



African Forest Forum

A platform for stakeholders in African forestry



**Training modules on forest based
climate change adaptation, mitigation,
carbon trading, and payment for
other environmental services**

**For professional, technical and informal
groups training for sub-Sahara Anglophone
African countries**



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CONTENTS

Acronyms & Abbreviations	viii
Preface	ix
Introduction	1
PART I	MODULES FOR PROFESSIONAL TRAINING
	3
Background	4
Module 1	Basic Science of Climate Change
	7
Module overview	7
Module aim	7
Module objectives.....	7
Chapter 1	Understanding Global Change and Climate Systems
	9
	Chapter Overview
	9
	Learning Outcomes
	9
	Content.....
	9
Chapter 2	Drivers of Climate Change
	11
	Chapter Overview
	11
	Learning Outcomes
	11
	Content.....
	11
Chapter 3	Vulnerability to and Impact of Climate Change
	12
	Chapter Overview
	12
	Learning Outcomes
	12
	Content.....
	12
Chapter 4	Climate Change Data
	14
	Chapter Overview
	14
	Learning Outcomes
	14
	Content.....
	14
Chapter 5	Climate Modeling and Scenario Development
	15
	Chapter Overview
	15
	Learning Outcomes
	15
	Content.....
	15
Chapter 6	International Dialogues, Processes and Mechanisms on Climate Change
	16
	Chapter Overview
	16
	Learning Outcomes
	16
	Content.....
	16

Module 2	Forests and Climate Change Adaptation.....	17
	Module overview	18
	Module aim	18
	Module objectives.....	18
	Chapter 1 Concepts of Adaptation	19
	Chapter Overview.....	19
	Learning Outcomes	19
	Content.....	19
	Chapter 2 Forest-Based Climate Change Adaptation	20
	Chapter Overview	20
	Learning Outcomes	20
	Content.....	20
	Chapter 3 Non-Forest Climate Change Adaptation Strategies	22
	Chapter Overview	22
	Learning Outcomes	22
	Content.....	22
	Chapter 4 Monitoring, Evaluation and Reporting of Adaptation Practices.....	23
	Chapter Overview.....	23
	Learning Outcomes	23
	Content.....	23
Module 3	Forests and Climate Change Mitigation.....	25
	Module overview	26
	Module aim	26
	Module objectives.....	26
	Chapter 1 Concepts of Mitigation of Climate Change.....	27
	Chapter Overview	27
	Learning Outcomes	27
	Content.....	27
	Chapter 2 Forests Based Mitigation Strategies	28
	Chapter Overview.....	28
	Learning Outcomes	28
	Content	28
	Chapter 3 Clean Development Mechanisms and REDD+	30
	Chapter Overview	30
	Learning Outcomes	30
	Content.....	30

Chapter 4	Non-Forest Climate Change Mitigation Strategies	31
	Chapter Overview	31
	Learning Outcomes	31
	Content.....	31
Chapter 5	Monitoring and Evaluation of Climate Change Mitigation Strategies	32
	Chapter Overview	32
	Learning Outcomes	32
	Content.....	32
Module 4	Carbon Market and Trading	33
	Module overview	34
	Module aim	34
	Module objectives.....	34
Chapter 1	Principles and Concept of Carbon Trade	35
	Chapter Overview	35
	Learning Outcomes	35
	Content.....	35
Chapter 2	Carbon Trading Processes and Agreements.....	36
	Chapter Overview	36
	Learning Outcomes	36
	Content.....	36
Chapter 3	Approaches to Carbon Stock Estimation.....	37
	Chapter Overview	37
	Learning Outcomes	37
	Content.....	37
Chapter 4	Methodological Issues in Carbon Trade and Marketing	38
	Chapter Overview	38
	Learning Outcomes	38
	Content.....	38
Chapter 5	Institutional and Legal Frameworks for Carbon Trading	39
	Chapter Overview	39
	Learning Outcomes	39
	Content.....	39
Chapter 6	Monitoring and Evaluation of Carbon Trading	40
	Chapter Overview	40
	Learning Outcomes	40
	Content.....	40

PART II	MODULES FOR TECHNICAL TRAINING.....	41
	Background	42
	1. Science of Climate Change	42
	2. Adaptation to Climate Change	42
	3. Mitigation of Climate Change.....	42
	4. Carbon Trade and Marketing.....	42
Module 1	Basic Science of Climate Change	45
	Module overview.....	46
	Module aim	46
	Module objectives.....	46
	Chapter 1 Understanding Global Change.....	47
	Chapter Overview.....	47
	Learning Outcomes	47
	Content.....	47
	Chapter 2 Causes of Climate Change	48
	Chapter Overview	48
	Learning Outcomes	48
	Content.....	48
	Chapter 3 Vulnerability to and Impact of Climate Change	49
	Chapter Overview	49
	Learning Outcomes	49
	Content.....	49
	Chapter 4 Generating Baseline Data on Climate Change.....	50
	Chapter Overview.....	50
	Learning Outcomes	50
	Content.....	50
	Chapter 5 International Dialogues, Processes and Mechanisms on Climate Change	51
	Chapter Overview.....	51
	Learning Outcomes	51
	Content.....	51
Module 2	Forests and Climate Change Adaptation.....	53
	Module overview	54
	Module aim	54
	Module objectives.....	54
	Chapter 1 Concepts of Adaptation.....	55
	Chapter Overview	55
	Learning Outcomes	55
	Content.....	55

Chapter 2	Forest-Based Climate Change Adaptation Mechanisms	56
	Chapter Overview	56
	Learning Outcomes	56
	Content.....	56
Chapter 3	Non-Forest Climate Change Adaptation Strategies	57
	Chapter Overview	57
	Learning Outcomes	57
	Content.....	57
Chapter 4	Monitoring, Evaluation and Reporting of Adaptation Practices.....	58
	Chapter Overview	58
	Learning Outcomes	58
	Content.....	58
Module 3	Forests and Climate Change Mitigation.....	55
	Module overview	60
	Module aim	60
	Module objectives.....	60
Chapter 1	Concept of Mitigation of Climate Change.....	61
	Chapter Overview	61
	Learning Outcomes	61
	Content.....	61
Chapter 2	Forests Based Mitigation Mechanisms.....	62
	Overview.....	62
	Learning Outcomes	62
	Content	62
Chapter 3	Clean Development Mechanisms and REDD+	63
	Chapter Overview	63
	Learning Outcomes	63
	Content.....	63
Chapter 4	Non-Forest Climate Change Mitigation Strategies	64
	Chapter Overview	64
	Learning Outcomes	64
	Content.....	64
Chapter 5	Monitoring and Evaluation of Climate Change Mitigation Strategies.....	65
	Chapter Overview	65
	Learning Outcomes	65
	Content.....	65

Module 4	Carbon Market and Trade.....	67
	Module overview	68
	Module aim	68
	Module objectives.....	68
	Chapter 1 Principles and Concepts of Carbon Trade	69
	Chapter Overview	69
	Learning Outcomes	69
	Content.....	65
	Chapter 2 Approaches of Forest Carbon Stock Estimation.....	70
	Chapter Overview	70
	Learning Outcomes	70
	Content.....	70
PART III	TRAINING MODULES FOR INFORMAL GROUPS CIVIL SOCIETY ORGANIZATIONS AND LOCAL COMMUNITIES.....	71
	Background	72
	1. Basic Science of Climate Change	72
	2. Adaptation to Climate Change.....	73
	3. Mitigation of Climate Change	73
	4. Carbon Trade and Marketing.....	73
Theme 1	Basic Science of Climate Change	74
	Theme Overview	74
	Session 1: Understanding Climate Change.....	74
	Session 2: Causes of Climate Change.....	74
	Session 3: Vulnerability to and Impact of Climate Change	74
Theme 2	Forests and Climate Change Adaptation	75
	Theme Overview	75
	Session 1: Definitions and Concepts of Adaptation	75
	Session 2: Forest-Based Climate Change Adaptation Mechanisms	75
Theme 3	Forests and Climate Change Mitigation	77
	Theme Overview	77
	Session 1: Definitions and Concepts of Mitigation of Climate Change	77
	Session 2: Forests Based Mitigation Strategies	77
	Session 3: Basics of Clean Development Mechanisms and REDD+	78
	Session 4: Non-Forest Climate Change Mitigation Strategies	78
Theme 4	Carbon Market and Trade	79
	Theme Overview	79
Theme 5	Monitoring and Evaluation of Forest Based Climate Change Adaptation, Mitigation and Carbon Trading.....	80

Annex 1	Some Broad Research Areas.....	81
Annex 2	List of Contributors.....	83
Tables	Table 1 Forest based climate change training needs for professionals in sub-Saharan Africa	5
	Table 2. Forest based climate change training needs for technical groups in sub-Saharan Africa.....	42
	Table 3. Forest based climate change training needs for informal groups in sub-Saharan Africa.....	72

ACRONYMS & ABBREVIATIONS

AFF	African Forest Forum
CCP	Climate Change Programme
CDM	Clean Development Mechanism
COP	Conference of Parties
DIVA	Dynamic and Interactive Vulnerability Assessment
DSSAT	Decision Support System for Agrotechnology Transfer
GHGs	Green House Gases
GIS	Geographical Information System
IPCC	Intergovernmental Panel on Climate Change
Jl	Joint Implementation
MRV	Measurement, Reporting and Verification
NAMAs	Nationally Appropriate Mitigation Actions
NAPAs	National Adaptation Programmes of Action
PDD	Project Development Document
PES	Payment for Environmental Services
PIN	Project Idea Note
REDD	Reduced Emissions from Deforestation and forest Degradation
SWAT	Soil Water Assessment Tool
SOM	Soil Organic Matter
TEK	Traditional Ecological Knowledge
TEM	Terrestrial Ecosystem Model
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
WEAP	Water Evaluation and Planning
WMO	World Meteorological Organization

PREFACE

Capacity building in forestry in all its forms is a central work area for the African Forest Forum (AFF). 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 on November 12-16, 2012, that drew 54 participants from selected academic, research and civil society institutions, as well as from the private sector and youth. The participants came from 22 countries, namely Benin, Botswana, Burkina Faso, Burundi, Cameroon, Côte d'Ivoire, Ethiopia, Gabon, Zambia, Ghana, Kenya, Malawi, Mali, Namibia, Niger, Nigeria, Senegal, Sudan, Tanzania, Togo, Uganda and Zimbabwe. It was also attended by staff from FAO and ICRAF.

The workshop identified the training needs on addressing the relationship between forests and climate change for educational and related forestry based training institutions at professional and technical levels, as well as for informal groups that are mainly made up of civil society organizations and local communities. Training needs and modules to guide training were developed based on agro-ecological regions of Sub-Saharan Africa. These are arid and semi-arid regions, including Sahelian belt; the savannas and woodlands of West, Eastern and Southern Africa; and the rainforests of West and Central Africa. Separate

analyses were done for Anglophone and Lusophone countries as a block, and for Francophone countries as another block, given the different educational systems in these two language blocks. These training modules therefore fill the gaps observed by the training institutions.

In order to carry this work forward AFF organized, in 2013, four sub-regional workshops to first improve on the needs and contents of the modules as well as validating the same. The workshops also served as avenues to better orient/ retool staff from academic, research, extension and civil society organizations in key areas of science and practice of climate change as it relates to forests, and basing such training on these modules. A total of 111 people from academia, research, public sector, private sector, youth and civil society in Sub-Saharan Africa have been involved in the development and validation of the needs and the training modules.

In 2013, AFF conducted country training using the modules in Ethiopia, Niger and Zambia; more countries will be covered in the near future. AFF first developed the teaching materials that will later be developed into specific compendiums. It would appear that there are no other institutions that are preparing such teaching materials for forestry training in Sub-Saharan Africa and on the same scope. AFF seeks to use, to the extent possible,

the capacity in the continent to develop local solutions to forestry problems; and teaching materials is one area where AFF will continue to engage the expertise on the continent to develop them.

We welcome interested individuals and institutions to make full and free use of these training modules in their work.

Prof Godwin Kowero
Executive Secretary, African Forest
Forum

INTRODUCTION

The African continent remains the most vulnerable region in the world to the impact of climate change, mainly due to weak resilience and adaptive capacity on the continent. There is limited knowledge on the relationship between forests and climate change in Africa; and especially on adaptation and mitigation to the adverse effects of climate change, as well as capitalizing on the opportunities that climate change and variability offer the continent. Understanding and further developing the relationship between forests and climate therefore are key for Africa's future development, given the key roles forests and trees outside forests play in the lives of people and animals on the continent, as well as on the economies of African countries and the environment in which the people, livestock and wildlife live. In this regard, Africa could start by enhancing advocacy on key issues of climate change and forests, crafting appropriate policies and plans to safeguard the roles of forests and trees in the context of climate change, and build capacity and develop skills that will support African people and their institutions to positively manage the impacts of climate change. Further, the continent also needs to acquire new and relevant knowledge on climate change issues as well as improve how it manages and shares knowledge and information related to climate change and forests.

