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Review

Climate impacts, forest-dependent rural livelihoods and adaptation strategies in Africa: A review

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The long term contribution of forests to the livelihoods of the rural poor had been long appreciated. More than half of Africa's fast-growing population rely directly and indirectly on forests for their livelihoods. As the continent faces stresses from poverty and economic development, another major uncertainty is looming that could alter many of the relationships between people and forests. This uncertainty is climate change. Climate impacts such as changes in temperature and rainfall patterns resulting in drought, flooding, all exert significant effect on forest ecosystems and their provision of goods and services, which form the safety nets for many African rural poor. Building adaptation strategies becomes an option for forest-dependent households and communities, and even countries whose economies largely depend on the related sectors. The review details cases of impacts, underlying causes of vulnerability, and identified coping and adaptation strategies, as reported in their National Communications by many African countries to the United Nations Framework Convention for Climate Change.

Key words: Climate change, impacts, forests, rural livelihoods, adaptation, Africa.

INTRODUCTION

Climate change is one of the greatest environmental, social and economic threats facing our world today (Chomitz et al., 2006). The warming of the climate system is believed to be unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global mean sea level (Nicholson et al., 2000; Dessai and Hulme, 2001). The earth's average surface temperature had risen by 0.76°C since 1850. Most of the warming that has occurred over the last 50 years is very likely to have been caused by human activities. In its Fourth Assessment Report (AR4), the Intergovernmental Panel on Climate Change (IPCC, 2007) projects that, without further action to reduce greenhouse gas (GHG) emissions, the global average surface temperature is likely to rise by a further 1.8 to 4.0°C this century. Even the lower end of this range would take the temperature increase since pre-industrial times above 2°C, the threshold beyond which irreversible and possibly catastrophic changes become far more likely.

Africa's contribution to the global anthropogenic emissions of greenhouse gases is relatively small; it amounted to approximately 7% in 1990, with land use changes included. Africa's contribution to global emissions caused by burning fossil fuels, including transportation, is even smaller, representing only 3.9% of the world's total (IEA, 1999). Deforestation alone accounts for a major part of Africa' GHG emissions, and compared to the industrialized countries of Europe and North America, Africa's contribution to global climate change is not significant. CO_2 emissions from fossil fuels are low in both absolute and per capita terms. Only five countries are largely responsible for Africa's emissions from fossil fuel and cement. South Africa is by far the greatest emitter, responsible for 39% of the continental total. Another 42% of CO_2 emissions come from Algeria,

Abbreviations: GHG, Greenhouse gas; **PRSPs,** poverty reduction strategy programmes; **GDP,** gross domestic product; **UNFCCC,** United Nations framework convention on climate change; **NAPAs,** national adaptation programmes of action.

Egypt, Libya and Nigeria combined (ECA, 2001).

Much of the focus on Africa with respect to climate change had been on the vulnerability of the region to the impacts of climate variability and change due to her low human adaptive capacity to anticipated increases in extreme events, resulting from widespread poverty, heavy reliance on rain-fed agriculture, lack of economic and technological resources, and insufficient safety nets and educational progress (IPCC, 2001; Sokona and Denton, 2001; Reid and Vogel, 2006; Tschakert, 2007). The response of many African countries to the undeniable evidence of climate change in the region led to their being signatories to the United Nations Framework Convention for Climate Change (UNFCCC) in 1993.

The reality of climate change in Africa is perceived as a potential threat to sustainable development ambitions and goals of the continent. It is worth mentioning that climate change has the capacity to undo many years of development in Africa. For Africa, climate change is not only about global warming, it is also associated with changes in climate variability and changes, and the frequency and magnitude of extreme events, such as more droughts and floods. Besides the impacts from abrupt climatic events, there is the possibility of imperceptible changes accumulating until thresholds are crossed that could cause entire thresholds to collapse (Nyong, 2005). This perceived or potential risk is greatest where much of the livelihoods and socio economic systems depend on natural resources. One of such natural resources is the forests.

The thrust of this review is to provide a detailed analysis of the implication of the multiple impacts of climate variability and change on African societies. It focuses on the reality of climate change on the African forest sector but more importantly on the livelihoods of the forest-dependent rural populations.

