FORESTS AND CLIMATE CHANGE

INTEGRATING CLIMATE CHANGE ISSUES INTO NATIONAL FOREST PROGRAMMES

BACKGROUND PAPER FOR THE NATIONAL WORKSHOP IN TANZANIA

CONTENTS

ABBREVIATIONS AND ACRONYMS

AFWC	African Forestry and Wildlife Commission
CBD	Convention on Biological Diversity
CBFM	Community Based Forest Management
CBOs	Community Based Organisations
CDM	Clean Development Mechanism
CEEST	Centre for Energy, Environment, Science and Technology
CO_2	Carbon dioxide
CREs	Carbon Reduction Emissions
DRR	disaster risk reduction
EAC	East African Community
EAM	Eastern Arc Mountains
EMA	Environmental Management Act
FAO	Food and Agriculture organisation of the United Nations
FBD	Forestry and Beekeeping Division
FRA	Forest Resource Assessment
FR(s)	Forest Reserve(s)
GCMs	Global Circulation Models
GDP	Gross Domestic Product
Gg	Giga grams
GHG	Green House Gases
IPCC	Intergovernmental Panel on Climate Change
JMAs	Joint Forest Management Agreements
JFM	Joint Forest Management
JMAs	Joint Management Agreements
LDCs	Least Developed Countries
MTEF	Medium Term Expenditure Framework
MLNRT	Ministry of Lands, Natural Resources and Tourism
MNRT	Ministry of Natural Resources and Tourism
MWe	Megawatts of electricity
NAPA	National Adaptation Programme of Action
NCCSC	National Climate Change Steering Committee
NFP	National Forest Programme
nfps	national forest programmes
NGOs	Non Governmental Organisations
NWFPs	Non Wood Forest Products
OECD	Organisation for Economic Cooperation and Development
PES	Payment for Environmental/Ecosystem Services
PEW	Payment for Water services
PFM	Participatory Forest Management
RD&D	Research, Development and Demonstration
REDD	Reduced Emissions form Deforestation and Forest Degradation
RIL	Reduced Impact Logging
SADC	Southern African Development Community
SFM	Sustainable Forest Management
SMEs	Small and Medium Enterprises
SUA	Sokoine University of Agriculture
TAFORI	Tanzania Forestry Research Institute
TFAP	Tanzania Forest Action Plan
TANWAT	Tanganyika Wattle Company
TaTEDO	Tanzania Traditional Energy Development Organisation
TPC	Tanzania Planting Company

UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
URT	United Republic of Tanzania

1. INTRODUCTION

The impacts of climate change are being felt globally. In Tanzania, the impacts are unfolding at unprecedented and devastating rates. The changes have adverse effects economically, socially and environmentally. This has far reaching implications not only to the livelihoods of Tanzanians but also to the economic and social development of the country. Efforts should therefore be made to ensure that climate change aspects are incorporated in development policies.

The Forestry Department of FAO and the National Forest Programme Facility have initiated a joint effort to assist countries address emerging policy issues related to forests and climate change through integrating climate change considerations into National Forest Programmes.

Against this background, the Ministry of Natural Resources and Tourism (MNRT), Forestry and Beekeeping Division (FBD) in collaboration with Food and Agriculture Organization of the United Nations (FAO) have organized a three day workshop on Integrating Climate Change Issues into National Forest Programme.

The FAO Forestry Department and the National Forest Programme Facility are collaborating on an effort to develop guidelines to assist countries incorporate climate considerations into their national forest programmes (nfps) or forest policy and institutional frameworks.

1.1 Rationale, Purpose and scope of paper

Climate change is currently one of the greatest environmental challenges facing humankind. Climate change is a reality that has to be addressed to ensure sustainability of existence, not only for the present but also for the future generations. According to the IPCC (2001), Africa will suffer the most from the impacts of climate change. Among others, climate change will impede the achievement of millennium development goals. There is growing evidence that climate change is impacting on forests and forest ecosystems. Tanzania is conscious of the serious consequences of climate change, and fully supports the ultimate objective of the UNFCCC to achieve stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. There is therefore need for Tanzania to think of adaptation to and mitigation of climate change and include these in mainstream development policies.

This is a background paper for Tanzania's national workshop on forest and climate change issues and actions in the country. The paper covers impacts of climate change in Tanzania, vulnerability to climate change, mitigation of and adaptation to climate change.

2. BACKGROUND

2.1 Demographic developments and trends

Since independence, Tanzania has undertaken censuses in 1967, 1978, 1988 and 2002. In addition, the country undertook Demographic and Health Surveys in 1991–1992, 1996 and 2004–2005 and the Reproductive and Child Health Survey in 1999 (URT 2006). These censuses and surveys show that the country has one of the fastest growing populations in the world. In 1948, Tanzania Mainland had a small population of 7.5 million people. By the 1978 census, another 10 million people had been added to the population. In 2005, Tanzania Mainland had an estimated population of around 36 million people and the population growth rate was about 2.9% per year. This population was nearly five times larger than it had been in 1948. At this rate, the population would double in about 25 years.

According to the latest State of World Population Report launched in Dar es Salaam on 18th November 2009 (Daily News 2009), Tanzania's population will reach 109.5 million in 2050, leading to increased pressure on available resources. The projected 2050 population is based on an average growth of 2.9% between 2005 and 2010. The country's current population is estimated at around 40 million.

Increasing population has in many rural areas of Tanzania contributed to changes in land use/cover patterns, land fragmentation and livelihood insecurity (Kangalawe and Lyimo 2010). Increasing demand for food, energy and other environmental services has contributed to expansion of agriculture, and 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.

2.2 World Bank Governance Indicators

Good governance means to govern well and to produce results that meet societal needs for the good of the citizens. The underlying principles of good governance are Transparency, Accountability, Participation, Rule of law, Responsiveness, Consensus oriented, Equity and Inclusiveness, Effectiveness and efficiency and Predictability (Hosea 2008).

The World Bank uses Voice and Accountability, Political stability and absence of violence, Effective Government, Quality of Regulatory framework, The Rule of law, and Control of corruption for measuring governance effectiveness. Table 1 shows Tanzania's scores in governance for the period 1996 to 2005 as reported by World Bank (Kaufmann, Kraay and Mastruzzi 2006). All indicators are below 50%. According to Hosea (2008), in corruption index, the World Bank praises Tanzania for being one of the countries improving governance. On the other hand, Transparency International corruption perception index of 2008 has positioned Tanzania at 102 among 180 Nations (Hosea 2008).

Table 1: Tanzania's governance performance

Criteria	**Score (%)**
Voice & Accountability	38
Political Stability	33
Government Effectiveness	42
Regulatory Quality	34
Rule of Law	41
Control of Corruption	29

Source: Kaufmann, Kraay and Mastruzzi (2006).

2.3 Social and economic values and utilization of forests

Forests supply a variety of wood and non wood forest products (NWFPs), offer employment, are a source of revenue through sale of wood and NWFPs and services, conserve soils, mitigate climate through sequestering carbon, are a source of water for domestic and industrial use, irrigation agriculture and power generation and have aesthetic, recreational, cultural, spiritual and scientific value. Forests contribute to agricultural stability by protecting the soil. Forests 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 (2009a) concluded that sampled households in Dodoma and Morogoro regions derived more than 50% of their cash income from sale of forest products, such as charcoal, honey, wild fruits and firewood, with the peri-urban households deriving almost 70% of their cash income from the 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 the farm income. Since early 1990s there has been reduction in government spending in terms of extension services and subsidies on farm inputs. Increasing agricultural production costs in relation to product prices and increasing living costs in general have pushed people to exploit more intensely forests, particularly on the general lands, to generate cash income. Miledge *et al.,* (2007) report that forests support the livelihoods of 87% of the rural poor.

In certain areas in the country communities can benefit from ecotourism. For example, Amani Nature Reserve involves local communities in ecotourism activities e.g. through training local guides and benefit sharing. The potential of eco-tourism as an income-generating activity in forestry is still to be assessed. Some issues, which will slow down the development of this area, are poor infrastructure and lack of services and marketing and a lack of legal framework.

The forest sector (including some wildlife related services) is estimated to have contributed 3.3% to the Gross Domestic Product (GDP) in 1998. MNRT (2008a) estimates that the combined annual value of forest goods and services is $2.2 billion which is equivalent to 20.1% of GDP based on 2006 prices. Table 2 shows breakdown of the value of forest goods and services. The contribution of the forest sector to the national economy is underestimated because of the unrecorded consumption of wood fuels, bee products, catchment and environmental values and other forest products.

Bioenergy, and in particular traditional solid bioenergy i.e. woodfuels (charcoal firewood), remains the dominant energy source for cooking in most rural and urban households. In addition to satisfying household energy requirement, bioenergy is also used in supplying process heat for many rural industrial production activities, pottery, brick and lime firing, drying tea and tobacco, local beer brewing, fish smoking and several other small industries. Some large industries such as sugar and saw mills, and pulp and paper mills also to a certain extent use bioenergy for cogeneration of electricity and heat.

MNRT (2008a) estimates that the forest sector provides about 3 million person-years of employment. This is about 3% of paid labour and even a bigger proportion of people in the informal forestry related sector activities. Employment is provided through forest industries, forest plantations, government forest administration and self-employment in forest related activities.

About a quarter of Tanzania's land area is covered by unique ecosystems in the form of forest reserves, marine parks and reserves, national parks and game reserves. The country's ecosystems have economic, scientific, recreational and aesthetic value.

In Handeni District and the North Pare Mountains, over 7,000 ha of forests which are maintained primarily for spiritual and cultural purposes, including as sites for traditional rites and ceremonies (MNRT 2009b PFM report).

Table 2 : Production of Forest Goods and Services, Physical and Monetary

Goods/Services		Quantity		Value	
		Unit	Amount	Unit price(USD)	Total value
Commercial production					
	Timber	M^3	3,455,524	202.8	700,780,267
	Beeswax	tons	332	3,511	1,165,490.0
	Honey	tons	821	1,325	1,087,657
	Other commercial products	tons	605	1,144	1,087,657
Non-market products					
	Fuel wood	M^3	76,000,000	0.75	57,000,000
	Poles, construction timber	M^3	4,789	43850	210,000,000
	Charcoal	Tons	800,864	340	272,293,760
	Wattle bark	Bags	1150	200	230,000
	Grasses and thatch	tons	3,701,145	1.6	5,921,832
	Wild fruits	tons	17,000	400	6,800,000
	Wild vegetables	kg	42,000	2	84,000
	Game, bush meat	Kg	435,371	2	870,742
	Wild medicines	Kg	16,240.70	3	48,723
	Beeswax	kg	783	2	1,566
	Natural honey	kg	830	1	830
	Carvings	kg	6,655	10	667,700
	Sub Total				**1,258,040,224**
	Forest Services				
	Watershed Service				359,141,651
	Carbon Sequestration		3,455,524	10	34,555,240
	Recreational Value-Based on valuation of tourist attractions.			7.5	7,068,953
	Sub Total				**7,068,953**
	GRAND TOTAL IN USD				**2,213,981,070**

Source: MNRT (2008a)

Table 3: Forest resource situation

FRA 2010 categories	Area (1000 hectares)			
	1990	2000	2005	2010
Forest	41 495	37 462	35 445	33 428
Other wooded land	18 183	14 901	13 260	11 619
Other land	28 902	36 217	39 875	43 533
...of which with tree cover	n/a	n/a	n/a	n/a
Inland water bodies	6 150	6 150	6 150	6 150
TOTAL	**94 730**	**94 730**	**94 730**	**94 730**

Source: (FAO 2010)

One of the major challenges facing Tanzania's forests is deforestation, estimated at 412,000 ha per annum between 1990 and 2005 (FAO 2009). This is equivalent to 1.1% of the country's total forest area. The main causes of deforestation are rapid population growth, poverty, clearing for agriculture, wildfires, policy and market failures, persistent reliance on wood fuel for energy, over-exploitation of wood resources and lack of land use plans and non adherence to existing ones. Deforestation is taking place in both reserved and unreserved forests but more so in the unreserved forests due to inadequate resources to implement active and sustainable forest management.

