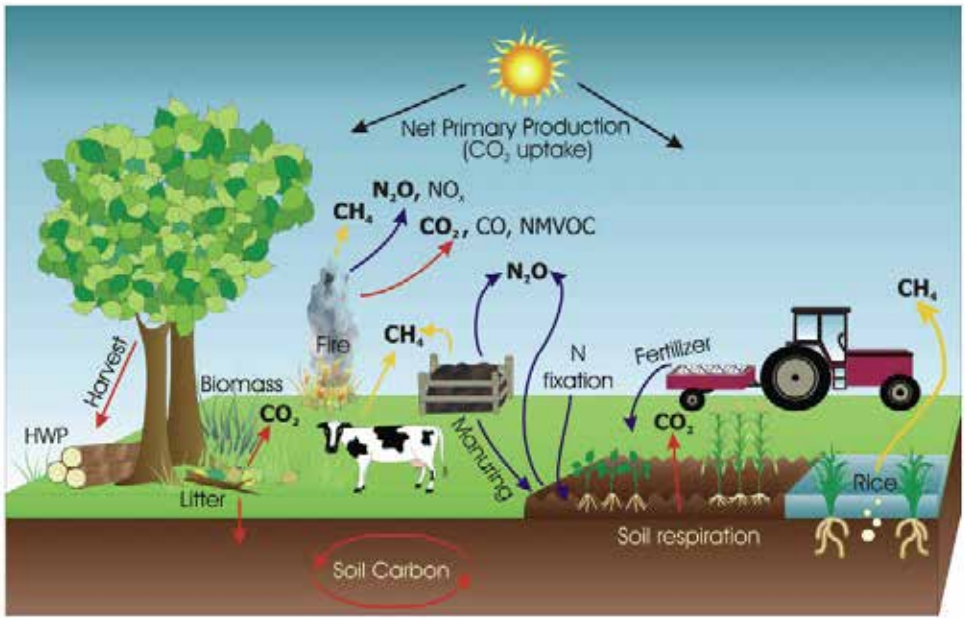


Figure 3: GHG emissions and Carbon sequestration in agro ecosystems (IPCC, 2006)

Oceans take up about 30% of Carbon emissions through phytoplankton (marine algae) that also remove CO2 from the atmosphere through photosynthesis. The rate of photosynthesis can be increased through ocean fertilisation to increase the uptake of CO2 from the atmosphere by increasing the phytoplankton populations. However, when the phytoplankton die, the photosynthesised CO2 is taken to the bottom of the ocean floor in their tissue. Although some CO2 would be released from the decomposition of these organisms, a significant portion would remain on the ocean floor and is turned into sedimentary rock (Agaliotis, 2020).

CO2can also be sequestered through non- biological means such as scrubbing towers and artificial trees. Scrubbing towers are used as air is funnelled in the inside by wind turbines and sprayed with either Sodium oxide or Calcium oxide to form Carbon precipitates and water, which can be piped to safe locations for storage. Artificial trees include a series of sticky, resin-covered filters capable of converting CO2 into a carbonate called soda ash. The soda ash could be washed off the filters and collected for storage elsewhere. The two methods are however expensive and may not b e feasible (Agaliotis, 2020). The capturing of Carbon can be achieved through four steps (Figure 4).

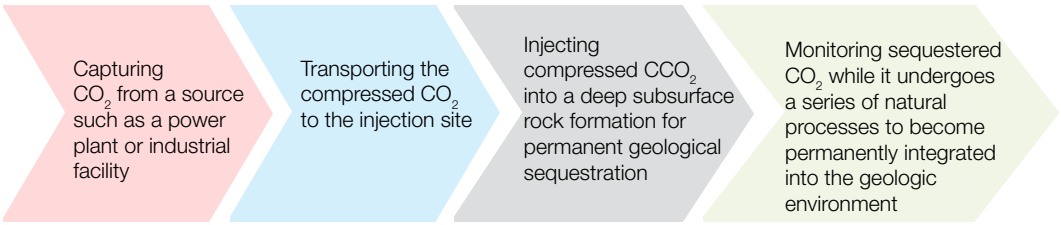
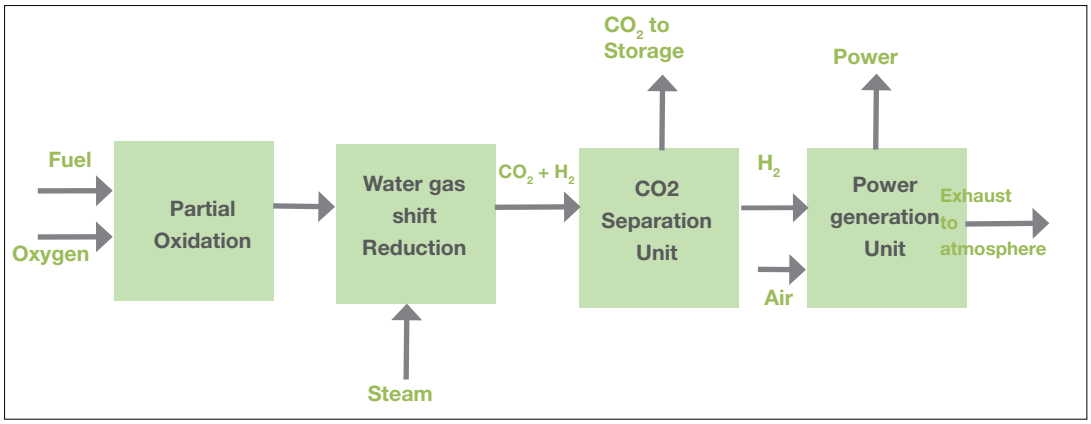
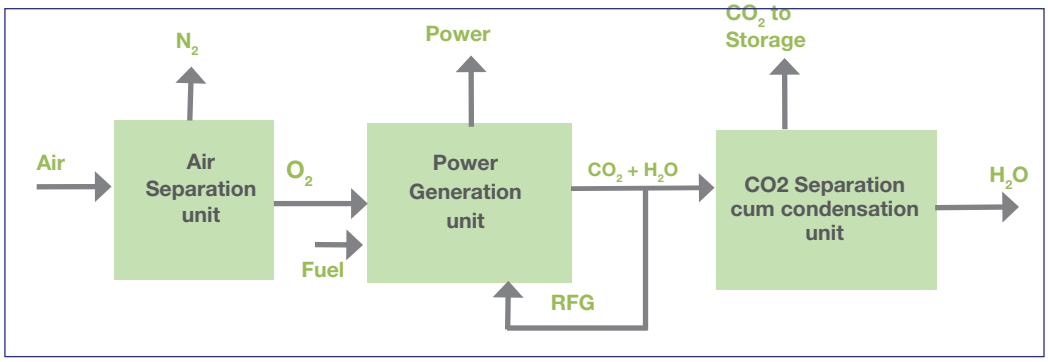


Figure 4: The carbon capture process (Source: Agaliotis, 2020)

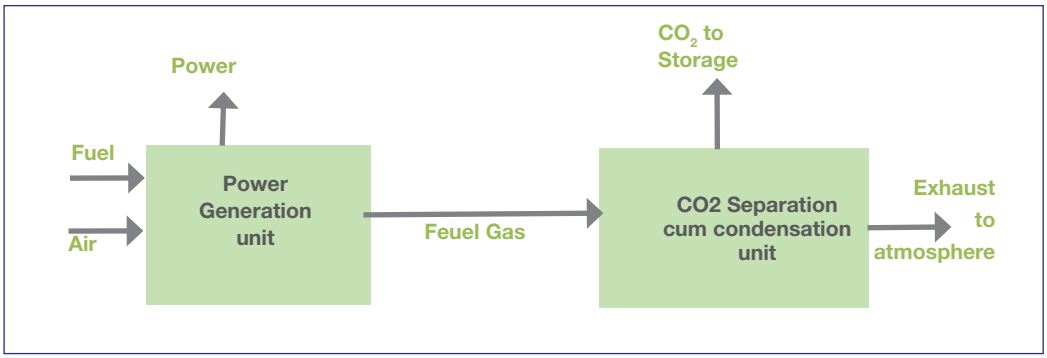
It is however, easier to collect the Carbon at source and store it safely somewhere through technologies involving either pre-combustion capture, oxyfuel combustion, or post combustion capture (Kheirinik et al., 2021). Figure 5 shows the differences in the three technologies (Agaliotis, 2020).



a



b



C

Figure 5: Carbon capture processes (a) pre-combustion capture, (b) oxyfuel combustion, and (c) post combustion capture (Source: Agaliotis, 2020

1.5 Mitigation approaches and actions for climate change

Mitigation approaches require a mixture of options implemented in a participatory and integrated manner to promote rapid reduction of GHG emissions. Such options are most effective when aligned with economic and sustainable development, with support from national governments (IPCC, 2018). The mitigation options and approaches are expanding rapidly across many geographical areas and vary by sector and environmental conditions. There are several approaches that can be taken by different sectors.

Figure 6 shows maximum climate mitigation potential under EbM with safeguards for reference year 2030 for three groups of ecosystems (Griscom et al., 2017). The forestry sector had the greatest potential to mitigate climate change. Furthermore, reforestation or the planting of trees on areas previously containing forests had the highest potential followed by avoided forest conversation. It is worth noting that all these actions have important co-benefits for air, biodiversity, water and soils. However, it is not clear why improved plantations do not benefit air, water and soils.

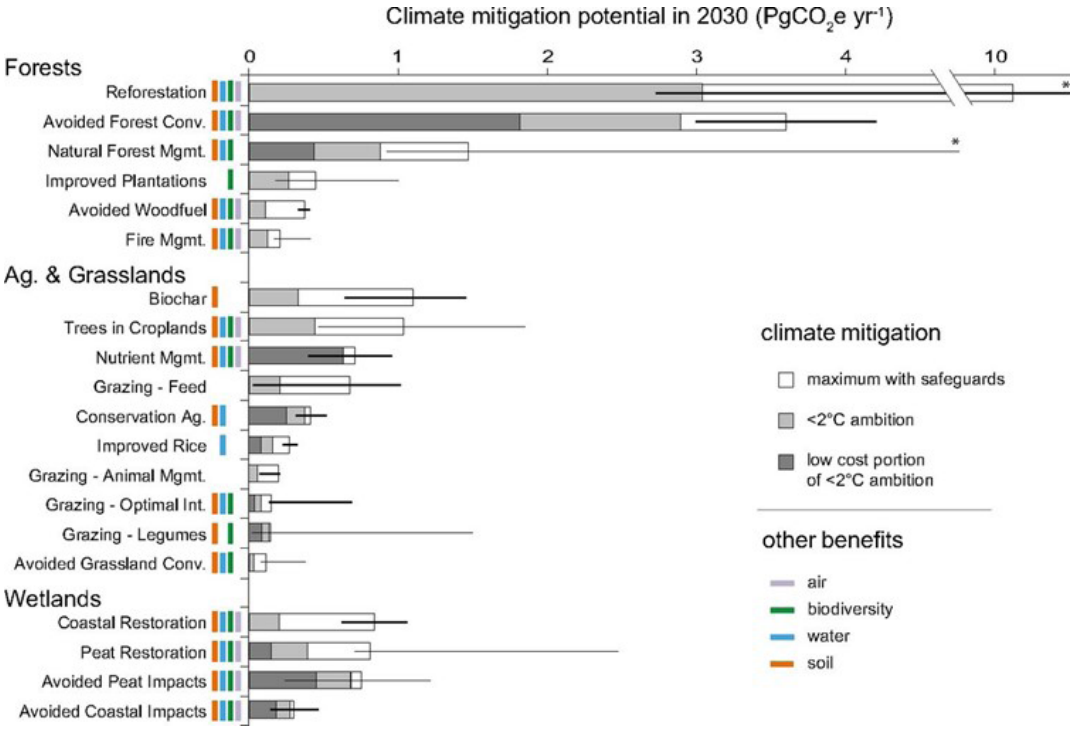


Figure 6: Climate change mitigation potential of 20 natural pathways

Conv = conversion; Mgmt = management' Ag = Agriculture;Int = Intensity (Source: Griscom. et al., 2017). Implementation of mitigation actions need enhanced institutional capabilities in all countries, including the building of capacities to utilise indigenous and local knowledge. Implementation of the responses would require technological, financial, and other forms of support to build capacity for poor and vulnerable people in developing countries. These require mobilisation of additional local, national and international

resources. Nevertheless, financial, public, institutional and innovation capabilities in all countries currently fall short of implementing the measures at scale. Transnational networks that support multilevel climate action are however, growing although there are challenges in their scaling-up (IPCC, 2018).

The literature on CCM reports three main approaches and actions although not specific to forestry (Fawzy et al., 2020):

i. **Conventional mitigation efforts** – These employ decarbonisation technologies and techniques that reduce CO2 emissions, and include renewable energy, nuclear power, switching fuels, improving efficiency and Carbon capture storage and utilisation (Ricke et al., 2017; Bataille et al., 2018).

ii. **Negative emissions technologies (CO2 removal methods)** – These are techniques that are potentially used to capture and sequester CO2 from the atmosphere (Ricke et al., 2017; Fawzy et al., 2020). The techniques include: use of biochar, soil Carbon sequestration, bioenergy Carbon capture and storage, enhanced weathering, direct air Carbon capture and storage, ocean fertilisation, ocean alkalinity enhancement, wetland construction and restoration, afforestation and reforestation as well as storage methods such as mineral carbonation, alternative negative emissions utilisation and use of biomass in construction. In this category are forest based activities (Lawrence et al., 2018; Lenzi, 2018; Royal Society, 2018; Palmer, 2019; Yan et al., 2019).

iii. **Radiative forcing geoengineering technologies** – These follow the principle of altering the earth's radiation balance through the management of solar and terrestrial radiation in order to stabilise or reduce temperatures. The techniques involved are mainly theoretical or at development stage, including: cirrus cloud thinning marine sky brightening, space-based mirrors, stratospheric aerosol injection, surface-based brightening and various radiation management techniques (Lawrence et al., 2018; Lockley et al., 2019).

1.6 Safeguard Information Systems, Free Prior Informed Consent

SIS are systems for providing information on how the safeguards are being addressed and respected by developing country parties implementing REDD+ activities. SIS is usually assumed to be a local institutional arrangement providing information on how country specific safeguards are addressed and respected in the context of implementation of proposed REDD+ actions (Rey et al., 2018).
There are no official guidelines on how countries should set up a system for their information for addressing and respecting safeguards but Parties to the UNFCCC agreed on some broad guidelines on the characteristics of providing transparent and consistent information that is accessible to all relevant stakeholders and updated regularly. These should be transparent and flexible to allow for improvements over time; provide information on how all the safeguards referred to in Decision 1/CP.16 are implemented. An appropriate SIS is demonstrated by a clear indication of adequate institutional arrangements for collecting, compiling, aggregating and analysing relevant information in addition to preparation and dissemination to satisfy the different reporting needs of the relevant national and international stakeholders.

The following are important in the design of SIS:

i. The SIS is able to collect and provide information on the implementation of the REDD+ safeguards management framework;
ii. Where appropriate, consider involving affected community representatives in monitoring or evaluation of activities;
iii. In cases where significant impacts have been identified, countries must retain external experts to verify its monitoring information;
iv. Information should be accessible to all relevant stakeholders and frequently updated; and
v. Information is provided with regards to an operational mechanism to receive complaints and address these complaints effectively.

According to the UNFCCC guidelines (UNFCCC Decision 12/CP.17 Paragraph 2), the SIS should:

i. Be consistent with guidance in decision 1/CP.16, Appendix I, paragraph 188 (Box 1.2);
ii. Provide transparent and consistent information that is accessible by all relevant stakeholders and updated on a regular basis;
iii. Be transparent and flexible to allow for improvements over time;
iv. Provide information on how all the safeguards are being addressed and respected;
v. Be country-driven and implemented at the national level; and
vi. Build upon existing systems, as appropriate.

Box 1.2: Decision 1/CP.16, Appendix I, paragraph 188.

REDD+ activities should:

i. Contribute to the achievement of the objective set out in Article 2 of the Convention;
ii. Contribute to the fulfilment of the commitments set out in Article 4, paragraph 3, of the Convention;
iii. Be country-driven and be considered options available to Parties;
iv. Be consistent with the objective of environmental integrity and take into account the multiple functions of forests and other ecosystems;
v. Be undertaken in accordance with national development priorities, objectives and circumstances and capabilities and should respect sovereignty;
vi. Be consistent with Parties' national sustainable development needs and goals;
vii. Be implemented in the context of sustainable development and reducing poverty, while responding to climate change;
viii. Be consistent with the adaptation needs of the country;
ix. Be supported by adequate and predictable financial and technology support, including support for capacity-building;
x. Be results-based; and
xi. Promote sustainable management of forests.

Depending on the type of funding mechanism, Countries are expected to prepare a Strategic Environmental and Social Assessment (SESA), and implement the Safeguards Plans prepared in accordance with the Environmental and Social Management Framework (ESMF) that has resulted from the SESA (World Bank, 1999). The ESMF gives principles, rules, guidelines and procedures to assess issues and impacts related to planned REDD+ activities that are uncertain. ESMF provides a framework for REDD+ countries to address environmental and social issues in their REDD+ Strategy as it is implemented. All REDD+ countries must produce an ESMF as a direct output of the SESA process. Activities that form part of the SESA include (World Bank, 1999):

i. Identification and prioritisation of the key social and environmental issues associated with the drivers, including issues such as land tenure, benefit-sharing and access to resources. It is also necessary to examine the possible social and environmental impacts of the REDD+ strategy options identified in the Readiness Preparation Proposal;
ii. Analyse the legal, policy and institutional aspects of REDD+ readiness;
iii. Assess existing capacities and gaps to address the environmental and social issues identified; and
iv. Establishing outreach, communication and consultative mechanisms with relevant stakeholders throughout the process.

Another safeguard principle is Free and Prior Informed Consent (FPIC) which refers to the rights of indigenous peoples to give or withhold consent to actions that will affect them, especially actions affecting their lands, territories and natural resources. FPIC is recognised in the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP), and is linked to individual and collective rights of indigenous peoples, such as to property and self-determination (Box 1.3). FPIC allows communities to assess the potential benefits and risks of REDD+ initiatives, influencing their strategy to reduce risks and promote benefits, and deciding whether or not to approve or participate in the initiatives. Considerations for FPIC are important to avoid negative impacts of activities on community rights and livelihoods, thus, generating missed opportunities for engagement to gain substantial indigenous knowledge and capacities and opportunities for local knowledge on SFM and forest stewardship (Finke, 2010). In this regard, FPIC can cause communities to guard against negative impacts and also shape REDD+ initiatives to support

traditional knowledge, management systems and livelihoods that will be vital for the success of the programmes (Springer and Retana, 2014).

Box 1.3: The Article 32 of the UNDRIP states that: .

i. Indigenous peoples have the right to determine and develop priorities and strategies for the development or use of their lands or territories and other resources;
ii. States shall consult and cooperate in good faith with the indigenous peoples concerned through their own representative institutions in order to obtain their free and informed consent prior to the approval of any project affecting their lands or territories and other resources, particularly in connection with the development, utilization or exploitation of mineral, water, or other resources; and
iii. States shall provide effective mechanisms for just and fair redress for any such activities, and appropriate measures shall be taken to mitigate adverse environmental, economic, social, cultural, or spiritual impact.

1.7 Climate change mitigation policies and legislation

Climate legislation includes rules and regulations focusing on mitigation- and exceeds sectoral actions while a climate strategy is a non-legislative plan or framework designed for mitigation actions that encompass more than a few sectors, and has a coordinating body responsible for its execution (Dubash et al., 2013). The risk associated with climate change impacts suggests a need for urgent action to significantly reduce GHG emissions. Reductions of GHG emissions can be achieved at relatively low costs when the right policies are in place, including the use of market-based instruments (initiatives that generate viable livelihood opportunities by supporting the most marginalised to engage in markets) to develop a global price for GHG emissions, accompanied by better integration of climate change objectives in relevant policy areas such as energy, transport, building, agriculture or forestry, and other measures to speed technological innovation and diffusion (OECD, 2007).

There are several possible policy approaches for maximising the potential of forests in CCM and adaptation, but the activities must be supported at the regional and national levels. For example, the success of REDD and SFM initiatives depends on how well their elements are integrated into national development strategies as part of holistic national land-use planning (CPF, 2008). In this regard, laws and policies are key enablers for achieving net-zero targets expressed in instruments such as climate change framework laws and strategies, as well as laws and policies in relevant sectors such as forestry, agriculture and land use and management. Forest policies and strategies should also target preserving the capacity of trees and forests to store Carbon for as long as possible.

Climate legislation and strategies follow a wide diversity of approaches to operationalisation and implementation where the institutions and processes of governance affect policy-making process and its implementation in multiple ways related to movement towards a low Carbon economy (Somanathan et al., 2014). Some of the policies include: imposition of Carbon prices e.g. European Union's Emissions Trading Scheme (ETS) or setting of Carbon taxes; establishing new dedicated climate change bodies that coordinate existing government agencies through multiple ways; or setting up national-level targets backed by explicit creation of institutions to manage performance to that target.

At national level, NAMAs are proposed as mitigation actions that are 'nationally appropriate' because they contribute to national development outcomes. In this regard, NAMAs provide a possible mechanism for connecting national policies and projects to the global climate regime. Low emissions development strategies (LEDS) are other mechanisms that can be formulated to integrate climate and development strategies (Clapp et al., 2010). Somanathan et al. (2014) showed that policy instruments and packages can be grouped into: economic instruments, regulatory, information policies, voluntary actions, and provision of public goods and services and procurement by government.

Economic instruments - Sometimes called market-based approaches due to the prices that are applied in environmental and climate policies. Economic instruments for CCM include taxes, subsidies and subsidy removal, and ETS.

Regulatory approaches - Regulations and standards are very important in environmental and climate policies all around the world. They are conventional regulatory approaches that establish a rule and/or objective that must be fulfilled by the polluters who would face a penalty in case of non-compliance with the norm. For climate policies, categories of standards that apply include:

i. Emission standards – also called performance standards -these represent the maximum allowable discharges of pollutants into the environment;

ii. Technology standards - specific pollution abatement technologies or production methods (IPCC, 2007); and

iii. Product standards - define the specifications for products that have potential to pollute the environment (Gabel, 2000).

Information policies – Good quality information is essential to raise public awareness and concern about climate change, identify environmental challenges, to improve design and monitoring of impacts of environmental policies, and providing relevant information to inform consumption and production decisions. Eco-labelling or certification schemes for products or technologies, together with the collection and disclosure of data on GHG emissions by important polluters are good examples (Krarup and Russell, 2005).

Government provision of public goods and services and procurement - Actions and programmes facilitated by governments to counteract or prevent climate change can be seen as public goods. Government can remove institutional and legal barriers for reducing GHG emissions as part of policy, including afforestation and conservation support.

Voluntary actions – These are actions taken by firms, Non-Governmental Organisations (NGOs), and other actors beyond their regulatory requirements. Voluntary agreements represent an evolution from traditional mandatory approaches based on conventional or economic regulations and intend to provide further flexibility to polluters. Voluntary agreements/long-term agreements, are voluntary commitments done after negotiations process between the regulator and the pollutant (Somanathan et al., 2014).

The first time the topic of climate change was discussed internationally was at the UN Scientific Conference, in Stockholm, Sweden from 5 to 16 June, 1972. By the Rio de Janeiro, Brazil, Earth Summit in 1992, several initiatives to increase public understanding of the impacts of climate change gained pace. UNFCCC was signed and came into effect in 1995, with the first Conference of the Parties to the Convention adopted the Berlin Mandate, starting discussions on a protocol or other legal instrument containing stronger commitments for developed countries and those in developing nations.

KP to the UNFCCC became the most significant climate change action adopted in Japan in December 1997, serving as the cornerstone of the global climate change response. The protocol consists of a number of specific reduction pledges made by developed nations, as well as programmes to encourage increased removals through sinks and the transfer of cleaner technologies from developed nations to both developed (Joint Implementation-JI) and developing nations (CDM). Investments that result in properly verified emission reductions in industrialised (through JI) or developing (via CDM) nations have the same effect as if the investor had reduced emissions in his own nation. The primary goal is to reduce emissions globally.

After series of disagreements, delegates finally signed an agreement at the COP21 conference in 2015 in Paris, France, to limit the rise in the global average temperature to no more than 2°C (3.6°F) above preindustrial levels; while also attempting to keep this increase to 1.5°C (2.7 °F) above preindustrial levels. This historic agreement, which was ratified by all 196 UNFCCC parties, effectively replaced KP. Additionally, it required a review of progress every five years and the creation of a $100 billion fund by 2020 that would be renewed annually to aid developing nations in implementing non-GHG gas emission technologies.

The Paris Agreement is a legally binding climate change international treaty that entered into force on 4 November 2016. It became a landmark in the multilateral climate change process that became the first binding agreement to bring all nations to a common cause of undertaking ambitious resolutions of CCM and adaptation. The goal of the Paris Agreement is

Nationally Determined Contributions (NDCs) are national climate plans that highlight climate actions, including climate related targets, policies and measures which governments aim to implement in response to climate change, contributing to global climate action (unfccc.int).

to limit global warming to a level well below 2 degrees, preferably to 1.5 degrees Celsius, compared to pre-industrial levels. To achieve this long-term temperature goal, countries aim to reach global peaking of GHG emissions as soon as possible to achieve a climate neutral world by mid-century (UNFCCC, 2022a).

The adoption of the Paris Agreement in 2015 (UNFCCC, 2015a), resulted in national commitment to prevent dangerous impacts of climate change through NDCs, showing the full national implementation plans for GHG emissions reduction targets. The commitments are estimated to cover only half of the emissions reductions by 2030 to stay on a global least-cost pathway consistent with keeping warming levels well below 2°C. This is required under a no-policy baseline (Rogelj et al., 2016). Policies and legislation will be discussed in more detail in section 2.4. All African countries submitted their first NDCs, and 38 countries out of 54 have submitted updated NDCs, as of 26 October 2021, signalling their commitment to combat climate change (Figure 7).

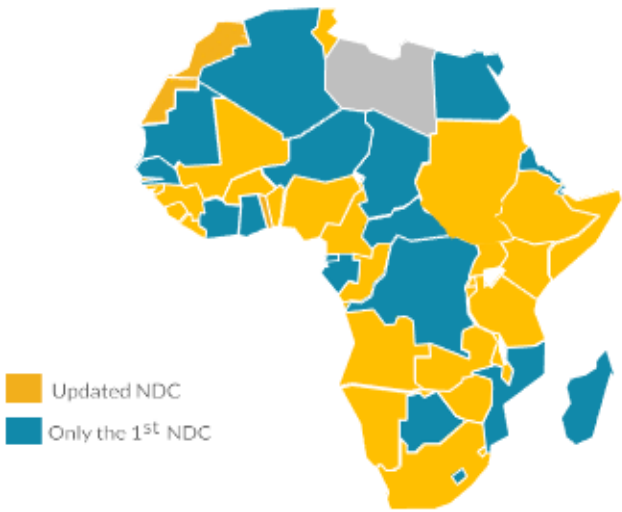


Figure 7: Overview of NDC submissions in Africa

(Source: UNFCCC. 2021a. NDC National Registry, 2021, CDKN, LDC Briefing)

Further reading:

Somanathan, E., Sterner, T., Sugiyama, T., Chimanikire, D., Dubash, N.K., Essandoh-Yeddu, J., Fifita, S., Goulder, L., Jaffe, A., Labandeira, X., Managi, S., Mitchell, C., Montero, J.P., Teng, F. and Zylicz, T. 2014: National and sub-national policies and institutions. Core Writing Team: R.K. Pachauri, P.K and Meyer L.A. (Eds.). Climate change 2014: Mitigation of climate change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

1.8 Relationship between adaptation and mitigation

The UNFCCC identifies two measures for climate change action and these include mitigation and adaptation. The two are interdependent as adaptation actions have consequences for mitigation and vice versa. The more likely the mitigation strategy is to succeed, the less need to resort to adaptation strategies (Kropp and Scholze, 2010). We have already learnt that CCM is an anthropogenic intervention for reducing sources or enhancing sinks of GHGs whilst adaptation includes adjustments in natural or human systems in response to actual or expected climatic stimuli or their effects, thus moderating harm or exploiting beneficial opportunities (IPCC, 2001). Figure 8 shows how the approach to managing the risks of climate change should involve both strategies (Kropp and Scholze, 2010).

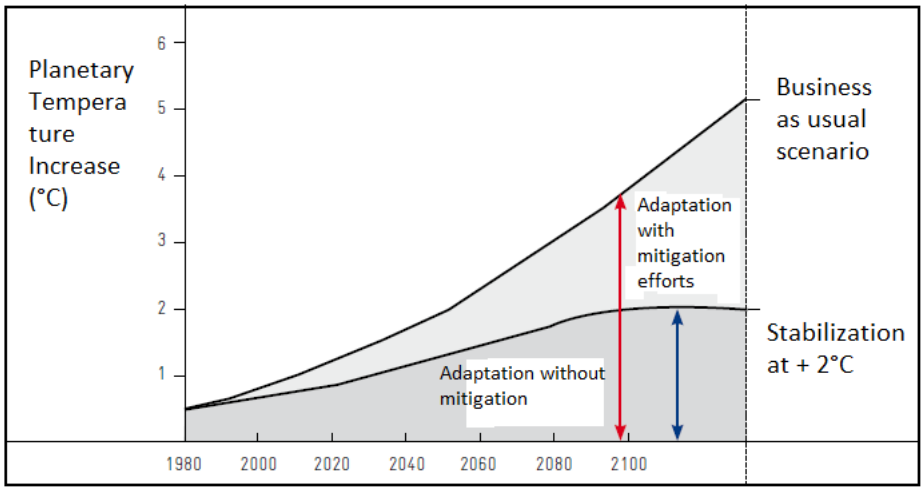


Figure 8: Adaptation and mitigation: two parallel strategies to react to climate change (Source: Kropp and Scholze, 2010)

The absence of a relevant knowledge base and the lack of human, institutional and organisational capacity can limit the ability to create synergies between mitigation and adaptation. The opportunities for synergies are greater in sectors such as agriculture and forestry, but are limited in others such as energy, coastal systems and health (Klein et al., 2007). Mitigation efforts can promote adaptive capacity if they reduce market distortions and failures, as well as perverse subsidies that inhibit players from making decisions on the basis of the true social costs of available options (Klein et al., 2007). For example, if afforestation is part of a regional adaptation strategy, it can also make a positive contribution to mitigation. Most of the mitigation actions such as afforestation/re-afforestation can have adaptation benefits such as control of floods; rain formation, and social-economic security. In this regard, forests become important in reducing impacts of climate change by regulating water flows and ecosystems, protecting biodiversity, playing an integral part in the Carbon cycle, supporting livelihoods, supplying goods and services that can drive sustainable growth, absorbing GHGs and protecting coastal communities from extreme events and sea level rise (World Bank, 2016; IUCN, 2021). Forests also create migration corridors to make the habitats of animal and plant species more resilient.

The following are differences between mitigation and adaptation actions:

i. Mitigation has global benefits while adaptation mostly works on the scale of an impacted system, which is regional at best, but mostly local. In this regard, adaptation focuses on reducing the vulnerability of sectors, communities and environments to the impacts of climate change (Klein et al., 2007);

ii. Verheyen (2005) stated that adaptation deals with direct prevention of damage, whereas mitigation is indirect damage prevention;

iii. Mitigation can be measured and compared as CO2 equivalence whereas, benefits of adaptation are more difficult to express in a single metric, impeding comparisons between adaptation efforts (Klein et al., 2007). However, adaptation benefits are valued differently depending on the social, economic, environmental and political contexts within which they occur;

iv. The benefits of mitigation become evident after several decades because of the long residence time of GHGs in the atmosphere, whereas many adaptation measures would be effective yielding immediate benefits of reducing vulnerability to climate variability; and

v. Mitigation is motivated by international agreements and ensuing national public policies, whereas most of the adaptation actions have historically been motivated by the self-interest of affected private actors and communities, usually facilitated by public policies.

In text Question(s) (10 minutes)

i. List at least three sources of GHGs.

ii. Define Carbon sequestration and explain how it can be achieved

iii. Explain any two approaches for climate change mitigation actions

iv. Explain the role of safeguards in climate change actions.Establish the link between climate change mitigation and adaptation.

Summary

In this chapter, we have learnt that that GHGs mainly defined by KP include; CO2, N2O, CH4, and fluorinated gases such as HFCs, SF6 and PFCs. CO2 is the most abundant gas that can be reduced through forestry activities. We also learnt that SIS are systems for providing information on how the safeguards are being addressed and respected by developing country parties implementing REDD+ activities. We saw that Paris Agreement is a good response to climate change impact by targeting a global warming to a level below 2 degrees. We also learnt that CCM includes all efforts to reduce or prevent emission of GHGs into the atmosphere and can be in the form of new technologies and renewable energies, improving efficiency of older equipment and machinery. Developing country parties can contribute to mitigation by REDD+. Mitigation approaches can take the form of conventional mitigation efforts e.g. climate smart agriculture; creation of institutions (laws, policies etc.), organisations (e.g. climate change departments), negative emission technologies or radiative forcing geo-engineering technologies. We concluded the chapter by discussing the relationship between CCM and climate change adaptation.

Chapter 2: Forest-Based Mitigation Initiatives

2.1 Chapter overview

Forests contribute to CCM through Carbon sequestration. CCM initiatives have important co-benefits that encompass economic, environmental, and socio- cultural benefits. In the tropical forest region where there is high rate of deforestation and forest degradation (FAO, 2020), the promotion of forestry and agroforestry programmes will increase mitigation of GHG emissions. This chapter introduces learners to various forest-based strategies for CCM and how they can be implemented under different scenarios/ conditions. It will explore some of the forest-based CCM initiatives, NAMAs, and forest-based challenges associated with CCM.

Learning outcomes

By the end of this session, the learner should be able to:

i. Identify and describe forest -based CCM strategies;
ii. Explain the role of forests in CCM;
iii. Assess forest-based mitigation initiatives and how they can contribute to CCM;
iv. Explain the co-benefits and non-Carbon benefits of using forests to mitigate climate change; and
v. Analyse the challenges associated with CCM through forestry.

2.2 Role of forests in climate change mitigation

Forests provide US$ 75–100 billion per year in goods and services such as clean water and healthy soils and they are home to about 80% of the world's terrestrial biodiversity but have often been destroyed through agricultural activities, forestry and other land uses, contributing about 25% of global emissions making them the second largest source of GHG emissions after the energy sector. About half of these emissions (5-10 GtCO2e annually) come from deforestation and forest degradation (IUCN, 2021).

Activity 2.1 (Brainstorming) (20 minutes)

- Discuss how we can maximise the potential of forest resources for climate change mitigation.

The Warsaw Framework for REDD+ was adopted at COP 19 in 2013 where REDD+ framework was created by the UNFCCC Conference of the Parties (COP) to guide activities that reduces emissions from deforestation and forest degradation, in the forest sector as well as the sustainable management of forests and the conservation and enhancement of forest Carbon stocks in developing countries. The role of forests in combating climate change action was further formally recognised at the 2015 UN climate change conference in Paris.

Forests absorb CO2 through photosynthesis, and they play three essential roles in climate mitigation (ADEME, 2021):

i. A reservoir due to Carbon storage in forest vegetation and soils, as well as in wood products;
ii. A sink because the increase in Carbon stocks in the forest reservoir makes it possible to remove CO_2 from the atmosphere; and
iii. Reduction of fossil emissions through the use of wood as a substitute for other materials (steel, cement, etc.) or energy (coal, oil, gas, etc.), which are more consumers or emitters of fossil Carbon.

Through its ability to maintain and increase Carbon stocks outside the atmosphere, in forests and wood products, and to reducing fossil GHG emissions, the forest-wood sector becomes strategic for achieving the goal of Carbon neutrality by 2050. These mechanisms are sometimes grouped under the name "4S": Carbon sequestration in the forest (reservoir and sink in situ), Carbon storage in wood products (reservoir and ex situ sink), and the two types of substitution, material and energy. These mechanisms need to be evaluated jointly because they are interconnected: i.e. actions that reduce fossil emissions through substitution, or that promote storage in wood products, can have an effect on the Carbon sink or reservoir function of forests. Forests slow climate change and increase resilience (Figure 9).

Forest land however, stores approximately 60% of the total terrestrial Carbon stock in different Carbon pools, (Federici et al., 2017) which include aboveground biomass (e.g., leaves, trunks, limbs), belowground biomass (e.g. roots), deadwood, litter (e.g. fallen leaves, stems), and soil Carbon pools. Given the potential of forests to store carbon both above and below ground, their destruction causes direct emissions from deforestation thus, reducing their capacity to reduce GHG emissions (van Goor and Snoep, 2019). In this regard, forests are one of the most important solutions for addressing the effects of climate change because they can absorb one-third of the CO2 released from the burning of fossil fuels (about 2.6 billion tonnes of CO2) every year (IUCN, 2021). Although Carbon sequestration and biodiversity preservation are generally considered as public services/goods that have an impact scales varying from regional to global, the provisioning services such as food and other forest products generally have impacts at local scale by affecting local livelihoods.

