Food and Agriculture Organization
of the United Nations

Forests and Climate Change Working Paper 16

Analysis of forests and climate change in Eastern Africa

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Food and Agriculture Organization of the United Nations
Rome, 2017

ISBN 978-92-5-109910-0

Contents

Acknowledgements

FAO wishes to express its gratitude to Professor P.K.T. Munishi, who authored this document. Input from country representatives - Léonidas Nzigiyimpa, Révocat Mukama, Kefiyalew Simegn Yimamu, Kahisay Hagos, Rurangwa Felix, Timothy Thwol Onak, Waran Patrick Taban Abdullai, Edwin Nssoko, Freddy K. Manyika, Muhammad Semambo, Charles Byaruhanga – and FAO staff Simmone Rose and Edward Kilawe helped to improve the text.

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Acronyms and abbreviations

ACCES	Climate Change Adaptation for Soil and Water Resources Conservation Project [Burundi]
ACP-FLEGT	Support Programme for African, Caribbean and Pacific countries
ACRP	Agriculture Climate Resilience Plan [United Republic of Tanzania]
ADB	African Development Bank
AF	Adaptation Fund [SCCF]
AGRA	Alliance for a Green Revolution in Africa
ANP	Akagera National Park [Rwanda]
A/R	Afforestation/reforestation
AU	African Union
BAU	business-as-usual
BINP	Bwindi Impenetrable National Park [Uganda]
BMUB	Ministry for the Environment, Nature Conservation, Building and Nuclear Safety [Germany]
Br	Ethiopia birr
CAAC	Clean Air Action Corporation
CBD	Convention on Biological Diversity
CBO	community-based organization
CCA	climate change adaptation
CCAA	Climate Change Adaptation in Africa
CCIAM	Climate Change, Impacts, Adaptation and Mitigation [United Republic of Tanzania]
CCX	Chicago Climate Exchange
CDM	Clean Development Mechanism
CO_2	carbon dioxide
CRGE	Climate-Resilient Green Economy [Ethiopia]
CSA	climate-smart-agriculture
DHS	Demographic and Health Survey [Uganda]
DPM	Disaster Preparedness and Management Policy [Uganda]
DRM	disaster risk management
DSIP	Development Strategy and Investment Plan [Uganda]
EbA	Ecosystem-based Adaptation
EC	Environment Council [Ethiopia]
EDPRS	Economic Development and Poverty Reduction Strategy [Rwanda]
EDRI	Ethiopian Development Research Institute
EMA	Environmental Management Act [United Republic of Tanzania]
ENR	Environment and Natural Resources [Rwanda]
ENRSSP	Environment and Natural Resources Sector Strategic Plan [Rwanda]
ENSO	El Niño–Southern Oscillation
EPA	Environmental Protection Authority [Ethiopia]
EPACC	Ethiopian Programme of Adaptation to Climate Change
EU	European Union
F Bu	Burundi franc
FCPF	Forest Carbon Partnership Facility
FEWS NET	Famine Early Warning Network
FLEGT	Forest Law Enforcement, Governance and Trade
FONERWA	National Fund for Environment and Climate Change [Rwanda]
FPIC	free, prior and informed consent
FRA	Forest Resources Assessment
GCF	Green Climate Fund
GCM	Global Circulation Models
GDP	gross domestic product
GEF	Global Environment Facility
GHG	greenhouse gas [es]
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit [Germany]
GIS	Geographic Information System
GSEAE	Sectoral Group on Water, Sanitation and the Environment [Burundi]
GVEP	Global Village Energy Partnership
ha	hectare[s]

HABP	Household Asset Building Programme [Ethiopia]
HIMA	Hifadhi ya Mazingira [United Republic of Tanzania]
I4EI	Institute for Environmental Innovation
ICF	International Climate Fund
ICT	information and communications technology
IDRC	International Development Research Centre [Canada]
IGEBU	Geographic Institute of Burundi
IMC	inter-ministerial committee [Ethiopia]
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
K:TGAL	Kyoto: Think Global, Act Local
LDCF	Least Developed Countries Fund
LULC	Land Use Land Cover
LULUCF	land-use, land-use change and forestry
MAM	March–April–May
MDG-F	Millennium Development Goals Achievement Fund
MEDIWR	Ministry of Electricity, Dams, Irrigation and Water Resources [South Sudan]
MEEATU	Ministry of Water, Environment, Land Management and Urban Planning [Burundi]
MEF	Ministry of Environment and Forest [Ethiopia]
MINAGRI	Ministry of Agriculture and Animal Resources [Rwanda]
MINIRENA	Ministry of Natural Resources [Rwanda]
MNRT	Ministry of Natural Resources and Tourism [United Republic of Tanzania]
MoFED	Ministry of Finance and Economic Cooperation [Ethiopia]
MRV	Measurement, Reporting and Verification
$MtCO_2e$	metric tons of carbon dioxide equivalent
NAFA	National Forestry Authority [Rwanda]
NAIP	National Agricultural Investment Programme [Burundi]
NAMA	Nationally Appropriate Mitigation Action
NAPA	National Adaptation Programme of Action
NBSAP	National Biodiversity Strategy and Action Plan [South Sudan]
NCCF	National Climate Change Forum [Ethiopia]
NCCFP	National Climate Change Focal Point [United Republic of Tanzania]
NCCP	National Climate Change Policy [Uganda; United Republic of Tanzania]
NCCS	National Climate Change Strategy [United Republic of Tanzania]
NCCSC	National Climate Change Steering Committee [United Republic of Tanzania]
NCCTC	National Climate Change Technical Committee [United Republic of Tanzania]
NCMC	National Carbon Monitoring Centre [United Republic of Tanzania]
NDP	National Development Plan [Uganda]
NEAP	National Environment Action Plan [United Republic of Tanzania]
NEMA	National Environment Management Authority [Uganda]
NEP	National Environmental Policy [United Republic of Tanzania]
NFP	National Forest Plan [Uganda]
NGO	non-governmental organization
NLC	National Land Centre [Rwanda]
NMSA	National Meteorological Service Agency [Ethiopia]
NNP	Nyungwe National Park [Rwanda]
NP	National Park
NPDPM	National Policy on Disaster Prevention and Management [Ethiopia]
NSGRP	National Strategy for Growth and Reduction of Poverty [United Republic of Tanzania]
NWFP	non-wood forest product
OBPE	Office for the Protection of the Environment [Burundi]
ODI	Overseas Development Institute
OECD	Organisation for Economic Co-operation and Development
OGMR	Rwanda Office of Geology and Mining
OND	October–November–December
OTC	Over-The-Counter
PABVARC	Watershed Management and Climate Resilience Improvement Project [Burundi]
PASDEP	Plan for Accelerated and Sustainable Development to End Poverty [Ethiopia]
PC	Participants' Committee [FCPF]
PES	Payments for Ecosystem Services/Payments for Environmental Services

PFM	Participatory Forest Management
PIF	Policy and Investment Framework
PIN	Project Idea Note
PNE-Bu	National Water Partnership [Burundi]
PoA	Program of Activities
PRSP	Poverty Reduction Strategy Paper [Ethiopia]
RCP	Representative Concentration Pathway
REDD	Reducing Emissions from Deforestation and Forest Degradation
REDD+	Reducing Emissions from Deforestation and Forest Degradation Plus
REMA	Rwanda Environment Management Authority
RNRA	Rwanda Natural Resources Authority
R-PP	REDD+ Readiness Preparation Proposal
RF	Rwanda franc
SCCF	Special Climate Change Fund
SDPRP	Sustainable Development and Poverty Reduction [Ethiopia]
SESA	Strategic Environmental and Social Impact Assessment [United Republic of Tanzania]
SFM	Sustainable Forest Management
SLM	sustainable land management
SLMP	Sustainable Land Management Project [Ethiopia]
SPA	Strategic Priority on Adaptation
SSMS	South Sudan Meteorological Service
TAP	Technical Advisory Panel [FCPF]
TEV	total economic value
TIST	International Small Group & Tree Planting Program
TPF	traditionally protected forest
UNECA	United Nations Economic Commission for Africa
UFP	Ugandan Forestry Policy
U Sh	Uganda shilling
UMET	Ukuzaji Maendeleo Endelevu Tanzania
UNCCD	United Nations Convention to Combat Desertification
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WB	World Bank
WMA	Wildlife Management Area

Foreword

This document is part of the publication series of FAO's Forest and Climate Change Programme. The programme works: (a) to strengthen countries' capacities to mitigate and adapt to climate change through actions consistent with sustainable forest management; and (b) to promote regional cooperation and international policy development related to forests and climate change.

Forest management decisions taken now – including the planning, implementation and monitoring phases of forest management – could affect forests for many decades into the future. Thus it is important for managers to take account of how forests may respond to future climatic conditions.

Because it is difficult to predict with accuracy what the climate will be at a specific location and time in the future, forest managers need to give greater weight to risk management measures and allow greater flexibility in adjusting forest management plans and practices. Some forest managers will be in a position to capture emerging incentives for forest-based mitigation, and will change their forest management plans and practices accordingly. In assessing adaptation options, forest managers may wish to consider their relative contributions to climate change mitigation, and vice versa, then choose management options that have synergistic adaptation and mitigation benefits. Forest management decisions related to mitigation and adaptation will have to be considered within the larger context of other management objectives for the site, the changing social and economic conditions, and other values placed on forests by society.

In an effort to assist forest managers to deal with the complex issue of managing forests in a changing climate, FAO has prepared guidelines to support these managers in responding to climate change challenges and opportunities at the forest management unit level. The primary objective of the guidelines is to help forest managers identify and prioritize options for adjusting forest management plans and practices in order to respond effectively to climate change.

FAO is committed to supporting countries in Eastern Africa with the first phase of implementation of the guidelines. The pilot countries are the Republic of Burundi, the Federal Democratic Republic of Ethiopia, the Republic of Rwanda, the Republic of South Sudan, the Republic of Uganda and the United Republic of Tanzania. The support provided to these states aims to:

- assist forest managers in identifying and prioritizing changes in practices to be better able to respond effectively to climate change;
- provide an operational approach for integrating climate change consistently into forest management practices;
- strengthen cross-sectoral coordination on climate change between forestry and other relevant land-use sectors;
- build individual and institutional capacity to implement climate change adaptation and mitigation actions; and
- promote subregional dialogue for the sharing of ideas, exchange of technologies and best practices among the target countries.

FAO is working through its Regional Forestry Commissions, as well as other regional and subregional processes, to encourage regional cooperation in the area of forests and climate change.

The objective of this report is to provide a review of forests and climate change in Eastern Africa. The publication is intended to provide a point of departure for identifying and catalysing regional action to complement and enhance national efforts. It will be of interest to specialists and policy-makers in forestry and climate change in the Eastern Africa subregion as well as forest managers, students and general audiences interested in learning more about forests and climate change in the region.

Among the report's key findings is a call for the review and revision of existing climate change plans, strategies and programmes to ensure that forestry is integrated and vice versa. Integration can enhance

the development of programmes to promote improved management of forests in the context of climate change.

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1. Forest resources in the subregion

Overview of forest resources

United Republic of Tanzania

About 40 percent of the United Republic of Tanzania's 88 359 000 hectares (ha) total land area is covered by forests and woodlands[1] that provide for wildlife habitat, unique natural ecosystems and biological diversity. Water catchments amount to 1.6 million ha (FAO, 2010b). Most of the forest area is occupied by woodland (90 percent); the other forest types include montane, mangrove, acacia forests and coastal woodlands.

About 18 million ha of this total forest area have been gazetted as forest reserves, of which 4.1 million ha are managed under Participatory Forest Management (PFM) (United Republic of Tanzania, 2012b). Over 17.3 million ha, a third of the total forested land, are on village and general land,[2] with no properly defined management regime.

Uganda

Uganda's natural forests vary in structure and composition in different parts of the country. The differences are because of the altitudes at which the forests occur, soil types, drainage and past human activities. Many areas presently designated as forest reserves have a long history of human occupancy (Obua *et al*., 2010). There are 2 077 000 ha of natural forests and woodlands in Uganda, covering 24.8 percent of the land area (Obua *et al*., 2010; FAO, 2015). About 75 percent of the land is other land, of which 20.8 percent has tree cover (Table 1.1). According to FAO (2015), Uganda's forests decreased by between 2 percent and 5.5 percent (average 3.3 percent) between 1990 and 2015 (Table 1.1).

Rwanda

Rwanda is a small, mountainous, landlocked country covering 25 312 000 ha with 8.16 million people and an average population density of about 317 people per km^2; it is characterized by vast hills and mountains interspersed with valleys. Rwanda is covered with diversified ecosystems: natural ecosystems constituted by montane forests on mountains like Nyungwe (89 450 ha), Mukura (1 600 ha) and Gishwati (estimated between 20 ha and 700 ha remaining area); the Volcanoes National Park (12 720 ha); forest galleries with 163 ha; and wooded areas covering 256 300 ha (Westinga and Lasry, 2006) (Table 1.2). Rapid changes in the state and extent of Rwanda's natural resources, including forests, are giving rise to growing environmental concern. The need to manage these resources in a more sustainable way is widely acknowledged. There is a need for data on the actual forest extent, deforestation, forest structure and composition. The latest forest cover information is from 1988, based on the topographical maps of the 1970s.

Rwanda's total forest cover is estimated at 696 402 ha (29.6 percent of the total land area). Plantations cover about 413 274 ha (59 percent): the most dominant species is *Eucalyptus sp*., which covers 384 000 ha (55 percent), followed by *Pinus sp*. with a cover of 17 792 ha (2.6 percent). Natural forests cover a total area of 283 128 ha (41 percent), comprising Nyungwe National Park (NP) with 111 562 ha (39 percent), Akagera NP with 113 160 ha (40 percent), Volcanoes NP with 16 000 ha (6 percent) and Gishwati-Mukura NP with 2 684 ha (2 percent).

[1] A vegetation type with trees that are mostly deciduous, canopy coverage of <40% and up to 8 m in height, scarce shrub cover and a continuous grass layer.

[2] A land category defined by the Village Land Act as a "residual category encompassing only land that cannot be defined as village or reserved land". The Land Act defines general land as "unoccupied or unused village land".

Table 1.1: Land cover and rate of change in Uganda (1990–2015)

Type	Area ('000 ha)
Forest	2 077
Other wooded land	2 879
Other land	15 025
Total	*19 981*

Year	Forest area ('000 ha)
1990	4 751
2000	3 869
2005	3 429
2010	2 753
2015	2 077

Year	Rate of change ('000 ha/yr)
1990–2000	-88.2
2000–2010	-116.6
2010–2015	-135.2

Source: FAO, 2015.

Table 1.2: Land cover in Rwanda (2006)

Forest type	Area (ha)
Non forest	*23,252*
Bushland	*343*
Bamboo Forest	*44*
Bush Ridge	*30*
Young Forest Plantation or Coppices	*392*
Eucalyptus Forest Plantation	*306*
Humid Natural Forest	*798*
Pine Forest Plantation	*110*
Dry Natural Forest	*37*
Total	*25,312*

Source: Westinga and Larsy, 2006

Table 1.3: Forest cover in Burundi (2005)

Forest type	Area ('000 ha)
Modified natural	67
Production plantation	86
Total	*153*
Land-cover type	**Area ('000 ha)**
Total land area	2 568
Total forest area	152
Other wooded land	722

Source: FAO, 2015.

Burundi

Burundi is a landlocked, resource-poor country that depends almost entirely on subsistence agriculture. Uncontrolled cutting of trees for fuelwood, coupled with agricultural clearing and grazing lands, has resulted in the nearly complete deforestation of the country. Due to the habitat destruction, gorillas and elephants are extinct in Burundi and virtually all wildlife is threatened.

Only some 5.4 percent of Burundi's land mass is under any form of protection. In 2005 the government announced a ban on the harvesting of natural Christmas trees in an effort to slow deforestation. Since these trees are an introduced plantation species, however, the ban has had little effect on the country's biodiversity. Burundi was once home to 2 500 species of plants, 597 birds, 26 amphibians, 80 mammals and 116 reptiles.

Burundi's natural ecosystems account for 504 116 ha (17.5 percent) of the national territory, including 8.6 percent of natural forest ecosystems and 9.9 percent of aquatic ecosystems. Natural forests are represented by mountain rain forests, including the Kibira National Park (40 000 ha). Woodlands occupy 4.6 percent of the country (133 500 ha), of which 61 375 ha are plantations, 24 125 ha are communal forests and 48 000 ha are private forest plantations. The classification of Burundi's forests is shown in Table 1.3.

Ethiopia

Ethiopia's forest resources supply most of the wood products used within the country, as well as a large volume of diverse non-wood forest products (NWFPs), besides their ecological functions. Several authors and national or subnational inventory projects have carried out assessments and documented the extent of forest resources and other land uses in Ethiopia (Chaffey, 1982; Moges *et al*., 2010; FAO, 2010a). The land-use/land-cover statistics show that woody vegetation, including high forests, covers over 50 percent of the land (WBISPP, 2005).

According to the census by the Woody Biomass Inventory and Strategic Planning Project of 2004 (Kefiyalew, 2016), Ethiopia owns a total of 59.7 million ha of land covered by woody vegetation. Of this total woody vegetation, 6.8 percent is high forests, 49 percent is woodland, 44.2 percent is shrubland or bushland, and plantations cover less than 1 percent. Current statistics show that Ethiopia has 17.22 million ha of forest resources, i.e. covering 15.5 percent of the country's total area. Ethiopia has been largely dependent on goods and services obtained from its forests.

Forest cover represents about 52.86 percent (highland forests, plantations, woodlands and shrublands) of the land cover of Ethiopia (Moges *et al*., 2010) (Table 1.4). Natural forests and other woody vegetation available for wood supply in 1990 were estimated at 14 million ha; the remaining 20 million ha do not supply wood (FAO, 2015). According to the same source, the total area of natural forests was estimated at 15.114 million ha in 1990, but this figure fell to 13.7 million ha in 2000, 13 million ha in 2005, 12.3 million ha in 2010 and 12.4 million ha in 2015, a recorded decrease in forest

cover. Ethiopia lost an average of 0.8 percent of its forests between 1990 and 2015 (FAO, 2015) (Table 1.4).

Further assessments (Friis, Demissew and van Breugel, 2010) show a potential vegetation map of Ethiopia that divides its vegetation into 12 major types, 5 of which have 12 subtypes. Recent estimates (Federal Democratic Republic of Ethiopia, 2013) aggregate the 12 major types into a new aggregation map to better represent the reliable carbon stock estimates. Using the 12 vegetation types as input, these have been aggregated into 4 biomes following expert judgement though no area coverage for the biomes has been given (Table 1.5).

Table 1.4: Land cover and rate of change in Ethiopia (1990–2015)

Type	**Area (ha)**
High forests	4 073 213
Plantations	501 522
Woodlands	29 549 016
Shrublands	26 403 048
Grasslands	14 620 707
Afroalpine	245 326
Highland bamboo	31 003
Lowland bamboo	1 070 198
Swamp	810 213
Water	828 277
Bare rock, soil	15 359 409
Cultivated land	21 298 529

Year	**Forest area ('000 ha)**
1990	15 114
2000	13 705
2005	13 000
2010	12 296
2015	12 499

Year	**Rate of change ('000 ha/yr)**
1990–2000	-140.9
2000–2010	-140.9
2010–2015	-140.6

Source: Moges *et al*., 2010.

Table 1.5: Vegetation biomes of Ethiopia

Biome	Stratum name	Vegetation type
1	*Acacia-Commiphora*	*Acacia-Commiphora* woodland and bushland (ACB); acacia wooded grassland (ACB/RV); desert and semi-desert scrubland (DSS)
2	*Combretum-Terminalia*	*Combretum-Terminalia* woodland and wooded grassland (CTW); wooded grassland of the Western Gambela region (WGG)
3	Dry Afromontane	Dry evergreen Afromontane forest and grassland complex (DAF); Afroalpine vegetation (AA); ericaceous belt (EB);
4	Moist Afromontane	Moist evergreen Afromontane forest (MAF); transitional rain forest (TRF)

Source: Federal Democratic Republic of Ethiopia, 2013.

South Sudan

South Sudan is well endowed with diverse natural forests and woodlands: out of its total land area (approx. 664 000 km^2), some 208 157 km^2 (33 percent) is covered by trees and another 257 236 km^2 (40 percent) by shrubs. The combination of forest reserves, protected areas, national parks and game reserves together accounts for approximately 19 500 km^2 (9 percent) of tree cover. Natural forests and woodland formations include the following:

- closed forests which are derivatives of tropical rain forest;
- main productive forest type (estimated yield of 1.2 m^3 ha^{-1} yr^{-1}), multistoried, predominantly hardwood species (69 900 km^2) which are open forests and woodlands with tree crown cover of 10–40 percent, covering an area of 407 600 km^2;
- savannah with trees (consisting of scattered or single trees);
- shrub formations covering an area of about 42 000 km^2.

The total allowable cut from these forest types is estimated at 44.4 million m^3. The natural forests/woodlands cover approximately 191 667 km^2 and are classified as:

- low rainfall woodland savannahs (27 percent of the land area), with rainfall of 300–900 mm per annum, and mainly short thorny *Acacia spp*.; and
- the high rainfall savannah zone (14 percent of the land area), with annual rainfall of 900–1 200 mm.

Other vegetation types include:

- gallery forests that are modified tropical rain forests confined to valley bottoms and stream banks; the major tree species are *Cola cordifolia, Syzigium cordatum, Syzigium guinensis* and *Mitragyna robrustipulosa*;
- montane "vegetation-true montane", covering less than 1 percent and including montane vegetation of the Imatong Mountains and Acholi ranges (1 500 m altitude), with *Podocarpus milanjianus, Juniperus excelsa, Olea spp.* and *Arudinaria alpine* (bamboo); and
- the floodplains and grasslands (10 percent) within the rainfall belt and palms, with mixed *Acacia – Balanites; Zyziphus spp*. as major species.

There are about 17 500 forest reserves, estimated to cover 1 900 km^2. There are 68 plantations of mainly *Tectona grandis* (teak) and a few other exotic tree species, covering up to 187 900 ha.

The widest inventory in South Sudan was launched during the period 1995–1997 after completion of the energy consumption survey in 1994 (African Forest Forum, 2011). The 1995–1997 inventory

covered most of the area north of 10° north latitude, with crown cover ≥10 percent, covering 62.27 million ha – 24 percent of the total area of the country. The results were published in 1998. Some tracts of forests have been inventoried in greater detail, e.g. biomass resources east of the Nile (1991), Southern Blue Nile and Northern Bahr el Ghazal (1984), parts of Kordofan and Darfur (1990–1994) and parts of Northern Blue Nile (1994). In addition, there are regular inventories of forest reserves as a basis for management plans. According to FAO (2015), forest cover in South Sudan is 11.3 percent while that of other woodlands (uncategorized) accounts for 51.6 percent.

Trends in forest and land use in the subregion

United Republic of Tanzania

Deforestation rates in the United Republic of Tanzania are quite high: between 1990 and 2005, an estimated 412 000 ha per annum were cleared, equivalent to about 1.1 percent of the total forest area (Blomley and Iddi, 2009). The main direct causes of deforestation are clearing for agriculture, overgrazing, wildfires, charcoal-making, persistent reliance on woodfuel for energy, over-exploitation of wood resources and lack of land-use planning (Blomley and Iddi, 2009; Blomley *et al*., 2008). Reliance on woodfuel and charcoal for energy supplies has been identified as a key driver behind national rates of deforestation and degradation, and it presents a real challenge, as almost all domestic (rural and urban) energy consumption is derived from these sources (Miles and Kapos 2008) .

The population of the United Republic of Tanzania is estimated at 41 million people, with a growth rate of 2 percent per annum. The population density averages about 44 persons per km^2. However, some areas are more densely populated, with over 200 persons per km^2, e.g. Ukerewe Island, Kilimanjaro, Mwanza and Dar es Salaam. Other areas are more sparsely populated, e.g. Lindi, Rukwa, Ruvuma and Tabora regions. Some of these regions have low and unreliable rainfall and, mainly, infertile soils. Comparison of the 2010 NAFORMA Land Use Land Cover (LULC) map with the 1995 LULC produces an estimate of forest cover loss of 372 816 ha per annum. The Forest Resources Assessment (FRA) 2015 (FAO, 2015) reported a forest loss of 372 ha per annum for the period 2010-2015. This means that the forest area has decreased from 3 ha/capita in the early 1980s to 1.1 ha/capita, using the 2012 population census data. In addition, the remaining forests are more degraded than they were in the early 1980s (United Republic of Tanzania, 2012b). It has been estimated that forests and woodlands cover 38.3 percent of the land area, followed by cultivated land which covers 36.3 percent of the land area. Bushland and thickets cover 14.5 percent of the land area while other classes cover the remaining 11 percent. The rate of deforestation in the United Republic of Tanzania has been estimated at 403 870 ha per annum for the period 1984–1995 and 372 816 ha per annum for the period 1995–2010. For the other wooded land, it was 328 643 ha per annum (1984–1995) and 248 871 ha per annum (1995–2010). For other land, it was 732 513 ha per annum and 621687 ha per annum for the same time periods (United Republic of Tanzania , 2012b) .

Uganda

The major direct drivers of forest and/or vegetation loss in Uganda have been identified as: agricultural expansion in forested land; charcoal production; firewood harvesting; livestock grazing; timber production; human settlement; and urbanization. Indirect drivers include: an increasing agrarian population; socio-economic dynamics; increased demand for forestry resources (with few alternatives or substitutes); and a weak extension system (Kissinger *et al*., 2012). Recent assessments show that the forest cover decreased from 4 880 484 ha (24 per cent of land cover) in 1990 to 1 829 779 ha (9 percent of land cover) in 2015 (Byaruhanga and Muhammed, 2016). According to FAO (2015), Uganda lost 3.3 percent of its forest cover between 1990 and 2015.

Rwanda

According to FAO (2010), 17.6 percent, or about 435 000 ha, of Rwanda are forested. Of this, 1.6 percent (7 000 ha) is classified as primary forest, the most biodiverse and carbon-dense form of forest. Rwanda had 373 000 ha of planted forests. Between 1990 and 2010, it lost an average of 5 850 ha (1.84 percent) per annum. FAO (2015) reports that between 1990 and 2015, Rwanda gained 1.7 percent of its forest cover, or around 6.5 ha annually (Rurangwa and Nduwamungu, 2016).

Burundi

About 5.9 percent (152 000 ha) of Burundi is forested. Of this, none is classified as primary forest, the most biodiverse form of forest. Between 1990 and 2000, Burundi lost an average of 9,100 ha of forest per annum. This amounts to an average annual deforestation rate of 3.15 percent. Between 2000 and 2005, the rate of forest change increased by 47.6 percent to 4.65 percent per annum . In total, between 1990 and 2005, Burundi lost 47.4 percent of its forest cover, or around 137 000 ha. Measuring the total rate of habitat conversion (defined as change in forest area plus change in woodland area minus net plantation expansion) for the 1990–2005 intervals, Burundi lost 22.1 percent of its forest and woodland habitat (Mongabay, 2016).

According to FAO (2015), forested areas in Burundi amounted to 7.15 percent in 2005, 0.63 percent in 2010 and 11.6 percent in 2015. The total forest area was 181 ha in 2005; it increased to 253 ha in 2010 and 276 ha in 2015. There was a decrease in forest area of 17 ha prior to 2005, but an increase of 72 ha in 2010 and 23 ha in 2015. The natural forest area increased by 37 ha between 2005 and 2010, and by 16 ha between 2010 and 2015. Primary forest area was constant at 40 ha over the period up to 2015, while planted forest area was 78 ha in 2005, 113 ha in 2010 and 120 ha in 2015. Recent estimates indicate that Burundi lost its forests at a rate of 3.7 percent between 1990 and 2000, while it gained forests at a rate of 2.5 percent between 2000 and 2010, and 1.8 percent between 2010 and 2015 (FAO, 2015).

Ethiopia

The major cause of deforestation in Ethiopia is the rapid population growth, which leads to an increase in the demand for crop and grazing land, and wood for fuel and construction. New settlements in forests are increasing and have resulted in the conversion of forested land into agricultural and other land-use systems.

The major direct driver of deforestation in Ethiopia is the expansion of traditional smallholder agriculture in forest areas, driven by population growth of the communities around forests (with a large impact). Other drivers are: the increased extraction of wood and other forest products following massive population growth and the resultant high domestic energy demand (with medium impact); and forest fires related to raising livestock (pasture improvement activities) and charcoal-making, due to: (a) poor incentives provided to local communities for sustainable forest use; and (b) weak forest protection (medium impact).

According to FAO (2015), the area of tree cover in Ethiopia in the year 2000 was 12.0 million ha; the gross tree cover loss between 2001 and 2014 averaged 21 115 ha per annum, but there was a net gain in forest area over this period. FAO (2015) estimates show that Ethiopia lost 0.8 percent of its forests between 1990 and 2015.

South Sudan

According to FAO (2015), it is clear that there is still inadequate information on trends in forest cover in the area. The forest area and other wooded lands seem to have remained constant over time which is unlikely. Global Forest Watch (2016) estimates that, in the year 2000, the area of tree cover in South Sudan was 7.16 million ha, and average loss of tree cover was 7 272 ha per annum. FAO (2015) estimates no loss in forest cover between 1990 and 2015 in South Sudan. Other estimates (Republic of South Sudan, 2016) show that the country is well endowed with diverse natural forests and woodlots: of the total land area of approximately 664 000 km^2, some 208 157 km^2 (33 percent) is covered by trees, and another 257 236 km^2 (40 percent) by shrubs. The combination of forest reserves, protected areas, national parks and game reserves covers approximately 19 500 km^2, or about 9 per cent of total tree cover.