2.5 Forest ownership and tenure rights distribution

Tables 4 and 5 show forest resource ownership and holder of management rights (FAO 2010).
MNRT (2009a) reports that 2,345,500 ha of forest are covered by Community Based Forest Management (CBFM) arrangements.

Major private industrial plantations include those owned by Tanzania Wattle (TANWAT) Company, Green Resources Ltd and Kilombero Valley Teak Company. The plantations cover about 30,000 ha (Simula and Mlowe 2009). There are also small scale woodlots and medium sized plantations owned by small holders, communities, districts, tea companies, faith based organizations, schools etc. According to Simula and Mlowe (2009), these are estimated to cover 120,000 to 150,000 ha.

In Handeni District and the North Pare Mountains, over 7,000 ha of forests have been protected by traditional and customary means.

Table 4:. Forest ownership in Tanzania

Ownership category	Forest area (1000ha)		
	1990	2000	2005
Public	41,425	37,342	35,295
Private	70	120	150
Individuals	n/a	n/a	n/a
Business entities and institutions	n/a	n/a	n/a
Local communities	n/a	n/a	n/a
Indigenous/tribal communities	n/a	n/a	n/a
Other types	0	0	0
Total	41,495	37,462	35,445

Source FAO (2010)

Table 5: Holder of management rights

	Forest area (1000ha)		
Holder	1990	2000	2005
Public	13,000	13,000	13,000
Private	n/a	n/a	n/a
Private corporations and Individuals	n/a	n/a	n/a
Communities	n/a	n/a	n/a
Local	n/a	n/a	n/a
Indigenous/tribal communities	n/a	n/a	n/a
Other	28,425	24,342	22,295
Total	41,425	37,342	35,295

Source: FAO (2010)

3. IMPACTS OF CLIMATE CHANGE AND ADAPTATION OPTIONS

3.1 Evidence of climate change impacts

Some of the impacts of climate change in Tanzania are (MNRT 2007):

(i) Sea level rise. During the 20th century, sea level rose by 10-20 cm due to melting glacier ice and expansion of warmer seawater. In Tanzania, this has caused coastal erosion and is a threat to islands such as Unguja, Pemba and Mafia. Maziwe and Fungu la Nyani islands in the coast of Tanzania have disappeared. Ras Nungwi at the Northern tip of Unguja Island in Zanzibar has lost almost 100 metres of beach and coconut palm plantation to the ocean due to rising sea level. The loss of prime beach to erosion and sea level rise would cripple the islands' economies since the value of beaches for tourism will be reduced.

(ii) Heavier rainfall causing flooding in many regions as warmer temperatures speed up the water cycle. In the last ten years, floods have caused more damage to crops, soil (erosion), and disruption of settlements, commerce, transport and pressures on urban and rural infrastructures than in the previous 30 years. Increased floods lead to food shortages and spread of water borne diseases. The most recent flooding affected Kilosa District and Mwanza Region. Same District was affected by landslides due to heavy rains. All these occurred in the 2009/2010 rain season. These events cause damage to crops, property such as houses, infrastructure, loss of life to humans and livestock, uproot trees and damage coral reefs.

(iii) Frequency of droughts has increased. The droughts have resulted into serious water shortages and attendant power outages, land degradation, lower crop yield/crop damage and failure and increased livestock deaths. Droughts have also contributed to acute drop in water levels in lakes Victoria, Tanganyika and Rukwa hence adversely affecting water cycles and fisheries.

(iv) The ice cap of Mount Kilimanjaro may be gone in less than 20 years because of global warming. About a third of Kilimanjaro ice field has disappeared in just 12 years and 82% of it has vanished since it was first mapped in 1912. The disappearance of the ice on Mount Kilimanjaro will lead to shortage of fresh water for irrigation and household use and adversely affect fisheries and energy generation at Nyumba ya Mungu dam, Hale and Lower Pangani.

(v) A warmer climate has expanded the range of carriers of malaria to high land areas like Lushoto, Amani, Rungwe, Njombe and Muleba, Kilimanjaro and Arusha. As more areas receive more rains, it will in turn attract more across the country."

(vi) Changing rainfall patterns. In the past, the rains lasted from November through to April, but in recent years, they have started later and finished sooner

3.2 Future climate change impacts scenarios

A study on the assessment of vulnerability and adaptation response options for Tanzania shows that the main consequences, predicted using the Global Climate Change Scenarios, include a rise in the mean daily temperature, on average, by 3^0C - 5^0C throughout the country, and a rise in the mean annual temperature on average by 2^0C - 4^0C (URT 2003). The results also indicate that there will be an increase in rainfall in some parts while other parts will experience decreased rainfall. Areas with a bimodal rainfall pattern (some areas of northern Tanzania) will have increased rainfall ranging from 5 % to 45 %. Areas receiving unimodal rainfall will experience reduced rainfall ranging from 5 to 15 %. This change in rainfall would make the central, western and southern part of the country unsustainable for agricultural production. As a result of these changes, several sectors will become vulnerable. These sectors include agriculture, water resources, forestry, grasslands, livestock, coastal resources and wildlife. (URT 2003) estimates that projected temperature and rainfall changes could decrease the average annual maize yield by 33% over the whole country. Maize is a staple crop in Tanzania (URT, 2003). Cotton and coffee yields may also decrease up to 20%. Cotton growing areas would be reduced. Increased temperature and rainfall will also likely increase the health hazards posed to

animals. Forest responses to climate change are uncertain. Highly fragmented forest or species populations will probably be more vulnerable to climate change.

URT (2003) predicts that changing climatic patterns in Tanzania, such as increased temperatures and changes in rainfall patterns, will have strong impacts on wildlife in the country. Species migratory patterns will likely change, pests and diseases may increase, and strain for resources will become more prominent. Already, 14 species of dry country birds have responded to a drying climate and have expanded their range. Mount Kilimanjaro has an exceptionally varied ecosystem with a range of fauna and flora; as of 2005, 22% of Tanzania's vascular plants were in the Kilimanjaro vicinity, and 140 mammalian species reside there along with 179 highland bird species and 88 species of reptiles. All of these species will be at risk due to the changing landscape and distribution pattern which have shifted due to weather patterns, decreased rainfall and population growth.

The runoff of three major rivers will be altered. In rivers Pangani and Ruvu, runoff would decrease by 6 to 10 % while in the Rufiji River runoff will increase by 5 to 11 %. These changes would adversely affect water supply and socio-economic activities. With a shift to a generally drier climate, and a greater human impact, fire has and will continue to play a huge role in promoting a yet drier overall environment.

3.3 Vulnerability of the country to climate change

According to URT (2003), the main human vulnerabilities and livelihood impacts of climate change are reduced agricultural production, water shortage and/or groundwater depletion, increased disease and/or other health problems, food security and energy.

More than 80% of the population of Tanzania relies directly on agriculture for their livelihoods. A 10% reduction in rainfall would in effect make most of Tanzania unsuitable for maize production. Climate change will adversely affect food production, energy and water supply, which are preconditions for the physical well-being if not survival of rural people who are the majority of the country's population. Moreover, predicted climate changes will have adverse consequences for their incomes. Rural populations are also more vulnerable than urban ones. Health and nutritional status as well as educational attainment is lower in rural areas than in the urban areas. Rural inhabitants also suffer more from the lack of access to technological alternatives and markets and have lower levels of income than their urban counterparts.

Future climate scenarios with the largest increases in climate volatility are projected to make Tanzanians increasingly vulnerable to poverty through its impacts on the production of staple grains, with as many as 90,000 additional people, representing 0.26% of the population, entering poverty in the median case. In the 20th century, the greatest predicted increase in poverty was equal to 880,000 people, while in the 21st century, the highest possible poverty increase was equal to 1.17 million people (approximately 3.4 percent of the population). The results suggest that the potential impacts of changes in climate volatility and climate extremes can be significant for poverty in countries like Tanzania.

The availability and access to transport infrastructure influences access to markets and e.g. vulnerability to food and fuel shortages. Tanzania's transport networks are sparse even by African standards (Platteau, 2000 in Paavola 2003). The country has less than 100 km of classified roads for 1000 km but only a fraction of roads are passable in all seasons and only about one percent of the total road network is paved. There are two rail systems in the country. Tanzania–Zambia Railway Authority TAZARA provides access from Zambia, Malawi and Zimbabwe to the port of Dar es Salaam and Tanzania Railway Corporation operates lines from Dar es Salaam to Tabora and from Tabora to Mwanza and Kigoma. In total there is less than 4 km of railroad for 1000 km. Transport infrastructure

will continue to be a bottleneck in the future despite efforts to allocate more resources for its improvement.

Many Tanzanians depend on the natural environment for their subsistence and income, such as forests, which provide timber, non-timber forest products and charcoal. These resources may be impacted by climate change. Furthermore, low levels of health, nutrition, education and skills combine with low incomes and limited access to markets and technological alternatives to make poor people vulnerable to climate change. Poor people in rural areas are already more vulnerable than their urban counterparts to shocks such as droughts and are likely to be more affected by climate change

Climate change will increase the pressure on vulnerable groups in Tanzania. Women, children, pastoralists, and rural dwellers in general will find their coping mechanisms stretched to the limit. Nutrition, health, education, and the environment can suffer as a result. This can in turn increase vulnerability because natural resources have been and still are a safety net during periods of stress.

Impact assessment on forest ecosystems has been done using literature reviews, expert judgment and the simulation model approach (URT 2003). Climate data i.e. precipitation and temperature from 83 meteorological points/stations across the country were used to produce Tanzania's natural life zones on a map. Climate change scenarios developed above have been used to predict conditions at single and double levels of CO_2 . The Holdridge Life Zone classification model and forest gap models have been applied to develop the potential distribution of vegetation and to assess the effect of different parameters on species composition and productivity, respectively. The actual Tanzania life zone base map at a single level of CO_2 has been developed using Tanzania's actual vegetation map. The dominant vegetation type in Tanzania is woodland (subtropical dry forest), which covers 78.8 % of the total land; the remainder are forests (subtropical moist forest), bush-land, grasslands and thickets (subtropical thorn woodland). The vegetation is classified in two regions, i.e., Zambezian and Somali-Masai; these differ in terms of area coverage, species composition and levels of annual precipitation. The results from the Holdridge model show that at $1xCO_2$ there are three dominant life zones, i.e. subtropical dry forest, subtropical moist forest, and subtropical thorn woodland. These life zones were established using the best Global Circulation Models (GCMs), which correspond to the real Tanzania vegetation map. At $2xCO_2$ the Holdridge life model predicts potential changes in vegetation, for example, subtropical dry forest and subtropical moist forest life zone classes would change, as CO_2 doubles, to tropical very dry forest, tropical dry forest and tropical moist forest. The model predicts that subtropical thorn woodland currently in existence will be completely replaced. Subtropical dry forest and subtropical moist forest will decline by 61.4% and 64.3% respectively. There will be an increase in tropical very dry forest, tropical dry forest and tropical moist forest, which are likely to replace the current life zones. The Forest Gap Model predicted that some species are more vulnerable to climate change than others, particularly those: that are drought/heat intolerant; with low germination rates; with low survival rate of seedlings; and with limited seed dispersal/migration capabilities. The expert judgment also shows that there will be changes in forest type, species and distribution as CO_2 in the atmosphere doubles. Different vegetation types will experience changes as a result of temperature and precipitation variation. Examples of such changes are:

(i) In the areas with well-drained soils, increase in precipitation and temperature along the Lake Zone and the south-eastern, the miombo woodland would develop into closed woodland and evergreen forest;
(ii) In areas with impeded soil characteristics, miombo woodland would be replaced by wooded grassland, which in severe cases would lead to thickets/bush-land as most of the moisture would evaporate due to the high temperatures;
(iii) In the southern highlands, an increase in precipitation of 30 % and a general temperature increase would cause wetter upland woodland forest to become afromontane forest/vegetation type;

(iv) In areas where there would be a slight decrease in precipitation and increase in temperature there would be higher evapotranspiration. Woodland forest would be converted into wooded grassland or to thicket/bush-land if conditions become severe;
(v) In the areas with imperfect-to-good excessively drained soils, where there would be increase in rainfall like in the north and north-eastern areas of Tanzania, the wooded grasslands would change to thicket/bush-land forest due to high evapotranspiration and runoff losses. Drought resistant species would dominate;
(vi) In the southern areas like Mbeya, where rainfall would increase slightly and temperature would rise as CO_2 doubled, the upland woodland forest would remain unchanged, as evapotranspiration would be reduced due to the high altitude; and
(vii) Areas with drought-resistant species like those available in the Central Zone would, most likely remain unchanged, irrespective of temperature increase and a decrease in rainfall.