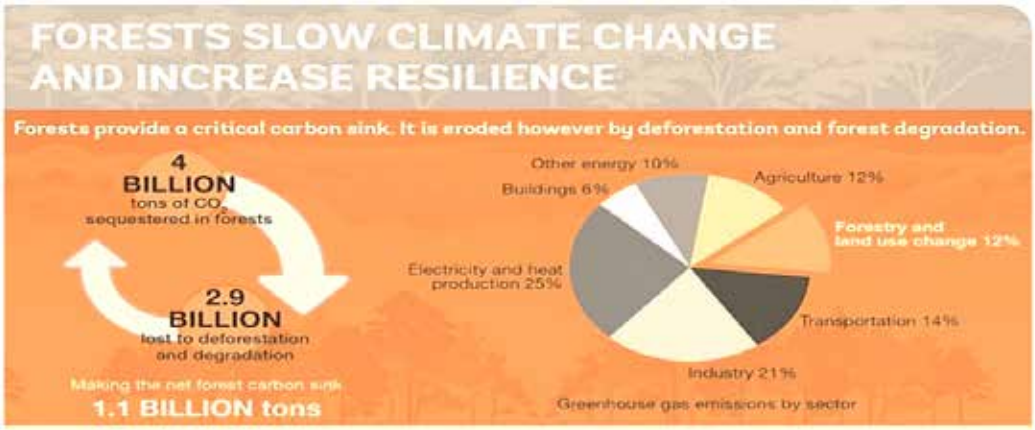


Figure 9: Carbon sink potential of forests and other sectorial emissions (Source: World Bank, 2016)

There is need to manage forests for CCM. There are several ways to maximise the potential of forests for mitigating climate change and these include; combatting deforestation and forest degradation, restoration of deforested landscapes, creating enabling environment with clearly defined rights for land resources (IUCN, 2021) by clarifying tenure and local forest rights and creating protected areas (Angelsen and Rudel, 2013).

Trees have different stages in their cycles where they capture Carbon at different rates. In the early years of life, growth rates are high and, therefore, the accumulation rates of biomass and Carbon are also very high (Nabuurs et al., 2015). As the trees continue to grow, they accumulate Carbon at rates higher than respiration emissions up to a certain age until they reach a stage of a balance between capture and emission before they finally collapse, a stage where emission rates are higher than capture rates (Maxwell and Lecture, 2016). The UNFCCC and KP, however state that trees and forests are temporal Carbon sinks, as part of the stored Carbon is released into the atmosphere after harvesting of the trees from forests or when the trees are burnt, or they die (Kellogg, 2019).

In this context, forests can be managed to mitigate change following three distinct paths of Carbon conservation, storage, or Carbon substitution (Brown et al., 1995; Brown, 1997) (Figure 10) (Nunes et al., 2019).

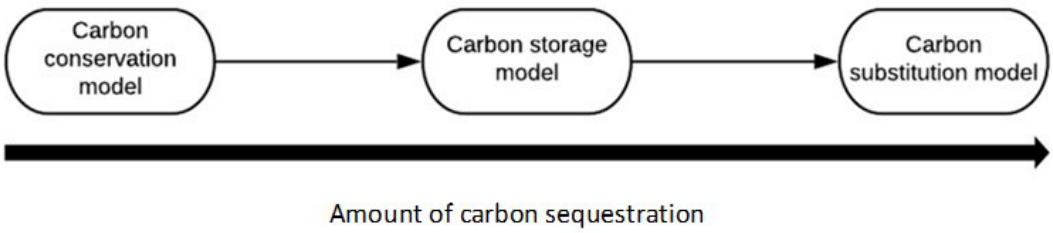


Figure 10: Paths for managing forests for climate change (Source: Nunes et al., 2019)

Carbon conservation entails forest management where the Carbon is conserved in the forest. In this model, there is neither a contribution to the reduction of atmospheric Carbon nor increase its amount but can be considered a neutral model of Carbon amount e.g. increase in rotation period of managed forests, reducing damage in the remaining trees, reduction of waste through application of soil conservation techniques, and use of wood in a more Carbon efficient manner. Carbon storage entails increasing the amount of Carbon in forest vegetation and soil by increasing content of biomass in all types of forests and increasing Carbon storage in durable wood products. Forest management for following Carbon substitution model is about Carbon transfer from forest biomass to products such as building materials and/or biofuels, instead of using energy and fossil fuel-based products and cement-based products (Brown et al., 1995; Brown et al., 1996; Hartley, 2002).

> A displacement factor is the reduction in emissions achieved per unit of wood used, representing the efficiency of biomass in decreasing GHG emissions

The value of keeping a forest as a Carbon sink for CCM or to harvest it depends on factors such as the age and assessment of standing timber, the growth rate, the time frame under consideration, the dynamics of the Carbon fluxes (including the threat of natural disturbances such as fire), and the perspective of Carbon displacement factors used when non-wood products are replaced by wood products (Pingoud et al., 2010). Furthermore, there is need to reduce forests vulnerability to disturbances (Jactel et al., 2017) and conserve biodiversity (Lagergren and Jönsson, 2017). However, increased Carbon sequestration through substitution should be guarded to reduce threats associated with biodiversity loss.

CCM initiatives can be done by using new technologies and renewable energies, improving energy efficiency of older equipment, or changing management practices or consumer behaviour (e.g. reduction of wood or other forest products uses). Figure 11 gives an outline of forest based mitigation activities (CPF, 2008).

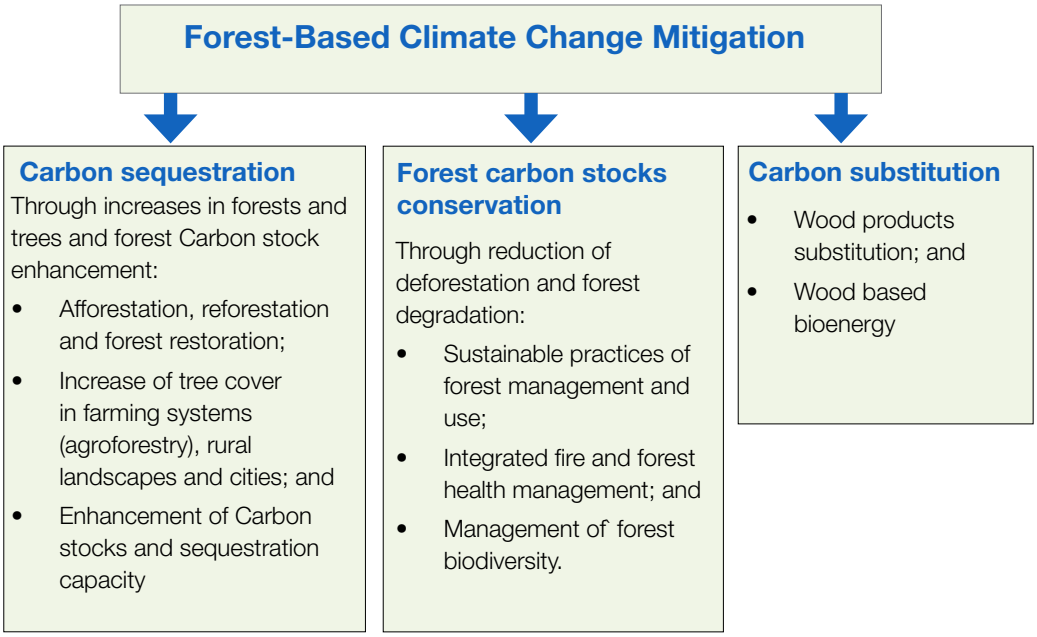


Figure 11: Components of forest based mitigation (Source: CPF, 2008)

Activity 2.2 (Brainstorming) (20 minutes)

i. What are the three main roles of forests in mitigating climate change?
ii. How we can maximise the potential of forest resources for climate change mitigation.

There is however, need for political will and the involvement of stakeholders in forested regions, to promote forest Carbon sequestration while enhancing economic, environmental, and sociocultural benefits. A crucial component is however, to reduce Carbon emissions from deforestation and forest degradation. Other options include identification of opportunities for reducing climate related impacts in forest operations.

2.3 Financing for climate change mitigation

Climate finance refers to local, national or transnational financing, drawn from public, private and alternative sources of financing. Climate finance can play a crucial role in supporting developing countries to transition to environmentally sustainable energy production and consumption systems, while addressing the development priorities of energy security and energy poverty (Watson and Schalatek, 2019).

Financing for climate action is supported by agreements adopted by the UNFCCC in 1992, including the principle of "common but differentiated responsibilities and respective capabilities." This principle recognises that developed nations, which have likely contributed more to the accumulation of GHGs because they industrialised earlier, should play a larger role in solving the climate crisis and helping the countries that contributed less to its creation. The polluter pays principle, also highlighted within the UNFCCC arena and Africa is supposed to receive support for CCM (AMCEN, 2011; Baimwera et al., 2017). Initiatives falling within this principle of polluter pays were conveyed through CDM and REDD+ processes. Nevertheless, countries still need to have their NAMAs contain national effort to mitigate climate change. Most global climate finance (91%) is for mitigation activities through both public and private finance going into renewable energy, energy efficiency, or sustainable transport. Financing is either through UNFCCC mechanisms or non UNFCCC mechanisms (Multilateral, Bilateral, Private, or Domestic).

At the international level, CDM supports afforestation and reforestation projects whilst the REDD+ initiative is based on financial incentives to preserve forests and thus maintain or increase Carbon stocks (see section 3.3. for details). The REDD+ approach has been proposed for financing forest conservation, the enhancement of forest Carbon stocks and SFM. This win for forests builds on the important Warsaw Framework for REDD+ that came out of the 2013 UN meetings. REDD+ and other international arrangements such as CDM and Internationally Transferred Mitigation Outcomes (ITMO) are discussed in detail in chapter 3.

The UNFCCC financing mechanisms include the Global Environment Facility (GEF) - operating entity since the Convention's entry into force in 1994. Another mechanism is the Green Climate Fund (GCF) which was established at COP 16, in 2010. In 2011 the GEF was designated as an operating entity of the financial mechanism to support low emission and climate resilient development. The financial mechanisms are accountable to COP, which decides on its policies, programme priorities and eligibility criteria for funding.

Parties to UNFCCC have established special funds in addition to providing guidance for GEF and GCF:

i. **Special Climate Change Fund (SCCF)** - to finance projects relating to adaptation; forestry, energy, technology transfer and capacity building, industry, transport, agriculture, and waste management; and economic diversification;

ii. **Least Developed Countries Fund (LDCF)** – supports preparation and implementation of countries NAPAs. SCCF and LDCF are managed by the GEF; and

iii. **Adaptation Fund (AF)** established under KP in 2001- supports concrete adaptation projects and programmes in developing countries. At the Paris Climate Change Conference in 2015, Parties agreed that the mechanisms also support KP.

The Climate Investment Fund (CIF) supports four types of programmes:

i. Clean Technology Fund;

ii. Pilot Programme for Climate Resilience - integrating climate resilience into development plans and financing private public partnerships;

iii. Scaling up Renewable Energy in Low Income Country Programme – renewable energy solutions; and

iv. Forest Investment Programme (FIP) – supports developing countries reduce emissions from deforestation and enhancing forest carbon stocks (REDD+).

In addition, the Global Energy Efficiency and Renewable Energy Fund, created by the EU, and the Renewable Energy Accelerated Development Programme, administered by the World Bank, provide smaller scale mitigation finance.

2.4 Forest-based climate change mitigation initiatives

Forest based CCM initiatives occur in several forms all aiming at reducing emissions and increasing Carbon sinks. These include forest protection, forest conservation, SFM, agroforestry and on farm tree planting, afforestation and reforestation, urban forestry and the management of protected forests. These will be discussed in the following sections. There is however, need for political will and the involvement of stakeholders in forested regions, to promote forest Carbon sequestration while enhancing economic, environmental, and sociocultural benefits. The effective and efficient implementation of these initiatives also requires an enabling environment with clearly defined rights to land resources (IUCN, 2021) by clarifying tenure and local forest rights (Angelsen and Rudel, 2013).

2.4.1 Forest protection and conservation

Protection of forests can enhance the lives of people while mitigating climate change as forests, soils and grasslands carry out their natural functions of removing CO2 from the atmosphere. When these natural ecosystems are damaged, they become more vulnerable to drought, fires and climate change (Müller et al., 2016). The threats to forests also affects the environmental services such as watershed conservation, including hydrological services, soil conservation, biodiversity conservation, and aesthetics that these ecosystems provide. These services are crucial for mitigating climate change and promoting societal adaptation. Dooley and Mackey (2019) stated that global Carbon emissions can be reduced annually by about 1 gigatonnes (Gt), when we reduce loss and degradation of primary forests and intact forest landscapes, and allow degraded forests to regrow naturally to reduce another 2-4 Gt of Carbon emissions through the natural regrowth. Restoration activities can follow paradigms of revegetation, ecological restoration, functional restoration, and/or forest landscape restoration (Stanturf et al., 2014). There is need to ensure bushfire reduction and prescribed fire to minimise damage to the ecosystems.

In agro-ecosystems, protected habitats can control pests, sustain populations of natural pollinators, and facilitate seed dispersal, while the natural and restored forested landscapes can promote water retention and counter flooding while regulating climate and rainfall at local, regional and continental scales (Christie and White, 2007).

2.4.2 Sustainable forest management

SFM entails the human interventions promoting sustainable use and protection of forest resources to maintain and enhance their multiple uses. SFM is dynamic and evolves aiming at the maintenance and enhancement of the four pillars of sustainability (social, economic, cultural and environmental values) in all forest types, for the benefit of all generations (FAO/ITTO/INAB, 2003). In this regard, SFM can contribute to climate mitigation and reverse the impacts of climate change on land degradation (IPCC, 2019).

> *Sustainable forest management provides a flexible, robust, credible and well-tested framework for simultaneously reducing Carbon emissions, sequestering Carbon, and enhancing adaptation to climate change.*

This is because it encompasses initiatives that aim at sustainable utilisation of forest resources through local control and management of existing forest resources, the multiple roles of trees in farming systems and the importance of working through local institutions (FAO, 2016). In this regard, SFM can help provide environmentally friendly forest products, protect biodiversity, secure freshwater supplies, and

provide other essential ecosystem services. SFM encompasses seven thematic elements: i. extent of forest resources; ii. biological diversity; iii. forest health and vitality; iv. productive functions of forests; v. protective functions of forests; vi. socioeconomic functions; and vii. the legal, policy and institutional framework (FAO/ITTO/INAB, 2003). The implementation of SFM can maintain land productivity, prevent and reduce land degradation and can reverse the adverse impacts of climate change on land degradation and contribute to mitigation and adaptation (IPCC, 2019). Box 2.1 shows examples of forest ecosystem management in West Africa.

Box 2.1: Sustainable Forest Ecosystem Management Programme to reduce climate change effects in Guinea

With the technical and financial support of the Climate Technology Centre and Network , the Republic of Guinea, through the National Directorate of the Environment, is implementing a sustainable management of forest ecosystems programme for adaptation to climate change. The general objective of this programme is to contribute to strengthening the adaptation capacities of populations to the effects of climate change through the sustainable management of forest ecosystems. Specifically, it aims to i. improve forest governance through the involvement of all stakeholders and harmonization of legislative and regulatory texts; ii. restore and rehabilitate degraded forest landscapes with a view to increasing the rate of Carbon sequestration and providing ecosystem services to the riparian communities on which they rely heavily to reduce their vulnerability to climate change; iii. sustainable management of protected areas through the involvement of communities and stakeholders for better conservation of natural resources; iv. improve the living conditions and resilience of populations through the development of forest potential. This project is located in the 4 natural regions of Guinea (Forest Guinea, Upper Guinea, Middle Guinea, Lower Guinea) and is implemented for a period of 7 years (CTCN, 2017).

2.4.3 Agroforestry and on-farm tree planting

Assemblages of trees not meeting the definition of forest based on agricultural and urban areas also play an important role in Carbon sequestration and the reducing GHG emissions. These are often referred as trees outside forests and have very significant contributions to overall global and national Carbon budgets (Schnell et al., 2015; Zomer et al., 2016). Agroforestry is among the highly flexible and versatile management option to improve GHG mitigation and production services. Agroforestry can mitigate climate change through the intentional integration of woody plants into crop and livestock production systems to purposely create a number of forest-derived services that support agricultural operations and lands, including those services that can directly address GHG mitigation and adaptation needs related to food security and natural resource protection under changing conditions (Nair, 2012; Vira et al., 2015).

Agroforestry has a global mitigation potential between 0.11 and 5.68 billion tons of CO2 equivalents per year (Shukla et al., 2019). Tschora and Cherubini (2020) showed that developing agroforestry within existing perennial crop plantations in some West African countries could absorb 0.14 GtCO2 per year over twenty years, as well as connecting forest remnants, providing fuelwood, improving soils, protecting crops against climate extremes and enhancing local food and energy security. In this regard, tree-based agricultural practices are likely to store more Carbon in the woody biomass and soil than treeless/more conventional agricultural alternatives under comparable conditions (Nair, 2012).

The GHG mitigation potential of agroforestry is however affected by the way the trees, crops, livestock components, or a combination of the three are assembled into the many different agroforestry practices. Practices include alley cropping, improved fallow, riparian forest buffers, windbreaks and shelterbelts,

silvopasture, home gardens, boundary planting, fruit orchards, hedgerows, woodlots and firewood plots and forest farming. Some of the agroforestry practices are defined below:

i. Alley cropping – planting rows of trees and/or shrubs in alleys within cropping systems (sometimes called intercropping);
ii. Improved fallows - planting of fast growing leguminous woody trees or shrubs in agricultural fields for a minimum of two years to ensure rapid soil fertility replenishment;
iii. Fodder banks – growing fodder using species with high plant biomass production to supplement dry season livestock feed;
iv. Silvopasture integration of trees and grazing livestock on same piece of land, intensively managed for forage and forest products;
v. Windbreaks – linear plantings of trees and shrubs to provide environmental, economic and community benefits;
vi. Riparian buffers – management of areas adjacent to streams, wetlands or lakes with combination of trees, shrubs and grasses and or other perennial plants for conservation benefits; and
vii. Forest farming – cultivation of high value crops under managed tree canopies.

Although agroforestry can be a GHG mitigation tool, it can also provide additional ecosystem goods and services that are of value to society, including increasing resilience to changing climate (Schoeneberger and Domke, 2017). The specifics of agroforestry design and management activities influence the amounts and duration of Carbon that is sequestered and the potential reduction in GHG emissions. Management in agroforestry systems, is actively focused on growing high amounts of biomass and returning as much of the dead biomass as possible to the soil, thus increasing Carbon sequestration. The amount of Carbon sequestered depends on the tree species, the soil type, the climate, and the form of natural resource management (Thissen, 2020). Box 2.2 shows examples of agroforestry in Kenya and Togo.

Box 2.2: Examples of agroforestry

Agroforestry in Kenya

In Kenya, there is an Agricultural Carbon Project that promotes agroforestry through partnership with World Bank and Vi agroforestry, growing over 3 million indigenous agroforestry trees, in conjunction with other sustainable land management practices such as mulching, composting, and use of livestock manure. The farmers involved were trained to increase soil organic matter content to improve yields, provide resilience to droughts and heavy rains, limit erosion, and store Carbon, for which the farmers receive payment. The project sequestered about 345 000 tons CO2 between 2010 and 2016, while improving agro-biodiversity, food security and adaptation to climate change as co-benefits. Farmers also had access to firewood, fruits and fodder in addition to climate change knowledge (Agroforestry Network, 2018).

Fertiliser tree planting project in Togo

The Association for the Promotion of Fertiliser Trees and Agroforestry (APAF) popularises agroforestry techniques in peasant environments in Togo, Burkina Faso and Senegal. The Togolese experience reveals both a strong potential for the dissemination of these practices. In Togo, APAF and farmers have set up 29 850 agroforestry fields (averaging 1.5 ha) and 2 900 forests in 530 villages and hamlets in the Plateaux-Ouest region and the Maritime region, as part of the Programme d'appui aux Initiatives d'Agroforesterie et de Foresterie Villageoise), funded by the European Union between 2001 and 2004, for an amount of 1 980 000 €. The majority (70%) of agroforestry fields set up under this framework are coffee-cocoa plots associated with food crops. The other agroforestry fields concern only vegetable or food crops such as maize, yam, cassava, and bananas. In total, more than 5 million trees from nurseries have been planted in Togo, in the fields of 30 000 families on more than 45 000 ha. If we take into account assisted natural regeneration, it is even more. The programme ended in 2004, but the 30 000 Togolese peasant families who benefited from APAF projects and programmes maintained and expanded their fields planted with fertilizer trees and new farmers replicated and spontaneously adopted the techniques in the APAF project area. In 2010, a study found that 99% of the fields in Togo's coffee-cocoa production area were planted with fertilised trees popularised by APAF: farmers in this sector have thus massively adopted these techniques.

From 2018 to 2019, APAF through another fertiliser tree planting project obtained the following results:

i. The training of 855 cocoa farmers in different agroforestry techniques using fertiliser trees in 30 villages;
ii. A minimum of 1 595 352 trees planted, including 305 700 fertiliser and/or forest trees and 1 289 652 Amelonado cocoa trees;
iii. The development of 3 200 hectares of agroforestry fields 141 hectares of reconstituted forests;
iv. A total of 2 121 535 tons of CO2 fixed in 20 years;
v. A total of 3 840 tons of organic cocoa each year, after 5 years of production; and
vi. For food crops, millions of banana plants, taros, yams, cassava, etc.

2.4.4 Afforestation and reforestation

Developed nations committed themselves to reduce CO2 emissions by ratifying the UNFCCC and they may partly offset their domestic CO2 emissions by sequestering Carbon, among others, through afforestation and reforestation activities. Developing countries are eligible to implement afforestation and reforestation projects. Afforestation and reforestation are direct human induced conversion of non-forested land to forested land through planting, seeding and/or the human-induced promotion of natural seed sources. Afforestation takes place on land that has not been covered by forest for at least 50 years. Reforestation occurs on land that was historically forested, but was subject to another land use (IPCC, 2007).

However implementation and permanence of reforestation bears risks of negative emissions mainly for areas located in regions with high investment risks and weak governance, such as in Sub-Saharan Africa. The need for more land may lead to a reduction in agricultural land, threatening food security (Doelman et al., 2020). The major economic constraint to afforestation/reforestation is the high initial investment for establishing new stands combined with the several-decade delay until afforested areas generate revenue. The non-Carbon benefits of afforestation, such as reduction in erosion or non-consumptive use of forests, however, can more than off-set afforestation cost (Richards and Stokes, 2004). Furthermore, according to IPBES (2021), the planting of trees in ecosystems that have not historically been forests and reforestation with monocultures – especially with exotic tree species, is often detrimental to biodiversity. Therefore, the expansion of natural forest area is best achieved by allowing degraded forests to recover naturally using nearby remnants of primary forests and seed banks in the soil of recently cleared forests. This will create Carbon-storing forests that are more resilient and longer-lasting than planting seedlings (Dooley and Mackey, 2019). Some countries are establishing plantations for restoration (e.g. Box 2.3).

Box 2.3 Examples of reforestation projects

Ghana Reforestation Project

The "Form Ghana" Reforestation Project aims at the restoration of degraded forest reserves through the establishment, on a large commercial and sustainable scale, of a plantation forest (11 700 ha) composed of (10% native trees and 90% Teak) in collaboration with the Government of Ghana through the Ghana Forestry Commission. Nearly 14 000 ha of degraded forest land has been acquired in Akumadan and Berekum districts, north of Kumasi, with a renewable 50-year lease and tripartite Benefit Sharing Agreements between the Government of Ghana, local communities and the project. The project will initially focus on the production of high-quality billets, poles and roundwood for local and export markets. This project is an opportunity to stimulate private sector participation in CCM and green growth by supporting the efforts of a scalable concept in a region with high replication potential and as an example. It is implemented by Form Ghana Ltd (associated with the project) in close collaboration with the Government of Ghana through the Forestry Commission, which is the first Forest Stewardship Council-certified plantation company in Ghana and West Africa that already generates Carbon offset credits according to the Verified Carbon Standard (VCS).From 2018 to 2019, APAF through another fertiliser tree planting project obtained the following results:

2.4.5 Urban forestry

Urban forestry is the care and management of tree populations in urban settings for the purpose of improving the urban environment.

The urban forestry comprises all green elements under urban influence and includes the following (CTCN, 2016):

Urban green and blue spaces can be used as nature-based solutions for climate mitigation and adaptation. They are also particularly good assets to use for social prescription and could have a significant impact on the feedback loop between health, drug prescription and their associated Carbon emissions (Chastin et al., 2021).

i. Public green spaces, such as parks, gardens, cemeteries;
ii. Street trees and road plantations;

iii. Semi-private space, such as green space in residential areas and in industrial or specially designated parks;
iv. Public and private tree plantations on vacant lots, green belts, woodlands, rangelands, and forests close to urban areas;
v. Natural forests under urban influence, such as nature reserves, national parks and forests for eco-tourism;
vi. Urban agricultural land, such as orchards, allotments etc; and
vii. Trees planted in urban areas can sequester CO2, thus mitigating CO2 emissions (Carter, 1995), offsetting up to 18.57% of Carbon emitted by the industries in urban areas and storing substantial amounts of Carbon (equivalent to 1.75 times the amount of annual Carbon emitted by industries energy use in the cities) (Zhao et al., 2010). Nowak (1994) showed that large trees in urban areas store approximately 1000 times more Carbon than small trees, with trees of diameter >77 cm sequestering approximately 90 times more Carbon than those with diameter <8 cm.

In this regard, urban forestry becomes an important component of intricate urban ecosystems providing several ecosystem services (both environmental, recreational, aesthetical), and economic benefits to urban communities (Nowak, 2017). Apart from Carbon sequestration, trees in urban areas provide other environmental benefits including: reduction of urban air pollution, reduction of urban heat island effects, soils conservation, improved biodiversity, reduced noise and a barrier against natural disasters (Frigeri et al., 2017).

2.4.6 Management of forest reserves

Forest management can enhance or maintain Carbon stocks and sinks in forest soils and biomass. The management of forest reserves can cover a broad spectrum of approaches, ranging from a passive or conservation-oriented approach to an active, production-oriented approach. In passive forest management interventions, there may be limited or even no activities but just focusing on storing Carbon in biomass and soil through natural processes. In active management, there may be interventions to strengthen Carbon storage through activities such as tree species selection, breeding, fertilisation, soil cultivation, weeding and other tending operations, thinning or harvest regimes to strengthen Carbon storage in forest ecosystems and products and avoiding emissions through substitution effects (Lindner and Verkerk, nd).

Protected areas represent about 15% of terrestrial ecosystems and 7.5% of marine ecosystems. When managing protected areas or forest reserves, positive outcomes are expected from substantially increasing areas of intact and effectively protected areas. Protected areas reduce climate induced stresses by building up populations, and connectivity of populations and habitats, thus securing species persistence and resilience to climate change (Roberts et al., 2017). Box 2.4 shows impact of protected area initiatives in Cameroon.

Box 2.4 Protected area management in Cameroon

To respect the country's international commitments related to the signature and ratification of the Convention on Biological Diversity (CBD), the establishment of protected areas was adopted as an important component of the country's agenda for forest protection and conservation. The Cameroon legislation makes provision for 33 percent of the national territory (475 442 km^2) to be classified as protected areas. Presently, 24 per cent of the 33 percent (115 000 km^2) have been classified as protected areas.

Carbon sequestration within inland protected areas between 1978 and 2014 revealed that the protected areas absorbed 166 590.73 tonnes/ha CO2 from the atmosphere and build up Carbon resulting to the amelioration of the local and regional climate with a positive impact on global climate change (Usongo et al., 2021).

Options to improve the positive impacts of forest reserves and other protected areas include better management and greater resourcing, enforcement, and improved distribution with increased inter-connectivity between these areas. Conservation measures beyond protected areas include migration corridors and planning for shifting climates, as well as better integration of people with nature to assure equity of access and use of nature's contributions to people (IPBES, 2021). The report by IPBES (2021) further identified priority actions that can support both climate change action and biodiversity conservation. The actions include:

i. **Stop the loss and degradation of Carbon- and species-rich terrestrial and marine ecosystems,** especially forests, peatlands, wetlands, grasslands, savannahs and mangroves, salt marshes, kelp forests, sea-grass meadows and deep water and polar blue Carbon habitats respectively. Reducing deforestation and forest degradation can contribute to reduction of human-induced GHG emissions, by a wide range from 0.4-5.8 gigatonnes of CO2 equivalent every year; and

ii. **Restoration of carbon- and species-rich ecosystems.** It is evident that restoration is among the cheapest and quickest nature-based climate mitigation measures to implement – offering much-needed habitat for plants and animals, thus enhancing resilience of biodiversity in the face of climate change, with many other benefits such as flood regulation, coastal protection, enhanced water quality, reduced soil erosion and ensuring pollination. Ecosystem restoration can also create jobs and income, especially when taking into consideration the needs and access rights of indigenous peoples and local communities.

2.4.7 Community participation in forest-based mitigation

Community participation as advocated by initiatives such as REDD+ provide forest based mitigation mainly for community based natural resource management initiatives. For example, national REDD+ initiatives help to create domestic conditions for addressing drivers of deforestation and forest degradation, providing an important foundation for future impact. These conditions include improved forest monitoring capacities, and increased stakeholder engagement (Duchelle et al., 2019).

Community participation can help in securing rights for indigenous peoples and local communities which are key for successful forest-based CCM. Recognition of indigenous peoples and local communities' rights on forest and trees rights is critical for placing them at the centre of forest and climate initiatives rather than just being project beneficiaries. Conserved forests store more Carbon and biodiversity while providing communities with timber and non timber forest products (NTFPs) (Duchelle et al., 2019).

Women may be more adversely affected by deforestation than men due to less secure rights to land and forests (Colfer et al., 2016).

However, African communities have also protected their forests and promoted biodiversity conservation through sacred forests. Sacred forests or sacred groves are forests conserved by communities or indigenous people mainly in Africa and Asia facilitating interactions between communities or indigenous people and their environments (forests) and acting as connecting link between man, nature, religious and indigenous beliefs. Sacred forests harbour rich biodiversity through their protection based on religious taboos, beliefs, indigenous and cultural values (Onyekwelu, 2021). In this regard, sacred forests promote ecosystem sustainability through biodiversity conservation, and have an important role in Carbon sequestration thus acting as a sink of atmospheric CO2. They therefore, contribute to CCM. For example, sacred forests in south-western Nigeria have mean Carbon stock ranging from 43.9 Mg ha-1 to 115.9 Mg ha-1 (Onyekwelu et al., 2022) and in other areas sacred forests can store as much as 481.47 Mg ha-1 to 587.19 Mg ha-1 (Pala et al., 2013; Waikhom et al., 2018). Figure 12 shows the sacred forest boundary in Nigeria.

Figure 12: Boundary of Osun-Osogbo sacred forest in Nigeria

Activity 2.3 (Brainstorming) (15 minutes)

- Describe the link between biodiversity conservation and climate change mitigation.

2.5 Nationally Appropriate Mitigation Actions

NAMAs refer to any action that reduces emissions from developed countries, supports sustainable development and is prepared through the initiative of a national government (GIZ, 2016; UNFCCC, 2007). NAMAs are defined either at national level or at individual level, where the individual contributes towards meeting the objectives of NAMAs at the national level. A NAMA may also be a sectorial goal, a strategy, a national or sectorial programme, or a project-level action. There are differences between NAMAs implemented with international support and those domestically supported. Both types of NAMAs may be registered with the UNFCCC (UNFCCC, 2007). There are several national and international mitigation initiatives, starting with NAMAs and NDCs. The NAMAs are a result of negotiations arising from the Bali Action Plan that were concluded at COP 18 in Doha. They refer to actions which reduce emissions in developing countries, prepared under the umbrella of a national governmental mitigation initiative (UNFCCC, 2007).

The NAMAs would be supported through financial assistance, technology transfer and capacity building for managing forests for CCM within the context of REDD. Actions can be in the form of policies focussing at transformational adjustments within a particular economic sector, or actions across sectors for broader national focus. The NAMAs and LEDS are the two main types of planning instrument for national mitigation planning. LEDS planning document can either be LEDS framework plans or LEDS action plans. LEDS framework plans identify priority sectors for mitigation policies and actions on the basis of national conditions, existing national development policy frameworks and analysis of baseline GHG emissions by sector (FAO, 2013a). In agriculture, forestry and other land uses (AFOLU) sector, there is a lack of NAMAs that have received financing.

In-Text Question(s) (10 Minutes)

i. What is the meaning of NAMAs?

ii. What is the relationship between NAMAs and NDCs.

2.6 Co-benefits and non-Carbon benefits of forest-based mitigation

CCM initiatives can have co-benefits and co-impacts. Co-benefits are positive effects whilst co-impacts include any climate mitigation and/or adaption action or policy with non-climate-related impacts on society and can be intentional, when a policy or action takes them into account, or is unintended (Chastin et al., 2021). Co-benefits can either be economic, social or environmental (Somanathan, 2014) (Table 1).

Table 1: Categorisation of co-benefits from climate change mitigation initiatives

Economic	Social	Environmental
Energy security	Improved health	Ecosystem impact
Employment	Access to energy	Water use quality
New business opportunities	Poverty alleviation	Land use competition
Improved productivity/ competitiveness	Food security	Biodiversity conservation
Technological innovations	Safety/disaster resilience	Reduced impact of urban heat island
	Gender balance	Resource/material use impact

Source: Somanthan (2014)

Other co-benefits include poverty alleviation, forest governance and building resilience though adaptation to climate change. Some of benefits are briefly explained in the following sections.

2.6.1 Employment and income generation opportunities

Climate change threatens the provision of many vital ecosystem services and thus endangers the jobs that depend on them. The provision of safe, healthy and decent working conditions is affected by environmental hazards and environmental instability which have greater impacts on the vulnerable workers (ILO, 2018). Box 2.5 shows ILO guidelines for just transition. ILO (2018) added that transition to a low-GHG economy is expected to cause a net creation of jobs through actions taken in the energy, transport and construction sectors. IRENA and ILO (2022) stated that the pursuit of sustainability in the energy sector could create around 139 million jobs globally by 2030 compared to the business-as-usual path.

Box 2.5. The ILO Guidelines for a just transition towards environmentally sustainable economies and societies for all

The Guidelines for a just transition towards environmentally sustainable economies and societies for all can be used to ensure that no workers are left behind during the transition to a green economy, and that the transition strengthens decent work. These guidelines offer a portfolio of policy options for addressing the issues associated with the greening of the economy and the workplace and, more broadly, with the transition towards sustainable development. The guidelines encourage governments to develop national policies and plans for CCM and adaptation and disaster preparedness, in order to strengthen resilience to the impacts of climate change and promote disaster preparedness (ILO, 2015).

The creation of employment will be driven by the higher labour demand of renewable energy sources, as well as of the entire value chain associated with renewable energy, electric vehicles and construction of the necessary infrastructure (IRENA and ILO, 2022). But will these jobs also be an opportunity to improve gender equality? Green Jobs Report noted that nearly 2.3 million women and men have been employed in

renewable energy jobs in recent years (UNEP et al., 2008). However, there is no indication of the distribution of these jobs between men and women. Where information exists on green jobs, particularly in renewable energy, half of the jobs concerned are in developing countries, although gender differences are less obvious.

The best-known example that combines renewable energy, job creation and training is the Grameen Shakti (GS) microcredit scheme in Bangladesh. GS has helped install more than 100 000 solar energy systems in rural communities, helping to create employment opportunities while empowering local women and youth. GS has trained more than 5 000 women as solar technicians and maintenance workers.

Many more jobs are created indirectly as solar systems allow local entrepreneurs to start a new business such as community television shops, solar-powered mobile phone charging shops and electronics repair shops. GS aims to create 100 000 jobs in solar energy and related sectors. Although not in Africa, this example reveals the possibilities.

Awono et al. (2013) identified at least 570 plants and 110 animal species harvested from the wild in Cameroon with main NTFPs fetching over US$ 1 billion annually. Small businesses across Cameroon and the Democratic Republic of the Congo employed more than 350 000 people to harvest 15 most widely used NTFPs, constituting more than twice the number of jobs in the formal forestry sectors. If the provision of forest products is sustained, emissions can be reduced while people get a livelihood from the forests. In REDD+ initiatives, the sustainable extraction of (some) NTFPs can contribute to forest conservation due to their different re-vegetation patterns and growing characteristics when compared to trees. The usage and extraction of NTFPs will provide income from the forest which consequently represents an incentive for forest conservation (Zhu and Lo, 2021).

Co-impacts of climate actions and policies which have positive effects on non-climate related objectives are termed co-benefits' (Chastin et al., 2021). The non-Carbon benefits of forests may provide sufficient economic justification for conserving them (Duchelle et al., 2019).

In initiatives dealing with biofuels, the production of biofuels will have a substantial impact on jobs and market opportunities in biomass production, logistics and bio-refineries, where many additional jobs in traditional areas will be created to supply bio-refineries with needed feedstock. Furthermore, industries providing enzymes, microbes and other supplies for bio-refineries will create new and expanded job opportunities as well (Carr et al., 2010; Gibbons and Hughes, 2011).

2.6.2 Biodiversity conservation

CCM measures have a range of positive human health, ecosystem functioning, macroeconomic, social, and/or equity side effects that in some cases outweigh the importance of CCM benefits. These ancillary benefits include biodiversity conservation for actions especially dealing with natural ecosystems (Urge-Vorsatz et al., 2014).

Mitigation initiatives should identify potential opportunities of integrating biodiversity within the climate change policies, programmes and projects, clearly showing their interconnectedness. Forest-based CCM can help to achieve biodiversity benefits. As sustainable management of forest ecosystems curbs

GHG emissions, the use of ecosystem based adaptation (EbA) and EbM is about the management and rehabilitation of ecosystems for adaptation and mitigation of climate change. The EbA is the use of biodiversity and ecosystem services as a component of the adaptation strategy to help societies adapt to the adverse effects of climate change while the EbM is the use of ecosystems for their Carbon storage and sequestration potential to help in CCM (Epple et al., 2016). When considering the uncertainties linked to climate change impacts, the ecosystem-based approaches are considered "no-regret," or "low-regret" options because they are not likely to cause any harm. They also have potential to be more cost-effective than other measures due to the fact that they provide multiple benefits (social, economic and environmental) (Doswald and Osti, 2011; Roberts et al., 2020).