Key demographic developments and implications for land and resource use

United Republic of Tanzania

According to the latest census (2012), the population of the United Republic of Tanzania had almost tripled since 1967 (the first post-independence census). At a growth rate of 2.7 percent per annum, the national average population growth rate ranks as one of the fastest in the world and translates to a net total of about 1.2 million people being added to the population annually. At this rate, the United Republic of Tanzania's population is projected to reach 70.1 million by 2025 (Agwanda and Aman, 2014). This high growth rate is driven by a persistently high level of fertility, reduced mortality and low international net migration. The past and current population growth rate has resulted in an unprecedented large youth population entering the labour market. The increase in youth population offers opportunities as well as challenges, however. To take advantage of this ever-increasing youth population, there is a need for appropriate policies and programmes to harness their potential. On the other hand, people aged 60 and above (though representing a much lower proportion of the population) are also increasing in large numbers: that means that attention must be paid to their welfare, particularly health.

In many rural areas of the United Republic of Tanzania, the increase in population has contributed to changes in land-use/-cover patterns, land fragmentation and livelihood insecurity (Kangalawe and Lyimo, 2010). The increasing demand for food, energy and other environmental services has contributed to the expansion of agriculture and to deforestation, often leading to environmental degradation. The high urban demand for food and biomass energy from rural areas has also contributed to rural deforestation and overall environmental degradation.

If the current rate of population increase is maintained until 2025, the renewable water resources per capita will be 1 405.3 m^3 (which is below the threshold of 1 667 m^3), while available cropland per capita will be about 0.16 ha (below the threshold level of 0.21 ha). This will have a significant bearing on the state of natural resources, especially forests, as the demand for products from forest resources increases. The implications of population increase in the United Republic of Tanzania are manyfold. First, as populations grow, energy use increases. Second, as wealth grows, energy use per capita also increases. Given the fact that over 90 percent of the United Republic of Tanzania's rural population depends on biomass energy in terms of firewood and/or charcoal, the increasing population is likely to increase the pressure on forest resources, with consequent increases in deforestation and forest degradation.

Uganda

According to the 2002 census, Uganda's population was 24.7 million. The total fertility rate (the number of children that, given current age-specific birth rates, a woman will have in her lifetime), as estimated by the Demographic and Health Survey (DHS), stood at 6.9. This figure was largely unchanged over the previous ten years and was much higher than in neighbouring countries (e.g. Kenya: 4.7; United Republic of Tanzania: 5.6.). Consequently, the population growth rate was about 3.4 percent per annum between 1991 and 2002, which puts Uganda among the countries with the highest population growth rates in the world. According to the demographic projections from the United Nations Population Division - based on the medium (and thus most probable) variant of the 2002 revision - Uganda's population is expected to reach 103.2 million by 2050. This projection is based on a considerable fertility decline from the present rate of about 7.0 to only 2.9 in 2045–2050. Whether this will be achieved is far from certain and will probably depend on overall economic development in the coming decades, as well as government efforts to support a fertility decline. But even with this considerable decline, population growth will still be over 2 percent per annum in 2045–2050 and Uganda's population is projected to stabilize at some 200 million only in the twenty-second century (Klasen and Lawson, 2007).

The major drivers of deforestation in Uganda are: agricultural expansion in forested land, charcoal production, firewood harvesting, livestock grazing, timber production, human settlement and

urbanization. Other factors leading to deforestation and forest degradation are: an increasing agrarian population, socio-economic dynamics, increased demand for forestry resources, with few alternatives or substitutes, and a weak extension system (Kissinger *et al*., 2012). It has been observed that the change in agricultural land share is affected by the land-tenure regime. Customary tenure is positively related (in comparison to public land) to agricultural land conversion (Place and Otsuka, 2000). Population variables are extremely important in explaining changes in land use. Increased agricultural land share has been linked to higher population growth and higher population density, the latter at a non-linear decreasing rate. This can be attributed to both increased benefits from, and lower costs of, conversion. The effect of population density shows that, at low levels, the change in share of agricultural land is high as families clear large areas for their farms. As the population increases, the land frontier diminishes and, eventually, new families must find land from within existing agricultural areas.

Rwanda

Historically, Rwandan farmers settled along the upper ridges of hills where soils are fertile. Rapid population growth has resulted in decreasing per capita land holdings, land fragmentation, extended cultivation in bottomlands and fragile ecosystems, with fallow periods becoming shorter. The consequence of all this transformation is declining land capability and land degradation (Clay *et al*., 1998). Rwanda is a land-locked, densely populated country, with over 67 percent of the population aged under 20.

Statistics from Rwanda's Forest Department show that forests were estimated to cover 659 000 ha in 1960 but have declined by approximately 64 percent between 1960 and 2007, which is more than 1.3 percent per annum (Republic of Rwanda, 2007). The main threat to forests comes from the rapid increase in population, which is leading to forest encroachment and deforestation, mainly as people search for settlement, agriculture and grazing land. Other threats include illegal logging, charcoal production and bush fires. Human activities likely to threaten the forests identified during the 2007 national forest inventory included illegal tree cutting (78.3 percent), charcoal-making (4.9 percent), livestock grazing (2.5 percent), farming activities (1.9 percent), bush fires (1.9 percent), stem debarking (0.6 percent), mining (0.5 percent) and beekeeping (0.4 percent) (MINITERE-ISAR, 2007).

The Volcanoes National Park has been under constant direct and/or indirect farming pressure because of the population increase due to the fertile volcanic soils in its immediate vicinity. In 1958, 700 ha were cleared to settle the population; and between 1969 and 1973, 1 050 ha were converted into agricultural lands to grow pyrethrum (ORTPN, 2004). In 1997 the government decided to reduce the Akagera National Park to an area of 108 500 ha, or approximately a third of its original area, to settle returnees in the aftermath of the 1994 genocide. About 100 km^2 of Gishwati Forest were converted to pasture. The area of the Mukura was reduced from about 2 100 ha in 1990 to 1 600 ha in 2006 (Munanura *et al*., 2006) due to the encroachment for agriculture (influenced by the installation of a refugee camp in its immediate vicinity) but also for livestock pastures.

Ethiopia

Population dynamics has been a major driver of land-cover change, including forest loss, in Ethiopia. The population is estimated to be growing at a rate of 2.92 percent per annum on a fixed land area of 1.1 million km^2, characterized by subsistence agriculture and extremely high population growth in the face of declining agricultural productivity. According to the 1984 census, the population of Ethiopia was 42.2 million, and it was growing at a rate of 2.95 percent per annum. By mid-1990, the population was estimated at 50.6 million of whom about 89 percent lived in rural areas. In 1994 the population stood at 53.5 million. By 1999 it had grown to 61.7 million of whom 85 percent were rural and 15 percent were urban. Based on the projection reported in Bekele 2001, the population is expected to increase to 102 million by 2020. The high population growth is driven by a high fertility rate of about 6 children per woman per annum.

The same report indicated that the annual population growth rate rose from 2.18 percent (1955–1960) to 2.43 percent (1975–1980) and to 2.45 percent (1995–2000). It is expected to grow to 2.49 percent between 2015 and 2020. In addition, the current population density of 57 persons per km^2 is expected to increase to 93 persons per km^2 by the year 2020. The rural population alone is expected to reach over 84 million from the current 54 million. Similarly, the urban population is expected to increase to 34.4 million from the current population of 11.6 million. The structure reflects a high dependency ratio, with about 45.4 percent of the total population under the age of 15, and 3.2 percent aged 65 and above (NMSA, 2001).

According to projections, the population will have reached above 90 million in 2015, which makes Ethiopia the most populous nation in Eastern Africa and the second-most populous in Africa after Nigeria. With the current annual population growth of over 2 percent, Ethiopia will have more than 120 million people by 2030 (Kefiyalew *et. al*., 2016). Over the past 50 years, poor rural families have not received sufficient social security support and have therefore turned to various other kinds of social security net surrogates, including:

- large families, which provide sufficient household labour for the family's livelihood;
- family support during difficult times in villages and town communities; and
- exploitable forests, which may provide many goods and services free of charge, such as wood energy, construction wood, food and fodder, new farm and housing land and drinking water.

Ethiopia today has approximately 10.2 million households, with about 5.2 persons per household. Urban households are smaller than rural households, with a high dependency on agriculture. If all other factors stay unchanged, the remaining forest land is likely to be converted to agricultural land. The increase in both human and livestock population has led to decreased holdings of arable land. Arable land per capita has declined significantly. In 1994/95, about 61 percent of farming households cultivated less than 1 ha of land. Only 1 percent of the farmers own holdings greater than 5 ha and these are likely to be concentrated in the sparsely populated areas with low agricultural potential.

The increase in both the rural and the urban population means that there will be more pressure on forest and agricultural lands. This also means an increased demand for forest products. As a result, deforestation will continue and all the positive functions of forests will disappear. The increase in urbanization also calls for more wood for construction. Unless appropriate forest policy and existing environmental policy are in place and effective, this trend will continue unabated.

Burundi

At the root of Burundi's environmental threats is one of the highest population densities in Africa: approximately 420 persons per km^2 of arable land (Hobbs and Knausenberger, 2003). Land pressure has led individuals to cultivate on hillsides, where soils are shallow, low in fertility, and easily affected by erosion. Cultivation is also spreading to low-lying wetlands, where constructed drainage systems, accompanied by siltation from surrounding hillsides, are destroying many of these ecologically valuable areas. Additionally, much of the original forest cover has been cleared due to the intensification of agriculture as well as timber and fuelwood harvesting. Little of Burundi's native fauna or flora remains today; species such as elephants and gorillas have become locally extinct. What habitats and natural flora do remain can be found largely in the national parks of Kibira and Ruvubu, and possibly in some pockets of forest reserves scattered throughout the country and which have not benefited from continuous or effective management over the last decade.

In this context, the major threats to land and tropical forest resources in Burundi include (but are not limited to) land clearing for cultivation. Increasing human pressure has been the greatest cause of deforestation in Burundi. Some of the clearing has been the result of subsistence farmers encroaching on the borders of forest reserves. Large-scale clearing for tea and coffee plantations has also contributed to the disappearance of Burundi's natural forests, particularly in the Kibira National Park. Bamboo has been particularly targeted in Kibira, as it is used to weave baskets for tea harvesting.

Small-scale land clearing has re-emerged as a major issue during the 1990s as a result of the return of displaced persons who require land for cultivation.

The other causes of forest loss are:

- fuelwood harvesting (as throughout much of Africa, the principal energy source for cooking and heating is fuelwood collected or felled from neighbouring forests); and
- civil unrest (the most recent period of civil war, beginning in 1993, has involved the widespread destruction of both natural and planted forests).

Forests have been utilized to provide fuelwood for refugee populations, rebel groups and the military. The targeted destruction of private and state domain forests has also occurred (Hobbs and Knausenberger, 2003), with an estimated loss of 30 641 ha of wooded areas and 2 000 ha of coffee plantations, but little impact on National Parks such as the Kibira National Park/protected areas. Despite the relative lack of forest cover and poor infrastructure (which limits the profitability of the timber business), the extraction of valuable timber species such as *Podocarpus milanjianus*, *Prunus africana* and *Hagenia abyssinica* has been reported (Hobbs and Knausenberger, 2003).

The main human activities in protected areas of Burundi include logging (accounting for 80 percent of human activities), tree harvesting (13.3 percent) and cultivation (6.6 percent). The most affected species due to tree harvesting were *Borassus aethiopuim*, *Phoenix reclinata* and *Hyphaene compressa*, while the most preferred tree species for construction of canoes and beehives were *Diospyros kabuyeana*, *Ficus sycomorus*, *Mimusops fruticosa* and *Mangifera indica* (Remegie and Yansheng, 2008).

South Sudan

Extraction of forest products is usually for subsistence and local and regional markets (fuelwood and charcoal, forest grazing) and may include industrial/commercial extraction of forest products such as selective logging, commercial agriculture, clearing for cattle ranching, row crops, subsistence agriculture, smallholder farming and shifting cultivation. FRA (2015) estimates no loss of forests in South Sudan for the period 1990–2015. The rate of forestation is determined by the national and foreign demand for tree products. It is likely that deforestation (without a significant improvement in protection) increases at least proportionally with the number of national consumers, but probably much faster due to accelerated deforestation for the reasons explained in the following sections.

The number of consumers increases as a result of immigration, natural population growth and the extension of the market (e.g. to Kenya, Uganda and Sudan) due to the reduction of transport barriers. Several factors play an important role in deforestation, including clearing for cultivation: the average small-scale farming household uses between 0.4 ha and 1 ha of land, and it is expected that the cultivated area will increase proportionally with the increasing population and, in the longer term (when agricultural mechanization becomes more common), even more. Since the improvement in the security situation, mechanized agriculture has expanded in all parts of South Sudan (Republic of South Sudan, 2015b). A recent survey of land-based investments (Deng, 2011) indicates that, from 2007 to 2010, foreign companies, governments and individuals sought or acquired at least 2.64 million ha (26 400 km^2) of land for projects in the agriculture, biofuel and forestry sectors in South Sudan. In order to create space for roads, settlements and other social and economic infrastructure, forested areas are often cleared. The area cleared is usually larger than the area occupied by the structures themselves. Continuous use of forest products by people and passing livestock results in an impact gradient in a wide zone along and around such areas, which may stretch over a distance of up to 5 km or more away from roads and settlements (Deodatus and Toko, 1998). Charcoal burning (the main fuel used in urban centres) is among the major activities for income generation by many returnees. Because no licence is needed, and only simple tools are required, the forest belongs "to nobody". As the production of charcoal requires large quantities of wood, it probably contributes significantly to deforestation.

Others factors leading to deforestation include:

- brick-making, estimated as using an average of 18 truckloads of firewood per annum;
- construction wood, the demand for which has increased due to the building of new settlements;
- livestock grazing/browsing, which removes seedlings, eliminating the capacity of the forest to regenerate; and
- fire, which destroy seeds, tree seedlings, rhizomes of perennial grasses and organic contents of the soil, resulting in loss of tree regrowth and perennial grasses.

Key forest products (timber and non-timber), economic value and contribution of the forest sector to GDP

United Republic of Tanzania

The major forest products obtainable from forests in the United Republic of Tanzania include timber, construction materials and non-wood forest products (NWFPs) (including medicinal plants, mushrooms and honey, charcoal and fuelwood) (DPG, 2012). The value of the country's forests is high due to the potential for royalty collection, exports and tourism earnings, as well as the recycling and fixing of CO_2, the provision of other ecosystem services such as water and the conservation of globally important biodiversity. The total annual economic value of forest goods alone is equivalent to 11 percent of GDP (based on 2006 estimates) while the total annual value of goods and services of forests is equivalent to 20.1 percent of GDP (United Republic of Tanzania, 2008a). It has been estimated that the potential value of catchment forests in the United Republic of Tanzania is around $620 million,[3] while the "actual" value is estimated to be some $496 million.

Forest products contribute 10–15 percent of the country's registered export earnings. Forests provide 95 percent of the country's energy supply through fuelwood and charcoal, with the amount of unaccounted woodfuels being estimated at over 30 million m^3 per annum. Approximately 75 percent of construction materials used in the country come directly from forests – construction was the second fastest growing sector (after mining) in the national economy in 2003. Forests are key to livelihoods in the United Republic of Tanzania, providing 100 percent of indigenous medicinal and supplementary food products, especially to poor rural family households. In terms of usage, various estimates have indicated that fuelwood extraction represents the largest use of forest products, estimated at an average of over 60 percent (UNEP, 2012).

According to MNRT (2008), the combined annual value of forest goods and services is $2.2 billion, equivalent to 20.1 percent of GDP based on 2006 prices. The charcoal industry in 2002 alone is estimated to have utilized 21.2 million m^3 of wood (equivalent to 624,500 ha of woodland), providing 43.7 million bags of charcoal to 6.8 million mainly urban consumers. The annual net value of this charcoal trade was $4.8 million.

The United Republic of Tanzania has a huge potential for NWFPs. The most important are tourism, game, bee products (especially honey and beeswax), tannins and gum arabic. The bulk of the non-wood products however, remain undeveloped. The management and utilization of these resources could be developed through multipurpose forest management, local processing and improved marketing. At community level, coastal forests are important for a variety of uses. The most frequently reported uses of these forests are firewood, charcoal, pit sawing, timber and poles for house construction, and furniture-making (Dallu, 2004).

It has been observed that forests supply a variety of wood products and NWFPs; provide employment; are a source of revenue through the sale of wood products, NWFPs and services; conserve soils; mitigate climate through sequestering carbon; are a source of water for domestic and industrial use, irrigation for agriculture and power generation; and have aesthetic, recreational, cultural, spiritual and

[3] United States dollars are used throughout this publication.

scientific value. Forests contribute to agricultural stability by protecting the soil. They also contribute to poverty reduction. The majority of the rural communities depend heavily on forest products for their livelihoods. A study by Monela *et al*. (2000), as reported by MNRT (2008), concluded that sampled households in Dodoma and Morogoro regions derived more than 50 percent of their cash income from the sale of forest products, such as charcoal, honey, wild fruits and firewood, with the peri-urban households deriving almost 70 percent of their cash income from woodlands. However, not many households have the capacity to take advantage of forest-based income-generating activities. The results indicated that income generation from forests is supplementing farm incomes. Since the early 1990s, there has been a reduction in government spending in terms of extension services and subsidies on farm inputs. Increasing agricultural production costs in relation to product prices, and rising living costs in general, have forced people to exploit forests more intensely, particularly on the general lands, to generate a cash income. Milledge *et al*. (2007) report that forests support the livelihoods of 87 percent of the rural poor.

Uganda

Forests are of immense importance to Ugandans. The major forest products from Ugandan forests include timber, NWFPs, charcoal, fuelwood, fibre, medicinal plants and gum arabic, among others. They form a major part of rural incomes and energy sources (Shepherd, 2012). According to the National Environment Management Authority (NEMA, 2006/07), fuelwood (consisting of firewood and charcoal) is by far the most important product from Uganda's forests. About 90 percent of the energy consumed in Uganda is obtained from fuelwood (Republic of Uganda, 2005). Moreover, the most significant growth in forest products consumption was fuelwood (firewood and charcoal) used in residences for household cooking. The other products derived from the forests include poles, sawn wood, and fuelwood for commercial use. Forests and savannah woodlands supply well over 90 percent of Uganda's energy requirements in the form of charcoal and fuelwood (Moyini, 2013). It is expected that woodfuel will continue to be the dominant source of energy in Uganda for the foreseeable future, supplying at least 75 percent of total energy consumption by 2015. Other key features are the following:

- Wood is the main source of energy in rural areas and among the poor.
- The extraction and supply of firewood is an income and employment generator.
- The use of firewood is vital for food security.
- Wood is widely used in many industrial processes.
- Firewood and charcoal are important in households.
- The fact that the majority of institutions and commercial establishments use firewood and charcoal saves on imported fossil fuels.

Poles are needed for buildings, fencing, and power and telephone lines. There is a growing demand for poles and with the ongoing expansion of electrification, this demand is likely to increase. Recent estimates suggest that poles are worth 66 billion Uganda shillings (U Sh) per annum. The local use of NWFPs has been estimated as worth between U Sh30 000 and U Sh130 000 per household per annum. Gum Arabic is harvested from acacia trees in northeastern Uganda. By 1974, 4 000 kg were being harvested annually. But this production has now ceased due to civil unrest. In the early 1990s, the domestic requirement was 5–8 tonnes per annum. There is an average yield of 85–120 kg/ha. Hundreds of different types of medicines are collected from natural forests. Shea butter is an important multiple-use product for people in northern Uganda for oil and medicinal purposes. The main product is shea butter oil: in 2000 it fetched between U Sh2 000 and U Sh5 000 per litre. Neem, another important multiple-product tree introduced into Uganda, is becoming popular in the treatment of common ailments such as malaria, skin diseases and AIDS-related opportunistic diseases; a litre of Neem oil sells for up to U Sh60 000. Bushmeat, a significant, but unrecorded item, generates substantial incomes for local communities and can total as much as U Sh1 million in a single year. Rattan is of considerable socio-economic importance. Many artisans are involved in craft-making. There are over 300 rattan-based enterprises in the country. Bamboo, found in high mountain areas, is reported to realize net monthly incomes of between U Sh40 000 and U Sh50 000 per collector.

The NFA report of 2008 indicates that in 2004, the total economic value of Uganda's forests, including all marketable and non-marketable values, was estimated at U Sh593.24 billion ($304 million at the exchange rate of $1 = U Sh1 920), equivalent to about 5.2 percent of GDP. Forests and trees contribute U Sh332.3 billion ($173 million) to the total annual incomes of households in Uganda. The Forest Sector Review Report (Ministry of Water, Lands and Environment, 2001) indicates that wood and non-wood products removed from the forest for subsistence use amount to about U Sh210 billion ($109 million), or 2.75 percent of GDP. Thus, the overall contribution of forests is about 6 percent of GDP.

The average annual household income from the different forest types in Uganda has been estimated to range between 8 percent and 35 percent. The total economic value (TEV), including all marketable and non-marketable values of Uganda's forests, is approximately U Sh593.24 billion, roughly equivalent to 5.2 percent in GDP terms. The months of most frequent forest use overall correspond with the long dry season over much of Uganda. This provides strong evidence regarding the role of forests in reducing vulnerability and providing a buffer against seasonal shocks (Bush *et al.*, 2004).

Rwanda

Rwanda's population relies heavily on its forest resources for woodfuel and charcoal, and for sawn wood due to its rapidly developing economy and the construction boom in the country (Republic of Rwanda, 2010a).

Natural ecosystems and their biodiversity, including natural capital, contribute substantially to Rwandan economic prosperity.[4] While there is now a good understanding of the linkages between biodiversity, ecosystem services and human well-being, the value of biodiversity is still not reflected in broader policies and incentive structures. Little is known about the economic cost of biodiversity loss as well as the benefits associated with its utilization and ecosystem services. Rwanda has key assets such as protected areas like national parks and reserves, and sites of scenic and scientific importance, which can all be used to further support tourism efforts.

Forestry is the provider of multiple tangible and intangible goods and services in Rwanda. The products and benefits can be grouped into three categories:

- timber products such as fuelwood, timber, pulp wood and bamboo material;
- NWFPs such as essential oils, tannins, resins, gums, drugs, spices, insecticides, soap substitutes, dyes, cork and honey; and
- services such as biodiversity conservation, carbon sequestration and oxygen supply replenishment, microclimate modification, soil fertility improvement, soil conservation, recreation (aesthetic) value; and
- the provision of employment in forestry and related activities like tree planting.

It has been estimated that forestry in Rwanda accounts for more than 10 percent of GDP (FAO, 1995).

NWFPs in Rwanda are commonly found in the following categories: plants used in traditional human and veterinary medicine, fodder, honey and melliferous plants, fruits, tree seeds, essential oils, handicraft materials, mushrooms, ornamental plants, game and fish, and ecotourism. The literature shows 59 woody plants used in traditional human medicine and 39 woody plants used in traditional veterinary medicine, as well as related diseases in both cases (Murekezi, 1999).

Tourism development in Rwanda has often been concentrated in and around protected areas that include forests. The tourism industry accounts for a significant portion of foreign revenue. Estimates of tourism revenue in 2007 and 2008 make up almost as much as the entire export base – $209 million in 2008 compared to $262 million for official exports. Local investment in tourism was also

[4] See nbsapforum.net/uploads

significant, with 140 billion Rwanda francs (RF), or 16 percent of total local investment between 2000 and 2009, going to hotels, restaurants and tourism. Again, the contribution of this sector to investment, totalling approximately $700 million over a ten-year period, demonstrates the major role the tourism industry is now playing in the Rwandan economy (MINICOM, 2013). There has been a substantial increase in revenue associated with the increase in tourism activities.

Burundi

Forests in Burundi make a significant contribution to the economy, and the country's forest resources provide a number of benefits to the local population. It is estimated that Burundi's forests contributed about 6.8 percent and 16.8 percent of GDP in 1970 and 2015, respectively (World Bank, 2015).

Observations show that plant species are used for medicinal purposes, food, energy and culture. There are several species with multiple uses and leaves (26.7 percent) and stems (28 percent) are the most collected plant parts. Edible mushrooms, honey and termites are also collected. Forests play a significant role by allowing the local populations to diversify their sources of income (various products marketed along the roads and in the urban centres), their food and, in particular, their popular medicine (Hakizimana *et al*., 2011).

Ethiopia

Local people depend on Ethiopia's forests as a source of fuelwood and construction materials. They also obtain wood for furniture, farm tools and household equipment from the forest. The only sources of water for all the people and animals are the streams and ponds whose water quality is maintained by the forests. There are neither water pipes nor ground wells used by the people. With the exception of chickens, all animals depend on the forest for grazing, especially during the dry period of the year, when other feed and fodder sources become scarce. Some of the plants in the forest provide edible parts. Among these are species of *Ficus*, *Rubus* and *Rhus*, as well as *Rosa abyssinica* R. Br., *Carissa edulis* (Forssk.) Vahl, *Dovyalis abyssinica* (A. Rich.) and other non-edible but socio-economically important tree species such as *Warburgia ugandensis*, *Podocarpus gracilior*, *Olea africana* and *Olea hochstetteri* (providing oil from seeds). *Hagenia abyssinica* (Bruce), Gmel., *Myrsine africana* L., *Ekebergia capensis* Sparr., *Croton macrostachyus* Hochst., *Calpurnia aurea* (Ait.) Benth., and some parasitic plants, are a few examples of the plants used in traditional medicine by the local people.

Forest fragments in southwestern Ethiopia have been seen to deliver a variety of ecosystem services, including species diversity and richness, fuelwood, lianas, wild fruits and vegetables, and marketed ecosystem services – honey, wild coffee and spices (Tadesse *et al*., 2014).

The contribution of the forest sector has been estimated at approximately 6 percent of Ethiopia's total GDP of $12.7 billion. However, this figure increases when the direct values of various ecosystems are taken into account. It has also been estimated that the Ethiopia highland forest provides ecosystem services worth approximately $6 276 000. Further, it has been estimated that Ethiopia's forests contribute about 13.1 percent of GDP, a figure that has remained fairly constant since the 1980s (World Bank, 2015). There was a steady increase in Ethiopia's exported forest products between 2000 and 2013, with products including articles of wood, wood pulp, gums and resins, paper and paperboard, and plaiting materials derived from bamboo and rattan. The export value of forest products from Ethiopia rose from $9.8 million in 2000 to $21.9 million in 2013 (FAO, 2015).

South Sudan

A basic inventory from community meetings in South Sudan shows that the country's forests have similar tree species, and that the uses to which those species are put vary little across different localities. Women are mostly involved in harvesting vegetables, herbs and fish, whereas men tend to collect forest-based resources for productive purposes. The major forest products include fuelwood (charcoal, firewood), food (fruits, vegetables, oil), medicine, construction materials (timber, poles, fencing, platforms), beverages (coffee) and weaving (UNEP/DFID, 2013). It is known that South Sudan is endowed with a diversity of natural forest and woodland resources. Among the non-timber

forest products, gum arabic from *Acacia spp*. is the most important as it has sustained the Sudanese economy for a long time. Gum arabic from South Sudan is produced by two main species, *A. senegal* (L.) Willd var. *senegal* and *A. seyal* Del var. *seyal*.

It is estimated that the potential annual production of gum arabic from South Sudan is between 6,541 and 15,580 tonnes, which translates to an annual export value of between $12 428 280 and $25 850 300. Forests in South Sudan are mainly used for food production (fruits, seeds, mushrooms, fodder, fibre and construction materials, and woodfuel/charcoal.

Key environmental values of forests in the region

Forests play an important role in environmental protection and delivering ecosystem services. There is a long history of the protection of forests in mountain areas, where they help to prevent soil erosion, landslides and avalanches, and are important in maintaining the quantity and quality of water in rivers draining forested catchments (Inne, 2016). Furthermore, forests contribute to atmospheric carbon and oxygen, and the water cycle, and conserve the biological diversity of flora and fauna. Forests also absorb climate shocks and improve resilience to climate change among forest-dependent communities, as well as climate change mitigation through carbon capture and storage.

United Republic of Tanzania

Catchment forests make a significant contribution to biological and gene pool conservation (of both flora and fauna) as they possess a high degree of endemism in plant and animal species. The catchment value and capacity of a forest (interception, re-evaporation, through fall, stem flow, infiltration, percolation and runoff) are highly dependent on the structural elements of the canopy and other vegetation layers as well as on meteorological factors.

The major river basins in the United Republic of Tanzania have their origins in the catchment forests. These provide water for hydropower stations, irrigation, domestic and industrial use, and tourism. It has been observed that – apart from tangible forest products such as a variety of wood and NWFPs, employment and revenue – they supply other environmental services such as soil conservation. They also mitigate climate through sequestering carbon, and are a source of water for domestic and industrial use from catchment forests (watershed services), irrigation agriculture and power generation. Forests also have aesthetic, recreational, cultural, spiritual and scientific value and contribute to agricultural stability by protecting the soils.

Uganda

Uganda's forests and woodlands provide a number of environmental services and direct benefits to the agriculture, water and fisheries sectors. These include the value of watershed and groundwater protection, erosion control and carbon sequestration (Obua *et al*., 2010).