The assessment also shows that some species are more vulnerable to climate change than others particularly:
(i) Those with a limited geographical range that are drought/heat intolerant;
(ii) That lie at boundaries of compatible climate regions at heat/drought tolerant limits;
(iii) With low germination rates;
(iv) With a low survival rate of seedlings; and
(v) With limited seed dispersal/migration capabilities.

3.4 Potential impacts on forests to hinder development

Impact assessment on forest ecosystems in Tanzania shows that subtropical thorn woodland currently in existence will be completely replaced (URT 2003). Subtropical dry forest and subtropical moist forest will decline by 61.4% and 64.3% respectively. There will be an increase in tropical very dry forest, tropical dry forest and tropical moist forest, which are likely to replace the current life zones. The Forest Gap Model predicted that some species are more vulnerable to climate change than others, particularly those; that are drought/heat intolerant; with low germination rates; with low survival rate of seedlings; and with limited seed dispersal/migration capabilities. Since many Tanzanians depend on forests for their subsistence and income, which provide timber, non-timber forest products and charcoal, the adverse climate change impacts will reduce the ability of the forests in providing timber and non timber forest products to the communities.

3.5 Adaptation needs in the country

The potential adaptation measures for forestry against climate change are (URT 2003):
(i) Better forest management practices;
(ii) Afforestation programmes in degraded lands using more adaptive species;
(iii) Improvement/change in the use of forests and forest products to reduce tree felling by the
(iv) application of alternative materials;
(v) Enhancement of forest seed banks and the development of new plant varieties;
(vi) Encouragement of multiple/diversity management practices in the case of plantations;
(vii) Reduction of habitat fragmentation,
(viii) Promotion of the development of migration corridors and buffer zones; and
(ix) The application of technologies that use other materials instead of wood, for example recycled plastics in the production of furniture will lead to a litter-free environment and conserve trees for environmental purposes e.g. their use as sinks for CO_2. Likewise, greater recycling of waste paper will also reduce the volume of tree logs used to manufacture paper and paperboards.

URT (2007) prioritised the following projects as adaptation strategies against climate change:

(i) Increase irrigation by using appropriate water efficient technologies to boost crop production in all areas
(ii) Alternative farming systems and water harvesting
(iii) Develop alternative water storage programmes and technology for communities
(iv) Community based catchments conservation and management programmes
(v) Explore and invest in alternative clean energy sources e.g. wind, solar, bio-diesel, etc. to compensate for lost hydro potential
(vi) Promotion of application of cogeneration in the industry sector for lost hydro potential
(vii) Afforestation programmes in degraded lands using more adaptive and fast growing tree species
(viii) Develop community forest fire prevention plans and programmes
(ix) Establishing and strengthening community awareness programmes on preventable major health hazards
(x) Implementation of sustainable tourism activities in the coastal areas and relocation of vulnerable communities from low-lying areas
(xi) Enhance wildlife extension services and assistance to rural communities in managing wildlife resources
(xii) Water harvesting and recycling
(xiii) Construction of artificial structures, e.g., sea walls, artificially placing sand on the beaches and coastal drain beach management system
(xiv) Establish good land tenure system and facilitate sustainable human settlements

Farmers have responded to droughts by expanding cultivations, reducing fallows, switching crops and engaging in wage employment or in charcoal, timber and brick production. Farmers also frequently migrate on temporary basis to locations which have favourable farming conditions or better access to markets. Improved health and education must support these other measures if vulnerable groups are to have a fair chance at participating in markets in a way that benefits them and assists them in adapting to climate change.

Many adaptive measures such as seasonal weather forecasts are based on a presumption of the availability of and access to functioning communications technologies. There are indeed 278 radios per 1000 people in Tanzania – over twice as much as in neighbouring countries – and the national network of radio stations covering 95% percent of the county provide the main access to mass media (World Bank, 2002 in Paavola 2003). Radio will continue to be the primary means of disseminating information in the country in the near future.

3.6 Estimation of costs

URT (2003) estimated that a project to address protection and conservation, together with promoting afforestation programmes to adapt to climate change impacts in Kilimanjaro which would involve restoration of vegetation cover on the degraded areas and making available forest products to communities living in the area would cost a total of USD 3,300,000 for three years.

4. MITIGATION ISSUES AND OPTIONS

4.1 Potential for various mitigation options

According to URT (2003), potential forestry projects that would lead to GHGs mitigation from the basis of the forestry mitigation assessment include:

(i) Commercial/industrial forest plantation (e.g. Sao Hill Forest Phase II);
(ii) Extension and replanting of other industrial forest plantations;
(iii) Small holder or village tree growing for multiple purposes;
(iv) Natural/catchment forest protection; and
(v) Bioenergy from forest waste

4.1.1 Commercial Forest (Sao Hill Forest) Plantation

The Sao Hill forest plantation which is located in Mafinga, Iringa, in the southern plateau of Tanzania. was developed for timber and pulp production. The Sao Hill plans and projections contained in the Tanzania Forestry Action Plan (TFAP) aim at expanding the forest from its current about 40,000 to 60,000 ha. It is assumed that half of the area will be planted with Pine and Cypress for sawlogs, while the other half will be planted with Pine for pulpwood. The rotation for the two species is 25 years and 15 years, respectively. The Sao Hill Forest plantation and its planned expansions if implemented properly will form a mitigation option. The Mean Annual Increment for the two species in m^3 of biomass/ha/annum is 25 and 17 for sawlogs and pulpwood respectively. Makundi (2001) examined the potential to sequester C through expansion of forest plantations aimed at reducing the dependence on natural forest for wood fuel production, as well as increase the country's output of industrial wood from plantations. Three sequestration options were analyzed, involving the establishment of short rotation and long rotation plantations on about 1.7×10^6 hectares. The short rotation community forestry option has a potential to sequester an equilibrium amount of 197.4×10^6 Mg C by 2024 at a net benefit of 79.5×10^6, while yielding a NPV of 0.46 Mg^{-1} C. The long rotation options for softwood and hardwood plantations will reach an equilibrium sequestration of 5.6 and 11.8×10^6 Mg C at a negative NPV of 0.60 Mg^{-1} C and 0.32 Mg^{-1} C. The three options provide cost competitive opportunities for sequestering about 7.5×10^6 Mg C yr^{-1} while providing desired forest products and easing the pressure on the natural forests in Tanzania. The endowment costs of the sequestration options were all found to be cheaper than the emission avoidance cost for conservation options which had an average cost of 1.27 Mg^{-1} C, rising to 7.5 Mg^{-1} C under some assumptions on vulnerability to encroachment. The estimates represent the upper bound, because the actual potential will be influenced by market prices for inputs and forest products, land use policy constraints and the structure of global C transactions.

4.1.2 Other plantations

Expansion of other forest plantations (Table 6) will also form a mitigation option.

4.1.3 Small Holder or Village Tree Growing for Multiple Purposes

Smallholder or village tree growing and management for multiple purposes includes agro-forestry, with wood fuel provision for own-use. The priority given by local people to growing trees for woodfuel varies greatly according to the farming systems and the amount of accessible forest or other tree resources in relation to consumption levels. Tree growing can also be for the sale of poles and fuel as a cash crop to local rural and urban markets. There are small scale woodlots and medium sized plantations owned by small holders, communities, districts, tea companies, faith based organizations,

schools etc. According to Simula and Mlowe (2009), these are estimated to cover 120,000 to 150,000 ha. The carbon sequestration potential of these forests has not been assessed.

Agroforestry refers to combinations of trees, crops and livestock that are intentionally designed and managed as a whole production unit. The benefits include increased crop yields, animal fodder, fruits, medicines, resins, improved soil and water quality, increased biodiversity, helping maintain soil health through nitrogen fixation and use of cuttings as fertilizer and mulch, ecosystem benefits such as pollination, water storage and erosion control as well as lower greenhouse gas emissions and increased carbon sequestration. Thus, Agroforestry systems offer an option for mitigating climate change, while also helping rural people adapt to its consequences. Agroforestry can play in improving the resilience of farming systems to climate variability. There is considerable adoption of Agroforestry in Tanzania including Arusha, Kilimanjaro, Shinyanga, Tabora and Kagera regions. The Business Plan for Scaling up/out agroforestry technologies in semi-arid Tanzania shows that the goal is to improve the well being of 300,000 low-income farmers' households in Tanzania through the use of agroforestry innovations and technologies (Anon. no date). UNDP (2008) reports that agroforestry has the potential to sequester 2 to 5 tons carbon/ha/year.

4.1.4 Natural/Catchment Forest Protection

Natural/catchment forests protection is another mitigation option identified in Tanzania, which will maintain the existing stands of trees/sinks and the proportion of forest products currently in use. This may involve the following activities:

(i) The sustainable use of forest resources through the harvesting of branches for food for animals, as well as fallen wood for woodfuel together with some tree cutting in natural forests on village or state lands, at or below the rate of natural regeneration;
(ii) Improved management for the greater productivity of village forest land. Also, improved control against unlicensed felling in these forestlands is important in order to raise village incomes but does not, of course, add to the total supplies. Improved control can also reduce the destructive impacts of indiscriminate felling, such as soil erosion, loss of valuable species, etc.
(iii) Improved management of and tighter controls of state forests. In the short term, the latter may reduce rural supplies of forest services as well as incomes from those who live off the forest. This income loss may be very significant.
(iv) Controlled clearing of natural forests for farm or grazing land as part of a sustainable long-term land use strategy. The question of the cutting rate is critical. If the rate is greater than the local capacity to use the wood, or sell it into commercial markets, the surplus will be burned as "waste".
(v) Forest protection and conservation including the protection of wildlife areas
(vi) Increased efficiency in forest management, and harvesting,
(vii) Restoration and rehabilitation of degraded areas through natural regeneration, assisted natural regeneration and enrichment planting. For example, since 1985, Wasukuma agropastoralists in Shinyanga region, northern Tanzania have restored more than 350,000 ha of degraded land (MNRT 2008 PFM) using traditional Wasukuma reserved areas called *ngitili* ('enclosure'). These *ngitili* are traditional dry season reserves where use of trees and other vegetation are regulated by either individuals or groups of people. Many of these *ngitili* have now been formalized as private, community or village forest reserves, managed for both woodland products as well as livestock grazing pasture. This has re-vitalized traditional resource management practices by giving local people the statutory authority to protect and manage their resources. According to UNDP (2008), rehabilitation of degraded land has the potential to sequester 0.25 to 0.9 tons carbon/ha/year.

4.1.5 Urban forestry

Urban forestry could improve the urban environment such as shade, beauty, micro-climate, noise reduction and reduce pollution and wind protection. It could also provide fuelwood, low cost construction materials and other wood products, provide amenity, recreational opportunities and other benefits for improved quality of life. Urban forestry could also contribute to carbon sequestration and biodiversity conservation especially where they cover extensive areas like parks, gardens and avenues managed over long periods. Thus, urban forestry has potential for carbon sequestration and therefore contributes to mitigation of climate change. It is being practiced in most urban areas in the country. There is considerable tree planting in urban areas but no statistics of the area under urban forestry and the carbon stock.

4.1.6 Bioenergy from Forest Waste

Energy production from forest products (the bio-energy option) will lead to a reduction in carbon emission by substituting the wood derived from renewable sources for other products particularly fossil fuels. Fossil fuel substitution with biomass derived from sustainably managed renewable resources, will:

(i) delay the release of carbon from fossil fuel until it is needed sometime in future;
(ii) increase and maintain carbon in sinks. It has been assumed that in order to produce 45 tonnes of timber 55 tonnes of waste is created, in the form of sawdust, treetops and branches, and is left to decay, burnt on site or collected as woodfuel, hence emitting greenhouse gases. These wastes can be used sustainably as fuels into the turbines to produce electricity.