It was on this basis that the African Forests Forum (AFF) organized a workshop on capacity building and skills development in forest-based climate change adaptation and

mitigation in Nairobi, Kenya, on 12th to 16th 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 issues related to forests and climate change for educational and research institutions at professional and technical levels, as well as for informal groups that are mainly made up of civil society organizations and local communities. 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 Trading and Marketing. This formed the basis for the workshop participants to develop training modules for professional training at university degree and postgraduate levels, technical training at certificate and diploma levels, and for training informal groups.

In short the modules are divided into three components: Professional, Technical and Informal. In each of the components, a brief introduction is provided followed by an overview, aim, objectives and chapters of the modules. In each module, a chapter overview is provided to introduce the reader to the issues addressed in it. This is followed by learning outcomes and contents of the chapter. The component for informal groups training is modified to suit specific themes that will be handled in the form of short term training, workshops and seminars, among other modes of delivery.

PART I
MODULES FOR
PROFESSIONAL TRAINING

BACKGROUND

The four core areas that characterize the common training needs for professionals in Anglophone sub-Saharan Africa are: basic science of climate change, adaptation, mitigation and carbon market and trade. The training needs in each of these four core areas are summarised in Table 1. As mentioned earlier, these training needs form the basis for developing this training module. The overall objective of the training is to build and strengthen the

capacity of professionals to understand, explain, and work with the linkages between forests and climate change, particularly taking actions that could strengthen the role of forests in climate change mitigation and adaptation. The module has been developed with an introduction, aim, objectives and contents. Further, it has been structured into various chapters, with each chapter starting with the learning outcomes and contents.

Table 1 Forest based climate change training needs for professionals in sub-Saharan Africa

Basic science of climate change	Adaptation	Mitigation	Carbon markets and trade
<ul style="list-style-type: none"> • Definitions of terms in relation to climate change • Elements of global change • Science of climate change • Global warming • Understanding climate systems • Biogeochemical cycles • Behavioural ecology and climate change (plants, animals and human being) • Indigenous technical knowledge on climate change • Trends and impacts of climate change • Causes and drivers of climate change • Trends / scenarios of global, regional and sub-regional climate change • Response of biophysical systems to climate change • Socioeconomic and livelihood vulnerability to climate change • Biophysical impacts of climate change • Socioeconomic impacts of climate change • Generating baseline data on climate change • Climate models, methods and applications • Allometric equations for generating national emission and removal factors • Modelling land-use changes and associated emission levels • Scenarios development, international dialogues and processes in climate change 	<ul style="list-style-type: none"> • Concept of adaptation • Types of adaptation (planned, autonomous, reactive, etc.) • Reasons for adaptation • Types of adaptation strategies: • Forest based adaptation mechanisms • Indigenous coping and adaptation mechanisms and strategies • National, regional, and international adaptation strategies • Ecosystem-based adaptations • Fire and disease management • Resilience of forests and people to climate change • Urban forestry, greening and their contribution to climate change adaptation • Conservation biology and ecology • Adaptation strategies outside the forestry sector • Technological adaptation • Socioeconomic and livelihood aspects on climate change adaptation • Challenges to adaptation • Information sharing and dissemination of adaptation practices • Monitoring, evaluation and reporting of adaptation practices • Legislation and policies on adaptation to climate change 	<ul style="list-style-type: none"> • Understanding mitigation and mitigation options for climate change • Forest based mitigation strategies • Conservation of forests to increase carbon stocks • Sustainable forest utilization • Agroforestry • Afforestation and reforestation • Forest resources and economic benefits of CDM and REDD+ mechanisms • Land tenure systems • Balancing economics and ecology • Avoiding deforestation and degradation • Non-forest/ alternative strategies to climate change mitigation • Non-extractive use of forests (ecotourism, etc.) • Alternative livelihoods • Resource substitution as a mitigation measure • Monitoring and evaluation of climate change mitigation strategies • Information sharing and dissemination • Legislation and policies on climate change mitigation • Case studies in Africa on climate change mitigation 	<ul style="list-style-type: none"> • Baseline on greenhouse inventories • Basic principles of economics and markets • Definitions and concepts of carbon trade and marketing • Principles and practices of carbon financing and trade • The myths and the realities of marketing and trade in carbon • Agreements on carbon trade and marketing • Annex I and Non-Annex I parties • Determination of carbon stocks • Carbon stock assessment • Assessing and calculating carbon units • Methodological issues and carbon markets and trade • The modalities for carbon financing • Payment schemes and benefit sharing • Watershed management, biodiversity and climate change • Institutional and legal frameworks for carbon trade (local, national and regional levels) • Monitoring and evaluation of carbon trading • Information sharing and dissemination

MODULE 1
BASIC SCIENCE OF CLIMATE
CHANGE



Module overview

Understanding the basics of science of climate change lays a foundation on the terms, definitions, and concepts used and their application in forestry science. This module will introduce learners to the key and basic concepts of science of climate change. It is divided into six chapters: understanding global change and climate systems; drivers of climate change; vulnerability to and impact of climate change; climate change data; climate change modeling and scenario development (projections); and international dialogues, processes and mechanisms on climate change.

Module aim

To build the learner's understanding of the concepts of basic science of climate change and their application in forestry and other related sectors.

Module objectives

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

- ▶ Describe the elements of global change, components of climate systems and concepts of climate change;
- ▶ Analyze the drivers of climate change;
- ▶ Explain the impact of climate change in forestry and in other related sectors;
- ▶ Relate concepts of vulnerability and response to climate change;
- ▶ Generate climate models that will predict vulnerability and impact of climate change based on the interaction of the components of the climate system;
- ▶ Evaluate the implications of international agreements, discussions, conventions, and negotiations on climate change.

CHAPTER 1

UNDERSTANDING GLOBAL CHANGE AND CLIMATE SYSTEMS

Chapter Overview

This chapter defines climate change and related terminologies, introduces the concepts of global change, climate systems, climate change and variability. It explores climate systems and the causes, drivers and effects of climate change. This chapter also explores the linkages between greenhouse gas (GHG) emissions and climate change, and examines the trends of climate change at the global, regional, and national levels.

Learning Outcomes

At conclusion of this chapter, the learners will be able to:

- ▶ Define global change and climate change;
- ▶ Explain elements of global change and their implications on climate change;
- ▶ Distinguish components of climate systems;
- ▶ Synthesize evidence of climate change;
- ▶ Describe trends of climate change and associated threats and opportunities at community (sub-national), national, regional and international levels.

Content

- 1) Definitions and terminologies in climate change
- 2) Basics of climate science and biogeochemical cycles - basic concepts of climate and climatology, the changing interpretations of climate, the modifying effects of surface-atmosphere interactions on the climate (volcanic activity, air pollutants, desertification). The earths' climate. Hydrologic and water cycles
- 3) Population growth, urbanization, industrialization, technological development/ advancement, climate change and land use change
- 4) Understanding climate systems
 - a) Components of the climate system: atmosphere, hydrosphere (of oceans, rivers, lakes, and ponds); cryosphere; lithosphere (land surface, snow, ice and permafrost); biosphere (vegetation, ecosystem, etc.)
 - b) Physical, chemical and biological interaction among the climate system components
 - c) Weather patterns and systems [(Inter Tropical Convergence Zone (ITCZ)]; definition of weather
 - d) Changes in solar inputs.

- 5) Science of climate change
 - a) Ocean circulation/ hydrological cycle
 - b) GHG emissions (sources, sinks, types, processes, consequences)
 - c) Ozone layer depletion (causes, processes, consequences)
 - d) The greenhouse effect
 - e) GHG emissions and global warming
 - f) Carbon cycle.
- 6) Evidence of climate change
- 7) Trends and impacts of climate change – global, regional, sub-regional, national
- 8) Threats and opportunities in climate change.

CHAPTER 2

DRIVERS OF CLIMATE CHANGE

Chapter Overview

Understanding the drivers of climate change forms an important part of the basic science of climate. The drivers are of three broad categories, namely: externally driven (by extra-terrestrial factors); internally driven (by factors within the earth system); and anthropogenic (caused by people and their activities). This chapter will introduce learners to these three broad categories, and with more emphasis on anthropogenic drivers of climate change such as human activities that result in GHG emissions and land use changes that include deforestation, urbanization and transportation, among others. The chapter will also review risks and hazards associated with emissions of GHGs.

Learning Outcomes

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

- ▶ Explain drivers of climate change;
- ▶ Assess how various drivers of climate change create climate variability and increase of GHGs.

Content

- 1) External drivers of climate change-regular variations in the earth's orbit around the sun; changes in solar thermal output; fluctuating levels of solar magnetic activity; and impacts by extra-terrestrial objects
- 2) Internal drivers of climate change
- 3) Anthropogenic drivers of climate change
 - a) Human activities that result in GHG emissions such as land use changes from forest to other land uses such as agriculture, urbanization and transportation, among others
 - b) Risks associated and hazards of climate change
- 4) Management of anthropogenic drivers of climate change.

CHAPTER 3

VULNERABILITY TO AND IMPACT OF CLIMATE CHANGE

Chapter Overview

Vulnerability to climate change is a critical component of the basic science of climate change because it reveals a set of conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of communities to the impact of hazards/or to get hurt by an external stress. The impacts of climate change are also reflected by the effects of climate change on different sectors, both in the natural and human systems. These impacts have serious implications for societies by aggravating vulnerabilities. To contain such adverse impacts requires the development of mechanisms for adaptation to the changing climate. This chapter will introduce learners to concepts of vulnerability, determinants of vulnerability, approaches to vulnerability assessment, dynamism of vulnerability, biophysical vulnerability and impacts, social-economic vulnerability and impacts, impacts of climate change to different sectors, and strategies to manage and reduce hazards, and how to reduce risks associated with climate change.

Learning Outcomes

At conclusion of this chapter, the learners will be able to:

- ▶ Classify key concepts of vulnerability to climate change;
- ▶ Analyze approaches to vulnerability assessment and their application in different key sectors with emphasis on the forestry sector;
- ▶ Describe the impact of climate change on socio-economic systems and sectors like water and fisheries, agriculture, tourism and health, among others; and with emphasis on ecosystems (habitat change, new and invasive species, vegetation types and decrease in productivity, etc.);
- ▶ Explain risks associated with climate change and to how to undertake disaster risk reduction across various sectors;
- ▶ Evaluate sub-national, national and regional level initiatives on response to vulnerability and impact of climate change.

Content

- 1) The conceptual understanding of vulnerability: definitions, key concepts, determinants (exposure, sensitivity, adaptive capacity), etc.
- 2) Approaches to vulnerability assessment
- 3) Dynamism of vulnerability across socio-economic systems
- 4) Impact of climate change
 - a) Biophysical vulnerability and impacts
 - i) Ecosystems
 - ii) Biodiversity (genes, species)
 - iii) Topography
 - iv) Edaphic factors

- b) Socio-economic and livelihood vulnerability and impacts
 - i) Infrastructure and settlement
 - ii) Sectoral impacts of climate change (e.g. in forestry, water, fisheries, agriculture, tourism, health, coastal resources, transportation and aquatic resources)
 - iii) Cross-cutting issues: governance, poverty, gender, human migration and vulnerability to and impact of climate change
- 5) Climate change risk and disaster management and reduction
 - a) Definitions and concepts
 - b) Weather factors that contribute to disasters
 - c) Disaster risk reduction and the role of the Hyogo Framework
 - d) Disaster risk reduction and the UNFCCC process
 - e) Strategies for reducing climate change disaster risks.

CHAPTER 4

CLIMATE CHANGE DATA

Chapter Overview

Climate change data facilitate providing evidence on climate change and its impacts, vulnerability to climate change and making early warnings, among others. Thus access to high quality and timely data is central to understanding the basic science of climate change. Also assessing the impacts of and vulnerability to climate change and subsequently working out adaptation needs requires good quality information. This chapter will introduce learners to different sources of climatic and climate related data, expose them to data collection methods, tools and instrumentation, data management, analysis and interpretation, development of climate hazards early warning systems, and information sharing and dissemination.

Learning Outcomes

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

- ▶ Distinguish sources of climatic and climate related data;
- ▶ Apply appropriate methods for collecting climate data;
- ▶ Synthesize climate data into meaningful information; and
- ▶ Develop climate hazards early warning systems.

Content

- 1) Types and sources of climate data
- 2) Data collection methods
- 3) Tools and instrumentation
- 4) Data management, analyses and interpretation.