Uganda's forests contribute significantly to the protection and stabilization of the environment. There is a hidden dimension to forests in Uganda in that they have a wider role in the maintenance of environmental quality such as soil/water conservation and carbon sequestration. Such hidden benefits are public goods that benefit many people at the local, national and international level. The loss of forests in many areas often results in serious environmental consequences in terms of soil erosion, flash floods and, not least, the depletion of a global carbon sink.

The assessment of indirect use values of Uganda's forest (calculated for the contribution of forests to soil and water management, sequestration of carbon and future uses for Uganda's biodiversity) shows the combined value of all of these services and option values as U Sh222.2 billion, or $127 million.

Rwanda

Rwanda's forests provide a number of environmental benefits. The best known (and perhaps most highly valued) forest resource value is the mountain gorilla. However, the forests provide other

significant benefits that have so far received little attention: among them are the value of ecological services provided by the forests, such as benefits to agricultural production of climate control, regulation of water flow and soil retention, and the wider benefits of atmospheric pollution control. Another value is the existence value of biodiversity (including a multitude of flora and fauna). For example, Rwanda's two isolated and protected Afromontane forests – Virunga and Bwindi – are Pleistocene refugia that are unique in their levels of endemism and species richness, and one of the most biodiverse areas in the world. These areas are commonly considered to be one of the top 20 of the Global 200 priority areas for biodiversity (Hatfield and Malleret-King, 2007).

Furthermore, the Virunga-Bwindi region, centrally located within the Albertine Rift, represents one of the area's biodiversity centres. Of particular significance is the fact that the two forests contain the world's only remaining natural populations of mountain gorilla (*Gorilla beringei beringei*). Despite the existence of long-running conservation programmes that have assisted protection, generated substantial tourism income, and enhanced local appreciation of the forests, the gorillas' long-term viability remains threatened by land pressure exacerbated by large-scale political conflict. The total value to international visitors of viewing mountain gorillas has been estimated at $13.64 million per annum (Hatfield and Malleret-King, 2007).

In addition to tourism as one of the main environmental services contributing to Rwanda's development, national parks and other natural ecosystems provide several services for local people, contributing not only to their economy but also to their daily livelihood and welfare. The Akagera National Park (ANP) wetlands play a major hydrological role and constitute an important fishing area, with high catch yield. The Nyungwe National Park (NNP), constituting the region's main bloc of remaining mountain forest, provides vital watershed protection for Rwanda and an important hydrological network for the Congo and Nile systems. Socio-economically, the forest offers opportunities for income-generating activities, i.e. beekeeping and different ecotourism initiatives that generate employment and provide a sustainable and equitable income for local communities and other stakeholders. The remaining mountain forests, under forest reserve status, make a significant contribution to human welfare and are the main sources of different ecosystem services that benefit local communities – for example, water for domestic purposes and livestock watering, food and nutrition security. Recent estimates of the total economic value (TEV) of Mukura Forest have been put at a total of RF1 150 649 800 ($1 692 132) (Republic of Rwanda, 2015).

Burundi

Burundi's forests provide important environmental services, which include catchment potential for water conservation, climate regulation, soil erosion control and conservation of the gene pool for both flora and fauna. Burundi's forests contain 17 million tonnes of carbon in living forest biomass. The country has some 819 known species of amphibians, birds, mammals and reptiles, according to figures from the World Conservation Monitoring Centre. Of these, 0.7 percent are endemic, meaning that they exist nowhere else in the world, and 2.7 percent are threatened. Burundi is home to at least 2 500 species of vascular plants (Mongabay, 2011).

Ethiopia

Ethiopian montane forests are an example of one unique and highly important ecosystem facing many socio-economic challenges. The mountains are host to the Bale Mountains National Park, one of the country's few remaining economically and ecologically important forest priority areas. The park harbours diverse flora and fauna, including 26 percent of the endemic species of Ethiopia (FARM AFRICA and SOS SAHEL, 2007). It provides a habitat for rare endemic species such as the Ethiopian wolf (*Canis simensis* Ruppell) and mountain nyala (*Tragelaphus buxtoni* Lydekker), and is the home of wild coffee (*Coffea arabica* L.). It is also the source of many rivers of both national and regional importance. This makes it crucial for the survival of millions of people in Ethiopia and neighbouring countries (Girma, 2006).

Over 67 percent of provisioning and <50 percent of cultural and regulating forest-based services can be provided by semi-forest and garden coffee systems in Ethiopia (Tadesse *et al*., 2014). Most forest-based cultural, regulating and supporting services cannot be substituted in coffee agroforests since these services are largely concentrated in the forest remnants.

South Sudan

South Sudan is endowed with different types of forest vegetation with diverse environmental values. The montane forests on the mountains (Imatong, Dongotona, Acholis, Didinga and Jebel Gumbiri) to the southeast are part of the Eastern Afromontane ecosystem, which is categorized as one of Africa's biodiversity hotspots. These forests are rich in endemic plants, animals and birdlife (Jackson, 1956). However, this ecosystem is highly deforested due to the extraction of timber and encroachment for agriculture. Common tree species in the montane forests are *Podocarpus milanjianus*, *Juniperus excels*a (pencil cedar), *Croton sp*, *Macaranga spp.*, *Albizia spp.* and *Arundinalia alpina* (mountain bamboo), among others. Common animal species include the Blue duiker and the bushbuck (Jackson, 1956; IRG, 2007).

The lowland forests, representing the northernmost extension of the Congo basin forests, are rich in forest biodiversity (flora and fauna). Several forest species of mammals have been known to occur in the region, but their status has to be confirmed. It is suspected that elephants migrate from the Central African Republic and the Democratic Republic of the Congo into these forests, thus forming a good connectivity migration corridor between the three countries. Other species likely to be found in the lowland forests are the eastern chimpanzee, the bongo (an ungulate) (*Boocercus eurycerus*), the African forest buffalo (*Syncerus caffer nanus*) and the giant forest hog (*Hylochoecus meinertzhageni*) (IRG, 2007; USAID, 2014).

Woodland savannah ecosystems constitute the largest ecological region in South Sudan, with diverse habitats. They are divided into two regions, namely, the low rainfall woodland savannah, which is mainly in Upper Nile state, and the high rainfall savannah woodlands. Common large mammals of the woodland savannah include the elephant (*Loxodonta africana* and *Loxodanta cyclotis*), hippopotamus (*Hippopotamus amphibious*), waterbuck (*Kobus defasa*), bushbuck, oribi, duiker, Uganda kob (*Kobus kob*), warthog (*Phacocoerus ethiopicus*), hartebeest (*Alcelaphus sp*.), giant eland (*Tragelaphus derbianus*), buffalo (*Syncerus caffer*) and various species of primates. A rich diversity of avifauna, reptiles, amphibians and invertebrates is also found in the woodland savannah ecosystem of South Sudan.

Social and cultural values of forests, including use by indigenous and other forest-based communities and gender-related issues

The variety of cultural values and symbolic functions ascribed to forests are as numerous and diverse as the communities and cultures of the region. Both physically and mystically, forests have defined the environment of communities in the region throughout time. The distinction that has been made between cultural values and the forest's functions is actually an artificial one. Tangibly and intangibly, forests feature in all aspects of culture: language, history, art, religion, medicine, politics and even the social structure itself. Forest trees may house the spirits of ancestors as well as those of the newborn. Forests are viewed in both positive and negative lights – as sources of power and munificence as well as of evil; as providers for, and hindrances to, development. The mystical qualities of specific forest resources often play a crucial role in traditional healing practices. Forests provide the venue for religious, social and healing ceremonies. Forest products such as tam-tams and forest foods such as palm wine are used in many ceremonies.

United Republic of Tanzania

The use of forests in the context of culture in the United Republic of Tanzania can be shown in Nyumba Nitu Forest in Iringa (in the south of the country) and the sacred forest patches among the

Pare/Gweno society (in the north of the country), among others. According to Yihaisi (2006), Handeni district has a total of 660 traditionally protected forests (TPFs) in 23 villages. Almost 50 percent of TPFs are located on a hill or hill slope, and about 30 percent on flat land. The rest of the forests are around rivers (10 percent) or around rocky and cave sites (almost 10 percent). On average, all the main habitats exist in every village, and 60 percent of the TPFs in Handeni are intact or only slightly disturbed. Msuya and Kideghesho (2009) identified nine traditional practices for the conservation of wild plants in forest ecosystems

- domestication;
- belief in the sacredness of trees;
- belief in sacred forests;
- respect for cultural forests;
- protection of plants at burial sites;
- selective harvesting;
- secrecy;
- collection of deadwood for firewood; and
- use of energy-saving traditional stoves.

Through botanical surveys of sacred forests, cultural forests, farms/homesteads and burial sites, some 1 518 wild plants belonging to 100 species were identified. A large proportion (85 percent) of these plants had medicinal value. Of the 173 respondents, 82 percent, 81 percent, 74 percent and 71 percent believed that sustainable use and conservation of medicinal plants can be achieved through secrecy, plant protection at burial sites, sacredness of plants and domestication, respectively. About 89 percent of the respondents pursued domestication (at least five plants each) and 70 percent had retained sacred trees (at least one tree each), of which the majority had medicinal value.

Gender dimensions are important to consider in forest management because of the different dependence on forests according to gender as well as impacts. Utilization of forest products and other ecosystem services is gender-segregated in this case. The government's forest policy (United Republic of Tanzania, 2008b) advocates gender considerations in forest management based on its policy statement (7): "private and community forestry activities will be supported through harmonised extension service and financial incentives". It also states that:

- Extension packages and incentives will be designed in a gender-sensitive manner.
- The establishment of village land forest reserves will take cognizance of land policy.
- The reserves will be demarcated on the ground, management objectives defined, and multipurpose forest management plans prepared covering all different uses of forests.
- Gender-specific and farmer-to-farmer extension advice, as well as financial incentives, will be provided for the establishment of forest plantations on farmlands.
- Plantations of multipurpose trees with good growth will be promoted.
- The establishment of private nurseries will be promoted through intensified extension and appropriate credit systems.
- The extension of agroforestry practices will be gender-sensitive and women's preferences for species will be given due consideration.

In 2000 the United Republic of Tanzania adopted a policy on women and gender development that emphasizes the need to mainstream gender equity in policies, plans, development strategies and actions in all sectors and at all levels in the development process. One example of this is the 2010 National Strategy for Growth and Poverty Reduction, which includes goals and targets focused on women's empowerment and rights in all aspects of societal development, including forest management.

The United Republic of Tanzania's National REDD+ (Reducing Emissions from Deforestation and Forest Degradation Plus) Strategy, adopted in June 2012, includes a number of references to gender. For example, it states that the Strategic Environmental and Social Impact Assessment (SESA) will give special consideration to a range of issues, including gender requirements. The strategy refers to

the Climate Change, Impacts, Adaptation and Mitigation (CCIAM) programme, which has carried out training to build capacity of relevant actors in preparation for REDD+. The programme aimed to address the socio-economic and gender aspects of climate change. In the drafting process, the REDD+ Task Force and Standards Technical Working Group were both advised by gender experts (Queseda-Aguilar *et al*., 2013).

References to gender also exist in other plans, policies and laws in the United Republic of Tanzania: it may be important to take these into account for REDD+ development and implementation. For example, the National Environment Action Plan (NEAP) of 2012–2017 acknowledges the impact of the Women and Gender Development Policy of 2000 on environmental management at large (Section 2.1). Gender equality in the context of the Gender Development Policy emphasizes the need for gender mainstreaming to speed up sustainable development, especially in terms of environmental protection and conservation. The National Energy Policy of 2003 aims to establish a reliable and efficient energy-production, procurement, transportation, distribution and end-use system in an environmentally sound manner and with due regard to gender. It also outlines the importance of improvements needed in inferior energy practices in order to reduce women's workload (e.g. the search, collection and use of fuelwood) and involve them in decision-making processes on energy issues.

The 2002 Forest Act contains very few references to gender equality. It only specifies that "where a village land forest management community is established it shall […] (b) be informed with due regard to gender balance". In terms of gender-related initiatives, the United Republic of Tanzania's Hifadhi ya Mazingira (HIMA) Project focuses on gender mainstreaming as a main objective. A training workshop was undertaken in April 2011 on "Gender and REDD+", organized by CARE and HIMA. The workshop highlighted the fact that most pilot projects concentrate on the number of women participating in them and their influence in household decisions. However, it was pointed out that gender equity is more complex than this. Tools are needed to better understand gender equity and to integrate it into the Measurement, Reporting and Verification (MRV) system. Finally, the MJUMITA/TFCG Project "Making REDD work for communities and forest conservation in Tanzania", launched in 2009, has been incorporating gender considerations in several project aspects. These include carrying out consultations and awareness raising in line with the principle of free, prior and informed consent (FPIC) at the village and sub-village levels.

Uganda

The cultural and symbolic functions of forests in Uganda include: the tree's significance as a link to culture and beliefs, and as a location for socio-cultural and religious activities; the symbolic, sacred significance of particular resources; the judicial function of trees; and the use of various tree parts in healing ceremonies (Falconer and Koppell, 1990). Accessing the numerous symbolic and cultural values is one way to discover these values. Kakudidi (2004) recorded 89 plant species from forests used for 26 cultural and social purposes. The highest numbers of plants are used in wedding ceremonies (25 species), followed by those against witchcraft (18) and those used in religious ceremonies (15), while the other uses range between 1 and 9 species. Whole plants contributed 24.8 percent, followed by leaves (24 percent), stems (22 percent), seeds (12.8 percent), flowers and bark (5.5 percent each), rhizomes (1.8 percent) and leaf sheaths, roots and fruit (0.9 percent each). Some plants have multiple uses, such as *Cymbopogon nardus* with seven uses, and *Ficus natalensis*, *F. ovata*, *Hibiscus fuscus* and *Phoenix reclinata* with four uses each. Nine species have three uses each, 19 species have two uses each, and 56 species have one use each.

Rwanda

The territory of Rwanda is covered with diverse ecosystems, which include natural ecosystems (consisting of mountain rain forests, gallery forests, savannah woodland, wetlands and aquatic forests), forested areas and agro-ecosystems. All these ecosystems are rich in flora and fauna that are important for the well-being of the majority of the population. Based on the census of 2002, the population of Rwanda stood at 8 128 553, with an annual growth rate of 3 percent and a population

density of 321 inhabitants per km^2, one of the highest densities on the African continent. Rwanda's GDP is dominated by the agricultural sector.

Rwanda's forests provide important economic, environmental and socio-cultural values through the provision of both wood and non-wood utility products. Woodfuel and wood for other uses are harvested from planted forests, whereas all natural forests are protected. Natural forests host a rich biodiversity, serve as the backbone of the tourism industry and support invaluable ecological functions such as water and soil protection. Forests thus contribute to rural livelihoods and the socio-economic stability of the country.

Rwandan forests are a renewable source of energy and, if properly managed, will provide an eternal energy supply that can be counted on at least until viable alternatives become available. Most importantly, as the largest source of national energy, the use of wood-based energy does not depend on external influences or foreign exchange. It is worth noting that, as far as environment protection is concerned, the Rwanda Government is aiming to decrease the use of wood and charcoal as energy sources, and eventually replace them with modern energy sources like liquid petrol gas, peat and biogas. Such energy contributes significantly to livelihood improvements and the socio-economic development of Rwanda's population (Njoroge and Muli, 2011).

Forests within parks and protected areas act as a source of employment and promote income generation for local communities, e.g. as guides, trackers and anti-poachers. The forests support outdoor recreation, education and ecotourism for both foreign and local tourists, thus contributing to socio-economic development. In total, the forest sector contributes around 100 000 full-time jobs in the country. In addition, the Rwanda Government hires local cooperatives to run nurseries for afforestation and reforestation on a contract basis, thus increasing revenues to the local population. Most of the plant species found in Rwanda's forests are used in traditional medicine, and some plant species can provide important biochemical extracts. Other benefits of forests to the population include non-wood products such as honey, fruits, other wild foods, and raw materials for handicraft production, all of which can act as a source of income and supplement resources to meet other household needs.

Burundi

Forests and trees in Burundi are full of hidden meanings. The trees that characterize the current landscape are the result of longstanding traditions, social practices and customs. Burundian agropastoralists respect certain tree formations and, although they are greatly attached to preserving the rangelands, their image of trees is not incompatible with woody resource management.

In the Burundian tradition, the Mpotsa Forest is a holly forest with four queen mothers resting in it: the mothers of Ntare II, of Mwezi II, of Mutaga II and of Mwambutsa II. This forest is used for the burial ceremonies of the queen mother and is a major tourist attraction: at the same time, it has natural, historical and cultural value. Its cachet associated with the mysterious death still inspires fear within the people of the region: this has helped to protect the forest, which, until now, has been spared from bush fires or destruction. This forest, which covers an area of 40 ha, still harbours a rich fauna, including a variety of medicinal plants, so it is not uncommon to find university researchers involved in exploring it. Other species of plants found in this giant rain forest include *Albizia adianthifolia* (imisebeyi), the *Myrianthus arboreus* (amuse), papyrus (imihotora), *Clausena anisata* (umutana) and *Ssyzgium guineense* (imigoti).

South Sudan

Among South Sudan's natural resources, forests are of particular significance to the country's development trajectory. With an estimated 30 percent forest cover, South Sudan's forests harbour a globally significant biodiversity of socio-economic and cultural importance**,** provide a globally significant greenhouse gas (GHG) sink, and provide numerous other goods and services to the country's growing population. In particular, South Sudan's forests play a significant part in the daily lives of South Sudanese, with more

than 90 percent of the population directly dependent on forests for fuelwood, food and nutrition security and hydrological cycling services. Forests also support a wide diversity of wildlife habitats and cultural heritage (FAO, 2015). The forestry subsector in South Sudan embraces both traditional gatherers of fire-wood and producers of charcoal – the main sources of fuel for homes and some industries. This indicates the social-cultural value of forest ecosystems in the country (Berry, 2015).

Ethiopia

Ethiopia's forested landscapes provide a wide range of environmental services that benefit both local forest communities and the global public. These benefits include biodiversity conservation – including flora and fauna species, such as the endangered species endemic to the Bale Mountains, and the forest coffee found in the Jimma/Illubabor Forest block that has social and cultural value for Ethiopian communities. Furthermore, the forests supply various ecosystem services and livelihoods for local communities, although these are difficult to quantify in financial terms. In addition, the forests provide cultural services for landscape values (aesthetic, spiritual, educational and recreational) and supporting services such as soil formation, water retention and regeneration of degraded lands. Climate adaptation benefits support Ethiopian farmers in adapting to climate change in increasingly degraded landscapes. For example, during the dry seasons and times of drought, forests are often accessed as the last resort for livestock grazing, which is a main livelihood activity for many pastoralists and rural communities. The forests also provide climate mitigation benefits which, in the context of Ethiopia, have the potential to generate climate finance. This may provide additional economic benefits in the form of carbon payments for Ethiopia's forest stakeholders, with implications for the social and cultural values of the forest ecosystems.

2. Impacts of climate change

Evidence of climate change, future scenarios of climate change and its impacts

United Republic of Tanzania

It has been observed that there is great variability in rainfall trends over the past four decades up to 2010 in the United Republic of Tanzania (Munishi *et al*., 2010). The Lake Victoria zone shows increasing rainfall trends in both long and short rain seasons. On the other hand, rainfalls for Zanzibar show a slight increasing trend during October to December (short rain season) and a significant increase during March to May (long rain season). The March–April–May (MAM) seasonal rainfall shows an increasing trend in Musoma zone, and a slight increase in Bukoba and Mwanza. The other zones show decreasing MAM seasonal rainfall trends. On the other hand, the total annual rainfall in zone 9 (comprising Dar es Salaam, Tanga and Ilonga) seems to have been constant. This indicates that the areas around Lake Victoria will experience increasing MAM rainfall while most of the other zones will experience decreasing MAM rainfall during the rainy season.

In the unimodal zones, where the major rainy season is October–November–December (OND), zone 1 (Bukoba) and zone 12 (Mbeya) show an increasing rainfall trend. The other zones show decreasing rainfall trends, with zone 5 (Tabora) showing a relatively constant rainfall. This implies that most of the country will experience decreasing rainfall trends. The number of rainy days in most parts of the country has decreased, meaning that the growing season has shortened in most areas. On the other hand, the rainfall start and cessation dates have either increased or decreased. This means that rainfall starts and ends earlier in different parts of the country, or starts late and ends earlier, an indication of a shift in the growing season over most areas of the country.

An assessment of temperature patterns in the 12 different climatic zones of the United Republic of Tanzania shows that the maximum and minimum temperature has increased in almost all except zone 6 (Dodoma and Singida), where the mean maximum and minimum temperatures fell, and zone 12 (Mbeya), where the July mean minimum temperature decreased. There is therefore a general increase in temperature of between 1°C and 2°C all over the country (Munishi *et al*., 2010).

The probability of dry spells has been variable in the different climatic zones (Munishi *et al*., 2010). Most of the zones show an increase in the probability of dry spells, with the probability of a 7-day dry spell showing a stronger change. Generally (except in a few instances) the 7-day, 10-day and 15-day probability of dry spells is higher in the period after the 1970s compared to the previous period, showing that the probability of dry spells has increased all over the country although it varies from place to place.

Climate change projections indicate that the frequency and severity of extreme climatic events will increase (United Republic of Tanzania, 2012a). Over the last 40 years, the country has experienced severe and recurring droughts, with devastating consequences for the agriculture, water and energy sectors. Currently more than 70 percent of all natural disasters in the United Republic of Tanzania are hydrometeorological, and are linked to droughts and floods. For example, the droughts of 2003, 2005 and 2009 severely affected the country's agriculture, energy and business sectors, while the environmental and ecological impacts of these droughts were alarming. Agriculture in the affected areas was crippled, and livestock and wildlife populations perished due to starvation and lack of water. Following these droughts, the United Republic of Tanzania suffered a serious energy crisis, which had severe social and economic implications. The floods of 2009, for example, were particularly devastating for humans, property and infrastructure.

The forestry sector will suffer from shifts in vegetation types as a response to climate change, as subtropical dry forests and subtropical moist forests will change to tropical very dry forests, tropical dry forests and tropical moist forests (Munishi *et al*., 2010). Further, subtropical thorn woodlands

(thickets) will be completely replaced or disappear, subtropical dry forests will decline by 61.4 percent and subtropical moist forests will decline by 64.3 percent. There will be an increase in tropical very dry forests, tropical dry forests and tropical moist forests. The constituent biodiversity in each vegetation type will shift accordingly or be driven to extinction if it cannot adapt. The more vulnerable are those that are drought/heat intolerant, and that have limited geographical range, low germination/recruitment rates, low survival rate of seedlings and limited seed dispersal/migration capabilities.

The major impact of climate change on the wildlife sector is likely to be the occurrence of new parasites/diseases that can cause mass deaths in wildlife populations. As temperature and precipitation change across the country, there will be a change in vegetation cover, an increase in pests and diseases, an alteration of agro-ecological zones and a shorter plant growth period as the temperature rises. The availability of foliage will therefore vary according to the pattern of change in the weather, thus influencing animal biomass and causing a general loss in biodiversity. In areas where precipitation increases simultaneously, vegetation cover will be enhanced. In areas where precipitation decreases, rangeland conditions will probably deteriorate. Species that are vulnerable to drought will pave the way for those that are more drought-resistant.

Uganda

While Uganda's natural climatic is moderate, the country has also been experiencing increased frequency and severity of extreme weather events. In the past decades, Uganda has experienced more erratic rainfalls, leading to the frequent bursting of rivers, mudslides and landslides that cause loss of life and loss of property in the communities, especially those living in mountainous areas. At the same time, people living in low-lying lands are experiencing floods. Prolonged dry seasons are also frequent, leading to loss of crops and livestock (Republic of Uganda, 2014).

An analysis of rainfall over a period of 40 years from the 1940s shows a general pattern of annual to interannual variations, during certain periods, with years of normal to above normal (or normal to below normal) rainfall persisting for several years. In particular, the period from the late 1950s to about the mid-1960s was when almost the entire country experienced record heavy rains. On the other hand, during the period from 1943 to about 1957–1958, most parts of the country (except the southwestern and to some extent the central western areas) experienced normal to below normal rainfall. The trend analysis revealed no significant trend of either increasing or decreasing rainfall over the 40-year period: the trend line was almost horizontal for almost all the zones analysed, with only the central western region indicating a moderate negative trend (Republic of Uganda, 2014).

A time series analysis (in the form of annual standardized temperature anomalies and trends) was also carried out over the 40-year period over the high ground southwestern region of Kabale. The analysis showed significant temperature increases, especially the minimum from the early 1990s to 2000 and beyond. Overall, over a 30-year period (1970–2000), the trend line indicates an increase in the minimum as well as the maximum temperature. Significantly, the gradient for the minimum temperature is greater than that for the maximum temperature. The minimum temperature increases are most pronounced during the period October–April of the El Niño phase of the El Niño–Southern Oscillation (ENSO) cycle. During this phase, positive temperature anomalies of over 1º C can occur, while during La Niña negative anomalies of up to -0.4º C can occur (Republic of Uganda, 2014).

Climate projections developed for Uganda, adopting the models used in the Intergovernmental Panel on Climate Change (IPCC) *Fifth Assessment Report* (IPCC, 2014), indicate an increase in near-surface temperature for the country in the order of +2° C over the next 50 years, and in the order of +2.5° C over the next 80 years under Representative Concentration Pathway (RCP) 4.5; and in the order of +2.5° C over the next 50 years, and in the order of +4.5° C over the next 80 years under RCP 8.5. They also predict a slight decrease in total annual rainfall in most of the country, with slightly wetter conditions over the west and northwest under both RCP 4.5 and RCP 8.5. Rainfall totals might drop significantly over Lake Victoria (-20 percent from the present) (Republic of Uganda, 2015). Uganda's climate may become wetter on average, and the increase in rainfall may be unevenly

distributed and occur as more extreme or more frequent periods of intense rainfall. Uganda's National Adaptation Programme of Action (NAPA), published in 2007, suggests a trend of increasing frequency of drought events and also increased rainfall variability in recent years, linking them to climate change (Hepworth and Goulden, 2008).

In summary, temperatures are likely to increase in Uganda by up to 1.5º C over the next 20 years and by up to 4.3º C by the 2080s. Changes in rainfall patterns and total annual rainfall amounts are also expected but these are less certain than changes in temperature. Regardless of changes in rainfall, changes in temperature are likely to have significant implications for water resources, food security, natural resource management, human health, settlements and infrastructure. In Uganda, as in the rest of the world, there are likely to be changes in the frequency or severity of extreme climate events, such as heat waves, droughts, floods and storms.

Ethiopia

Over the last decades, Ethiopia has experienced climatic changes. Average temperature has increased markedly, with rises of 0.2° C to 0.28° C per decade over the last 40–50 years. Temperature rise differs according to region and season. It has been most extreme in already dry and hot areas of the country, most notably in the north and east, and in the July–September season. The number of "hot days" and "hot nights" has also increased by 20 percent and 38 percent between 1960 and 2003 respectively, especially from June to August, where the increase has been as high as 32 percent and 59 percent, respectively. Simultaneously, the number of "cold days" and "cold nights" has decreased by 6 percent and 11 percent respectively. Consequently, the country's minimum temperature has increased by between 0.37° C and 0.4° C per decade (Warner *et al*., 2015b).

While the increase in temperature is significant and relatively steady across regions and over time, changes in precipitation are more ambiguous and different sources report different figures. Precipitation has remained fairly stable over the last 50 years when averaged over the country, and the initial decreases in July–September rainfall in the 1980s recovered in the 1990s and 2000s. However, these averages do not reflect local conditions, which are vastly divergent, and the natural variability in rainfall over the country makes it difficult to detect long-term trends.

Different climate models present roughly similar projections concerning temperature change, but different ones for precipitation. Temperatures are expected to increase in all seasons, by an average of 1° C by 2030, 2° C by 2050, and 3° C by 2080 (compared to 1975). Some models project maximum increases as high as 5.1° C by the 2090s. While all models foresee warming, they contradict each other as to where the largest increase will occur: in the west and north, in northwest, northeast and central areas, or in the south central part. Most models indicate substantial increases in the frequency of hot days and nights, with up to 93 percent of days and 99 percent of nights considered "hot" in the July–September season by the 2090s (compared to 10 percent of days and nights in the same season in the 1960s).

Despite current trends of rainfall decreases in Ethiopia, the long-term precipitation for the country as a whole is projected to increase by about 9 percent over 50 years (compared to 1975). Higher-resolution analyses, however, show both increases and decreases in different parts of the country. Even on a more local scale, there can be large differences: a study of different districts in the Central Rift Valley projected rainfall decreases of over 11 percent for some, and increases of almost 9 percent for other, relatively nearby districts. An increase in rainfall variability is predicted for the whole country, making rainfall less predictable. Moreover, a larger share of total precipitation will fall during heavy precipitation events, especially from July to December. This is expected to lead to increased incidence of extreme events, with severe droughts in one year, and heavy flooding with erosion and landslides in the next.

Ethiopia is not only biophysically, but also socio-economically vulnerable to climate change. Rapid population growth and expansion of agriculture in a potentially drier and certainly warmer climate could dramatically increase the number of people at risk. Just as the country is heterogeneous in

topography and climate regime, it is also heterogeneous in social, cultural and economic factors. The degree of vulnerability of different localities and their livelihoods varies accordingly. Several densely populated areas – especially in southern Oromia – are expected to experience the strongest declines in rainfall during crucial cropping seasons. In these areas, all arable land is already being cultivated and landholdings are continuously being reduced in size: there is no possibility of further expanding agricultural production. These areas may become hotspots of food insecurity due to climate change.