Mufindi Paper Mills Limited, in Mufindi Iringa have plans to make use of huge volumes of wood residues available at Sao Hill Plantations evaluated the feasibility of building a bio-fuel fired power plant for meeting the balance requirement of electrical energy for the mill. Apart from the wood waste at Sao Hill, TANWAT, located around 140 km from the paper mill site, leaves around 70,000 green tons of debarked wattle wood after tan extraction on the forest floor. Considering the sustained availability of these bio-fuels Mufindi Paper decided to build a 35.6 MWe Bio-fuel Fired Power Plant for meeting the electrical energy requirements for its operations as well as exporting it to the grid. The project activity reduces CO_2. Sao Hill Sawmills are also using forest waste to generate electricity and steam for timber drying.

4.2 Reduction of emissions from Deforestation and Forest Degradation

One of the major challenges facing Tanzania's forests is deforestation, estimated at 412,000 ha per annum between 1990 and 2005 (FAO 2009). This is equivalent to 1.1% of the country's total forest area. Since deforestation through burning accounts for at least 20 % of global carbon emissions, measures to curb this complex phenomenon ought to be one of the principal strategies for reducing greenhouse gas emissions. Prevention of deforestation can maintain the amount of carbon held in forests. Tanzania has strengthened law enforcement and advocates participatory approaches to forest management as a means of reducing deforestation. According to URT (2003), the total CO_2 removal by change in forest and other woody biomass stock and the abandonment of management lands in 1990 was 3,745.3 Gg . Forests subject to human activities (management of forests) accounted for half of the removals while another half was contributed by abandonment of managed lands. Management of forests comprises plantation forests, village woodlot, natural forests subject to human activity, wood exploited informally for woodfuel, and urban and rural tree planting. Abandonment of managed lands comprises the abandoned wooded grassland and tropical open forests.

Table 6: Possible extension of other forest plantations

	Main species	Existing forest area (ha)	Possible extension of planted area (ha)
Meru	eucalypts	3,482.3	821
Training forest	eucalypts	660*	25
Usa	Loliondo, grevillea	944.9	50
West Kilimamnjaro	pines	3,966.9	646
North Kilimanjaro	pines	3,809.2	1,000
Shume	pines	1,515	131
Magamba	Black wattle	849	243
Longuza	teak	1,608.1	2,850
Kwamkoro	Maesopsis, mtambara	647.4	400
Ukaguru	pines	965.5	68
Mtibwa	teak	999.5	768
Ruvu	Senna	617	2,662
Rondo	Pines, mvule, teak	1915	6,000
Matogoro	Pines	864.5	11,281
Kawetire	pines	871.9	25,000
Kiwira	pines	1,243.3	300
Rubare	pines	94.6	11
Rubya	pines	1098.2	3,300
Buhindi	pines	3209.3	7,800
Total		**28,701.6**	**62,592**

Source: URT (2003)

4.3 Reduction of emissions by improved forest management

Reduction of emissions through forest management can be obtained by fire control; disease and pest control; adoption of low-impact harvesting, prolongation of rotation cycles.

Selective cutting schemes, lengthened rotations, reduced-impact logging, and species choice may achieve a higher average level of sequestered carbon. Regulations requiring forest managers to use RIL techniques would be a major step forward in sustainable forest management and would substantially reduce carbon emissions from logged forests. Post-logging silvicultural treatments would double this benefit, and control of illegal logging would likely double it again. Longer-term benefits of RIL practices accrue to forest owners because RIL-logged stands regenerate more quickly than those logged conventionally. There is therefore need for the government of Tanzania to put in place through legislation requirements for adoption of RIL.

The government has formulated an Eastern Arc Strategy which among others has a component of fire control in the EAM forests. Management plans of forest reserves incorporate fire, disease and pest control. The establishment of the Tanzania Forest Service (TFS) as an executive agency and the Tanzania Forest Fund are expected to lead to improvement of forest management through improved service delivery including strengthened law enforcement and reliable funding. The Eastern Arc Mountains Endowment Fund established in 2001 also aims at improving management of forest resources in the EAMs. PFM has also been reported to improve forest condition resulting from

improved management. However, reduction in emissions as a result of improved forest management has not been assessed.

Makundi (2001) examined the potential to sequester C through expansion of forest plantations aimed at reducing the dependence on natural forest for wood fuel production, as well as increase the country's output of industrial wood from plantations. Long rotation options for softwood and hardwood plantations will reach an equilibrium sequestration of 5.6 and 11.8 × 10^6 Mg C at a negative NPV of 0.60 Mg^{-1} C and 0.32 Mg^{-1} C.

4.4 Substitution of harvested wood products for other materials and of wood fuels for fossil fuels

Substituting essentially carbon-neutral wood for energy-intensive materials such as brick, aluminium or steel may significantly reduce the use of fossil fuels, which of course release carbon dioxide when burned. Sustainable production of wood fuel from forests can displace fossil fuels. Although burning of biomass fuels releases CO_2, the regrowth of a sustainably managed forest offsets that release. Thus, forest fuels can supply energy virtually without net contribution to GHG levels. Using wood in buildings and other long-lived objects effectively sequesters carbon for the life of the object.

A land-use option that shows great potential for reducing greenhouse gas emissions–but might also involve difficult tradeoffs – is the production of renewable biofuels, such as biodiesel and bioethanol. Such products are derived chiefly from materials referred to in their raw form as "biomass." This includes agricultural residues and wastes but increasingly also crops grown specifically for biofuel production.

Tanzania, has embarked on pilot programmes for liquid biofuel development. More than ten companies already are at different stages of establishing farms for biofuels production. Such companies include among others; Prokon (Germany), Wilma (USA), SEKAB (Sweden), Diligent (Netherlands), some are in joint ventures such as FELISA with investors form Tanzania and Belgium. Local institutions at the forefront of promoting liquid biofuels include Kakute which supports small farmers to grow Jatropha and sell its oil for soap production.

Biofuels can reduce carbon emissions, because the plant materials from which they are derived capture carbon from the air. When biofuels are used to generate energy, this carbon is subsequently returned to the atmosphere, thus completing the cycle. In other words, the consumption of biofuels, unlike that of petroleum products, involves no net increase in carbon emissions. So, to the extent that biofuels displace petroleum in energy markets, emissions should decline.

Biofuels may offer the additional benefits of helping cope with increased energy prices and providing rural communities with new sources of income and employment. However, biofuels production has a number of potentially negative consequences. One of the principal concerns is that production of biofuels will compete with that of food, driving up the price of basic foods. Poor consumers would be hurt most by rising prices, though farmers would benefit. On the other hand, the poor might benefit from lower energy prices and from new employment opportunities in the bioenergy sector. The prospect of a biofuels revolution has also aroused concerns in Tanzania about adverse environmental impacts. Considerable areas of coastal forests in Pwani and Lindi regions which are important for their biodiversity values have been cleared for biofuel production. These fuels will not be used in Tanzania. They are being produced for external markets mainly.

Woodfuel is a good substitute for fossil fuel if the wood is harvested from sustainable production systems. Similarly, renewable energy like hydro-, solar or wind power is a good substitute for woodfuel that is harvested unsustainably.

Substituting fossil fuel or clean electricity for fuel wood would particularly benefit women and girls who are in charge of cooking and fuelwood collection in many places, but it would also improve air quality for all members of the household. A subsidised supply of improved stoves or electricity would be important to poorer urban households.

4.5 Improvement of fuel wood efficiency and supply

In 2006 the Vice President's Office issued a strategy on conservation of land environment and water sources. Regarding addressing environmental degradation caused by cutting of trees for woodfuel, the strategy requires institutions such as prisons and schools which use large quantities of woodfuel and tobacco farmers to establish their own plantations/woodlots for supply of wood for energy. The strategy further requires villages and urban centres to establish fuelwood plantations/woodlots (URT 2006).

The government has established the Ruvu fuelwood project in Pwani region as a community operated sustainable production system for provision of fuelwood to Dar es Salaam. The project also promotes improved charcoal making by introducing improved kilns and use of energy-efficient stoves. The project collaborated with Tanzania Traditional Energy and Environment Development Organisation (TaTEDO) in promoting appropriate technology in wood fuel production and use. The short term objective of JFM in Ruvu North Forest Reserve is to empower communities to participate in forest resource management and improve efficiency in production and utilization of wood fuels, hence increasing benefits to the participating communities. Charcoal production is done using Improved Basic Earth Kilns (IBEK). These kilns were introduced as part of JFM arrangements. IBEK produces 3 – 4 bags of charcoal from 1 m^3 of wood compared to 1 – 2 bags from 1 m^3 using traditional earth kilns (Nshubemuki 2009).

As part of implementation of promoting efficient biomass conversion and end-use technologies in order to save resources, reduce rate of deforestation and land degradation; and minimising threats on climate change TaTEDO has made the following interventions:

(i) Promotion of production and use of modern efficient cook stoves, baking and meat roasting ovens in households and SMEs: Based on the 2000-2006 TaTEDO annual reports it shows that production and uptake of improved charcoal stoves was 1,204,307.
(ii) Capacity building on construction and promotion of the improved stoves: Bioenergy department has managed to train more than 400 artisans in nine regions where some programme are undertaken in Tanzania.
(iii) Research and development: Bioenergy department in its period of existence has carried out various adaptive researches and come up with improved products, which include 10 prototypes of stoves and five types of ovens. The thermal efficiency of these stoves and ovens as compared to the traditional ones has been raised from 15 percent of the traditional charcoal stoves to between 30 and 40 percent. This implies that improved stoves can save consumption of charcoal by 40 to 50 percent as compared to traditional charcoal stoves.

5. ADAPTATION-MITIGATION SYNERGIES AND TRADE-OFFS

5.1 Synergies and tradeoffs between adaptation and mitigation options in the land use sector

A key trade-off is between the production of bioenergy crops and food security. To the extent that bio-energy production uses crop residues, excess agricultural products or surplus land and water, there will be little resultant loss of food production. But above this point, proportional losses of food production will be strongly negative. Food insecurity is determined more by inequity of access to food (at all scales) than by absolute food production insufficiencies, so the impact of this trade-off depends among other things on the economic distributional effects of bio-energy production. For example, intensification of agriculture and large-scale production of biomass energy crops will lead to loss of biodiversity where they occur in biodiversity-rich landscapes.

Areas so far identified for biofuels in Tanzania are not marginal lands as false fully indicated by many biofuel investors. These ares are characterised by a fairly high rainfall, water resources, rich soils, and naturally are fairly densely populated. For example, in so far as sugarcane cultivation in the country is concerned, the primary sites are Kagera region (Kagera Sugar Limited), Moshi (Tanganyika Planting Company), Morogoro (Mtibwa Sugar Estate) and Kilombero (Kilombero Sugar Company), which are fertile areas and with enough rainfall/water.

Agricultural mitigation practices may influence non-agricultural ecosystems. For example, practices that diminish productivity in existing cropland (e.g., set-aside lands) or divert products to alternate uses (e.g., bio-energy crops) may induce conversion of forests to cropland elsewhere. Conversely, increasing productivity on existing croplands may 'spare' some forest or grasslands (West and Marland, 2003; Balmford *et al.*, 2005; Mooney *et al.*, 2005 in Smith *et al.,* (2007) The net effect of such trade-offs on biodiversity and other ecosystem services has not yet been fully quantified (Huston and Marland, 2003; Green *et al.*, 2005 in Smith *et al.,* 2007).

Mitigation, climate change impacts, and adaptation will occur simultaneously and interactively. Mitigation-driven actions in agriculture could have (a) positive adaptation consequences (e.g., carbon sequestration projects with positive drought preparedness aspects) or (b) negative adaptation consequences (e.g., if heavy dependence on biomass energy increases the sensitivity of energy supply to climatic extremes. Adaptation-driven actions also may have both (a) positive consequences for mitigation (e.g., residue return to fields to improve water holding capacity will also sequester carbon); and (b) negative consequences for mitigation (e.g., increasing use of nitrogen fertilizer to overcome falling yield leading to increased nitrous oxide emissions). In many cases, actions taken for reasons unrelated to either mitigation or adaptation may have considerable consequences for either or both(e.g., deforestation for agriculture or other purposes results in carbon loss as well as loss of ecosystems and resilience of local populations).