CHAPTER 5

CLIMATE MODELING AND SCENARIO DEVELOPMENT

Chapter Overview

Climate modeling forms an essential part of assessing and predicting the impacts of climate change on different sectors. This requires good information that includes climate data such as rainfall, temperature and the frequency of extreme events; as well as non-climatic data such as the current situation on different sectors like terrestrial ecosystems, biodiversity, agriculture, water resources, food security, human health, and coastal zones, among others. This chapter will introduce learners to the development of climate impact models as well as to scenario development. To introduce the concept of modeling climate data, the learners will be inducted to the Global Circulation Model. Then they will be exposed to some important models that have been used for the sectoral assessments of impacts of climate change such as the Decision Support System for Agro-technology Transfer (DSSAT) Model for crops, the Terrestrial Ecosystem Model (TEM) for terrestrial vegetation/ ecosystems, the Water Evaluation and Planning (WEAP) model for water resources, the Dynamic and Interactive Vulnerability Assessment (DIVA) model for coastal resource/systems and the Soil Water Assessment Tool (SWAT) model for soils. The chapter will also cover the development of allometric equations for generating national emissions and removal factors; modeling land use changes, especially conversion of agriculture to forestry and vice versa; as well as the development of scenarios in different sectors, with an emphasis on

forestry.

Learning Outcomes

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

- ▶ Describe climate change models used in different sectors (agriculture, terrestrial/vegetation systems, water resources, coastal systems, and soils);
- ▶ Generate information for different sectors from climate change models;
- ▶ Predict the impact of climate change on different sectors, and with emphasis on forestry;
- ▶ Assess scenarios based on the impact of climate change in forestry and other related sectors.

Content

- 1) Concepts and definitions of modeling
- 2) The basis of climate change modeling: Global circulation model
- 3) Climate models (DSSAT, TEM, WEAP, DIVA, SWAT, etc.), methods and applications
- 4) Allometric equations for generating national emission and removal factors (applications)
- 5) Modeling land-use changes and associated emission levels
 - a) Application of remote sensing and GIS
 - b) Forest climate modeling
- 6) Scenarios development
 - a) Definition and nature of scenarios
 - b) Types of scenarios.

CHAPTER 6

INTERNATIONAL DIALOGUES, PROCESSES AND MECHANISMS ON CLIMATE CHANGE

Chapter Overview

The initial discourses on climate have mainly been global, though now there are also many discussions at regional and national levels. For instance, in 1992, countries joined an international treaty, the United Nations Framework Convention on Climate Change (UNFCCC), to cooperatively consider what they could do to limit average global temperature increases and the resulting climate change, and to cope with whatever impacts were, by then, inevitable. By 1995, countries realized that emission reductions provisions in the Convention were inadequate. They launched negotiations to strengthen the global response to climate change, and, two years later, adopted the Kyoto Protocol which legally binds developed countries to emission reduction targets. More recently the debates have been on REDD+ and the revision of Kyoto Protocol that has already been accomplished. This chapter will introduce learners to these international dialogues and processes related to climate change, global-level responses to climate change, global and institutional mechanisms that addresses/will address the issues of climate change vulnerability, mitigation and adaptation.

Learning Outcomes

At conclusion of this chapter, the learners will be able to:

- ▶ Analyze international agreements, discussions, conventions, and negotiations on climate change;
- ▶ Evaluate implications of the climate change discussions and negotiations for developing countries;

- ▶ Describe institutional mechanisms that will address forestry related issues of climate change vulnerability, mitigation and adaptation.

Content

- 1) Historical overview of international responses to climate change
- 2) First multilateral organizations tasked to address climate change
 - a) The World Meteorological Organization (WMO)
 - b) The United Nations Environment Program (UNEP)
- 3) The UN Framework Convention on Climate Change (UNFCCC)
 - a) Objectives
 - b) Conference of Parties
 - c) The Intergovernmental Convention on Climate Change (IPCC)
- 4) The Kyoto Protocol: Market-based mechanisms toward climate change mitigation
 - a) Emissions Trading
 - b) Joint Implementation (JI)
 - c) Clean Development Mechanism (CDM)
 - d) Communications and Negotiations
 - e) Limitation and challenges
- 5) REDD and REDD+
- 6) Africa's preparedness and position in CC negotiations
- 7) Review of national climate change dialogue, processes and mechanisms.

MODULE 2
FORESTS AND CLIMATE CHANGE
ADAPTATION

2

Module overview

Climate change impacts society and ecosystems in many ways. The ability of a system to adjust to climate change in order to reduce its vulnerability and enhance its resilience to observed and anticipated impacts of climate change is the main thrust of this module. Adaptation occurs in physical, ecological, and human systems, and involves changes in social and environmental processes, perceptions of climate risk, practices and functions to reduce risk, and exploit new opportunities. In particular, this module will emphasize the role of forests in climate change adaptation, and how forests and trees adapt to climate change. For instance, planting forests and sustainable forest management can aid the protection of soil and land against detrimental impacts of flooding. Also, forests can be used to rehabilitate degraded land and maintain water quality by trapping sediments, taking up nutrients, and immobilizing toxic substances. Adaptation strategies that promote sustainable forest management and better community based forest management have the potential to not only protect land and people from some of the harmful effects of rising global temperatures, but also to provide opportunities for greater, more sustainable rural development and poverty alleviation through income generation and employment opportunities. This module will introduce learners to the concept of adaptation to climate change, types of adaptation, assessment of forest based adaptation mechanisms, determinants of adaptation, monitoring and evaluation, impact (economic, social, biological) assessment of adaptation, as well as integration of climate change adaptation into development policies and plans.

Module aim

To build learners' understanding of the principles of climate change adaptation and equip them with the skills and knowledge to design and implement climate change adaptation strategies.

Module objectives

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

- ▶ Describe the concepts of adaptation to climate change;
- ▶ Distinguish types of adaptation to climate change;
- ▶ Synthesize determinants of adaptation to climate change in the context of forestry;
- ▶ Assess and design forest-based adaptation mechanisms to climate change;
- ▶ Describe adaptation strategies and mechanisms outside the forest sector;
- ▶ Integrate forestry adaptation to climate change into development policies and plans.

CHAPTER 1

CONCEPTS OF ADAPTATION

Chapter Overview

This chapter introduces the concept of climate change adaptation. It covers types of adaptation to climate change, determinants of adaptation to climate change, and relates adaptation to development policies and plans. It also offers practical examples of climate change adaptation.

Learning Outcomes

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

- ▶ Define adaptation to climate change;
- ▶ Explain the concept of adaptation to climate change in the context of forestry and people ;
- ▶ Distinguish the different types of adaptation;
- ▶ Explain the determinants of adaptation to climate change;
- ▶ Relate forestry adaptation to climate change to development policies and plans.

Content

- 1) Definitions and concepts of adaptation
- 2) Types of adaptation
 - Anticipatory and reactive adaptation; private and public adaptation; autonomous and planned adaptation.
- 3) Determinants of adaptation
 - System characteristics that influence a system's propensity to adapt - sensitivity, vulnerability, resilience, susceptibility, impact potential, responsiveness, adaptive capacity, adaptability.
- 4) Integrating climate change adaptation into development policies and plans
- 5) Practical examples/case studies of adaptation to climate change in the context of forestry and other related sectors.

CHAPTER 2

FOREST-BASED CLIMATE CHANGE ADAPTATION

Chapter Overview

While forests are affected by climate change, they also play a key role in adaptation to climate change. Forests support species to adapt to changing climate patterns and sudden climate events by, for example, providing refuge and migration corridors. Also, they indirectly support economies to adapt to climate change by reducing the costs of climate-related negative impacts. Forest ecosystems also provide goods and services during extreme events (droughts and floods), and are key assets for reducing vulnerability to the effects of climate change. This chapter will introduce learners to forests' response to climate change, role of forests in adaptation to climate change, resilience of forests and people to climate change, forest based adaptation mechanisms/strategies, ecosystem-based adaptation, forests and livelihoods, indigenous coping and adaptation mechanisms and strategies; and challenges associated with adaptation to climate change.

Learning Outcomes

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

- ▶ Explain how forests are affected by climate change and the role forests play in climate change adaptation;
- ▶ Identify appropriate forest-based activities that could help to adapt to climate change;

- ▶ Implement the various climate change adaptation strategies;
- ▶ Analyze the challenges to climate change adaptation facing their countries.

Content

- 1) Forests response to climate change
- 2) Role of forests in adaptation to climate change
- 3) Resilience of forests to climate change
- 4) Forest-based adaptation strategies/ measures
 - a) Plant adaptation options/ strategies;
 - i) Vegetation response to climate change
 - ii) Species resistance to climate change
 - iii) Eco-physiology of tree growth
 - iv) Intra- and inter-species genetic variation
 - v) Stress physiology
 - vi) Applied plant genetics and tree improvement
 - vii) Monitoring of species growth, mortality, recruitments, etc.
 - b) Technological adaptation;
 - i) Agroforestry designs
 - ii) Urban forestry, greening and their contribution to urban development

- iii) Use of renewable energy
- iv) Plant water relations, including water efficiency.
- c) Conservation biology/ecology
 - i) Forest management under changing climate
 - ii) Adaptive management of protected areas
 - iii) Role of trees and forests in climate change adaptation
 - iv) Increasing carbon sequestration through improvement of forest management systems - control of deforestation, reforestation and afforestation
 - v) Development of forest fire management plans
 - vi) Development and maintenance of seed banks
 - vii) Creation of parks/reserves, protected areas and biodiversity corridors
- viii) Vulnerability of ecological systems
- d) Social economic adaptation
 - i) Concept of sustainable livelihoods
 - ii) Vulnerability of social systems
 - iii) Gender and forest based adaptations
- 5) Ecosystem/landscape-based adaptations
- 6) Indigenous coping and adaptation mechanisms and strategies
- 7) National, regional, and international adaptation strategies
- 8) National Adaptation Programmes of Action (NAPAs); legislation and policies on adaptation to climate change
- 9) Challenges to adaptation
 - Adaptation gaps and barriers
- 10) Case studies in forest-based climate change adaptation strategies.

CHAPTER 3

NON-FOREST CLIMATE CHANGE ADAPTATION STRATEGIES

Chapter Overview

Understanding strategies used in adaptation to climate change in other sectors is fundamental in providing a holistic approach to learners on how to relate them to forestry. This will enhance the knowledge and understanding of learners because the forestry sector also plays a significant role to other sectors like water, health, agriculture, fisheries and coastal ecosystems, among others. This chapter will introduce learners to adaptation strategies and related mechanisms from outside the forest sector.

Learning Outcomes

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

- ▶ Explain adaptation measures in different sectors;
- ▶ Assess priority activities outside the forest sector that could help their countries to adapt to climate change.

Content

- 1) Other sectors impacted by climate change outside forestry such as agriculture, fisheries, livestock, health and sanitation, built environment, among others.
- 2) Sectoral adaptation measures
- 3) Adaptation strategies in agriculture:
 - Changing planting strategies, improving agricultural methods, planting drought-resistant crops, shifts from rain-fed to irrigated agriculture, etc.
- 4) Other adaptation strategies:
 - Preparing risk assessments, managing water resources, building settlements in safe zones, developing early warning systems, instituting better building designs, improving insurance coverage, developing social safety nets, etc.
- 5) Planning and cross-sectoral coordination as adaptation strategies.
- 6) Case studies on non-forest sector climate change adaptation strategies.

CHAPTER 4

MONITORING, EVALUATION AND REPORTING OF ADAPTATION PRACTICES

Chapter Overview

Effective monitoring, evaluation and reporting of adaptation practices and projects are important for climate change adaptation. This chapter is designed to enhance the skills of learners in monitoring and evaluating adaptation projects and practices.

Learning Outcomes

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

- ▶ Describe concepts of monitoring and evaluation in the context of adaptation to climate change in forestry;

- ▶ Apply correct methods for monitoring and evaluation of adaptation to climate change in forestry projects;
- ▶ Choose appropriate types of evaluation in adaptation to climate change in forestry projects.

Content

- 1) Concepts and purpose of monitoring and evaluation
- 2) Types of monitoring and evaluation
- 3) Methods of monitoring, evaluation and reporting
- 4) Tools of monitoring
- 5) Reporting processes.