Climate change will have significant economic effects on the Ethiopian economy, and on the agricultural sector in particular. It has been estimated that climate change will affect the country's GDP growth by 0.5–2.5 percent per annum in the near future. An integrated vulnerability assessment of climate change effects in Ethiopia's regional states found that the top four vulnerable states are Afar, Somali, Oromia and Tigray (Zeray and Demie, 2015). These states are all heavily agriculture-dependent and are among the poorest states in the country: 90 percent of all people in Tigray and Afar, and 60–70 percent of those in Oromia and Somali, live on less than $2 a day.

Climate change has strong links with poverty and hunger. Not only does it increase poverty and hunger through its adverse effect on food security and economic development; poverty and hunger also decrease people's resilience and their adaptive capacity to the effects of climate change.

Rwanda

The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007) found that the observed changes in average surface temperature in Africa indicated an increase of between 0.2 °C and 2.0 °C within the period 1970–2004. According to the same estimates, the annual temperatures in Rwanda may be between 1.0 °C and 2.0 °C higher. Climate projections for Rwanda were carried out for the period 2010–2100, using the period 1971–2007 as the baseline.

Projections based on outputs of Global Circulation Models (GCM) show an average increase in minimum, average and maximum temperatures towards the years 2020–2100 (Republic of Rwanda, 2011b). The increase in annual maximum temperatures reaches 3.3 °C. For rainfall, the projections show a variability of two wet seasons during March–April–May and September–October–November, but with a rising change which reaches 50 mm in April and December. Projections for the average potential evapotranspiration show it rising during the dry seasons in December–January and June–August, with sharp rises from June to August. The projections show that the annual potential evapotranspiration is likely to increase every year. It is predicted that it will reach 1 351 mm by 2020, 1 432 mm by 2050 and 1 682 mm by 2100. The projected minimum temperature shows the same increasing trend every year; the annual change related to the historical mean varies from 0.44 °C to 0.6 °C for 2020, 1.2 °C to 1.9 °C for 2050, and 2.3 °C to 3.3 °C for 2100. Mean temperatures are expected to increase by approximately 1.3 °C to 1.9 °C in 2050, and 2.3 °C to 3.3 °C in 2100, above the baseline mean (Republic of Rwanda, 2012).

Rwanda has experienced a temperature increase of 1.4 °C since 1970, higher than the global average, and can expect an increase in temperature of up to 2 °C by the 2030s from 1970. Rainfall is highly variable in Rwanda, but average annual rainfall may increase by up to 5–10 percent by the 2030s from 1970. Analysis of rainfall trends has shown an increasing occurrence of extremes over time and in various regions of the country. Rainy seasons are becoming shorter and more intense, especially in the northern and western provinces, which increases the risk of erosion in these mountainous parts of the country. Eastern regions have experienced serious rainfall deficits in a number of years over previous decades, alternating with rainfall excesses in other years. At the same time, there has been a trend over the past decades towards higher temperatures: increases of up to 2 °C were recorded between 1970 and 2009.

Current trends in rainfall and temperature are expected to continue in the future. Predictions suggest that the country's temperature will increase by another 1 °C–2.5 °C between 2000 and 2050, and by 1 °C–6 °C by 2100. The increase is expected to be consistent across the country and across seasons – although the increase in the long dry season may be slightly higher than in other seasons. Average

annual rainfall models predict a change of between 100 mm and 400 mm for the period 2000–2050. Frequent rainfall deficits are expected in parts of the eastern province (Bugesera, Nyagatare, Gatsibo, Kayonza, Ngoma and Kirehe) and the southern province (Nyanza and Gisagara), while increased rainfall is expected in parts of the western, northern and southern provinces. Rainfall is expected to be more intense in the rainy seasons while dry seasons will be longer and dryer, which brings new challenges for water management, storage and drainage.

The consequences of climate change in Rwanda are numerous. The trends in climate are expected to lead to increasing rainfall intensity, causing a higher frequency of floods and storms. This will result in landslides, crop losses, health risks and damage to infrastructure, as well as an increase in temperatures, resulting in the proliferation of diseases, crop decline and reduced land availability that impacts on food security and export earnings. Some of these challenges are extreme events, including severe droughts and floods, which will occur more often due to climate change. Droughts have already resulted in famine, population displacement, conflicts and biodiversity loss. Seasonal droughts are expected to be prolonged, which will cause problems especially in the east and southeast of the country (Bugesera, Mayaga and Umutara). An inventory of the most current environmental risks and most pressing problems due to climate change has identified them as: prolonged seasonal drought, dry spells in rainy seasons, and recurrent droughts (Warner *et al*., 2015c). At the same time, the country experienced major floods in a number of consecutive years (2006–2009), resulting in serious health problems, displacement, large-scale erosion and damage to infrastructure. Droughts and floods are region-specific problems, with droughts occurring mainly in the east of the country and floods in the western/central north and south. Some regions are also prone to erosion.

Rwanda is highly vulnerable to climate change because of its dependence on agriculture, which accounted for 33 percent of GDP in 2013 and employs 90 percent of the country's population (directly or indirectly). Almost all agricultural activities are rainfed, which makes the country very vulnerable to changes in rainfall patterns. Climate change has different effects on the production of different crops. Cassava, once the main food and income-generating crop, was reported in 2009 to be a rare commodity because of declining yields due to low soil moisture. Expected future effects on the country's main staple crops (in order of importance) are shown below:

- bananas (35 percent of productive area): productivity is unlikely to change as bananas grow well in higher temperatures;
- beans (22–30 percent of cultivated land): yields will seriously decrease because this crop requires cooler temperatures (14 °C–18 °C) that will no longer exist. Low soil moisture will further decrease yields;
- sorghum: this crop will become suitable for some areas in the (north)west that are currently too cold;
- potatoes: yields are expected to increase (25–90 percent between 2010 and 2050), which will make Rwanda able to meet all domestic demand and supply an export market by 2050; and
- coffee and tea: these are the country's most important cash crops. Coffee, especially, is very sensitive to climatic factors: temperatures above 25 °C, as well as atypical rainfall patterns, have adverse effects on the plants. Higher temperatures, due to climate change, will force coffee producers to cultivate higher lands that are more prone to erosion, leading to possible conflicts with small-scale farmers in these areas (Warner et al., 2015c).

Burundi

Nationwide, Burundi has alternatively experienced severe droughts, resulting in crop failure and 35 percent livestock mortality (1998–2005), and severe floods, with similar effects (2006–2007). Such events are estimated to result in a loss of 5–17 percent of GDP per event. Changes in the duration of wet and dry seasons have recently been observed. Total precipitation has declined, and the long wet season ends sooner (often in April) while the short wet season starts later (in October). This means that the long dry season is further prolonged and can now be considered as lasting from May to September. Moreover, an increase in average temperature of 0.8 ºC was observed between 1930 and 2012. This intensification of dry and wet seasons results in more severe droughts and floods.

Projections for future changes in temperature due to climate change estimate an increase of 0.4 ºC per decade. For both temperature and rainfall, the projected changes vary according to season:

- in the long wet season (January–May), precipitation will increase slightly by 3–10 percent by the year 2100;
- in the long dry season (specifically May–October), precipitation will decrease by 4–16 percent and the temperature will increase significantly (up to 5 ºC) by the year 2100; and
- in the short wet season and the short dry season (specifically November–February), precipitation will increase by 0–25 percent by the year 2100 (Warner *et. al.*, 2015a).

This suggests that the long dry season is not only being prolonged as a consequence of climate change, but also receives less rainfall and faces the most significant temperature increase, resulting in acute problems for food security and water availability. Projected changes and their influences also differ according to geographical zone. Northern and eastern provinces, which already suffer from frequent droughts, are likely to see a decrease in annual precipitation of 50–100 mm. Potential increases in total rainfall (of 200 mm annually) or in rainfall intensity are likely to cause floods in the western Imbo plains and erosion in the southern zone and central plateau.

Changes in rainfall and temperature will influence both food security and water availability. Food security in Burundi is already extremely fragile: 61 percent of the country's households risk food insecurity at some point during the year. Heavier rainfall is expected to result in floods that damage crops, soil and infrastructure, while it may also increase the presence of pests or diseases that affect food crops and livestock. Increased temperatures will result in bush fires and increased water consumption/requirements; the latter especially since a temperature increase in Burundi's tropical humid climate will result in high evapotranspiration rates.

Simultaneously, prolonged periods of drought will lead to lower water levels and therefore decreased crop and livestock productivity, as well as increased livestock mortality. Water availability for agricultural activities will be influenced by the decrease in Lake Tanganyika's water level, which is already resulting in desertification of the area and salinization problems in the Ruzizi plain. The water quality of river and lake systems is decreasing due to increased temperatures and sediment load. In the long term, rainfall peaks may result in an increase of 40 percent in the average flows of the Ruzizi and Ruvubu rivers between 2000 and 2050. This poses challenges in terms of: (a) protecting the country against extreme rainfall events; and (b) using such peak rainfalls to compensate for decreased water availability elsewhere in the country.

The major impacts related to climate change in Burundi include:

- drying up of lakes and other waterways;
- disappearance of aquatic flora;
- deterioration of surface water quality;
- increased rainwater erosion and silting of certain rivers;
- decline in production by hydroelectric power plants;
- increased competition for the use of unpolluted groundwater resources;
- more frequent shutdowns of certain active hydroelectric power plants because of exceeding operating thresholds due to insufficient rainfall and prolonged drought;
- increased runoff from land degradation in the hydroelectric power plants' watersheds;
- major fluctuations in electricity production due to stresses on the water supply system and changes in rainfall patterns;
- a greater deficit in the electricity sector, leading to real electrical power supply problems in the country's various socio-economic domains; and
- widespread scarcity of firewood and wood charcoal due to heightened, combined pressure from human activities, rising temperatures and changes in biomass growth rates.

The agriculture and livestock farming sectors will see declines in harvests, cattle, goats, sheep and poultry, aggravated by more prolonged, more frequent drought (with likelihoods of occurrence of between 40 and 60 percent), while the health problems include increased cases of malaria.

At the landscape level, there will be the risk of more frequent, larger-scale flooding of lowlands, an escalation of soil erosion along groundwater trenches in the watersheds of the Mirwa Mountains, and decreasing water levels in lakes (Lakes Cohoha, Rweru, Rwihinda and Kanzigiri in the Bugesera Depression) due to intensification of drought, with their waters retreating at above 400 m. This has already been seen towards the centres of those lakes and puts some of the shallower ones at risk of completely disappearing while the level of Lake Tanganyika will rise due to heavy precipitation.

As regards terrestrial ecosystems (forests), there will be the possible disappearance of the subalpine zone starting at an elevation of 2 450 m, the disappearance of certain plant species and aggravation of erosion, bush fires and degradation of the groves in Bugesera and forests of *Hyphaene* palm trees on the Ruzizi plain, with an increased vulnerability to bush fires.

It has been shown that climate change has already affected forest ecosystems in Burundi. Such effects include hot and dry seasons that have led to more severe damage, such as the development of insect pests like termites in northern Burundi in the Bugesera region of Kirundo province, and cases of eucalyptus woodlands being attacked by insect pests (tree lice), especially during the prolonged dry season, almost throughout the country. There have also been increasing incidences of pathogenic fungi that are observed to have moved to previously disease-free areas, causing widespread damage to forest plantations. Furthermore, land degradation due to climate change threatens the livelihoods of thousands of people in Burundi, particularly in the rural areas; threatens a loss of biodiversity and ecosystem services; and increases food insecurity and poverty, e.g. in Kirundo province, eastern and southern Burundi.

South Sudan

Climate change has increased the frequency of severe droughts, floods, storms and cyclones in various parts of the world (IPCC, 2007, 2012 and 2014; Meadowcroft, 2009). In South Sudan, seasonal patterns have become erratic and rainfed agricultural areas have decreased significantly in the northern and eastern parts of the country (Funk *et al*., 2011). Rainfalls have decreased in South Sudan by 10–20 percent and temperatures have increased by more than 1 ºC since the middle of the 1970s. These rainfall and temperature changes are linked to an increase in atmospheric CO_2 since the industrial revolution (IPCC, 2012 and 2014; Royal Society and US National Academy of Sciences, 2014). Observations suggest that patterns in which floods and droughts occur in the same season have become widespread, with droughts occurring earlier in the season around May/June and floods occurring later around August/September in South Sudan. These climatic shocks have wide negative impacts on people in terms of food security, health and safety needs. The government and relevant actors can develop policy and institutional measures to address these shocks.

According to the climate analysis of the Famine Early Warning Network (FEWS NET), much of South Sudan has experienced a 10–20 percent decrease in long rains since the mid-1970s. The region that received 500 mm or more of rain has contracted, increasingly exposing populations in Upper Nile, Jonglei and Eastern Equatoria to rainfall deficits. In the Upper Nile, the shift was from approximately 11° to 10° north latitude. A westward retraction is occurring in Jonglei and Eastern Equatoria, with the 500 mm contour shifting from approximately 33° to 32° east latitude. Due to the reduced rainfall trend between the 1960s and late 2011, the area receiving adequate rainfall to support agropastoralist livelihoods (500 mm) has been reduced by 18 percent. In addition to the 30 years' trend of declining precipitation, there is evidence that variability in the amount and timing of rainfall will increase from year to year. Smoothed time series of 1960–2009 rainfall, extracted from the extended Darfur region in Sudan and South Sudan, show that rainfall between 1960 and 2009 was, on average, about 20 percent lower than rainfall between 1960 and 1989.

Over the past 30 years, South Sudan has been among the most rapidly warming locations on the planet, with temperatures increasing by as much as 0.4 °C per decade. Temperatures have increased by more than 1 °C across large parts of the country. The spatial pattern of warming corresponds (broadly) with the areas associated with reduced precipitation. South Sudan and western Sudan are becoming drier and hotter.

Actual rainfall records of East Africa since the 1970s indicate that precipitation has declined, and a recent study predicts continued declines in the future (Funk, 2011). If present rainfall trends continue, by 2025 the drying impacts that are currently experienced in Upper Nile, Jonglei and Eastern Equatoria states will probably reach into Western and Northern Bahr el Ghazal, Warrap, Unity, Lakes and Central Equatoria states. Temperature impacts will amplify the effects of drought: observed warming of more than 1 °C is equivalent to another 10–20 percent reduction in rainfall. Climate change will affect water availability in the country. Most of South Sudan is covered by the Bahr el Ghazal, Nile and Sobat river catchments that join at their confluence near Malakal to form the White Nile. In contrast to the Nile, the Sobat river and the Bahr el Ghazal river catchments have a strong seasonal character.

Research on the Equatorial lakes and Bahr el Ghazal sub-basins suggests that an increase of 2 °C in temperature might cause the natural flow to fall to 50 percent of the current average in these two sub-basins. The rising temperatures and uncertain rainfall could also impact on the Sudd, which is not only an important source of fish and products, but also a wetland of global importance for biodiversity. Temperature increases, in regions with very high average air temperature, can amplify the impact of water shortages on agriculture. These warming effects can combine with decreases in rainfall to reduce evapotranspiration and crop yields. This transition to an even warmer climate has strong food security implications, reducing crop harvests and pasture availability, and it can amplify the impact of droughts. The shrinking of the area receiving more than 500 mm of rainfall will leave a large number of people exposed to increased food insecurity, and will strongly impact crop production in the southeastern part of the country.

Climate change and vulnerability in South Sudan are strongly related to forest degradation and deforestation. In socio-economic terms, the forest-dependent communities' livelihoods and source of meagre incomes are disrupted; resulting in social instability and physical insecurity among communities, loss of human life and livestock (hunger and starvation) due to fluctuations/delays droughts and invasive disease changes in physical/chemical soils characteristics (loss of fertility, reduced food crops production and productivity).

Vulnerability and projected impacts of climate change on forests and forest communities

United Republic of Tanzania

Climate change impacts on forest ecosystems and biodiversity have been evidenced in many parts of the country and they are expected to vary depending on vegetation type and species composition. The common impacts on all forests types include:

- loss of biodiversity;
- disappearance of wildlife habitats;
- increased risk of bush fires;
- limited availability of forest products (both timber and non-timber products); and
- ecosystem shift (for example, forest to woodlands, or woodlands to grasslands).

Based on forecasts, there will be a change to drier forests and ecosystems as a result of climate change (United Republic of Tanzania, 2007; Munishi *et al*., 2010; Shayo, 2013). The most vulnerable species are those with limited geographical range and heat intolerance; low germination rates; low survival rate of seedlings; and limited seed dispersal/migration capabilities. However, knowledge about the magnitude of effects on individual species is still limited. All these changes due to the impacts of

climate change on forest ecosystems will have negative implications for communities that depend on the various forest types for their livelihood. These impacts may include reduced availability of products and services from the forest ecosystems and variability in the supply of the products and services.

Uganda

Climate change-induced changes are likely to affect forests and wildlife in various ways. According to Uganda's NAPA (Republic of Uganda, 2007), the impacts are felt through a number of extrinsic and intrinsic reactions. In wildlife, extrinsic behaviour involves movement to a hostile environment in search of food and water. Intrinsic manifestations involve an imbalance in physiology, leading to phenomena such as reduced immunity and also hormonal imbalance, giving rise to disruptions in reproduction. Extreme weather and climatic events such as windstorms and flooding can destroy and kill trees on a massive scale, as observed in Bwindi Impenetrable National Park (BINP).

Trees and forests, on the other hand, are generally resilient when compared to wildlife (depending on type and diversity of species in a forest ecosystem and respective type of impact) and respond to the impacts of climate change very slowly and insidiously. To illustrate this, a genuine climate-induced shift in phenology of leafing, flowering and fruiting of forest trees may not be attributed to climate change since such a phenomenon can easily be fitted into natural cyclical patterns. Similarly, unlike animals, the migration of trees and plants as a result of environmental shifts induced by climate change, in general, is seriously curtailed.

Known constraints imposed by the dispersal process (e.g. the mean period between germination and the production of seeds, and the mean distance that an individual seed can travel) suggest that, without human intervention, many species would not be able to keep up with the rate of movement of their preferred climatic niche projected for the twenty-first century, even if there were no barriers to their movement. The heavy cutting and burning of the forest cover has contributed to land and soil degradation. In such fragile ecosystems, deforesting and/or degrading forests predispose poor communities to climate change disasters (e.g. landslides), exacerbate the severity of some disasters (e.g. floods and windstorms) and trigger a downward spiral of food insecurity and its consequences.

The disappearance of medicinal plant species has been consistently reported (Bush *et al*., 2004). This is serious because a large proportion of the rural population depends on direct herbal medicine to treat a wide range of ailments. The disappearance is mainly related to changes in the ecosystems, land degradation and unsustainable use. The loss of herbal plants has been most prominent in highland ecosystems (Bush *et al*., 2004).

Ethiopia

Climate change is expected to have adverse ecological, social and economic impacts. So far, there have only been limited numbers of quantitative climate change impact assessments for the various socio-economic sectors in Ethiopia. According to Ethiopia's NAPA (Federal Democratic Republic of Ethiopia, 2007), the major impacts of climate change on forests include the expansion of tropical dry forests and the disappearance of lower montane wet forests, and the expansion of desertification. One of the specific impacts of climate change is the increased fire risk: drier conditions will increase the risk of fire, making forest fires more frequent and intense, resulting in degradation. Further impacts of climate change include land-use change; increase in invasive species such as *Prosopis juliflora* and *Acacia drepanolobium* in Afar and Somali regions, where they are causing considerable socio-cultural damage; and changes in forest-dependent livelihoods due to changes in forest extent. Furthermore, the changing climate will impact species with a narrow ecological range (e.g. highland bamboo, alpine species), which are likely to be threatened.

Climate change has the potential to affect both timber and NTFPs – as well as wider ecosystem services (water and soil, catchment management and flood protection) and rural livelihoods, which depend on forests for a large proportion of their income and as a coping strategy during times of

drought – by damaging the products and services obtained from the forest and causing species extinction. This will particularly affect people who depend on timber production and NTFPs such as forest coffee, honey, beeswax, medicinal herbs, bamboo, mushrooms, latex, gums and resins. Changing climatic conditions make agriculture more precarious in current agricultural production areas, driving farmers to move into higher rainfall areas (woodland and forest areas). Increased demand on forests to diversify sources of livelihood (as agricultural systems become more precarious as a result of climate change) may increase the pressure on forests. There are a limited number of quantitative studies in Ethiopia on the specific impacts of climate change, but hazards such as outbreaks of pests and diseases and forest fires (which are already affecting forest areas) are likely to increase in frequency and intensity. Further, although models are not yet sufficiently developed to predict the future climatic trends in Ethiopia, anecdotal evidence suggests that climate variability is already occurring (Kefiyalew, 2016).

Ethiopia has experienced both dry and wet years over the last 54 years (Zerga and Gebeyehu, 2016). These changes in the physical environment are expected to have an adverse effect on agricultural production, including staple crops such as wheat and maize. Trend analysis of annual rainfall in Ethiopia shows that rainfall has remained more or less constant when averaged over the whole country, while a declining trend has been observed in northern and southwestern Ethiopia (IPCC, 2007). The rainfall is highly variable (both in amount and distribution) across regions and seasons. The seasonal and annual rainfall variations are the result of the macro-scale pressure systems and monsoon flows that are related to changes in the pressure systems (Tesfaye, 2003).

The spatial variation of the rainfall is influenced by changes in the intensity, position and direction of movement of these rain-producing systems over the country (Temesgen, 2000). Moreover, the spatial distribution of rainfall in Ethiopia is significantly influenced by topography, which has also resulted in many unexpected changes in the Rift Valley. The National Meteorological Agency (2007) revealed that climate variability and change in Ethiopia is mainly manifested through the variability and decreasing trend in rainfall and increasing trend in temperature. Besides, rainfall and temperature patterns show large regional differences. For the IPCC mid-range emission scenario, the mean annual temperature over Ethiopia will increase in the range of 0.9 °C–1.1 °C by 2030, in the range of 1.7 °C–2.1 °C by 2050, and in the range of 2.7 °C–3.4 °C by 2080, compared to the normal range for 1961–1990.

A small increase in annual precipitation is expected over the country. Other sources of data have substantiated the variability of climate and its trends in somewhat similar ways. Historical climate analysis for Ethiopia indicates that mean annual temperature increased by 1.3 °C between 1960 and 2006, an average rate of 0.28 °C per decade. This increase in temperature has been most rapid in June, August and September, at a rate of 0.32 °C per decade (McSweeney *et al*., 2010). Rainfall is historically highly variable and there is no clear trend in the amount of rainfall over time (McSweeney *et al*., 2010; Federal Democratic Republic of Ethiopia, 2007). Studies of localized meteorological data alongside community perceptions indicate that seasonal change may already be occurring as there are declining and increasing trends in certain months of the year. Mean annual temperature is projected to increase by 1.1 °C–3.1 °C in the 2060s and 1.5 °C–5.1 °C in the 2090s. Under a single emissions scenario, the projected changes from different models span a range of up to 2.1 °C (McSweeney *et al*., 2010).

The wide range between these different scenarios highlights the uncertainty in future projections for climate change in Ethiopia. Clearly, the country is highly vulnerable to current variability and there are also indications that climate change will increase rainfall variability, which will probably increase losses from rainfed agriculture. The country's ecosystems, as well as its community, are highly exposed to climatic variability. Ethiopia is vulnerable to climatic variability owing to its low adaptive capacity: this can be explained by the low level of socio-economic development, high population growth, inadequate infrastructure, lack of institutional capacity and high dependence on climate-sensitive, natural resource-based activities (NMA, 2007).

Rwanda

Over the last two decades, the negative consequences of disturbances in the climate have affected different sectors and the natural resources involved in Rwanda's socio-economic development. A correlation exists between the increase in temperature and the humidity of the soil, the lowering of lake water levels and water flows, the drying up of sources and decreased agricultural productivity. In 1997 serious floods linked with the El Niño episode of 1997–1998 destroyed a large number of agricultural plantations and ecosystems occupying the shallows and swamps of the Nyabarongo and Akanyaru river basins. From 1999 to 2000, a prolonged drought seriously affected Bugesera, Umutara and Mayaga regions. Like the severe Ruzagayura famine from 1943 to 1945, such disasters are mostly provoked by climate change. One of the major impacts of climate change in Rwanda is the degradation of forests although the type and extent of degradation resulting from climate change are not well understood.

According to the Republic of Rwanda (2011b), climate change may cause more flooding of roads, bridges and airport runways, especially in lowland areas, as a result of erratic rains, stiff rising sea levels and surges brought on by more intense storms. Energy production will be affected in various ways, but is likely to decline: the effect of climate change on forest resources could result in more trees and woodlands being converted into agricultural land, with a likely negative impact on biomass energy availability and access. On the other hand, climate change provides an opportunity to increase forest cover and reduce the consumption of fuelwood and other biomass resources. This could also negatively affect access to biomass energy, however, since the alternatives to wood are still likely to be fewer and more costly for a sizeable part of the population.

Hydropower (the cleaner and more renewable source of energy) will be both positively and negatively affected, depending on the effects and how they are managed. Intense rains will increase water flow in the river systems, enabling the country to increase electricity generation capacity. On the other hand, persistent drought will reduce water levels in major lakes, rivers and swamps and lead to lower power production. Rwanda has already experienced this crisis, especially around 2003–2004. Climate change will affect settlement patterns and housing, through internal migration (this is already happening with the influx of people from Western and Northern provinces to Eastern province). Increased hazard risks, especially in hilly areas, could encourage the implementation of grouped settlements. Energy consumption in households and commercial buildings is likely to increase.

Rwanda is likely to experience hotter than normal days, necessitating increased cooling efforts. The safety and resilience of the infrastructure (buildings, telecommunications, grouped settlements and so on) could be destroyed by floods or strong winds and extreme temperatures, unless provisions are made to reinforce the structures. The high-rise buildings advocated in the urbanization policy will require extra safety provisions. The effects of climate change will also be influenced by the development policies and models adopted. Climate adaptation may be compromised when people are compelled to settle in fragile areas (e.g. steep slopes or wetlands) or build houses that are not climate-resilient (e.g. use of raw bricks instead of baked bricks due to rising costs). They may also become susceptible to poverty and health hazards due to breakdowns in communications and increased epidemic risks as a result of flooding or road breakdown. Water supply and sanitation systems could be affected by water stress and reduced water levels. Water supply installations could be destroyed and their functionality undermined in flood-susceptible areas or landslide-prone regions.

Burundi

The potential adverse effects of climate change on the environment in Burundi have been reported as based on several scenarios of change, and no impacts have been identified specifically for forest ecosystems. In the event of rainfall deficit, the effects will include: dryness; late rains; famine; deficit of water for various uses; reduced livestock and agricultural production; loss of human life and biodiversity; degradation of vegetable cover; bush fires; migrations of the population and cattle; drying up or reduction of the level of dams and rivers; and reduced hydropower energy. In the event of excess rainfall, the effects will include: rain erosion; loss of harvests; loss of human and animal

life; loss of habitats for the species; destruction of the infrastructure; landslides; windfall of the trees; outbreaks of parasitic, intestinal and nutritional deficiency diseases; sandbanks/silting of rivers and lakes; floods of lowlands and marshes; and deterioration of water quality.

In the event of high temperatures, the adverse effects will include: thermal stresses; breakout of respiratory and vector-borne diseases: higher consumption of water: increased evapotranspiration and evaporation: and the acceleration of bush fires. In the event of lightning, thunder and hail, the following consequences can be expected: deaths of cattle and people; bush fires in forests and woodlots; food insufficiency; falling of blossoms in crops; destruction of large trees; and lower agricultural output (Republic of Burundi, 2007).

South Sudan

Traditional subsistence agriculture dominates the Sudanese economy, with over 80 percent of the population dependent upon crop production and/or livestock husbandry to support their livelihoods. Agricultural activities account for nearly half of GDP, and are responsible for the vast majority of employment. The agricultural sector is dominated by small-scale farmers. Typically, such farmers live in conditions of persistent poverty and rely on rainfed and traditional practices. This combination makes them highly vulnerable to climate variability, as evidenced by the widespread suffering in rural areas during past droughts. Indeed, chronic drought is one of the most important climate risks facing South Sudan. Other important climate risks include drying out of streams and rivers, low agricultural production, impact on forest ecosystems and decline in livestock. Recurring series of dry years have become a normal occurrence in the Sudano-Sahel region. Drought is threatening the existing cultivation of about 12 million ha of rainfed, mechanized farming and 6.6 million ha of traditional rainfed lands. Pastoral and nomadic groups in the semi-arid areas of South Sudan are also affected.

3. Adaptation options

Adaptation needs and forest management options to promote resilience, reduce vulnerability and enhance adaptation

United Republic of Tanzania

The United Republic of Tanzania will embark on a climate-resilient development pathway. In doing so, the adaptation contributions will reduce climate-related disasters from 70 percent to 50 percent, and significantly reduce the impacts of spatial and temporal variability of declining rainfall, and frequent droughts and floods: these have long-term implications for all productive sectors and ecosystems, particularly the agricultural sector. Access to clean and safe water will be increased from 60 percent to 75 percent through improved management of water resources such as catchment management and efficient use of water for both domestic and agricultural practices. Based on a conservative and a worse-case scenario of a 50 cm and a 1 m rise in sea levels, the contributions will verifiably reduce the impacts of sea-level rise for the island and coastal communities, infrastructure and ecosystems (United Republic of Tanzania, 2015).

The following measures are pertinent to forestry:

- enhancing efficiency in woodfuel utilization;
- enhancing participatory fire management;
- enhancing forest governance and protection of forest resources; and
- enhancing sustainable forest management.