Table 7 shows interaction between adaptation and mitigation of climate change. The implications of forestry mitigation to forestry development are shown in Table 8.

6. INTEGRATING CLIMATE CHANGE ISSUES INTO FOREST POLICY, LEGAL AND INSTITUTIONAL FRAMEWORKS: NEEDS, ISSUES AND OPTIONS

6.1 Forests policy and climate change

The National Forest Policy was approved by government in 1998. The overall goal of the national forest policy is to enhance the contribution of the forest sector to the sustainable development of Tanzania and the conservation and management of her natural resources for the benefit of present and future generations.

The objectives of the forest sector on the basis of the overall goal are:

(i) Ensured sustainable supply of forest products and services by maintaining sufficient forest area under effective management;
(ii) Increased employment and foreign exchange earnings through sustainable forest-based industrial development and trade;
(iii) Ensured ecosystem stability through conservation of forest biodiversity, water catchments and soil fertility; and
(iv) Enhanced national capacity to manage and develop the forest sector in collaboration with other stakeholders.

Among others, the policy promotes sustainable forest management and participatory approaches to forest management, especially participatory forest management through CBFM and JFM. These are important for addressing the impacts of climate change. Policy review took place in light of the linked forces of decentralizing forest management, encouraging participatory forest management (e.g. Joint Forest Management or Community Based Forest Management), and ensuring forests contribute towards national poverty alleviation goals.

The current National Forest Policy has been reviewed and is awaiting approval by the government. The draft policy maintains PFM as one of the priorities for promoting sustainable forestry management.

The current National Forest Programme (NFP) was endorsed by the Government in November 2001 and covers ten years (2001-2010). The NFP guides implementation of the Forest Policy (MNRT 2001). Development of community forestry is one of the priorities of the National Forest Policy. Participatory Forest Management (PFM) guidelines were drawn up in 2001 and revised in 2008. However, Joint Forest Management guidelines are not yet operational as mechanism for cost-benefit sharing between participating partners are not yet in place.

In the implementation of the NFP, the central and local governments, private sector, NGOs, CBOs at all levels and the international community have key roles to play so as to maximize the benefits and minimize the costs of management. While the central government focuses more on coordinating, guiding and monitoring implementation, local governments and the private sector are responsible for the actual management.

Implementation arrangements for forest reserves including plantations and general lands, a semi-autonomous Executive Agency/(cies) will be established at national level. In the field level activities, ongoing reforms under the Local Government Reform Programme provide a framework for organizational arrangements to support forest management. The ultimate goal is to integrate and mainstream pilot activities into the district plans in a programme approach. Implementation modalities for the different sets of forests include community-based forestry management under the respective local governments, joint forest management where partnership with central government is a key and private forests management including plantations and natural forests.

In this respect, some key institutions include the Regional Administration and Local Government, Lands, natural resources and other land based sectors, research and training institutions (Sokoine University of Agriculture – Faculty of Forestry and Nature Conservation and Tanzania Forest Research Institute), Civil Service Department and Legal affairs and Private Sector Foundation.

In addition to the FBD, there are some private companies, religious organizations and individuals who manage plantations, of which records are not available. Some of the private forests, such as the Tanganyika wattle company, have a major contribution to foreign earnings (MLNRT, 1989). To improve fuelwood supply in rural areas and reduce pressure on environmental degradation, the government adopted the village afforestation approach since the early 1970's. The programme relied on the participation of villages and NGOs, mainly religious groups, in tree planting. Although the quality of the stock is not known, about 80 000 hectares of scattered woodlots have been established through this programme (MLNRT, 1989).

Forest administration is embedded in three main, almost parallel, organizations. These include the FBD under the MNRT, the Regional Organization, under the Prime Minister Office, and the District organizations under the Ministry of Local Governments. The existence of the parallel organizations within natural resource management has been a source of inefficiency in forest management initiatives. At the regional and District levels, forestry and beekeeping officers have only an advisory role. They have no direct link to planning and control of personnel or field activities. Further, local governments are self-financing, as a result revenue collection in the form of royalties tends to dominate the decision making when issuing harvesting licenses.

Table 7: Adaptation and mitigation matrix

Mitigation option	Venerability of the mitigation option to climate change	Adaptation options	Implications for GHG emission due to adaptation
A: Increasing or maintaining the forest area			
Reducing deforestation and forest degradation	Vulnerable to changes in rainfall, higher temperatures (native forest dieback, pest attack, fire and, droughts).	Fire and pest management. Protected areas management. linking corridors of protected areas	No or marginal implications for GHG emissions, positive if the effect of perturbations include by climate change can be reduced.
Afforestation/Reforestation	Vulnerable to changes in rainfall, and higher temperatures (increase of forest frees, pests, dieback due to drought).	Species mix at different scales. Fire and pest management increase biodiversity in plantations by multi-species plantations. Introduction of irrigation and fertilization. Soil conservation.	No or marginal implications for GHG emissions, positive if the effect of perturbations included by climate change can be reduced. May lead to increase in emissions from soils or use of machinery and fertilizer.
B: Changing forest management increasing carbon density at plot and landscape level			
Forest management in plantations	Venerable to changes in rainfall, and higher temperatures (i.e. managed forest dieback due to pest, or droughts)	Pest and forest fire management. Adjust rotation periods. Species mix at different scales. Pest and fire management Species mix at different scales.	Marginal implications on GHGs. May lead to increase in emissions from soils or use of machinery or fertilizer use. No or marginal
C: Substitution of energy intensive materials			
Increasing substitution of fossil energy intensive products by wood products.	Stocks in products not vulnerable to climate change		Not implications in GHGs emissions
D: Bio-energy			
Bio-energy product from forestry	An intensively managed plantation from where biomass feedstock comes is vulnerable to pests, drought and fire occurrence, but the activity of substitution is not.	Suitable selection of species to cope with changing climate. Pest and fire management	No implications for GHGs emissions accept form fertilizer or machinery use.

Source: Nabuurs et al (2007)

Table 8: Sustainable development implications of forestry mitigation

Activity category	Sustainable development implications		
	Social	**Economic**	**Environmental**
A: Increasing or maintaining the forest area			
Reducing deforestation and forest degradation	**Positive** Promotes livelihood	**Positive or negative** Provides sustained income for poor communities Forest protection may reduce local incomes	**Positive** Biodiversity conservation, Watershed production Soil protection. Amenity values (Nature reserves, etc).
Afforestation/reforestation	**Positive or negative** Promotes livelihood. Slows population migration to other areas (when a less intense land use is replaced). Displacement of people may occur if the former activity is stopped, and alternate activities are not provided. Influx of outside population has impacts on local population	**Positive or negative** Creation of employment (when less intense land use is replaced). Increase/decreases of the income of local communities. Provision of forest products (fuel wood, fibre food construction materials) and other services.	**Positive or negative** Impacts on biodiversity at the tree, stand, or landscape level depend on the ecological context in which they are found. Potential negative impacts in case on biodiversity conservation (mono specific plantations replacing biodiverse grasslands or shrub lands). Watershed protection (except if water-hungry species are used). Losses in stream flow. Soil protection. Soil properties might be negatively affected.
B: Changing to sustainable forest management			
Forest management in plantations	**Positive** Promotes livelihood	**Positive** Creation of employment. increase of the income of local communities. Provision of forest products (fuel hood, fibre, food, construction materials) and other services	**Positive** Enhance positive impacts and minimize negative implications on biodiversity, water and soils
Sustainable forest management in native forest	**Positive** Promotes livelihood	**Positive** Creation of employment Increase of the income of local communities. Provision of forest products (fuelwood, fibre, food, construction materials) and	**Positive** Sustainable management prevents forest degradation, conserves biodiversity and protects watersheds and soils.

		other services	
C: Substitution of energy intensive materials			
Substitution of fossil intensive products by wood products	**Positive or negative** Forest owners may benefit. Potential for competition with the agricultural sector (food production, etc).	**Positive** Increased local income and employment in rural and urban areas. Potential diversification of local economies, Reduced imports.	**Negative** Non-sustainable harvest may lead to loss of forests, biodiversity and soil.
D: Bio-energy			
Bio-energy production from forestry	**Positive or negative** Forest owners may benefit. Potential for competition with the agricultural sector (food production, etc).	**Positive or negative** Increased local income and employment. Potential diversification of local economics. Provision of renewable and independent energy sources. Potential competition with the agricultural sector (food production etc.)	**Positive or negative** Benefits if production of fuelwood is done in a sustainable way. Mono specific short rotation plantations for energy may negatively affect biodiversity, water and soils, depending on site conditions.

Source: Nabuurs et al (2007)

6.2 Other policies

The government of Tanzania has within her energy, agriculture, land, environment and forest policies, statements of intentions to improve the supply and demand of solid bioenergy and ensure its sustainability. Such statements include: Energy policy of 2003 statement 37, Promote efficient biomass conversion and end-use technologies in order to save resources, reduce rate of deforestation and land degradation and minimizing threat on climate change. Environmental policy of 1997: Investment in Biomass development vital for environmental protection and poverty reduction. The Environmental Policy further recognises the importance of forests on climate change mitigation. It calls for responsible ministries to put measures to address climate change.

The Land policy of (1997). Recognized the confusion and uncertainty regarding land tenure and management authority over most land in Tanzania. Policy sought to dispel this confusion by reiterating government of Tanzania general underlying right to land, but clearly recognizing and clarifying customary and other use rights to land. Agriculture policy (1997) seeks to promote sustainable food security, income generation, employment growth, and export enhancement through the development and dissemination of appropriate and environmentally friendly practices and technologies.

However, while these policies have ambitious goals, they have rarely linked plans and capacity to implement them through effective strategies and regulatory framework; as a result for example the solid bioenergy situation in Tanzania has continued to deteriorate with serious negative environmental socioeconomic consequences in most rural areas (Sawe 2008).

6.3 Forest and other Legislation

The Forest Act No. 14 of 2002 promotes sustainable forest management including through community and private ownership which are important for the implementation of the REDD policy. However it falls short in mentioning specific issues on climate change mitigation. . Policy and legislative revision took place in light of the linked forces of decentralizing forest management, encouraging participatory forest management (e.g. Joint Forest Management or Community Based Forest Management), and ensuring forests contribute towards national poverty alleviation goals. Participatory Forest Management (PFM) guidelines were drawn up in 2001 and revised in 2008. However, Joint Forest Management Guidelines are not yet operational since cost-benefit sharing mechanism between participating parties is not in place.

The Village Land Act No. 5 of 1999 provides procedures to transfer of village land to general or reserved land that can be used for forestry investments.

Forest management in Tanzania is also dependent upon a range of other sectoral policies and actors. For example, Participatory Forest Management (PFM) is dependent on land titling (Land Act Number 4 of 1999 and Village Land Act Number 15 of 1999) and the enactment of village by-laws (Local Government Miscellaneous Amendments Act, 1982). Other specific examples include the influence of infrastructure developments and energy demand on forests.

The legal framework in support of environmental management in Tanzania promotes sustainable forest management and protection which are important for the implementation of the REDD policy. For example, the National Land Policy of 1995 has the objective to promote and ensure wise use of land, guide allocations, prevent degradation and resolve conflicts. On issues related to environmental management, this policy is one of the major guiding principles to local authorities, which are in dire need of decision-making mandates on land use and resources.

6.4 Institutional framework.

The Vice President's Office is overarching institution for formulating environment management policy and legal framework in the country. In accordance with Sections 15 and 75 of the Environmental Management Act, 2004, all environmental management issues including climate change are coordinated by the Vice President's Office. This Act mandates the Division to coordinate all climate change issues including adaptation and mitigation. The Division of Environment, is therefore the focal point for all matters related to environment. Reducing emissions from deforestation and forest degradation (REDD) is one of the mitigation options to address climate change.