The options under EbA include ecological restoration, wetland and floodplain conservation and restoration, afforestation and reforestation, fire management, conservation and replanting mangrove forests, green infrastructure (e.g., shade trees, green roofs); sustainable fisheries management, ex situ conservation and seed banks, ecological corridors, community-based natural resource management and adaptive land use management. Protecting and conserving forests ecosystems can be a cost-effective emissions mitigation strategies although it needs clear synergies with objectives of biodiversity conservation (Roberts et al., 2020). For example, it is important to mainstream the multiple co-benefits from wildlife and habitat protection in climate mitigation and adaptation planning.

2.6.3 Watershed conservation

Watershed conservation can be achieved through application of a set of actions aimed at ensuring the sustainable use of natural resources in a watershed. Watershed management is the management of all human activities and their effect on the environment within a geographical area defined by a watercourse, applied to promote coordinated actions and linkages between upstream and downstream environments and populations. Integrated watershed management should be associated with the livelihoods of people, providing opportunities for improved incomes and increased resilience to climate change. All land uses, water resources and natural resources within a watershed must be included in watershed management initiatives, including domestic and productive uses at all levels (FAO, 2017a). Therefore, identifying needs at all levels will help find interventions that support environmental protection as well as climate change adaptation and mitigation. Examples from Ethiopia, Ghana (Volta Basin), Kenya, Rwanda, Senegal, and Uganda demonstrated that improving and strengthening watershed management can effectively address land and water resource challenges, while at the same time providing a first step to meeting the challenges posed by climate change (Joosten and Grey, 2017).

CCM initiatives in watershed areas promote resilience of natural ecosystems by avoiding deforestation, reversing natural resource degradation, safeguarding agricultural productivity and maintaining ecosystem services. The benefits overflow by helping communities to adapt to climate change, conserving the environment and improving people's lives and livelihoods in addition to the reduction of GHG emissions. Furthermore, it allows diverse groups of stakeholders and institutions to work together to maintain watershed/ecosystem services for all, thus addressing issues that were previously addressed in a sectoral way (Joosten and Grey, 2017). Watershed management should not only target environmental or conservation benefits, but also productivity and economic benefits for households and communities residing in the watersheds (FAO, 2017a).

2.6.4 Provision of timber and non-timber forest products

Forests provide NTFPs, which provide food, fuel, medicine, raw materials, incomes, and keep traditional knowledge alive and can have an important role in climate action (Nadkarni and Kuehl, 2013) for rural and urban communities in Africa. The goods are either used for self-consumption or sold at local markets and can play an important role for rural well-being, providing additional benefits apart from emissions reductions in activities targeting REDD. In Africa, biodiversity conservation promotes the continued provision of these benefits under a changing climate.

The NTFPs (and timber) have a tremendous potential to create rural employment, help in reducing poverty and reducing urban migration, their dependence on forest ecosystems, can be a strong incentive for forest conservation. Furthermore, NTFPs can be used to create emission reductions as a direct tool for Carbon sequestration indirectly helping to store and sequester Carbon in forest systems. NTFPs such as honey and mushrooms require healthy and functioning forest systems in order to be productive (Nadkarni and Kuehl, 2013). The use of timber and NTFPs in a REDD+ context needs to be based on their sustainable harvesting and extraction. In developing countries for example, wood and NTFPs provide about 20% of rural households' incomes when they have moderate or broad access to forest resources (Angelsen et al., 2014). Counting direct, indirect and induced employment, it is estimated that the formal forest sector accounts for 45 million jobs worldwide and labour income exceeds US$ 580 billion per year (FAO, 2018).

2.6.5 Aesthetic and recreational services

Climate change affects aesthetic value due to its effects on nature, the technological developments for mitigation to reduce GHG emissions (e.g. geo-engineering and structures for renewable energy) and changes to other human structures and activities e.g. changing crop types, transport modes and building structures. The aesthetic values are generated through appreciative experiences for CCM.

Beneficial effects include feelings of being uplifted, greater perceptual sensitivity and activation of imagination (Brady, 2014). In an urban context, forests and parks can contribute to enhancing health through better air quality and provision of leisure spaces (European Environment Agency, 2021). CCM can increase biodiversity and improve aesthetic value especially with restoration activities.

2.6.6 Poverty alleviation

CCM activities may have adverse effects on poor and vulnerable households who depend on environmentally-damaging activities, such as unsustainable agriculture, charcoal production or logging. CCM measures carry additional costs and can endanger incomes and livelihoods of the poor (Györi et al., 2021). For example, when the Chinese government announced the closure of thousands of their coal mines, about 1.3 million jobs were lost in the coal sector, along with 500 000 jobs in the steel industry (Yan, 2016).

Sometimes CCM measures such as REDD+ may improve livelihoods through strengthening governance and land use rights. REDD+ initiatives can improve local livelihoods as the drivers of deforestation are addressed. In this regard, climate mitigation is achieved while local livelihoods are sustained. Deforestation can be reduced when smallholder farmers have alternative livelihood sources that take them away from forests or conversion of forest to agricultural land. The climate change interventions with performance-based finance mechanisms measured by the amount of GHG emissions avoided or sequestered can be beneficial to local communities.

However, climate change measures based on creating 'green growth', 'green jobs', and the 'green economy' share a broad consensus that 'green transformation' needs to be designed in an inclusive way (UNFCCC, 2016a). These will lead to a net increase in employment, with new jobs mainly emerging in sectors that are characterised by high levels of informality and in-work poverty (Malerba and Wiebe, 2020). Avenues focusing at payment for ecosystem services (PES) clearly incentivise owners/users of environmental assets such as forests or water resources, to conserve or use them in a sustainable manner as they are compensated for the opportunity cost of sustainably using the natural asset. When the PES targets individuals living below the poverty line, benefits can be adequately generous to make PES an option for reducing poverty (Györi et al., 2021). However, programme impacts may only last as long as payments for conservation are received, after which there is a risk of people resuming their unsustainable use of the forest resources. Therefore, PES should be linked to a long-term change of attitudes and values (Chan et al., 2017) or the long term alternative income-generating opportunities. In

addition, REDD+ is an opportunity to also provide more benefits derived from Carbon finance, including improving community infrastructure, health and education sector.

2.6.7 Forest governance

CCM initiatives promote good governance arrangements at the national and sub-national levels across the globe increasing the participation at local level and improving their capacity to self-regulate. Multiple decision-making centres can contribute to solving a particular issue based on their statutory responsibilities as decision makers cooperate, compete, resolve conflicts, learn from each other, and mutually adjust their behaviour and/or negotiate (Heinen et al., 2022).

Other areas that need improved governance are linked to sustainable extraction mechanisms for NTFPs which need to be defined and integrated into policies in-order to make it economically interesting for local farmers and forest dwellers to conserve forests (Nadkarni and Kuehl, 2013). Issues of forest governance frameworks will be covered in chapter 3

2.6.8 Adaptation to climate change

Measures for protecting and increasing Carbon can increase the resilience of ecosystems to climate change. Watershed conservation initiatives promoting Carbon sequestration using vegetation can reduce flood risk. Likewise, trees in urban areas reduce heat stress in cities. Mechanisms for forest Carbon protection (such as REDD+) improve forest resilience to climate change by conserving biodiversity, increasing landscape connectivity, and reducing fire risks (Locatelli et al., 2011). Carbon payments can diversify livelihoods and improve economic resilience to climate shocks (Campbell, 2009; Jarvis et al., 2011). Initiatives focusing at forest Carbon sequestration or emission reduction in energy can facilitate people's adaptation to climate change by diversifying local livelihoods, enhancing incomes or health and strengthening local institutions (Lasco et al., 2008; Alexander et al., 2011).

Furthermore, conserving Carbon protects other ecosystem functions and services, which facilitate the adaptation of society, such as microclimatic regulation for protecting livestock and crops from climatic variations, wood and fodder as safety nets, soil erosion protection and soil fertility enhancement for agricultural resilience, coastal area protection and water regulation (Stringer et al., 2012).

However, CCM in forest and biofuel plantations may impede the adaptation of communities by decreasing food security, competition for land and short-term benefits for few stakeholders (Alexander et al., 2011; Stringer et al., 2012,). There is therefore, need for climate policy integration, moving from the traditional 'end of-pipe' approach to a preventative approach that considers both mitigation and adaptation starting at the stage of policy formulation, including consideration of specific institutional procedures and structures that can facilitate such integration (Locatelli et al., 2015).

Further reading:

Chastin, S., Jennings, N., Toney, J., Anadon, D.L. and Smith, P. 2021. Co-benefits of climate change mitigation and adaptation actions. COP26 Universities Network Briefing. Media_814662_smxx.pdf (gla.ac.uk).

In Text Question(s) (10 Minutes)

i. How does land use change affect Carbon emissions?
ii. Explain co-benefits of a forest conservation project under a climate change initiative.

2.7 Forest-based challenges associated with climate change mitigation

The forest based challenges associated with CCM are mainly associated with processes of mitigation options, addressing drivers of deforestation, policy support and technical capacities to support CCM. The challenges can be categorised into technical, institutional or professional.

2.7.1 Technical

Technical challenges associated with CCM are mainly linked to issues around realistic baselines, proving the additionallity of the climate benefits from forest activities showing that it would not have happened anyway, measuring, monitoring, reporting, and verifying the actual emissions avoided or arbon stocks preserved in forests.

i. In some countries, lack of data, validity and credibility of data, and acceptance of the results of quantitative analysis based on that data is a challenge (Trollip and Boulle, 2017). Data gaps are also in most countries related to : the unavailability of a Quality Assurance/Quality Control plan and reliability of activity data (AD); weak collaboration between data producer/holding structures; the inappropriate format for storing and archiving data with data holding structures; and statistics are often aggregated at the level of forest typology;

ii. Another challenge is associated with the benefit sharing mechanisms for local and indigenous peoples and ensuring that environmental co-benefits are not undermined (Virgilio and Marshall, 2009);

iii. Addressing the underlying drivers of deforestation and land degradation;

iv. Inadequate capacity to ensure multi-stakeholder engagement, community participation and support;

v. The complex design and implementation processes of REDD+ policies and measures at national and subnational levels, can result in severe risks and challenges for policy makers desiring to implement objectives of sustainable emissions reductions and the provision of social and environmental safeguards concurrently (Loft et al., 2017);

vi. UNEP and IUCN (2021) stated that there are challenges associated with uncertainties related to the scale of the contribution, mainly challenges with implementation and financing; doubts about whether the necessary safeguards will be applied; and concerns about the use of offsets by private sector;

vii. Technical challenges are also related to conducting mitigation studies (MERF, 2021). These challenges relate to: insufficient mastery of tools and methods for assessing and developing mitigation scenarios and technical difficulties in identifying appropriate technologies; the weak technical capacity of the institutions responsible for carrying out the studies; very limited technical expertise in all key themes in relation to other priority sectors concerned by mitigation studies, and the absence of climate indicators for most government plans, programmes and policies;.

viii. Some of the initiatives e.g. for CDM, countries limited ability to secure financing for the underlying GHG emission reduction activities, particularly in the least developed countries. Among the key reasons for this is the fact that most host countries have limited or no knowledge of the financing modalities and procedures (UNEP, 2009);

ix. Lack of activity in some countries is due to limited understanding of the CDM and capacity to develop projects that meet the CDM criteria; and

x. Limited knowledge of Carbon stocks in alternative forest types and forest uses.

2.7.2 Institutional

i. Lack of credible data and quantitative analysis which are necessary for effective policy formulation and implementation;
ii. Need for stronger political and policy support and national implementation capacity;
iii. Insecure tenure makes it difficult to ensure permanence of emission reductions, making investment unattractive;
iv. Lack of clarity over rights to arbon and lack of access to legal systems even where rights are well defined they may exclude poor people;
v. Brockhaus et al. (2014) stated that REDD+ implementation was in danger of being consumed by existing policies that are dominated by business-as usual intentions;
vi. The non-operationalisation of the monitoring, reporting and verification (MRV) system; and
vii. The low level of collaboration between institutions in charge of implementing government policies and institutions in charge mitigation of studies.

2.7.3 Professional

i. Some of the initiatives e.g. for CDM, countries limited ability to secure financing for the underlying GHG emission reduction activities, particularly in the least developed countries. Among the key reasons for this is the fact that most host countries have limited or no knowledge of the financing modalities and procedures (UNEP, 2009);
ii. Lack of activity in some countries is due to limited understanding of the CDM and capacity to develop projects that meet the CDM criteria; and
iii. Limited knowledge of Carbon stocks in alternative forest types and forest uses.

Further reading

Loft, L., Thuy, T.P., Wong, G.Y., Brockhaus, M., Dung, N.L., Tjajadi, J.S. and Luttrell, C. 2017. Risks to REDD+: potential pitfalls for policy design and implementation. Environmental Conservation. 44(1): 44-55. https://doi.org/10.1017/S0376892916000412.

2.8 Forest-based climate change mitigation practices case studies

In Ethiopia, the restoration of native forests in Humbo is expected to absorb about 880 000 metric tons of CO2 over 30 years, generating Carbon payments and income from forest products. Ethiopia has two major REDD+ programmes: The REDD+ Investment Programme, and The Oromia Forested Landscapes Programme, funded through the Ethiopia-Norway REDD+ Partnership and World Bank BioCarbon Fund Initiative for Sustainable Forested Landscapes respectively. Ethiopia can receive results-based payments for emissions reduced, as measured and reported through a REDD+ MRV system. Ethiopia has also received readiness funding from the Forest Carbon Partnership Facility (FCPF), as well as the two REDD+ programmes (World Bank, 2021a).

In the Ferlo Biosphere Reserve and Plateau of Thiès in Senegal is a project on 'Ecosystem-based adaptation for resilient natural resources and agro-pastoral communities". The project supports the conservation, sustainable management and restoration of the forests and savannah grassland ecosystems. EbA approaches sustainably increase the resilience of agro-pastoral populations in the project areas, by providing climate-resilient green infrastructure that enhances soil water storage, fodder availability and water for livestock; and developing valuable alternative livelihoods from the conservation and maintenance of these local forest and savannah ecosystems (e.g. timber and NTFPs, climate-adapted vegetable gardens and eco-tourism) (UNDP, 2022).

In Burundi, the United Nations Development Programme (UNDP) also proposed a project on "Landscape restoration for increased resilience in urban and peri-urban areas of Bujumbura". The project strengthens integrated watershed management and flood management of the Ntahangwa river by embarking on landscape restoration in areas connected to Bujumbura in order to restore flood-related ecosystem protection for both highland upstream communities and lowland urban communities with adaptive solutions ranging from tree planting to watershed protection and reinforcement of riverbank structures (UNDP, 2022).

In Cameroon, Forest Landscape Restoration is provided for in the national Forest Law. In 2006, the government set a target of planting at least 1 million seedlings a year and to provide the required funding. In addition to these national reforestation targets, Cameroon pledged in 2017 to restore forests and degraded lands over an estimated surface area of 12,062,768 hectares by 2030 as part of the African Forest Landscape Restoration Initiative (AFR100). Also in 2017, Cameroon launched the national chapter of the Great Green Wall (GGW) for its northern regions and the national campaign of reforestation in May 2018 for more than 556100 trees to be planted all over the country (Chemete, 2018). Actors involved in reforestation are many and diverse. The Ministry in charge of forests has provided grants since 2006 and material and financial support to councils, NGOs, associations and traditional chiefdoms, to establish forest plantations and to develop urban and suburban reforestation initiatives. Other state agencies and private organizations are also involved in reforestation including: the Ministry of Environment, Nature Protection and Sustainable Development, the National Forestry Agency, the Network of Parliamentarians for sustainable Management of Central Africa Forest Ecosystems, mobile telephone operators (e.g. MTN Group and Orange), Concessionaires of Forest Management Units in all regions of the country, and some grass root associations.

In Text Question(s) (10 Minutes)

i. Explain any three co-benefits of climate change mitigation initiative.

ii. Explain technical challenges of climate change mitigation initiatives.

Summary

In this chapter, we discussed the role of forests in combating climate change. These efforts were formally recognised at the UN climate change conference in Paris in 2015. Forests are important in reducing the impacts of climate change by regulating water flows and ecosystems, protecting biodiversity, having an integral part in the Carbon cycle, supporting livelihoods, supplying goods and services that can drive sustainable growth, absorbing GHGs and protecting coastal communities from extreme events and sea level rise. Some of the services have not been given their true monetary value. About 80% of the world's terrestrial biodiversity have often been destroyed through agricultural activities, forestry and other land uses, contributing about 25% of global emissions making them the second largest source of GHG emissions after the energy sector. Forests store Carbon in different pools above and below ground. Forests can be managed to maximise their potential for mitigating climate change by combatting deforestation and forest degradation, restoring forest landscapes, unlocking benefits from forests, creating enabling environment with clearly defined rights for land resources, clarifying tenure and local forest rights and also creating protected areas. Financing for CCM initiatives can be obtained from the GEF, GCF and CIF. The forest-based initiatives include activities linked to forest protection, forest conservation, SFM, agroforestry and on farm tree planting, afforestation and reforestation, urban forestry and protected area management. These activities generate co-benefits associated with biodiversity conservation, poverty alleviation, employment and income generation, watershed conservation, provision of timber and NTFPs, aesthetic and recreational services, poverty alleviation, forest governance and building resilience. The chapter concluded by discussing institutional, technical and professional challenges associated with CCM. In the next chapter we will learn about international arrangements for CCM.

Chapter 3: Clean Development Mechanism, Redd+ And Other Forest-Based Approaches For Mitigating Climate Change

3.1 Chapter overview

In the previous chapter, we learnt about forest based CCM, associated benefits and challenges. CCM response over the continent have gradually been build up around CDM, NAMAs REDD+ initiatives (Walker et al., 2008; Gizachew et al., 2017; Tsayem Demazu et al., 2015). The slowness of the mitigation response of the continent was, partially, due to the insignificant contribution to global emission of GHG. The developed world with their industrialisation trajectories contributes immensely to GHG emissions, yet in Africa only a few countries are considered among the world top polluters or Organization for Economic Co-operation and Development OECD economies. This chapter focuses on CDM and REDD+ which are international forest-based CCM mechanisms. The discussions build an understanding of the evolution of the CDM and REDD processes, implementation processes, the difference between Reducing Emissions from Deforestation (RED), Reducing Emissions from Deforestation and forest Degradation (REDD), and REDD+, economic benefits from the mechanisms, governance issues, financing and multi-stakeholder participation in the CDM and REDD+ processes.

Learning outcomes

By the end of this session, the learner should be able to:

i. Explain the genesis of CDM and evolution of REDD+ in relation to mitigation of climate change;
ii. Describe the implementation processes of CDM and REDD+;
iii. Evaluate the implications of the CDM and REDD+ projects in mitigation of climate change;
iv. Analyse financing mechanisms for CDM and REDD+ processes;
v. Contribute to the development of REDD+ project proposals at local, sub-national, national, regional and international levels;
vi. Analyse the role of NDCs forest-based options in CCM;
vii. Evaluate the role of other forest-based initiatives at regional and international level in CCM; and
viii. Evaluate the relationship between global and regional initiatives such as sustainable development goals (SDGs), African Agenda 2063 and CCM..

3.2 Introduction

KP was adopted on 11 December 1997 and entered into force on 16 February 2005. There are 192 Parties to KP. KP operationalises the UNFCCC by committing industrialised countries and economies in transition to limit GHG emissions in accordance with agreed individual targets, policies and measures on mitigation that are reported periodically. KP has flexible market mechanisms, which are based on the trade of emissions permits achieved through three market based mechanisms:

i. International Emissions Trading - Carbon is tracked and traded like any other commodity in the Carbon market. Emissions trading allows countries that have emission units to spare (emissions they are permitted but not "used") to sell them to countries that are over their targets. Other trading mechanisms with other units that may be transferred under the scheme, each equal to one tonne of CO2, may be in the form of:
   - a removal unit (RMU) on the basis of land use, land use change and forestry (LULUCF) activities such as reforestation,
   - an emission reduction unit (ERU) generated by a JI project or
   - a certified emission reduction (CER) generated from a CDM.

ii. CDM – this mechanism will be discussed in detail in section 3.3.

iii. JI - Projects generate ERUs as defined in Article 6 of KP. Transfers and acquisitions of the units are tracked and recorded through the KP registry systems. Secure transfer of ERUs between countries is done through international transactions log. JI allows a country to develop an emissions-reduction project in another of the 35 nations, for credit against the first country's target from an emission-reduction or emission removal project with each ERU equivalent to one tonne of CO2. The JI Supervisory Committee under the authority and guidance of COP Serving as the Meeting of Parties to the KP (CMP) supervises the verification of ERUs generated by JI projects following the specified verification procedures (UNFCCC, 2008). Countries hosting CDM or JI emission reduction projects have the benefit of attracting foreign investment, benefiting from the transfer of technology, and contribution of project to national SDGs (UNEP, 2009).

3.3 The Clean Development Mechanism

3.3.1 Definitions of CDM

The CDM is a market based instrument established by the KP to foster collaboration for afforestation and reforestation between industrialised and developing countries. The CDM is one of the three market-based flexibility mechanisms that were created to assist developed countries to achieve their emission targets at a lower cost through offsets of their obligations using projects in developing countries (UNFCCC, 2021b). The projects can earn saleable CER credits, each equivalent to one tonne of CO2, which can be counted towards meeting Kyoto targets (UNFCCC, 2022b).

In this regard, the CDM provides an opportunity for industrialised countries to initiate interventions such as rural electrification projects using solar panels, installation of more energy-efficient boilers or afforestation and reforestation projects in developing countries and trade respective Carbon credits. CDM directs finance from public and private sectors in developed countries to innovative low Carbon projects in developing countries, reducing CO2 concentrations in the atmosphere through enhancing forest Carbon sinks and reservoirs, in forestry mainly, afforestation and reforestation projects.

CPF (2008) showed that although afforestation and reforestation activities are included among the few CDM projects in Africa since 2001, due to high transaction costs, and given the potential of afforestation and reforestation in Carbon sequestration, CDM procedures need to be simplified. An example of a CDM forestry project in Africa is the Humbo project in Ethiopia. In developing countries, there is risk of displacement of forests that are not eligible for the CDM except afforestation and reforestation (GOFC–GOLD, 2016).

3.3.2 Development and implementation of CDM: Transition to sustainable development mechanism

KP had the first commitment period from 2008-2012 and the second commitment post 2012 up to 2020. In the second commitment period, the CDM had a low demand for CERs compared with demand in the first commitment period of KP (2008–2012) (UNFCCC, 2021c). Under the Paris Agreement of 2015, all parties are expected to make and implement climate commitments in their NDCs to help fulfil the Paris Agreement's goals.

The Paris agreement established the Sustainable Development Mechanism (SDM) to reach the goals of the Paris Agreement and become the predecessor to the CDM and JI. The CDM catalogue of methodologies and associated emission reduction estimates can be adopted for SDM to provide a quantified estimate of emission reductions for a given amount of financing (Carbon Market Watch, 2017). The difference between the two mechanisms is that the CDM was established as an offsetting mechanism where emissions in developed countries that had climate targets were met through emission reducing projects in developing countries that had no targets. The SDM must however; function in a world where all countries have climate mitigation targets, contributing to sustainable development, and delivering an overall mitigation of GHG emissions through results based finance (Carbon Market Watch, 2017).

Differences between NAMAs and CDM

CDM follows a project/activity based approach whilst NAMAs are a mechanism for countries to reduce their own GHG emissions in one or multiple sectors and involve a wider range of activities with broader time horizons. They also provide more opportunities for large-scale national GHG reductions. Furthermore, there has not been any decision for an international climate negotiation option to issue Carbon credits from NAMAs..

CDM mechanism innovated and transformed global climate change cooperation, leading to the registration of 7 800 projects, with about 355 Programmes of Activities issue of 2 billion CERs with the procedural and institutional framework applied in more than 140 countries (UNEP and DTU, 2021). Parties to KP and other governing bodies should plan and manage the transition from the Kyoto environment into the Paris environment (Kainou, 2022). Kainou (2022) also suggested that COP Serving as the Meeting of the Parties to the Paris Agreement (CMA) and CMP could mutually authorise the temporary use of the CDM mechanism (including its infrastructure) under Article 6.4 until the Article 6.4 mechanism becomes available. In the absence of CDM transitional arrangements, or for CDM activities that do not qualify for a possible transitional arrangement, project developers could reapply so that their activities become recognised under the Paris Agreement as either under Article 6.4 market mechanism or as a bilateral cooperative approach between two governments under Article 6.2 (Climate Focus, 2017).

The CDM project cycle is a seven step process which starts with preparation and submission of project design document (PDD) by the project participant, making use of approved emissions baseline and monitoring methodology. This is then approved by the Designated National Authority (DNA) housed in each country. This is followed by validation done by independent assessment by accredited designated operational entity (DOE), private third-party certifier.

Verification: refers to establishing whether the measured GHG reductions actually occurred, similar to an accounting audit performed by an objective, accredited party not directly involved with the project. Verification can occur without certification.

Certification: refers to certifying whether the measured GHG reductions actually occurred, and is expected to be the outcome of a verification process. The value-added function of certification is in the transfer of liability/responsibility to the certifier (STAP, 2017).

A validated project is submitted for registration and formal acceptance as a CDM project activity by the Executive Board. Registration is the prerequisite for the verification, certification and issuance of CERs related to that project activity. The project developer then monitors, reports and request for issuance. DOE verifies the emission reduction, in the amount claimed, according to approved monitoring plan and the executive board issues CER. Figure 13 shows the CDM project cycle (Michaelowa et al., 2004).

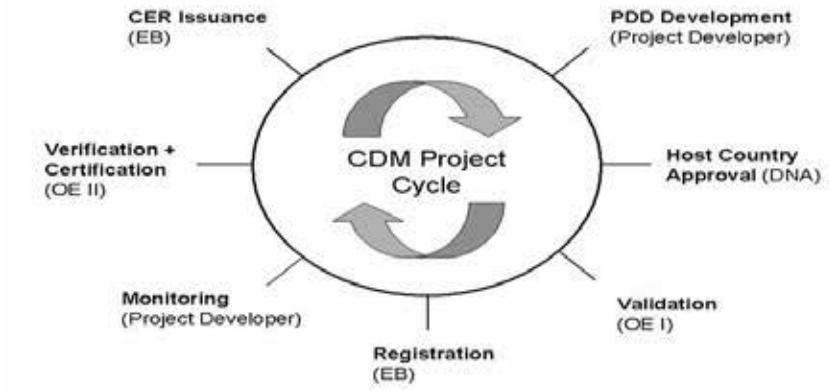


Figure 13: The CDM project cycle (Michaelowa et al., 2004)

EB =Executive Board, OE = Operational Entity, DNA = Designated National Authority.

3.3.3 Financing of CDM

Although Carbon markets have the potential to bring major investments into the world's poorest and most vulnerable countries where they are needed most, the uncertain market outlook discourages investors. The participation of the African continent in the GHG market has been very low with only 261 projects representing 3.0% of the 8 814 CDM global projects in 2016 and 1% of voluntary global market (Baimwera et al., 2017). The recent years have seen increase in the trends to 54% of the 45.1 Mt CO2 trade by the continent by 2015 (Baimwera et al., 2017). Funding for CDM projects normally comes from multilateral, governmental and private sector Carbon funds. Examples are given in Table 2.

Table 2: Examples of flexible mechanism funding in Africa

Name of Fund/Website	Management	Type of Projects & Geographic Focus	CDM Project Support & Fund Dates
BioCarbon Fund www.carbonfinance.org	World Bank Carbon Finance Group	CDM: Afforestation/ Reforestation. JI: - LULUCF. - Also: plans to purchase credits not applicable under Kyoto	Some project related documents can be paid by Fund (baseline study, additionality, verification) but charged to project, if approved. Fund is expected to stop purchase in 2017
Swedish International Climate Investment Programme SICLIP 2002 - 2012 www.stem.se	Swedish Energy Agency	CDM & JI projects with preference for renewable energy, energy efficiency, small-medium sized projects. - Geographic scope: Asia, Latin America, Africa, Central/ Eastern Europe	Support for document preparation can be provided if requested. Can cover +50% of costs in some cases. - Be fully invested in 2007.

The start-up finance scheme offers a new opportunity for clean energy projects in developing countries given the current downturn in the Carbon market. The first call for proposals for CDM resulted in start-up funding for two projects in Africa aimed at reducing GHG emissions and deforestation. The projects were on sustainable biomass in Senegal and efficient cook stoves in Zambia and Malawi which were expected to annually save about 138 559 of CO_2 emissions from the sustainable energy programme. The additional benefits to local people include reduced exposure to health hazards caused by indoor smoke pollution. In 2014, two projects were selected for providing safe drinking water to schools in Uganda and Rwanda, and for producing biogas in East African countries (UNFCCC, 2015b). The CDM is the main source of income for the UNFCCC Adaptation Fund, through 2% levy on CERs (Adaptation Fund | UNFCCC).

The Carbon Initiative for Development (Ci-Dev) was established by the World Bank to mobilise finance for access to clean energy in developing countries with 12 energy access projects in sub-Saharan Africa, financed through results-based finance schemes. This follows a three step process:

i. **Select and contract for emission reductions** – public auctions and select bidders. Sign contracts with winning bidders;

ii. **Achieve emission reductions** – putting option contract in hard currency to help implementers overcome financial and other barriers; and

iii. **Verify and pay for performance** –monitor and verify emission reductions using established GHG accounting standards. If market price is below the put option strike price, contract holders take options and Pilot Auction Facility purchases the Carbon credits.

Through the focus on increasing energy access, Ci-Dev provides financing for projects that support low-

Carbon energy access in low income countries in collaboration with other parts of the World Bank Group. The piloting of innovative results-based climate finance used for Ci-Dev projects, applies results-based payments as a vehicle for financing energy access projects building on two decades of Carbon finance experience of the World Bank Group and the new Standardised Crediting Framework (SCF) building on the infrastructure that was created by CDM. Ci-Dev developed this new, simplified approach (SCF) to crediting emissions reductions (World Bank Group, 2016; Ci-Dev, 2017; Ci-Dev, 2022).

Ci-Dev has initiated projects in eight African countries. One of them is an emissions reduction purchase agreement with the SNV Netherlands Development Organisation for the purchase of approximately 540 000 CERs to be generated by biogas digesters installed in rural households in Burkina Faso through end 2024. This was signed in 2016..

3.3.4 Regulatory frameworks supporting CDM

The detailed rules and modalities for the CDM were agreed upon by KP parties in 2001, as part of the Marrakesh Accords, in that same year. Below is an outline of regulatory frameworks for CDM (Curnow and Hodes, 2009):

The UNFCCC - provides a framework for activities addressing climate change, including the preparation of national GHG inventories, the consideration of climate change in the development of domestic policy, the transfer of technologies with which to tackle climate change, and the raising of awareness of climate change and its impacts.

KP – is legally binding, providing for quantified emission reduction obligations under international law since 1997. To participate, a country should ratify the protocol and is expected to conform to the CDM methodologies and guidelines in order to benefit from the initiative.

Host Country should have laws which address the implementation CDM, without impacting negatively on the development of CDM projects. In the same way, countries should have domestic laws relevant to CDM Projects.

Several compliance programmes, and voluntary standards recognise and accept CERs from CDM. The schemes or standards include the VCS and the European Union ETS. The classification and hierarchy of decisions is shown in Figure 14. Another scheme is the Gold Standard which certifies projects that use CDM methodologies and also comply with additional Gold Standard criteria (Broekhoff et al., 2019).

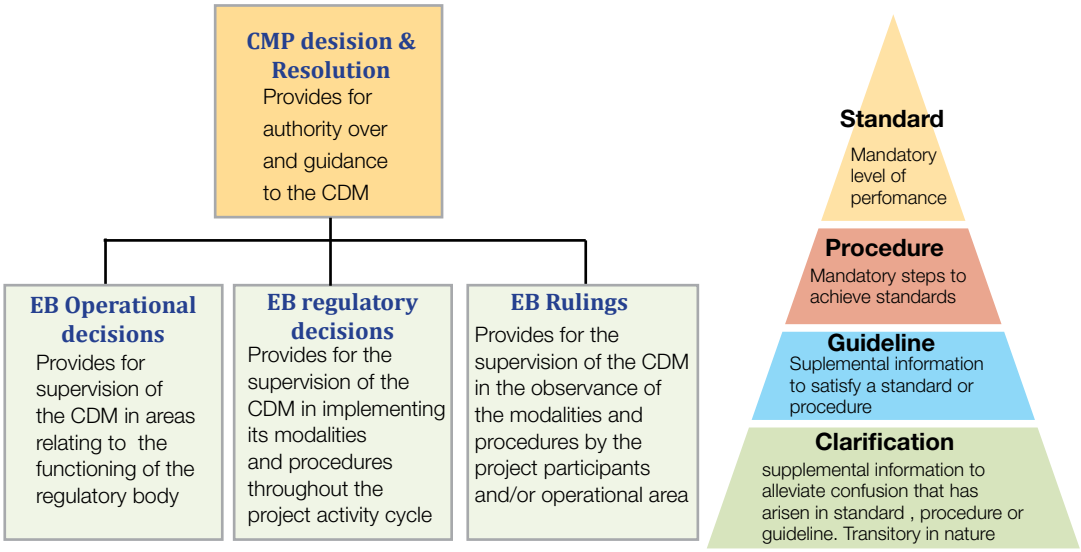


Figure 14: The CDM cycle a. classification of decisions and b. hierarchy of regulatory decisions (Source: UNFCCC, https://unfccc.int)

3.3.5 Implementation of CDM projects

CDM requires the application of a baseline and monitoring methodology in order to determine the amount of CERs generated by a mitigation CDM project activity in a host country. The methodologies are classified into five categories:

i. Methodologies for large-scale CDM project activities;
ii. Methodologies for small-scale CDM project activities;
iii. Methodologies for large-scale afforestation and reforestation CDM project activities;
iv. Methodologies for small-scale afforestation and reforestation CDM project activities; and
v. Methodologies for Carbon capture and storage project activities.

In order to secure approval, project developers should show how the project contributes to sustainable development goals of the host nation. Furthermore, both should agree to voluntarily carry out the initiative including stakeholder participation. In addition, all CDM projects must satisfy the following conditions:

> The South African Carbon tax system came into force in 2019. Under this system, major Carbon emitters, such as electric power and mining companies, are taxed according to their emission volume at a nominal tax rate of around $ 8/tonne of CO2 but are exempted from paying taxes for the portion of their emissions that is covered by voluntarily cancelled CERs (Kainou, 2022).

i. The project must not cause any degradation in local social, economic or environmental domains;
ii. Project emission reductions must be above and beyond business as usual. The mechanism for accounting, certification, reporting and verification should be defined and initiated before considering them as fulfilling emission reductions commitments under the CDM of Annex I Parties (UNFCCC, 1998). The project must demonstrate that it was undertaken for its emission reduction benefits known as “additionality”;

iii. Project must create real, measurable and verifiable GHG reductions and must measure and report the amount of GHGs reduced (in tonnes) verified by an independent party. The project can also not cause increase of GHGs in another location, e.g. across a border - this is known as “leakage”;

iv. Projects must bring appropriate technology. Technologies that are transferred must be appropriate to the needs and business environment of the host country; and

v. Total involvement – Credits owner must be identified and should be involved in all contract negotiations about transfer of ownership of the CERs, with evidence that the CERs generated are owned by the party selling them.

3.4 Economic benefits of CDM

Apart from benefits related to sustainable development, technology transfer, poverty reduction, access to energy efficient lighting and cooking, improvement of air quality and living conditions, reduction of costs and generation of jobs and skills, CDM can have economic benefits. In China, a CDM Afforestation/ Reforestation project promoted local economic growth by optimising the local industrial structure, increasing the regional capital stock and raising the regional government's fiscal revenue and expenditure (Hu et al., 2021).

Significantly greater investments are required to reduce emissions from developed countries own advanced and huge industries than it would take them to develop cleaner processes in developing countries. In developing countries, marginal investments can significantly reduce emissions through small-scale and effective technology upgrades (Ukabiala, nd).

A liquidation scheme for CDM which centred on the cancellation system was almost completed by 2020. The liquidation was aided by the fact that many investing companies begrudgingly accepted loss-cutting cancellation of CER credits upon expiry of the project period (ten years, or seven years with two possible renewals). However, the CDM scheme was revived with unexpected support from the US and developing countries (Kainou, 2022).

3.5 Non-Carbon benefits

Non Carbon benefits were extensively discussed in section 2.6 and they apply to all forest based initiatives where the main target is emission reduction or Carbon sequestration.

Activity 3.1 (Brainstorming) (20 Minutes)

- What do you understand by the term REDD+ and how has it been implemented in your country?

Further reading

UNFCCC. 2021b. CDM-Methodology-Booklet_fullversion.pdf (unfccc.int)
UNFCCC CDM website: https://cdm.unfccc.int/
CDM methodologies, submission of proposed new methodologies and requests for clarification and revision: https://cdm.unfccc.int/methodologies/index.html
CDM project cycle: http://cdm.unfccc.int/Projects/diagram.html
CDM project activities: https://cdm.unfccc.int/Projects/index.html
CDM programmes of activities (PoA).

3.6 REDD+ process

3.6.1. History of REDD+

The REDD+ process began with the concept of RED which was first proposed at COP 11 in Montreal in 2005 (Figure 15).