Adjustments in forest management plans and practices to cope with changing climate would include:

- understanding climate-change impacts in the forest sector and various ecosystems;
- reviewing existing plans and mainstreaming climate change-relevant interventions, with short-, medium- and long-term targets;
- undertaking cross-sectoral harmonization of the plans;
- developing and harmonizing the plans with other sectors; and
- supporting implementation, including mainstreaming in government budgets (Manyika *et al*., 2016).

Furthermore, increasing the areas under forests (supplemented by tree planting), as well as increasing the diversity of species in forest ecosystems, will ensure resilience. Forest conservation measures would aim to maintain areas of forests with sufficient diversity as well as protect existing forests.

Uganda

Uganda has the overarching objective of ensuring that all stakeholders take appropriate measures to address climate-change impacts and their causes, while promoting sustainable development and green growth. The country will continue to work on reducing vulnerability in the following priority sectors: agriculture and livestock, forestry, infrastructure (with an emphasis on human settlements, social infrastructure and transport), water, energy and health. A cross-cutting issue for adaptation in these actions is disaster risk management.

The forestry sector adaptation actions include:

- promoting intensified and sustained forest restoration efforts (afforestation and reforestation programmes, including in urban areas);
- promoting biodiversity and watershed conservation (including re-establishment of wildlife corridors);
- encouraging agroforestry; and
- encouraging efficient biomass energy production and utilization technologies (Republic of Uganda, 2015).

Adjustments in forest management to address climate change in Uganda are important. The importance of adjusting forest management plans and practices to cope with the changing climate revolves around the need to promote community forest stewardship so that communities live in harmony with natural resources like forests and wetlands, reducing the costs of inaction due to climate change, enhancing carbon stocks for reduction of emissions and promoting Ecosystem-based Adaptation (EbA) for ecosystem resilience. Adjusting forest management plans and practices to cope with the changing climate would include strengthening coordination of forestry actors, sensitization programmes, training, technical assistance, forest vulnerability assessment, forest inventories and strengthening GIS mapping (Byaruhanga and Muhammed, 2016).

Rwanda

The priority adaptation actions identified in Rwanda's Green Growth and Climate Resilience Strategy (2011) are ongoing and will be partially or fully achieved by 2050. Many of the actions are specified under sector programmes and have both mitigation and adaptation benefits. Of significance to forestry are: the promotion of afforestation/reforestation of designated areas through enhanced germplasm and technical practices in planting and post-planting processes; improved forest management for degraded forest resources; and the establishment of a national integrated water resource management framework that incorporates district and community-based catchment management, especially catchment forestry practices (Republic of Rwanda, 2015). Current adaptation activities in regards to climate-change adaptation in agriculture include: the creation of radical/bench terraces, especially on steep slopes; erosion control measures; irrigation in valleys (rice and vegetable cultivation); crop rotation in order to maintain soil quality and minimize erosion (reducing the risk of desertification); crop diversification and crop mixing; and agroforestry practices on farms and pastures. In the water sector, adaptation measures include: rainwater harvesting (roof catchment); protecting lakes and river shores; prohibition of settlements; tree/shrub/grass planting along river/lake banks to protect them from erosion; and methane gas extraction from Lake Kivu – a great potential source of energy (electricity and gas). Finally, of relevance to forestry are: protection and management of existing forests; afforestation, reforestation and agroforestry; rehabilitation of natural forests; and rehabilitation of degraded forests.

Ethiopia

Ethiopia's long-term goal is to ensure that adaptation to climate change is fully mainstreamed into development activities. This will reduce vulnerability and contribute to an economic growth path that is resilient to climate change and extreme weather events. Because climate change will affect all geographic areas of the country, its solution requires the participation of the entire population, especially farmers and pastoralists. Parallel to this, Ethiopia's response to climate change aims to integrate actions that improve the status of women and the welfare of children. Measures to address climate change will also be planned and implemented in a manner that addresses the well-being of the elderly, persons with disabilities and environmental refugees. Of relevance to the forest sector is enhancing ecosystem health through ecological farming, sustainable land management practices and improved livestock production practices in order to reverse soil erosion, restore water balance and increase vegetation cover, including drought-tolerant vegetation. Furthermore, Ethiopia has designed comprehensive policies and strategies related to forest development and environmental protections at the federal and regional levels.

Burundi

Burundi's national priorities for adaptation to climate change are clearly outlined in its National Adaptation Programme of Action (NAPA) (Republic of Burundi, 2007); the National Climate Change Policy (2012); and the National Strategy and Action Plan on Climate Change (2012). In regards to forestry, adaptation measures include:

- development and rational management of forest resources, thus raising the forest cover to 20 percent by 2025;
- promotion of sustainable forest resources management; and

- human and institutional capacity building to ensure sufficient capacity to manage forests for increased resilience and reduced vulnerability.

South Sudan

With the effects of climate change already being felt in South Sudan in the form of erratic and reduced rainfall periods, and the consequent increased frequency of droughts and floods, the country is currently in an advanced stage of developing its National Adaptation Programme of Action (NAPA). The NAPA and the Intended Nationally Determined Contribution (INDC) will form the basis of South Sudan's adaptation strategy. A sectoral approach has been adopted in this INDC, though in South Sudan, the technical assessments of vulnerabilities, hazards and priority sectors are limited. Priority actions are based on observed adverse effects of climate change on the various sectors. The INDC includes priority actions in agriculture and livestock, forests, biodiversity and ecosystems, community development and infrastructure. Pertinent to forestry are measures designed to:

- promote agroforestry practices as a way of diversifying land production systems and encourage alternative livelihood options;
- promote afforestation of degraded landscapes/watersheds, using multiuse forest species to increase community safety nets and diversify livelihoods;
- develop forest reserves and management plans to protect watersheds and improve future water availability;
- promote alternative sources of energy to reduce deforestation and the consequent loss of livelihood options;
- improve the enforcement of environmental regulations;
- establish conservancies and protected areas to buffer local communities and biodiversity against climate-change impacts;
- establish water points for wildlife in protected areas to reduce the negative effects of drought on animal populations;
- increase awareness of local communities about climate change and environmental protection;
- introduce fire management plans to prevent the spread of wildfires during periods of drought; and
- introduce an integrated natural resource management approach (Republic of South Sudan, 2015b).

4. Mitigation options and issues

Deforestation and forest degradation are the major activities that result from emissions in forests. If well planned and implemented, forest management practices and approaches – especially those that aim to mitigate deforestation and degradation – can be major avenues towards enhancing carbon stocks in forest ecosystems. Furthermore, any activity in the land-use sector that increases the biomass on land also increases carbon stocks. Other mitigation activities include: conservation of existing carbon stocks; sustainable forest management - which maintains and increases the area of forests to minimize the reduction of carbon stocks in forest management practices; reduced impact logging; and other improved forest management practices. Other mitigation measures include: forest conservation, which involves maintaining the area of intact forests (e.g. in protected areas); and enhancement of forest carbon stocks by increasing the area under sustainable forest and land management practices and through afforestation (Kanninen *et al*., 2010). Other important mitigation measures include the substitution of wood products as an avenue to improve mitigation measures by using materials that could substitute wood for energy and other uses.

United Republic of Tanzania

The United Republic of Tanzania has the potential to address the problem of climate change through enhancing the role of forests in climate-change mitigation. The country has a total of 35.3 million ha of forest land, of which 16 million ha comprise reserved forests, 2 million ha are forests in national parks, and the rest (17.3 million ha) are unprotected forests in general land. The adoption and implementation of REDD+, therefore, provides an exceptional opportunity for the United Republic of Tanzania to benefit from financial mechanisms that take cognizance of the increasing importance of sustainable forest management in reducing emissions and increasing storage of CO_2 to mitigate climate change and its impacts. The government has embarked on sustainable forest management practices that include:

- conservation of existing forests as means of conserving existing carbon stocks;
- encouragement of reduced tillage to mitigate emissions from soils resulting from frequent soil disturbance; and
- production of biofuels and energy conservation through the use of energy-efficient stoves to reduce biomass burning.

The REDD+ institutionalization process in the United Republic of Tanzania could support the mainstreaming of sustainable agricultural practices.

REDD+ seems to follow the same trend as Participatory Forest Management (PFM) but with a stronger incentive package attached and formalized. The government established a REDD+ Strategy in 2013 after a long process of consultation on how to address climate-change mitigation in the forest sector. As part of the global efforts to reduce GHG emissions, the REDD+ package is a stand-alone effort focusing on the forestry sector. Institutionalization of the REDD+ initiative is based on the government's long-term commitment to forest management and to addressing issues of climate change. The REDD+ Strategy gives an additional thrust to government policy on the management of the country's forest resources, especially those on private, community and general land that previously received little attention from government.

The REDD+ Strategy identified eight key factors responsible for deforestation and forest degradation that need to be addressed. In making the REDD+ initiative ready for the implementation phase, two key instruments have been put in place with the assistance of a clear strategy: establishment of the National Carbon Monitoring Centre (NCMC); and establishment of the Measurement, Reporting and Verification (MRV) system. Furthermore, the REDD+ Strategy formulated an institutional arrangement for coordination of REDD+ activities that is entrenched in the existing government structure established by the National Environmental Policy (NEP) (1997) and the Environmental Management Act (EMA) (2004) on the coordination of climate-change programmes.

The United Republic of Tanzania has strategically put the forestry sector at the forefront of mitigation and adaptation to climate change. This is reflected in different legal and institutional frameworks to enable realization of the contribution of forests to climate-change adaptation and mitigation. In the Nationally Determined Contributions (NDC) to the United Nations Framework Convention on Climate Change (UNFCCC), the issues related to forests include:

- enhancing efficiency in woodfuel utilization;
- enhancing participatory fire management;
- enhancing forest governance;
- protection of forest resources; and
- enhancing sustainable forest management by ensuring sustainable utilization and conservation of sufficient areas of forests to cater for different uses.

Forestry also features within the energy sector, with respect to enhancing integrated basin catchment and upstream land management for hydrosources and enhancing the use of renewable energy potential across the country (hydro, solar, wind, biomass and geothermal), all of which are of relevance to forests. The United Republic of Tanzania has also taken steps to mainstream climate change in sectoral policies and practices to ensure harmonized actions, taking cognizance of the fact that climate change is a cross-cutting issue that requires a coordinated, integrated approach.

Uganda

Mitigation actions in Uganda's forestry sector include:

- development of an enabling environment for forestry management, including community forest management, forest law enforcement and governance, and strengthening forest institutions responsible for forest management and development. These actions ensure the conservation of existing forests, and an increased area under forests through community actions, resulting in an increase in (or maintenance of) carbon stocks on land; and
- a reverse deforestation trend to increase forest cover to 21 percent in 2030, from approximately 14 percent in 2013, through forest protection, afforestation and sustainable biomass production measures.

REDD+ (which entails reducing emissions from deforestation; reducing emissions from forest degradation; conservation of forest carbon stocks; sustainable management of forests; and enhancement of forest carbon stocks) is part of the National Climate Change Policy (NCCP) that aims for a harmonized, coordinated approach towards a climate-resilient and low-carbon development path for sustainable development in Uganda. The government will take several steps towards this, including a coordinated response to climate change with a policy framework for the harmonization and coordination of the various sectoral efforts already underway and to be put forth in the future. This calls, in particular, for the following measures:

- the mainstreaming of climate-change concerns in the relevant sectoral, national and local policies, plans and budgets;
- communicating effectively and promoting participatory approaches in climate-change management;
- promoting community-based approaches to adaptation;
- devoting adequate attention to capacity development and institutional set-ups;
- devoting adequate attention to technology needs, development and transfer in climate-change management;
- identifying, developing and influencing financing mechanisms; and
- providing a credible delivery structure for climate-change mitigation (Republic of Uganda, 2012).

Ethiopia

Ethiopia's total GHG emissions in 2010 were 150 $MtCO_2e$. The sectoral GHG emission sources and their quantities were the following:

- Livestock emitted methane and nitrous oxide totalling 65 $MtCO_2e$, i.e. 42 percent of the total.

- Crop cultivation emitted nitrous oxide totalling 12 $MtCO_2e$, i.e. 9 percent of the total.
- Deforestation and forest degradation due to cutting and burning fuelwood and due to logging emitted 55 $MtCO_2e$, i.e. 37 percent of the total.
- Electric power generation emitted 5 $MtCO_2e$, i.e. 3 percent of the total.
- The transport sector emitted 5 $MtCO_2e$, i.e. 3 percent of the total.
- The industrial sector emitted 4 $MtCO_2e$, i.e. 3 percent of the total.
- The building sector emitted 5 $MtCO_2e$, i.e. 3 percent of the total.

The mitigation actions see climate change as a cross-cutting issue that requires an integrated approach. In this respect, several sectors are considered in mitigation, including agriculture (livestock and soil), forestry, transport, electric power, industry (including mining) and buildings (including waste and Green Cities). They hinge on four pillars:

- improving crop and livestock production practices for greater food security and higher farmer incomes while reducing emissions;
- protecting and re-establishing forests for their economic and ecosystem services, while sequestering significant amounts of CO_2 and increasing the carbon stocks on landscapes;
- expanding electric power generation from renewable energy; and
- leapfrogging to modern, energy-efficient technologies in the transport, industry and building sectors.

In the forestry sector, it is important to protect and re-establish forests for their economic and ecosystem services, while sequestering significant amounts of CO_2 and increasing the carbon stocks on landscapes (Federal Democratic Republic of Ethiopia, 2015).

Rwanda

Based on its INDC, Rwanda's mitigation contribution includes reductions from projected emissions for the year 2030. In this respect, Rwanda will take steps based on policies and actions by different sectors, cognizant that each sector has a role to play in climate-change mitigation. Rwanda will adopt an integrated landscape management approach that recognizes the importance of moving beyond single-sector interventions in order to take initiatives that facilitate linkages and encourage coordination among sectors. Priority sectors include forestry, agriculture, energy and infrastructure. The aim of mitigation is a low-carbon economy that aims to achieve energy security and a low-carbon energy supply that supports the development of green industry and services and avoids deforestation. Of relevance to the forestry sector is the promotion of the sustainable use of biomass fuels, and sustainable forestry (i.e. the management of forests according to the principles of sustainable development, which ensures a balance between three main pillars of ecological, economic and socio-cultural values of forest management) and agroforestry.

The Rwanda National Strategy on Climate Change and Low Carbon Development is based on a few "big wins": it addresses the major sectors with high emissions which will enable low-carbon development, thus increasing food and energy security, reducing vulnerability to oil price spikes and reducing payments abroad. The low-carbon development/mitigation is based on enabling pillars that focus on mainstreaming climate resilience and low-carbon development into initiatives that are currently underway in an integrated manner (Republic of Rwanda, 2011b).

Burundi

In terms of mitigation, the INDC for Burundi should make it possible to meet the sustainability objectives defined in national policies and strategies. Under the National Reforestation Programme, Burundi has undertaken to increase its CO_2 gas through 4,000 ha of annual reforestation over the course of 15 years, beginning in 2016, and the replacement of 100 percent of traditional charcoal kilns and traditional home ovens by 2030 (Republic of Burundi, 2015).

South Sudan

South Sudan is embarking on a sustainable development path and employs the latest clean technologies to realize a low-carbon, climate-resilient development outcome. It has committed to undertaking a national GHG inventory, as part of its Initial National Communication, in 2016. This will allow a better assessment of the potential for mitigation and quantify the emission reductions possible through various actions. It aims to undertake actions in the sectors of energy generation and use, land-use/land-use change and transport, in order to address the future emissions that are likely to result from the country's development strategies. These efforts are contingent on the availability of technical assistance to develop the necessary regulations, policies and standards, as well as financial support for investing in low-carbon options.

As regards the forestry sector, South Sudan aims to declare approximately 20 percent of its natural forests as reserve forests in order to protect the country from deforestation. It is embarking on an ambitious reforestation and afforestation project to plant 20 million trees over a period of ten years, as outlined in the National Environmental Policy. This will help to restore watershed and water catchment areas during the post-2020 period as well as sequestering carbon and reducing emissions from deforestation and forest degradation (Republic of South Sudan, 2015a).

5. Adaptation/mitigation synergies and trade-offs

So far, adaptation and mitigation have been treated separately, even though the adaptation measures undertaken by different countries have both adaptation and mitigation components. It is important for adaptation measures to be developed, considering the synergies between adaptation and mitigation. The REDD+ options provide a good example of both mitigation and adaptation (UNFCCC, 2009; Locatelli, 2011; Illman, *et al*., 2013).

United Republic of Tanzania

The United Republic of Tanzania has embarked on (and will continue to embark on) a climate-resilient development pathway. Its adaptation contributions aim to reduce climate-related disasters from 70 percent to 50 percent and reduce the impacts of spatial and temporal variability of declining rainfall, droughts and floods. This has implications for all productive sectors and ecosystems, particularly the agricultural sector. There are also synergies between the activities that mitigate climate change and those that are designed for adaptation. In the forestry sector, they include:

- enhancing efficiency in woodfuel utilization;
- enhancing participatory fire management to reduce emissions associated with extensive biomass burning;
- enhancing forest governance and protection of forest resources for both mitigation and adaptation; and
- enhancing sustainable forest management.

The enhancement of sustainable forest management has the co-benefits of mitigating emissions as well as adapting forest ecosystems and dependent livelihoods to climate change.

In the energy sector, adaptation and mitigation synergies are found in actions that:

- explore and invest in energy diversification systems;
- promote the use of energy-efficient technologies and behaviour;
- enhance integrated basin catchment and upstream land management for hydrosources; and
- enhance the use of renewable energy potential across the country (hydro, solar, wind, biomass and geothermal).

Actions in the coastal, marine environment and fisheries sectors that have synergies for mitigation and adaptation include:

- mangrove and shoreline restoration programmes;
- investment in protection and conservation of water catchments, including flood control and rainwater harvesting structures; and
- promotion of diversified tourist attractions (e.g. ecotourism and cultural tourism).

Uganda

In Uganda, actions with both adaptation and mitigation benefits in the various sectors include (but are not limited to):

- expanding climate information and early warning systems;
- expanding climate-smart agriculture (CSA);
- expanding rangeland management; and
- expanding research on climate-resilient crops.

In the forestry sector, actions include:

- promoting intensified and sustained forest restoration efforts (afforestation and reforestation programmes, including in urban areas);

- promoting biodiversity and watershed conservation (including re-establishment of wildlife corridors);
- encouraging agroforestry; and
- encouraging efficient biomass energy production and utilization technologies.

In the water sector, actions include improving water catchment protection.

In the energy sector, actions include:

- increasing efficiency in the use of biomass in the traditional energy sector;
- promoting renewable energy and other energy sources;
- increasing efficiency in the modern energy sector (mainly electricity); and
- ensuring the best use of hydropower by careful management of water resources.

With respect to risk management, it is important to mainstream climate resilience in all sectors to ensure an integrated approach to climate change adaptation and mitigation.

Rwanda

Rwanda's Intended Nationally Determined Contribution (INDC) is built upon its National Strategy for Climate Change and Low Carbon Development. The full implementation of this strategy rests upon five enabling pillars: institutional arrangements; finance; capacity building and knowledge management; technology, innovation and infrastructure; and integrated planning and data management (Republic of Rwanda, 2015).

Rwanda's long-term vision in adapting to and mitigating climate change is to become a climate-resilient economy, with strategic objectives to achieve:

- energy security and a low-carbon energy supply that supports the development of green industry and services;
- sustainable land-use and water resource management that result in food security,
- appropriate urban development and preservation of biodiversity and ecosystem services,
- social protection, improved health and disaster risk reduction that reduces vulnerability to climate-change impacts.

The vision will be implemented through sectoral adaptation approaches. The priority adaptation actions have been identified in Rwanda's Green Growth and Climate Resilience Strategy (Republic of Rwanda, 2011c) and are ongoing.

Many of the actions specified under the sectoral programmes have both mitigation and adaptation benefits. In the agriculture sector, they include sustainable intensification of agriculture, with actions such as: mainstreaming agro-ecology techniques using spatial plant stacking, as in agroforestry; soil conservation; and land husbandry.

In the forestry sector, mitigation actions include: sustainable forestry, agroforestry and biomass energy, with actions like promoting afforestation/reforestation of designated areas through enhanced germplasm and technical practices in planting and post-planting processes, and employing improved forest management for degraded forest resources.

In the water sector, mitigation actions include integrated water resource management and planning, with actions to establish a national integrated water resource management framework that incorporates district and community-based catchment management. In the land-use sector, Rwanda's programme of action involves actions designed to ensure an integrated approach to planning and sustainable land-use management and to improve spatial data by harnessing ICT and GIS technology.

Burundi

The Burundi Government has a vision designed to fight climate change by developing "a State that promotes development that is resilient to the harmful effects of climate change" (Republic of Burundi,

2015). Several integral and complementary sectoral approaches have been adopted and priority actions defined. In the energy sector, mitigation actions include hydroelectric power production through developments adjusted to align with the successive growth phases of the Burundian economy. In the forestry sector, mitigation actions include: development and rational management of forest resources by raising the forest cover rate to 20 percent by 2025; promoting the sustainable management of forest resources; and human and institutional capacity building. In its National Strategy and Action Plan on Climate Change (2012), Burundi identifies several programmes to be implemented for climate-change adaptation (Republic of Burundi, 2015). One of these programmes relates to climate risk adaptation and management, the components of which are:

- integrated water resources management by a small hydrological unit;
- integrated management of climate risk and forecasts over time (by means of probabilities and forward-looking studies) to enable advance action;
- protection of aquatic and land-based ecosystems;
- coaching of communities to develop resilience to climate change;
- development of institutional and operational capacities to coordinate programmes that are resilient to climate change;
- research on the vulnerability and adaptation of socio-economic sectors to climate change;
- establishment of functional monitoring and evaluation mechanisms for climate change, as well as knowledge management and information mechanisms;
- research and extension on drought-resistant forest species; and
- promotion of climate-smart agriculture (agrometeorology).

Another programme covers capacity building, knowledge management and communication, the components of which are:

- enhancement of data and information management and distribution mechanisms;
- reinforcement of climate-change impact tracking systems by means of observations and investigations;
- improvement of scientific and technological research on adapting to climate change, supported by climate observations;
- improvement of the legislative and regulatory framework for handling climate change as part of investment programmes;
- promotion of public–private partnerships; and
- strengthening of the information and data communication and exchange system.

Burundi has in place several ongoing initiatives to support adaptation. These include:

- Climate Change Adaptation for Soil and Water Resources Conservation (ACCES) Project, financed by the Special Fund for Energy and Climate;
- Watershed Management and Climate Resilience Improvement (PABVARC) Project;
- Communication and Early Warning Strategy for Adaptations to Climate Change;
- integration of smart agriculture into the National Agricultural Investment Programme (NAIP);
- National Action Plan; and
- various Global Environment Facility (GEF) small grants projects.

Ethiopia

Ethiopia intends to undertake adaptation initiatives to reduce the vulnerability of its population, environment and economy to the adverse effects of climate change. This will be done through its Climate-Resilient Green Economy (CRGE) Strategy, integrated into the national Second Growth and Transformation Plan, which is a strategy to ensure a resilient economic development pathway while decreasing per capita emissions.

Several sectors will be considered in the adaptation process, including agriculture (livestock and soil), forestry, transport, electric power, industry (including mining) and buildings (including waste and Green Cities). In moving towards the long-term adaptation goal, the main effort up to and beyond

2020 is for Ethiopia to increase resilience and reduce vulnerability of livelihoods and landscapes in three pillars: drought, floods and other cross-cutting interventions. The emissions reduction, which constitutes a reduction of 255 $MtCO_2e$, or 64 percent compared to "business-as-usual" (BAU) emissions in 2030, includes 90 $MtCO_2e$ from agriculture, 130 $MtCO_2e$ from forestry, 20 $MtCO_2e$ from industry, 10 $MtCO_2e$ from transport and 5 $MtCO_2e$ from buildings.

South Sudan

An intersectoral approach has been adopted in South Sudan's Intended Nationally Determined Contribution (INDC), although the technical assessment of vulnerabilities, hazards and priority sectors is limited. Priority actions are based on observed adverse effects of climate change on the sectors. Further assessments of specific actions and needs are required.

INDC includes priority actions in the agriculture and livestock sector. This sector provides the main livelihood for the majority of the population. South Sudan will thus embark on promoting sustainable, climate-smart agriculture and livestock production and management. Actions to reduce the population's vulnerability to climate change-induced hazards in the agriculture sector include:

- enhancing access to water (in light of growing climate threats) through integrated watershed management, wetland management and improved waste management;
- enhancing food security under a changing climate through the introduction of climate-smart agricultural techniques and irrigated agriculture; and
- ensuring capacity building and participation of the society, local communities, indigenous peoples, women, men, youth, civil organizations and the private sector in national and subnational climate change planning.

In the area of forestry, biodiversity and ecosystems, the actions include:

- supporting forest governance;
- reducing over-reliance on forest products by providing alternative income-generating activities; and
- encouraging planting of climate-resilient tree species.

This will be further supported by the development of mechanisms to ensure equitable sharing of the benefits accrued from the forest resources management.

6. Climate-change policies, strategies and issues

Policies and strategies

United Republic of Tanzania

The United Republic of Tanzania has several policies, strategies and plans that directly or indirectly address issues pertaining to climate change and their impacts on various sectors. The sectors themselves have put in place policy directives that seek to provide solutions to the impacts of climate change. These policies, strategies and plans further provide policy directives, guidelines and steps towards addressing adaptation and mitigation priorities by the various sectors affected by climate change (Majule *et al*., 2015). In addition, the government has adopted and implemented various other policies, legislations, strategies, plans and programmes in the course of addressing climate change. Some of these are the following:

- National Environmental Policy (NEP) (1997);
- National Forest Policy (1998);
- National Communications (2003 and 2015);
- Environmental Management Act (EMA) (2004);
- National Adaptation Programme of Action (NAPA) (2007);
- National Environment Action Plan (NEAP) (2012–2017);
- National Transport Master Plan (2013);
- Zanzibar Environmental Policy (2013 and 2014);
- National REDD+ Strategy and Action Plan (2013);
- Natural Gas Policy (2013);
- Renewable Energy Strategy (2014); and
- Natural Gas Act (2015) (United Republic of Tanzania, 2015).

Tanzania Development Vision 2025

This Vision lies at the heart of the United Republic of Tanzania's economic and social development and provides the country's long-term strategic focus. All other government policies and programmes are expected to fall in line with the Vision. For example, climate-change impacts, which cut across all the five thrusts of the Vision, are supposed to be addressed by each sector.

National Environmental Policy (1997)

Climate change, as one of the cross-cutting issues in natural resources management, is embedded in the umbrella policy. Thus the United Republic of Tanzania has only one Climate Change Strategy to enforce and operationalize climate-related issues of concern, as directed by the National Environmental Policy (NEP) and its 2004 Environmental Management Act (EMA). Other line sectors, which directly or indirectly interact with the NEP and EMA, have their own policies, acts, guidelines and strategies.

National Strategy for Growth and Reduction of Poverty

The National Strategy for Growth and Reduction of Poverty (NSGRP II) (MKUKUTA II) has three clusters, among which the first, "Growth for reduction of income poverty", is concerned with climate change. This cluster has three broad outcomes and five goals. The fourth goal is "ensuring food and nutrition security, environmental sustainability and climate change adaptation and mitigation". Thus MKUKUTA II laid the foundation on which climate-change issues are articulated in government policies and strategies that aim to improve livelihoods and raise incomes.

Agricultural Environmental Action Plan (2011–2017)

This reinforces the Environmental Management Act (2004) and addresses the General Budget Support Performance Framework requirements. Management of natural resources in the agricultural sector has

been the main emphasis for action: among the key issues identified is land degradation due to deforestation and livestock overgrazing.

Revised National Forest Policy (2012)

The revised National Forest Policy reiterates how forests will be affected as climate is projected to change towards drier regimes. Key policy areas relevant to climate change include: Forest Land Management and Ecosystem Conservation and Management.

National Climate Change Strategy (2012)

The National Climate Change Strategy (NCCS) covers a broad natural resource base in addressing issues pertaining to climate change. It covers interventions in adaptation and mitigation, and cross-cutting issues that affect the social, economic and physical environment. The NCCS has been the main strategy document driving the implementation of the climate change and variability agenda; it is also responsible for guiding other sectoral strategies in this thematic area. The NCCS's goal is to enable the United Republic of Tanzania to effectively adapt to climate change and participate in global efforts to mitigate it, with a view to achieving sustainable development in line with the Five Year National Development Plan and the Tanzania Development Vision 2025, as well as with national sectoral policies. This strategy also reaffirms the United Republic of Tanzania's commitment to address climate change in consideration of the fact that the country is among the most vulnerable group of countries globally. The challenge of climate change mitigation requires the commitment and participation of all countries. Under the auspices of the United Nations Framework Convention on Climate Change (UNFCCC), the United Republic of Tanzania will effectively participate, provided there is adequate and sustained support.

National Agricultural Policy (2013)

Development of the agricultural sector in the United Republic of Tanzania is founded on a basis of natural resource management. Agricultural intensification, led by the government, should entail a low-carbon pathway in order to help mitigate climate change. Thus the Ministry of Agriculture has put forward several policy statements and guidelines to address environmental and climate change issues pertaining to the agricultural sector. Among these, activities that enhance the carbon-storage capacity (for example, conservation agriculture and agroforestry) will be upscaled and the efficient use of renewable natural resources will be strengthened.