The government has put in place a National Climate Change Steering Committee (NCCSC) and National Climate Change Technical Committee to oversee and guide the implementation of climate change activities in the country (URT 2007). In order to avoid overlaps and duplication of efforts, the same institutional arrangement will also save for REDD activities. The NCCSC which handles all climate change related issues in Tanzania will serve as a top decision making body for the national REDD scheme, and technical issues will be handled by the technical committee. The National Climate Change Committee comprises members from government ministries and institutions, nongovernmental organizations (NGOs), and academic and research institutions. The main function of the committee is to advise the division of environment on climate change related issues and options in the country. The committee receives periodic reports for review. It gives advice on the study implementation process and provides guidance to researchers. The NCCSC is made up of the following twelve members:

(i) Director for Environment (NCCSC Chairman);
(ii) Director General of Meteorology (NCCSC Co-Chairman);
(iii) Director General of National Environment Management Council;
(iv) Commissioner for Energy and Petroleum Affairs;
(v) Representative from the Planning Commission;
(vi) Representative from the Ministry of Foreign Affairs and International Cooperation;
(vii) Representative from the Attorney General's Chambers;
(viii) Director for Fisheries
(ix) Director for Forestry;
(x) Commissioner for Agriculture;
(xi) Representative from the University of Dar es Salaam;
(xii) Tanzania Chamber of Commerce Industry and Agriculture;
(xiii) Chairman/Director of CEEST. CEEST provides the secretariat for the NCCC.

The existing composition of the members of these committees may be broadened as need arises.

However, FBD will have important role in implementing, supervising and operationalizing REDD initiative. This is based on the already existing initiative in the forestry sector such as Participatory Forest Management (PFM) which includes Joint Forest Management (JFM) and Community Based Forest Management (CBFM). Likewise, local Government will ensure smooth implementation of REDD related activities in their areas of jurisdiction. In addition, REDD coordination at district level will adhere to the existing institutional structure whereby Environmental Officers (as established by EMA, 2004) at district and Municipal levels will serve as coordinators for REDD activities in their respective areas. Since there are complementary initiatives by UN agencies namely UN – REDD, there is a need to synchronize activities under the existing and any other REDD emerging initiatives.

6.5 Current initiatives on forests and climate change

6.5.1 Planned or existing systems of payment for environmental services

Payment for Environmental Services (PES) is an approach aimed at facilitating conservation. Environmental services include watershed protection, forest conservation, biodiversity conservation, carbon sequestration and landscape beauty in support of ecotourism. PES is considered as a direct incentive to encourage ecosystem management to ensure the continued provision of these services. PES is part of a new and more direct conservation paradigm, explicitly recognizing the need to bridge the interests of landowners and outsiders and has to be seen partly as a response to a need to identify additional sources for financing conservation. It is a highly promising conservation approach that can benefit buyers, sellers and improve the resource base.

There are no fully operational PES activities in Tanzania, the sole exception is the TIST programme (Scurrah-Ehrhart 2006). However, its carbon sales are currently stalled, awaiting a Government of Tanzania CDM letter of approval. Payment for water services (PWES) is also being piloted in the Uluguru landscape (MNRT 2008 ULMF). PES project ideas and potential ecosystem service sellers are slowly emerging in Tanzania, particularly among private and public organizations in the Energy, Water and Forestry sectors. Activities are at their most advanced stage among Conservation NGOs in the water and forestry sectors, where there are projects in proposal, planning and commencement stages. For example, Kulindwa (2005) conducted a feasibility study to design PES mechanism for the Pangani River Basin. FBD (2007) also carried out studies aimed at establishing a mechanism for PWES in Tanzania using the EAM forests and the Rufiji Basin as a whole.

6.5.2 Afforestation/Reforestation CDM and CDM bioenergy project activities

According to Muyungi (2008), there is only one bioenergy project which has been registered in Tanzania. This is the Mtoni Landfill Gas Capture and Energy Generation project worth 202,271 CREs. There are other CDM projects at various levels of development. These include Same and Mwanga Forest project, Biomass Cogeneration at Tanga Cement (T) Ltd, Power production from sisal waste, Katani Tanga and Bagasse Cogeneration at TPC Moshi. Potential areas for CDM projects include efficient use of biomass efficient cook stoves and switch from non renewable to renewable biomass. Green Resources is developing a CDM afforestation project in Idete, Mufindi district where it is estimated that more than 1.8 million tCERs will have been generated by 2020.

6.5.3 Forest and bioenergy project activities for the voluntary market

Green Resources is developing a forestry VCS project in Mapanda/Uchindele. The VCS project is the first reforestation project in the world to be validated and registered according to VCS standards. Green Resources has planted more than 7,500 ha of new forest in Tanzania's Southern Highlands, sequestering over 500,000 tons of CO_2e to date. It is forecasted that the Mapanda/Uchindile projects will create over 3.5 million VCUs over their lifetime.

6.5.4 REDD initiatives

Reducing emissions from deforestation and forest degradation (REDD) is based on a core idea of rewarding individuals, communities, projects and countries that reduce greenhouse gas (GHG) emissions from forests. REDD has the potential to deliver large cuts in emissions at a low cost within a short time frame and, at the same time, contribute to reducing poverty and sustainable development. The government of Tanzania considers the REDD policy a viable option that can provide

opportunities for the country to meet its obligations of managing her forests and woodlands on a sustainable basis and at the same time respond to poverty reduction initiatives accordingly. In this respect the government envisages to participate in the future REDD policy and in its development. Already a process to develop a National Strategy and Action Plan for REDD has been initiated (URT 2009). The process started with development of a National REDD Framework in 2009 and the Strategy is expected to be completed by end of 2010.

There are five in-depth studies which are being carried out at the moment. The findings from these studies will provide useful inputs in the National REDD Strategy. The key thematic areas addressed are:

(i) Modalities of establishing and operationalising National REDD Trust Fund;
(ii) Role of REDD for rural development;
(iii) Legal and institutional framework review in the context of REDD intervention;
(iv) Development of business case for carbon trade through REDD initiative; and
(v) Preparation of REDD information needs, communication and REDD knowledge management.

Non-Governmental organizations have taken part in implementing REDD pilot projects in the country. The main thematic areas addressed by the NGOs include:

(i) Approaches to organizing REDD work at the local level, with a focus on governance and tenure;
(ii) Incentive schemes that provided equitable benefit sharing mechanisms, especially to local communities;
(iii) Baseline studies and methods for estimating deforestation, carbon sequestration and emissions;
(iv) Participatory methods for monitoring, assessing, reporting and verifying; and
(v) Approaches that address drivers of deforestation and forest degradation.
(vi)

6.5.5 Opportunities for enhanced inter/intra regional collaboration on climate change issues

Tanzania is a member of the East African Community (EAC) and is party to the Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region and Related Protocols. The Partner States of EAC have agreed to take concerted measures to foster co-operation in the joint and efficient management and sustainable utilisation of natural resources including forests and undertake, through environmental management strategy, to co-operate and coordinate their policies and actions for the protection and conservation of the natural resources, including forests and environment against all forms of degradation and pollution arising from developmental activities. Regional collaboration on climate change issues could be fostered through this Community agreement and Convention.

Tanzania is also a member state of Southern African Development Community (SADC) and signatory of the SADC Protocol on Forestry which is the over-arching policy framework for collaboration among member states on forest development. The Protocol focuses on promoting the development, conservation, sustainable management and utilisation of all types of forests and trees, trade in forest products throughout the region in order to alleviate poverty and generate economic opportunities for the peoples of the region and achieve effective protection of the environment, and safeguard the interests of both the present and future generations. This grouping also offers an opportunity for collaboration on climate change issues through the Forestry Protocol. This is another forum for collaboration on climate change mitigation and adaptation measures in the sector such as through establishment of a sub-regional fire monitoring centre and development of capacity for CDM and REDD forestry project design, implementation and monitoring and sharing of information and best practices. Furthermore, Tanzania is a member of the African Forestry and Wildlife Commission (AFWC)**.** This is another forum for regional cooperation in matters related to climate change.

6.5.6 Options and strategies to include adaptation and mitigation in national forest and other key policies influencing forest-related adaptation and mitigation options

6.5.6.1 Adaptation

The national level is critical for mainstreaming climate change adaptation. The national level is where overall political responsibility is located. This level is vital for climate change adaptation efforts for the following reasons (OECD 2009):

(i) the national government sets legislation and regulations, many of which directly or indirectly affect the climate risks facing the country or create the incentives (or disincentives) for exploring climate change adaptation opportunities. Examples include private-sector regulations, land ownership and national-level land-use planning directives; regulations and legislation guiding the management of natural resources. These rules and regulations can enhance or constrain the ability of other actors to adapt to the impacts of climate change.

(ii) the national level provides the overall guiding policy framework within which lower levels (sectoral and local government) operate. National government priorities are defined and implemented through budget allocations and can, therefore, facilitate adaptation across different government levels. The delivery of important prerequisites for adaptation at various levels–such as fundamental climatic and other data, analysis and assessments on climate change impacts, vulnerability and early warning systems–often has to be provided by the national level.

(iii) co-ordination of sectoral policies and branches of government takes place at this level. The national level is the locus of many cross-cutting responsibilities and functions related to the co-ordination of lower-level authorities, notably those responsible for specific sectors. Some of those are embedded in the intersectoral discussions that take place through regular planning and budgeting processes, but others have a separate operational role. A key example is disaster risk management, including both response and risk reduction. Other examples include mechanisms for the co-ordination of policies across key sectors such as agriculture, water management, health, education, natural resources, transport and others.

(iv) international relations with other countries are managed at the national level. These will become increasingly important for shared resources (such as water) and cross-border pollution (such as air pollution) and for the successful implementation and management of international treaties. Multilateral environmental agreements, such as the United Nations Convention to Combat Desertification (UNCCD) and United Nations Convention on Biological Diversity (CBD), are implemented at the national level and have objectives that are intertwined with those of the United Nations Framework Convention on Climate Change (UNFCCC). The UNCCD and the CBD also have national action programmes (the National Action Programmes for the UNCCD and the National Biodiversity Strategies and Action Plans for the CBD) which may be of relevance to adaptation efforts. Climate change may also lead to increased national and international migration and to conflicts over access to natural resources, and these will have to be addressed by national governments.

Climate change adaptation need to be mainstreamed into the national governance organization and processes. Adaptation at the national level will require adjustments to the national governance framework–its structures, policy formulation processes, systems and procedures–to make it responsive to the new challenges created by climate change. It is about putting in place a more flexible and forward-looking process whereby policies are formulated and investment decisions are taken bearing in mind the risks posed and opportunities offered by the changing climate.

Integrating adaptation requires the involvement of all key national-level players. The main players at this level of government include Vice President's Office, Prime Minister's Office, Ministries of Finance, and Economy. The Prime Minister's Office is responsible for the co-ordination of disaster risk management, while the vice President's Office is responsible for cross-sectoral co-ordination of

environmental management in the country. Adaptation to climate change closely related to disaster risk reduction (DRR) for which there are existing platforms and co-ordination mechanisms at the national level. Adaptation will therefore need to be more closely linked to these existing mechanisms. Existing DRR mechanisms, meanwhile, may also need to better reflect how climate change might affect the frequency and severity of certain types of natural disasters, such as droughts, floods, hurricanes and cyclones, and therefore also affect the adequacy or effectiveness of DRR measures and policies. Other important players include parliaments, political parties, private-sector organisations, labour unions and non-governmental organisations (NGOs).

The ministry responsible for finance is central to the mainstreaming of climate change adaptation into the policy planning process, as well as the management of public finances to support adaptation. An active engagement by members of parliament on adaptation policy debates is also essential to the drafting of an appropriate regulatory framework. Civil society organisations can play a vital role in strengthening public awareness on the need for adaptation and in bridging gaps between scientific research and policy making. Donor agencies can contribute by mainstreaming adaptation into their development co-operation programmes (*e.g.* their country assistance strategies), by screening their funded operations for climate risks, by providing access to new adaptation technologies and by channelling new resources to help national governments absorb the additional costs of adaptation.

An important prerequisite for informed decision making on adaptation is that it is based upon the best available information on the implications of both the current and the future climate on the country. This includes information on current climate and extremes, projections of climate change, and assessments of impacts and vulnerabilities. Several sources of information already exist in most national contexts.

Several least-developed countries (LDCs) have recently developed their National Adaptation Programme of Action (NAPA) which identify priority activities that respond to their urgent and immediate needs with regard to adaptation to climate change. The NAPA focus on activities addressing urgent and immediate adaptation needs of the country–those for which further delay could increase vulnerability or lead to increased costs at a later stage. NAPA is intended to be action oriented and country-driven and be flexible and based on national circumstances. NAPA establishes priorities for action and may therefore be useful for development planners.