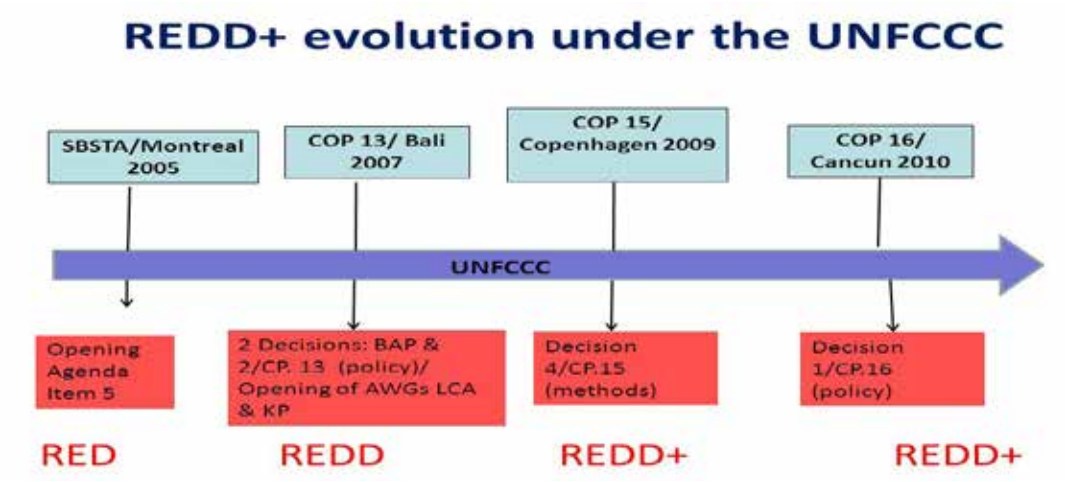


Figure 15: REDD+ evolution under UNFCCC

This was later changed to REDD where the second 'D' represented forest Degradation. Then REDD+ emerged where the "plus" includes afforestation, poverty alleviation, biodiversity conservation and improved forest governance. This was adopted at COP 19 in 2013 in Warsaw and was supported by seven decisions making the Warsaw Framework for REDD-plus (Decisions 9-15/CP.19) (UNFCCC, 2014a). The chronology of major decisions by the UNFCCC COP, starting with KP is outlined below:

i. KP (1997) - incorporated provisions on LULUCF activities in developed countries (Annex I), permitting them to credit to their reduction or stabilisation targets removals in the LULUCF sector. Flexibility mechanism under the Protocol (CDM and JI), provided options for Annex I countries to meet their emission reduction targets by investing in "offset projects" in developing countries;

ii. COP 11 Montreal (2005) - The concept of RED was introduced. This only included changes from "forest" to "non-forest" land cover types and details very much depend on the national definition of a forest;

iii. COP 13 Bali (2007) - Bali Action Plan was developed for REDD catering for deforestation and forest degradation and provided five pillars that form the basis of future activities by the Parties outside KP: adaptation, mitigation, shared vision, finance and technology transfer. RED was expanded to include forest degradation, the role of conservation, sustainable management of forests and enhancement of forest Carbon stocks in the scope of methodological issues to be explored by Subsidiary Body on Scientific and Technical Advice (SBSTA);

iv. COP 14 Cancun (2008) - SBSTA identified the REDD+ methodological concerns that needed to be elaborated and these were linked to: estimation and monitoring, reference emission levels (REL), displacement of emissions, national and subnational approaches, capacity-building, effectiveness of actions and cross-cutting issues. The "plus" in REDD+ was explicitly recognised as additional activities that can be financed focusing on the role of conservation, sustainable management of forests and enhancement of forest carbon stocks;

v. COP 15 Copenhagen (2009) - Agreement on five activities related to REDD+;
vi. COP 16 Cancun Agreements (2010) - Established four REDD+ elements to be developed by developing country Parties who want to participate in REDD+ and these included: a national strategy or action plan, national forest REL and/or forest reference level (FREL/FRL), national forest monitoring system and SIS (see Box 3.4 on establishment of the seven REDD+ safeguards). Other issues identified for inclusion in developing country REDD+ strategies and action plans include: drivers of deforestation and forest degradation, land tenure, forest governance, gender considerations and safeguards;
vii. COP 17 in Durban (2011) - added SIS and modalities relating to FREL/FRL;
viii. COP 18 in Doha (2012) - developed work programme to focus on ways and means to transfer payments for results-based actions, ways to incentivise non-Carbon benefits, and ways to improve the coordination of results-based finance;
ix. COP 19 Warsaw (2013) - Warsaw Framework for REDD+," agreed on seven decisions completing the "package" of REDD+ rules and procedures needed to get results-based actions and payments off the ground;
x. COP 20 Lima (2014) - Emphasised the need for further guidance on SIS and non-market-based approaches for REDD+; and
xi. In December 2015 - the Paris Agreement was adopted and encourages forest-based nature-based solutions through its REDD+ framework (UNFCCC, 2021c).

3.6.2 Definitions of REDD+

The REDD+ international initiative strategy is a process for reducing emissions from deforestation and forest degradation, sustainably managing forests, and conserving and enhancing Carbon stocks leading to mitigation of climate change in developing countries by reducing the release of Carbon stored in forest ecosystems. In this regard, REDD+ can include all projects contributing to emission reductions from avoided deforestation and forest degradation, SFM, conservation and enhancement of forest Carbon stocks that were not eligible under CDM or other KP mechanisms. Reducing deforestation and forest degradation lowers GHG emissions, with an estimated technical mitigation potential of 0.4–5.8 GtCO2 yr-1 (IPCC, 2019).

In the 2010 Cancun Agreements (COP 16), REDD became REDD+ and activities eligible to be qualified as REDD+ were defined as:

i. Reducing emissions from deforestation;
ii. Reducing emissions from forest degradation;
iii. Conservation of forest Carbon stocks;
iv. Sustainable management of forests; and
v. Enhancing forest Carbon stocks.

3.6.3 Development and implementation of REDD+

REDD+ is a financing framework aimed at transforming land use patterns in developing countries and a bridge to finance the transition to a low Carbon development pathway. REDD+ focuses on investments in low Carbon growth opportunities that reduce pressure on forests and the strategies include a portfolio of activities including multiple use landscapes, sustainable extractive activities and traditional conservation strategies. Development and implementation of REDD+ follows key steps and procedures but has to include explanation of mitigation strategies, financing (public, private or other), stakeholder involvement and how benefits will be shared, biodiversity and ecosystem services, institutional frameworks and issues of leadership and management.

Local empowerment and local "ownership" in REDD+ programmes are critical to long-term success. REDD+ includes processes that meet the principle of FPIC and proper identification and representation of stakeholders in different planning processes. Furthermore, REDD+ programmes should create sustainable economic alternatives to forest destruction that generate economic growth with long-term livelihood improvement, protecting biodiversity and ecosystem services. REDD+ programme should also assess the legal and institutional arrangements to determine appropriate combinations of existing and new institutions to support the REDD+ programme. Above all these, the need for strong political will and capacity cannot be over emphasised.

3.6.4 Phases of REDD+

The UNFCCC has outlined a three-phased approach to implementing REDD+ (Angelsen et al., 2012; UNFCCC, 2010, 2014) (Figure 16).

Phase I – the 'readiness' phase – involves developing national strategies, policies and measures, accounting frameworks and capacity building;

Phase II – the 'implementation' phase – involves implementation of national strategies, policies and measures, technology development and results-based demonstration activities; and

Phase III – the 'results-based payment' phase – involves payments for fully measured, reported and verified emission reductions.

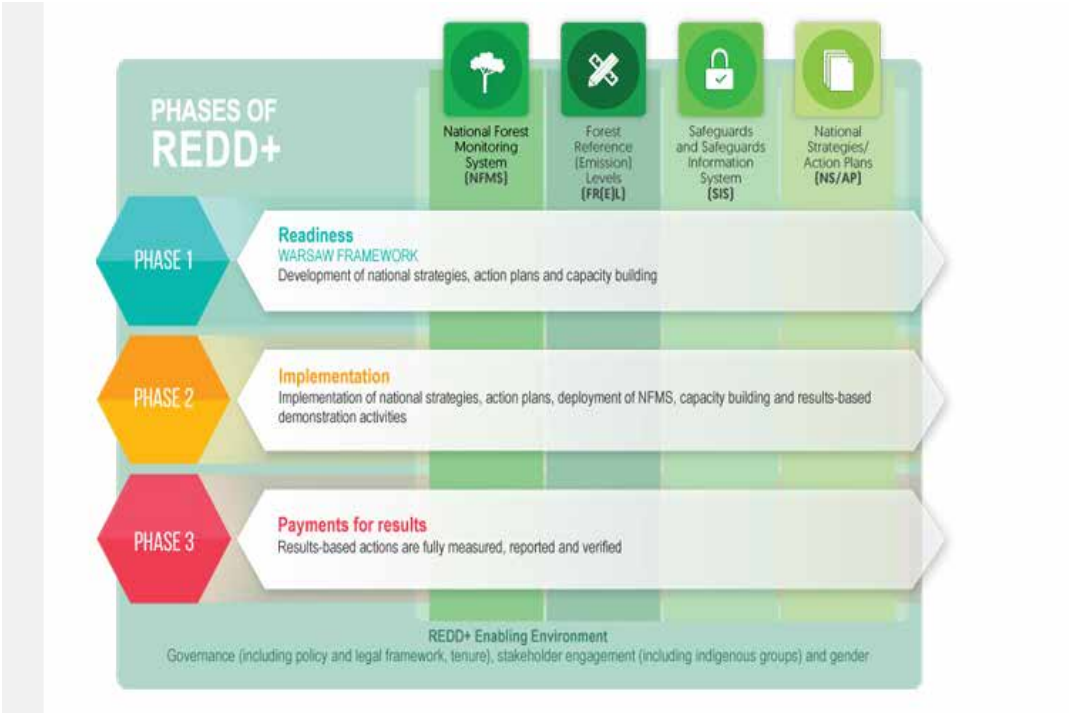


Figure 16: Phases of REDD+

(Source: https://www.fao.org)

3.6.5 Requirements

In getting 'ready' and 'implementing' REDD+, the UNFCCC identifies four elements that REDD+ countries must establish (UNFCCC, 2010) (Box 3.1).

Box 3.1 Elements of REDD+

i) Development of national REDD+ strategies and action plans- this involves a detailed assessment of a country's situation with respect to deforestation and forest degradation, relevant governance issues, and a proposition of policies and measures to realise REDD+;

ii) Setting of FREL – Under this element, a baseline of emissions against which any future emission reductions would be monitored is established;

iii) Development of a MRV) system to monitor, account for and internationally report on any changes in Carbon emissions as a basis for payments. Use of rigorous transparent and replicable methods with careful reporting of uncertainty levels, and conservative estimates is included. It includes reference levels, scope, MRVs, leakage and permanence; and

iv) Development of REDD+ safeguards to ensure that REDD+ activities do not compromise the livelihood of forest dependent communities. The safeguards also ensure that biodiversity is conserved.

3.6.6 REDD+ methodological decisions

Methodological decisions can take more than one year even up to three years or more depending on responses. The decisions are based on the four methodological elements of the Cancun Agreements:

i. National Strategies or Action Plans;

ii. FREL/FRLs;

iii. National Forest Monitoring Systems (NFMS); and

iv. SIS on how safeguards are being respected and addressed.

Furthermore, the REDD+ project should contribute to the sustainable development of the local community (UNEP, nd). Methodological decision for REDD+ follow a nine stage process beginning with a project idea note (PIN) for reducing or avoiding Carbon emissions ending with verification and issuance of Carbon credits. The process requires some extra financing or some assistance to secure finance. Identification of partners and a Standard that can be used are done before development of a PIN and presentation of the project to credit buyers. After this, funding is sought for PDD followed by implementation, culminating in verification and issuance of Carbon credits. REDD projects can generate income for 10 years or more. The chronology of the stages is shown in Figure 17.

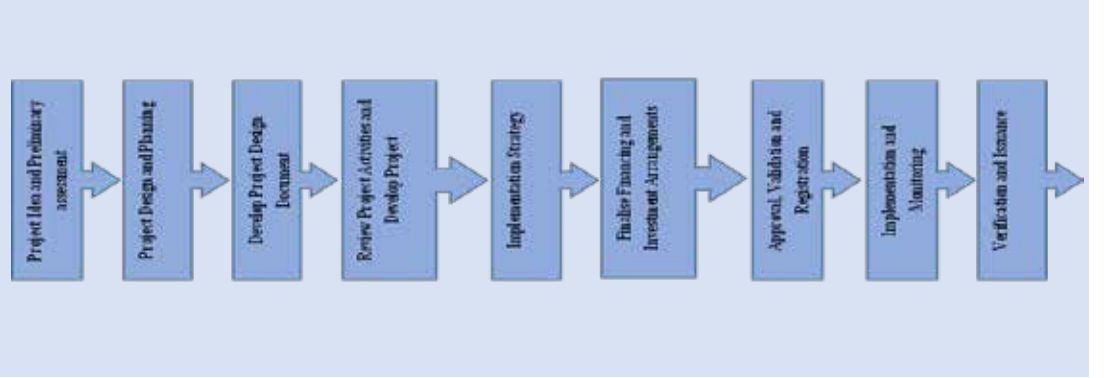


Figure 17: The REDD+ process

3.6.7 Regulatory frameworks on REDD+

The UNFCCC COP established rules and provided methodological guidance for the operationalisation of REDD at COP 19 in Warsaw, in 2013. The framework outlined the requirements expected to be met by developing countries in order to participate in the international REDD+ mechanism under the UNFCCC and they receive results-based payments. Five core elements of this framework include institutional arrangements, finance, safeguards, NFMS (plus MRV), and RELs/reference levels. The decisions supporting the core elements are outlined in Box 3.2.

Box 3.2: Warsaw Framework Decisions supporting the five core elements of REDD+

Decision 9/CP.19: - Work programme on results-based finance to progress the full implementation of the activities referred to in decision 1/CP.16, paragraph 70.

Decision 10/CP.19: Coordination of support for the implementation of activities in relation to mitigation actions in the forest sector by developing countries, including institutional arrangements.

Decision 11/CP.19: Modalities for NFMS.

Decision 12/CP.19: The timing and the frequency of presentations of the summary of information on how all the safeguards referred to in decision 1/CP.16, Appendix I, are being addressed and respected.

Decision 13/CP.19: Guidelines and procedures for the technical assessment of submissions from Parties on proposed FRELs/FRLs.

Decision 14/CP.19: Modalities for MRV.

Decision 15/CP.19: Addressing the drivers of deforestation and forest degradation.

(Source: Warsaw Framework for REDD-plus | UNFCCC)

There are several elements of REDD+ frameworks and they include non-binding policy instruments such as strategy, policy, and plans and programmes and legally binding instruments such as statutory laws and regulations (Denier et al., 2014). These will be discussed in detail under REDD+ governance in section 3.8.

3.7 Economic benefits of REDD+

Different REDD+ options can have different economic benefits from the different combinations of forest conservation for biodiversity benefits, the Carbon stocks, and other ecosystem services (Narloch et al., 2012). These benefits from the forest can have high economic values through the production of various goods and services that support local livelihoods and national economies (TEEB, 2010) However, economic importance of REDD+ options are often not valued and therefore, are not visible because they are not directly accounted for in local and national markets.

Forests provide NTFPs that serve as food, raw materials and medicine in rural communities as the goods are either used for subsistence or are sold at local markets, thus playing an important role in rural well-being and livelihoods. The NTFPs create a serving on the purchase of food while creating income from NTFPs sales.

3.8 Governance issues in REDD+

Governance is a key priority for most REDD+ interventions and is shown by how public and private entities design and enforce decisions linked to use, management and conservation of forest resources (FAO, 2023). REDD+ activities are more effective especially on the long term in regions where governance and law enforcement are strong or are being enhanced. Good governance implies effective decision-making, transparency, adequate capacities and integrity. Governance can be effectively part of protecting and enhancing forest Carbon stocks by observing Cancun safeguards for national level REDD+ and/or working with design standards such as the Climate Community and Biodiversity Standards for project level REDD+.

Governance system for REDD+ has basically three different components of legal, compliance and institutional frameworks. To address underlying governance issues, the following should be addressed to ensure the realisation of REDD+ goal: access to information; access to justice; public participation; Carbon rights; clear land tenure rights; gender equality; anti-corruption; benefit distribution; consistency between sectorial laws and policies; and vertical and horizontal coordination (Denier et al., 2014). The links between the three governance frameworks is shown in Figure 18.

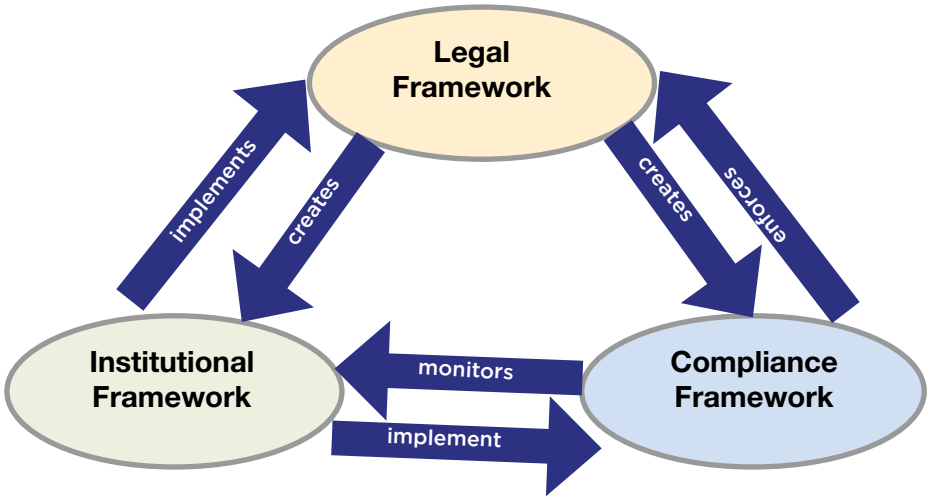


Figure 18: The inter-linkages between components of a REDD+ governance system (After Denier et al., 2014)

Legal frameworks - the key elements of the legal framework are represented by non-binding policy instruments in the form of strategy, policy, plans and programmes and legally binding instruments composed of statutory law and regulations. Legal status of customary law is however not very clear because it is not established or defined by the state and is not normally enforceable in national courts.

Compliance frameworks - the compliance framework ensures that actions comply with the rules set out by the legal framework and addressing any grievances that may arise. The framework is created by the legal framework and implemented by the institutional framework and includes monitoring, enforcement (or 'non-compliance'), and dispute resolution functions. Monitoring tracks performance of implementing entities based on the rules established in the legal framework. Enforcement measures are triggered when non-compliance occurs. These could be administrative or judicial in nature, and should aim to provide a legal opportunity for redress (Denier et al., 2014). Furthermore, the governance system needs to ensure that actors who might be affected by the implementation of an activity are supported by strong mechanisms for addressing grievances.

Institutional frameworks - an institutional framework is mainly composed of public administrative bodies whose mandates and powers are established by the legal framework. This includes institutions or agencies that are responsible for delivering REDD+ strategies and action plans, national or subnational reference levels. Includes a robust and transparent system to measure, report and verify forest change, a system to provide information on how safeguards are being addressed and respected, and a system for the receipt, management and disbursal of REDD+ finance (UNFCCC Decision 1.CP/16, UNFCCC Decision 9/CP.19). Denier et al. (2014) showed that the institutional framework has two roles:

i. The implementation of the strategies, policies, programmes, plans and legislation, constituting the legal framework at national and sub-national levels. This can include implementing mechanisms for stakeholder consultation, and their participation in planning and implementation; and

ii. The implementation of the compliance framework.

Further reading

Holloway, V. and Giandomenico, E. 2009. The History of REDD Policy. Carbon Planet White Paper. The History of REDD (unfccc.int).

Denier, L., Korwin, S., Leggett, M. and MacFarquhar, C. 2014. The Little Book of Legal Frameworks for REDD+, Global Canopy Programme: Oxford. https://globalcanopy.org/wp-content/uploads/2020/12/LittleBookofLegalFrameworksforREDD_EN.pdf.

3.9 Importance of multi-stakeholder participation and consultation in REDD+

Stakeholders are defined as those groups that have a stake/interest/right in the forest and those that will be affected by REDD+ activities positively or negatively (Box 3.3). Stakeholders include relevant government agencies, formal and informal forest users, private sector entities, indigenous peoples and other forest-dependent communities. Stakeholders include national government agencies, civil society organisations (CSOs), community-based organisations, indigenous peoples' organisations, NGOs, local people, environmental law enforcement agencies and academia (UN-REDD, 2012). Stakeholder involvement should be based on transparency and timely dissemination of information at all levels, in a socially appropriate way, including access to prior information linked to proposed consultation activities.

Box 3.3 Engaging Indigenous Peoples and Other Forest Dependent Communities
The UN-REDD Programme considers stakeholder engagement to be an indispensable priority for REDD+ for the following reasons:

i. The UNFCCC decisions call for Parties to the Convention to ensure the full and effective participation of relevant stakeholders in the design and implementation of REDD+ strategies and action plans in particular indigenous peoples and local communities;

ii. Meaningful stakeholder engagement has been strongly requested by donors, civil society and REDD+ countries from the early days of REDD+ conceptualisation;

iii. Successful implementation of REDD+ depends on buy-in across a wide range of stakeholders to enact reforms that may be necessary; and

iv. The UN-REDD Programme follows a human-rights based approach, which mandates adherence to and promotion of the core human rights principles of participation, non-discrimination, transparency and accountability (UN-REDD, 2022)..

Stakeholder engagement is not only a matter of integrating the views of the different actors affected by REDD+ but is also important for crafting consensus, partnerships and inclusive policies and processes that make REDD+ transformational, achievable and long-lasting. The importance of different stakeholders are discussed below.

3.9.1 Governments and others state actors in REDD+

Although UN-REDD Programmes are implemented by FAO, UNDP and/or UNEP, the UN-REDD Programme is not an exclusive UN mechanism because national governments, regional development banks and NGOs can receive funding through one of the participating UN organisations when they act as executing agencies. Governments have the following prominent roles during the whole National Programme cycle:

i. Managing the preparation of the National Programme;

ii. Signing the final National Programme document before it is transmitted to the Secretariat for consideration; and

iii. Appointing a national focal point for the coordination and implementation of the activities under the Programme.

Furthermore, the country programme oversight is undertaken by a National Steering Committee in line with the principle of strong country ownership and shared and common decision-making (Schalatek et al., 2017).

3.9.2 Local communities, indigenous peoples and the REDD+

Local communities are either affected positively or negatively by any intervention. REDD+ has a significant impact on biodiversity conservation and restoration, livelihoods and the preservation and recovery of a broad range of ecosystem services provided by forests (UN-REDD, 2012). However, engagement of local communities is important for ensuring participation following the rights-based principle of FPIC applicable to REDD+ discussions about potential changes in resource uses that could impact livelihoods of indigenous peoples.

The active involvement of indigenous peoples and other forest-dependent communities in forest management produces positive results, such as reducing rate of deforestation. However, indigenous peoples and other forest-dependent communities are often disproportionately impacted by ecosystem degradation and they often lack political power and voice (UN-REDD, 2022).

REDD+ sustains ecological functions through provision of ecosystem services, functions or processes that directly or indirectly contribute to human well-being. However, the ecosystem services and their value vary considerably in terms of extent of impact and the beneficiaries concerned (Mullan, 2014).

3.9.3 Private sector and REDD+

The private sector as defined by UN, encompasses individual, for-profit, commercial enterprises or businesses; business associations and coalitions as well as corporate philanthropic foundations (UN, 2009). The private sector can range from the individual up to the largest multinational corporation employing millions of people, covering a wide spectrum, from those living a subsistence lifestyle to highly profit-focused enterprises. It includes formal and informal sectors, foreign and domestic enterprises, including actors along the length of supply and value chains. There are two groups of private sector groups that are relevant in the context of REDD+: i. Those producing VERs; and ii. Those supplying chains of forest-risk commodities. There are however, other private sector actors involved in harvesting non-timber forest goods who can be important forest stewards to reduce forest loss (Henderson et al., 2013).

Interventions can include private sector relative to land use and can range from the implementation of policies to the creation of financial instruments, development of certification schemes and other interventions of a voluntary nature and influence behaviour through varying degrees of legality, price and awareness. In this regard, the private sector is important for realising opportunities presented by REDD+ as designers, developers, operators and enablers of 'forest-friendly' initiatives at a variety of scales. The private sector becomes a source of implementation, innovation and investment and is a key REDD+ stakeholder whose engagement can be broadened to slow, halt and reverse forest cover loss. Engagement of private sector in REDD+ can be achieved through incentives, risk mitigation instruments, setting of minimum standards and enabling conditions (Henderson et al., 2013).

3.9.4 Civil Society Organizations including NGOs

CSOs are important for ensuring that activities are carried out in a transparent and professional manner. For example, the civil society platform contributed to ensuring that key provisions for the rights of local communities and indigenous peoples are integrated in the National REDD+ Framework Strategy. The CSO is also important for creating and maintaining a dynamic link between decision-makers and local communities to ensure that policies become fair and efficient (Rainforest Foundation, 2018).

CSOs are important for facilitating communication and disseminating between levels, raising awareness and building capacities for others, implement projects and they play advocacy role affecting decisions. They are also important in monitoring and reporting development activities and environmental issues.

3.9.5 Women and marginalised groups

The role of indigenous peoples, particularly indigenous women, in preserving traditional knowledge, and native plants in water and forests and their management, is important in REDD+. Women have a wealth of knowledge and strong relationships with forest systems, making them important actors for REDD+ initiatives yet they are marginalised in community decision making and sharing the benefits of climate investment finances. In this regard, they remain under-valued agents for addressing forest loss (FAO and UNEP, 2021).

Climate change programmes consider gender equality as a significant project component that ensures that the outcomes and outputs of the programme achieve the desired results. For example, the UN-REDD Programme presents gender equality and women's empowerment as catalysts for reaching goals for REDD+ (gender-responsive policy and in practice) and sustainable development.

The ability of men and women to participate and benefit from REDD+ initiatives is shaped by a multitude of socioeconomic contexts and cultural norms that are often characterised by gender inequality and marginalisation of women (IIED, 2012). IIED (2012) identified four key areas that support integration of gender equity in REDD+ and these include:

i. Building an understanding of gender-differentiated roles and needs;

ii. Addressing gendered use, access to and control of resources, knowledge and power;

iii. Affording women equal representation and influence in all decision-making arenas; and

iv. Introducing affirmative action to advance gender equity and integrating monitoring and evaluation of impact.

3.10 Pro-poor REDD+ approach

The poor people in developing countries are often dependent on forests for both subsistence and cash income because of lack of alternative sources of income and livelihoods. They resort to forest resources for survival as they are perceived as free or open access goods especially timber, firewood and charcoal. Therefore, REDD+ effectiveness depends on involvement of the poor and vulnerable groups (women, landless and youths) in the project cycle. This includes helping communities to secure tenure rights for trees and forests and helping with alternative sources of income that eliminates unsustainable harvesting of forests products (CTCN, 2015).

REDD+ pilot projects in Tanzania have demonstrated importance of pro-poor approaches by increasing the reach and effectiveness of interventions. The approaches consider interests of the poor, forest dependent communities (mainly women and other marginalised groups) and the need to strengthen their rights and improve livelihoods (CTCN, 2015). Social and environmental safeguards are a form of pro poor initiative.

3.10.1 Social and environmental safeguards for REDD+

REDD+ interventions become more robust and reliable by observing the safeguards specifically developed for REDD+. The UN members agreed on a number of safeguards, known as the Cancun safeguards for REDD+ in 2010 (Decision 1/CP.16, Appendix I, par. 2), to limit risks and maximise social and environmental benefits while implementing REDD+ in developing countries. Box 3.4 shows the safeguards. The principles of these safeguards should be addressed and respected; should be country-driven, implementation at national level; and they should build upon existing systems. For example, the UNFCCC Warsaw Framework for REDD+ outlined three key safeguard-related requirements for countries participating in REDD+ and pursuing results-based payments. The safeguards are to:

i. Ensure that REDD+ activities, regardless of the source and type of funding, are implemented in a manner consistent with the UNFCCC REDD+ safeguards (the Cancun safeguards (Box 3.4));

ii. Develop a system for providing information on how the safeguards are being addressed and respected throughout the implementation of REDD+ activities; and

iii. Submit the most recent summary of information on how all the Cancun safeguards are being addressed and respected.

Box 3.4: The Cancun safeguards (UNFCCC Decision 1/CP.16 Appendix 1 paragraph 2
When undertaking the activities referred to in paragraph 70 of this decision, the following safeguards should be promoted and supported:

- That actions complement or are consistent with the objectives of national forest programmes and relevant international conventions and agreements;
- Transparent and effective national forest governance structures, taking into account national legislation and sovereignty;
- Respect for the knowledge and rights of indigenous peoples and members of local communities, by taking into account relevant international obligations, national circumstances and laws, and noting that the United Nations General Assembly has adopted the United Nations Declaration on the Rights of Indigenous Peoples;
- The full and effective participation of relevant stakeholders, in particular indigenous peoples and local communities, in the actions referred to in paragraphs 70 and 72 of this decision;
- That actions are consistent with the conservation of natural forests and biological diversity, ensuring that the actions referred to in paragraph 70 of this decision are not used for the conversion of natural forests, but are instead used to incentivise the protection and conservation of natural forests and their ecosystem services, and to enhance other social and environmental benefits (taking into account the need for sustainable livelihoods of indigenous peoples and local communities and their interdependence on forests in most countries, reflected in the United Nations Declaration on the Rights of Indigenous Peoples, as well as International Mother Earth Day);
- Actions to address the risks of reversals; and
- Actions to reduce displacement of emission.

(Source: UNFCCC, 2011)

REDD+ projects and policies that are based on these safeguards guarantee that climate and other impacts are real and remain intact for the long term. The UNFCCC also requires developing country partners to address drivers of deforestation and forest degradation, gender, land tenure and forest governance when developing and implementing their national REDD+ strategies or action plans.

The safeguards are applied when dealing with rights and traditional knowledge of indigenous people, governance, stakeholder participation, biodiversity and conservation of natural forests, permanence and leakage. Parties are required to provide a summary of information on how safeguards are addressed and respected, before results-based payments can be received (Braña Varela et al., 2014). Positive impact to stakeholders, including forest-dependent communities, and their involvement at all stages of design and implementation, goes hand in hand with ensuring permanent Carbon storage.

In addition to the UNFCCC safeguards, the main funding mechanism for REDD+ have additional safeguards supporting their operations. Table 3 highlights the differences in the two funding mechanisms.
The World Bank adopted a new set of environment and social policies in August 2016 and are referred to as the Environmental and Social Framework (ESF) which offers a broad and systematic coverage of environmental and social risks. The framework outlines the requirements for Borrowers relating to the identification and assessment of environmental and social risks and impacts associated with projects supported by the Bank through Investment Project Financing. Box 3.5 shows the policies included in ESF.

Table 3: Overview of additional requirements for REDD+ funding

FCPF	GCF
Countries apply Cancun safeguards and the 11 Operational Policies of the World Bank (triggered as relevant)	Countries apply Cancun safeguards and the provisional 8 standards of the International Finance Cooperation (triggered as relevant)
Countries must carry out a SESA, and implement the Safeguards Plans prepared in accordance with ESMF that has resulted from the SESA	Countries must conduct an environmental and social assessment and establish and maintain an Environmental and Social Management System
Benefit Sharing Plan must be in place as it is a requirement of all Emission Reduction Programmes	A benefit sharing plan must be in place linked to the Indigenous People Plan
A Feedback and Grievance Redress Mechanism must be in place as it is a requirement of all Emission Reduction Programmes	GCF Environmental and Social Standard (ESS) require relevant stakeholders have access to grievance mechanisms

Source: Rey et al. (2018)

These ESF standards aim to:

i. Support Borrowers in achieving good international practice relating to environmental and social sustainability;

ii. Support Borrowers in fulfilling their national and international environmental and social obligations;

iii. Enhance non-discrimination, transparency, participation, accountability and governance; and

iv. Enhance the sustainable development outcomes of projects through on-going stakeholder engagement.

Box 3.5 Environment and social policies of ESF:

i. ESS 1: Assessment and Management of Environmental and Social Risks and Impacts;
ii. ESS 2: Labour and Working Conditions;
iii. ESS 3: Resource Efficiency and Pollution Prevention and Management;
iv. ESS 4: Community Health and Safety;
v. ESS 5: Land Acquisition, Restrictions on Land Use and Involuntary Resettlement;
vi. ESS 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources;
vii. ESS 7: Indigenous Peoples/Sub-Saharan African Historically Underserved Traditional Local Communities;
viii. ESS 8: Cultural Heritage;
ix. ESS 9: Financial Intermediaries; and
x. ESS 10: Stakeholder Engagement and Information Disclosure.

In text Question(s) (10 minutes))

i) What are core elements of REDD+.

ii) Explain the importance of compliance in climate change initiatives.

iii) Explain the importance of at least two stakeholder categories in REDD+.

3.11 Financing mechanisms, instruments and other opportunities for REDD+

Climate finance for mitigation is needed because of the large-scale investments required to significantly reduce emissions as it is equally important for adapting to the adverse effects of a changing climate. Programmes for financing REDD+ provide countries with support for making national REDD+ strategies or action plans, strengthening NFMS and establishing national emissions baselines, plus designing environmental and social safeguards systems to meet international standards (Green Climate Fund, 2019).

Some pledges for additional forest financing were made by governments of Germany, United Kingdom and Norway who promised yearly funding for REDD+ to countries developing ambitious proposals, with US$ 1 billion per year by 2020, or over US$ 5 billion between 2015 and 2020. The World Bank also planned to mobilise approximately US$ 2 billion for forests and resilient landscapes through the Africa Climate Business Plan (World Bank, 2015).

FCPF is a global partnership of governments, businesses, civil society, and indigenous people's organisations administered by the World Bank, focusing on supporting REDD+ efforts. The countries participating in the FCPF include countries in Africa (18), Latin America (18) and the Asia-Pacific (11) regions. As of June 2018, the FCPF Readiness Fund had disbursed US$ 128 million. Examples of World Bank funding are shown in Box 3.6.

The UN-REDD Programme has worked with 64 partner countries over the past decade with financing reaching a total of US$ 319.63 million over the period 2008 to 2018 (UNDP, 2019). As of April 2019, Congo, Côte d'Ivoire, the Democratic Republic of the Congo, Nigeria and Uganda had benefited from the two REDD+ programmes i.e. FCPF and the UN-REDD Programme.

Another financing mechanism is FIP, which was established in 2008 as part of the CIF (US$ 749.9 million). FIP has established a portfolio of 34 projects, of which 21 with a total of US$ 340.6 million have active investments and are being implemented Brazil, Burkina Faso, the Democratic Republic of the Congo, Ghana, Indonesia, the Lao People's Democratic Republic, Mozambique and Mexico (Green Climate Fund, 2019). In Africa, the Democratic Republic of the Congo, Ghana, Burkina Faso and Mozambique were among the top ten recipients of REDD+ funds between 2008 and 2019. The amounts allocated are given in Table 3.

Box 3.6 Examples of World Bank funding in Africa

There are three forest trust funds under the World Bank: FCPF FIP and the BioCarbon Fund. These funds support REDD+ at a large or 'landscape' scale by combining up-front investments, technical assistance packages and performance-based payments to ensure sustainable development for the countries and communities. Examples are: the Congo Basin forests which are the green lung of the African continent, providing vibrant regional and global ecological services. The World Bank supported the Congo basin countries, with a grant of US$ 13 million from GEF preparing the countries to benefit from a future REDD+ incentive mechanism by building institutional and technical capacities. The regional integration prevents deforestation from moving from one country to another and helps countries to combine resources towards cutting-edge forest and Carbon monitoring, capacity building, analytical and field work. Integration also improves countries' influence in international climate negotiations. Initiative was implemented by the Central Africa Forests Commission (World Bank, 2016).

In Ethiopia, the Oromia Forested Landscape Programme, a land regeneration project initially covering over 2 700 hectares paved the way for a large-scale initiative spanning 8.7 million hectares of forest in Oromia state. The programme seeks to reduce deforestation by improving SFM, and lowering GHG emissions from land use, including from the livestock sector, by encouraging better herd management, thus improving land use systems, forest retention, and forest gains.

In Zambia, Integrated Forest Landscape Programme seeks to improve landscape management and increase the environmental and economic benefits for targeted rural communities in Zambia's Eastern Province. The programme aims to achieve significant emission reductions and reduce communities' vulnerability to the impacts of climate change by curbing unsustainable agricultural expansion and enhancing the benefits derived from forests, agriculture, and wildlife (World Bank, 2021b).

Table 4: African countries among the top 10 recipient countries of REDD+ funding

Country	TOTAL (in millions of US$)
Democratic Republic of the Congo	82,173,200
Ghana	64,486,000
Burkina Faso	40,092,000
Mozambique	37,199,000

In addition to the three programmes discussed above, a GEF, launched GEF-7 (2018-2022), which supports impact programmes such as the SFM which, among other features, focusses on the implementation of REDD+. The mission of GEF is to safeguard the global environment by supporting developing countries in meeting their commitments to multiple environmental conventions and by creating and enhancing partnerships at national, regional and global scales. In this regard, the GEF has a unique mandate across several Multilateral Environmental Agreements. The GEF supports formal financing mechanism under CBD, the United Nations Convention to Combat Desertification (UNCCD), the UNFCCC, the Minamata Convention and the Stockholm Convention and the Montreal Protocol (for economies in transition) (GEF Secretariat, 2018).