National REDD+ Strategy (2013)

The United Republic of Tanzania has developed and adopted a National REDD+ Strategy to address the mitigation of climate change. The strategy's main goal is to facilitate effective and coordinated implementation of REDD+ related policies, processes and activities in order to contribute to the climate change agenda and overall sustainable development. The REDD+ institutionalization process in the United Republic of Tanzania could also support the mainstreaming of sustainable agricultural practices. As part of global efforts to reduce GHG emissions, the REDD+ package is a stand-alone effort focusing on the forestry sector. Institutionalization of the REDD+ initiative is based on the government's long-term commitment to forest management and to addressing issues of climate change. Two key instruments have been put in place towards operationalization of the REDD+ Strategy: the National Carbon Monitoring Centre (NCMC) and the Measurement, Reporting and Verification (MRV) system, with an institutional arrangement for coordination entrenched in the existing government structure.

Agriculture Climate Resilience Plan (2014–2019)

The Agriculture Climate Resilience Plan (ACRP) seeks to: (a) respond to the most urgent impacts posed by climate change variability in the crop subsector; (b) mainstream climate change in agriculture policies, strategies, initiatives and plans; and (c) build the resilience of current crop productivity and future investment.

National Climate Change Strategy

The strategy underscores the fact that all countries must play a role in addressing climate change consistent with their unique national circumstances. The United Republic of Tanzania will do its part, in particular, by improving energy availability to reduce deforestation. It will also improve the energy diversification and efficiency of its major energy-consuming sectors, including power generation, manufacturing and transportation. Sustainable production and use of coal will remain central to ensuring the availability of affordable and reliable energy sources in the country.

With over 33.5 million ha of forest reserves, and sizeable rural land under forest cover, the United Republic of Tanzania's commitment to the conservation of its forests is timely, considering that these contribute to sustainable development and act as a sink of GHG produced elsewhere. The strategy provides strategic interventions to ensure that the communities, and the nation as a whole, benefit from such global services.

According to the United Republic of Tanzania (2012a), the National Climate Change Strategy covers adaptation, mitigation and cross-cutting interventions that will enable the country to benefit from the opportunities available to developing countries in their efforts to tackle climate change, as recognized under the Copenhagen Accord, Cancun Agreements and Durban Platform for Enhanced Action, including opportunities offered by REDD+.

In addressing climate change at national level, the government has undertaken various initiatives and programmes. Those which have a bearing on forestry include:

- preparation of the national Clean Development Mechanism (CDM) Investor's Guide to enable the approval process for CDM projects in the United Republic of Tanzania;
- preparation of the National CDM Handbook to further implement the approval procedure for CDM in the United Republic of Tanzania;
- preparation of the National REDD+ Framework, including the National REDD+ Strategy. Its main goal is to facilitate effective and coordinated implementation of REDD+ related policies, processes and activities so as to contribute to the climate change agenda and overall sustainable development. It will also establish mechanisms required for the United Republic of Tanzania to benefit from a post-2012 internationally approved system for forest carbon trading, based on demonstrated emission reductions from deforestation and forest degradation; and
- establishing the Climate Change, Impacts, Adaptation and Mitigation programme (CCIAM), a research programme initiated to support the country's REDD+ implementation capacity. The programme has developed a comprehensive research and methodology tool kit for climate change adaptation and mitigation that can enable the United Republic of Tanzania to implement the post-2012 climate mitigation and adaptation regimes successfully.

Uganda

Uganda has developed several national policies related to climate change. Although the National Development Plan (NDP) (2010) does not adequately capture climate change, it has a subsector on disaster management that reflects climate change – the objectives seem to focus on disaster impacts, disaster preparedness, risks and management, but not climate change adaptation.

The Disaster Preparedness and Management Policy (DPM) (2010) mentions climate change as one of the issues that need to be addressed and calls for proactive action to encourage climate change mitigation and adaptation. The Environment Policy (1995) recognizes the need to monitor the climate and atmosphere, with the aim of guiding land-use and economic decisions to address climate change. The Energy Policy (2002) mentions climate change, although it does not clearly spell out how climate change and disaster risk reduction will be addressed.

The agriculture sector Development Strategy and Investment Plan (DSIP) (2010) identifies climate change as one of the challenges affecting Uganda's agricultural output. It recommends the

development of plant and animal varieties that are resistant to climate change as a strategy for adaptation.

The National Land-use Policy (2007) notes that climate variability is responsible for current trends of drought and desertification and calls for better monitoring and coping strategies. The Forest Policy (2001) acknowledges the importance of participating in international obligations such as the UNFCCC. The National Water Policy (1997) suggests negligence in human activities as the main threat to water resources although it does not propose specific measures to address challenges in water resources resulting from climate change.

The Climate Change Policy (2012) recognizes the need to act upon a number of sector-specific priorities in order to: (a) increase the resilience of the country's development path to the impacts of climate change; and (b) contribute to the reduction of atmospheric GHG emissions. The National Adaptation Programme of Action (NAPA) (2007) lists climate change impacts in the context of trends such as: rapid population growth, agricultural production, water availability, food security, health, education, infrastructure development, energy, deforestation/forestry, wildlife, weather and climate information. Uganda has developed its Nationally Appropriate Mitigation Actions (NAMAs) for the development of grid-connected renewable energy and sustainable charcoal in the country.

Uganda initiated the REDD+ process by preparing and submitting a REDD+ Readiness Preparation Proposal (R-PP) in March 2010. The undertaking involved an analysis and description of the actions necessary to prepare Uganda for REDD. In March 2011 the draft R-PP was presented for comments to the Forest Carbon Partnership Facility (FCPF) Participants' Committee (PC) and the Technical Advisory Panel (TAP). The final R-PP was approved during the ninth PC meeting in Oslo on 22 June 2011, with comments. Uganda submitted an acceptable and updated R-PP in May 2012. The Readiness Preparation Grant Agreement was signed on 10 July 2013 between the Government of Uganda (represented by the Minister of Finance, Planning and Economic Development) and the International Bank for Reconstruction and Development (acting as a trustee of the Readiness Fund of the FCPF).

The Government of Uganda is developing a National REDD+ Strategy as a long-term measure for tackling deforestation and forest degradation, ensuring sustainable forest management, and enhancing carbon stocks and forest biodiversity conservation, while meeting the demands for energy, and other forest products. The intended REDD+ Strategy options must be developed with a view to enhancing their positive impacts, and reducing any likely negative social and environmental consequences for forest-dependent communities and the communities overall. The goal for R-PP implementation support is "Uganda ready for REDD+ by 2016". This goal aims at ensuring that Uganda completes all assessments, and designs and approves a REDD+ Strategy for the country.

Rwanda

The National Forestry Strategic Plan builds on the constitution of the Republic of Rwanda, the government's flagship programmes of Vision 2020, the Economic Development and Poverty Reduction Strategy (EDPRS), the Environment and Natural Resources Sector Strategic Plan (ENRSSP), the National Forestry Policy and other sectoral policies (Republic of Rwanda, 2010b).

Constitution of the Republic of Rwanda

Article 49 of the constitution reflects the close link of forestry to the environment and stipulates that:

- Every citizen is entitled to a healthy and satisfying environment.
- Every person has the duty to protect, safeguard and promote the environment.
- The State shall protect the environment.
- The law will determine modalities for protecting, safeguarding and promoting the environment.

Vision 2020

Vision 2020 recognizes that the major problem in the field of environmental protection in Rwanda is the imbalance between the population and the country's natural resources. This leads to alarming degradation, observed through massive deforestation, the depletion of biodiversity, erosion and landslides, pollution of waterways and the degradation of fragile ecosystems. The Vision further argues that wood is the energy source for 99 percent of the population, which leads to massive deforestation and soil destruction; it therefore recommends diversification of energy sources and making them accessible to the population in order to ease the pressure on biomass.

Economic Development and Poverty Reduction Strategy (EDPRS)

Rwanda's EDPRS for the period 2008–2012 prioritizes forestry as a strategic sector for public intervention in order to limit the degradation of natural resources. Accordingly, EDPRS (2008–2012) recommends that the forestry sector designs and implements a reforestation strategy with diverse species, an inventory and the mapping of national forest resources. This will form the basis for a ten-year national forestry plan and a joint strategy with the Ministry of Agriculture and Animal Resources (MINAGRI) to promote agroforestry for non-wood uses, including medicinal uses, honey production, wild foods and handicraft production. EDPRS (2008–2012) further proposes:

- an increase of forest and agroforestry cover from 20 percent (2006–2007) to 23.5 percent (2012) of total surface land area, an increment of 89 583 ha;
- a reduction of annual wood consumption by 30 percent;
- the rehabilitation of degraded ecosystems such as Gishwati and Mukura by 80 percent;
- the intensification of agroforestry over up to 85 percent of farmlands; and
- the development of a strategy to involve the private sector in forest management.

Sectoral policies and strategies

Forestry activities are interlinked with many development sectors due to the cross-cutting nature of goods and services provided by forests.

The National Environment Policy and Strategy acknowledges that soil erosion is among the major environmental problems faced by the country and proposes adequate forest/vegetation cover as one of the solutions.

The National Population Policy recognizes environmental degradation as one of the causes of poverty in the country and recommends that the Ministry of Natural Resources should consider land degradation and deforestation as national priorities.

The action plan drawn up by MINAGRI aims to enhance soil fertility and water conservation through control of soil erosion. Among the priority actions proposed is agroforestry using nitrogen fixing and multipurpose trees.

In Rwanda, the majority of the population (more than 90 percent) depend largely on biomass energy. The Energy Policy proposes to increase production and improve access to alternative energy by a larger number of people. Strategies proposed include the dissemination and promotion of improved stoves as a means of saving wood.

The Water Policy aims at equitable and sustainable access to clean water for all and enhancement of the management of water resources through reforestation of water catchment areas.

The National Agricultural Policy and the Agricultural Transformation Strategy aim at ensuring food security by means of increased agricultural production and income generation through crop intensification, diversification and the improvement of agroprocessing and marketing systems. The increase in agricultural production will be achieved mainly through improvement of soil fertility and erosion control. This is possible through the promotion of agroforestry practices.

The Industrial Policy and Investment Code aim to increase value addition to primary production in order to boost exports and create more jobs. This policy mentions, in particular, value addition on forest products through wood processing and woodwork (the production of wooden panels, plywood and match-making, among other activities).

The Gender Policy clearly states the integration process of gender-related issues in all development sectors in order to promote gender equity and equality. In Rwanda, forests and trees provide the bulk of energy used by most households. The collection of fuelwood is usually the responsibility of women and children. Easy access to forests and trees may eventually improve the livelihoods of vulnerable groups, especially women and children.

The overall goal of the Land Policy is to establish a land-tenure system that ensures security for every Rwandan citizen. Thus, the policy aims to guarantee equal rights on land tenure for all users of the land, so they may invest more in the land and use it rationally. Land tenure has a direct relationship to tree tenure and forestry as well as implications for climate change adaptation and mitigation.

National Forestry Policy and Forest Law

At the global level, new developments in efforts to mitigate and adapt to global warming also call for a new interest in forests as carbon sinks (in addition to their traditional ecological and economic roles). The revised National Forest Policy and the National Forestry Strategy have principles that guide the implementation of forest management plans, among which are the following:

- Sustainable Forest Management (SFM): to manage all forest and tree resources so that they yield sustainable streams of social, economic and ecological goods and services in order to meet the forestry needs of the current generation without compromising similar rights of future generations;
- species diversification: to use a wide range of tree species in reforestation programmes on the basis of species matching to site in order to increase resilience of forest ecosystems to climate change;
- agroforestry technologies: to promote on-farm forestry, using multipurpose fertilizer tree species to enhance carbon capture on the land;
- gender and equity: to integrate assenting actions in all forest management plans in order to redress gender inequalities and aid disadvantaged groups; and international obligations: to internalize current and future international conventions, agreements and protocols related to forestry in all strategies and interventions in the forest sector with a bearing on mitigating climate change through sustainable forest management.

Ethiopia

Ethiopia has undertaken several strategic and programmatic adaptation actions. They include:

- NAPA since 2007;
- Ethiopian Programme of Adaptation to Climate Change;
- Nine National Regional States and two City Administrations adaptation plans;
- five sectoral adaptation plans; and
- Agriculture-sector Adaptation Strategy.

Other sectoral policies include agriculture (livestock and soil), forestry, transport, electric power, industry (including mining) and buildings (including waste and Green Cities).

Burundi

In its Vision Burundi 2025, the government states its intention to fight against climate change as follows: “A State that promotes development that is resilient to the harmful effects of climate change”. Activities relating to climate change were marked in particular by the development and publication of the first and second national communications under the UNFCCC for Burundi and the NAPA. These documents put forward the need for each sector to address issues of climate change during the implementation of its policies.

The policy documents that take climate change and GHG emissions generating activities into consideration include:

- energy: Sectoral Strategy for the Energy Sector in Burundi (2011); National Environment Strategy;
- land use and forestry: National Forestry Policy of Burundi (2012); National Biodiversity Strategy and Action Plan (2013–2020); and
- agriculture: National Agricultural Strategy, 2008–2015 (2008); National Sustainable Land Use Strategy (2007); National Action Programme to Fight Land Degradation (2005); National Strategy and Action Plan to Fight Soil Degradation (2011–2016); National Agricultural Investment Plan (2012–2017).

Other documents with a bearing on climate change are: Vision Burundi 2025; Strategic Framework for Growth (2012); first and second national communications on climate change (2001 and 2010); National Adaptation Programme of Action (2007); summary report on GHG inventories (2009); summary report on GHG emission mitigation studies (2009); National Climate Change Policy (2012); and National Strategy and Action Plan on Climate Change (2012).

Current policy and strategy documents for adaptation in Burundi with a bearing on forestry include: National Water Resources Management Policy and Action Plan (2001) and the Water Code (Law 1/02 of 26/03/2012) enacting the Water Code in Burundi, all with a bearing on management of forests for the protection of water and fight against land degradation; Sectoral Strategy for the Energy Sector in Burundi (2011) and Law 1/13 of 23/04/2015, reorganizing the electricity sector in Burundi, with a bearing on biomass energy and forest management; National Forestry Policy of Burundi (2012), catering for sustainable forest management; National Agricultural Strategy, 2008–2015 (2008); National Action Programme to Fight Land Degradation (2005); and Sustainable Land Use Strategy (2007), all of which aim to reduce deforestation and land conservation through forestry practices.

South Sudan

South Sudan is vulnerable to climate change, and the associated socio-economic losses and damage, due to the dependence of its population on climate-sensitive natural resources for their livelihoods. Furthermore, there is currently only limited institutional and technical capacity, appropriate technologies and financial resources to support the implementation of interventions for adaptation to climate change. The Ministry of Environment has developed an Environment Policy Framework and Environmental Bill that will regulate the exploitation of natural resources and all forms of socio-economic development in the country. Both the policy and the bill will address the drivers of environmental degradation and contribute to the mitigation of climate change while ushering the country towards a path of environmentally sustainable development. To respond to the negative impacts of climate change, the Ministry of Environment – in collaboration with other line ministries and civil society stakeholders – has developed a NAPA (2015) to form the basis for adapting to the new realities of climate change impacts.

Within the context of these national circumstances, South Sudan's INDCs are based on a cross-sectoral consultative process involving multiple stakeholders that was conducted in parallel with the NAPA preparatory work and associated meetings. The INDCs will also contribute towards the attainment of the South Sudan Vision 2040 and the South Sudan Development Plan, both of which aim (among other objectives) to ensure that economic development is environmentally sustainable.

As for mitigation, South Sudan is embarking on a sustainable development path and would like to employ the latest clean technologies to realize a low-carbon, climate-resilient development outcome. The government has committed to undertaking a national GHG inventory, as part of its Initial National Communication, in 2016. This will allow a better assessment of the potential for mitigation and quantify possible emission reductions. South Sudan aims to undertake policies and actions in the sectors of energy generation and use, land-use, land-use change and forestry (LULUCF) and

transport, in order to address the future emissions that are likely to result from its growth strategies. However, this is contingent on the availability of technical assistance to develop the necessary regulations, policies and standards, as well as on financial support for investing in low-carbon options. In the area of energy generation and energy use, such actions include:

- increasing the use of clean and carbon-neutral energy;
- construction of a hydroelectricity plant at the Fulla rapids;
- increasing the use of the country's high potential for solar and wind energy to meet the energy demand;
- increasing the efficiency of biomass use (particularly fuelwood and charcoal) in the traditional energy sector;
- increasing the efficiency of electricity usage in the formal energy sector; and
- ensuring the best use of hydropower by careful management of the water resources.

In the LULUCF sector, the area considered is reforestation and deforestation. With its abundant natural forests, South Sudan aims to declare approximately 20 percent of its natural forests as reserve forests to protect the country from deforestation. It will embark on an ambitious reforestation and afforestation project to plant 20 million trees over a period of 10 years (2 million trees in each of its 10 states), as outlined in the National Environmental Policy. This will contribute towards restoring watershed and water catchment areas during the post-2020 period as well as sequestering carbon and reducing emissions from deforestation and forest degradation.

In the transport sector, the country aims to establish emission standards for vehicles. Exhaust testing centres will be set up: cars that fail the tests by emitting fumes above allowable emissions levels will have to undergo mandatory repairs or be scrapped. Measures are being considered to restrict imports of vehicles that do not adhere to permissible emissions levels. To maintain a clean and green environment, the country will encourage payment for ecosystem services and access to resources, and institute benefit sharing to avoid depletion of important natural resources. This would contribute towards the sustainability and viability of initiatives to reduce emissions from deforestation and forest degradation.

Integration of climate change issues into forest policy, legal and institutional frameworks

United Republic of Tanzania

The United Republic of Tanzania has strategically put the forestry sector at the forefront of mitigation and adaptation to climate change. This is reflected in different strategies, and legal and institutional frameworks, to enable realization of the contribution of forests to climate change adaptation and mitigation. In the INDC to the UNFCCC, the issues considered with respect to forests include:

- enhancing efficiency in woodfuel utilization;
- enhancing participatory fire management;
- enhancing forest governance;
- protection of forest resources; and
- enhancing sustainable forest management by managing forests according to the principles of sustainable development.

These aim to retain the balance between three main pillars: ecological, economic and socio-cultural.

Within the energy sector, forestry also features with respect to enhancing integrated basin catchment and upstream land management for hydrosources, and enhancing the use of renewable energy potential across the country (hydro, solar, wind, biomass and geothermal), all of which are of relevance to forests. The key issue in the National REDD+ Strategy is sustainable forest management, and forest management features are substantially covered in the strategy. The main goal of the National REDD+ Strategy is to facilitate effective and coordinated implementation of REDD+ related policies, processes and activities in order to contribute to the climate change agenda and overall

sustainable development. It will establish the necessary mechanisms for the United Republic of Tanzania to benefit from a post-2012 internationally approved system for forest carbon trading, based on demonstrated emission reductions from deforestation and forest degradation.

The Climate Change Strategy reiterates the role of forestry in climate change mitigation, especially in the aspect of REDD+ related to sustainable forest management. The National Environmental Policy (1997) also advocates the role played by forestry in climate change mitigation by recognizing the main objective of the forest policy in development of sustainable regimes for soil conservation and forest protection, taking into account the close links between desertification, deforestation, freshwater availability, climate change and biological diversity.

Uganda

As one of the means to monitor climate change, the parties to the UNFCCC undertake to periodically update, publish and make available to the Conference of Parties national inventories of anthropogenic emissions by source, and removals by sinks, of all GHG not controlled by the Montreal Protocol, using comparable methodologies to be agreed upon by the Conference of Parties. Uganda carried out a National Inventory of Sources and Sinks of Greenhouse Gases in 1993; this was partly updated in 1995. The emission categories covered in this inventory are: energy; industrial processes; agriculture; solvents; land-use change and forestry; and waste. The inventory gives a comprehensive list of emissions of GHG by source, and removals by sinks, in Uganda.

With respect to mitigation measures, Uganda has put an emphasis on “no-regrets” mitigation option measures through the Uganda Enabling Project and the East African power study, which carried out a GHG mitigation assessment in the energy sector. The measures adopted by Uganda to mitigate emissions, forestry and land use are among the major sectors given particular consideration when it comes to the Kyoto Protocol – afforestation/reforestation; renewable forms of energy; enhancement of sinks; CO_2 sequestration; and promotion of sustainable forest management practices (the REDD+ aspects) (Mabasi, 2008).

In 2011 Uganda submitted a Readiness Preparation Proposal (R-PP) to the Forest Carbon Partnership Facility (FCPF) with the aim of developing strategies to address the drivers of deforestation and forest degradation. Formulated in coordination with the Ministry of Water and Environment and the National Forestry Authority, the proposal seeks to realize this goal through a number of key objectives. They include: promoting sustainable forest management and conservation; piloting test processes for stakeholder engagement in implementing REDD+ initiatives; and developing the various logistical, procedural and institutional mechanisms that will facilitate the implementation of the REDD+ Strategy.

Forests and forestry are central to Uganda’s economic and social development. As a result, outside of the climate change motivated REDD+ Strategy, several policies and action plans relating to forestry have been developed. The Ugandan Forestry Policy (UFP) of 2001 and the National Forest Plan (NFP) of 2002 are two examples of such instruments. The UFP is guided by general principles designed to coincide with the government’s priorities of poverty eradication and good governance. The overall objective of the policy is to manage the use of forests to meet present needs without jeopardizing the rights of future generations. The policy aims to achieve sustainable increases in economic, social and environmental benefits in order to improve livelihoods while safeguarding biodiversity through conservation and improved governance. To achieve this, the government is tasked with protecting, maintaining and managing the state-owned Permanent Forest Estate while also improving public education and advisory services to the private sector and civil society to ensure that privately owned forests are well maintained.

The NFP, meanwhile, provides a framework to implement the UFP. The overarching aim of the NFP is to develop an integrated forest sector that is able to achieve sustainable increases in economic, social and environmental benefits from forests and trees. The objectives of the NFP, more specifically, focus on poverty eradication, economic development and sustainable forest resource

management. The NFP also identifies seven programmes of action to achieve these objectives. These programmes cover issues such as proper regulation and conservation of forests, increased awareness of good forestry practice, development of commercial forestry and promotion of forestry research (Nachmany *et al*., 2015).

Ethiopia

The major direct drivers of deforestation and degradation in Ethiopia are numerous and include:

- forest clearance and land-use conversion for smallholder agricultural expansion;
- illegal extraction and collection of forest products (mainly fuelwood and charcoal);
- government-led human settlement in forest areas;
- forest fires; and
- increasing development of infrastructure and road networks in proximity to forests.

More specifically, deforestation and degradation in Ethiopia are mainly triggered by drought and low agricultural productivity, and by weak monitoring and law-enforcement capacity of the local governments.

Amid this pressure on Ethiopia's forests from the various drivers and actors, the government is adopting policy measures and practical undertakings to harness deforestation and reduce GHG emissions from deforestation and forest degradation as a matter of policy related to forestry and the environment. The country has adopted the Climate-Resilient Green Economy (CRGE) Strategy, which aims to build sustainable economic development through substantial CO_2 emission reductions in major economic sectors. The forestry sector is identified as one of the four fast-track implementation pillars responsible for achieving 50 percent of the national abatement potential. In view of this, the government has fully embraced REDD+ as an integral part of the national CRGE Strategy. Another important milestone is the government's issuance of the country's first forest policy proclamation in 2007, with a set of incentives encouraging private-sector and community participation in forestry activities. The country also established its first Ministry of Environment and Forest in 2013, instituting the national REDD+ Secretariat under the new ministry. Ethiopia is also undertaking several multisectoral programmes in its nationally appropriate mitigation actions (including afforestation and reforestation programmes, degraded lands rehabilitation and watershed management projects), all designed to mitigate the adverse effects of climate change.

Rwanda

The objective of Rwanda's Environment and Natural Resources Strategic Framework is to ensure that the environment and natural resources are utilized and managed productively in support of equitable and sustained national development and poverty reduction, as indicated in the government's Economic Development and Poverty Reduction Strategy (EDPRS). This will be achieved through five specific objectives:

- to increase and sustainably manage ecosystems and forest resources to optimize their economic as well as their ecological functions;
- to put in place and operationalize an efficient system of land administration and land management that secures land ownership, and promotes investment in land for socio-economic development and poverty reduction;
- to ensure that development in Rwanda is undertaken in a manner that inflicts minimal damage on the environment, and building resilience to threats posed by climate change, in order to provide sustained support for Rwanda's economic, social and cultural development;
- to secure and provide water of adequate quantity and quality for all social and economic needs of present and future generations, with the full participation of all stakeholders in decisions affecting the management of this resource; and
- to improve the geology and mines subsector to contribute optimally and sustainably to the national income and to the social and economic welfare of the community (Republic of Rwanda, 2013).

The priorities and innovations of the Environment and Natural Resources (ENR) sector will focus mainly on supporting key thematic areas identified in EDPRS II (2013–2018) related to economic transformation, rural development, productivity and youth employment, and effective governance. The contribution of forestry resources to economic growth and poverty reduction will be attained by the increase of forest cover across the nation as well as the increase and sustainable management of ecosystems and forestry resources.

Rwanda's EDPRS II retains forestry as a main concern in recognition of its prime contribution to GDP. This will be achieved through increased job creation in forestry from 0.3 percent to 0.5 percent by 2018, and a reduction in the use of biomass energy through the use of improved stoves and kilns to produce 75 percent of charcoal by 2018. EDPRS II supports the previous targets of increasing forest cover to 23.5 percent by 2012, and resets a new indicator to reach 30 percent by 2018. In addition, EDPRS II recommends the sustainable management of forest biodiversity and critical ecosystems through protection and maintenance of 10.25 percent of the land area, and a reduction of wood energy consumption from 86.3 percent to 50 percent by 2020, as reflected in the Vision 2020 targets.

Burundi

Among Burundi's national priorities for climate change adaptation are those stipulated in various country strategic documents/programmes, such as the NAPA (2007), the National Climate Change Policy (2012), the National Strategy and Action Plan on Climate Change (2012) and the National Forestry Policy of Burundi (2012). All these policy and programme documents affirm the need to use forests and forestry as one of the avenues for climate change mitigation and adaptation. Specific aspects related to climate change include:

- the crucial role played by increasing forest cover and maintaining an ecological balance as a key foundation of sustainable development;
- the contribution to climate change mitigation and climate regulation by increased carbon stocks;
- the attention paid to the maintenance of natural forest cover; and
- the preservation of some regional species, such as medicinal plants, and possession of a comprehensive institute (arboretum) which conserves more than 205 species.

The priority areas for adaptation include common forestry activities such as reforestation and agroforestry, with priority actions of reforestation of terrains on steep slopes and colonization of terrains on mild slopes through agroforestry. The reforestation and agroforestry actions have a strong bearing on climate change with respect to increasing carbon stocks on the land and mitigating carbon emissions. Burundi's NAPA recognizes forestry activities as among the major paths towards climate change mitigation and adaptation. Such activities in forestry include:

- preserving existing woodlots and reforesting the stripped zones;
- reinforcing the management of the existing protected areas and protecting threatened and vulnerable natural ecosystems; and
- identifying and popularizing drought-resistant forest species.

South Sudan

The main objectives of South Sudan's forestry policy include:

- protecting, establishing and developing forestry resources in a way that achieves full protection for the environment and meets the country's needs in terms of food production;
- assessment and national planning to invest in forest land;
- bolstering the role of agricultural production;
- combating desertification;
- improving forest management outside the reserved areas and encouraging citizens to participate in management; and
- establishing community forests with multiple uses.

South Sudan's forestry policy is relatively strong in terms of: (a) recognizing forests as providers of critical environmental services; and (b) proposing activities to enable the flow of climate financing to South Sudan. The policy also calls for: the ratification of UNFCCC; the requirements for REDD to be met; and the establishment of a designated national authority to coordinate international assistance for climate change adaptation and mitigation in South Sudan. However, one of the policy's weaknesses is that it does not recognize climate change as one of the threats to forests, failing to suggest how to protect them from the impacts of climate change. Although the land policy and law require an environmental and social impact assessment before any land investment activities take place, they say little about the challenges of climate change regarding land use except the mention of displacement due to natural disasters.

The policy on wildlife conservation and protected areas recognizes climate change as a threat and suggests coping strategies such as institutional partnerships to study, predict and monitor the impacts and make adaptation protocols. However, it does not clearly state how to protect wildlife species and their habitats from climate change-induced floods and droughts. Nor does it make a case for mitigation or reduction of GHG emissions. Energy policies, which include the petroleum and electricity sectors, have no direct measures to address climate change, even though an environmental and social impact assessment and an environmental baseline assessment are required before the development of any energy project.

Main policies and strategies relevant to climate change and forests, and recent changes

United Republic of Tanzania

The Government of the United Republic of Tanzania has put in place several policies, strategies and plans that directly address issues pertaining to climate change and their impacts on various sectors. These sectors, which are highly affected by climate change, have put in place policy statements and directives that seek to provide solutions to the impacts of climate change. These policies, strategies and plans further provide policy directives, guidelines and steps towards addressing adaptation and mitigation priorities by the various sectors affected by climate change (Majule *et al*., 2015).

The Tanzania Development Vision 2025 is designed to foster the country's development agenda: all other government policies and programmes are expected to fall in line with this Vision. For example, climate change impacts – which cut across all the five thrusts – are supposed to be addressed by each sector.

The National Environmental Policy (1997) is an umbrella policy containing general directives in natural resource management. Climate change, as one of the cross-cutting issues in natural resources management, is thus embedded in this umbrella policy.