MODULE 3
FORESTS AND CLIMATE CHANGE
MITIGATION

3

Module overview

The rising of GHG emissions especially carbon dioxide has led to the recognition of forests in climate change mitigation through the process of carbon sequestration. This is achieved by increasing forest area and density through afforestation, reforestation and forest restoration as well as through the substitution of forest products for fossil fuels or use of products requiring fossil fuels in their production, resulting into increased absorption of carbon dioxide from the atmosphere. The contribution of forests to climate change mitigation has also been recognized as a cornerstone of the post-2012 climate change agenda with the decision on the Reducing Emissions from Deforestation and forest Degradation (REDD+) adopted by COP16 of UNFCCC. REDD+ includes policy approaches and positive incentives on issues relating to reducing emissions from deforestation and forest degradation in developing countries, and recognizes the contribution of conservation, sustainable management of forests and enhancement of forest carbon stocks in achieving REDD+ objectives. This module will introduce learners to the concepts of mitigation of climate change, forest based mitigation measures/strategies, clean development mechanism (CDM), REDD+, non-forest based mitigation measures of climate change, monitoring and evaluation.

Module aim

To build an understanding of the principles of climate change mitigation and forest-based as well as non-forest based climate change mitigation strategies.

Module objectives

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

- ▶ Define forest and non-forest based climate change mitigation
- ▶ Describe concepts of climate change mitigation;
- ▶ Synthesize forest based and non-forest based climate change mitigation strategies;
- ▶ Relate CDM and REDD+ and other mechanisms to the mitigation of climate change;
- ▶ Design appropriate monitoring and evaluation tools for climate change mitigation projects and practices.

CHAPTER 1

CONCEPTS OF MITIGATION OF CLIMATE CHANGE

Chapter Overview

This chapter introduces the concept of climate change mitigation and explores national strategies and actions aimed at climate change mitigation and the inter-relationships between adaptation and mitigation. It covers an understanding of climate change options, GHGs, legislations and policies of climate change mitigation.

Learning Outcomes

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

- ▶ Define climate change mitigation;
- ▶ Explain the concept of climate change mitigation and the linkages between adaptation and mitigation;
- ▶ Analyze national strategies; or actions and policies in mitigation of climate change.

Content

- 1) Definition of mitigation in the context of climate change and forestry
- 2) Concept of climate change mitigation
- 3) Mitigation options for climate change
- 4) Green House Gases (GHG) sources and sinks
- 5) Climate change mitigation policies and legislation
- 6) Relationship between adaptation and mitigation
- 7) Legislation, policies and strategies for climate change mitigation.

CHAPTER 2

FORESTS BASED MITIGATION STRATEGIES

Chapter Overview

Forests contribute to climate change mitigation through carbon sequestration as well as by offering economic, environmental, and socio-cultural benefits. In the tropical forest region where there is high rate of deforestation and forest degradation, the promotion of forestry and agro forestry programmes will increase mitigation of GHG emissions. This chapter introduces learners to various forest-based strategies for climate change mitigation and how they can be implemented under different scenarios/conditions.

Learning Outcomes

At conclusion of this chapter, the learners will be able to:

- ▶ Identify forest based climate change mitigation strategies;
- ▶ Explain the role of forests in climate change mitigation;
- ▶ Describe the various forest based climate change mitigation strategies;
- ▶ Assess Nationally Appropriate Mitigation Actions (NAMAs) in relation to forestry and how they can contribute to climate change mitigation;
- ▶ Explain the co-benefits of using forests to mitigate climate change;
- ▶ Analyze the challenges associated with climate change mitigation through forestry .

Content

- 1) Concepts and definition of carbon sequestration
- 2) Role of forests in climate change mitigation
- 3) Managing forests for climate change mitigation
- 4) Legislations and policies on climate change mitigation
- 5) Forest based mitigation strategies of climate change:
 - a) Reservation and conservation of forests
 - b) Sustainable forest management
 - c) Agroforestry and on-farm tree planting
 - d) Afforestation and reforestation
 - e) Urban forestry
- 6) Non-forest based climate change mitigation strategies
 - a) Community participation in forest-based mitigation
 - b) Appraisal of forest based mitigation options
 - c) Non-extractive use of forests (e.g. ecotourism, beekeeping)
 - d) Substituting use of forest-based products such as bio-energy and durable wood products with less eco-efficient materials
 - e) Using fuels such as bio-diesel.

- 7) Nationally Appropriate Mitigation Actions (NAMAs) and other similar experiences related to forests
- 8) Co-benefits of forest-based mitigation
 - a) employment and income generation opportunities
 - b) biodiversity conservation
 - c) watershed conservation
 - d) provision of timber and fiber
 - e) aesthetic and recreational services
 - f) poverty alleviation.
- 9) Analysis of forest based challenges associated with climate change mitigation.

CHAPTER 3

CLEAN DEVELOPMENT MECHANISMS AND REDD+

Chapter Overview

This chapter focuses on CDM and REDD+ as forest-based mechanisms for mitigating climate change. It builds an understanding of the evolution of the CDM and REDD processes, implementation processes, the difference between RED, REDD, and REDD+, economic benefits from the mechanisms, governance issues involved, and multi-stakeholder participation in the CDM and REDD+ processes.

Learning Outcomes

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

- ▶ Explain the genesis of CDM and evolution of REDD+ in relation to mitigation of climate change;
- ▶ Describe the implementation processes of CDM and REDD+;
- ▶ Evaluate the implications of the CDM and REDD+ projects in mitigation of climate change;
- ▶ Analyze financing mechanisms for CDM and REDD+ processes;
- ▶ Support the development of REDD+ project proposals at local, sub-national, national, regional and international levels.

Content

- 1) Definitions of CDM and REDD+
- 2) Evolution of CDM and REDD+
- 3) Implementation of CDM projects
- 4) Implementation of REDD+
- 5) CDM and REDD+ policies and legislation (international and national levels)
- 6) Economics benefits of CDM and REDD+
- 7) Governance issues in REDD+
 - a) Importance of multi-stakeholder participation and consultation in REDD+
 - b) Local communities and the REDD+
 - c) Pro-poor REDD+ approach
 - d) Social and environmental safeguards for REDD+
- 8) Financing mechanisms for REDD+
- 9) Measurement, Reporting and Verification (MRV) in REDD+
- 10) Concepts of leakage, permanence, additionality and reference levels .

CHAPTER 4

NON-FOREST CLIMATE CHANGE MITIGATION STRATEGIES

Chapter Overview

There are measures outside the forestry sector that can contribute significantly to climate change mitigation. For example, the agriculture and other land use sectors have potential to make significant contributions to the mitigation of climate change and the reduction of greenhouse gas emissions. These sectors are also closely linked and also 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 amelioration of climate change.

Learning Outcomes

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

- ▶ Explain mitigation measures in different sectors with emphasis on agriculture;
- ▶ Design activities outside the forest sector that could help to mitigate climate change;
- ▶ Evaluate the application of non-forest/-alternative strategies to climate change mitigation.

Content

- 1) Sectoral mitigation measures
- 2) Mitigation strategies through SMART Agriculture, i.e.
 - a) Climate-friendly agricultural practices - focus on increasing the carbon content in soil - using cover crops, farming with perennials, reduced tillage or rotational grazing
 - b) Community participation in forest-based mitigation
 - c) Appropriate use of chemical fertilizers (responsible for nitrous oxide emissions)
 - d) Managing livestock systems to reduce methane emissions
 - e) Low-emission farming systems - conservation agriculture, agro-ecology and organic farming
 - f) Climate-conscious consumption - reducing food losses, switching to second or third generation bio-fuels, curbing meat consumption
 - g) The use of bio-char
- 3) Alternative livelihoods (alternative to forests) as climate change mitigation measures.
- 4) Resource substitution as a mitigation measure (e.g. renewable energy)
- 5) Case studies on non-forest based climate change mitigation strategies.

CHAPTER 5

MONITORING AND EVALUATION OF CLIMATE CHANGE MITIGATION STRATEGIES

Chapter Overview

Monitoring and evaluating mitigation practices and projects can help countries assess progress towards climate change mitigation and to also identify which strategies work and which do not work. It will also help to assess whether intended objectives for mitigation projects will be achieved with available resources. This chapter will introduce learners to the concepts of monitoring and evaluation in mitigation projects, methods for monitoring and evaluation of mitigation projects, and techniques for reporting.

Learning Outcomes

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

- ▶ Describe concepts for monitoring and evaluation in the context of mitigation to climate change;
- ▶ Apply correct methods for monitoring and evaluation of mitigation activities to climate change;
- ▶ Identify appropriate types of evaluation of mitigation activities related to climate change.

Content

- 1) Concepts and purpose of monitoring for climate change mitigation
- 2) Purpose and types of evaluation
- 3) Reporting processes
- 4) Methods of monitoring, evaluation and reporting.
- 5) Tools of monitoring.

MODULE 4
CARBON MARKET
AND TRADING

4

Module overview

Carbon market-based mechanisms such as emissions trading have become widely accepted as being cost-effective in addressing climate change and other environmental issues. The carbon market trades emissions under cap-and-trade schemes or with credits that pay for or offset GHG reductions. This module will introduce learners to principles and concepts of carbon trade, payments for environmental services, carbon trading processes and agreements, approaches to carbon stock estimation, methodological issues in carbon trade and marketing, carbon market risks and opportunities, global, regional and national marketing and trade in forest carbon, dynamics of carbon markets and institutional and legal frameworks for carbon trade.

Module aim

The aim of this module is to improve the knowledge of the learners on carbon markets and trade with respect to forestry, and related financing mechanisms.

Module objectives

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

- ▶ Describe principles and concepts of carbon trade;
- ▶ Explain carbon trading processes and agreements;
- ▶ Synthesize institutional and legal frameworks in carbon trade;
- ▶ Estimate carbon stocks in different forest types.

CHAPTER 1

PRINCIPLES AND CONCEPT OF CARBON TRADE

Chapter Overview

This chapter is designed to build learners' competence on the principles and concepts of carbon trade and marketing. It introduces learners to the concept of Payment for Ecosystem Services (PES) and basic principles of economics and markets, carbon markets risks and opportunities, dynamics of carbon markets, principles and practices of forest carbon financing and trading mechanisms; and global, regional and national marketing and trade in forest carbon.

Learning Outcomes

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

- ▶ Describe concepts and principles of carbon trading;
- ▶ Demonstrate an understanding of the broader concepts and principles of Payment for Ecosystem/Environmental Services (PES);
- ▶ Analyze basic principles and concepts of economics as they relate to carbon markets and trade ;
- ▶ Evaluate the principles and practices of forest carbon financing and trading mechanisms (for CDM, REDD+ and voluntary markets);
- ▶ Assess carbon market risks and opportunities.

Content

- 1) Definitions and concepts of carbon trading and marketing
 - a) Carbon transactions
 - b) Cap-and-trade schemes
 - c) Carbon credits
- 2) Basic principles on Project Idea Note (PIN) and Project Design Document (PDD)
- 3) Principles of carbon economics and markets
 - a) The concept of demand, supply and the market
 - b) Basic concept of economic value
 - c) Property rights
 - d) Characteristics of efficient or well-defined property rights
 - e) Exchange of property rights
- 4) Carbon market risks and opportunities
- 5) Dynamics of carbon markets
- 6) Payment for Ecosystem Services (PES)
- 7) Principles and practices of forest carbon financing and trading mechanisms (e.g. CDM, REDD+, voluntary markets).
- 8) Trade in forest carbon credits
- 9) Climate change and carbon trading
- 10) Access to carbon finance
- 11) Global, regional and national marketing and trading of forest carbon.

CHAPTER 2

CARBON TRADING PROCESSES AND AGREEMENTS

Chapter Overview

This chapter will introduce learners to the processes involved in carbon trading and marketing. It will also cover various agreements and rules governing carbon trade and marketing, types of carbon credits, roles of professionals in carbon credit projects and mechanisms for carbon benefit sharing at different levels.

Learning Outcomes

At conclusion of this chapter, the learners will be able to:

- ▶ Demonstrate an understanding of the agreements on carbon trading and marketing;
- ▶ Explain the processes and rules governing carbon trading;
- ▶ Evaluate the implications of various carbon trading processes;
- ▶ Analyze the myths and realities in carbon trading and marketing;
- ▶ Explain the role of professionals in forest carbon credit projects;
- ▶ Describe mechanisms for sharing carbon benefits at community, sub-national, national, regional and international levels.

Content

- 1) Agreements on carbon trading and marketing
- 2) International carbon standards and carbon trading
- 3) Obligations of Annex I and Non-Annex I Parties
- 4) Rules governing carbon trading
- 5) Myths and the realities of marketing and trading in carbon
- 6) Types of markets for carbon credits offset projects
- 7) Roles of professionals in carbon credit projects
- 8) Mechanisms for carbon benefit sharing at community (sub-national), national and international levels.

CHAPTER 3

APPROACHES TO CARBON STOCK ESTIMATION

Chapter Overview

Measuring and estimating carbon stocks and changes in carbon stocks in various pools are very important to carbon trading and marketing. Countries continue reporting changes in carbon pools of forests to UNFCCC. This requires transparent and verifiable methods, quantification of uncertainties and appropriate monitoring systems. This chapter will therefore introduce learners to the concepts of biomass and carbon stock estimation; methods for calculating and estimating carbon stocks; measurement, reporting and verification (MRV) systems.