FORESTS AND LIVELIHOODS IN AFRICAN SOCIETIES

The study of livelihood as a concept has its root traceable to disciplinary lines such as economics and development studies. The multiple definitions and conceptualizations of the concept have largely reflected these lines (Bernstein et al., 1992; Chambers and Conway, 1992; Ellis, 1998; Carney, 1998; Batterbury, 2001; Francis, 2000, 2002; Radoki, 2002). Livelihoods can be thought of as the way people make a living. Livelihoods contribute to human well-being, which includes tangibles as assets and goods for consumption. Chambers and Conway (1992) gave the following definition of livelihood “A livelihood comprises capabilities, assets (both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from shocks and stresses, and maintain or enhance its capabilities and assets, both now and in the future, while not undermining the natural resource base”. According to the livelihoods framework described by the UK Department for International Development (DFID); five types of capital support livelihoods (Carney, 1998): 1. Natural capital (such as lands, water, forests and fisheries); 2. human capital (such as knowledge and skills); 3. financial capital (such as income opportunities); 4. physical capital (such as infrastructures), and 5. social capital (such as social networks).

Essentially, livelihood holds a central place to human survival and comprise of opportunities and strategies for a sustainable living. The pursuit of livelihood strategies however, depend on the tangible and intangible assets at the disposition of people either as possessions (Scoones, 1998), or accessibility (Ellis, 2000). These types of capital form the concept of sustainable livelihoods, since they empower the rural poor people in local decision-making and enhancing security, reducing their vulnerability to shocks and increasing their capacity to recover from them. A range of assets is needed to achieve positive livelihood outcomes; no single category of assets sufficiently provides all the many and varied livelihood outcomes that people seek. Those with more assets have a greater range of options and an ability to shift emphasis in their livelihood strategies (Warner, 2000). In some contexts, to be poor is to have few assets or resources from which to create a secure livelihood.

The long-term contribution of forest resources to the livelihood strategies of the rural poor had long been appreciated as significant (Salafsky and Wollenberg, 2000; Belcher, 2003; Levang et al., 2005; Sunderlin et al., 2005). In the forestry context, forest or trees resources that the rural poor can freely access might form a critical part of their lives. A primary role of forest or tree resources in the lives of the rural poor is thus as a “safety net”, as one of many strategies to avoid falling into destitution (Shimizu, 2006). In the context of Africa, forests are vital for the welfare of millions of people, especially the rural poor and marginalised, and their wise use could improve livelihoods and quality of life. Over two-thirds of Africa’s 600 million people rely directly and indirectly on forests for their livelihoods, including food security. Wood is the primary energy source of at least 70% of households in Africa (CIFOR, 2005). For example, a review of the Poverty Reduction Strategy Programmes (PRSPs) for several countries (Burkina Faso, Mali, Ghana, Niger and Senegal) shows (where data exists) that between 86 and 93% of the poor live in rural areas.

These countries have between 60 and 90% of their labour force in the rural sector and between 16 and 45% of Gross Domestic Product (GDP) generated by forestry (Anderson et al., 2006). In some situations, forests provide income, in others they act as safety nets for the rural poor. Forests may also fulfil many ecological functions that are vital to the livelihoods of the rural people; for example, they provide habitats for animals

and plants and help in water and soil conservation, which are indispensable to the livelihoods of the people.

Furthermore, the multi-functional nature of forests means that they can support and sustain local livelihoods, as well as alleviate poverty in a variety of ways, and also support Africa's economic, social, cultural and environmental development, especially in rural areas.

Natural and planted forests represent more than natural capital. They contribute to human capital by providing a range of goods, such as wild game, fruits or traditional medicines that improve health (Smith and Scherr, 2002). Income from the sales of forest products, such as woods, medicinal herbs, gums, latex, resins and spices, provide financial capital that can be used as working capital for trading activities or to educate children (Byron and Arnold, 1999). Forest foods and incomes from forest products tide households over seasonal and unforeseen shortfalls, or provide lump sums for paying off debts. Forest incomes are a vital economic buffer, particularly for women, children and the poorest households in village communities (Byron and Arnold, 1999) and for the entire community during periods of stress, such as seasonal shortages and crop failures. Forests also provide essential environmental services, whose loss often disproportionately afflicts the livelihoods of the rural poor, who have fewer alternatives (Smith and Scherr, 2002).

Arnold (1998) in examining the contribution of forests to sustainable livelihoods defines forests "to include all resources that can produce forest products. These comprise woodland, scrubland, bush fallow and farm bush, and trees on farm, as well as forests". Arnold's definition focuses not on tenure or tree cover as the basis for defining a forest, but on the potential for producing products. Moreover, the contribution of forests is measured not only by the products they provide, but also by the non-tangible services they offer (Warner, 2000). Arnold (2001) later reported that the role of forests and trees in poverty alleviation is multidimensional. The African forests are no exception. For millions of people living in forest environments, the forest forms a dominant part of their physical, material, economic and spiritual lives, but its importance is often undervalued. The forest, as well as providing a wealth of material outputs of subsistence or commercial value, is the basis for livelihood systems based on hunting and gathering, or of rotational agriculture systems that depend on the ability of bush fallow to revive the productivity of the land. The forest thus constitutes an integral part of the habitat and of the social and cultural structure of those living within it. However, rather than only evaluating the importance of forest resources based on the number of people depending on them, it is even more important to understand the dependency relationships and its dynamics.