The National Strategy for Growth and Reduction of Poverty (NSGRP II) (MKUKUTA II) has three clusters, among which the first cluster – "Growth for Reduction of Income Poverty" – is concerned with climate change. This comes under its fourth goal of "ensuring food and nutrition security, environmental sustainability and climate change adaptation and mitigation".

The Agricultural Environmental Action Plan (2011–2017) is a way of mainstreaming environmental protection in development planning and project implementation. Management of natural resources in the agricultural sector has been the main emphasis for action. Key issues identified for intervention related to mitigation include: land degradation due to deforestation and livestock overgrazing; and lack of agricultural land-use management plans. The AEAP was structured to address impacts of climate change through joint efforts with other sectors, including the livestock and forestry sector.

The Revised National Forest Policy (2012) restates how forests will be affected as climate is projected to change towards drier regimes. Key policy areas relevant to climate change include forest land

management, and ecosystem conservation and management. Several policy statements related to climate change and REDD+ have been established.

The National Climate Change Strategy (NCCS) (2012) covers a broader natural resource base in addressing issues pertaining to climate change. It covers interventions in adaptation and mitigation, and cross-cutting issues that affect the social, economic and physical environment. The main goal of the strategy is to enable the United Republic of Tanzania to efficiently adapt to climate change, and participate in global mitigation efforts, in order to achieve sustainable development in line with the Tanzania Development Vision 2025 and other sectoral policies.

The National Agricultural Policy (2013) admits the existence in the country of a number of unsustainable farming methods and systems, including deforestation, land clearing and bush fires; these also contribute to GHG emissions.

The National REDD+ Strategy (2013) is a response by the United Republic of Tanzania to global efforts to reduce GHG emissions. The REDD+ package is a stand-alone effort focusing on the forestry sector. The REDD+ initiative is based on the government's long-term commitment to forest management and to addressing issues of climate change.

The Agriculture Climate Resilience Plan (ACRP) (2014–2019) is a new plan that seeks to: respond to the most urgent impacts posed by climate change variability in the crop subsector; mainstream climate change in agriculture policies, strategies, initiatives and plans; and build the resilience of current crop productivity and future investment.

Uganda

Climate change is expected to bring new challenges and possible opportunities for the livelihoods of rural communities in Uganda, where more than 80 percent of the population depends on rainfed agriculture. A number of policies and regulations have been developed to address climate change, under both mitigation and adaptation (Banana *et al*., 2014).

The Land Act (1998), National Forestry and Tree Planting Act (2003) and other national laws and international conventions ratified by Uganda provide legal frameworks under which different types of forests are managed and owned. In addition, a range of natural resource policies have significant impacts, enabling (or unintentionally limiting) the adaptation of stakeholders and ecosystems to climate change and/or contributing to increasing national carbon sequestration levels. These include: national environment policy (1995); national energy policy (2002); agriculture sector development strategy and investment plan (2010); national land-use policy (2007); Uganda forest policy (2001); national water policy (1997); and national policy for the conservation and management of wetland resources (1994). A draft climate change policy (2012) is awaiting cabinet approval. The Ministry of Water and Environment, through its climate change unit, is the focal institution and is responsible for coordinating the country's responses to climate change issues.

Global forest-related processes that are underway in Uganda and have an impact on land-use and forest cover change include: the Clean Development Mechanism (CDM); Payments for Ecosystem Services (PES) (also known as Payments for Environmental Services); Reducing Emissions from Deforestation and Forest Degradation (REDD); and the Forest Law Enforcement, Governance and Trade (FLEGT) Support Programme for African, Caribbean and Pacific countries (ACP-FLEGT). These all influence the domestic policy environment and the behaviour of actors in the forestry sector (Banana *et al*., 2014). For example, more civil society organizations can hold government institutions accountable when forest rules and regulations are violated. A climate change unit in the Ministry of Water and Environment, a REDD Focal Point and a REDD working group have been established to stimulate policy discussions on measures that might contribute to the mitigation of climate change, including sustainable forest management.

Rwanda

Rwanda's Vision 2020 describes the country's aspirations for achieving economic development and poverty reduction and is supported by the Economic Development and Poverty Reduction Strategy (EDPRS), the framework for implementation. This strategy looks beyond 2020 to 2050, and recommends actions that Rwanda can take in the short to medium term to ensure its future stability and prosperity in a changing climate and uncertain energy future. The purpose of the strategy is threefold: to guide national policy and planning in an integrated way; to mainstream climate change into all sectors of the economy; and to position Rwanda to access international funding to achieve climate resilience and low-carbon development. The strategy calls on national planning to chart a new development pathway for integrated sector planning that balances cross-cutting issues of resource management.

The Rwanda Green Growth and Climate Resilience Strategy recognizes the role of forests in mitigating and adapting to climate change. It recognizes that forests, parks and agroforestry can play a role in low-carbon development by acting as carbon sinks. By preserving current forests and parks, agroforestry and urban tree planting, Rwanda's growing emissions can be reduced. Forests provide ecosystem services, which are vital for socio-economic development, and support ecotourism, which will continue to contribute to economic growth. Wood will continue to be Rwanda's largest source of energy in the next few years, but this needs to be managed in order to prevent deforestation.

Agroforestry can provide suitable woodfuel while preserving natural forests and parks. Rwanda seeks to follow a climate-resilient pathway, incorporating adaptation to climate change into policy and planning. It recognizes that integrated land-use planning and water resource management are fundamental for adapting to climate change and preserving biodiversity and ecosystem services.

Actions in the forestry sector include meeting energy demands for biomass through controlled tree planting by means of afforestation, reforestation, agroforestry and urban tree planting initiatives. These will provide wood for fuel, improve slope stability, support food security, act as a carbon sink and earn carbon credits. To ensure the sustainability of these initiatives, the government will promote afforestation/reforestation of designated areas through enhanced germplasm and technical practices in planting and post-planting processes. It will also promote improved cook stoves for efficient, clean wood and charcoal consumption.

Ethiopia

Ethiopia has repeatedly demonstrated its commitment to developing a green economy with implications for climate change. The government has launched the Climate-Resilient Green Economy (CRGE) initiative, led by the Prime Minister's Office, the Environmental Protection Authority (EPA), the Ethiopian Development Research Institute (EDRI) and six ministries. These institutions, together with the relevant ministries, have allocated significant resources and have organized a robust and participatory process to develop the green economy initiative. One of its four pillars – "Abatement/avoidance potential – GHG emissions in case of implementation as compared to BAU" – focuses on climate change (Federal Democratic Republic of Ethiopia, 2011).

Many of Ethiopia's emerging policy narratives on agriculture and climate change crystallized in early 2012, when a decision was taken to harmonize and mainstream agriculture-related activities under the CRGE into the Agricultural Sector Policy and Investment Framework (PIF). The CRGE, launched in 2011, has been described as a "strategic framework for organizing Ethiopia's response on climate change" (DFID, 2011). The CRGE Strategy contains a number of sectoral plans implemented by different sectors to harmonize the mainstreaming of climate change responses among sectors. Sector ministries, such as agriculture, will lead on implementation, although the CRGE Facility is located within the Ministry of Finance and Economic Development (DFID, 2011).

The key actors and policies within the CRGE are:

- Environmental Policy of Ethiopia (1997);
- initial national communications (2002) and Ethiopia's Intended Nationally Determined Contributions (INDC) (2015) to the UNFCCC;
- Environmental Impact Assessment (2002);
- Proclamation No. 299 of 2002;
- National Adaptation Programme of Action (NAPA);
- Growth and Transformation Plan of Ethiopia (2010);
- Climate-Resilient Green Economy (CRGE) initiative Vision (2011);
- Nationally Appropriate Mitigation Action (NAMA) plan (2010);
- Ethiopian Programme of Adaptation to Climate Change (EPACC) (2011);
- Green Economy Strategy (2011);
- Agriculture Development-led Industrialization (1993);
- Rural Development Policy and Strategies (2003);
- Pastoral Development Policy (2002);
- Productive Safety Nets Programme (2004);
- Household Asset Building Programme (HABP) (2010);
- Sustainable Land Management Project (SLMP) (2009);
- Agriculture Sector Programme of Adaptation to Climate Change (2011); and
- Ethiopia's Agricultural Sector Policy and Investment Framework (PIF) (2010–2020).

Other key policies include:

- Poverty Reduction Strategy Paper (PRSP), known as Sustainable Development and Poverty Reduction (SDPRP);
- Plan for Accelerated and Sustained Development to End Poverty (PASDEP) (2006–2010);
- National Policy on Disaster Prevention and Management (NPDPM) (1993);
- Constitution of the Federal Democratic Republic of Ethiopia (1995);
- Food Security Strategy (2002);
- Food Security Programme (2009);
- National Policy and Strategy on Disaster Risk Management (DRM) (2010); and
- Strategic Programme and Investment Framework (2011).

Burundi

The Government of Burundi has stated its vision to fight against climate change by affirming that it will be a "State that promotes development that is resilient to the harmful effects of climate change". In this respect, each sector in the country is charged with ensuring that climate change is mainstreamed into policy strategies and actions. In line with this aim, different sectors have developed policies and strategies towards achieving this goal. They include:

- National Water Resources Management Policy and Action Plan (2001);
- Water Code (Law 1/02 of 26/03/2012, enacting the Water Code in Burundi);
- sectoral strategy for the energy sector in Burundi (2011);
- Law 1/13 of 23/04/2015, reorganizing the electricity sector in Burundi;
- National Forestry Policy of Burundi (2012), promoting development and rational management of forest resources, raising the forest cover rate to 20 percent by 2025 and promotion of forest resources;
- National Agricultural Strategy, 2008–2015 (2008); and
- National Sustainable Land Use Strategy (2007) and National Action Programme to Fight Land Degradation (2005), which aim at increasing agricultural production and productivity, and the development of sustainable production systems that can re-establish food self-sufficiency in the short and medium terms.

Furthermore, the political/legal tools available to the country with relevance to climate change adaptation and mitigation include:

- Vision Burundi 2025;
- Second Strategic Framework for Fighting against Poverty;
- Sectoral Policy of the Ministry of Water, Environment, Land Planning and Urbanization;
- National Forest Policy;
- 1st and 2nd communication on climate change, and 3rd national communication on climate change (in preparation).

The legislative instruments include:

- Constitution of the Republic of Burundi;
- revised Land Code;
- revised Forest Code;
- Environment Code; and
- several international conventions ratified by Burundi (including the UNFCCC, the Convention on Biological Diversity and the United Nations Convention to Combat Desertification).

South Sudan

The climate vulnerability of South Sudan's abundant, unexploited natural resources makes it pertinent for the country's INDC to comprise both mitigation and adaptation components, based on its national circumstances. South Sudan therefore has committed to (and has undertaken) a national GHG inventory, as part of its National Communication for 2016: this will allow a better assessment of the potential for mitigation and quantify the possible emission reductions. Policies and actions are intersectoral and cut across all productive sectors, as seen by the government, making it possible for sectoral policies that address climate change. The sectors of focus include energy generation and use; land-use and land-use change; and the forestry and transport sectors. The aim is to address future emissions that are likely to result from growth strategies.

Of particular importance in the energy sector is the need to:

- increase the efficiency of biomass use (particularly fuelwood and charcoal) – this is closely linked to actions in the forestry sector;
- increase efficiency of electricity usage in the formal energy sector; and
- ensure the best use of hydropower by careful management of water resources – this is linked to catchment forest management, reforestation and forest conservation.

The government has declared approximately 20 percent of its natural forests as reserve forests for protection against deforestation. In this sector, the government is embarking on an ambitious reforestation and afforestation project to plant 20 million trees over a period of 10 years (2 million trees in each of its 10 states), as outlined in the National Environmental Policy. This will contribute to restoring watershed and water catchment areas during the post-2020 period as well as sequestering carbon and reducing emissions from deforestation and forest degradation. In the transport sector, the government aims to establish emission standards for vehicles. Payment for ecosystem services is also seen as a means to maintain a clean and green environment and contribute towards reducing emissions from deforestation and forest degradation.

Institutional framework of organizations dealing with forests and climate change

United Republic of Tanzania

In the United Republic of Tanzania, governmental and non-governmental organizations have the mandate to undertake actions to mitigate and adapt to climate change. The Focal Points and national authorities for international agreements/initiatives are based in the relevant sectors: agriculture, livestock, coastal and marine environment, fisheries, water resources, forestry, health, tourism, human

settlement and energy. Identified mitigation priority sectors are: energy, transport, forestry and waste management. The focal office for climate issues is the Vice President's Office, Department of Environment. However, different sectors have the mandate to mainstream climate change in their actions. The Forestry Division of the Ministry of Natural Resources and Tourism is the major sector that deals with forestry and hence climate change and forestry.

Implementation of the national Climate Change Strategy will follow the government financial management guidelines and systems established under the Ministry of Finance to ensure effective resource and financial mobilization (United Republic of Tanzania, 2015). To ensure effective implementation, the National Climate Change Technical Committee (NCCTC) and the National Climate Change Steering Committee (NCCSC) will guide the coordination and implementation of the strategy. The NCCTC will provide technical advice to the National Climate Change Focal Point (NCCFP), while the NCCSC will provide policy guidance and ensure coordination of actions as well as cross-sectoral participation.

Uganda

In Uganda, responding to climate change is likely to entail a range of new initiatives and tasks. It will also engage new actors and bodies in forest and land-use-related climate change activities. It is therefore likely that modifications to existing organizational structures – together with the establishment of new bodies and a revision of roles, responsibilities and work modalities – will be needed. New or revised cross- and intra-sectoral coordination and participation mechanisms in planning, decision-making, implementation and monitoring will also probably be required.

Conflict management mechanisms will have to be adequate to deal with new conflicts that arise due to climate change. In this context, the desired outcomes for cross- and intra-sectoral coordination include organizational structures that provide effective support for the planning, implementation and monitoring of forest and climate change strategies and policies. The responsibilities of key organizations and bodies in forestry and other relevant land-use sectors are clearly defined. Mechanisms are in place to support the coordination and collaboration of different bodies and initiatives related to the implementation of forest-related climate change policies and actions. Conflict management mechanisms are in place to support stakeholder mediation and other services to manage and resolve conflicts related to forest and climate change.

However, the existence of Focal Points for forestry-related issues, as well as climate change actions to address forestry and climate change, seems multi/cross-sectoral (FAO, 2011). According to the Republic of Uganda (2012), although the Focal Point for climate change is the Ministry of Water and Environment, the Ugandan climate change policy is not meant to replace sectoral policies, but rather to provide a framework for the harmonization and coordination of the various sectoral efforts that are already underway and will be implemented in the future. At the core of this policy is the recognition that climate change is a fundamentally multisectoral issue, and that all sectors and categories of stakeholders must be actively involved if the policy is to be implemented successfully. This especially calls for the mainstreaming of climate change concerns in the relevant sectoral, national and local policies, plans and budgets (Republic of Uganda, 2012).

An overview of the actor landscape on climate change in Uganda identified and logged the interests of 84 climate change actors in: government (23), development partners (22), NGOs (20), research institutes (16) and the private sector (3). A breakdown of activities by type indicates that the majority are engaged in capacity building, awareness raising and research (Hepworth, 2010).

Ethiopia

Ethiopia also intends to undertake adaptation initiatives to reduce the vulnerability of its population, environment and economy to the adverse effects of climate change, based on its Climate-Resilient Green Economy (CRGE) Strategy. The CRGE is Ethiopia's strategy for addressing both climate change adaptation and mitigation objectives. The implementation of the CRGE would ensure a

resilient economic development pathway while decreasing per capita emissions by 64 percent or more. The CRGE is also integrated into the Second Growth and Transformation Plan (the national development plan). In the long term, Ethiopia intends to achieve its vision of becoming carbon-neutral, with the mid-term goal of attaining middle-income status. The CRGE is a multisectoral body and priority sectors have been identified to undertake mitigation and adaptation actions. These sectors include agriculture (livestock and soil), forestry, transport, electric power, industry (including mining) and buildings (including waste and Green Cities).

Although the Focal Points for climate change are the Environmental Protection Authority (EPA) and the National Meteorological Service Agency (NMSA), forestry-related activities are implemented by the Ministry of Environment and Forest. Other ministries and institutions with a stake in implementing the adaptation and mitigation activities include: Ministry of Water Resources, Ministry of Agriculture and Rural Development, Ministry of Finance and Economic Development, Disaster Prevention and Preparedness Agency, Ethiopian Science and Technology Agency, Addis Ababa University and other relevant universities, Institute of Biodiversity Conservation and Research, Ethiopian Rural Energy Promotion and Development Center and various NGOs (Ministry of Environment and Forest, 2014). NMSA was responsible for drafting the NAPA and is the UNFCCC National Focal Point. NMSA is responsible for reporting to UNFCCC on climate change issues in Ethiopia while EPA is the National Focal Point for the Kyoto Protocol (UNDP, UNICEF and WFP, 2010).

Rwanda

The environment and natural resources sector has a broad mandate, which it executes through five major subsectors: forestry, lands, environment, water resource management, and mining (Republic of Rwanda, 2013). The cross-cutting nature of the sector, particularly in the environment and climate change thematic areas, puts it in a strategic position to influence sustainable development. Reference is made to the Prime Minister's Order determining mission, functions, organizational structure and summary of job positions of the Ministry of Natural Resources (MINIRENA). Order No. 106/03 of 28/9/2011 states that MINIRENA shall have the mission to ensure the protection and conservation of the environment and ensure optimal and rational utilization of natural resources for sustainable national development. Specifically, the ministry will:

- develop and disseminate the sector policies, strategies and programmes related to environment and natural resources;
- regulate the sector and related subsectors through the development of laws and regulations to ensure the rational utilization of natural resources; and
- ensure protection of the environment and conservation of natural ecosystems.

This will be done by: developing institutional and human resources capacities in the environment and natural resources sector and subsectors; and monitoring and evaluating the implementation of sector and subsector policies, strategies and programmes. Implementation of sector priorities is undertaken by the subsectors organized under two national agencies. Environment and climate change priorities are implemented by the Rwanda Environment Management Authority (REMA) whereas land, forestry, water resources and mining are executed under the mandate of the Rwanda Natural Resources Authority (RNRA).

Burundi

In Burundi, the field of environmental conservation falls within the responsibility of several national institutions involved at various levels. General coordination is carried out by the Ministry of Water, Environment, Land Management and Urban Planning (MEEATU), which also implements government policy in this area. Below the primary ministries related to the environment, there are several organizations that work interactively. MEEATU comprises three General Directorates: the General Directorate of Forests and Environment, comprised of the Directorate of Forestry and the Directorate of Environment; the General Directorate of Land Management, Rural Engineering and Land Property Protection, comprised of the Directorate of Planning and the Directorate of Rural

Engineering and Land; and the General Directorate of Urban Planning and Buildings, which oversees the design and execution of government policy on urbanization. It provides management, land allocation and designation, and declared urban land use. It also coordinates all activities undertaken by other stakeholders in urban centre development (Beck *et al*., 2010).

South Sudan

Institutional frameworks in response to climate change, and environmental and natural disaster risks, are not well developed in South Sudan and are thus in their infancy. The relevant institutional framework (which is in place) covers: the Ministry of Humanitarian Affairs and Disaster Management; South Sudan Relief and Rehabilitation Commission; Ministry of Environment; South Sudan Meteorological Service (SSMS); Ministry of Agriculture, Forestry, Tourism, Animal Resources and Fisheries; Ministry of Electricity, Dams, Irrigation and Water Resources (MEDIWR); Ministry of Finance, Commerce and Economic Planning; Ministry of Lands, Housing and Physical Planning; Ministry of Petroleum, Mining and Industry; Ministry of Foreign Affairs and International Cooperation; and Ministry of Wildlife Conservation and Tourism.

These institutions are part of the climate change adaptation, mitigation and disaster risks reduction institutional framework, because of their role helping the country adapt or mitigate climate change impacts. In this respect, a multisectoral approach is adopted, with each institution playing its relevant role, although most of the institutions do not have climate-resilient units. The Ministry of Agriculture, Forestry and Fisheries has no climate change resilience department. However, it has a number of institutions, which can be improved for climate change resilience. They include the Yei Agricultural Research Center and the Yei Seed Factory, which have been testing and developing seeds for climate change resilience (Nhial, 2015).

Despite some weaknesses, South Sudan's forestry policy is relatively strong in terms of: (a) recognizing forests as providers of critical environmental services; and (b) proposing activities to enable the flow of climate financial benefits to South Sudan. The forestry policy also calls for: (a) ratification of UNFCCC; (b) meeting the requirements for REDD+; and (c) the establishment of a designated national authority to coordinate international assistance for climate change adaptation and mitigation in South Sudan (Nhial, 2015).

Institutional capacity in relation to forest adaptation and mitigation policy

United Republic of Tanzania

The United Republic of Tanzania has various ministries, sectors and institutions with experience in mainstreaming cross-cutting issues like climate change adaptation (CCA). However, the capacity of these institutions to ensure that CCA is mainstreamed into the development planning process is overwhelmed by the challenges posed by climate change itself; hence there is only limited awareness. Financial, technical, human and other resources are inadequate to ensure effective adaptation, and political influence is still in limbo. The limited available institutional capacity mostly exists at national level, leaving a void at other levels. Hence a comprehensive training framework is required at all levels. Multiple plans for CCA exist with no budget or only a limited budget – they are mostly donor-funded since CCA is not well factored into the national development agenda. Coordination of CCA from international to community level is weak, possibly because effective policy, strategies/framework and guidelines for communication and coordination are missing. Good governance and corruption also need be addressed in order to improve institutional capacity to deliver expected outputs and to win people's trust. Only when these institutional capacity needs are adequately addressed will there be an effective mainstreaming of CCA in the country's development planning (Nandi, 2012). There are several critical entry points for mainstreaming climate change adaptation into the country's development planning process. They include the need to build understanding and an adaptive capacity that comprises significant new actions to identify and fill knowledge gaps to enable effective adaptation action at all levels.

This necessitates increased access to knowledge about climate change and its causes, impacts, evidence and vulnerability: the knowledge must be shared at different levels for effective adaptation. Grassroots feedback mechanisms are important for effective adaptation planning. Data on climate change are needed for easy advocacy and awareness raising. This requires a strong meteorological observation centre that can analyse, translate and communicate climate information to various stakeholders for effective adaptation. Indeed, while sectors need to interpret climate trends for effective adaptation, there is a lack of comprehensive data at national level. Thus institutional capacity building (financial, human, technical and other resources) is needed if the meteorological agency is to deal with this overwhelming task. Another entry point is the formulation or review of the environment and sectoral policies, strategies, action plans, acts, regulations and budget to seriously address climate change, including adaptation measures.

Uganda

A climate change policy (2012) exists in Uganda. The Ministry of Water and Environment (through its climate change unit) is the focal institution and is responsible for coordinating the country's responses to climate change issues. The policy suggests that policy responses, either sector-specific or cross-cutting in nature, should be harmonized in order to better address the challenges associated with climate change adaptation and mitigation. Uganda is a signatory to a host of environmental agreements that require countries to develop implementation mechanisms that will enable reporting, training, public education, and other activities to achieve the goals of each agreement.

Rwanda

Rwanda's INDC is built upon its National Strategy for Climate Change and its Low Carbon Development Strategy (Republic of Rwanda, 2015). Their full implementation rests upon five enabling pillars: institutional arrangements; finance; capacity building and knowledge management; technology, innovation and infrastructure; and integrated planning and data management.

At the institutional level, the Ministry of Natural Resources (MINIRENA) is the ministry responsible for formulating and monitoring national policies related to climate change and environment, while the Rwanda Environment Management Authority (REMA) is the official organ responsible for implementing national policies and strategies related to climate change and the environment.

Successful implementation of this INDC requires close coordination and collaboration between MINIRENA, REMA and all potential stakeholders, including the private sector, civil society and public institutions such as the ministries of Agriculture and Animal Resources, Trade and Industry, Local Government, Infrastructure, Education, Health, and Finance and Economic Planning (Republic of Rwanda, 2011a). Other institutions involved in the implementation of Rwanda's National Strategy for Climate Change and Low Carbon Development Strategy are: Ministry of Disaster Management and Refugee Affairs; Rwanda Meteorology Agency; National Institute of Statistics; Rwanda Development Board; Rwanda Standards Board; Rwanda Agriculture Board; Rwanda Energy Group; Water and Sanitation Corporation; Rwanda Natural Resources Authority (RNRA); Rwanda Biomedical Centre; Rwanda Transport Development Agency; Rwanda Housing Authority; Rwanda Revenue Authority; National Industrial Research and Development Agency; and various research centres and universities.

In order to coordinate and monitor the implementation of the adaptation and mitigation actions in the different sectors, Rwanda has set up several bodies and operationalized institutional arrangements, namely the Green Economy Technical Coordinating Committee and the National Fund for Environment and Climate Change (FONERWA) as a national green fund to mobilize additional internal and external climate funds. In addition, MINIRENA has been accredited as the implementing entity for the Adaptation Fund and Green Climate Fund (GCF) while REMA has been nominated as the national designated authority for GCF. These institutions are based on a sector-wide approach and work closely with development partners, civil society, academia and the private sector to implement the necessary climate change adaptation and mitigation actions.

Burundi

Activities relating to climate change in Burundi were marked, in particular, by the development and publication of the first and second national communications under the UNFCCC. At the same time, Burundi also prepared its NAPA. The actions identified in the NAPA covered the key sectors of the Burundian economy. As various sectoral adaptation and vulnerability assessment studies have shown, climate change affects every sector of the country's economy, particularly agriculture (Republic of Burundi, 2015).

The prospects for sustainable ecological growth were defined in Vision Burundi 2025 and translated into a short-term action plan as part of the Growth and Poverty Reduction Strategic Framework (2012–2015). In the medium to long term, the government plans to engage in a transition towards a green economy. Vision Burundi 2025 makes a firm commitment to prioritizing the country's protection and rational management of the environment such that Burundians can live in a protected, properly managed setting. The government has stated its vision of the fight against climate change – "a State that promotes development that is resilient to the harmful effects of climate change".

At the institutional level, the various departments of the Ministry of Water, Environment, Land Management and Urban Planning, and institutions such as the Geographic Institute of Burundi (IGEBU) and Burundian Office for the Protection of the Environment (OBPE), handle matters relating to climate change. In order to fulfil its mission, the ministry enjoys the support of frameworks for dialogue such as the National Environment Commission, the Sectoral Group on Water, Sanitation and the Environment (GSEAE), the National Water Partnership (PNE-Bu) and the National Platform for Risk Prevention and Disaster Management.

Ethiopia

The Ethiopian Government has already put in place a number of policies, strategies and programmes aimed at enhancing the country's adaptive capacity and reducing its vulnerability to climate variability and change. Such programmes include the Plan for Accelerated and Sustainable Development to End Poverty (PASDEP), the Environmental Policy, and the Agriculture and Rural Development Policy and Strategy. The government has established a Strategic Investment Framework for sustainable land management (SLM) but the cost and capacity implications of climate change have yet to be built into this.

The Environmental Protection Authority (EPA) and the National Meteorological Service Agency (NMSA) (of the Ministry of Water Resources) are the focal institutions for climate change in Ethiopia. NMSA was responsible for drafting the NAPA and is the UNFCCC National Focal Point. It is also responsible for reporting to UNFCCC on climate change issues in Ethiopia. EPA is the National Focal Point for the Kyoto Protocol. In early 2009 a National Climate Change Forum (NCCF) was set up with the support of the international community. The NCCF provides a forum for sharing information and best practice on climate change-related issues among development practitioners.

The NCCF is in the process of developing a strategic framework for Ethiopia that outlines the key strategic issues and actions for tackling climate change. However, there remains the problem of low technical capacity and skills at the community level, particularly related to the management of natural resources, and the formulation and implementation of disaster management plans.

Recognizing the urgency and intersectoral nature of the environment, the Ethiopian Government has established the Environment Council (EC) by proclamation to provide: (a) overall leadership in environmental policy and regulatory systems; and (b) high-level oversight of environmental standards and directives. The Prime Minister chairs this council. Its members are Federal Ministries, all Regional State presidents, representatives of trade unions and environmental NGOs, and the Ethiopian Chamber of Commerce. It is the highest-level decision-making body in government for the environment. The EPA is the secretariat of the EC. At present, the EC draws technical advice from the relevant line ministries through the secretariat (Eshetu *et al*., 2014).

The establishment of the Climate-Resilient Green Economy (CRGE) Strategy, and the subsequent creation of the CRGE Facility within the Ministry of Finance and Economic Cooperation (MoFED), is expected to reduce many of the problems associated with coordination and collaboration across the different line ministries. The new arrangement is expected to facilitate a centralized mobilization and delivery of climate change funds, and the subsequent implementation of programmes and projects focusing on climate change mitigation and adaptation by different line ministries. This is mainly in response to the mainstreaming challenge of climate change, and a need to build on the previous arrangement whereby the former EPA was in charge of coordinating climate change finance delivery.

Climate change-relevant line ministries coordinate their actions at different levels. At the federal level, the interministerial committee (IMC) under the Prime Minister's Office maintains regular interaction and collaboration among federal institutions engaged in climate change and related activities. MoFED and the Ministry of Environment and Forest (MEF) coordinate two important aspects of the Climate-Resilient Green Economy (CRGE) Facility: MoFED is responsible for managing the Facility, including the mobilization of both domestic and external resources for the implementation of CRGE programmes; and MEF is responsible for overseeing the technical component of the Facility, including the evaluation and validation of proposals/investment plans submitted for funding through the Facility.