Learning Outcomes

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

- ▶ Explain the concepts of carbon pools, biomass, carbon stock and carbon fluxes;
- ▶ Apply appropriate protocols and methods for estimating carbon stocks from different carbon pools;
- ▶ Design efficient measurement, reporting and verification systems for carbon accounting.

Content

- 1) Definitions of carbon pools.
- 2) Concept of biomass, carbon stock, and carbon fluxes.
- 3) Carbon pools – above-ground biomass, below-ground biomass, dead wood, litter, Soil Organic Matter (SOM), harvested wood products.
- 4) Tree species based allometric equations for biomass estimation
- 5) Generalized allometric equations for biomass estimation on different landscapes and forest types
- 6) Determination of carbon stocks in various pools.
 - General methods for estimating carbon stocks and changes in stocks
- 7) Carbon stock assessment and accounting
- 8) Forest carbon project accounting issues
 - a) Baseline setting
 - b) Additionality
 - c) Leakage
 - d) Permanence
- 9) Monitoring/Measurement, Reporting and Verification (MRV) systems.

CHAPTER 4

METHODOLOGICAL ISSUES IN CARBON TRADE AND MARKETING

Chapter Overview

Carbon trading and marketing presents several methodological issues and challenges. For example, there is the question of whether or not to use a quantity-based scheme or a price-based one. The quantity scheme sets a limit on emissions and lets the market decide the price for emissions, while the price scheme sets the price for emissions and leaves the market forces to drive down emissions. This chapter will introduce learners to various methodological issues and challenges associated with trading and marketing of carbon. In particular it will cover the methodology for carbon trading, pricing of carbon credits, carbon accounting issues and corruption/illegalities.

Learning Outcomes

At conclusion of this chapter, learners will be able to:

- ▶ Analyze methodological issues in carbon trading and marketing;
- ▶ Assess carbon pricing in relation to sale of wood products;
- ▶ Detect and rate corruption/illegality levels at different stages of forest carbon trade and marketing.

Content

- 1) Conceptual underpinnings for carbon trading
 - a) Pigouvian taxes (– Pigou pointed out the social benefits of forcing companies to pay for the costs of their pollution)
 - b) Coase theorem (– Coase showed that allocating property rights and allowing trade can yield efficient results.)
 - c) Certification for carbon trading
- 2) Methodological issues and challenges in carbon marketing and trading
- 3) The modalities for carbon financing
- 4) Setting a market price for carbon
- 5) Corruption/illegality issues in carbon trading and marketing
 - a) Perverse incentives
 - b) Conflicts of interest and the ‘revolving door’ syndrome
 - c) Transparency and access to information
 - d) Fraud
 - e) Erosion of the rule of law by power and influence.

CHAPTER 5

INSTITUTIONAL AND LEGAL FRAMEWORKS FOR CARBON TRADING

Chapter Overview

This chapter provides an understanding of the legal and institutional frameworks for carbon trading and marketing. In particular, it will cover forest policy and legislation, forest governance and ownership, policies for carbon trading and role of carbon taxation and trading.

Learning Outcomes

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

- ▶ Analyze forest policy and legislation that supports carbon trading and marketing;
- ▶ Synthesize the role of community based forest institutions in carbon trading and marketing ;
- ▶ Assess the role of national policies on carbon trading, marketing and taxation.

Content

- 1) Forest policy and legislation
- 2) Forest governance issues
 - a) Ownership and tenure issues
 - b) Stakeholder participation
- 3) Insurance
- 4) National policies for the trading of carbon credits
- 5) Legal aspects in carbon trading
 - Role of taxation and trading.

CHAPTER 6

MONITORING AND EVALUATION OF CARBON TRADING

Chapter Overview

The growing body of knowledge on climate change and carbon trading often lacks an African perspective. To address this imbalance, monitoring, evaluating and reporting carbon trading on the continent is important. This will, among other things, stimulate a continental awareness and response on these issues, and this will guide/inform African policy-making and thinking on carbon trading, as well as on broader approaches to combating climate change. This chapter will introduce learners to the methods of monitoring, evaluating and reporting carbon trading.

Learning Outcomes

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

- ▶ Describe concepts of monitoring and evaluation in the context of carbon trading and marketing;
- ▶ Analyze the role of actors involved in carbon trade and marketing;

- ▶ Apply correct methods for monitoring and evaluation of carbon trading and marketing in forestry projects;
- ▶ Choose appropriate types of monitoring and evaluation in carbon trading and marketing on forestry projects.

Content

- 1) Concepts and purpose of monitoring carbon trading
- 2) Actors involved in carbon trading and their roles and interests
 - a) Developers
 - b) Financiers
 - c) Designated National Authorities and CDM Boards
 - d) Consultants/independent third-party verifiers
- 3) Methods for monitoring, evaluating and reporting.
- 4) Country contexts
- 5) Assessing the validity of monitoring and evaluation (M&E) reports.

PART II
MODULES FOR TECHNICAL
TRAINING

BACKGROUND

The training needs for technical people in forestry were also identified in four key areas, namely: basic science of climate change, adaptation, mitigation, and carbon markets and trade. The training needs in each of these four areas (Table 2) facilitated the development of the training module.

The key elements that will guide development of the training module, and in each of these four core areas, are identified in the following sections:

1. SCIENCE OF CLIMATE CHANGE

- 1) Elements of global change (population increases, industrialization, technology, etc.)
- 2) Definition and elements of climate (temperature, rainfall, humidity, etc.)
- 3) Definition of climate change
- 4) Climate systems
- 5) Science and evidence of climate change
 - a) IPCC Assessment Reports
 - b) Global warming
- 6) Opportunities and challenges associated with climate change
- 7) Causes of climate change (GHG emissions, ozone layer and interactions, risks associated with emissions, deforestation, urbanization, ocean circulation, transportation, etc.)
- 8) National climate change trends / scenarios
- 9) Vulnerability to climate change
- 10) Impact of climate change
- 11) Generating baseline data on climate change
- 12) National and international dialogues and processes in climate change.

Table 2. Forest based climate change training needs for technical groups in sub-Saharan Africa

Basic science of climate change	Adaptation	Mitigation	Carbon market and carbon trading
<ul style="list-style-type: none"> • Basic concepts, basic sciences on climate and climate change, and ecology (avoid modeling at this level) • International dialogues and processes in climate change 	<ul style="list-style-type: none"> • General concept of adaptation • Linkage of impact of climate change to adaptation • Ecosystem vulnerability • Ecosystem dynamics • Early warning measures • Rural sociology (include gender) • Current legislations • Technological, biological and socio economic adaptation strategies • Adaptation strategies outside the forestry sector 	<ul style="list-style-type: none"> • General concept of mitigation • Impact-mitigation • Silviculture • Forest management • Forest governance • Up scaling of knowledge and information sharing • Forest management for carbon 	<ul style="list-style-type: none"> • Carbon markets and how to develop a carbon project • Existing trading mechanisms • Governance at local level • Carbon stock estimation

2. ADAPTATION TO CLIMATE CHANGE

- 1) Concept of adaptation (definitions, adaptation to climate change in relation to forestry, legislations and policies associated with adaptation to climate change)
- 2) Types of adaptation (planned and autonomous; reactive, unplanned, etc.)
- 3) Mechanisms for climate change adaptation
- 4) Types of adaptation strategies
- 5) Forest based adaptation strategies
 - a) Plant adaptation options/strategies
 - i) Resistance tree species
 - ii) Urban forestry planning, greening and their contribution to urban development
 - b) Technological adaptation
 - i) Agroforestry designs
 - ii) Use of renewable energy
 - c) Conservation biology/ecology
 - i) Ecosystem management
 - ii) Role of trees and forests in climate change adaptation
 - d) Social economic aspects of adaptation strategies
 - i) Gender and forest based adaptation
 - ii) Sustainable livelihoods
 - iii) Resilience of forests and people to climate change
- 6) Challenges to adaptation.

3. MITIGATION OF CLIMATE CHANGE

- 1) Concept of mitigation and mitigation options for climate change
- 2) Role of forests in climate change mitigation
- 3) Forest based mitigation measures
 - a) Promotion of agroforestry practices
 - b) Afforestation and reforestation
 - c) Promotion of cultivation/ planting of climate resilient species
- 4) Non-forest/alternative strategies to climate change mitigation
 - a) Promotion of non-extractive use of forests (e.g. ecotourism)
 - b) Promotion of alternative livelihood strategies.

4. CARBON TRADE AND MARKETING

- 1) Definitions and concepts in carbon trade and marketing
- 2) Principles and practices of carbon financing and trade
 - a) Ownership of forest land
 - b) Voluntary carbon markets
- 3) Payment schemes and benefit sharing
- 4) Carbon stock assessment
 - a) Determination of carbon stocks
 - b) Biomass measurements above and below ground

The four training modules are structured into several components: overview, aim, objectives, and chapters. In each module chapter, an overview, learning outcomes and content are provided.

MODULE 1
BASIC SCIENCE OF CLIMATE
CHANGE



Module Overview

Increasing of GHG emissions in the atmosphere is raising global concern. This is because these emissions have led to a shift of temperatures, unpredictable weather patterns and sporadic rainfall that has caused heavy floods, among other adverse impacts. As a result many countries are pursuing various policies and strategies to help mitigate and adapt to climate change. This will require an understanding of the processes that contribute to climate change. This module will introduce learners to the basic science of climate change by focusing on an understanding of global change, concept of climate change, causes of climate change, vulnerability to, and impact of climate change, generation of climate change data, and international dialogues, processes and mechanisms on climate change.

Module Aim

To build the learners' understanding of the basic science of climate change and its application in forestry and other related sectors.

Module Objectives

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

- ▶ Describe the elements of global change, components of climate systems and concepts of climate change;
- ▶ Explain the causes of climate change;
- ▶ Explain the impact of climate change in forestry and other related sectors;
- ▶ Relate concepts of vulnerability and response to climate change; and
- ▶ Generate relevant data for climate change;
- ▶ Interpret international agreements, discussions and conventions on climate change.

CHAPTER 1

UNDERSTANDING GLOBAL CHANGE

Chapter Overview

This chapter introduces the concept of climate change and terminologies used. It also explores the basics of climate science, weather systems, hydrological cycles, elements of global change, definition and elements of climate; in addition to opportunities and challenges associated with climate change.

Learning Outcomes

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

- ▶ Define and differentiate among global change, climate change and climate variability;
- ▶ Explain elements of global change and their implications on climate change;
- ▶ Distinguish components of climate systems;
- ▶ Comprehend evidences of climate change;
- ▶ Describe trends in climate change, as well as associated threats and opportunities at community (sub-national), national, regional and international levels.

Content

- 1) Definition of climate change and terminologies used
- 2) Basics of climate science - basic concepts of climate and climatology, the modifying effects of surface-atmosphere interactions on the climate (volcanic activity, air pollutants, desertification). The climate of the earth components of the climate system (atmosphere, hydrosphere, cryosphere, biosphere)
- 3) Weather systems [(Inter Tropical Convergence Zone (ITCZ)]
- 4) Hydrological cycles
- 5) Elements of global change (population growth, urbanization, industrialization, technological development/ advancement)
- 6) Definition and elements of climate (temperature, rainfall, humidity, etc.)
- 7) Opportunities and challenges associated with climate change.

CHAPTER 2

CAUSES OF CLIMATE CHANGE

Chapter Overview

The causes of climate change are an integral part of the basic science of climate. The causes of climate change have mainly been associated with human (anthropogenic) activities. This chapter will introduce learners to the anthropogenic causes of climate change that result in GHG emissions such as land use changes including deforestation, urbanization and transportation, among others. The chapter will also describe the risks associated with GHGs emissions and review trends in climate change.

Learning Outcomes

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

- ▶ Explain the causes of climate change;
- ▶ Describe the risks associated with climate change;
- ▶ Assess and interpret trends in climate change and their impacts.

Content

- 1) Understanding the causes of climate change
 - a) GHG emissions - human activities that result in GHG emissions (Deforestation, urbanization, transportation, etc).
 - b) Risks associated with GHG emissions.
- 2) National climate change trends / scenarios.

CHAPTER 3

VULNERABILITY TO AND IMPACT OF CLIMATE CHANGE

Chapter Overview

Vulnerability to climate change is a critical component of the basic science of climate change because it comprises a set of conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards/ or to get hurt by an external stress. The impacts of climate change demonstrate the effect of climate change on different sectors from both natural and human systems. These impacts have serious implications for societies by aggravating vulnerabilities. To contain such adverse effects will require the development of adaptation mechanisms to the changing climate. This chapter will introduce learners to concepts of vulnerability, biophysical vulnerability and impacts, socio-economic vulnerability and impacts, and disaster reduction, and risks associated with climate change.