3.12 Forest transition curves

The dynamics of forest cover over time is captured and theorised through a theory proposed by Mather (1992), known as the forest transition theory. Forest transitions are experienced differently depending on the location and they occur when forest cover ceases to decline and starts to recover. Angelsen (2009) however, identified five stages, with stages of: i. undisturbed forests, ii. and iii. forest frontiers, iv. forest/ agricultural mosaics and v. forest plantations and agriculture mosaics. Forest transitions have occurred in two, sometimes overlapping circumstances where either economic development has created enough non-farm jobs to pull farmers off of the land (inducing the spontaneous regeneration of forests in old fields) or a scarcity of forest products has prompted governments and landowners to plant trees in some fields. Although the transitions do not conserve much biodiversity, they conserve soil and sequester Carbon (Rudel et al., 2005).

Forest transition describes a sequence where a forested region goes through four stages:

i. Initially high forest cover and low deforestation;
ii. Accelerating and high deforestation;
iii. Slow-down of deforestation and forest cover stabilization; and
iv. A period of reforestation (Angelsen, 2007).

Forest transition curves show the changes in forest cover over time as the value of land uses changes relative to the competing uses, usually causing a rapid decrease in forest area during early industrialisation and development, followed by slow expansion of forest area to lower than original levels (UN-REDD, 2022). The model demonstrates that, natural resource destruction is inevitable to meet human needs at an early stage. Later, the rising demand and price of natural resources will motivate people to conserve and to restore their natural resources. Furthermore, voluntary instruments cause expansion of alternative models of sustainable production that lead to forest recovery (Furumo and Lambin, 2021).

Transition occurs when the declining forest cover trend is reversed into an increasing forest cover trend. Figure 19 shows a simplified transition curve under a REDD+ initiative (Angelsen, 2007).

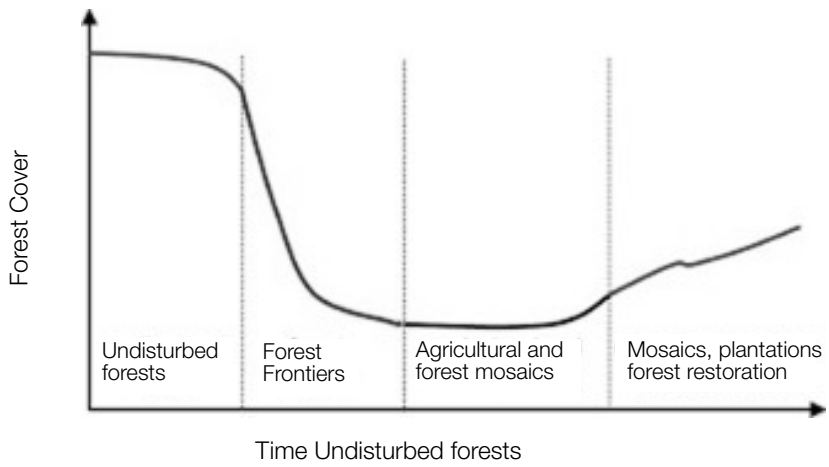


Figure 19: A forest transition curve under REDD+ initiative

The transition can also show stages of policy sequencing along the forest transition curve (Figure 20). The transition curve shows that earlier in the forest transition, coercive instruments can be designed to control deforestation and disrupt operation of existing production models. Instruments are supported by more targeted deployment of incentives.

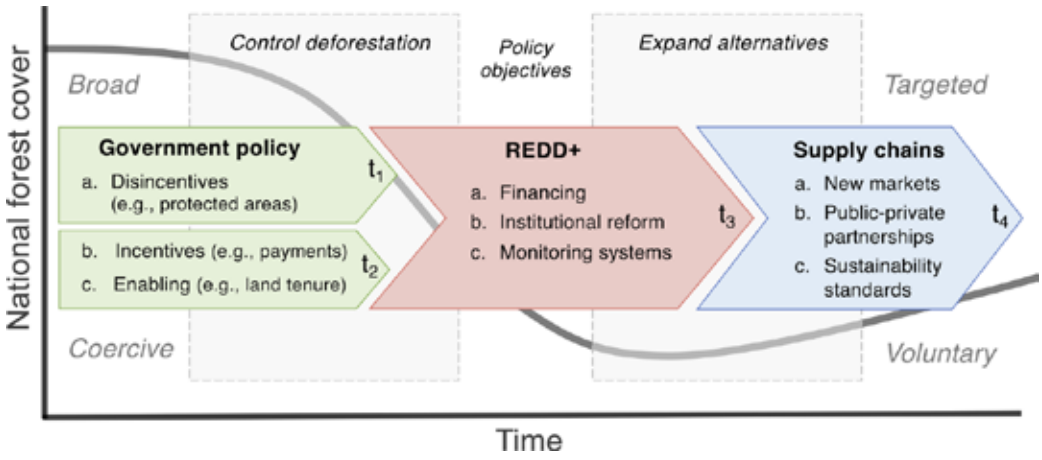


Figure 20: Policy sequence along a forest transition curve

The policy sequence (tn) represents the addition of (not transition to) new actor domains as interventions are added into the policy mix (Source: Furumo and Lambin, 2021).

3.13 Measurement, Reporting and Verification in REDD+

The UNFCCC's decisions on REDD+ and MRV requirements introduced new ideas and demands for forest monitoring in developing countries. The REDD+ countries are not only required to monitor, report and verify REDD+ impacts but also to establish NFMS to perform MRV (UNFCCC, 2009b; UNFCC, 2010). The NFMS established are required to:

i. Use a combination of remote sensing and ground-based methods;
ii. Provide estimates that are accountable, transparent, and should be made publicly available; and
iii. Involve non-state actors including indigenous and forest communities (UNFCCC, 2009b).

Although forest monitoring has mainly been concerned with assessment of timber stocks (Mohren et al., 2012), MRV requires assessment of forest Carbon stocks and their changes as an additional forest variable. These demands can be read as calls for change in the institutional arrangements for forest monitoring in developing countries.
The UNFCCC also encourages REDD+ countries to involve indigenous and local communities in forest monitoring (UNFCCC, 2009b), and to provide forest Carbon estimates that are transparent and accountable. Furthermore, forest monitoring should involve other state agencies as they use both remote sensing and ground-based methods causing a need for other non-forestry agencies. Participation, transparency and accountability constitute key principles of good governance (Kishor and Rosenbaum, 2012; Secco et al., 2013), it is clear that good governance in national forest monitoring and Carbon accounting for REDD+ is imperative. The UNFCCC specifies the technologies and methodologies that can be used for measuring forest area and area changes, and for estimating forest Carbon emissions (IPCC, 2003; IPCC, 2006; UNFCCC, 2009b). This calls for alterations in the methods and participants in national forest monitoring (Gupta et al., 2014).

3.13.1 Other concepts in REDD+

There are criteria for safeguarding and enhancing the impacts of REDD+ activities and they include issues to do with leakage, additionallity, permanence, governance and reference levels. These are discussed below.

Leakage is about the transferring of emissions elsewhere as a result of a REDD+ intervention. In this case, the GHG emissions take place outside the project boundary or the area of intervention, as an unintended result of a project or intervention. This can be unintentionally caused by shifting activities or through market effects, when the prices of goods are influenced by REDD+ interventions. Market leakage (is an increase in GHG emissions after a project changes the supply and demand equilibrium, resulting in other market actors shifting their activities) is generally not important for project based interventions and is more relevant for national policies with large scale impact (UN-REDD, nd).

The REDD+ activities avoid leakage by identifying and assessing drivers of deforestation and forest degradation and how they can be best addressed without creating leakage effects. For example, when the drivers of deforestation change to a more sustainable and profitable land-use or alternative economic activities, this prevents displacement of emissions while contributing to improved livelihoods. The best and most efficient way of addressing leakage is through jurisdictional, subnational or national Carbon accounting. There are however, indications that REDD+ activities contribute to more protection of forests outside the project boundary due to the discouragement of illegal activities.

Additionality is the real Carbon impact that is additional to what can normally be expected without a climate-based intervention and finance. By supporting projects that have demonstrated additionality, the investor has a guarantee that funding is spent on activities that make significant differences for the climate; e.g. protection of forests that are under threat of deforestation or forest degradation. Certification standards demand a conservative approach to Carbon accounting, to ensure that the real Carbon impact is most likely larger than the claimed impact to provide confidence to investors' performance-based payments. In many cases the additionality of conserving forests is marked by many global tropical forests that are under high pressure from deforestation and forest degradation (van Goor and Snoep, 2019).

Permanence is about the long term continuation of the REDD+ impact when Carbon remains stored in the trees and the soil for a long time. Permanence is enhanced through careful assessment, minimisation and mitigation of risks. For example, certification standards as solutions for compensating any unanticipated Carbon losses from Carbon projects, e.g. VCS realises this through a pooled buffer that is maintained by all projects certified under the same standard. If any of the projects has a Carbon loss, it will be compensated for by the Carbon credits that are placed in the pooled buffer. These backstopping mechanisms add to the credibility of forestry projects.

Stakeholder participation - REDD+ projects and policies that are based on an inclusive approach focusing on the participation of stakeholders throughout the REDD+ process, gives legitimacy to the outcome of REDD+, building strong support and therefore contributing to the permanence of protected forests. REDD+ has the potential to create positive social impacts, by avoiding negative social impacts as they involve forest-dependent people and indigenous groups in design and implementation of projects. In tropical areas, forests are important for livelihoods of local population, especially marginalised groups. The forests often act as safety nets. Given the dependence of certain groups on forests, it is important to include them in decision-making, design, development and implementation of project activities and national REDD+.

Most REDD+ projects consider the principle of FPIC to legitimise their REDD+ design and implementation strategy. REDD+ projects developed on the basis of FPIC can become more effective. FPIC ensures that all the stakeholders participate and are well informed about the positive and negative impacts of REDD+. Such involvement facilitates support for REDD+ implementation especially when the formal or customary land rights are clearly defined.

Land tenure and Carbon rights - Clear ownership and use rights are essential for the permanence of emission reductions and GHG removals leading to the long-term success of REDD+. Actors participating in initiatives for reducing emissions and slowing deforestation need the long-term rights that can be rewarded. A clear definition of Carbon and land rights in the areas where REDD+ is implemented is important because lack of distinct rights results in a situation where competing claims and conflicts can decrease the incentive to implement REDD+ (Loft et al., 2017). This is the reason, certification standards require projects to prove their respect for rights and how overlapping claims and conflicts over use rights are properly addressed.

In developing countries, land tenure rights are often customary or traditional and not really, formalised. REDD+ initiatives offer great potential for the formalisation of rights, giving local communities' confidence on their land ownership, which can be considered as collateral. REDD+ has also a strong potential to make local or indigenous communities to be able to face economic threats that have an impact on deforestation through agricultural activities, corruption, mining and human settlement. For example, the period between 2004 and 2012, saw REDD+ having potential to reduce deforestation by preventing threats from other economic sectors in Brazil. Implementation of REDD+ by indigenous groups results in reduced deforestation and protection of forests (Savedoff, 2018).

3.14 Other forest-based climate change mitigation initiatives

3.14.1 Paris Agreement and the NDC mitigation options

The Paris Agreement was discussed in section 1.7. The implementation of the Paris Agreement works on a five-year cycle and requires economic and social transformation, based on the best available science. Initiatives such as CDM, REDD, NAMAs, etc. were repackaged in the NDCs processes. By 2020, countries were expected to submit their plans for climate action through their NDCs outlining their long-term low GHG emission development strategies (LT-LEDS) to the UNFCCC (UNFCCC, 2016b). However, LT-LEDS are not mandatory but they provide a vision and direction for future development for the country (UNFCCC, 2016b). The Paris Agreement requests countries to outline and communicate their post 2020 actions through NDCs. NDCs become national determinations for implementation of national responses to climate change that contribute to global climate action. Box 3.7 shows examples of NDC mitigation options in Africa.

Box 3.7: Examples of NDCs in Africa

Ethiopia - NDC expects forestry sector to contribute more than 50% (132 Mt CO2e) of the national goal to reduce emissions by 255 MtCO2e by 2030. The National REDD+ Strategy identified forests and REDD+ as central for reducing GHG emissions and outlines a series of actions to achieve this. The National Forest Sector Development Programme aims to transform the forestry sector, being the main guiding document for coordinating strategic policy interventions and sector-wide investments for the coming ten-years. The targets include doubling forest cover to 30% land cover, reducing national emissions by half in 2030, and increasing the Gross Domestic Product contribution of the forestry sector from 4 to 8%.

Madagascar –The concrete actions related to forestry and land use include:

- Large-scale reforestation (270,000 hectares) for sustainable timber production and indigenous species for conservation;
- Reduction of forest timber extraction, promotion of REDD+ and large-scale adoption of agroforestry; and
- Enhanced monitoring of forest and grassland forests.

(https://www4.unfccc.int/sites/ndcstaging/)

Mozambique- The National REDD+ Strategy, estimates increased emissions from deforestation and forest degradation to reach 39 MtCO2e/yr by 2030 (World Resources Institute, 2016). The overall National REDD+ Strategy aims to reduce those emissions to 3 MtCO2e/yr by 2030, by reducing deforestation and increasing Carbon stocks. This represents an overall objective of avoiding 170 MtCO2e during the reference period 2016 to 2030. The Emission Reduction Programme is expected to significantly reduce emissions about 10.7 MtCO2e between 2018 and December 2024, 30% in the period (2018- 2019) and by 40% in the second period (2020-2024). A total of 10,000,000 tCO2e could be sold to the FCPF Carbon Fund (World Bank, 2021c).

Cameroon - NDC targets GHG emissions reduction of 35% by 2030 compared to 2010, including an unconditional contribution of 12%. Priority sectors of emission reduction commitments are agriculture, forestry and other land uses. The updated NDC reflects Cameroon's vision for turning climate-related challenges into development solutions in the five agro-ecological zones of the country. Through the implementation of its NDC, the country is aiming at reducing the vulnerability of local populations and achieving sustainable development for all.

The Paris Agreement provides a framework for financing, technology transfer and capacity building. This is achieved through the provision of financial assistance to countries that are less capable and more vulnerable to climate change, while also encouraging voluntary contributions by other Parties. The Paris

Agreement encompasses a vision to fully appreciate the value of technology development and transfer to improve resilience to climate change and reduce GHG emissions. A technology framework provides overarching guidance to a functional Technology Mechanism. The mechanism accelerates technology development and transfer through its policy and implementation arms. Climate-related capacity-building support is given to countries that need it.

Further reading

UNFCCC. 2016b. Report of the Conference of the Parties on its twenty-first session, held in Paris from 30 November to 13 December 2015. Addendum Part two: Action taken by the Conference of the Parties at its twenty-first session. UNFCCC. (unfccc.int).

3.14.2 Internationally Transferred Mitigation Outcomes

The Paris Agreement differs significantly from the KP in ways that have important implications for the design of the framework for market-based mechanisms. The compliance regime in the Paris Agreement is less centralised than KP which is mainly based on transparent reporting as the means for assessing progress against its objectives. Another major difference is that developing countries participated in the international Carbon market as hosts for CDM activities under the KP without having mitigation targets on their own. Under the Paris Agreement, developing countries also have mitigation targets through their NDCs, and can participate in international Carbon markets as sellers or buyers of ITMOs.

Article 6 of the Paris Agreement contains two Carbon market routes; Article 6.2 involves limited international oversight and covers cooperative approaches that lead to a transfer of ITMOs and provides an accounting framework for managing all types of cooperative approaches, be it emissions trading between states, linking of ETSs, bilaterally or multilaterally designed, or agreed baseline-and-crediting mechanisms. In this regard, countries are free to "relabel" CDM activities into activities under Article 6.2. For ITMO transactions under Article 6.2, countries are likely to have to apply "double bookkeeping" as was the case for industrialised countries under JI, called "corresponding adjustments" in the Paris Agreement. This entails CCM achieved in one country but claimed by another for achieving their NDC targets which may also build on the CDM rules and experience. Malawi has embarked on initiatives supporting ITMOs (Box 3.8).

Box 3.8: ITMO in Malawi

Malawi has a cook stove and sustainable biomass programme expected to generate an estimated 10 million ITMOs over an 8-year period (2022-2030) in urban and peri-urban areas. The emission reductions will be generated from a stove programme targeting rural communities developed under the Verra VCS, with the Verified Carbon Units sold into the voluntary Carbon market. About 200 000 rural households will receive two Total Land Care Rocket Stove, expected to reduce about 8 million tCO_2e between 2022 and 2030 (KLIK Foundation, 2022).

Article 6.4 creates a new mitigation and SDM with a governance structure subject to centralised oversight (as was the case under the CDM). It generates emission reductions (A6.4ERs) that will then become ITMOs once internationally transferred. Article 6.4 may take up CDM modalities and adopt elements of the CDM if Parties and international regulators are willing to do so. To what extent developing countries have to apply "corresponding adjustments" under the Article 6.4 mechanism is still heavily contested by a few countries. Article 6 of the Paris Agreement enables countries to use international Carbon market mechanisms towards the achievement of mitigation targets in their NDCs. All countries were eligible as host countries under Article 6.4 mechanism.

Article 6.4 establishes a new crediting mechanism under international supervision that could be used for similar purposes where the ITMOs could be international units transferred between electronic registries

or they could be amounts that are reported by countries for accounting purposes (Howard et al., 2017; Schneider et al., 2017). Requirements for activities under Article 6.4 show similarities with those of the CDM including:

i. Being supervised by a body designated by the CoP serving as the meeting of the Parties to the Paris Agreement;
ii. Involvement of public and private entities:
iii. Having real mitigation benefits that are measurable and long-term;
iv. Assurance for additionality; and
v. Verification and certification of emission reductions by designated operational entities.

Building on CDM rules and institutional arrangements, and taking into account related lessons learnt with the CDM, may also contribute to the environmental integrity and acceptance of the new Article 6.4 mechanism.

3.14.3 Non-Market-Based approaches

Non-market based approaches can include anything and everything that is not market-based. The non-market approaches mechanism focus on cooperation on climate policy, and can include fiscal measures, such as putting a price on Carbon or applying taxes to discourage emissions but do not result in tradable units. The broad classifications of non-market-based policies and measures include the following (UNFCCC, 2014b):

i. Economic and fiscal instruments - include policies such as energy and Carbon taxes that act as incentives to shift towards using fuels which emit less Carbon when combusted;

ii. Regulations - include rules, standards and permitting requirements that are used to directly shape the market by reducing the role played by less-efficient, more Carbon-intensive products, such a prosecuting those selling poorly performing equipment, or by increasing the role of climate-friendly operating practices. Examples of regulations include industrial permits and approvals, building codes, standards for appliance and equipment efficiency, landfill operating standards and vehicle standards;

iii. Voluntary agreements - known as long-term agreements, are contracts negotiated between industry and government, mostly including voluntary targets and time frames. Voluntary environmental agreements may be binding once entered into, and may also involve regulatory or fiscal sanctions in the case of non-compliance. Voluntary agreements can be classified into one of four types:

- Unilateral commitments by industry,
- Private agreements between industry and stakeholders,
- Environmental agreements negotiated between industry and government,
- Voluntary programmes developed by government that individual firms can join;

iv. Framework targets – these establish legally binding or indicative goals for GHG emissions, technology shares, fuel shares and efficiency, followed up with MRV procedures to ensure compliance;

v. Information, education and awareness programmes - These help individuals to understand and address the impact of climate change, encourage them to change attitudes and behaviour and help them to adapt to climate change related trends. Information can be passed on in a number of ways, including through public awareness campaigns; the use of labels for household appliances and office equipment; ratings and certification programmes; audits for buildings; and best practice manuals; and

vi. **Research and development** – Include policies that lead to the development of new products or procedures, or to the improvement of existing products or procedures. Such policies do not have an immediate impact, but help to ensure that in the long term, countries will be able to respond adequately to climate change while improving their competitive position in potential markets for the new technologies. They include direct funding and contributions to joint international research efforts.

3.14.4 International and regional initiatives

Other international and regional initiatives that support CCM include SDGs, UN Strategic Plan on Forests (UNSPF), Agenda 2063, AFR 100 in response to Bonn Challenge on CCM, GGW Initiative for the Sahel and Sahara, and Sub Regional Forest Convergence Plans. Indeed, there are several regional and international regulations that promote the reduction of emissions and increasing Carbon sequestration. Some of these are discussed below.

SDGs are a set of 17 aspiration goals with 169 targets contained in paragraph 54 of the UN Resolution A/RES/70/1 of 25 September 2015 (2030 Agenda for Sustainable Development 2015). Goal 13 and goal 15 are associated with climate change and forests respectively.

Goal 13: Take urgent action to combat climate change and its impacts

Goal 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

UNSPF is a reference for forest-related work of the United Nations (UN) system for forest-related contributions to the implementation of SDGsCBD (1992), UNCCD (1992), UN Forest Instrument (UNFI) (2007), the Paris Agreement under the UNFCCC (2015) and other international forest-related instruments, commitments, processes and aspirations. In this regard, the UNSPF is guided by six voluntary and universal global forest goals with 26 associated targets also to be achieved by 2030. Relative to CCM, the global forest goal Number 1 is linked to SDGs 13 and 15 while goal 5 supports SDG 15. Global Forest Goal 5 stresses the need to promote governance frameworks to implement SFM, including through the UNFI, to enhance the contribution of forests to the 2030 Agenda.

UNSPF Goal 1 - "Reverse the loss of forest cover worldwide through sustainable forest management, including protection, restoration, afforestation and reforestation, and increase efforts to prevent forest degradation and contribute to the global effort of addressing climate change".

Furthermore, the African continent's strategic framework (Agenda 2063) aims to attain inclusive and sustainable development. Agenda 2063 is Africa's blueprint and master plan for transforming Africa into a global powerhouse of the future (African Union Commission, 2015). Paragraph 17 and 18 under Agenda 2063 Aspiration 1, states that:

> *"Africa will participate in global efforts for climate change mitigation that support and broaden the policy space for sustainable development; and that Africa shall have equitable and sustainable use and management of water resources for socio-economic development, regional cooperation and the environment".*

Agenda 2063 advocates for environmentally sustainable and climate resilient economies and communities in African states (African Union Commission, 2015). Some goals of Agenda 2063 are also linked to SDGs numbers 6, 7, 13 and 15 which are stated in Table 5. The African Ministerial Conference on Environment advises the Committee of African Heads of States and Governments on Climate Change.

Table 5: SDGs that are linked to Agenda 2063 of the African Union

SDG goal	Statement	Agenda 2063
6	Ensure availability and sustainable management of water and sanitation for all.	iv) Biodiversity, conservation and sustainable natural resource management. v) Water security. vi) Climate resilience and natural disaster preparedness.
7	Ensure access to affordable, reliable, sustainable and modern energy for all.	
13	Take urgent action to combat climate change and its impacts.	
15	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.	

Forest landscape restoration is the planned process of regaining ecological functionality and enhancing human well-being across whole deforested or degraded landscapes for multiple benefits and land uses over time (IUCN, 2019). The Bonn Challenge is a global aspiration which targeted to restore 150 million hectares of the world's deforested and degraded lands by 2020 and 350 million by 2030. The Bonn Challenge facilitates implementation of national priorities related to water, food security, and rural development, while at the same time assisting countries to contribute to the accomplishment of international climate change, biodiversity and land degradation neutrality obligations.

In Africa, AFR100 was launched to support leadership and collaboration for forest landscape restoration and the Bonn Challenge. Seventeen African countries have contributed 63.3 million hectares to the Bonn challenge (IUCN, 2016). Box 3.9 shows examples of restoration initiatives in West Africa.

Box 3.9: Examples of restoration initiatives in Africa (IUCN, 2016)

Burkina Faso – The assisted natural regeneration of trees has greatly benefitted small landowners with improvements in soil fertility and crop diversification which helped them withstand seasonal food deficits.

In Malawi and Ethiopia, International Union for Conservation of Nature and the World Resources Institute are assisting in the identification of areas for restoration of degraded landscapes that can contribute to food security, disaster risk reduction, access to water and gender inequity.

Cameroon - The government launched widespread assistance for forest landscape restoration in the Lake Chad region. Key activities include encouraging local tree seedling productions, purchasing of seedlings from farmers, employment of local communities, and organisation of labour for afforestation/reforestation programmes by youths and NGOs. The activities are being implemented in order to boost water levels, promote sustainable agro-pastoral activities, and preserve the country's declining biodiversity.

I**vory Coast** - Pledged to restore degraded lands covering more than 20% of the country by 2030. Ivory Coast is consistently taking actions through amendment of existing regulatory frameworks, integrating the challenges of intensive cocoa farming and on-going climatic disturbances. They recommended agroforestry as an alternative solution combining afforestation and intensive agriculture (cocoa).

The African Union leadership from 11 countries met in 2007 with an initiative of restoring degraded landscapes by growing an 8000 km natural wonder across Africa, from coast of Senegal to the coast of Djibouti forming the GGW. The movement has more than 20 African countries signed up targeting to restore 100 million hectares of degraded land, sequestering 250 million tons of CO2 and creating 10 million jobs in rural areas by 2030 (Planet Banana, 2022). In this regard, the GGW is more than just growing trees and plants, but is transforming the lives of millions of people in the Sahel region, thus directly supporting the Global SDGs (GGW, nd). Forest landscape restoration is an effective mechanism important in operationalising key elements of global processes such as SDGs, UNFCCC, CDB, the Aichi Targets, and UNCCD. The UNCCD is a key partner in the GGW initiative (IUCN, 2016).

Other initiatives are implanted at sub-regional level e.g. East African Community and Southern African Development Community (SADC). SADC has a Protocol on Environmental Management for Sustainable Development whose objectives include the promotion of effective management and response to impacts of climate change and variability. One of the climate change obligations is for Parties to take nationally appropriate voluntary CCM. Furthermore, the SADC climate change strategy and action plan was developed and approved by Ministers responsible for Environment and Natural Resources in 2015. The strategy provides a broad outline for harmonised and coordinated regional and national actions to address and respond to the impacts of climate change (SADC Secretariat, 2015).

Further Reading

African Forest Forum. 2019. International dialogues, processes and mechanisms to climate change: A compendium for professional and technical training in African forestry. Technical Working Paper. 132pp.

In Text Question(s) (10 Minutes)

i) Distinguish between certified emission reduction and emission reduction unit.

ii) List the components of REDD+.

iii) Explain linkages between three components of REDD+ governance system.

iii) Justify the emergence of ITMOs and SDMs.

iv) Explain some of the African initiatives that support climate change mitigation.

Summary

In this chapter, we have discussed the genesis of CDM and evolution of REDD+ in relation to mitigation of climate change. KP has flexible market mechanisms, which are based on the trade of emissions permits achieved through three market based mechanisms of emission trading scheme, CDM and JI. The CDM cycle has seven steps which results in Carbon credits. The mechanisms of KP were effective till 2020 after which the Carbon trading is expected to transition into SDM, taking lessons from CDM processes. REDD+ is aimed at reducing emissions from deforestation, reducing emissions from forest degradation, conservation of forest Carbon stocks, sustainable management of forests, and enhancing forest Carbon stocks. We also discussed the financing mechanisms for CDM which include BioCarbon fund, and The Ci-D. For REDD+ financing is results based. The REDD+ frameworks include non-binding policy instruments such as strategy, policy, and plans and programmes and legally binding instruments such as statutory laws and regulations. For governance, frameworks are an integration of legal, compliance and institutional. The importance of different stakeholders ranging from local communities to NGOs and government and private sector including pro poor approaches have been discussed. Financing mechanisms, instruments and other opportunities for REDD+ are FIP, FCPF and UN-REDD. The transition curves have also been discussed relative to REDD+. The issues of MRV are a critical in REDD+ component and NDCs are important for countries to contribute towards global emission reduction. Unlike KP, Paris agreement encourages participation by all in reducing of emissions by stating their emission reduction targets in their NDCs. Under the Paris Agreement, developing countries also have mitigation targets through their NDCs, and can participate in international Carbon markets as sellers or buyers of ITMO. The chapter concluded by evaluating the role of other forest-based initiatives at regional and international level in CCM including the relationship between global and regional initiatives such as SDGs, African Agenda 2063 and CCM.

Chapter 4: Non-Forest Climate Change Mitigation Initiatives And Other Approaches

4.1 Chapter overview

Since the African continent is not among the big GHG emitters, the main challenge is how to continue with development taking a pathway with less negative impacts on the environment. This requires technological transfer and paradigm shift to more clean development initiatives. In this regard, mitigation is an opportunity for green growth (AMCEN, 2011; APP, 2014), where the transition to green growth goes beyond 'Foreign Knowledge'. This requires environmental policies that are: i) broad and cross-cutting to strengthen market incentives to preserve natural capital; ii) expanding green infrastructure and improvements in infrastructure efficiency; iii) modernising agriculture, facilitating adoption of climate smart agriculture, and investment in key public goods; iv) facilitating adoption of green urban policies (Brahmbhatt et al., 2017). These issues need to be considered within the thematic pillars of the African Union strategy of: i. Improving climate change governance, ii. Mainstreaming and integrating climate change imperative into national and regional policy, planning, and development processes; iii. Enhancing research, awareness, and education on climate change; and iv. Promoting national, regional, and international cooperation.

Measures outside the forestry sector can contribute significantly to CCM. For example, agriculture and other land use sectors have potential to make significant contributions to the reduction of GHGs and mitigation of climate change. These sectors are also closely linked and related to the forestry sector. Therefore, this chapter will introduce learners to sectoral mitigation measures, alternative use of forests, resource substitution and use of bio-char in addressing climate change.

Learning outcomes

i. At the end of this chapter, the learners will be able to:
ii. Explain mitigation measures in different sectors with emphasis on agriculture;
iii. Design activities outside the forest sector that could help to mitigate climate change; and
iv. Evaluate the application of non- forest/-alternative strategies to climate change mitigation.

4.2. Climate change mitigation response in Africa

African countries do not need to be prevented to their development by putting response to climate change as priority (Davidson et al., 2003), but based on the principle of common but differentiated responsibility, the role of Africa is recognised as minor. It may be strategic to link his climate response to development in Africa as proposed by Davidson et al. (2003)'s 'Development First' approach. Sectors that emit GHGs have potential to reduce their emissions, thus contributing to CCM. For example, agriculture being among the major drivers of deforestation and forest degradation can be used to mitigate climate change and promote resilience of communities (FAO and UNEP, 2020). Non forest based mitigation actions can include reduction in non-Carbon emissions where all sectors are pushed for sustainable low Carbon alternatives and they include tree planting activities as part of their mitigation actions.

4.3. Non-forest-based climate change mitigation initiatives

Reducing GHG emissions can be achieved through management options that can also reduce CH4 and N2O emissions. CH4 is the second-most-important GHG in terms of current anthropogenic climate forcing, and global anthropogenic CH4 emissions continue to increase. UNEP (2020) identified six sectors where CCM can be applied to reduce GHG emissions to the desired levels and these include:

i. **Energy sector** – use of less energy and use of renewable energy can result in a reduction of 12.5 Gt/year;
ii. **Transport sector**- accounts for a quarter of all emissions and can be reduced by up to 4.7 Gt/year by using electric vehicles to cut on fossil fuel use and using non-motorised transport;
iii. **Agriculture and food waste** – reducing food wastes, switching to plant based diets and working on climate smart agriculture can reduce emissions by 8.7 Gt/year;
iv. **AFOLU sector** - reducing deforestation and forest degradation and restoring ecosystems can reduce emissions by 5.9 Gt/year;
v. **Industry** – using efficient and passive heating and cooling systems, energy efficiency and reducing CH4 leaks can result in emission reduction of 7 Gt/year; and
vi. **Buildings and cities** – Updating existing infrastructure can reduce emissions by 5.9 Gt.

4.4. Non-extractive use of forests (e.g. ecotourism, beekeeping)

Climate smart agriculture is an integrated approach for landscape management (forests, croplands, livestock and fisheries) addressing the interlinked challenges of climate change and food security. It is based on the pillars of food security, adaptation and mitigation (World Bank, 2021d). Forests provide recreational benefits for local people but can also be useful for national and international tourists to come to visit some of the sites, making tourism an important source of income for mitigation projects. Eco-tourism already plays a major role in some areas. Reforestation and afforestation and agroforestry can reduce land degradation by reducing soil erosion, loss of soil fertility, as well as soil sedimentation in downstream rivers and water reservoirs.

Forests and trees provide habitat for wild bees and other insects that contribute to pollination services, thereby enhancing agricultural production on nearby fields. Beekeeping is an important livelihood source for most communities in some African countries.

Activity 4.1 (Brainstorming) (20 Minutes)

Identify agricultural practices that can contribute to climate change mitigation.

4.5 Mitigation strategies through SMART Agriculture

4.5.1 Climate-friendly agricultural practices

The use of EbM approaches can be extended beyond the forestry sector to include AFOLU. Interventions can generate multiple benefits, such as landscape restoration that provides CCM, biodiversity conservation, livelihoods benefits for local communities (e.g. NTFPs), and water regulation (Doswald and Osti, 2011). There are a variety of practices that can be used to reduce GHG emissions related to production of crops and livestock. Climate friendly agricultural practices aim at promoting sustainable agricultural practices to improve the capacity of farming systems to adapt to climate change, enhance biodiversity, increase Carbon storage and reduce emissions. These practices include measures such as increasing productivity of the land or increasing soil Carbon content through cover crops, farming with perennials, reduced tillage, rotational grazing, diversification of planted crops and forest species, agroforestry and agro-ecology, conservation agriculture, organic farming, soil conservation and reduced use of fertiliser. These can create low-emission farming systems, offering an estimated annual CCM potential of 3-6 giga tonnes of CO2 equivalent (IPBES, 2021). Some of the mitigation actions may not have a direct impact on farm productivity, but may help farmers meet other objectives such as water quantity or water quality improvements. We discussed agroforestry in section 2.4 where its importance in agriculture systems was emphasised. Some of the climate friendly agricultural systems with potential to reduce GHG emissions are discussed below:

Sustainable intensification – the Royal Society (2009) defined sustainable intensification as a process or system where yields are increased without adverse environmental impact and without the cultivation of more land. In this regard, sustainable intensification can reduce emissions intensity of agriculture through production of more with less land with a decrease of negative environmental impacts and simultaneously increasing contributions to natural capital and the flow of environmental services (Pretty et al., 2011; Pretty and Bharucha, 2014). Inputs are used more efficiently or new inputs that address limiting factors of production are added. Intensification is based on alterations in the types and use of direct inputs, e.g. improved crop and livestock varieties/breeds, agrochemicals, water and mechanisation. In addition, a variety of agronomic practices is available, broadly aimed at optimised density, rotations and precision of farming methods.

Intensification reduces the need for clearing more land to increase food production, thus reduces GHG emissions without degrading soils and causing wider environmental degradation (Vanwalleghem et al., 2017). Intensification of crop and livestock production has potential to mitigate agricultural emissions in developing countries and avoiding production of emissions and land use change between 100 and 400 Mt CO2e per year by 2050. When compared to a less fertiliser-intensive intensification pathway, the potential emission reduction increases by 30 percent (Valin et al., 2013).

Further reading

Titonnel, P. and Giller, K.E. 2013. When yield gaps are poverty traps: The paradigm of ecological intensification in African smallholder agriculture. Field Crops Research 143: 76-90. Available at: http://www.sciencedirect.com/science/article/pii/s0378429012003346.

Manure management - about 16 % agricultural GHG emissions are caused by manure deposited on pastures and 7% are from stored manure with manure and urine accounting for about a quarter of direct agricultural GHG emissions (FAO, 2013a). Emissions from manure can be reduced through application of more efficient use of manure as an energy or crop nutrient source, reducing emissions from

stored manure through practices by reducing storage time, avoiding straw/hay bedding, covering the manure, changing the diet of livestock to manipulate the volume and composition of manure, using waste management systems that facilitate better handling of manure and diversifying the farming systems to integrate crops and livestock to increase effectiveness of manure nutrient use (Dickie et al. 2014). In another study, use of manure sequestered more carbon than inorganic fertiliser application after nine years of cropping (Mujuru et al., 2016).

Conservation agriculture - this entails the application of three related principles i.e. no or minimum mechanical soil disturbance, biomass mulch soil cover and crop species diversification, in conjunction with other good complementary agricultural practices such as integrated crop production and management. The global adoption of conservation agriculture since 2008 has been highest in South and North America and least in Africa (Kassam et al., 2019). Overall, conservation agriculture practices of no-till with the use of cover crops produced lower CO2 emissions than conventional tillage and fallow (O'Dell et al., 2020). In other studies, minimum and no tillage practices sequestered more Carbon than conventional tillage (Mujuru et al., 2013) and the increase in Carbon stocks depends on the available inputs from litter and root biomass. Furthermore, soil conservation is important in reducing Carbon emissions from soils (FAO, 2015).

4.5.2. Innovations developed for climate change adaptation and mitigation in sub-Saharan African farming systems

Efforts have been made to develop innovations that support the sub-Saharan region to deal with climate change at all levels. Several organisations have been involved in the development and implementation of innovations linked to water management, dissemination of information, organisational initiatives, crop diversification and management and soil management. Water management innovations include: farmer led micro-irrigation technologies including use of bucket kits, sprinklers, tube emitters, shifting drip irrigation, etc. for optimising irrigation in smallholder agriculture in wetlands, along perennial rivers and streams and large scale irrigation schemes (Fan et al., 2018). Others embarked on construction of dykes in flood prone areas to divert water (Government of Malawi, 2012). Initiatives about information include programmes sharing climate information with farmers through mobile phones and computers (Krell et al., 2020). Organisational initiatives include approaches that promote agricultural innovation, improve food and nutrition security and build sustainable value chains in the agri-food sector e.g. Green Innovation Centres. The Green Innovation Centres focused on rice, potatoes, vegetables and fruit value chains (ZEF et al., 2017).