The CRGE sets out an ambitious national agenda. This task cannot be achieved by government alone. It requires the concerted efforts of all sectors of society: government, non-government, community, private sector, and innovative micro and small business actors. As the owner of the CRGE, the government must create an enabling environment to facilitate implementation of CRGE targets across a broad spectrum of green-friendly sectors, including forestry, energy and roads.

The effectiveness of the CRGE Facility will largely depend on the capacity of local institutions to implement the CRGE. In this context, local institutions are of two types: (a) government institutions (e.g. *woreda*-level sector offices); and (b) non-government actors in the private, NGO and community sectors as well as micro and small businesses. The linkage between national and local-level government institutions, as far as the CRGE is concerned, is beginning to take shape with the establishment of CRGE units in the regional bureaux. The new MEF structure will soon reach *woreda* level, which will facilitate linkages among the different sectors.

The weakest linkage is between public institutions and non-government actors. This is partly a result of government emphasis on intersectoral coordination, with less attention being paid to important climate change stakeholders operating in the private, NGO and community space. The government has yet to engage fully with non-state actors to secure the successful implementation of the CRGE (Eshetu *et al*., 2014).

South Sudan

The Ministry of Environment is the operational Focal Point for the UNFCCC and the UN Convention on Biological Diversity (CBD), while the Ministry of Agriculture, Forestry, Tourism, Animal Resources and Fisheries is the operational Focal Point for the UN Convention to Combat Desertification (UNCCD). The greatest challenge is that the nascent institutions involved with climate change have been weakened by a lack of technical know-how and financial resources, and by the low priority of the environment and climate change issues in the government's agenda. The Ministry of Environment has established a climate change unit but it is not operational due to lack of financial and human resources (Warner *et al*., 2015d).

7. Financing and technology transfer

Overview of financing sources and mechanisms available for mitigation and adaptation

For the period prior to 2013, most adaptation/mitigation projects in the Eastern African region were primarily supported and funded by bilateral sources, although many also received funds from multilateral donors. The multilateral funds provided $64.8 million, with more than twice this amount ($143.4 million) in additional co-finance, assuming this co-finance was mostly provided by bilateral sources (Tippmann *et al*., 2013). More than half the multilateral funding was provided by the Least Developed Countries Fund (LDCF), followed by the Adaptation Fund (AF) of the Special Climate Change Fund (SCCF). The Global Environment Facility (GEF) Trust Fund, the Strategic Priority on Adaptation (SPA) and the Millennium Development Goals Achievement Fund (MDG-F) support one project each. The Government of the United Kingdom of Great Britain and Northern Ireland has been very active in the region, funding 10 projects via its International Climate Fund (ICF) and another 11 projects together with Canada's International Development Research Centre (IDRC) through the joint Climate Change Adaptation in Africa (CCAA) initiative. Other donor governments active in the region are Germany and Japan, followed by Denmark, the Netherlands, Sweden and Switzerland (Tippmann *et al*., 2013).

Private foundations, including the Rockefeller Foundation and the Howard G. Buffett Foundation, as well as NGOs such as the Alliance for a Green Revolution in Africa (AGRA), support adaptation measures in the region. There are also regional adaptation projects as well as Africa-wide projects that involve East African countries funded almost exclusively by bilateral sources.

United Republic of Tanzania

In the United Republic of Tanzania, the main sources of finance for forest management are currently: charges levied on major forest products and services; state budget allocations to the forestry administration; and donor grants and loans for forestry projects (Whiteman, 2002). The Tanzania Forest Fund was also recently established. This fund consists of 2 percent of every fee and a levy of 3 percent of any royalty apart from grants and donations from donor organizations. The purpose of the fund is basically to promote forest management and to help the country benefit from international initiatives and funds directed towards forest management. However, the fund has not yet identified innovative financing market mechanisms to attract new sources of investment in forest management outside the traditional channels.

The immediate needs for building adaptive capacity and enhancing resilience against future climate change in the United Republic of Tanzania have been estimated at $100–$150 million per annum. Added to this is the funding required to address current climate risks, estimated at an additional cost of $500 million per annum (at a conservative estimate). Financing needs of up to $1 billion per annum by 2030 are not considered unreasonable (Norrington-Davies and Thornton, 2011).

While donors continue to allocate funding for climate change, it is currently not possible to capture climate change financing on the government budget. Aid being provided through budget support is allocated by government for national development priorities, with very little of this funding going to climate change activities as such. Where climate change financing is included in wider sector programmes, it is not yet reported on separately. The government does not yet earmark climate change finance, nor does it have sufficient capacity to identify additional costs; therefore it is not possible to include adaptation costs in the budget for new programmes. There is potential to introduce a policy marker for climate change in the United Republic of Tanzania to facilitate government tracking of mitigation and adaptation funding in the future. This could be based on the existing Organisation for Economic Co-operation and Development (OECD) DAC Creditor Reporting System (Norrington-Davies and Thornton, 2011).

According to Yanda *et al*. (2013), climate change-relevant expenditure has increased steadily as a proportion of the total budget from 4.2 percent in 2009/10 to 6.5 percent in 2012/13. This rise has been driven by an increase in donor funding that is on-budget. The financing of climate change actions appears to be treated primarily as a budgetary rather than a policy issue. The composition of climate change-relevant expenditure appears to have shifted over the four-year period, from projects with a primary focus on either adaptation or mitigation, to projects that appear to combine both objectives. There is a considerable amount of spending taking place in ministries without a full realization of the significance of such spending in terms of its relation to climate change (Tables 7.1 and 7.2).

Table 7.1: Past commitments for climate change-relevant activities from global funds in United Republic of Tanzania

Project	Fund	Amount ($ million)	Disbursed ($ million)	Theme
TEDAP	GEF 4	6.50	6.50	Mitigation/general
Ministry of Finance and Economic Affairs	Global Climate Change Alliance	2.93	0.08	Multiple
NAPA	LDC Fund	0.20	0.20	Adaptation
Mainstreaming climate change in integrated water resource management in Pangani River Basin	Special Climate Change Fund	1.00	1.00	Adaptation
Developing core capacity to address adaptation to climate change in productive coastal zones	LDC Fund	3.10	3.10	Adaptation
Conserving mountain forests	International Climate Initiative	3.25	3.25	Mitigation/REDD+
Mini-grids based on small hydropower sources to augment rural electrification	GEF 4	3.35	3.35	Mitigation/general
UN-REDD national programme – United Republic of Tanzania	UN-REDD	4.28	4.28	Mitigation/REDD+

Key:
GEF: Global Environment Facility.
LDC: Least Developed Countries.
NAPA: National Adaptation Programme of Action.
TEDAP: Tanzania Energy Development and Access Project
Source: Norrington-Davies and Thornton, 2011.

Table 7.2: Summary of existing donor commitments for climate change-relevant activities in United Republic of Tanzania (2009–2015)

Donor	Time frame	($ million) Committed	Planned
DFID	2009–2014	1.3	15.61
EU	2010–2014	3.9	
Finland	2009–2015	13.3	14.52
Norway	2009–2013	49.05	52.28
One UN	2009–2015	3.4	14.36
UN-REDD	2010–2012	4.2	
UNDP/UNEP	2009–2015	8.4	
UNIDO	2011–2015		3.4
USAID	2010–2012	2.5	5
World Bank	2011		0.5
Total	*2009–2015*	*86.05*	*105.67*

Source: Norrington-Davies and Thornton, 2011.

Table 7.3: Climate change-relevant expenditure in Uganda as a share of government expenditure (2008–2012)

Year	Total government expenditure (U Sh billion)	Total climate change-relevant expenditure (U Sh billion)	% of government expenditure
2008/09	3 901	41.5	1.06
2009/10	5 443	53.6	0.98
2010/11	8 213	66.5	0.81
2011/12	8 251	71.8	0.87

Uganda

According to Tumushabe *et al*. (2013), the Government of Uganda Chart of Accounts does not contain a marker for "climate change-relevant" spending. However, climate change spending can be identified from programmes and projects, and a total of 96 expenditure lines can be classified as climate change-relevant. The national policy narratives on funding with regard to the volume, sources and delivery mechanisms for climate finance have yet to mature. On-budget climate change-relevant spending was approximately 0.2 percent of GDP for the period between 2008/09 and 2011/12. This contrasts with that recommended in the draft Implementation Strategy of the Climate Change Policy, which estimated that around 1.6 percent of GDP needs to be spent on climate change-relevant activities. Over this period, the available evidence does not show significant levels of funding to have come from international climate funds. Actions taken by the Government of Uganda, and in particular the Ministry of Finance, to address the current weaknesses in public finance management will be a key determinant of effective climate finance delivery. Total spending on climate change-relevant activities is estimated at less than 1 percent of government expenditure, and this has remained broadly constant over the four-year period, 2008/09–2011/12 (Table 7.3).

Ethiopia

According to Eshetu *et al*. (2014), there are major challenges ahead for Ethiopia if it is to finance its response to climate change. The national Climate-Resilient Green Economy (CRGE) Strategy has called for annual spending of $7.5 billion to respond to climate change. With national budgetary

resources for climate change-relevant actions estimated to be in the order of $440 million per annum, and international sources adding several tens of millions of dollars per annum, there appears to be a major financing gap. Therefore, if the strategy is to be delivered, much more needs to be done to mobilize additional funds. Expenditure on climate change can come from a variety of sources. These include international climate funds, bilateral and multilateral donor funds, public funds, and private-sector fund resources, both domestically and externally (Eshetu *et al*., 2014).

Four initiatives have been selected to fast-track the implementation of the green economy element of the CRGE Strategy: hydropower development, rural cooking technologies, the livestock value chain, and forestry development. These initiatives represent a rational policy prioritization as they offer the prospect of immediate economic growth and large carbon abatement potential, and are attractive to international climate finance funding sources.

Ethiopia has established an innovative funding mechanism to support the implementation of the priorities set out in the CRGE Strategy: the CRGE Facility. Designed as a single, national funding mechanism, this Facility is intended to make the administration of funds easier for the government so that it can drive and manage international climate funds, donor funds and domestic funds in a coordinated manner. The public expenditure on climate change-relevant actions for the period 2008/09–2011/12 fluctuated considerably. It is estimated that the average annual percentage share of such expenditure over the four years was 15 percent of total government expenditure, which represents 1.8 percent of GDP (Table 7.4) (Eshetu *et al*., 2014).

At least for its on-budget spending, the country seems to depend mostly on its own resources in order to finance public activities designed to address climate change. For example, government funding on climate change-relevant development expenditures in 2011/12 accounted for approximately 80 percent of the expenditure, while donor support accounted for the remaining 20 percent.

Rwanda

Despite the costs and challenges of climate change adaptation and mitigation, Rwanda is a dynamic and adaptable country with strong leadership. The government knows that it will need extra funds to address the risks of climate change and to continue on its path of economic development, which will make it less reliant on farming and more resilient to the increasing impacts of climate change. Thus it has developed a specialized fund to mobilize this finance: the National Fund for Environment and Climate Change (FONERWA), a sustainable financing mechanism for environment and climate change initiatives in Rwanda. Through this mechanism, Rwanda will access international climate finance, as well as extra climate funds from elsewhere, which will be distributed to the government, the private sector and civil society. Twenty percent of FONERWA funds will be kept aside for the private sector, and 10 percent for the local districts (IIED, 2013).

Table 7.4: Climate change-relevant spending for Ethiopia as a percentage of GDP (2008–2012)

Budget year	Total climate change-relevant expenditure (Br million)	Climate change-relevant expenditure (% GDP)
2008/09	5 945	1.5
2009/10	10 263	2.3
2010/11	8 409	1.7
2011/12	9 970	1.8

Table 7.5: Current funding partnerships on climate and environment in Rwanda

Programme	Donor
Support programme to afforestation and reforestation in North and Eastern Province (PAREF BE2) 2010–2016	Belgium
Support programme to afforestation and reforestation in Western and Northern Province (PAREF NL2) 2013–2016	Belgium
Support to afforestation and rehabilitation of degraded forests in Southern Province (PGREF) 2011–2017	AfDB
Support to natural forest management in Volcanoes National Park and agroforestry in high plains VNP(PACEBCO) 2014–2016	AfDB
Support to watershed management in Kirehe (HRI/KWAMP) 2010–2016	IFAD
Landscape restoration programme 2015–2019	IUCN
Sustainable Forestry, Agroforestry and Biomass Energy for Climate Resilience 2015–2017	FONERWA

Key:
AfDB: African Development Bank.
FONERWA: National Fund for Environment and Climate Change.
IFAD: International Fund for Agricultural Development.
IUCN: International Union for Conservation of Nature.

The fund will have "windows" when groups can apply for financing that reflects government priorities, many of which have been laid out in Rwanda's Green Growth and Climate Resilience Strategy. It is hoped that FONERWA will make up the funding shortfall in Rwanda for these priorities, but this will require considerable resources from Rwanda's development partners (such as the United Kingdom of Great Britain and Northern Ireland's Department for International Development [DFID]), international climate funds and the private sector. The government also intends to raise domestic capital for the fund through a proposed local tax.

The first priority for adapting to climate change is to address "no-regret measures" – measures that are advantageous even without the impacts of climate change. Examples include strengthening local institutions and/or encouraging better farming practices. "Low-regret measures" come next and include measures that will only have very low costs. These could include providing better weather information for farmers and water conservation measures. The next priority after this is to address those long-term investments and decisions that could be significantly affected by the impacts of climate change, such as infrastructure or other large investments such as the location of a bridge or the durability of a new road. The current funding partnerships on climate change and environment in Rwanda are shown in Table 7.5.

Burundi

Burundi has drawn up several programmes and costs associated with implementation of the Intended Nationally Determined Contribution (INDC) in which several climate-related projects are envisaged and indicative costs given. However, most of the climate change adaptation actions identified in previously developed national and sectoral action plans have not yet been implemented due to financial constraints. These projects include climate risk adaptation and management estimated at $3 719 000; mitigation of GHG emissions and low-carbon developments estimated at $1 446 118; and reforestation and agroforestry estimated at $10 million (Republic of Burundi, 2012).

Support to the environment sector from donors has remained very limited, and has so far been provided only by the African Development Bank (ADB) and the European Union (EU). Based on the Indicative Programme of Grant Operations, Capacity Building Operations and Analytical Work in

Burundi, only one project on "Responding to Climate Change: Challenges and Opportunities" (Burundi Government, EU, OSAN4, ORQR3) for 2014 can be identified (African Development Bank, 2015).

South Sudan

According to the Government of South Sudan, for government operations to be sustainable, their functions must be funded through current government budgets as far as possible. Taxes on revenues are normally indirectly used as they are absorbed in the country's treasury at the various administrative levels. In this respect, although the amount allocated to the Ministry of Environment (1.8 percent) seems low, the government budget allocates substantial funds to sectors that directly or indirectly address climate change (or have close links to climate change in their practices), such as the Ministry of Agriculture's Forestry Land Commission. For example, 24 percent of the 2011 national budget was allocated to the Ministry of Agriculture and Forestry, 52 percent to the Ministry of Wildlife Conservation and Tourism, 0.8 percent to the Land Commission, and 16 percent to the Ministry of Animal Resources and Fisheries.

Typically, donor funding is used for climate change adaptation and mitigation actions and can be sourced from multilateral and bilateral sources that are earmarked for specific purposes such as climate change or sustainable forest management, or through a framework for budget support. Finally, funding may be attracted from the private sector in the form of direct investments or public–private partnerships (Republic of South Sudan, 2012).

In respect of donor funding, the GEF is earmarked for the following areas: supporting projects in climate change mitigation (reducing or avoiding GHG emissions in the areas of renewable energy; energy efficiency; sustainable transport; and management of land use, land-use change and forestry [LULUCF]) and climate change adaptation. This aims to help the country to become climate resilient by promoting both immediate and longer-term adaptation measures in development policies, plans, programmes, projects and actions. In regards to bilateral cooperation, a number of bilateral donors are supporting South Sudan in the field of sustainable natural resources management (including water management) and livelihood security. Climate change and environment are considered as cross-cutting issues by some of these projects.

No figures are available on the government's total contribution to climate change-related actions. South Sudan joined the GEF in April 2013 and was to engage in working on GEF-enabling activities (to fully qualify for GEF funding), including a National Adaptation Programme of Action (NAPA), a National Biodiversity Strategy and Action Plan (NBSAP) and a country self-assessment. In total, South Sudan was allocated $3 700 000 for climate change projects, $2 220 000 for biodiversity, and $1 million for land degradation (management). None of these funds has been utilized so far.

The Ministry of Environment and relevant institutions are working on enabling activities with technical assistance from the United Nations Environment Programme (UNEP). As soon as these are ready, South Sudan could receive between $40 million and $70 million in climate change financing over the coming years. After fulfilling the UNFCCC requirements, South Sudan will also have access to a number of key funds within the GEF, the GEF 6 allocation, the LDCF (on climate change adaptation), the Adaptation Fund and the SCCF.

According to the Overseas Development Institute (ODI), South Sudan – considered a fragile state with lower and middle incomes – received $700 000 in climate funds between 2004 and 2014. This places the country at around 133 in the climate finance approved ranking list composed of 135 countries (Warner *et al*., 2015d).

Current situation with afforestation/reforestation, forest-based bioenergy, CDM, REDD demonstration activities, and forestry projects in the voluntary carbon market

It has been observed that Eastern Africa has the high number of biocarbon projects (Chomba and Minang, 2009), although there is no clear boundary in their classification and they may overlap with other project activities. Most of the projects are forestry-related and include: forestation (afforestation and reforestation); reduced/avoided deforestation; and other aspects of sustainable forest management. Countries in Eastern Africa have well-developed forestry sectors responsible for implementing forest legislation and policies, which may explain this region's greater uptake of biocarbon projects. Despite their large number, most of these projects are in the formative stage, with fewer than 5 percent actually selling carbon and paying farmers. Among the projects that do pay farmers are: the Plan Vivo project in Uganda; the Nhambita Community Carbon Project in Mozambique; and the International Small Group & Tree Planting Program (TIST) projects in Kenya, Uganda and the United Republic of Tanzania.

Most biocarbon projects sell their carbon at voluntary markets, including the Chicago Climate Exchange (CCX) and Over-The-Counter (OTC), which have less restrictive rules. Voluntary markets nearly doubled in 2008 compared with 2007, reaching 123.4 $MtCO_2e$. In 2008 carbon sink projects comprised 11 percent of the voluntary markets and only 1 percent of the CDM market. The price paid to farmers per tonne of CO_2 varies from project to project but reflected the lowest price on the CCX (equivalent to $4 or 1/5 of the average EU market). The price of carbon at international markets in 2009 varied from $3.50 at the CCX to an average of $20 in EU trading schemes.

United Republic of Tanzania

There exists the most extensive inventory of CDM-related activities for the United Republic of Tanzania (Scurrah-Ehrhart, 2006). However, some programmes were already in motion, such as Wildlife Management Areas (WMAs) and Participatory Forest Management (PFM): these were close enough to being forestry carbon-related activities and could easily be structured as such, given a few minor adjustments. These projects were reported to be slowly emerging in the United Republic of Tanzania, particularly among private and public organizations. Activities that were under conservation NGOs were at their most advanced stage of planning, proposal writing and/or commencement. However, the majority of other potential projects have remained in the realm of ideas due to lack of technical and marketing support, combined with lack of regulatory frameworks to support such activities. Notably, awareness of carbon trading and its development potential was lacking among individuals, and public and private organizations (Indufor, 2011).

In the process of developing a REDD Strategy for implementing REDD policy, the government carried out a detailed review of the country's existing carbon trading-related projects (United Republic of Tanzania, 2010). The review identified the following categories:

- existing REDD-related projects, including the National REDD Strategy and REDD+ demonstration projects;
- existing REDD-related voluntary projects, e.g. Kyoto: Think Global, Act Local (K:TGAL) and Carbon Tanzania;
- existing activities with potential for REDD, e.g. PFM, WMAs and related programmes;
- existing activities that reduce pressure on deforestation and forest degradation; and
- other non-REDD/CDM projects.

Following the Bali Road Map, the United Republic of Tanzania decided to participate in implementing REDD demonstration activities. Nine pilot REDD projects were commissioned by different NGOs:

- HIMA – Piloting REDD in Zanzibar through Community Forest Management (2010–2014) (CARE International).
- Advancing REDD in the Kolo Hills Forests (ARKFor), Kondoa district (AWF).

- Building REDD Readiness in the Masito Ugalla Ecosystem Pilot Area in Support of Tanzania's National REDD Strategy.
- Combining REDD, PFM and FSC certification in South-Eastern Tanzania (MCP).
- Making REDD and the Carbon Market work for Communities and Forest Conservation in Tanzania (MJUMITA).
- REDD-based Mechanisms for Sustainable Forest Management in Semi-Arid Areas (Case of Ngitilis in Shinyanga Region (TaTEDO).
- REDD projects in Mbeya and Sumbawanga (WSCT).
- Reduced Emissions from Deforestation and Forest Degradation (REDD Readiness in South Western Tanzania (WCS).
- Enhancing Tanzanian capacity to deliver short- and long-term data on forest carbon stocks in the country – covering different vegetation cover types in Tanzania (WWF-SUA).

In the United Republic of Tanzania, very few REDD+ related voluntary funded projects that were under experimentation still exist. These are, notably, the K:TGAL research project and Carbon Tanzania. Activities with potential for REDD are PFM and WMAs, which make a positive contribution to REDD. However, the current speed under which PFM projects are established is observed to be very low. Access to REDD finance could potentially facilitate and speed up this process and possibly reduce the high levels of deforestation and forest degradation. Similar to PFM WMAs are inter-village associations or community based organizations (CBOs) promoted by the government through the Wildlife Division. They are situated in tracts of villages or districts that are rich in wildlife and other natural resources.

Activities that reduce pressure on deforestation and forest degradation also exist. These include all activities that address the drivers of deforestation. In addition, the following are key examples of activities that would enhance REDD implementation:

- land-use planning programmes, including agriculture and animal husbandry intensification;
- tree planting in woodlots, agroforestry and plantation forests; and
- wood energy efficiency projects.

There are a number of NGOs and projects dealing with environmental conservation throughout the United Republic of Tanzania. Most of them are in the regions of Dodoma, Iringa, Mbeya and Singida.

All these organizations and projects have the primary goal of initiating activities that reduce pressure on the dwindling natural forests and improve livelihoods. Thus they advocate:

- encouraging better land-use practices such as establishing land-use plans;
- combating soil erosion;
- improving good governance in forest management;
- improving domestic energy use and creating public awareness of alternative sources of energy;
- promoting alternative income-generating activities such as beekeeping; and
- promoting tree planting.

Examples of such NGOs are DONET, Sunseed Tanzania Trust (STT), DOBEC, MIGESADO, INADES HADO, Earth Greenery Activities Japan (Egaj) TFCG, LAMP, World Vision Central Zone, Green Resources Ltd and Tanganyika Wattle Company.

There are very few CDM-related projects in the United Republic of Tanzania. Two notable examples are TIST and the Greed Resources Company Ltd. TIST operates in the United Republic of Tanzania, Kenya, Uganda and India. It is a project jointly implemented by the Institute for Environmental Innovation (I4EI) and the Clean Air Action Corporation (CAAC). TIST supports small groups of between 6 and 12 farmers to engage in tree-planting activities. In the United Republic of Tanzania,

the project was implemented by UMET (Ukuzaji Maendeleo Endelevu Tanzania) in areas located in Morogoro and Dodoma regions.[5]

The project received funding from the World Bank (WB) BioCarbon Fund for a five-year period (2000–2005). The total amount paid was $45 000 at $4 per tonne of carbon, whereby farmers were paid $0.2 per tree per annum (Scurrah-Ehrhart, 2006). The money was given to the groups through their bank accounts after a proof of the number of trees retained every year. However, in 2005, TIST activities in the United Republic of Tanzania were halted by the government through the Vice President's Office on the grounds that the deal entered into with farmers' groups is exploitative.

Uganda

In Uganda, in an attempt to seed the Ugandan carbon market, the World Bank supported three carbon finance projects in 2005: the National Forestry Authority's Nile Basin reforestation project; the West Nile electrification project; and the Kakira co-generation project. Two of these projects have been registered, but the cost and time associated with them have served as disincentives in replicating the experience.

The two Ugandan-registered projects are in reforestation and hydropower. However, the pipeline of projects at the validation stage is promising, with relatively good diversification of methodologies. Over the last two years, fifteen projects have reached the validation stage: five are part of the same small-scale forestry programme, three are cogeneration projects in the sugar industry, three are hydropower projects, two are biomass and two are landfill gas. An additional 17 projects are at the earlier Project Idea Note (PIN) stage. Forestry and hydropower investments dominate among these projects, but there are also interesting opportunities emerging for Program of Activities (PoA), including a proposal for a revolving fund to enhance PoA capacity. In addition, there are opportunities that have yet to be fully scoped in the energy, agriculture, transport and industrial sectors (Clark *et al*., 2010).

The Global Village Energy Partnership (GVEP) is a non-profit organization that works to increase access to modern energy and reduce poverty in developing countries. This is done by supporting the development of small and medium-sized renewable energy businesses, in part through entrepreneurship development programmes that provide technical, financial and business development advice. To tap the opportunities of the carbon market, GVEP has written a guide to carbon finance for energy enterprises and has partnered with the Uganda Carbon Bureau to increase access to carbon finance for such enterprises.

With its CDM/JI Initiative, Germany's Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) aims to increase the CDM capacity and application of the UNFCCC market mechanisms in various countries all over the world, among them Uganda. It furthermore aims to foster cooperation between Germany and the host countries as regards carbon market development. The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH has been contracted by BMUB to implement the initiative's interventions in Uganda (Climate Sense, 2012).

[5] See www.tist.org/tist/tanzania.php

8. Challenges/constraints to adaptation and mitigation

Resources, both financial and technical, seem to be among the major constraints in climate change adaptation and mitigation actions in the Eastern Africa subregion. Despite some governments committing internally generated resources for actions to mitigate and adapt to climate change, the resources are still meagre given the magnitude of the problem and the level of effort required. Further, the poor knowledge on relevant options for adaptation/mitigation, especially at the grassroots level, is a constraint on actions.

The incentives to undertake actions are inadequate: for example, REDD+ financial gains as an incentive to sustainable forest management are yet to be seen. Given the fact that REDD+ is a relatively new initiative, no country has so far seen any real benefits associated with implementation of REDD+ activities – apart from bilateral and multilateral support to prepare the countries for REDD+ activities that are underway (and at different stages in the various countries). The implementation of policy or adaptation/mitigation actions on the ground is poor (even where support has been given for implementation) due to poor human and technical capacity in monitoring, reporting and evaluation systems. Other major constraints are the lack of capacity to coordinate civil society and the private sector as well as the difficulty of mainstreaming climate and the environment into national plans. Furthermore, there is intense competition between forestry and other activities (such as agriculture and settlements) in which forestry stands at a competitive disadvantage.

In some countries, such as South Sudan, there is a specific challenge in the fact that climate change is not seen as a priority in the forest sector. Over and above the incentives for REDD+, the lack of suitable alternatives (techniques or livelihoods) to address the drivers of deforestation is a major challenge. In other instances, the lack of clear institutional mandates and poor intersectoral coordination may be a fundamental constraint on adaptation and mitigation. Finance is always a constraint as well as capacity and the availability of relevant information and data on which adaptation and mitigation actions may be based.

The restoration of degraded lands (the Bonn Challenge target to restore 150 million ha of deforested and degraded lands worldwide by 2020) is a challenge to all countries in the subregion. This is especially relevant in supporting countries, organizations, communities and enterprises to define and implement pledges for the target.

9. Conclusion and key observations

- Climate change adaptation and mitigation are, in large part, integrated into forest sector activities; however, it is important to strengthen the interlinkages. There is a need to ensure that forestry concerns are adequately reflected in national climate change policies and strategies.
- When reviewing existing plans and mainstreaming climate change-relevant interventions (with short-, medium and long-term targets), it is important to ensure that forestry is integrated and vice versa. Integration can enhance the development of programmes to promote improved management of forests in the context of climate change, e.g. supporting beekeeping as an alternative environmentally friendly and income-generation activity. Forests can serve as hubs for minimizing risks related to extreme weather events such as floods.
- Integration of climate change mitigation and adaptation into national forest and environmental policies and supporting implementation, including mainstreaming in government budgets, can strengthen internally generated financing.
- In the past, most adaptation/mitigation projects and actions in the Eastern Africa subregion were primarily supported and funded by multilateral and/or bilateral sources as well as private foundations. National funding for financing climate change adaptation and mitigation is limited in most countries in the region. Thus there is a need to ensure that adequate funds are allocated from national budgets or that national financing mechanisms are established.
- Resources (both financial and technical) seem to be among the major constraints in climate change adaptation and mitigation actions in the region. Despite some governments committing internally generated resources for actions to mitigate and adapt to climate change, the resources are still meagre given the magnitude of the problem and the level of effort required.
- Climate change impacts on forest ecosystems in Eastern Africa are diverse and widespread. Understanding the nature and consequences of the impacts will require further research and assessments, particularly at the level of individual species.
- The restoration and rehabilitation of degraded forest land are potential activities to facilitate the maintenance and/or improvement of ecosystem goods and services provided by forests while at the same time reducing the vulnerability of forests to climate change.
- Reducing dependence on wood as the main source of energy, improvement of charcoal production methods and promotion of energy use efficiency are important adaptation and mitigation measures.

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ISBN 978-92-5-109910-0

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I7757EN/1/09.17