Learning Outcomes

At conclusion of this chapter, the learners will be able to:

- ▶ Classify key concepts of vulnerability to climate change;
- ▶ Describe the biophysical and socio-economic sectoral impacts of climate change on ecosystems;
- ▶ Explain risks associated with climate change and how to undertake disaster risk reduction across various sectors.

Content

- 1) The concept of vulnerability: definitions and issues
- 2) Biophysical vulnerability and impacts
 - a) Biodiversity (genes, species and ecosystems)
 - b) Topography
 - c) Edaphic factors
- 3) Socio-economic and livelihood vulnerability and impacts
 - a) Infrastructure and settlements
 - b) Sectoral vulnerabilities (forest, health, agriculture and food security, water and coastal resources, transportation)
- 4) Climate change and disaster risk reduction.
 - a) Definitions and concepts
 - b) Weather factors that contribute to disasters
 - c) Strategies for reducing climate change disaster risks.

CHAPTER 4

GENERATING BASELINE DATA ON CLIMATE CHANGE

Chapter Overview

Access to high quality and timely data and other information is central to managing the challenges of climate change. Such information includes climate data (temperature, rainfall and the frequency of extreme events), as well as non-climatic data (e.g. with respect to the current situation on the ground for different sectors including water resources, agriculture and food security, human health, terrestrial ecosystems and biodiversity, and coastal zones). This chapter will introduce learners to different sources of climate and non-climatic data, data collection methods, tools and instrumentation, data management, analysis and interpretation.

Learning Outcomes

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

- ▶ Distinguish climatic and non-climatic data and sources;
- ▶ Apply appropriate methods for collecting climate data;
- ▶ Summarize climate data into meaningful information.

Content

- 1) Data types and sources
- 2) Data collection methods
- 3) Tools and instrumentation
- 4) Introductory data management, descriptive analyses and interpretation.

CHAPTER 5

INTERNATIONAL DIALOGUES, PROCESSES AND MECHANISMS ON CLIMATE CHANGE

Chapter Overview

The initial discourses on climate have mainly been global, though now there are also many discussions at regional and national levels. For instance, in 1992, countries joined an international treaty, the United Nations Framework Convention on Climate Change (UNFCCC), to cooperatively consider what they could do to limit average global temperature increases and the resulting climate change, and to cope with whatever impacts were, by then, inevitable. By 1995, countries realized that emission reductions provisions in the Convention were inadequate. They launched negotiations to strengthen the global response to climate change, and, two years later, adopted the Kyoto Protocol which legally binds developed countries to emission reduction targets. More recently the debates have been on REDD+ and the revision of the Kyoto Protocol that has already been accomplished. This chapter will introduce learners to these international dialogues and processes related to climate change, global-level responses to climate change, global and institutional mechanisms that address/ will address the issues of climate change vulnerability, mitigation and adaptation.

Learning Outcomes

At conclusion of this chapter, the learners will be able to:

- ▶ Identify international agreements, discussions, conventions, and negotiations on climate change;
- ▶ Highlight implications of the climate change discussions and negotiations for developing countries;
- ▶ State institutional mechanisms that will address forestry related issues of climate change vulnerability, mitigation and adaptation.

Content

- 1) Historical overview of international responses to climate change
- 2) First multilateral organizations tasked to address climate change
 - a) The World Meteorological Organization (WMO)
 - b) The United Nations Environment Program (UNEP)
- 3) The UN Framework Convention on Climate Change (UNFCCC)
 - a) Objectives
 - b) Conference of Parties
 - c) The Intergovernmental Convention on Climate Change (IPCC).

- 4) The Kyoto Protocol: Market-based mechanisms toward climate change mitigation
 - a) Emissions Trading
 - b) Joint Implementation (JI)
 - c) Clean Development Mechanism (CDM)
 - d) Communications and Negotiations
 - e) Limitation and challenges
- 5) REDD and REDD+
- 6) Africa's preparedness and position in climate change negotiations
- 7) Review of national climate change dialogue, processes and mechanisms.

MODULE 2
FORESTS AND CLIMATE
CHANGE ADAPTATION



Module overview

The impact of climate change on society and ecosystems is evident. The ability of a system to adjust to climate change in order to reduce its vulnerability and enhance its resilience to observed and anticipated impacts is the main thrust of this module. Adaptation occurs in physical, ecological, and human systems, and involves changes in social and environmental processes, perceptions of climate risk, and practices and functions to reduce risk and to exploit new opportunities. In particular, this module will emphasize the role of forests and trees in climate change adaptation and how forests and trees adapt to climate change. For instance, planting forests and sustainable forest management can aid the protection of soil and land against detrimental impacts of flooding. In addition, forests can be used to rehabilitate degraded land and maintain water quality by trapping sediments, taking up nutrients, and immobilizing toxic substances. Adaptation strategies that promote sustainable forest management and community based forest management have the potential to not only protect land and people from some of the harmful effects of rising global temperatures, but also to provide opportunities for greater, more sustainable rural development and poverty alleviation through income generation and employment opportunities. This module will introduce learners to the concept of adaptation to climate change, types of adaptation, determinants of adaptation, assessment of forest based adaptation mechanisms and monitoring and evaluation.

Module aim

To enhance an understanding of the principles of climate change adaptation and forest-based climate change adaptation strategies.

Module objectives

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

- ▶ Describe the concepts of adaptation to climate change;
- ▶ Identify and distinguish different types of adaptation to climate change;
- ▶ Explain determinants of adaptation to climate change in the context of forestry;
- ▶ Describe adaptation strategies and mechanisms outside the forest sector;
- ▶ Compare forest-based adaptation mechanisms to climate change.

CHAPTER 1

CONCEPTS OF ADAPTATION

Chapter Overview

This chapter introduces the concept of climate change adaptation. It also covers types of adaptation to climate change, determinants of adaptation to climate change and offers practical examples of climate change adaptation.

Learning Outcomes

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

- ▶ Define adaptation to climate change;
- ▶ Explain the concept of adaptation to climate change in the context of forestry and people ;
- ▶ Distinguish the different types of adaptation;
- ▶ Explain the determinants of adaptation to climate change.

Content

- 1) Concept of adaptation - definitions
- 2) Types of adaptation
 - Anticipatory and reactive adaptation; private and public adaptation; autonomous and planned adaptation.
- 3) Determinants of adaptation - system characteristics that influence a system's propensity to adapt - sensitivity, vulnerability, resilience, susceptibility, impact potential, responsiveness, adaptive capacity, adaptability.
- 4) Practical examples of adaptation.

CHAPTER 2

FOREST-BASED CLIMATE CHANGE ADAPTATION MECHANISMS

Chapter Overview

While forests are affected by climate change, they also play a key role in facilitating adaptation to climate change, for example, by increasing the resilience of rural communities. Forests support species to adapt to changing climate patterns and sudden climate events by providing them refuge and migration corridors. Also, they indirectly support economies to adapt to climate change by reducing the costs of climate-related negative impacts. Forest ecosystems also provide goods and services during extreme events (droughts and floods), and are key assets for reducing vulnerability to the effects of climate change. This chapter will introduce learners to how forests respond to climate change, role of forests in adaptation to climate change, resilience of forests and people to climate change, forest-based and other ecosystem-based adaptation mechanisms/strategies, forests and livelihoods, indigenous coping and adaptation mechanisms and strategies, and challenges associated with adaptation to climate change.

Learning Outcomes

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

- ▶ Explain how forests are affected by climate change and the role forests play in climate change adaptation;
- ▶ Identify appropriate forest-based activities that could help to adapt to climate change;
- ▶ Implement the various climate change adaptation strategies;
- ▶ Describe the challenges to climate change adaptation in the context of their countries.

Content

- 1) Forests response to climate change
- 2) Role of forests in adaptation to climate change
- 3) Forest-based adaptation strategies/ measures
- 4) Ecosystem/landscape-based adaptation
- 5) Forests and livelihoods
- 6) Resilience of forests and people to climate change
- 7) Indigenous coping and adaptation mechanisms and strategies
- 8) Case studies in forest-based climate change adaptation strategies
- 9) Challenges to adaptation
 - Adaptation gaps and barriers.

CHAPTER 3

NON-FOREST CLIMATE CHANGE ADAPTATION STRATEGIES

Chapter Overview

Understanding strategies used in adaptation to climate change in other sectors is fundamental in providing a holistic approach to learners on how to relate them to forestry. This will enhance the knowledge and understanding of learners because the forestry sector also plays a significant role to other sectors like water, health, agriculture, fisheries and coastal ecosystems, among others. This chapter will introduce learners to adaptation strategies and related mechanisms from outside the forest sector.

Learning Outcomes

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

- ▶ Explain adaptation measures under different sectors;
- ▶ Assess priority activities outside the forest sector that could help their countries to adapt to climate change.

Content

- 1) Other sectors impacted by climate change outside forestry-agriculture, fisheries, livestock, health and sanitation, built environment, etc.
- 2) Sectoral adaptation measures
- 3) Adaptation strategies in agriculture: changing planting strategies, improving agricultural methods, planting drought-resistant crops, shifts from rain-fed to irrigated agriculture, etc.
- 4) Other adaptation strategies: preparing risk assessments, managing water resources, building settlements in safe zones, developing early warning systems, instituting better building designs, improving insurance coverage, developing social safety nets.
- 5) Case studies/examples on climate change adaptation strategies.

CHAPTER 4

MONITORING, EVALUATION AND REPORTING OF ADAPTATION PRACTICES

Chapter Overview

Effective monitoring, evaluation and reporting of adaptation practices and projects are important for understanding and guiding climate change adaptation activities. This chapter is designed to enhance the skills of learners in monitoring and evaluating adaptation projects and practices.

Learning Outcomes

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

- ▶ Describe the concepts of monitoring, evaluation and reporting in the context of adaptation to climate change in forestry;
- ▶ Apply correct methods for monitoring, evaluation and reporting of adaptation to climate change in forestry projects;
- ▶ Choose appropriate types of evaluation of adaptation to climate change in forestry projects.

Content

- 1) Concepts and purpose of monitoring
- 2) Purpose and types of evaluation
- 3) Reporting processes
- 4) Methods for monitoring, evaluation and reporting
- 5) Tools of monitoring, Interviews, surveys, etc.

MODULE 3
FORESTS AND CLIMATE
CHANGE MITIGATION

3

Module overview

Forests play a significant role in climate change mitigation through the process of carbon sequestration that is achieved through afforestation, reforestation, forest restoration and forest management practices. This has led to the recognition of the contribution of forests to climate change mitigation with the decision on adopting the Reducing Emissions from Deforestation and forest Degradation (REDD+) in COP16 of UNFCCC. REDD+ includes policy approaches and positive incentives on issues relating to reducing emissions from deforestation and forest degradation in developing countries, and recognizes the contribution of conservation, sustainable management of forests and enhancement of forest carbon stocks in achieving REDD+ objectives. This module will introduce learners to the concepts of mitigation of climate change, forest based mitigation measures/strategies, clean development mechanisms (CDM), REDD+, and non-forest based mitigation measures of climate change, monitoring and evaluation.

Module aim

To build an understanding of the principles of climate change mitigation and forest-based climate change mitigation strategies.

Module objectives

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

- ▶ Define climate change mitigation;
- ▶ Describe concepts of forest based climate change mitigation measures;
- ▶ Distinguish forest and non-forest based mitigation mechanisms for climate change;
- ▶ Identify appropriate monitoring and evaluation tools for climate change mitigation projects and practices.

CHAPTER 1

CONCEPT OF MITIGATION OF CLIMATE CHANGE

Chapter Overview

This chapter introduces the concept of climate change mitigation and explores national strategies and actions aimed at climate change mitigation and the relationship between adaptation and mitigation.

Learning Outcomes

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

- ▶ Define mitigation of climate change and forest based mitigation of climate change;
- ▶ Explain the concept of climate change mitigation and the

relationship between adaptation and mitigation;

- ▶ Describe national strategies or actions and policies in mitigation of climate change.

Content

- 1) Definitions of mitigation in the context of climate change.
- 2) Mitigation options for climate change
- 3) GHG sources and sinks
- 4) Relationship between adaptation and mitigation
- 5) Exploring national policies and strategies or actions to mitigate climate change.

CHAPTER 2

FORESTS BASED MITIGATION MECHANISMS

Chapter Overview

Forests contribute to climate change mitigation through carbon sequestration as well as by offering economic, environmental, and socio-cultural benefits. In the tropical forest region where there is high rate of deforestation and forest degradation, the promotion of forestry and agro forestry programmes will increase mitigation of GHG emissions. This chapter introduces learners to various forest-based strategies for climate change mitigation and how they can be implemented under different scenarios/conditions.