Soil and crop management innovations include programmes like the West Africa Agricultural Productivity Programme and ICRISAT-HOPE project for the Sahel that have contributed to the introduction of new, early maturing, more resilient crop varieties to maintain a steady production level during rainy seasons and ensure their availability during shortage times (ZEF et al., 2017). Additionally, as an adaptation practice, millet and sorghum are planted in one field depending on the rainfall patterns. This practice is known as "sequential adjustments" to changing weather conditions (Jansen and Vellema, 2011). Some farmers adjust the sowing time for maize and they use improved crop varieties (Soglo and Nonvide, 2019).

Diversification of innovations by farmers includes some mixed agro-pastoralism, fishing and hunting wherever possible (Crane et al., 2011). Farmers use mixed cropping, planting of drought tolerant crops, cereal-legume intercropping or other crop associations, agroforestry and conservation agriculture to mitigate the risks of low yields (Yegbemey et al., 2017). In Malawi, the Government promoted planting of vitamin A rich and drought tolerant orange fleshed sweet potato among smallholder farmers (Government of Malawi, 2012). Furthermore, multifunctional cropping systems were recommended as adaptation strategies. Strategies include crop and soil management and integrated pest management. These strategies reduce the incidence of diseases and pests, increases nutrient and water use efficiency, productivity, yields and enhance dietary diversity (Rajendran et al., 2017). Scaling up agroforestry technologies such as fertiliser and fruit trees improve soil fertility, sequester Carbon and improve food,

incomes and nutrition security. Establishment of fish ponds, water harvesting and integrated fish farming, forest co-management and apiculture are also important (Government of Malawi, 2012).

4.5.3 Appropriate use of chemical fertilisers

Nitrogen fertilisers (both synthetic and organic) on croplands are responsible for N2O emissions when they have not been absorbed by plants, and they instead leach into the environment. The run-off fertiliser creates GHG emissions in the form of nitrogen oxide and contaminates both ground and surface water quality. Nitrogen balances in agricultural soils vary greatly in space and time making it difficult for farmers to know optimum prescriptions needed by plants at a particular time. Subsequently, farmers tend to over-apply fertiliser as an insurance mechanism against low yields (Dickie et al., 2014).

Given these challenges, the global technical mitigation potential for reducing N2Ofrom soils is estimated as 325 Mt CO2e. Better management of fertiliser application is achieved by increasing nitrogen use efficiency within the cropping system. This is achieved by matching the nitrogen supply from fertilisers with the crop nitrogen demands, bearing in mind key aspects of amount applied, timing of when to apply, type of fertiliser and placement where the plant can most easily reach the fertiliser e.g. avoid broadcasting the fertiliser. Optimal nitrogen use efficiency can be improved through plant breeding and genetic modifications to increase the uptake of nitrogen by the crop so that less fertiliser is needed to achieve the same yields, accounting and using organic fertilisers to make agricultural systems that are less dependent on external inputs, use appropriate decision support tools for input management, ensure regular soil testing to develop the correct nutrient regimes, and use of technologically advanced fertilisers (Dickie et al., 2014).

4.5.4 Managing livestock systems to reduce methane emissions

Methane has a lifetime of about 12 years, and a global warming potential (GWP) of approximately 82 over a 20-year period and 29 over a 100-year period.

> *GWP is a metric used to compare the ability of each GHG to trap heat in the atmosphere (relative to another gas).*

Therefore, reducing CH4 emissions can provide an opportunity for slowing down the rate of global warming in the short term. Emission reductions reduce peak warming over the century and helps to bridge the emissions gap between current trajectories and those consistent with the goal of 2°C or 1.5°C temperature rise. Reducing CH4 emissions from the agricultural sectors (mainly livestock), fossil fuels, and waste contribute significantly to closing the emissions gap and warming in the short term (UNEP, 2021). In livestock systems, emissions can be reduced from enteric fermentation which is part of the digestive process in herbivorous animals ('ruminants' such as cows, goats, buffalos and sheep). The ruminants have a rumen, a large four-compartment stomach with a complex microbial environment which allows the animals to digest complex carbohydrates, resulting in the production of CH4 as a by-product. This enteric fermentation is responsible for more than 40% of direct agricultural emissions, with dairy and beef cattle accounting for almost two-thirds of all emissions from enteric fermentation (Dickie et al., 2014). Enteric fermentation can be reduced in several ways including:

i. Improving forage quality by processing feeds to improve digestibility, and adding grain-based concentrates to livestock diets can improve the diet and nutrition of the animals;

ii. Using supplements and additives reduce CH4 by changing the microbiology of the rumen, usually without yield improvements; and

iii. Reducing the number of animals necessary to sustain a given level of production

4.5.5 Rangelands management

Managing rangelands has potential to contribute to CCM through the reduction of bare ground and promotion of perennial vegetation thus, enhancing Carbon sequestration. Carbon stored in grazing lands can be protected and increased through a variety of measures that promote productivity of grasses. Improved pasture management practices include timing and rotation of livestock, managing stocking rates, introducing some grass species or legumes with higher productivity, and application of compost, biochar, fertiliser, or irrigation to increase productivity. These practices can also increase soil organic Carbon storage (Schnabel et al., 2001) depending on soil type, diversity of plant species and climatic conditions and Carbon accumulation on optimally grazed lands is greater than on ungrazed or overgrazed lands (Liebig et al., 2005).

Globally, livestock production contributes significantly to rural livelihoods (Asner et al., 2004) although the sector has also been identified as a significant source of GHG emissions (mainly CH4) and land-based degradation caused by production of industrial feed and soil erosion linked to overgrazing (Gerber et al., 2013). IPCC (2019) highlighted that there are options that have great potential to mitigate climate change in livestock systems and these include better management of grazing lands to increase net primary production and soil organic Carbon stocks.

4.6 Climate-conscious consumption

4.6.1 Reducing food losses and curbing meat consumption

Food wastage refers to both food losses and wastage whose Carbon footprint is estimated at 3.3 Gt CO2e, making it the third largest source of emissions after China and the US. (FAO, 2013b). About one third of all food intended for human consumption is lost or wasted in the value chain from production, handling and storage, processing and packaging, distribution and marketing, and consumption (FAO, 2013b).

Reducing food loss and waste can increase food availability and access by increasing local supplies and freeing available resources (Dickie et al., 2014). The increase in consumption and production of meat, especially beef, has caused considerable environmental damage including deforestation, water contamination and soil degradation apart from health issues. In this regard, dietary alterations to reduce demand for meat to a relatively small amount would have a significant absolute impact on GHG emissions and other impacts. FAO (2013b) added that cereals, fruits and vegetables and meat account for 53, 44 and 7% share of losses by calorie respectively and emissions of 34, 21 and 21%.

4. 6.2 Switching to second or third generation biofuels

Biofuels are renewable energy sources that can play a major role in substituting fossil fuels. Materials that can be burnt directly to provide energy are considered as primary biofuels, and include firewood, pellets, wood chips, animal waste, forest and crop residues (Gibbons and Hughes, 2011). Livestock manure can become a source of bioenergy to displace fossil fuels either as a source of biogas, electricity, or transportation fuel. Secondary fuels are derived from some primary energy sources through physical or chemical processes.

Biofuels can be classified as first, second, third or fourth generation (Kalita, 2008; Inderwildi and King, 2009; Aylott, 2010; Dragone et al., 2010).

The 1st generation biofuels are directly related to biomass include:

i. Bioethanol produced by starch fermentation from corn, wheat, corn or potato) or sugars (from sugarcane or sugar beet); and
ii. Biodiesel produced by transesterification of oil crops (e.g. soybeans, rapeseed, sunflower, coconut and palm) and animal fats.

The 2nd generation biodiesel also known as advanced biofuels manufactured from several types of non-food biomass and includes:

i. Liquid fuels derived from Jatropha seed oil and from a catalytic conversion process of synthetic gas from the gasification of biomass; and
ii. Second generation ethanol is a liquid fuel from non-food bio-material parts of crops, such as biomass and bio-waste having high cellulose and from other forms of lignocellulosic biomass such as wood, grasses, and municipal solid wastes.

The 3rd generation biofuels include:

i. Algae-derived fuels such as biodiesel from microalgae oil;
ii. Bioethanol from microalgae and seaweeds; and
iii. Hydrogen from green microalgae and microbes.

The 4th generation biofuels include “Drop in” fuels like “green gasoline,” “green diesel,” and “green aviation fuel” produced from biomass.

4.6.3 The use of bio char

Soils play a role in the natural Carbon cycle, having more Carbon than the atmosphere and terrestrial plants combined. The process of storing organic Carbon in soils is termed soil organic Carbon sequestration.

An alternative to use Carbon-rich soil amendments such as biochar, that has low decay rates and long mean residence times can be a solution in agricultural systems (Gross et al., 2021). Biochar is a solid porous material produced through carbonisation of biomass under low or no oxygen conditions. Type of raw materials and pyrolysis temperature are the major factors that influence the quality of biochar that can be used in any conditions (Almutairi et al., 2022). Biochar is a viable CCM option because of its ability to sequester Carbon for centuries and to reduce GHG emissions from soils.

Biochar is also an attractive alternative due to its potential to increase the availability of nutrients, availability of water in the soil, crop yields, and microbial biomass and soil diversity (Gross et al., 2021). Additionally, biochars with a lower nitrogen content, and a Carbon/Nitrogen ratio >30, were more suitable for mitigation of N2O emissions from soils. Furthermore, biochars that are produced at a higher pyrolysis temperature, and with Oxygen/Carbon ratio <0.2, Hydrogen/Carbonorg ratio <0.4 and volatile matter below 80% may have high Carbon sequestration potential than those not having these characteristics. Biochar reduces rate of organic carbon mineralisation and the proportion of mineral-bonded organic carbon, making it an effective strategy for carbon sequestration (Brassard et al., 2016).

In text question (5 minutes))

Explain how we can reduce emissions from food systems?

4.7 Alternative livelihoods (alternative to forests) as climate change mitigation measures

Most rural communities in Africa depend directly or indirectly on natural forests for their livelihoods but climate change impacts on the availability of forest resources, posing new challenges on natural resources, biodiversity, agriculture, rural livelihoods and food availability (Hashida and Lewis, 2019; Weiss et al., 2019).

Alternative livelihoods can reduce deforestation and forest degradation through initiatives that substitute livelihood strategies that cause harm to the forest resource base. Such alternative livelihood projects can be part of a broader integrated conservation and development programme or can be stand-alone initiatives aiming at providing local people with an alternative means of making a living that reduces pressure on the forest resource (Roe et al., 2015). Figure 21 shows women beekeepers celebrating receipt of beehives under GEF 6 project in Zambazi valley Zimbabwe.

a.

b.

Figure 21: a. Women beekeepers in Lower Zambezi valley, and b. Honey harvest from individual beekeeping in Zimbabwe

Income generation through beekeeping provided a strong incentive for communities to conserve forests (Matsvange et al., 2016). Other activities include, support to small-scale agricultural production, poultry and small livestock production, ecotourism, fish farming and craft production (Roe et al., 2015; Harvey et al., 2018). Such small-scale livelihood projects have contributed to both improved livelihoods and enhanced forest conservation for communities in Madagascar (Harvey et al., 2018).

4.8 Resource substitution as a mitigation measure

Resource substitution has potential GHG emissions reduction from the marginal replacement of a non-wood based functional equivalent product. Wood has been identified to have significant sustainable environmental benefits contributing to CCM and the benefits provided by product displacement (Lippke et al., 2010; Ramage et al., 2017). Wood and engineered wood products have lower GHG emissions than mineral based materials. The high potential of wood to mitigate climate change is mainly with the construction sector where long lived wood products and options using wood waste for bioenergy replace concrete, steel, and other non-renewable goods and promoting Carbon storage in other wood products (Leskinen et al., 2018).

The CCM benefits of such substitution are often presented and quantified as displacement factors measured in terms of Carbon fluxes (Howard et al., 2021). Leskinen et al. (2018) estimated about 1.2 kg C of emissions reduction for every kilogramme of Carbon in wood products that are used to substitute non-wood products in the construction industry although substitution factors have not provided sufficient information to guide policy making.

In some developed countries, advances in engineered wood products is supported by adoption of new regulations and superior physical, environmental and economic properties for the products compared to mineral-based building materials. The engineered products include cross-laminated timber, glued laminated (glulam) wood, laminated veneer lumber, and wood fibre insulated boards (Hildebrandt et al., 2017).

In Africa, 48 countries submitted their NDCs and 81% of these have quantified renewable energy targets. Of the 48, fifteen countries have quantified renewable energy targets for direct heat, transport (13) and energy sector targets (2) whilst 39 have quantified renewable power targets (IRENA, 2021). IRENA (2020) suggested the following five emission reduction measures for the industry and transport sectors:

i. Reduced demand and improved energy efficiency;
ii. Direct use of clean, predominantly renewable, electricity (from solar, wind, ocean, geothermal energy);
iii. Direct use of renewable heat and biomass;
iv. Indirect use of clean electricity via synthetic fuels and feedstocks displacing fossil fuel sources; and
v. Use of CO_2 removal measures.

In terms of energy, an increase of renewable energies in the energy mix could reduce emissions from fossil energy-intensive materials. While renewable energy can be a mature and cost-effective CCM technology, its role in NDCs can be more strengthened to realise objectives of the Paris Agreement of 2015. The majority of energy used in industry is normally obtained from fossil fuels although energy use is not the only source of GHG emissions because CO2 emissions also come from production processes and the life cycle of products (IRENA, 2020).

4.9 Case studies on non-forest-based climate change mitigation projects and programmes

The World Bank supported the government of Ghana by building processing facilities for cassava flour and shea butter. This relieved pressure off forests in the North East region of the country while creating jobs and generating income. The initiative provided alternative livelihoods for rural women who used to cut down trees to produce charcoal for sell. Furthermore, sustainably produced cocoa will benefit from future payments for emissions reductions rewarding community efforts for reducing Carbon emissions from deforestation and forest degradation (World Bank, 2021b).

In Zambia, the World Bank also helped to improve sustainable land management, diversifying livelihood options for rural commodities, including climate-smart agriculture and forest-based livelihoods, and reducing deforestation (World Bank, 2021b).

The International Renewable Energy Agency supported Gambia's NDC update through the analysis of cost-effectiveness of renewable energy technology options in the climate action planning processes. The study provided information for the identification, quantification and selection of mitigation measures in the power sector and helped inform the path to cost-effectively achieve mitigation targets. This became an input to the development of long-term sector plans, while supporting the development of renewable energy mitigation options, fostering energy access and promoting the involvement of the private sector (IRENA, 2021).

In text question (10 minutes))

Explain how methane and nitrous oxide emissions can be reduced in agricultural systems.

Summary

CCM can be done by sectors outside forestry to reduce emissions of GHGs. Other sectors such as agriculture have potential to reduce GHG emissions through management options that reduce CH4 and N2O emissions. Emissions can also be reduced by incentivising communities to protect their forest resources due to the availability of other benefits such as NTFPs and non-extractive utilisation. The potential of other sectors such as energy, transport, industry and buildings and cities to reduce GHG emissions was demonstrated. Several climate smart agriculture practices were discussed including agriculture intensification, use of cover crops, farming with perennials, conservation agriculture, agroforestry and agro-ecology, appropriate use of fertiliser, manure management, grazing management, and managing livestock to reduce CH4 emissions. Other initiatives include community participation, climate conscious consumption, use of biofuels and other renewable energy sources, use of biochar, alternative livelihoods and resource substitution. The Chapter concluded by giving some examples of non- forest-based CCM.

Chapter 5: Monitoring, Reporting and Evaluation of Climate Change Mitigation Initiatives and Other Approaches

5.1 Chapter overview

Monitoring and evaluating mitigation initiatives can help countries assess progress towards CCM and to also identify which initiatives work and which do not work. M&E is a key management tool supporting the planning, implementation and performance of an intervention in any sector. It also helps to assess whether intended objectives for mitigation projects will be achieved with available resources. M&E plays an essential role in understanding where to focus investments, what is working and what and is not, and gives room to learn from experience and maximise impact. Ssekamatte (2018) stated that the critical roles of M&E in an intervention include: enhancing learning, supporting decision-making, accountability tool and helping organisations to improve. This chapter will introduce trainees to the concepts, methods and techniques of M&E of mitigation projects, and techniques for reporting.

Learning outcomes

By the end of this session, the learner should be able to:

i. Describe the concepts for monitoring, reporting and evaluation in the context of mitigation to climate change initiatives and other approaches;
ii. Apply recommended methods for monitoring, reporting and evaluation of mitigation activities to climate change initiatives and other approaches; and
iii. Identify appropriate types of evaluation of mitigation activities related to climate change initiatives and other approaches.

5.2 Monitoring for climate change mitigation initiatives and other approaches

Concepts of monitoring and evaluation are centred around several components that are described below (STAP, 2017):

Monitoring is a continuous function that uses systematic collection of data on specified indicators to provide management and the main stakeholders of an ongoing development intervention with indications of the extent of progress and achievement of objectives and progress in the use of allocated funds (OECD, 2002). This entails systematic and continuous collection of quantitative and/or qualitative data on the progress of a project or programme over time.

Reporting is often done at annual (or more/less frequent) intervals, except stock taking of progress and support for routine management and accountability purposes.

A results framework is often depicted as a theory of change, logic model, or log frame—identifies the intended results and the logical cause-and-effect relationship between the intervention's inputs, activities, and these results.

A Theory of Change framework is increasingly favoured for M&E initiatives. A 'theory of change', according to UNICEF (2014) explains how activities are understood to produce a series of results that contribute to achieving the final intended impacts. It can be developed for any level of intervention – an event, a project, a programme, a policy, a strategy or an organisation.

Indicators are markers of progress toward the intended results, and are used to demonstrate the status of an activity, project, or programme.

Evaluation is the systematic assessment of the operation and/or outcomes of a program or policy, compared to a set of explicit or implicit standards, as a means of contributing to the improvement of the program or policy (Weiss, 1998). The aim is to determine the relevance and fulfilment of objectives, efficiency, effectiveness, impact and sustainability of the project (OECD, 2002). The definition of evaluation emphasises that one acquires and assesses information rather than just assessing worth or merit. All evaluation work involves gathering and examining data, making conclusions about the validity of the information and inferences derived from it (Suulola, nd).

Other terms involved in M&E are baseline (minimum starting point used for comparison), assumptions (statement accepted as true or as certain to happen without proof) and means of verification (tools used and processes followed to collect data used to measure progress) which are normally part of the logical framework. The logical framework is an approach used to conceptualise projects and can be used as an analytic tool to clearly communicate a complex project on a single sheet of paper (World Bank, 1996).

5.3 Purpose and types of evaluation

Evaluation is carried out for several reasons (Suulola, nd), including the following:

i. The major goal is to influence decision-making or policy formulation through the provision of empirically-driven feedback;
ii. Improving programme design and implementation by periodically assessing and adapting activities to ensure they are as effective as they can be;
iii. Helping to identify areas for improvement and ultimately help realise goals more efficiently. Demonstrating the program impact (success or progress).

There are several types of evaluations depending on what is being evaluated and the purpose of the

evaluation. Evaluations can generally be classified as either formative or summative evaluations (Suulola, nd).

Formative evaluations - used mainly to provide information that can help improve the initiative through examination of the delivery of the initiative, its implementation, procedures, personnel, etc. There are two types of formative evaluation:

i. Needs assessment- Establish who needs the programme, extent of the need and what can be done to best meet the need? and

ii. Process or implementation evaluation- Examines the process of implementing the programme and determines whether the programme is operating as planned.

Summative evaluations - examines the outcomes of an initiative and provides information that will assist in making decisions regarding the adoption, continuation or expansion of an initiative and can assist in judgments of the overall merit of the initiative based on given criteria

i. Outcome evaluation - Investigates to what extent the programme is achieving its outcomes. These outcomes are the short-term and medium-term changes in programme participants that result directly from the programme;

ii. Impact evaluation - Determines any broader, longer-term changes that have occurred as a result of the programme. These impacts are the net effects, typically on the entire school, community, organisation, society, or environment; and

iii. Cost-effectiveness and cost-benefit analysis - Cost effectiveness shows the extent to which something is effective or productive relative to its cost. Cost benefit analysis is the systematic approach for estimating the strengths and weaknesses of several alternatives.

Activity 6 Brainstorming (20 minutes)

Describe any elements that that you think form the core of GHG reporting.

5.4 Reporting processes

5.4.1 Methods of monitoring, evaluation and reporting in line with IPCC guidelines

GHG emissions from the AFOLU sector account for 24% of the total emissions (IPCC, 2014). The Bali Action Plan (Decision 1/CP.13), shows that developed and developing country Parties agreed to enhance their action on mitigation of climate change, notably by implementing "measurable, reportable and verifiable nationally appropriate mitigation actions".

For climate change initiatives, monitoring is about gathering periodic information on results of any initiatives done as part of national policies and measures, guided by Article 4.2, paragraphs a) and b) of the Convention:

> *"In order to promote progress to this end, each of these Parties shall communicate, within six months of the entry into force of the Convention for it and periodically thereafter, and in accordance with Article 12, detailed information on its policies and measures referred to in subparagraph (a) above, as well as on its resulting projected anthropogenic emissions by sources and removals by sinks of greenhouse gases»*

"In order to promote progress to this end, each of these Parties shall communicate, within six months of the entry into force of the Convention for it and periodically thereafter, and in accordance with Article 12, detailed information on its policies and measures referred to in subparagraph (a) above, as well as on its resulting projected anthropogenic emissions by sources and removals by sinks of greenhouse gases"

MRV can be considered as the means of addressing a country's commitments to collect and share information about progress of implementation of provisions and/or commitments of Parties, according to Article 4.1 (a) of the Convention i.e. to:

"develop, periodically update, publish and make available to the Conference of the Parties, in accordance with Article 12, national inventories of anthropogenic emissions by sources and removals by sinks of all GHGs not controlled by the Montreal Protocol, using comparable methodologies to be agreed upon by the Conference of the Parties".

Estimates are done following the guidance given by the IPCC, Good Practice Guidance for LULUCF. UNFCCC (2009b) provided initial methodological guidance in relation to MRV for REDD+ at COP 15, Decision 4/CP.15, paragraph 1(d) where Parties were requested to: "establish, according to national circumstances and capabilities, robust and transparent NFMS and, if appropriate, sub-national systems as part of NFMS that:

i. Use a combination of remote sensing and ground-based forest Carbon inventory approaches to estimate, as appropriate, anthropogenic forest-related GHG emissions by sources and removals by sinks, forest Carbon stocks and forest area changes (Monitoring and Measurement);

ii. Provide transparent, consistent, as far as possible accurate, estimates that reduce uncertainties, taking into account national capabilities and capacities (Reporting); and

iii. Are transparent with results that are available and suitable for review as agreed by the Conference of the Parties" (Verification) (Box 5.1).

Box 5.1: Implications of MRV for REDD+ initiatives

Parties aiming to undertake REDD+ activities are encouraged to:

i). Set up a robust and transparent NFMS comprised of both a monitoring function and an MRV function;

ii.) Ensure that REDD+ activities, policies and measures are results-based, by using an NFMS that:
- Measures anthropogenic sources and removals (by sinks) of GHG emissions in the forestry sector, including changes in forest Carbon stocks, and changes in forest area.
- Minimise uncertainty by providing transparent, coherent, comparable, consistent and accurate estimates of GHG emissions and removals associated with REDD+ activities.
- maximise transparency, by making the results of the measurements available for international appraisal, as agreed by the COP; and

iii). Follow the most recent methodological recommendations provided by the IPCC, as adopted or encouraged by the COP.

There are several MRV schemes and these include the following:

i. National Communications – reporting of CCM and adaptation and provision of information on programmes comprising measures to mitigate climate change, meteorological information, adaptation and GHG emissions;

ii. GHG inventories – reporting GHG emissions and removals with information on GHG emissions by sources and removals by sinks by sectors and categories;

iii. Biennial Update Reports (BURs) - CCM, adaptation and support. Includes information on mitigation actions planned and under implementation, including national GHG inventories;

iv. Reporting for CDM and other Carbon market projects showing emission reductions from projects;

v. NFMS - information on forest cover and associated Carbon stocks and their changes; and

vi. Policy M&E - depends on the policy objective, therefore depends on policy sector.

5.4.2 Biennial update report

BURs are reports that are submitted by non-Annex I Parties (Box 5.2), with updates of national GHG inventories, including a national inventory report and information on mitigation actions, needs and support received.

Box 5.2 Three main groups of Parties to UNFCCC

Annex I Parties - Include industrialised countries that were members of the Organisation for Economic Co-operation and Development (OECD) in 1992, including countries with economies in transition, the Russian Federation, the Baltic States, and several states in Central and Eastern Europe.

Annex II Parties – these are OECD members in Annex I, but are not EIT Parties. They are required to provide financial resources to enable developing countries to undertake emissions reduction activities under the Convention and to help them adapt to adverse effects of climate change. Funding provided by Annex II Parties is channelled mostly through the financial mechanism of the convention.

Non-Annex I Parties include developing countries recognised by the Convention as being particularly vulnerable to the adverse impacts of climate change, including countries with low-lying coastal areas and those prone to desertification and drought. They need investment, insurance and technology transfer (unfccc.int).

The reports provide updates on actions carried out by a Party to implement the Convention, including the status of its GHG emissions and removals by sinks, as well as on the actions to reduce emissions or enhance sinks. Key elements of the BUR are shown in Figure 22. The BUR is a form of MRV scheme.
GEF provides resources to cover the requirements for both national communications and BURs on an agreed full cost basis following its operational procedures for financing national communications and the policy guidelines for funding BURs. The funds can be accessed by
Non-Annex I Parties either through a GEF Implementing Agency (which supports enabling activities – for example, national communications and BUR preparation) or directly from the GEF secretariat (GEF Secretariat, 2018).

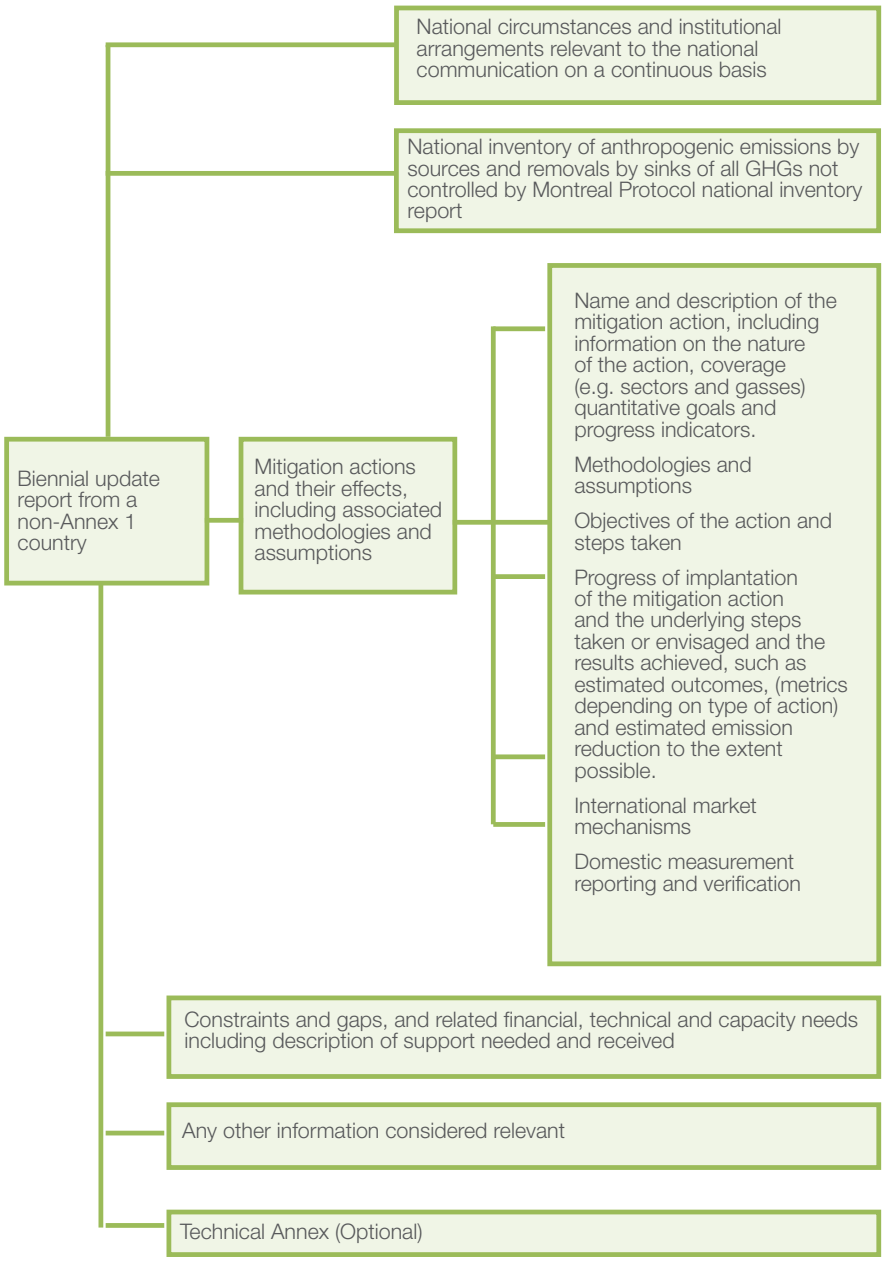


Figure 22: Key elements of BUR scheme (UNFCCC, 2022c)

5.4.3 Reporting process at project level

The information reported to the UNFCCC Secretariat must be documented following the reporting guidelines required by the UNFCCC, as decided by the COP. When developing and reporting GHG estimates, there is need to follow principles of accuracy (minimising estimation uncertainties), transparency (disclosure of GHG accounting data inputs, methodologies, and assumptions), consistency (achievement of a consistent time series of data across years or other frequency of estimation), comparability (comparable results across entities using the standard) and completeness (avoiding omissions and double counting in estimates). These principles are also relevant for the verification and assessment process that is independent of the GHG inventory. The IPCC developed the guidelines forming a methodological framework for the MRV function of the NFMS. The guidelines can be applied to the monitoring function to ensure consistency in estimations, for example when estimating emissions reductions for a demonstration activity.

Development of the MRV function of NFMS for REDD+ activities should consider key concepts and elements of the methodological guidance and guidelines of the IPCC. The UN-REDD NFMS Strategy is built on three 'pillars' following IPCC Good Practice Guidance of 2003 or the guidelines for National GHG Inventories (IPCC, 2006), with the methodological approach combining information on the extent of human activities (referred to as AD) and coefficients that quantify emissions or removals per unit activity (referred to as EF) (equation

1). These form the three pillars of national forest monitoring.

Emission Estimate = AD x Emission Factor [1]

Where: AD=Activity Data and EF=Emission Factor

5.4.3.1 Approaches to determine Activity data

The IPCC's Good Practice Guidance for LULUCF defined AD as data that shows the magnitude of human activity causing emissions or the removals taking place during a particular period of time. In the LULUCF sector, examples of AD are; data on land area, management systems, liming and fertiliser use etc (IPCC, 2003).

The IPCC proposed three approaches to generate AD when referring to land identification, which are not presented hierarchically and are not mutually exclusive (IPCC, 2003; IPCC, 2006). National entities responsible for GHG inventories are required to select an approach based on their national circumstances and capabilities. The three approaches can be used for identifying total change in area for each individual land use category within a country, but does not inform on the nature and area of conversions between land uses (Approach 1). The second approach introduces some tracking of land-use conversions between categories though it's not spatially explicit (Approach 2). The third approach extends the second approach by allowing land use conversions to be tracked in a spatially explicit way (Approach 3). These three approaches are briefly explained below (IPCC, 2003; IPCC, 2006);

Approach 1- represents totals for land use areas within a defined spatial unit, often defined by administrative borders, such as a province, municipality or a country. Only net changes in land use area can be tracked within the boundaries of the spatial unit through time following this approach. However, the geographical location of each land use change is not known together with the actual changes that occur between land uses.

Approach 2- provides an assessment of both the gross and net losses or gain of the surface area for specific land use categories and allows the determination of locations where these changes take place. The approach provides information on conversions between categories, and tracks these changes with not spatially-explicit data (i.e. the location of specific land uses and land-use conversions are not known).

Approach 3 - is characterised by spatially explicit observations of land use categories and land use conversions, often through sampling at specific geographical points and/or complete ('wall-to-wall') mapping. Approach 3 uses satellite data for analysis.

5.4.3.2 Approaches to determine the emission factor

An EF is either the average emission rate of a given GHG for a given source, relative to units of activity, or the average Carbon stock increase for net removals. The estimations of emissions and removals can be obtained in different ways and the methodological approaches are classified into three different 'Tiers'. The tiers differ based on increasing quantity of information required and the extent of complexity (IPCC, 2003; IPCC, 2006). Tier 1 is a basic method, Tier 2 is intermediate and Tier 3 has most demanding complexity and data requirements. Tiers 2 and 3 are often referred to as higher tier methods usually considered more accurate. The Tiers are described below (See also Box 5.3):

Tier 1- approach uses default EF data provided by the IPCC (including on the Emissions Factor Database). This tier level is appropriate for countries where national data are scarce or absent and they use default EF.

Tier 2 - can use a similar methodological approach as Tier 1 but applies country or region specific EFs for the most important land use categories, usually allowing the use of more disaggregation on the AD.

Tier 3 –uses higher order methods, including models and inventory measurement systems tailored to address national circumstances, repeated over time, and driven by high-resolution AD and disaggregated at sub-national to fine-grid scales. These higher-order methods provide estimates with greater certainty than lower tiers and, for the LULUCF sector, shows a closer link between biomass and soil dynamics.

Box 5.3: NFMS in the Congo

The NFMS in the Congo complies with the IPCC guidelines and directives. The first comprehensive national forest inventory was completed, in addition to conducting a historical analysis of forest cover change. These two projects enabled establishment of robust AD and EF for the construction of its FREL as well as the regular monitoring of emissions from forests on its territory. The NFMS was institutionalised and REDD + monitoring and MRV (satellite land monitoring system, national forest inventory, GHG inventories) produced. The UN-REDD measures historical analyses of deforestation have been published and the methodology for monitoring deforestation is in place using the Terra Mayombe platform. The NFMS includes a Satellite Land Tracking System and the National Forest Inventory. The NFMS also includes a national GHG inventory. As the FREL document shows, the NFMS is capable of estimating anthropogenic forest GHG emissions by source and removal through sinks, forest Carbon stocks and area change in forests as a result of the implementation of REDD + activities. Maps and a nationwide forest inventory covering all the forests of the countries, including natural forests, are available (World Bank, 2021c)..

5.5 Specific monitoring and evaluation frameworks performance indicators

Performance indicators are measures of project impacts, outcomes, outputs, and inputs that are monitored during project implementation to assess progress toward project objectives. They are also used later to evaluate a project's success. Indicators organise information in a way that clarifies the relationships between a project's impacts, outcomes, outputs, and inputs and help to identify problems along the way that can impede the achievement of project objectives (World Bank, 1996). Cook et al. (1995) outlined several benefits of performance indicators and these include:

i. Use in strategic planning as they can clarify objectives and logic of the programme/project;
ii. Use in performance accounting by informing resource allocation decisions if they are used to direct resources to the most successful activities and thereby promote the most efficient use of resources;
iii. As a tool for forecasting and early warning during programme implementation. They provide feedback that can be used for planning, identifying areas that need improvement, and suggesting what can be done;
iv. Used for measuring and demonstrating programme results;
v. Benchmarking data generated data against other projects or programmes; and
vi. Measuring beneficiary satisfaction.

The natural resources and environment initiatives, the OECD (2017) outlined some indicators relevant to the forestry sector and these are outlined in Table 6.

Table 6: Performance indicators relevant to the forestry sector

Theme	Indicator(s)	Measurability (short, medium or long term)
Carbon and energy productivity	i. CO2 productivity ii. Energy productivity	Short to medium term
Resource productivity	i. Nutrient flows and balances ii. Water productivity	Short to medium term
Natural resource stocks	Index of natural resources expressed in monitory terms	Medium term
Renewable stocks	i. Freshwater availability ii. Area and volume of forest stock changes over time iii. Proportion of fish stocks within biological limits	Short to medium term
Biodiversity and ecosystems	i. Land use and land cover changes ii. Degree of topsoil losses iii. Species threat status iv. Trends in species abundance	Short to medium term
Environmental health and risks	i. Years of healthy life lost due to degraded environments ii. Exposure to natural or industrial risks	Short term
Environmental services and amenities	Population with access to safe drinking water	

Environmental goods and services	Production of environmental goods and services-gross value added in the sector (% of Gross Domestic Product), employment (% of employment) and expenditure	

5.6 Global stock take of NDCs implementation

The global stocktake (GST) of the Paris Agreement is a process for taking stock of the implementation of the Paris Agreement with the aim of assessing the world's collective progress towards achieving the purpose of the agreement and its long-term goals. The first GST will run from 2021 to 2023 and will be repeated every 5 years thereafter. At the Paris Agreement, countries established an enhanced transparency framework (ETF) where countries are expected to report transparently on actions taken and progress in CCM, adaptation measures and means of implementation, and support provided or received, starting in 2024. The ETF also provides for international procedures for the review of the submitted reports and the information gathered will feed into the GST which will assess the collective progress towards the long-term climate goals. This will enable countries to set more ambitious plans in the next round. For mitigation activities, the GST focuses on the overall effect of NDCs and the state of GHG emissions and removals and mitigation efforts undertaken by Parties (UNFCCC, 2022d).

Components of GST

i. Information Collection and Preparation - Gathering, compiling and synthesising information in preparation for the Technical Assessment component;

ii. Technical Assessment - Assessing collective progress towards achieving the purpose and long-term goals of the Paris Agreement, as well as identifying opportunities for enhanced action and support, including international cooperation for climate action. Normally timed to take advantage of the release of IPCC reports; and

iii. Consideration of outputs- Discusses implications of findings of a technical assessment to inform Parties for updating and enhancing, in a nationally determined manner, their actions and support in accordance with relevant provisions of the Paris Agreement, as well as enhancing international cooperation for climate action.