At the national level, statutory regulations and standards also represent an important tool to establish the enabling environment and proper incentives for downstream agencies and actors to integrate adaptation considerations within their activities. Such mechanisms can be used to ensure that climate change is considered in development projects (*e.g.* design and building of infrastructure), service delivery (*e.g.* water supply and pollution control) and in the management of government assets.

In addition to national co-ordination mechanisms and regulatory processes, there is also a need to integrate considerations of adaptation within various stages of the policy cycle at the national level. This is particularly critical as it affects the way resources are allocated and therefore has significant downstream implications. The policy cycle includes four stages: policy formulation, planning, resource allocation and programming/implementation.

For example, there are close linkages between Tanzania's National Poverty Eradication Strategy (adopted in 1998) for the period until 2010 and its "Vision 2025" (adopted in 1999) outlining development goals for the period up to 2025. The national visions and sustainable development strategies have a long-term horizon that makes them particularly relevant for climate change adaptation, which also has to consider longer-term timeframes

National long-term visions bring together different groups of society to agree common development objectives. They are usually elaborated for a 15- to 25-year time horizon, guide economic and social

development efforts and provide the overarching framework for the development of national policies. National visions may take the form of national sustainable development strategies.

The planning stage involves the formulation and costing of multi-year development plans based on top-down input from national policies and bottom-up input from sector level development plans. Higher-level policy objectives are translated into operational action plans and budgets. Examples of planning processes at the national level include the *multi-year national development plans*. These plans often cover a five-year period, set out development objectives and targets, and detail multi-sectoral plans for achieving them. These plans are generally linked to the annual budget or to the medium-term expenditure framework (MTEF). This stage has very concrete impacts on shaping downstream plans and programmes at the sectoral and other levels.

The resource allocation stage corresponds to the translation of operational action plans into budgets. National budgets and, in some countries, MTEFs, constitute the main instruments at this level. The national budget is spread across the different sectors and thus determines the budget envelope that each sector has to implement in its sector-level development plans. In addition, the national budget also funds other non-sectoral/cross sectoral investments/actions that have to be provided/funded at the national level/by the national (or central) government.

The national budget is the main instrument for operationalising a government's policy. It is allocated by the Ministry of Finance across different sectoral areas, as well as for cross-cutting priorities and investments. It provides the sectors with a resource envelope with which they can implement their development plans. Once the budget is allocated, each sectoral ministry has to revise its development plan to fit with the budget envelope it has been provided with. This may involve prioritizing certain programmes and activities over others according to a set of predefined criteria.

Many climate adaptation measures and investments are undertaken by sector-level authorities. In the case of Tanzania sector level authorities include the forest sector. In the case of "public service delivery" sectors, this may primarily involve strengthening the monitoring of key climate-relevant variables which have an impact on their activities and factoring in the consequences, as well as ensuring that facilities which are established under their sectoral authorities' responsibility are not located in particularly vulnerable areas or are capable of withstanding climate conditions. In the case of sectors which primarily undertake physical investments such as the forestry sector, the key will be to ensure that planned infrastructure investments are designed and located so as to withstand future expected climatic conditions. Particular emphasis should be placed on sectors or domains where investments or decisions have long-term consequences and that would be very costly to modify later. Similar considerations apply to authorities responsible for land-use planning.

At the national level, several types of initiatives can be undertaken to enable the integration of adaptation into development processes. A "whole of government" approach needs to be adopted. This involves the engagement of key stakeholders, improving the coordination with existing mechanisms for disaster risk reduction and the implementation of relevant multilateral and regional environmental agreements. It also entails reviewing and adjusting relevant regulations and standards to reflect climate change impacts. In addition, an important prerequisite for informed decision making on adaptation is that it should be based upon the best available information on the implications of both the current and the future climate in the country. To this end, the availability and quality of climate information needs to be improved. This will involve improving the coverage and quality of climate monitoring data, commissioning assessments of climate change impact, vulnerability and adaptation if they are not already available, and using multi-model ensembles with a clear articulation of associated uncertainties.

Priorities at the national level include:

(i) Improving the coverage and quality control of climate monitoring data. Commissioning national-level assessments of climate change impacts, vulnerabilities and adaptation options. This will lead to improved and more targeted information on how climate change affects specific national priorities and core government functions.
(ii) Moving the co-ordination for adaptation into powerful central bodies, such as the Office of the President or Prime Minister or planning agencies. Including considerations of climate change risks within long-term visions, poverty reduction and sustainable development strategies.
(iii) Making a sound economic case for investing in adaptation. Ensuring adequate resource allocation (for example through a *horizontal fund for adaptation*) for the incorporation of adaptation considerations in policies, plans and programmes.
(iv) International donors can encourage action on adaptation through budgetary support mechanisms, country and joint assistance strategies.

At the sector level, climate change adaptation can be integrated at several stages along the policy cycle. This can be at the sectoral policy formulation and sectoral planning stages. At the planning stage, the intervention involves building in necessary adaptation-specific activities. At the resource allocation and programming stage, three interventions are suggested: *(i)* incorporating the adaptation activities and projects identified during the planning stage; *(ii)* including climate change risks to the screening criteria used to assess project proposals before their inclusion into the investment programme; and *(iii)* making ”room” in the budget for adaptation responses identified in the context of cross-sectoral plans, or claiming resources from a horizontal fund for adaptation. Finally, at the monitoring and evaluation stage, interventions to incorporate adaptation consist of mobilising the necessary resources to strengthen monitoring and evaluation systems and capacities, and producing indicators to track performance against adaptation.

Many climate adaptation measures and investments will be undertaken by sector-level authorities. In the case of “public service delivery” sectors, this may primarily involve strengthening the monitoring of key climate-relevant variables which have an impact on their activities and factoring in the consequences, as well as ensuring that facilities which are established under their sectoral authorities’ responsibility are not located in particularly vulnerable areas or are capable of withstanding climate conditions. In the case of sectors which primarily undertake physical investments, the key will be to ensure that planned infrastructure investments are designed and located so as to withstand future expected climatic conditions. Particular emphasis should be placed on sectors or domains where investments or decisions have long-term consequences and that would be very costly to modify later. Similar considerations apply to authorities responsible for land-use planning.

A number of priority actions are suggested:

(i) carry out an assessment of the available sector-specific information on climate change impacts and vulnerabilities;
(ii) raise awareness among both sectoral planners and their counterparts within donor agencies of the implications of climate change on their specific areas of activity;
(iii) in cases where sectoral regulations and other decision-making processes are based entirely on historical climate information, there might be a need to introduce greater flexibility – such as more frequent updating of the climatic baseline (*e.g.* in the case of water resource management);
(iv) boost in-house capacity within sectoral ministries and donor agencies to better evaluate the implications of climate change for specific sectors;
(v) collect better information on the costs and benefits of adaptation actions so that decision makers at various levels can factor such information into their decision making on how to implement adaptation-related actions.

Through sector-level budget support and sector-wide approaches, donor agencies can support many of the above actions. They can help mobilise the additional resources required to integrate the needed

adaptation measures in the context of sectoral strategies, plans and programmes. In addition, they can provide support for capacity development needed to apply *climate lenses* (including climate information gathering and monitoring at the sectoral level) and for the implementation of the different interventions associated with these. This implies supporting the development and application of sector-specific methodologies to identify, assess, cost and prioritise the needed climate adaptation measures and investments. Finally, donor agencies can encourage and support the monitoring and evaluation of progress towards integrating climate adaptation into sectoral strategies, plans and programmes. This includes providing financial and technical support for the implementation of reporting tools and indicators as well as performance assessment frameworks.

The local level is important for mainstreaming climate change adaptation for three reasons. First, climate change impacts are manifested locally, affecting local livelihood activities, economic enterprises, health risks, etc. Second, vulnerability and adaptive capacity are determined by local conditions. Regional or national vulnerability indices often mask the dramatic variations in vulnerability at local levels. Third, adaptation activities are often best observed at the local level. Decisions about livelihood strategies and investments can represent real-life demonstrations of adaptation. These demonstrations allow for the monitoring and evaluation of how policies, programmes and projects are supporting adaptation. They also provide a basis for scaling up, revising and learning.

In general, the process for integrating climate change adaptation into development policies and activities linking two separate but related processes in order to achieve stated objectives: *i)* the process of understanding climate risks and selecting adaptation options; and *ii)* the process of formulating and implementing development policies conducive to adaptation.

The successful integration of climate change adaptation into local development processes depends on a number of enabling conditions. There needs to be broad and sustained engagement with and participation of local stakeholders, including local governments, communities, civil society and businesses. Local authorities need to adopt a collaborative approach where local actors are seen as legitimate decision-making agents. In addition, there needs to be greater awareness raising and targeted messaging on climate change, as local actors need to know why they might have to take different decisions or call on different or additional resources in shaping their livelihoods.

Four entry points are identified to facilitate the integration of climate change adaptation into local development planning processes: *(i)* consideration of the implications of climate change in development planning processes of local governments (village action plans and rural or district development plans, as well as city development plans or strategies); (*ii)* adjustment of local regulatory and service provision frameworks, to include provision of information based on likely local impacts of climate change; *(iii)* adjustment of local government accountability mechanisms; and *(iv)* engagement of private-sector and civil society organizations and processes, which can support adaptation at the local level by internalizing and institutionalizing climate risk management into their own decision-making processes and operations.

6.5.6.2 Mitigation

A wide variety of policy tools can be applied by governments to create incentives for mitigation action taking into account national circumstances and interactions between policies. Experience from various countries and sectors shows there are advantages and drawbacks for any given policy instrument. It is important to consider environmental effectiveness of policies and instruments, their cost effectiveness, institutional feasibility and how costs and benefits are distributed.
Examples of policies and instruments:
(i) Integrating climate policies into broader development policies makes implementation easier.

(ii) Regulations and standards generally provide some certainty about emission levels, but they may not encourage innovation and the development of new technologies.
(iii) Taxes and charges can set a "carbon price" (a cost for each unit of greenhouse gas emissions) and be an effective mitigation incentive, but cannot guarantee a particular level of emissions.
(iv) Tradable emission permits establish a "carbon price". The volume of allowed emissions determines their environmental effectiveness, while the way permits are allocated determines who bears the costs. Fluctuation in the "carbon price" makes it difficult to estimate the total cost of complying with emission permits.
(v) Subsidies and tax credits can provide financial incentives for the development and diffusion of new technologies. Though sometimes costly, they are often critical to overcome barriers.
(vi) Voluntary agreements between industry and governments are politically attractive, raise awareness, and have played a role in the evolution of many national policies. Only a few of them have led to measurable emission reductions.
(vii) Awareness campaigns may positively affect environmental quality by promoting informed choices and possibly contributing to behavioural change. However, their impact on emissions has not been measured yet.
(viii) Research, Development and Demonstration (RD&D) can stimulate technological advances, reduce costs, and enable progress toward stabilization.

Economic instruments, government funding or regulation that lead to a "carbon price" (a cost for each unit of greenhouse gas emissions) could create incentives for producers and consumers to significantly invest in products, technologies and processes reduce greenhouse gas emissions.

7. LINKAGES BETWEEN NATIONAL FOREST PROGRAMME PROCESSES AND CLIMATE CHANGE

The advantages of better linking climate change policy and national forest programmes is to ensure sustainability of the forest resources by reducing/minimising climate change impacts. Forests contribute significantly to the country's development. The disadvantages of better linking climate change policy and national forest programmes are not yet clear. Potential options for linking climate change and national forest programmes include reviewing the National Forest Programme and legislation. Since the reviewed National Forest Policy is still in draft form, it can be linked to climate change policy before it is approved.

Better linkage of forests with society and greater integration of forests and forestry into the broader development agenda are seen as the key parts of a strategy for safeguarding forests and their future sustainable management.

One important approach for linking forests and society is through the participation of stakeholders in forest policy development and implementation. A second approach, related to participation, is to work actively with the sectors whose activities most affect forests in order to develop joint and coordinated policies on forest-related aspects.