Learning Outcomes

At conclusion of this chapter, the learners will be able to:

- ▶ Identify forest based mitigation strategies on climate change;
- ▶ Explain the role of forests in climate change mitigation;
- ▶ Describe the various forest based mitigation strategies for climate change;
- ▶ Explain the benefits of using forests to mitigate climate change;
- ▶ Identify forest based challenges associated with climate change mitigation.

Content

- 1) Concepts and definition of carbon sequestration
- 2) Role of forests in climate change mitigation
- 3) Forest based mitigation strategies of climate change
 - a) Agroforestry and on-farm tree planting
 - b) Afforestation and reforestation
 - c) Urban forestry for climate change mitigation
 - d) Sustainable forest management
 - e) Management of forest reserves
- 4) Legislation and policies on climate change mitigation
- 5) Benefits of forest-based mitigation
 - a) employment and income generation opportunities
 - b) biodiversity conservation
 - c) watershed conservation
 - d) provision of timber and fiber
 - e) aesthetic and recreational services
 - f) poverty alleviation.

CHAPTER 3

CLEAN DEVELOPMENT MECHANISMS AND REDD+

Chapter Overview

This chapter focuses on CDM and REDD+ as forest-based mechanisms for mitigating climate change. It builds an understanding of the evolution of the CDM and REDD processes, implementation processes, the difference between RED, REDD, and REDD+, economic benefits from the mechanisms, governance issues involved, and multi-stakeholder participation in the CDM and REDD+ processes.

Learning Outcomes

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

- ▶ Describe the implementation processes of CDM and REDD+;
- ▶ Explain how CDM and REDD+ projects lead to climate change mitigation;
- ▶ Identify financing mechanisms for CDM and REDD+ processes;
- ▶ Support the implementation of REDD+ project proposals at local, sub-national, national, regional and international levels.

Contents

- 1) Definitions of CDM and REDD+
- 2) Differentiate between RED, REDD and REDD+
- 3) Implementation of CDM projects
- 4) Implementation of REDD+
- 5) Economic benefits of CDM and REDD+
- 6) Governance issues under REDD+
 - a) Importance of multi-stakeholder participation and consultation in REDD+
 - b) Local communities and the REDD+
 - c) Pro-poor REDD+ approach
 - d) Social and environmental safeguards for REDD+
 - e) How individuals and communities will share in the benefits of REDD+
- 7) Financing mechanisms for REDD+
- 8) Principles for Measurement Reporting and Verification (MRV) in REDD+.

CHAPTER 4

NON-FOREST CLIMATE CHANGE MITIGATION STRATEGIES

Chapter Overview

There are measures outside the forestry sector that hold potential to contribute significantly to climate change mitigation. Such measures are found in sectors like agriculture as well as in other land use sectors. If properly employed, such measures can significantly address mitigation of climate change and the reduction of greenhouse gas emissions. This chapter briefly introduces these alternative mitigation measures/strategies.

Learning Outcomes

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

- ▶ Explain mitigation measures from different sectors with emphasis on agriculture;
- ▶ Identify activities outside the forest sector that could help to mitigate climate change;
- ▶ Describe the application of non-forest/ alternative strategies to climate change mitigation.

Content

- 1) Sectoral mitigation measures
- 2) Mitigation strategies in agriculture:
 - a) Climate-friendly agricultural practices - focus on increasing the carbon content in soil - using cover crops, farming with perennials, reduced tillage or rotational grazing.
 - b) Appropriate use of chemical fertilizers (responsible for nitrous oxide emissions)
 - c) Managing livestock systems to reduce methane emissions.
 - d) Low-emission farming systems - conservation agriculture, agro-ecology and organic farming
 - e) Climate-conscious consumption - reducing food losses, switching to second or third generation biofuels, curbing meat consumption.
- 3) Alternative livelihoods (alternative to forests) as climate change mitigation measures.
- 4) Resource substitution as a mitigation measure (e.g. renewable energy).

CHAPTER 5

MONITORING AND EVALUATION OF CLIMATE CHANGE MITIGATION STRATEGIES

Overview

Monitoring and evaluating mitigation practices and projects can help countries assess progress towards climate change mitigation and to identify which strategies work and which do not work, as well as reasons behind this. This chapter is designed to enhance the skills of learners in monitoring and evaluating mitigation projects and practices.

Content

- 1) Concepts and purpose of monitoring
- 2) Purpose and types of evaluation
- 3) Methods of monitoring, evaluation and reporting
- 4) Reporting process.

Learning Outcomes

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

- ▶ Describe concepts of monitoring and evaluation in the context of mitigation of climate change;
- ▶ Apply correct methods for monitoring and evaluation of climate change mitigation activities;
- ▶ Choose appropriate types for evaluation of mitigation of climate change.

MODULE 4
CARBON MARKET AND TRADE

4

Module overview

Carbon market-based mechanisms such as emissions trading have become widely accepted as being cost-effective in addressing climate change and other environmental issues. The carbon market trades emissions under cap-and-trade schemes or with credits that pay for or offset GHG reductions. This module will introduce learners to principles and concepts of carbon trade; payments for environmental services; carbon trading processes and agreements; approaches to carbon stock estimation; methodological issues in carbon trade and marketing; carbon market risks and opportunities; global, regional and national marketing and trade in forest carbon; dynamics of carbon markets; and institutional and legal frameworks in carbon trade.

Module aim

The aim of this module is to improve the knowledge of the learners on carbon trade with respect to forestry and related financing mechanisms.

Module objectives

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

- ▶ Describe principles and concepts of carbon trade;
- ▶ Explain carbon trading processes and agreements;
- ▶ Compare institutional and legal frameworks in carbon trade;
- ▶ Measure carbon stocks in different forest types;
- ▶ Explain carbon market risks and opportunities.

CHAPTER 1

PRINCIPLES AND CONCEPTS OF CARBON TRADE

Chapter Overview

This chapter is designed to build learners' competence on the principles and concepts of carbon trade and marketing. It introduces learners to the concept of Payment for Ecosystem Services (PES), and basic principles of economics and carbon markets.

Learning Outcomes

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

- ▶ Describe concepts and principles in carbon trade;
- ▶ Explain concepts and principles of PES;
- ▶ Describe carbon market risks and opportunities.

Content

- 1) Definitions and concepts of carbon trade and marketing
 - a) Carbon Transactions
 - b) Cap-and-trade schemes
 - c) Carbon credits
- 2) Basic principles of economics and markets
 - a) The concept of demand, supply and the market
 - b) Basic concept of economic value
 - c) Property rights
 - d) Characteristics of efficient or well-defined property rights
 - e) Exchange of property rights
- 3) Payment for Ecosystem/ Environmental Services (PES)
- 4) Principles and practices of carbon financing and trade (e.g. CDM, REDD+, voluntary markets).
- 5) Climate change and carbon trade
- 6) Access to carbon finance.

CHAPTER 2

APPROACHES OF FOREST CARBON STOCK ESTIMATION

Overview

Measuring and estimating carbon stocks and the changes in carbon stocks in various pools are of particular importance to carbon trade and marketing. Countries continue reporting changes in carbon pools of forests to the UNFCCC. According to the reporting guidelines, methods should be transparent and verifiable, and also the quantification of the uncertainty established. This chapter introduces learners to the methods for calculating and estimating carbon stocks.

Learning Outcomes

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

- ▶ Explain the concepts of carbon pools, biomass, carbon stock and carbon fluxes'
- ▶ Apply appropriate protocols and methods for estimating carbon stocks from different carbon pools
- ▶ Implement measurement, reporting and verification systems for carbon accounting.

Content

- 1) Definitions of carbon pools.
- 2) Concept of biomass, carbon stock, and carbon fluxes
- 3) Carbon pools – above-ground biomass, below-ground biomass, dead wood, litter, Soil Organic Matter (SOM), harvested wood products.
- 4) Determination of carbon stocks in various pools.
 - General methods for estimating carbon stocks and changes in stocks
- 5) Carbon stock assessment.

PART III
TRAINING MODULES
FOR INFORMAL GROUPS
CIVIL SOCIETY ORGANIZATIONS AND LOCAL COMMUNITIES

BACKGROUND

The training needs for informal groups such as civil society organisations and local communities were identified in four key areas, namely: basic science of climate change, adaptation, mitigation, and carbon market and trade (Table 3); and they facilitated the development of the training module.

Table 3. Forest based climate change training needs for informal groups in sub-Saharan Africa

Basic science of climate change	Adaptation	Mitigation	Carbon market and carbon trading
<ul style="list-style-type: none"> • Impacts and indicators of climate change • Linking climate impacts to actions (e.g. for early warning) • Opportunities and challenges of climate change 	<ul style="list-style-type: none"> • Definitions of adaptation, vulnerability • Agroforestry and ecosystem services • Local knowledge • Sustainable forest management (SFM) • Early warning systems • Vulnerability (physical, socio-economic) • Mechanisms for climate change adaptation 	<ul style="list-style-type: none"> • Definition of mitigation, • Sustainable use of forest (low emission activities), • Bioenergy • Forest based mitigation measures 	<ul style="list-style-type: none"> • Principles of green economy • REDD+ and CDM; and opportunities for carbon markets • How to evaluate Project Idea Note (PIN) and Project Design Document (PDD) • Monitoring and assessment of carbon stocks

The key elements that will guide development of the training module, and in each of these four core areas, are identified in the following sections:

1. BASIC SCIENCE OF CLIMATE CHANGE

1. Signs and evidence of climate change
2. Elements of climate (temperature, rainfall, humidity, etc.)
3. Definition of climate change
4. Global warming

5. Opportunities and challenges associated with climate change
6. Causes of climate change
7. National climate change trends / scenarios
8. Vulnerability to and impacts of climate change.

2. ADAPTATION TO CLIMATE CHANGE

- 1) Concept of adaptation
- 2) Types of adaptation (planned and autonomous; reactive, unplanned, etc.)
- 3) Legislation and policies on adaptation
 - a) National and international policies
 - b) Implications of policies and legislation on adaptation
- 4) Types of adaptation strategies
 - a) Technological adaptation mechanisms
 - i) use of renewable energy
 - ii) soil and water conservation
 - iii) high value indigenous crops/ orphan crops
 - b) Management of forest resources to increase carbon stock
 - i) Forestry and other forestry practices for adaptation
 - c) Socio-economic aspects of adaptation mechanisms
 - i) Application of indigenous coping and adaptation mechanisms and strategies
 - ii) Traditional ecological knowledge (TEK)
 - iii) Gender and forest based adaptations
 - iv) Sustainable livelihoods
- 5) National, regional, and international adaptation strategies
- 6) Resilience of people to climate change
- 7) Challenges to adaptation
- 8) Sourcing and using climate information
- 9) Monitoring, evaluation and reporting of adaptation practices

3. MITIGATION OF CLIMATE CHANGE

- 1) Concepts of mitigation and mitigation options for climate change
- 2) Legislation and policies on climate change mitigation
- 3) Role of forests in climate change mitigation
- 4) Forest-based mitigation measures
 - a) Afforestation/reforestation
 - b) Rehabilitation of degraded areas
 - c) Urban forestry
 - d) Reservation and conservation of forests
 - e) Sustainable forest utilization
 - f) Promotion of agroforestry practices
 - g) Promoting the cultivation/ planting of climate resilient species
- 5) Basic concepts of CDM and REDD+
- 6) Non-forest strategies for climate change mitigation
- 7) Socio economic aspects of mitigation strategies
 - a) Promotion of non-extractive use of forests (e.g. ecotourism)
 - b) Promotion of alternative livelihood strategies
- 8) Monitoring and evaluation of climate change mitigation strategies

4. CARBON TRADE AND MARKETING

- 1) Basic principles of economics and markets
- 2) Principles and practices of carbon financing and trade
- 3) Payment schemes and benefit sharing
- 4) Introduction to monitoring and assessment of carbon stocks

THEME 1

BASIC SCIENCE OF CLIMATE CHANGE

Theme overview

Climate change is expected to continue in response to increasing trends in global greenhouse gas (GHG) emissions. Therefore, course participants will be introduced to the key and basic concepts of the science of climate change. This theme is divided into three sessions namely; understanding climate change, causes of climate change, and vulnerability to and impact of climate change.

SESSION 1: UNDERSTANDING CLIMATE CHANGE

This session introduces the concepts of climate, climate change and climate variability. It explores the science, causes, and impacts of climate change. It examines the linkages between GHG emissions and climate change, and explores the opportunities and challenges associated with climate change.