> The National Forest Inventory is commonly used to describe the technical process of data compilation and analysis of forest resources from several data sources, including field inventories and remote sensing, to estimate relevant forest characteristics at particular points in time (FAO, 2017b).

Types of information required for GST

The sources of input for the GST considers information gathered collectively including:

i. The state of GHG emissions by sources and removals by sinks and mitigation efforts undertaken by Parties, including the information referred to in Article 13, paragraph 7(a), and other Articles of the Paris Agreement;

ii. The overall effect of Parties' NDCs and overall progress towards the implementation of their NDCs, including the information referred to in Article 13, paragraph 7(b), of the Paris Agreement;

iii. The state of adaptation efforts, support, experience and priorities;

iv. The financial flows, means of implementation and support, mobilisation and provision of support. This should include information from the latest biennial assessment and overview of climate finance flows of the Standing Committee on Finance;

v. Efforts for enhancing cooperative and facilitative understanding, action and support related to averting, minimising and addressing loss and damage associated with the adverse effects of climate change;

vi. Barriers and challenges faced by developing countries, including technology, finance and capacity-building gaps;

vii. Good practices, experience and potential opportunities to enhance international cooperation on mitigation and adaptation and to increase support under Article 13, paragraph 5, of the Paris Agreement; and

viii. Considerations of fairness, including equity, as communicated by Parties in their NDCs.

The GST is designed to finish its work before the commencement of each new NDCs cycle to allow Parties to consider the outputs of the collective assessment when formulating and submitting subsequent NDCs (UNFCCC, 2022d).

5.7 REDD+ monitoring and evaluation systems

The UN-REDD Strategy targets building technical capacities on elements linked to NFMSs in developing countries. The implementation of UNFCCC REDD+ decisions is the core of the approach that takes into account national circumstances and capacities while combining experiences acquired through international REDD+ initiatives. This encompasses forest monitoring experiences from individual countries including those implementing the UN-REDD programme and the FCPF. The quality of the GHG inventory depends on the robustness of results from the measurements, the credibility of estimates, and also the manner and method in which the information was organised and presented. The UN-REDD+ NFMS are based on three principles:

i. **National ownership** - countries need to exercise full control over the entire NFMS development process based on their national circumstances and development priorities, assuming full responsibility for the implementation and effective operation of their NFMS from Phases 1 to 3 of REDD+ (see section 3.6.3). International partner organisations and foreign institutions will only provide support for technology transfer, technical capacity building and the development of institutional capacities;

ii. **Building on existing systems and capacities** - this is one of the key principles focusing on building upon existing national/regional and/or international capacities, programmes and initiatives for the implementation of NFMSs; and

iii. **Consistency with the UNFCCC process** - countries should fully integrate REDD+ activities and their NFMS based on their UNFCCC commitments, in addition to their national policy and legislation.

The NFMS should be in line with relevant UNFCCC decisions on REDD+, (decisions 4/CP.15 and 1/CP.16), and all other subsequent decisions adopted by COP. Furthermore, they should be relevant for the phased approach of UNFCCC REDD+ activities (Decision 1/CP.16, paragraph 73) and should be robust, transparent, focused at the national level, with subnational monitoring systems as a potential interim measure.

5.8 Monitoring, reporting and verification, Safeguards Information System and National Forest Inventory

M&E of CCM projects is required for accurate determination of net GHGs, benefits and costs, to ensure fulfilment of country obligations and the protection of the global climate. Under the KP's JI, the reduction in emissions by sources, or an enhancement of removals by sinks, must be additional to any that would otherwise occur, entailing project evaluation (Article 6). The emission reduction units from these projects can be used to meet Annex I Party's commitment under Article 3 of the KP, facilitating implementation of all monitoring, evaluation, reporting, verification, and certification (MERVC) of activities (Vine et al., 1999). Similarly, under CDM, emission reductions must be additional and certified as real and measurable, emanating from projects that contribute to sustainable development, again calling for performance of all MERVC activities (STAP, 2017). The UN-REDD+ NFMS is based on three technical pillars or building blocks of the NFMS essential for supporting the MRV function:

Pillar 1: A Satellite Land Monitoring System – used to collect and assess, activity data, related to forest land over time;

Pillar 2: National Forest Inventory – used for collecting information on forest carbon stocks and changes, relevant for estimating emissions and removals and to provide emissions factors; and

> *The National Forest Inventory is commonly used to describe the technical process of data compilation and analysis of forest resources from several data sources, including field inventories and remote sensing, to estimate relevant forest characteristics at particular points in time (FAO, 2017b).*

Pillar 3: A national GHG Inventory – used as a tool for reporting to the UNFCCC Secretariat the anthropogenic forest-related GHG emissions by sources and removals by sinks.

The establishment of SIS is critical for the success of CCM activities and these have already been discussed.

In Text Question(10 minutes)

i. Distinguish between monitoring and evaluation.
ii. Explain the process of reporting in forestry.
iii. Explain the principles of REDD+ monitoring system.

Summary

In this chapter, we have learnt about concepts of M&E and associated components. Monitoring is a continuous process whilst evaluation can be done at mid-term and at the end of project. We also learnt about the reasons why M&E are done and that evaluation can be either formative or summative. Another important component is the issue of reporting which is normally the end product of a monitoring and/or evaluation process. Under the UNFCCC process both developed and developing country Parties enhance their action on mitigation of climate change, by implementing NAMAs actions that are measurable, reportable and verifiable. The MRV can be interpreted as the means for addressing a country's commitments to collect and share information on the progress of the implementation of provisions and/or commitments of Parties. There are several reporting schemes that have been discussed including BUR and NFMS. Reporting at project level includes the reporting of emissions based on AD (either approaches 1, 2 or 3) and EFs generated using either tier 1, 2, or 3. The performance indicator specific to forestry sector have been discussed. The chapter concluded by discussing GST of NDC implementation, reporting systems for REDD+, MRV and SIS. .

References

ADEME. 2021. Forêts et usages du bois dans l'atténuation du changement climatique. 40 p. www.ADEME.fr/mediatheque.

African Forest Forum. 2019. International dialogues, processes and mechanisms to climate change: A compendium for professional and technical training in African forestry. Technical Working Paper. 132pp.

AMCEN. 2011. Addressing climate change challenges in Africa: A practical guide towards sustainable development. African Ministerial Conference on Environment (AMCEN), Addis Ababa, Ethiopia.

APP. 2014. Grain fish money: Financing Africa's green and blue revolutions. Geneva. 180pp.

African Union Commission. 2015. Agenda 2063: The Africa we want. African Union.

Agaliotis, V. 2020. Carbon sequestration technology and methods. ClimateOrb.

Agroforestry Network. 2018. Scaling up agroforestry: Potential, challenges and barriers. A review of environmental, social and economic aspects on the farmer, community and landscape level. Agroforestry Network and Vi-Agroforestry, Stockholm, Sweden. 85pp.

Alexander, S., Nelson, C.R., Aronson, J., Lamb, D., Cliquet, A., Erwin, K.L. and Hobbs, R.J. 2011. Opportunities and challenges for ecological restoration within REDD+. Restoration Ecolology 19:683–689.

Almutairi, A.A., Ahmad, M., Rafique, M.I. and Al-Wabel, M.I. 2022. Variations in composition and stability of biochars derived from different feedstock types at varying pyrolysis temperature. Journal of the Saudi Society of Agricultural Sciences. https://doi.org/10.1016/j.jssas.2022.05.005.

Angelsen, A. 2007. Forest cover change in space and time: Combining the von Thunen and forest transition theories. Policy Research Working Papers 4117. World Bank. Washington, DC. https://doi.org/10.1596/1813-9450-4117.

Angelsen, A. (Ed). 2009. Realising REDD+: National strategy and policy options. Bogor, Center for International Forestry Research (CIFOR). Bangor. Indonesia.

Angelsen, A., Brockhaus, M., Sunderlin, W.D. and Verchot, L.V. 2012. Analysing REDD+: Challenges and choices. CIFOR.

Angelsen, A., Jagger, P., Babigumira, R., Belcher, B., Hogarth, N.J., Bauch, S., Börner, J., Smith-Hall, C. and Wunder, S. 2014. Environmental income and rural livelihoods: A global-comparative analysis. World Development 64: S12–S28.

Angelsen, A. and Rudel, T.K. 2013. Designing and implementing effective REDD+ policies: A forest transition approach. Review of Environmental Economics and Policy 7(1): 91-113.

Asner, G.P., Elmore, A.J., Olander, L.P., Martin, R.E. and Harris, A.T. 2004. Grazing systems, ecosystem responses, and global change. Annual Review of Environment and Resources 29:261-299. (doi:10.1146/annurev.energy.29.062403.102142).

Awono, A., Ingram, V., Schure, J. and Levang, P. 2013. Guide for small and medium enterprises in the sustainable non-timber forest product trade in Central Africa. Center for International Forestry Research (CIFOR).

Aylott, M. 2010. Forget palm oil and soya, microalgae is the next big biofuel source. The Ecologist. http://www.theecologist.org/blogs_and_comments/commentators/other_comments/609556/forget_palm_oil_and_soya_microalgae_is_the_next_big_biofuel_source.html.

Baimwera, B., Wang'ombe, D. and Kitindi, E. 2017. Carbon markets: Have they worked for Africa?. Review of Integrative Business and Economics Research 6(2): 90–104.

Bataille, C., Åhman, M., Neuhoff, K., Nilsson, L.J., Fischedick, M., Lechtenböhmer, S., Solano-Rodriquez, B., Denis-Ryan, A., Stiebert, S., Waisman, H., Sartor, O. and Rahbar, S. 2018. A review of technology and policy deep decarbonization pathway options for making energy-intensive industry production consistent with the Paris Agreement. Journal of Cleaner Production 187: 960-973. https://doi.org/10.1016/j.jclepro.2018.03.107.

Bernoux, M., Feller, C., Cerri, C.C., Eschenbrenner, V. and Cerric, E.P. 2005. Soil Carbon sequestration. 1st edition. In: Soil erosion and Carbon sequestration. CRC Press. p10.

Brady, E. 2014. Aesthetic value, ethics and climate change. Environmental Values 23(5):551-570.

Brahmbhatt, M., Haddaoui, C. and Page, J. 2017. Green industrialisation and entrepreneurship in Africa. Contributing Paper for African Economic Outlook 1–60.

Braña Varela, J., Lee, D., Rey Christen, D. and Swan, S. 2014. REDD+ Safeguards: Practical considerations for developing a summary of information. Prepared with support from the Government of Norway's International Climate and Forest Initiative. Available at www.merid.org/reddsafeguards.

Brassard, P., Godbout, S. and Raghavan, V. 2016. Soil biochar amendment as a climate change mitigation tool: Key parameters and mechanisms involved. Journal of Environmental Management 181:484-497.

Brockhaus, M., Di Gregorio, M. and Mardiah, S. 2014. Governing the design of national REDD+: An analysis of the power of agency. Forest Policy and Economics 49: 23–33.

Broekhoff, D., Gillenwater, M., Colbert-Sangree, T. and Cage, P. 2019. Securing climate benefit: A guide to using Carbon offsets. Stockholm Environment Institute & Greenhouse Gas Management Institute. Offsetguide.org/pdf-download/.

Brown, S., Sathaye, J., Cannell, M. and Kauppi, P. 1995. Management of forests for mitigation greenhouse gas emissions. Cambridge University Press: Cambridge, UK.

Brown, S., Sathaye, J., Cannell, M. and Kauppi, P.E. 1996. Mitigation of Carbon emissions to the atmosphere by forest management. Commonwealth Forestry Review 75: 80–91.

Brown, S. 1997. Los bosques y el cambio climático: El papel de los terrenos forestales como sumideros de carbono. In: Proceedings of the Actas del XI Congreso Mundial Forestal. Recursos Forestales y Arboles, Antalya. Turkey. 13–22. pp. 13–22.

Campbell, B.M. 2009. Beyond Copenhagen: REDD plus, agriculture, adaptation strategies and poverty. Global Environmental Change 19:397–399.

Carbon Brief Ltd. 2021. Global CO2 emissions have been flat for a decade, new data reveals. Available at: Global CO2 emissions have been flat for a decade, new data reveals - Carbon Brief.

Carbon Market Watch. 2017. Good-Bye Kyoto: Transitioning away from offsetting after 2020. Carbon Market Watch Policy Brief.

Carr, M., Davies, S. and Locke, B. 2010. Job creation and market opportunities for biobased chemicals and products. Industrial Biotechnology 6:477.doi:10.1089/ind.2010.0003.

Carter, J.E. 1995. The potential of urban forestry in developing countries: A concept paper. Food and Agriculture Organization (FAO), Rome, Italy.

Chan, K.M., Anderson, E., Chapman, M., Jespersen, K. and Olmsted, P. 2017. Payments for ecosystem services: Rife with problems and potential – for transformation towards sustainability. Ecological Economics. 140:110–122. https://doi.org/10.1016/j.ecolecon.2017.04.029.

Chastin, S., Jennings, N., Toney, J., Anadon, D.L. and Smith, P. 2021. Co-benefits of climate change mitigation and adaptation actions. COP26 Universities Network Briefing.

Chemete, P. 2018. Lutte contre les changements climatiques: 600 millions de FCFA pour le reboisement. Cameroon tribune daily. Accessed January 2022 at https://www.cameroon-tribune.cm/ articles/18674/fr/.

Crane, T.A., Roncol, C. and Hoogenboom, G. 2011. Adaptation to climate change and climate variability: The importance of understanding agriculture as performance. NJAS: Wageningen Journal of Life Science 57(3-4): 179–185.

Christie, P. and White, A.T. 2007. Best practices for improved governance of coral reef marine protected areas. Coral Reefs 26:1047–1056.

Ci-Dev. 2017. Post-2020 Ci-Dev Portfolio Transition Report. World Bank.

Ci-Dev. 2022. The Carbon initiative for development. Available at: Ci_Dev_Brochure_General_Updated 2022_Senegal, Rwanda, Rwanda Inactive_0.pdf (ci-dev.org).

Clapp, C., Briner, G. and Karousakis, K. 2010. Low-emission development strategies (LEDS): Technical, institutional and policy lessons. Organisation for Economic Cooperation and Development/ International Energy Agency, Paris, 56pp. Available at: www.oecd.org/dataoecd/32/58/46553489.pdf.

Climate Focus. 2017. What is the future of the CDM? Questions and answers. Briefing Note. Climate Focus.

Colfer, C.J.P., Basnett, B.S. and Elias, M. 2016. Gender and forests: Climate change, tenure value chains and emerging issues. CIFOR. Taylor and Francis.

CPF. 2008. Strategic framework for forests and climate change: A proposal by the Collaborative Partnership on Forests for a coordinated forest-sector response to climate change. www.fao.org/forestry/ cpf-climatechange.

Curnow, P. and Hodes, G. 2009. Implementing CDM projects a guidebook to host country legal issues. UNEP.

Cook, T.J., VanSant, J., Stewart, L. and Adrian, J. 1995. Performance measurement: Lessons learned for development management. World Development 23(8):1303–15.

CTCN. 2015. Pro-poor approaches to REDD+. CTCN. Copenhagen.

CTCN. 2016. Urban forestry. Available at: Urban forestry | Climate Technology Centre & Network | Tue, 11/08/2016 (ctc-n.org).

CTCN. 2017. Programme de gestion durable des ecosystemes forestiers (GDEF) pour une adaptation aux changements climatiques. 25pp.

Davidson, O., Halsnæs, K., Huq, S., Kok, M., Metz, B., Sokona, Y. and Verhagen, J. 2003. The development and climate nexus: The case of Sub-Saharan Africa. Climate Policy 3(S1): 97–113.

Denier, L., Korwin, S., Leggett, M. and MacFarquhar, C. 2014. The little book of legal frameworks for REDD+. Global Canopy Programme. Oxford.

Dickie, A., Streck, C., Roe, S., Zurek, M., Haupt, F. and Dolginow, A. 2014. Strategies for mitigating climate change in agriculture: Abridged report. Climate Focus and California Environmental Associates, with the support of the Climate and Land Use Alliance.

Dié, A., De Ridder, M., Cherubini, P., Kouamé, F.N., Verheyden, A., Kitin, P. Toirambe, B.B., Van den Bulcke, J., Van Acker, J. and Beeckman, H. 2015. Tree rings show a different climatic response in a managed and a non-managed plantation of two Teak species (Tectona grandis L.f.) in West Africa. IAWA journal / International Association of Wood Anatomists 36(4):409-427.

Doelman, J.C., Stehfest, E., van Vuuren, D.P., Tabeau, A., Hof, A.F., Braakhekke, M.C., Gernaat, D.E.H.J., van den Berg, M., van Zeist, W-J., Daioglou, V., van Meijl, H. and Lucas, P.L. 2020. Afforestation for climate change mitigation: Potentials, risks and trade-offs. Global Change Biology 26:1576– 1591. https://doi.org/10.1111/gcb.14887.

Dooley, K. and Mackey, B. 2019. Want to beat climate change? Protect our natural forests. The Conversation, Inc.

Doswald, N. and Osti, M. 2011. Ecosystem-based approaches to adaptation and mitigation—good practice examples and lessons learned in Europe. Bonn: Federal Agency for Nature Conservation.

Dragone, G., Fernandes, B., Vicente, A.A. and Teixeira, J,A. 2010. Third generation biofuels from microalgae. Applied Microbiology 2:13551366.

Dubash, N.K., Hagemann, M., Höhne, N. and Upadhyaya, P. 2013. Developments in national climate change mitigation legislation and strategy. Climate Policy 13: 649–664. doi: 10.1080/14693062.2013.845409, ISSN: 1469-3062.

Duchelle, A.E., Seymour, F., Maria Brockhaus, M., Angelsen, A., Larson, A.M., Moeliono, M., Grace, Y., Wong, G.Y., Pham, T.T. and Martius, C. 2019. Forest-based climate mitigation: Lessons from REDD+ implementation. Center for International Forestry Research.

Epple, C., García Rangel, S., Jenkins, M. and Guth, M. 2016. Managing ecosystems in the context of climate change mitigation: A review of current knowledge and recommendations to support ecosystem-based mitigation actions that look beyond terrestrial forests. Technical Series No.86. Secretariat of the CBD. Montreal. 55pp.

European Environment Agency. 2021. Nature-Based Solutions in Europe: Policy, knowledge and practice for climate change adaptation and disaster risk reduction. EEA Report. Copenhagen. https://www.eea.europa.eu/publications/nature-based-solutions-in-europe.

FAO. 2013a. National planning for GHG mitigation in agriculture: A guidance document. Mitigation of Climate Change in Agriculture Series 8. FAO. Rome.

FAO. 2013b. Food wastage footprint: Impacts on natural resources. FAO. Rome.

FAO. 2015. Soils help to combat and adapt to climate change by playing a key role in the carbon cycle. FAO.

FAO. 2016. Forty years of community-based forestry. A review of its extent and effectiveness. FAO Forestry Paper No. 176. FAO. Rome.

FAO. 2017a. Integrating climate change adaptation and mitigation into the watershed management approach in Eastern Africa. Food and Agriculture Organization of the United Nations. Available at: http://www.fao.org/3/a-i7489e.pdf.

FAO 2017b. Voluntary guidelines on national forest monitoring. FAO. Rome.

FAO. 2018. La Situation des forêts du monde 2018. Rome. www.fao.org/3/I9535FR/i9535fr.pdf].

FAO. 2020. La situation des forêts du monde. Forêts, biodiversité et activité humaine. Rome. https://doi.org/10.4060/ca8642fr.

FAO. 2023. REDD+ Reducing emissions from deforestation and forest degradation. Governance and tenure. FAO.org.

FAO and UNEP. 2020. The state of the world's forests 2020. Forests, biodiversity and people. Rome. https://doi.org/10.4060/ca8642en.

FAO and UNEP. 2021. Promoting transformational change and innovation in REDD+ action. UN- REDD Info Brief Global. Gender FINAL(1)_1.pdf (un-redd.org).

FAO/ITTO/INAB. 2003. International Conference on the contribution of criteria and indicators for sustainable forest management: The way forward. Final Report 1. Rome.

Fan, Y., Park, S. and Nan, Z. 2018. Participatory water management and adoption of micro-irrigation systems: Smallholder farmers in arid north-western China. International Journal of Water Resources Development 34(3): 434–452.

Fawzy, S., Osman, A.O.I., Doran, J. and Rooney, D. 2020. Strategies for mitigation of climate change: A review. Environmental Chemistry Letters. 18: 2069–2094. https://doi.org/10.1007/s10311-020-01059-w.

Federici, S., Lee, D. and Herold, M. 2017. Forest mitigation: A permanent contribution to the Paris Agreement? (Working Paper). Norwegian International Climate and Forest Initiative.

Finke, A. 2010. Briefing document on indigenous peoples and climate change/REDD: An overview of current discussions and main issues. IUCN. Briefing paper IPs & CC/ REDD (iucn.org).

Frigeri, J., Krefta, S., Paula, A., Germano, A.D. and Krefta, S. 2017. Environmental and socioeconomic benefits of urban trees. Environmental Science. Corpus ID: 135323541.

Furumo, P. and Lambin, E. 2021. Policy sequencing to reduce tropical deforestation. Global Sustainability 4: E24. doi:10.1017/sus.2021.21.

Gabel, H.L. 2000. Principles of environmental and resource economics: A guide for students and decision-makers. Edward Elgar Publishing, 820 pp. ISBN: 9781840643817.

GEF Secretariat. 2018. GEF-7 replenishment programming direction. Fourth Meeting for the Seventh Replenishment of the GEF Trust Fund. Stockholm. Sweden.

GEF. 2022. Climate change mitigation. Available at: Climate Change Mitigation | GEF (thegef.org).

Gerber, P.J., Steinfeld, H., Henderson, B., Mottet, A., Opio, C., Dijkman, J., Falcucci, A. and Tempio, G. 2013. Tackling climate change through livestock: A global assessment of emissions and mitigation opportunities. FAO. Rome, Italy.

GGW. nd. The great green wall. https://www.greatgreenwall.org/about-great-green-wall.

Gibbons, W. and Hughes, S. 2011. Distributed, integrated production of second and third generation biofuels. In: Economic effects of biofuel production. IntechOpen. https://doi.org/10.5772/18463.

GIZ. 2016. Mesures d'atténuation appropriées au niveau national. Étapes de passage d'une NAMA d'une simple idée à la mise en œuvre. 103pp.

Gizachew, B., Astrup, R., Vedeld, P., Zahabu, E.A. and Duguma, L.A. 2017. REDD+ in Africa: Contexts and challenges. A United Nations Sustainable Development Journal. 41(2): 92–104.

GOFC-GOLD, 2016. A sourcebook of methods and procedures for monitoring and reporting anthropogenic greenhouse gas emissions and removals associated with deforestation, gains and losses of Carbon stocks in remaining forests and forestation. GOFC-GOLD Report version COP22-1. (GOFC-GOLD Land Cover Project Office, Wageningen University, The Netherlands).

Green Climate Fund. 2019. Accelerating REDD+ implementation. Green Climate Fund Working Paper 2. Korea.

Government of Malawi. 2012. Climate change adaptation and mitigation bestpractices in Malawi. https://ees.kuleuven.be/klimos/toolkit/documents/354_Malawi_CCAM.pdf.

Griscom, B.W., Adams, J., Ellis, P.W., Houghton, R.A., Lomax, G., Miteva, D.A., Schlesinger, W.H., Shoch, D., Siikamäki, J.V., Smith, P., Woodbury, P., Zganjar, C., Blackman, A., Campari, J., Conant, R.T., Delgado, C., Elias, P., Gopalakrishna, T., Hamsik, M.R., Herrero, M., Kiesecker, J., Landis, E., Laestadius, L., Leavitt, S.M., Minnemeyer, S., Polasky, S., Potapov, P., Putz, F.E., Sanderman,

J., Silvius, M., Wollenberg, E. and Fargione, J. 2017. Natural climate solutions. Proceedings of the National Academy of Science 114 (44):11645-11650.

Gross, A., Bromm, T, and Glaser, B. 2021. Soil organic Carbon sequestration after biochar application: A global meta-analysis. Agronomy. 11(12):2474. https://doi.org/10.3390/agronomy11122474.

Gupta, A., Vijge, M.J., Turnhout, E. and Pistorius, T. 2014. Making REDD+ transparent: The politics of measuring, reporting and verification systems. In: Gupta, A. and Mason, M. (Eds). Transparency in global environmental governance: Critical perspectives. MIT Press, Cambridge. pp. 181-201.

Györi, M., Diekmann, K. and Kühne, E. 2021. The importance of social protection for climate change mitigation in LMICs: Success stories and opportunities for the future. GIZ.

Hartley, M.J. 2002. Rationale and methods for conserving biodiversity in plantation forests. Forest Ecolology and Management 155: 81–95.

Harvey, C.A., Rambeloson, A.M., Andrianjohaninarivo, T., Andriamaro, L., Rasolohery, A., Randrianarisoa, J., Ramanahadray, S., Christie, M., Siwicka, E., Remoundou, K., Vilchez-Mendoza, S. and MacKinnon, J.L. 2018. Local perceptions of the livelihood and conservation benefits of small-scale livelihood projects in rural Madagascar. Society and Natural Resources. 31(9): 1045-1063, DOI: 10.1080/08941920.2018.1484974.

Hashida, Y. and Lewis, D.J. 2019. The intersection between climate adaptation, mitigation, and natural resources: An empirical analysis of forest management. Journal of the Association of Environmental and Resource Economists 6(5):893-926.

Heinen, D., Arlati, A. and Knieling, J. 2022. Five dimensions of climate governance: A framework for empirical research based on polycentric and multi-level governance perspectives. Environmental Policy and Governance 32(1): 56– 68. https://doi.org/10.1002/eet.1963.

Henderson, I., Coello, J., Fischer, R., Mulder, I. and Christophersen, T. 2013. The role of the private sector in REDD+: The case for engagement and options for intervention. UN-REDD Programme Policy Brief 04.

Hildebrandt, J., Hagemann, N. and Thrän, D. 2017. The contribution of wood-based construction materials for leveraging a low carbon building sector in Europe. Sustainable Cities and Society 34:405-418.

Howard, A., Chagas, T., Hoogzaad, J. and Hoch, S. 2017. Features and implications of NDCs for Carbon markets. Climate Focus. http://www.energimyndigheten.se/contentassets/2600659ecfa54ec995b835a4c99d75fb/final_report_ndcs_and_art._6.2-002.pdf.

Howard, C., Dymond, C.C., Griess, V.C. Tolkien-Spurr, D. and van Kooten, G.C. 2021. Wood product Carbon substitution benefits: A critical review of assumptions. Carbon Balance and Management 16: 9. https://doi.org/10.1186/s13021-021-00171-w.

Hu, Y., Zheng, W., Zeng, W. and Lan, H. 2021. The economic effects of clean development mechanism afforestation and reforestation project: evidence from China. International Journal of Climate Change Strategies and Management 13(2):142-161.

IIED. 2012. His REDD+, her REDD+: How integrating gender can improve readiness. IIED Briefing. Available at: http://pubs.iied.org/17136IIED.

ILO. 2015. Guidelines for a just transition towards environmentally sustainable economies and societies for all. International Labour Office. Geneva.

ILO 2018. The employment impact of climate change adaptation. Input Document for the G20 Climate Sustainability Working Group International Labour Office – Geneva, ILO.

Inderwildi, O.R. and King, D. A. 2009. Quo vadis biofuels. Energy and Environmental Science 2(4): 343–346. https://doi.org/10.1039/b822951c.

IPBES. 2021. Tackling biodiversity and climate crises together and their combined social impacts. Global experts identify key options for solutions, first-ever collaboration between IPBES and IPCC selected scientists.

IPCC. 2001. Climate change 2001: Synthesis report. A Contribution of Working Groups I, II, III to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Watson RT, Core Team, (Eds)., Cambridge University Press, Cambridge and New York, 398pp.

IPCC. 2003. Good practice guidance for land use, land-use change and forestry, prepared by the National Greenhouse Gas Inventories Programme. IGES, Japan.

IPCC. 2006. IPCC guidelines for national greenhouse gas inventories, Ppepared by the National Greenhouse Gas Inventories Programme. Eggleston, H.S., Buendia, L., Miwa, K., Ngara, T. and Tanabe, K. (Eds). Published: IGES, Japan.

IPCC. 2007. Climate change 2007: Mitigation of climate change. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (Metz, B., Davidson, O.R., Bosch, P.R., Dave, R. and Meyer, L.A. (Eds.)). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 863 pp. ISBN: 9781139468640.

IPCC. 2014. Climate change 2014: Synthesis report. Contributions of Working Groups I, II, and III to the 5th Assessment Report of the InterGovernmental Panel on Climate Change. Geneva, Switzerland. 151pp.

IPCC. 2018. Global warming of 1.5 °C. In: Masson-Delmotte, V., Zhai, P., Pörtner, H-O., Roberts, D., Skea, J., Shukla, P.R., Pirani, A., Moufouma-Okia, W., Péan, C., Pidcock, R., Connors, S., Matthews, J.B.R., Chen, Y., Zhou, X., Gomis, M.I., Lonnoy, E., Maycock, T., Tignor, M. and Waterfield, T. (Eds). An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Full_Report_High_Res.pdf.

IPCC. 2019. Climate change and land. An IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. IPCC, Geneva, Switzerland.

IRENA. 2020. A summary of reaching zero with renewables: Eliminating CO2 emissions from industry and transport in line with the 1.5oC climate goal, International Renewable Energy Agency, Abu Dhabi.

IRENA. 2021. Climate action with energy transition: Enhancing and implementing Nationally Determined Contributions. IRENA, Abu Dhabi.

IRENA and ILO. 2022. Renewable energy and jobs: Annual review 2022, International Renewable Energy Agency, Abu Dhabi and International Labour Organization, Geneva, Switzerland.

IUCN. 2013. Africa and the Bonn Challenge: A demonstration of leadership. IUCN Forest Brief No. 13. IUCN, Gland, Switzerland.

IUCN 2016. Africa and the Bonn Challenge: A demonstration of leadership. Forest Brief No. 13. IUCN, Gland, Switzerland.

IUCN 2019. Forest landscape restoration pathways to achieving the SDGs. IUCN. Gland, Switzerland. Available Forest_landscape_restoration_pathways_to_achieving_the_SDGs.pdf (unece.org).

IUCN. 2021. Forests and climate change. Issues Brief. IUCN, Gland, Switzerland.

Jactel, H., Bauhus, J., Boberg, J., Bonal, D., Castagneyrol, B., Gardiner, B., Gonzalez-Olabarria, J.R., Koricheva, J., Meurisse, N, and Brockerhoff, E. 2017. Tree diversity drives forest stand resistance to natural disturbances. Current Forestry Reports 3(3):223-243.

Jansen, K. and Vellema, S. 2011. What is technography? NJAS: Wageningen Journal of Life Sciences 57: 169–177. https://doi.org/10.1016/j.njas.2010.11.003.

Jarvis, A., Lau, C., Cook, S., Wollenberg, E., Hansen, J., Bonilla, O. and Challinor, A. 2011. An integrated adaptation and mitigation framework for developing agricultural research:Synergies and trade-offs. Experimetal Agriculture 47:185–203.

Joosten, K. and Grey, S. 2017. Integrating climate change adaptation and mitigation into the watershed management approach in Eastern Africa – Discussion paper and good practices. FAO. Addis Ababa, Ethiopia.

Kainou, K. 2022. Collapse of the Clean Development Mechanism scheme under the Kyoto Protocol and its spill-over: Consequences of 'Carbon panic'. VOX EU/CPER.

Kalita, D. 2008. Hydrocarbon plant- New source of energy for future. Renewable and Sustainable Energy Review 12. 455471.

Kassam, A., Friedrich, T. and Derpsch, R. 2019. Global spread of conservation agriculture, International Journal of Environmental Studies 76(1): 29-51. DOI: 10.1080/00207233.2018.1494927.

Kellogg, W.W. 2019. Climate change and society: Consequences increasing atmospheric Carbon dioxide. Routledge. Abingdon. UK.

Kheirinik, M., Ahmed, S. and Rahmanian, N. 2021. Comparative techno-economic analysis of Carbon capture processes: Pre-combustion, post-combustion, and oxy-fuel combustion operations. Sustainability 13: 13567. https://doi.org/10.3390/ su132413567.

Kishor, N. and Rosenbaum, K. 2012. Assessing and monitoring forest governance: A user's guide to a diagnostic tool. Programme on Forests (PROFOR), Washington DC.

Klein, R.J.T., Huq, S., Denton, F., Downing, T.E., Richels, R.G., Robinson, J.B. and Toth, F.L. 2007. Inter-relationships between adaptation and mitigation. Climate change 2007: Impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden, P.J. and Harrison, C.E. (Eds). Cambridge University Press, Cambridge. UK. 745-777.

KLIK Foundation. 2022. Cookstove and sustainable biomass programme: Clean cooking in Malawi's urban and peri-urban areas. KLIK Foundation, Zurich, Germany.

Krarup, S. and Russell, C.S. 2005. Environment, information and consumer behaviour. Edward Elgar Publishing. 328 pp. ISBN: 9781845420116.

Krell, N.T., Giroux, S.A., Guido, Z., Hannah, C., Lopus, S.E., Caylor, K.K. and Evans, T.P. 2020. Smallholder farmers' use of mobile phone services in central Kenya. Climate and Development 13(3): 215–227. https://doi.org/10.1080/17565529.2020.1748847.

Kropp, J. and Scholze, M. 2010. Information sur le changement climatique pour une adaptation effective. Manuel à l'intention des praticiens. 60pp.

Lagergren, F. and Jönsson, A.M. 2017. Ecosystem model analysis of multi-use forestry in a changing climate. Ecosystem Services 26:209-224.

Lasco, R.D., Pulhin, F.B., Sanchez, P.A.J., Villamor, G.B. and Villegas, K.A.L. 2008. Climate change and forest ecosystems in the Philippines: Vulnerability, adaptation and mitigation. Journal of Environmental Science and Management 11:1–14.

Lawrence, M.G., Schäfer, S., Muri, H., Scott, V., Oschlies, A., Vaughan, N.E., Boucher, O., Schmidt, H., Haywood, J. and Scheffran, J. 2018. Evaluating climate geoengineering proposals in the context of the Paris Agreement temperature goals. Nature Communications 9: 3734. https://doi.org/10.1038/s41467-018-05938-3.

Lenzi, D. 2018. The ethics of negative emissions. Global Sustainability 1:e7. https://doi.org/10.1017/sus.2018.5.

Leskinen, P., Cardellini, G., González-García, S., Hurmekoski, E., Sathre, R., Seppälä, J., Symth, C., Stern, T. and Verkerk, P.J. 2018. Substitution effects of wood-based products in climate change mitigation. From Science to Policy. https://www.efi.int/publications-bank/substitution-effects-wood-based-products-climate-change-mitigation.

Liebig, M., Morgan, J., Reeder, J., Ellert, B., Gollany, H. and Schuman, G. 2005. Greenhouse gas contributions and mitigation potential of agricultural practices in northwestern USA and western Canada. Soil and Tillage Research 83. DOI: 10,1016/J.STILL.2005.02.008.

Lindner, M. and Verkerk, H. nd. To manage or not to manage – how can we support forests to mitigate climate change and adapt to its impacts? EFI's knowledge to action. Available at: https://efi.int/publications-bank/key-questions-forests-eu.

Lippke, B., Wilson, J., Meil, J. and Taylor, A. 2010. Characterising the importance of Carbon stored in wood products. Wood and Fiber Science 42(1):5–14.

Locatelli, B., Evans, V., Wardell, A., Andrade, A. and Vignola, R. 2011. Forests and climate change in Latin America: Linking adaptation and mitigation. Forests 2:431–450.

Locatelli, B., Pavageau, C., Pramova, E. and Di Gregorio, M. 2015. Integrating climate change mitigation and adaptation in agriculture and forestry: Opportunities and trade-offs. Wiley Interdisciplinary Reviews: Climate Change 6: 585-598. https://doi.org/10.1002/wcc.357.

Lockley, A., Mi, Z. and Coffman, D. 2019. Geoengineering and the blockchain: Coordinating Carbon dioxide removal and solar radiation management to tackle future emissions. Frontiers of Engineering Management 6: 38–51. https://doi.org/10.1007/s42524-019-0010-y.

Loft, L., Thuy, T.P., Wong, G.Y., Brockhaus, M., Dung, N.L., Tjajadi, J.S. and Luttrell, C. 2017. Risks to REDD+: Potential pitfalls for policy design and implementation. Environmental Conservation 44(1): 44-55. https://doi.org/10.1017/S0376892916000412.

Malerba, D, and Wiebe, K.S. 2020. Analysing the effect of climate policies on poverty through employment channels. Environmental Research Letters. https://iopscience.iop. org/article/10.1088/1748-9326/abd3d3/pdf.

Mather, A.S. 1992. The forest transition. Area 24(4): 367-379.

Matsvange, D., Sagonda, R. and Kaundikiza, M. 2016. The role of communities in sustainable land and forest management: The case of Nyanga, Zvimba and Guruve districts of Zimbabwe. Journal of Disaster Risk Studies 8. DOI: 10.4102/jamba,v8i3.281.

Maxwell, S. and Lecture, C.A. 2016. Climate compatible development: Pathway or pipe dream. CDKN: London, UK.

MERF. 2021. Deuxième rapport biennal actualisé. Rapport final. 147pp.

Michaelowa, A. 2004. CDM incentives in industrialised countries: The long and winding road. International Review for Environmental Strategies 5:217-231.