Good governance has to be on the national agenda nfps are first and foremost broadly based, country-driven processes, which depend on strong leadership from within government. Forest policy and legislation need to be major elements of nfps. Recent revision of both these instruments has led to increased recognition of traditional and customary rights of, *inter alia*, indigenous groups, local communities, forest dwellers and forest owners in some cases, notably in Latin America and East Africa.

In many countries the forest sector is heavily regulated. The institutions charged with the responsibility of overseeing the regulatory system are often weak, with regulations not being enforced. This imbalance must be addressed by the nfp. This applies not only to those institutions that hold responsibility for forests, but also covers those not traditionally at the centre of discussions on forests, such as ministries of the environment, finance and economic planning, agriculture, energy, and water.

Linkages between sectoral and inter-sectoral planning are very poor in many countries: nfps have the potential to raise awareness of the importance of forests and their contribution to national development. Explicit links still need to be established between nfps and the broader environmental, economic and social sectors, and vice versa.

Decentralization has become a major political theme that affects national planning processes. Nfp's need to be understood not as a process for central planning but as part of decentralisation and devolution efforts. Collaborative forest management approaches (involving local people, the private sector and other stakeholders) can be model cases for elaboration of institutional arrangements in the context of decentralisation. Participatory mechanisms that involve all interested parties are becoming a prominent feature of nfps. Attention now needs to be given to establishing conflict-resolution procedures at both the national and local levels, as forests are the scene of overlapping social, economic and environmental interests. here has been much interest in privatising parts of the national forest estate, and/or the bodies responsible for public forests, in search of greater efficiency and equity, to reduce direct costs on the state and to access new sources of finance and experience for sustainable forest management. New and innovative financing mechanisms – to help pay for the environmental services provided by forests and their derived benefits – now need to be developed. This reflects a broadening of approaches to the valuation of all the functions of forests. Payments from tourism and carbon services may offer an opportunity to part-finance forest management. At the same time, it is

recognised that other incentives than cash, e.g., secure land tenure or better access to natural resources for local people, are strong driving forces for increased domestic investment in forest management.

8. SUMMARY AND ISSUES FOR CONSIDERATION

8.1 Key observations

(i) Population censuses and surveys show that Tanzania has one of the fastest growing populations in the world. Rapid population places huge pressure on forests
(ii) Forest resources contribute significantly to rural incomes
(iii) There is overdependence on woodfuel for energy. It accounts for more than 90 % of energy use in the country. This also places huge pressure on forests.
(iv) Deforestation was estimated at 412,000 ha per annum between 1990 and 2005 (FAO 2009).
(v) Tanzania considers REDD to be a viable option that can provide opportunities for the country to meet its obligations of managing her forests and woodlands on a sustainable basis and therefore contribute to carbon emission reductions and at the same time respond to poverty reduction initiatives accordingly. The government is therefore envisaging to participate in the future REDD policy and in its development. Already a process to develop a National Strategy and Action Plan for REDD has been initiated. To benefit from REDD, drivers of deforestation must be addressed.
(vi) Climate change is one of the biggest global problems posing challenges to sustainable livelihoods and economic development, particularly for developing countries like Tanzania. The adverse impacts of climate change on environment, human health, food security, human settlements, economic activities, natural resources and physical infrastructure are already noticeable in Tanzania.

8.2 Key questions

(i) What are the main risks from climate change to the forest sector?
(ii) Have climate change risks been taken into account in the national forest policy and national forest programme?
(iii) How can the risks be mitigated?
(iv) Which mitigation option has highest priority?
(v) Are forest mitigation options currently incorporated in policies and national forest programme?
(vi) Is there any reference to climate change adaptation in the national forest policy and national forest programme? How has the sector adapted to climate change?
(vii) To what extent have programmes and plans been implemented?
(viii) Is there adequate capacity financially and human resources for effective implementation of the national forest programme?
(ix) What key policy and legislative changes are required to promote adaptation of climate in the context of the national forest policy and national forest programme?
(x) Are the objectives of the national forest policy and national forest programme at risk of being undermined by climate change impacts? Did any climatic event or trend affect the attainment of the national forest policy and national forest programme objectives?
(xi) Is there any risk that implementation of the national forest policy and national forest programme may lead to increased vulnerability of the affected natural and human systems?
(xii) How can the national forest policy and national forest programme help to enhance the resilience of people affected by climate change impacts?
(xiii) Does the current forest policy ensure that the country have sufficient data on forests to be able to report on forest carbon stocks and stock changes?
(xiv) Is there sufficient awareness among decision makers and stakeholders on climate change, its impacts, and appropriate adaptation responses? How can relevant information be communicated to decision makers?
(xv) Are the institutional frameworks and coordination mechanisms adequate to address the new challenges and opportunities posed by climate change on forests?

8.3 Future needs

(i) Financial resources to facilitate sustainable forest management and capacity and focus on engaging with international funds that supports mitigation and adaptation action.
(ii) Capacity building cross sectoral collaboration among government, civil and non-governmental institutions.
(iii) supporting implementation of relevant programme components, e.g. Biodiversity and Ecosystem conservation component
(iv) Harmonizing the National Land Act and Village Land Act
(v) Analysing factors limiting tenure Security
(vi) Research on Forestry and Biodiversity: effects of climate change to biodiversity; better forest management practices; development of country specific methodologies for assessing the impacts of climate change; development of plant species adaptable to climate change; and the demonstration of feasible alternative uses of forest and forest products.

REFERENCES

Agrawala, S., Moehner, A., Hemp, A., van Aalst, M., Hitz, S., Smith, J., Meena, H., Mwakifwamba, S. M., Hyera T., and Mwaipopo O. U. (2003). Development and climate change in Tanzania: Focus on Mount Kilimanjaro: Environment Directorate, Development Co-Operation Directorate, Working Party on Global and Structural Policies Working Party on Development Co-Operation and Environment. Organisation for Economic Co-operation and Development. 72pp

Anon. (year not given) Tanzania land ownership law. 6pp

Daily News. (2009). Tanzania: Population to exceed 100 within 40 years. 19.11.2009.

FAO. (2008). Regional Forestry Commissions. Outcomes of the 2008 sessions related to UNFF and CPF

FAO. (2009). State of the World's Forests, Rome

FAO. (2010). Global Forest Resource Assessment 2010, Country report, United Republic of Tanzania. Forestry Department. 56 pp

FBD. (2007). Eastern Arc Mountains Strategy – Thematic Strategy: Mechanism for Payments for Water Environmental Services, Rufiji River Basin, Tanzania. Compiled by Conservation and Management of the Eastern Arc Mountain Forests, Forestry and Beekeeping Division, Morogoro.

ftp://ftp.fao.org/docrep/fao/meeting/013/ai573e.pdf

ftp://ftp.fao.org/docrep/fao/meeting/013/ai681e.pdf

Hosea, E. (2008). the 13th International anti – corruption conference [iacc]: Athens, Greece.
The empirical tools for governance and corruption analysis:The Case For Tanzania.

http://www.forestry.gov.uk/website/forestry.nsf/byunique/infd-6vlkmx

IPCC. (2001: ClimateChange 2001:Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change, J.J. McCarthy, O.F. Canziani, N.A.Leary, D.J. Dokken and K.S. White, Eds., Cambridge University Press, Cambridge, 1032 pp.

Jamhuri ya Mwungano wa Tanzania. (2006). Mkakati wa Kuhifadhi Mazingira ya Ardhi na Vyanzo vya Maji. Ofisi ya Makamu wa Rais. Dar es Salaam. 33pp

Kangalawe R. Y. M. and J. G. Lyimo. (2010). Population dynamics, rural livelihoods and environmental degradation: some experiences from Tanzania. Environ Dev Sustain

Kaufmann, D, A Kraay and M Mastruzzi (2006), "Governance Matters V: Governance Indicators for 1996-2005" World Bank Policy Research Working Paper, and "A Decade of Measuring the Quality of Governance

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

Kulindwa, K. (2005). A Feasibility Study To Design Payment For Environmental Services Mechanism For Pangani River Basin. IUCN. 133 pp

Madulu, N. F. 2001. Population Dynamics and Sustainable Conservation of Protected Areas in Tanzania: The Case of Swagaswaga Game Reserve in Kondoa District. Reports in Environment Assesment and Development (READ) No. 2. 26 pp

Madulu, N. F. 2004. Assessment of Linkages Between Population Dynamics and Environmental Change in Tanzania. AJEAM-RAGEE Volume 9, p88-102

Makundi, W R. (2001). Carbon mitigation potential and costs of forestry options in Tanzania. Mitigation and Adaptation Strategies for Global Change. Volume 6, Numbers 3-4: p 335-353.

Milledge, S.A.H., Gelvas, I. K. and Ahrends, A. (2007). Forestry, Governance and National Development: Lessons Learned from a Logging Boom in Southern Tanzania. An Overview. TRAFFIC East/Southern Africa / Tanzania Development Partners Group / Ministry of Natural Resources of Tourism, Dar es Salaam, Tanzania. 256pp.

MNRT. (1998). National Forest Policy. Forestry and Beekeeping Division.

MNRT. (2007). Concept Paper on Carbon Trading in Forestry in Tanzania. 18pp

MNRT (2008a). Tanzania Forest Sector Outlook Study: 2008-2018. Forestry and Beekeeping Division. 142 pp

MNRT. (2008b). Participatory Forest Management in Tanzania. Facts and Figures. Forestry and Beekeeping Division. 13pp

MNRT. (2009a). Participatory Forest Management in Tanzania:1993 – 2009.Lessons learned and experiences to date. Forestry and Beekeeping Division. 72pp

MNRT. (2009b). First Draft National Forest Policy.

Ministry of Planning, Economy and Empowerment December 2006. Tanzania: Population, Reproductive Health and Development. 72pp

Muyungi, R. (2008). Status of CDM in Tanzania. Presentation at CDM Workshop, Dar es Salaam International Conference Centre. 16pp

Nabuurs, G.J., O. Masera, K. Andrasko, P. Benitez-Ponce, R. Boer, M. Dutschke, E. Elsiddig, J. Ford-Robertson, P. Frumhoff, T. Karjalainen, O. Krankina, W.A. Kurz, M. Matsumoto, W. Oyhantcabal, N.H. Ravindranath, M.J. Sanz Sanchez, X. Zhang, 2007: Forestry. In Climate Change (2007): Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

OECD. (2009). Development Assistance Committee (DAC) Environmental Policy Committee (EPOC) Policy Guidance on Integrating Climate Change Adaptation into Development Co-operation. 189pp

Sawe, E. (2008) National Policies and Strategies on Bioenergy in Africa Case Study: Tanzania January COMPETE Competence Platform on Energy Crop and Agroforestry Systems for Arid and Semi-arid Ecosystems – Africa.

Paavola, J. (2003). Vulnerability to Climate Change in Tanzania: Sources, Substance and Solutions. A paper presented at the inaugural workshop of Southern Africa Vulnerability Initiative (SAVI) in Maputo, Mozambique June 19-21, 2003. 26pp

scidev.net/en/health/climate-change-in-africa/opinions/...

Scurrah-Ehrhart, C. (2006). Tanzania Inventory of Payments for Ecosystem Services Commissioned by Forest Trends and the Participatory Environmental Management (PEMA) Programme. 94pp.

Smith, P., D. Martino, Z. Cai, D. Gwary, H. Janzen, P. Kumar, B. McCarl, S. Ogle, F. O'Mara, C. Rice, B. Scholes, O. Sirotenko, (2007): Agriculture. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

UNDP. (2008). Tanzania Final Draft UN-REDD Joint Programme. 58 pp

URT. (2003). Initial National Communication under the United Nations Framework Convention on Climate Change (UNFCCC). Vice President's Office. 166pp

URT. (2007). National Adaptation Programme for Action. Vice President's Office. 61pp.

URT. (2009). National Framework for Reduced Emissions from Deforestation and Forest Degradation (REDD). Vice President's Office.

worldagroforestry.org/ research/grp5_climate_change

www.agroforestry.net.au/ main.asp? _=Climate+Change

www.climatechangeconnection.org/ Solutions/Agroforestry.htm

www.oxfam.org/en/policy/ people-centred-resilience -