SESSION 2: CAUSES OF CLIMATE CHANGE

The causes of climate are an integral part of the basic science of climate. The main causes of climate change have been associated with human (anthropogenic) activities. This session introduces learners to the

anthropogenic causes of climate change that result into GHG emissions, such as land use changes including deforestation, urbanization and transportation, among others. The session also reviews trends in climate change.

SESSION 3: VULNERABILITY TO AND IMPACT OF CLIMATE CHANGE

Vulnerability to climate change comprises a set of conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards/or to get hurt by an external stress. The impacts of climate change demonstrate the effect of climate change on different sectors in both natural and human systems. These impacts have serious implications for societies by aggravating vulnerabilities. To contain them will require the development of adaptation mechanisms for the changing climate. This session introduces trainees to concepts of vulnerability, biophysical vulnerability and impacts, social-economic vulnerability, and impacts and reduction of risks associated with climate change.

THEME 2

FORESTS AND CLIMATE CHANGE ADAPTATION

Theme overview

This theme focuses on building an understanding of the interactions between forests and climate change, the concept of adaptation, and the role forests can play in climate change adaptation. This is motivated by fact that the diversity of functions and services provided by forests such as the provision of wood and non-wood forest products, soil fertility, water regulation and biodiversity conservation, give forests a potentially significant role in climate change adaptation approaches undertaken through different natural resources and land based sectors including agriculture, water, energy, and rangeland management. Moreover, trees and shrubs in farming systems, including agroforestry, have always played an important role in protecting agricultural soil from erosion and also from sand storms, thus contributing to sustainable agricultural production and food security. Therefore, adaptation strategies that promote sustainable forest management and better community based forest management have the potential to not only protect land and people from some of the harmful effects of rising global temperatures, but also to provide opportunities for greater, more sustainable rural development and poverty alleviation through income generation and employment opportunities. This theme introduces the concepts of climate change adaptation, mechanisms for climate change adaptation, monitoring and evaluation

of climate change adaptation strategies. It is divided into two sessions as follows:

SESSION 1: DEFINITIONS AND CONCEPTS OF ADAPTATION

This session introduces the concepts of climate change adaptation. It explores the various definitions and types of adaptation including anticipatory and reactive, private and public, autonomous and planned. The session also offers practical examples of climate change adaptation.

SESSION 2: FOREST-BASED CLIMATE CHANGE ADAPTATION MECHANISMS

While forests are affected by climate change, they also play a key role in adaptation to climate change. Forests support species to adapt to changing climate patterns and sudden climate events by providing them refuge and migration corridors. Forest ecosystems also provide goods and services during extreme events (droughts and floods), and are key assets for reducing vulnerability to the effects of climate change. This session explores the role of forests in climate change adaptation. It also examines forest based adaptation strategies/measures such as;

- ▶ Agroforestry for adaptation;
- ▶ Urban forestry, greening and their contribution to urban development;
- ▶ Improvement of forest management systems - control of deforestation, reforestation and afforestation;

- ▶ Development/improvement of national forest fire management plans;
 - ▶ Creation of parks/reserves, protected areas and biodiversity corridors;
 - ▶ Identification/development of species resistant to climate change;
 - ▶ Better assessment of the vulnerability of ecosystems;
 - ▶ Monitoring of species;
 - ▶ Development and maintenance of seed banks.
- ▶ planting drought-resistant crops, shifts from rain-fed to irrigated agriculture;
 - ▶ National Adaptation Programmes of Action (NAPAs);
 - ▶ Application of indigenous coping and adaptation mechanisms and strategies;
 - ▶ Preparing risk assessments, managing water resources, building settlements in safe zones, developing early warning systems, instituting better building designs, improving insurance coverage, developing social safety nets.

The session also introduces adaptation strategies and mechanisms taken outside the forest sector such as;

- ▶ Adaptation strategies in agriculture: changing planting strategies, improving agricultural methods,

Finally the session introduces the challenges to adaptation with particular emphasis on adaptation gaps and barriers.

THEME 3

FORESTS AND CLIMATE CHANGE MITIGATION

Theme overview

Forests have considerable potential to sequester carbon. This can be achieved through afforestation, reforestation, forest restoration and changes to forest management practices; as well as substitution of forest products for fossil fuels or products that require fossil fuels in their production. The contribution of forests to climate change mitigation is also through the decision to adopt the approach on Reducing emissions from Deforestation and forest Degradation (REDD+) at COP16 of UNFCCC. REDD+ includes policy approaches and positive incentives on issues relating to reducing emissions from deforestation and forest degradation in developing countries; and recognizes the contribution of conservation, sustainable management of forests and enhancement of forest carbon stocks in achieving the REDD+ objectives. This theme focuses on the contribution of forests to climate change mitigation. It has four sessions covering definition and concept of mitigation of climate change, forest based mitigation strategies, basics of the clean development mechanism (CDM) and REDD+, as well as non-forest based mitigation strategies.

SESSION 1: DEFINITIONS AND CONCEPTS OF MITIGATION OF CLIMATE CHANGE

This session introduces the concept of climate change mitigation and explores national strategies and actions aimed at climate change mitigation and the inter-

relationships between adaptation and mitigation. In particular it covers:

- ▶ Definitions of mitigation in the context of climate change;
- ▶ Understanding mitigation options for climate change;
- ▶ GHG sources and sinks;
- ▶ Linking mitigation and adaptation;
- ▶ Inter-relationships between adaptation and mitigation;
- ▶ National strategies or actions to mitigate climate change,

SESSION 2: FORESTS BASED MITIGATION STRATEGIES

Forests contribute to climate change protection through carbon sequestration. They also offer economic, environmental, and socio-cultural benefits. In this regard, a key opportunity in tropical forest regions is the reduction of carbon emissions from deforestation and degradation. This session explores the various forest-based strategies for climate change mitigation and how they can be implemented under different conditions. It covers the following areas:

- ▶ Concept and definition of carbon sequestration;
- ▶ Role of forests in climate change mitigation;
- ▶ Managing forests for climate change mitigation;
- ▶ Legislation and policies on climate change mitigation;

- ▶ Forest based climate change mitigation strategies
 - ▶ Reservation and conservation of forests;
 - ▶ Sustainable forest management
 - ▶ Agroforestry and on-farm tree planting ;
 - ▶ Afforestation and reforestation
 - ▶ Urban forestry.
- ▶ Non forest based climate change mitigation strategies
 - ▶ Community participation in forest-based mitigation;
 - ▶ Appraisal of forest based mitigation options;
 - ▶ Non-extractive use of forests (e.g. ecotourism, beekeeping);
 - ▶ Substituting increasing use of forest-based products such as bio-energy and durable wood products with less eco-efficient materials;
 - ▶ Using fuels such as bio-diesel made from wood products.
- ▶ Nationally Appropriate Mitigation Actions (NAMAs) and other experiences related to forests;
- ▶ Co-benefits of forest-based mitigation.

SESSION 3: BASICS OF CLEAN DEVELOPMENT MECHANISMS AND REDD+

This session focuses on the fundamentals of CDM and REDD+ as forest-based mechanisms for mitigating climate change. It builds an understanding of the evolution of the CDM and REDD, implementation processes, the

difference between RED, REDD, and REDD+, economic benefits from the mechanisms, and governance issues associated with the mechanisms.

SESSION 4: NON-FOREST CLIMATE CHANGE MITIGATION STRATEGIES

There are measures outside the forestry sector that can contribute significantly to climate change mitigation. For example, the agriculture and other land use sectors can make significant contributions to the mitigation of climate change and the reduction of greenhouse gas emissions. This session briefly introduces the following alternative mitigation strategies.

- ▶ Sectoral mitigation measures
 - ▶ Mitigation strategies in agriculture:
 - ▶ Climate-friendly agricultural practices;
 - ▶ Minimizing the need for chemical fertilizers;
 - ▶ Managing livestock systems to reduce methane emissions;
 - ▶ Low-emission farming systems - conservation agriculture, organic farming;
 - ▶ Climate-conscious consumption;
 - ▶ Use of biochar for mitigation;
 - ▶ Mitigation strategies in the transportation sector.
- ▶ Alternative livelihoods (alternative to forests) as climate change mitigation measures;
- ▶ Resource substitution as a mitigation measure (e.g. renewable energy).

THEME 4

CARBON MARKET AND TRADE

Theme overview

Carbon trade, sometimes called emissions trading, is a market-based tool to limit GHG emissions. The carbon market trades emissions under cap-and-trade schemes or with credits that pay for or offset GHG reductions. Market-based mechanisms such as emissions trading have become widely accepted as a cost-effective method for addressing climate change and other environmental issues. Dealing with environmental issues is now quickly moving out of the confines of corporate environmental departments where they have been for quite some time into the realm of corporate financial strategy. This session focuses on the fundamentals of carbon trade and marketing, paying particular attention to the following:

- ▶ Principles and concepts in carbon trade
 - ▶ Concepts of payment for environmental services (PES);
- ▶ Basic principles of economics and markets
 - ▶ The concepts of demand, supply and the market;
 - ▶ Basic concept of economic value;
 - ▶ Property rights.
- ▶ Definitions and concepts in carbon trade and marketing
 - ▶ Carbon transactions
 - ▶ Cap-and-trade schemes
 - ▶ Carbon credits
 - ▶ Financing mechanisms
- ▶ Principles and practices of carbon financing and trade (e.g. CDM, REDD+, voluntary markets);
- ▶ Payment schemes and benefit sharing;
- ▶ Regulations on carbon trade and marketing.

THEME 5

MONITORING AND EVALUATION OF FOREST BASED CLIMATE CHANGE ADAPTATION, MITIGATION AND CARBON TRADING

Monitoring and evaluation of forest based climate change adaptation, mitigation and carbon trading can help countries assess progress they are making towards climate change mitigation and to also identify which strategies work and which do not work. This theme is designed to enhance the skills of trainees in monitoring and

evaluating adaptation projects and practices. It will address the following areas:

- ▶ Purpose of monitoring;
- ▶ Purpose and types of evaluation;
- ▶ Reporting processes;
- ▶ Methods of monitoring, evaluation and reporting.

ANNEX 1

SOME BROAD RESEARCH AREAS

In the process of developing these modules the resource people in Annex 2 identified some broad research areas that could also be explored in the process of understanding better the relationship between climate change and tree and forest resources, as well as on the consequences of adverse climate change effects and how to contain them, among other issues. The broad research areas were also related to the four basic areas, viz. on basic science of climate change, forests and climate change adaptation, mitigation and carbon trading and marketing:

- 1) Basic science of climate change
 - ▶ Vulnerability of biophysical systems due to climate change; or
 - ▶ Response of biophysical systems to climate change;
 - ▶ Indigenous Technical knowledge on climate change;
 - ▶ Generation of climate data;
 - ▶ Phenological changes in natural forests.
- 2) Research needs on forests and climate change adaptation:
 - ▶ Anthropology and sociology of communities;
 - ▶ Ecosystem dynamics, hydraulic stress and temperature raise;
 - ▶ Impacts of climate change;
 - ▶ Indigenous Knowledge systems to climate change adaptation;
 - ▶ Water and climate change;
 - ▶ Identification and promotion

- of pro-poor climate change adaptation mechanisms;
- ▶ Biogeography and species distribution;
- ▶ Modelling and scenarios development;
- ▶ Policy and governance that will improve forest resilience to climate change;
- ▶ Restoration of forest degraded areas;
- ▶ Gender and forest and non-forest based climate change adaptation options;
- ▶ Non-forest based adaptation mechanisms;
- ▶ Urban forestry, greening and their contribution to climate change adaptation;
- ▶ Climate smart agriculture;
- ▶ Forest health;
- ▶ Forest protection from fire
- ▶ Land tenure

- 3) Research needs on forests and climate change mitigation:
 - ▶ GHG inventory estimates;
 - ▶ Renewable energy;
 - ▶ Sustainable forest management;
 - ▶ Tree improvement to enhance carbon stocks;
 - ▶ Identification and promotion of pro-poor climate change mitigation mechanisms;
 - ▶ Agroforestry, silviculture and afforestation;
 - ▶ Domestication and promotion of local tree species;
 - ▶ Use of fuel wood versus fossil fuel on emission;
 - ▶ Drivers of climate change;
 - ▶ Driver of deforestation and forest degradation;
 - ▶ Measurement reporting and Verification (MRVs) in the context of REDD+;
 - ▶ Gender and forest and non-forest based climate change mitigation options.

- 4) Research needs on forests and carbon market and trading:
 - ▶ Allometric models for carbon sequestration both aboveground, belowground and soils and associated carbon emissions;
 - ▶ Carbon balance in various land use;
 - ▶ Trade-offs in carbon project with other benefits;
 - ▶ Mechanisms of payment of ecosystem services (PES);
 - ▶ Spatial and temporal dynamics of carbon estimations.

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