Mohren, G.M.J., Hasenauer, H., Köhl, M. and Nabuurs, G.J. 2012. Forest inventories for Carbon change assessments. Current Opinion in Environmental Sustainability 4: 686-695.

Mujuru, L., Mureva, A., Velthorst, E. and Hoosbeek, M.R. 2013. Land use and tillage effects on soil organic matter fractions in sandy and clayey soils of Bindura and Shamva districts in Zimbabwe. Geoderma 209–210: 262–272.

Mujuru, L,. Rusinamhodzi, L., Nyamangara, J. and Hoosbeek, M.R. 2016. Effects of Nitrogen fertiliser and manure application on storage of Carbon and Nitrogen under continuous maize cropping in

Arenosols and Luvisols of Zimbabwe. Journal of Agricultural Science 154: 242–257 doi:10.1017/S0021859615000520.

Mullan, K. 2014. The value of forest ecosystem services to developing economies. Center for Global Development Working Paper No. 379. https://ssrn.com/abstract=2622748 or http://dx.doi.org/10.2139/ssrn.2622748.

Müller, F., Burkhard, B., Hou, Y., Kruse, M., Ma, L. and Wangai, P. 2016. Indicators for ecosystem services. In: Routledge Handbook Ecosystem Services. Routledge. Abingdon, UK. pp. 157–169.

Nabuurs, G.J., Delacote, P., Ellison, D., Hanewinkel, M., Lindner, M., Nesbit, M., Ollikainen, M. and Savaresi, A. 2015. A new role for forests and the forest sector in the EU Post-2020 climate targets. European Forest Institute, Joensuu, Finland.

Nadkarni, M. and Kuehl, Y. 2013. Forests beyond trees: NTFPs as tools for climate change mitigation and adaptation. INBAR Working Paper No. 74.

Nair, P.K.R. 2012. Climate change mitigation and adaptation: A low hanging fruit of agroforestry. In: Nair, P.K.R. and Garrity, D.P. (Eds). Agroforestry: The future of global land use. Advances in Agroforestry 9: 31–67. New York: Springer.

Narloch, U., Miles, L., Kapos, V., Bodin, B. and Bertzky, M. 2012. Towards a holistic economic assessment of national REDD+ options: Accounting for non-Carbon environmental benefits in REDD+ planning. UNEP World Conservation Monitoring Centre, Cambridge, United Kingdom.

Nowak, D.J. 1994. Atmospheric Carbon dioxide reduction by Chicago's urban forest. In: McPherson, E.G., Nowak, D.J. and Rowntree, R.A. (Eds). Chicago's urban forest ecosystem: Results of the Chicago Urban Forest Climate Project. USDA Forest Service General Technical.

Nowak, D.J. 2017. Assessing the benefits and economic values of trees. In: Ferrini, F., van den Bosch, C.C.K. and Fini, A. (Eds). Routledge handbook of urban forestry. New York, NY: Routledge: 152-163. Chapter 11.

Nunes, L.J.R., Meireles, C.I.R., Pinto Gomes, C.J. and Almeida Ribeiro, N.M.C. 2019. Forest management and climate change mitigation: A review on Carbon cycle flow models for the sustainability of resources. Sustainability 11(19):5276. https://doi.org/10.3390/su1119527.

O'Dell, D., Eash, N.S., Hicks, B.B., Oetting, J.N., Sauer, T.J., Lambert, D.M., Thierfelder, C., Muoni, T., Logan, J., JZahn, J.A. and Goddard, J.J. 2020. Conservation agriculture as a climate change mitigation strategy in Zimbabwe. International Journal of Agricultural Sustainability 18(3): 250-265. DOI: 10.1080/14735903.2020.1750254.

OECD. 2002. Glossary of key terms in evaluation and Results Based Management. OECD, Paris, France.

OECD. 2007. Climate change policies. Policy Brief. OECD, Paris, France.

OECD. 2017. Green growth indicators 2017. OECD green growth studies. OECD Publishing, Paris, France. https://doi.org/10.1787/9789264268586-en.

Onyekwelu, J.C. 2021. Can the fear of the gods sustain biodiversity conservation in sacred groves? Academia Letters. Article 635. https://doi.org/10.20935/AL635.

Onyekwelu, J.C., Agbelade, A.D., Stimm, B. and Mosandl, R. 2022 (in press). Role of sacred groves in southwestern Nigeria in biodiversity conservation, biomass and Carbon storage. Accepted by Southern Forests: A journal of Forest Science.

Pala, N.A., Negi, A.K., Gokhale, Y., Aziem, K., Vikrant, K.K. and Todaria, N.P. 2013. Carbon stock estimation for tree species of Sem Mukhem sacred forest in Garhwal Himalaya, India. Journal of Forestry Research DOI 10.1007/s11676-013-0341-1.

Palmer, C. 2019. Mitigating climate change will depend on negative emissions technologies. Engineering 5:982–984. https://doi.org/10.1016/j.eng.2019.10.006.

PBL Netherlands Environmental Assessment Agency. 2020. Trends in global CO2 and total greenhouse gas emissions. The Hague, Netherlands. 85pp.

Pingoud, K., Pohjola, J. and Valsta, L. 2010. Assessing the integrated climatic impacts of forestry and wood products. Silva Fennica 44:155–75.

Planet Banana. 2022. The great green wall a pan African initiative to mitigate climate change and create millions of jobs. Planet Banana.com.

Pretty, J., Toulmin, C. and Williams, S. 2011. Sustainable intensification in African agriculture. International Journal of Agricultural Sustainability 9(1): 5-24.

Pretty, J. and Bharucha, Z.P. 2014. Sustainable intensification in agricultural systems. Annals of Botany 114(8): 1571–1596. https://doi.org/10.1093/aob/mcu205.

Rainforest Foundation. 2018. What should be the role of civil society in national REDD+ processes? Rainforest Foundation, Norway.

Rajendran, S., Afari-Sefa, V., Shee, A., Bocher, T., Bekunda, M., Dominick, I. and Lukumay, P.J. 2017. Does crop diversity contribute to dietary diversity? Evidence from integration of vegetables into maize-based farming systems. Agriculture and Food Security 6: 50. https://doi.org/10.1186/s40066-017-0127-3.

Ramage, M.H., Burridge, H., Busse-Wicher, M., Fereday, G., Reynolds, T., Shah, D.U., Wu, G., Yu, L., Fleming, P.H., Densley-Tingley, D., Allwood, J., Dupree, P., Linden, P. and Scherman, O. 2017. The wood from the trees: the use of timber in construction. Renewable and Sustainable Energy Reviews https://doi.org/10.1016/j.rser.2016.09.107.

Rey, D., Ribet, U., Dunthorne, E. and Guittard, A. 2018. State of play of REDD+ safeguard requirements for accessing results based finance. CLP and SNV, London, United Kingdom.

Richards, K.R. and Stokes, C. 2004. A review of forest Carbon sequestration cost studies: A dozen years of research. Climatic Change 63: 1-48.

Ricke, K.L., Millar, R.J. and MacMartin, D.G. 2017. Constraints on global temperature target overshoot. Scientific Reports 7:14743. https://doi.org/10.1038/s41598-017-14503-9.

Roberts, C.M., O'Leary, B.C., McCauley, D.J., Curry, P.M., Duarte, C.M., Lubchenco, J., Pauly, D., Saenz-Aroyo, A., Sumaila, U.R., Wilson, R.W., Worm, B. and Castilla, J.C. 2017. Marine reserves can mitigate and promote adaptation to climate change. Proceedings of the National Academy of Science 114(24):6167-6175. https://doi.org/10.1073/pnas.1701262114.

Roberts, C.M., O'Leary, B.C. and Hawkins, J.P. 2020. Climate change mitigation and nature conservation both require higher protected area targets. Philosophical Transanctions of the Royal Society B37520190121 20190121.

Roe, D., Booke, F., Day, M., Zhou, W., Allebone-Webb, S., Hill, N., Kumpel, N., Petrokofsky, G., Redford, K., Russell, D., Shepherd, G., Wright, J. and Sunderland, K. 2015. Are alternative livelihood projects effective at reducing local threats to specified elements of biodiversity and/or improving or maintaining the conservation status of those elements? Environmental Evidence 4:22. DOI 10.1186/s13750-015-0048-1.

Rogelj, J., den Elzen, M., Höhne, N,, Fransen, T., Fekete, H., Winkler, H., Schaeffer, R., Sha, F., Riahi, K. and Meinshausen, M. 2016. Paris Agreement climate proposals need a boost to keep warming well below 2°C. Nature, 534:631-639. 10.1038/nature18307.

Royal Society. 2009. Reaping the benefits: Science and the sustainable intensification of global agriculture. The Royal Society. London.

Royal Society. 2018. Greenhouse gas removal. https://royalsociety.org/-/media/policy/projects/greenhouse-gas-removal/royal-society-greenhouse-gas-removal-report-2018.pdf. Lin A. 2019. Carbon dioxide removal after Paris. Ecol Law Q 45:533. https://doi.org/10.15779/Z386M3340F.

Rudel, T.K., Coomes, O.T., Moran, E., Achard, F., Angelsen, A., Xu, J. and Lambin, E. 2005. Forest transitions: Towards a global understanding of land use change. Global Environmental Change. 15 (1): 23-31.

SADC Secretariat. 2015. SADC Climate change strategy and action plan. SADC Secretariat, Gaborone, Botswana.

Savedoff, W. 2018. Competing or complementary strategies? Protecting indigenous rights and paying to conserve forest. Center for Global Development. Working Paper 490. Washington D.C.

Schalatek, L., Neil Bird, N. and Charlene Watson, C. 2017. The Green Climate Fund update. climate finance fundamentals 11. Heinrich Böll Stiftung.

Schnabel, R., Franzluebbers, A., Stout, W., Sanderson, M. and Stuedemann, J. 2001. The effects of pasture management practices. The potential of U.S. grazing lands to sequester Carbon and mitigate the greenhouse effect. In: Follett, R.F., Kimble, J.M. and Lal, R. (Eds). 291- 322.

Schneider, L., Füssler, J., Kohli, A., Greichen, J., Cames, M., Broekhoff, D., Lazarus, M., La Hoz Theuer, S. and Cook, V. 2017. Discussion paper: Robust accounting of international transfers under Article 6 of the Paris Agreement. German Emissions Trading Authority (DEHSt) at the German Environment Agency.

Schnell, S., Altrell, D., Ståhl, G. and Kleinn, C. 2015. The contribution of trees outside forests to national tree biomass and Carbon stocks—a comparative study across three continents. Environmental Monitoring and Assessment 187(1): 1–18.

Schoeneberger, M. and Domke, G. 2017. Chapter 3: Greenhouse gas mitigation and accounting. In: Schoeneberger, M., Bentrup, G. and Patel-Weynand, T. (Eds). Agroforestry: Enhancing resiliency in U.S. agricultural landscapes under changing conditions. General Technical Report WO-96. Washington, DC: U.S. Department of Agriculture, Forest Service. 43-62.

Secco, L., Da Re, R., Pettenella, D.M. and Gatto, P. 2013. Why and how to measure forest governance at local level: A set of indicators. Forest Policy and Economics http://dx.doi.org/10.1016/j.forpol.2013.07.006.

Shukla, P.R., Skea, J., Slade, R., van Diemen, R., Haughey, E., Malley, J., Pathak, M. and Portugal Pereira, J. (Eds). 2019. Technical summary. In: Shukla, P., Skeg, J., Buend́ ıa, E., Masson-Delmotte, V., Pörtner, H., Roberts, D., Zhai, P., Slade, R., Connors, S., Diemen, S. V., Ferrat, M., Haughey, E., Luz, S., Pathak, M., Petzold, J., Pereira, J., Vyas, P., Huntley, E., Kissick, K., Belkacemi, M. and Malley, J. (Eds). Climate change and land: An IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems.

Soglo, Y.Y. and Nonvide, G.M.A. 2019. Climate change perceptions and responsive strategies in Benin: The case of maize farmers. Climate Change 155:245–256. https://doi.org/10.1007/s10584-019-02452-3.

Somanathan, E., Sterner, T., Sugiyama, T., Chimanikire, D., Dubash, N.K., Essandoh-Yeddu, J., Fifita, S., Goulder, L., Jaffe, A., Labandeira, X., Managi, S., Mitchell, C., Montero, J.P., Teng, F. and Zylicz, T. 2014: National and sub-national policies and institutions. Core Writing Team: R.K. Pachauri, P.K and Meyer L.A. (Eds.). Climate change 2014: Mitigation of climate change. Contribution of Working Group

III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Springer, J. and Retana, V. 2014. Free, prior and informed consent and REDD+: Guidelines and resources. WWF Working Paper.

Ssekamatte, D. 2018. The role of monitoring and evaluation in climate change mitigation and adaptation interventions in developing countries'. African Evaluation Journal 6(1): a254. https://doi.org/10.4102/aej.v6i1.254.

Stanturf, J.A., Palik, B.J., Williams, M.I., Dumroese, R.K. and Madsen, P. 2014. Forest restoration paradigms. Journal of Sustainable Forestry 33(1): S161-S194, DOI: 10.1080/10549811.2014.884004.

STAP. 2017. Strengthening monitoring and evaluation of climate change adaptation: A STAP advisory document. Global Environment Facility, Washington, D.C.

Stringer, L.C., Dougill, A.J., Thomas, A.D., Spracklen, D.V., Chesterman, S., Speranza, C.I., Rueff, H., Riddell, M., Williams, M., Beedy, T., Abson, D.J., Klintenberg, P., Syampungani, S., Powell, P., Palmer, A.R., Seely, M.K., Mkwambisi, D.D., Falcao, M., Sitoe, A. and Ross, S. 2012. Challenges and opportunities in linking Carbon sequestration, livelihoods and ecosystem service provision in drylands. Environ Science and Policy 19–20:121–135.

Suulola, O. Nd. Methods of evaluation in planning. (99+) Methods of evaluation in planning. Oluwaseyi Suulola - Academia.edu.

TEEB. 2010. The economics of ecosystems and biodiversity: Mainstreaming the economics of nature: A synthesis of the approach, conclusions and recommendations of TEEB. UNEP. 2-39.

Thissen, W. 2020. Why agroforestry is a promising climate change solution. reNature. Amsterdam.

Trollip, H. and Boulle, M. 2017. Challenges associated with implementing climate change mitigation policy in South Africa. Energy Research Centre, University of Cape Town, Cape Town, South Africa.

Tsayem Demaze, M., Ngoufo, R. and Tchawa, P. 2015. Du savoir vers le savoir-faire: évolution de la conception de la REDD+ et contraintes à sa mise en oeuvre en Afrique centrale. Natures Sciences Sociétés 23: 91–101.

Tschora, H. and Cherubini, F. 2020. Co-benefits and trade-offs of agroforestry for climate change mitigation and other sustainability goals in West Africa. Global Ecology and Conservation 22. DOI: 10.1016/j.gecco.2020.e00919.

Ukabiala, J. nd. Investing in clean development. United Nations Africa Renewal.

UN. 2009. Guidelines on cooperation between the United Nations and the business sector. United Nations, New York. USA.

UNDP. 2019. UN-REDD programme 2019 annual report. UNDP.

UNDP. 2022. Ecosystem-based adaptation and mitigation. www.adaptation-undp.org.

UNEP. 2009. Guidebook to financing CDM projects The CD4CDM Project. UNEP.

UNEP. 2019. Emissions gap report. UNEP. Nairobi, Available at: EGR2019.pdf (unep.org).

UNEP. 2020. Emissions gap report. UNEP. Nairobi. Available at: Emissions Gap Report 2020.

UNEP. 2021. Emissions gap report 2021: The heat is on – A world of climate promises not yet delivered. Nairobi.

UNEP and DTU. 2021. CDM pipeline, and POA pipeline. Copenhagen. www.cdmpipeline.org.

UNEP, ILO, IOE and ITUC. 2008. Green jobs:Towards decent work in sustainable, low Carbon world. United Nations Office. Nairobi. p11.

UNEP andIUCN . 2021. Nature-based solutions for climate change mitigation. Nairobi and Gland.

UNEP nd. Introduction to CDM. UNEP. Denmark.

UNICEF. 2014. Theory of change. UNICEF, Florence, Italy. 13pp.

UNICEF. 2020. Le glossaire climatique pour les jeunes. 28 p.

UNFCCC. 1998. Matters related to decision 1/CP.3 paragraph 5. UNFCCC. Available at: FCCC/CP/1998/MISC.7 (unfccc.int).

UNFCCC. 2007. Bali Action Plan. Decision 1/CP.13. https://unfccc.int/resource/docs/2007/cop13/eng/06a01.pdf.

UNFCCC. 2008. Kyoto Protocol reference manual on accounting of emissions and assigned amount. https://unfccc.int/resource/docs/publications/08_unfccc_kp_ref_manual.pdf. Accessed March 2022.

UNFCCC. 2009a. United Nations Framework Convention on Climate Change fact sheet: The need for mitigation. https://unfccc.int/files/press/backgrounders/application/pdf/press_factsh_mitigation.pdf. Accessed on 03 October 2022.

UNFCCC. 2009b. Methodological guidance for activities relating to reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries, Decision COP 15/4.

UNFCCC. 2010. Outcome of the work of the Ad Hoc Working Group on long-term cooperative action under the Convention - policy approaches and positive incentives on issues relating to reducing emissions from deforestation and forest degradation in developing countries; and the role of conservation, sustainable management of forests and enhancement of forest Carbon stocks in developing countries. UNFCCC COP 16 Cancun.

UNFCCC. 2011. Report of the Conference of the Parties on its sixteenth session, held in Cancun from 29 November to 10 December 2010. Decision 1/CP.16.

UNFCCC. 2014a. key decisions relevant for reducing emissions from deforestation and forest degradation in developing countries (REDD+)' Decision booklet REDD+. UNFCCC Secretariat.

UNFCCC. 2014b. Non-market based approaches. UNFCCC Technical Paper. Available at:10.pdf (unfccc.int).

UNFCCC. 2015a. Paris Agreement - decision 1/CP.21 - report of the conference of the Parties on its twenty-first session, held in Paris from 30 November to 13 December 2015 addendum part two: action taken by the Conference of the Parties at its twenty-first session. UNFCCC, Bonn, Germany.

UNFCCC. 2015b. Start-up finance for CDM Projects. UNFCCC.

UNFCCC. 2016a. Just transition of the workforce, and the creation of decent work and quality jobs, technical paper by the Secretariat. UNFCCC. Bonn. https://unfccc.int/ resource/docs/2016/tp/07.pdf.

UNFCCC. 2016b. Report of the Conference of the Parties on its twenty-first session, held in Paris from 30 November to 13 December 2015. Addendum Part two: Action taken by the Conference of the Parties at its twenty-first session. UNFCCC. Report of the Conference of the Parties on its twenty-first session, held in Paris from 30 November to 11 December 2015. Addendum. Part two: Action taken by the Conference of the Parties at its twenty-first session. (unfccc.int).

UNFCCC. 2021a. NDC National registry, 2021, CDKN, LDC Briefing.

UNFCCC. 2021b. CDM-Methodology-Booklet_fullversion.pdf (unfccc.int).

UNFCCC. 2021c. Annual report of the Executive Board of the clean development mechanism to the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol. Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol Sixteenth session Glasgow, 1–12 November 2021.

UNFCCC. 2022a. Key aspects of the Paris Agreement. UNFCCC. Key aspects of the Paris Agreement | UNFCCC.

UNFCCC. 2022b. Clean Development Mechanism. Available at: The Clean Development Mechanism | UNFCCC.

UNFCCC. 2022c. Biennial update reports. Biennial Update Reports | UNFCCC.

UNFCCC. 2022d. Global stocktake. UNFCCC. The Global Stocktake.pdf (unfccc.int).

UNFCCC. Decision 1.CP/16 paragraph 71 (a, b, c), paragraph 70 (d). Available at: unfccc.int.

UNFCCC. Decision 1/CP.16, appendix I,. Available at: unfccc.int.

UNFCCC. Decision 9/CP.19. Available at: unfccc.intUN-REDD Programme, 2012. UN-REDD programme social and environmental principles and criteria. UNREDD/PB8/2012/V/1.

UN-REDD. nd. Glossary. Market leakeage. UN-REDD Programme.UN-REDD. 2022. Glossary. UN-REDD programme.

Urge-Vorsatz, D., Herrero, S.T., Dubash, N.K. and Lecocq, F. 2014. Measuring the co-benefits of climate change mitigation. Annual Review Of Environmental Resources 39:549–82.

Usongo, A.P., Gordon, A.N., Tepoule, J.N. and Guy, E.E. 2021. Potentials of protected areas as Carbon sinks and implication on climate change in Cameroon. Journal of Earth Science and Climate Change. 12: 552.

Valin, H., Havlík, P., Mosnier, A., Herrero, M., Schmid, E. and Obersteiner, M. 2013. Agricultural productivity and greenhouse gas emissions: Trade-offs or synergies between mitigation and food security? Environmental Research Letters. 8. DOI 10.1088/1748-9326/8/3/035019.

van Goor, W. and Snoep, M. 2019. The contribution of forests to climate change mitigation. A synthesis of current research and understanding. Face the Future. Wageningen, The Netherlands.

Vanwalleghem, T., Gomez, J.A., Amate, J.I., Gonzalez de Molina, M., Vanderlinden, K., Guzman, G., Laguna, A. and Giraldez, J.V. 2017. Impact of historical land use and soil management change on soil erosion and agricultural sustainability during the Anthropocene. Anthropocene 17: 13–29.

Verheyen, R. 2005. Climate change damage and international law: Prevention, duties and state responsibility. Martinus Nijhoff, Netherlands. 418pp.

Vine, E., Sathaye, J., Makundi, W. and Jones, J. 1999. Monitoring, evaluation, reporting, verification, and certification of climate change mitigation projects. In: Dixon, R.K. (Ed) The U.N. Framework Convention on Climate Change activities implemented jointly (AIJ) pilot: Experiences and lessons learned. Institute for Global Environmental Strategies, Vol 1. Springer, Dordrecht. https://doi.org/10.1007/978-94-011-4287-8_13.

Vira, B., Agarwal, B., Jamnadass, R.H., Kleinschmit, D., McMullin, S., Mansourian, S., Neufeldt, H., Parrotta, J.A. Sunderland, T. and Wildburger, C. 2015. Forests, trees and landscapes for food security and nutrition. In: Vira, B., Wildburger, C. and Mansourian, S. (Eds). Forests and food: addressing hunger and nutrition across sustainable landscapes. Cambridge, United Kingdom. Open

Book Publishers: 9–28.Virgilio, N. and Marshall, S. 2009. Forest Carbon strategies in climate change mitigation: Confronting challenges through on the-ground experience. The Nature Conservancy.

Waikhom, A.C., Nath, A.J. andYadava, P.S. 2018. Aboveground biomass and Carbon stock in the largest sacred grove of Manipur, Northeast India. Journal of Forestry Research29(2):425–428.

Walker, S.M., Pearson, T.R.H., Munishi, P. and Petrova, S. 2008. Carbon market opportunities for the forestry sector of Africa. Winrock International. FAO African Forestry and Wildlife Commission 16th Session, Khartoum, Sudan. 17-24 February, 2008.

Watson, C. and Schalatek, L. 2019. Note thématique sur le financement climatique: le financement de l'atténuation. 4pp.

Weiss, C.H. 1998. Have we learned anything new about the use of evaluation? American Journal of Evaluation 19(1): 21–33. https://doi.org/10.1177/109821409801900103.

Weiss, G., Lawrence, A., Lidestav, G., Feliciano, D., Hujala, T., Sarvašová, Z., Živojinoví , D.I. 2019. Research trends: Forest ownership in multiple perspectives. Forest Policy and Economics 99: 1-8.

WMO. 2018. WMO greenhouse gas Bulletin No. 14. The state of greenhouse gases in the atmosphere based on global observations through 2017. WMO.

World Bank. 1996. Performance monitoring indicators: A handbook for task managers. World Bank. Washington DC.

World Bank. 1999. OP 4.01. Environmental assessment. World Bank Operational Manual. Operational Policies. Revised 2013.

World Bank. 2015. Finance for climate action a snap shot of the World Bank Group's climate Work. The World Bank. Washington DC.

World Bank Group. 2016. The CDM as a vehicle for delivering results based climate finance. Available at: Presentation (unfccc.int).

World Bank. 2016. Forests combat climate change. Brief. The World Bank Group.

World Bank. 2021a. BioCarbon Fund programs. World Bank BioCarbon Fund. Available at: Programs | ISFL (biocarbonfund-isfl.org).

World Bank. 2021b. Lessons learned from the implementation of MRV systems for REDD+. Global Forest Observations Initiative (GFOI).

World Bank. 2021c. Climate stories: Forest protection in Ghana. World Bank Group.

World Bank. 2021d. Climate Smart Agriculture. The World Bank Group.

World Resources Institute. 2016. World greehouse gas emmisions 2016. World Resources Insitute, Washington DC. USA.

Yan, S. 2016. China plans to cut 1.8 million coal and steel jobs. CNN Money, 29 February. Available at: http://money.cnn.com/2016/02/29/news/economy/china-steel-coal-jobs/.

Yan, Y., Obersteiner, M., Möllersten, K., Moreira, J.R. 2019. Negative emission technologies – NETs. Applied Energy 255: 13749. https://doi.org/10.1016/j.apenergy.2019.113749.

Yegbemey, R.N., Yegbemey, E.O. and Yabi, J.A. 2017. Sustainability analysis of observed climate change adaptation strategies in maize farming in Benin, West Africa. Outlook on Agriculture 46(1): 20–27. https://doi.org/10.1177%2F0030727016689638.

ZEF/FARA/IEA. 2017. Country Dossier. "Innovation for sustainable agricultural growth in Mali". https://research4agrinnovation.org/wp-content/uploads/2017/10/MaliDossier2017.pdf.

Zhao, M., Kong, Z.H., Escobedo, F.J. and Gao, J. 2010. Impacts of urban forests on offsetting Carbon emissions from industrial energy use in Hangzhou, China. Journal of Environmental Management 91(4):807-13. doi: 10.1016/j.jenvman.2009.10.010. Epub 2009 Nov 14. PMID: 19914765.

Zhu, L. and Lo, K. 2021. Non Timber Forest Products as livelihood restoration in forest conservation: A restorative justice approach. Environmental Science. DOI: 10.1016/J.TFP.2021.100130. Corpus ID: 238692449.

Zomer, R.J., Neufeldt, H., Xu, J,. Ahrends, A. Bossio, D., Trabucco, A. van Noordwijk, M. and Wang, M. 2016. Global tree cover and biomass carbon on agricultural land: the contribution of agroforestry to global and national carbon budgets. Scientific Reports 6: 29987. doi:10.1038/srep29987. http://www.nature.com/articles/srep29987.

Glossary of Terms

This glossary is compiled according to the Lead Authors of the Report drawing on glossaries and other resources available on the websites of the following organizations, networks and projects: Intergovernmental Panel on Climate Change, United Nations Environment Programme, United Nations Framework Convention on Climate Change and World Resources Institute.

Anthropogenic methane: Methane emissions derived from human activities. Anthropogenic emission sources include coal mining, agricultural practices, wastewater treatment, certain industrial processes and oil and gas systems, among others.

Baseline/reference: The state against which change is measured. In the context of climate change transformation pathways, the term 'baseline scenarios' refers to scenarios that are based on the assumption that no mitigation policies or measures will be implemented beyond those that are already in force and/or are legislated or planned to be adopted.

Baseline scenarios are not intended to be predictions of the future, but rather counterfactual constructions that can serve to highlight the level of emissions that would occur without further policy effort. Typically, baseline scenarios are compared to mitigation scenarios that are constructed to meet different goals for greenhouse gas emissions, atmospheric concentrations or temperature change. The term 'baseline scenario' is used interchangeably with 'reference scenario' and 'no policy scenario' In much of the literature, the term is also synonymous with the term 'business as usual scenario', although the term 'business as usual' has fallen out of favour because the idea of 'business as usual' in century long socioeconomic projections is hard to fathom.

Carbon border adjustment mechanisms: Mechanisms that act to equalise the price of Carbon between domestic products and imports to eliminate financial incentives in order to relocate production outside of regions with strong climate controls.

Carbon dioxide emission budget (or carbon budget): For a given temperature rise limit, for example a 1.5°C or 2°C long-term limit, the corresponding Carbon budget reflects the total amount of Carbon emissions that can be emitted for temperatures to stay below that limit. Stated differently, a Carbon budget is the area under a Carbon dioxide (CO_2) emission trajectory that satisfies assumptions about limits on cumulative emissions estimated to avoid a certain level of global mean surface temperature rise.

Carbon dioxide equivalent (CO_2e): A way to place emissions of various radiative forcing agents on a common footing by accounting for their effect on climate. It describes, for a given mixture and amount of greenhouse gases, the amount of CO_2 that would have the same global warming ability, when measured over a specified time period. For the purpose of this report, greenhouse gas emissions (unless otherwise specified) are the sum of the basket of greenhouse gases listed in Annex A to the Kyoto Protocol, expressed as CO_2e assuming a 100-year GWP.

Carbon markets: A term for a Carbon trading system through which countries may buy or sell units of greenhouse gas emissions in an effort to meet their national limits on emissions, either under the Kyoto Protocol or other agreements, such as that among member states of the European Union. The term comes from the fact that CO_2 is the predominant greenhouse gas, and other gases are measured in units called Carbon dioxide equivalent.

Carbon neutrality: This is achieved when an actor's net contribution to global CO_2 emissions is zero. Any CO_2 emissions attributable to an actor's activities are fully compensated by CO_2 reductions or removals

exclusively claimed by the actor, irrespective of the time period or the relative magnitude of emissions and removals involved.

Carbon offset: See Offset. Carbon price: The price for avoided or released CO_2 or CO_2e emissions. This may refer to the rate of a Carbon tax or the price of emission permits. In many models that are used to assess the economic costs of mitigation, Carbon prices are used as a proxy to represent the level of effort in mitigation policies.

Clean development mechanism (CDM): A mechanism under the Kyoto Protocol, the purpose of which, in accordance with article 12 of the Protocol, is to assist non-Annex I parties in achieving sustainable development and in contributing to the ultimate objective of the United Nations Framework Convention on Climate Change, and to assist Annex I parties in achieving compliance with their quantified emissions XII Emissions Gap Report 2021: The Heat Is On limitation and reduction commitments under article 3 of the Protocol.

Conditional nationally determined contribution (NDC): An NDC proposed by some countries that are contingent on a range of possible conditions, such as the ability of national legislatures to enact the necessary laws, ambitious action from other countries, realization of finance and technical support, or other factors.

Conference of the Parties (COP): The supreme body of the United Nations Framework Convention on Climate Change. It currently meets once a year to review the Convention's progress.

Double counting: Double counting involves two countries taking credit for the same emissions reductions, thereby giving the impression that the world has reduced emissions more than it actually has. For example, emissions reduction credits from one country might be sold to another country, but the reductions may still be counted towards the achievement of the NDC of the country where the credits originated.

Emission pathway: The trajectory of annual greenhouse gas emissions over time. Emissions trading: One of the three Kyoto mechanisms, by which an Annex I party may transfer Kyoto Protocol units to, or acquire units from, another Annex I party. An Annex I party must meet specific eligibility requirements to participate in emissions trading.

EU Emissions Trading System (ETS): The EU ETS is a trading system for Carbon emissions and the first international emissions trading system in the world. The EU ETS covers the following sectors and gases: electricity and heat generation, energy-intensive industry sectors (including oil refineries, steel works and production of iron, aluminium, metals, cement, lime, glass, ceramics, pulp, paper, cardboard, acids and bulk organic chemicals, commercial aviation within the European Economic Area), N_2O from production of nitric, adipic and glyoxylic acids and glyoxal, and perfluorocarbons from production of aluminium. GWP: An index representing the combined effect of the differing times greenhouse gases remain in the atmosphere and their relative effectiveness in absorbing outgoing infrared radiation.

Forest: Defined by UNFCCC as having a minimum canopy cover of 10-30%, minimum tree height of 2-5 m and minimum area of 0.1 ha.

Forest transition curve: The change in forest cover over time as the value of land uses changes relative to the competing uses, usually resulting in rapidly decreasing forest area during early industrialization and development, followed by slow expansion of forest area to lower than original levels.

Greenhouse gas removal: Withdrawal of a greenhouse gas and/or a precursor from the atmosphere by a sink.

Greenhouse gases: The atmospheric gases responsible for causing global warming and climatic change. The major greenhouse gases are Carbon dioxide (CO_2), Methane (CH4) and Nitrous oxide (N_2O).

Less prevalent, but very powerful, GHGs are Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulphur hexafluoride (SF6).

$GtCO_2e$ GHG: Billion tons (gigatons) of Carbon dioxide equivalent greenhouse gas emissions.

Integrated assessment models: Models that seek to combine knowledge from multiple disciplines in the form of equations and/or algorithms in order to explore complex environmental problems. As such, they describe the full chain of climate change, from production of greenhouse gases to atmospheric responses. This necessarily includes relevant links and feedbacks between socioeconomic and biophysical processes.

Intended nationally determined contribution (INDC): INDCs are submissions from countries describing the national actions that they intend to take to reach the Paris Agreement's long-term temperature goal of limiting warming to well below 2°C. Once a country has ratified the Paris Agreement, its INDC is automatically converted to its NDC, unless it chooses to further update it. Katowice Climate Package: The Katowice Climate Package, also known as 'the Katowice outcome', is a complex package containing operational guidance on information provision, communication and rules for the functioning of the climate transparency framework, the global stocktaking of overall progress and the evaluation of progress, and the provision of prior information on financial assistance. The package sets out the essential procedures and mechanisms that operationalised the Paris Agreement. The guidelines of the package aim to build greater trust and strengthen international cooperation.

Kyoto Protocol: An international agreement, standing on its own, and requiring separate ratification by governments, but linked to the United Nations Framework Convention on Climate Change. The Kyoto Protocol, among other things, sets binding targets for the reduction of greenhouse gas emissions by industrialised countries.

Land use, land-use change and forestry (LULUCF): A greenhouse gas inventory sector that covers emissions and removals of greenhouse gases resulting from direct human induced land use, land-use change and forestry activities.

Leakage: A phenomenon whereby the reduction in emissions (relative to a baseline) in a jurisdiction/sector associated with the implementation of mitigation policy is offset to some degree by an increase outside the jurisdiction/sector through induced changes in consumption, production, prices, land use and/or trade across the jurisdictions/sectors. Leakage can occur at a number of levels: project, state, province, nation or world region.

Least-cost pathway: Such scenarios identify the least expensive combination of mitigation options to fulfil a specific climate target. A least-cost scenario is based on the premise that, if an overarching climate objective is set, society wants to achieve this at the lowest possible costs over time. It also assumes that global actions start at the base year of model simulations (usually close to the current year) and are implemented following a cost-optimal (cost-efficient) sharing of the mitigation burden between current and future generations depending on the social discount rate.

Likely chance: A likelihood greater than 66 per cent chance. Used in this assessment to convey the probabilities of meeting temperature limits.

Measurement, reporting and verification (MRV): The collection of data and information at a national (or sub-national) level, and performance of the necessary calculations for estimating emission reductions or enhancement of Carbon stocks and associated uncertainties against a reference level.

Mitigation: In the context of climate change, mitigation relates to a human intervention to reduce the sources, or enhance the sinks of greenhouse gases. Examples include using fossil fuels more efficiently for industrial processes or electricity generation, switching to solar energy or wind power, improving the

insulation of buildings and expanding forests and other 'sinks' to remove greater amounts of CO_2 from the atmosphere.

Nationally determined contribution (NDC): Submissions by countries that have ratified the Paris Agreement which presents their national efforts to reach the Paris Agreement's long-term temperature goal of limiting warming to well below 2°C. New or updated NDCs were expected to be submitted in 2020 and should be submitted every five years thereafter. NDCs thus represent a country's current ambition/target for reducing emissions nationally.

Offset (in climate policy): A unit of CO_2e emissions that is reduced, avoided or sequestered to compensate for emissions occurring elsewhere. Recovery-type measure: Fiscal, monetary or regulatory intervention by a government to reinvigorate economic activity in response to a crisis.

RED: Reduced emissions from deforestation.

REDD credits: Emission reductions and enhancements in forest Carbon stocks measured in tCO_2e that are converted into tradable Carbon units.

REDD: Reduced emissions from deforestation and forest degradation.

REDD+: REDD plus conservation, sustainable management of forests and enhancement of forest Carbon stocks.

Reference emission level: The amount of gross emissions from the forest sector from a geographical area estimated within a reference time period.

Reference level (RL): The amount of net/gross emissions and removals from the forest sector from a geographical area estimated within a reference time period.

Rescue-type measure: Immediate fiscal, monetary or regulatory intervention by a government to protect citizens' lives and socioeconomic well-being and/or to provide emergency support to businesses and the economy in response to a crisis.

Scenario: A description of how the future may unfold based on 'if-then' propositions. Scenarios typically include an initial socioeconomic situation and a description of the key driving forces and future changes in emissions, temperature or other climate change-related variables.

Sink: a forest, ocean, or other natural environment viewed in terms of its ability to absorb Carbon dioxide from the atmosphere.

Source: Any process, activity or mechanism that releases a greenhouse gas, an aerosol or a precursor of a greenhouse gas or aerosol into the atmosphere.

Technical REDD+ potential: Biophysical potential of the forest sector to remove and store greenhouse gases in biomass and other Carbon pools as estimated in academic literature. The technical REDD potential does not include discounts for political and capacity constraints (i.e. feasible REDD potential).

African Forest Forum

A platform for stakeholders in African forestry

African Forest Forum
United Nations Avenue, Gigiri
P.O. Box 30677-00100
Nairobi, Kenya
Tel: +254 20 722 4203
Fax: +254 20 722 4001
Email: exec.sec@afforum.org