Baron and Arnold (1997) researched into the first step towards measuring the forest-people relationship by establishing clear categorizations of forest users. The suggested four categories are:

1. People living in the forest such as hunter-gatherers and long-rotational-shifting-cultivators, who obtain most of their livelihoods from the forest.
2. Populations of small farmers relying for part of their livelihood on adjacent forest or woodland.
3. Traders and processors of forest products and employees in local forest industries (that is, artisans and the landless rural poor).
4. Urban and peri-urban consumers of forest products.

For this paper, user categories 1 to 3 are considered the core population for the rural livelihoods, especially with respect to the situation in Africa. User category 4 is not considered for the definition of rural livelihoods in Africa; hence, disaggregating the total forest dependent population into user categories. People living in forest environments and practising hunting, collecting and shifting cultivation draw heavily on forest products, not only for subsistence but also for income from forest products. Forest-related income also includes that obtained by selling crops or livestock for which forest nutrients or fodder were essential (Shepherd et al., 1999). While some hunter-collector populations have retained a self-reliant and subsistence way of life (Grenand and Grenand, 1996), most are increasingly becoming involved with outside markets and goods. However, the level of forest dependency among these peoples remains high, as does the cultural significance of the forest to them.

Herders of the African Sahel are likewise forest dependent, as their animals (camels, cattle, sheep and goats) browse trees rather than grazing for much of the year, particularly during the dry season (Shepherd et al., 1999). African rural communities basically depend on forests food; both for the ones that are produced from agricultural fields, and wild fruits and foods that are only obtained in the forests. This dependence fulfils the literal sense of dependence that their condition would worsen if they no longer had access to the forest outputs that form an integral part of their livelihood systems.

IMPACTS OF CLIMATE VARIABILITY AND CHANGE ON AFRICAN ENVIRONMENT

Impacts are the negative or positive consequences that result from an event. In the case of climate change, the increased concentration of GHGs in the atmosphere causes disruptions in the climate system such as changes in precipitation regime and the frequency and severity of extreme events (typhoons, hurricanes, flooding, etc.) or changes in the rhythm and intensity of such phenomena as El Nino (Robledo and Forner, 2005). While these impacts will vary in degree, magnitude,

probability, frequency and duration, across different regions of the continent, modifications in the structure and functioning of the ecosystems are expected to be produced by these impacts. Since the natural range of most types of ecosystem is primarily determined by a combination of temperature and rainfall patterns, a change in these climate variables therefore implies a change in the structure and functioning of the forest ecosystems.

Rainfall in Africa exhibits notable spatial and temporal variability. Inter-annual rainfall variability is large over most of Africa and for some regions, multi-decadal variability is also substantial (Hulme et al., 2005). In the tropical rainforest zone, a decline in mean annual precipitation of around 4% in West Africa, 3% in North Congo and 2% in South Congo for the period 1960 to 1998 have been noted; however, a 10% increase in annual rainfall along the Guinean coast for the last 30 years had been observed (Mahli and Wright, 2004). In different parts of Southern Africa (e.g. Angola, Namibia, Mozambique, Malawi, Zambia), a significant increase in heavy rainfall events had also been observed, including evidence for changes in seasonality and extremes (Usman and Reason, 2004). Since the mid 1970s, precipitation had declined by about 2.4±1.3% per decade in tropical rainforest Africa, this rate being stronger in West Africa (-4.2±1.2% per decade) and in North Congo (-3.2±2.2% per decade). Overall, in the West Africa/north Congo tropical rainforest belt rainfall levels were 10% lower in the period 1968 to 1997 than in the period 1931 to 1960 (Nicholson et al., 2000). Nicholson (2001) further reports that the Sahelian region of Africa underwent a 20 to 40% drop in precipitation from the mid to the late 20th century (1930 to 1965 vs. 1966 to 2000), representing the largest and most sustained rainfall shift of any contemporary region on earth.

In addition, observational records show that the continent of Africa has been warming through the 20th century at the rate of about 0.05°C per decade with slightly larger warming in June to November seasons than in December to May (Hulme, 2001). As of 2000, the five warmest years in Africa had all occurred since 1988, with 1988 and 1995 being the two warmest years. The warming trend observed is consistent with changes in the global climate and is likely to be a signal of the anthropogenic greenhouse effect (Hulme, 2001; Kruger and Shongwe, 2004; Mahli and Wright, 2004). There had also been a moderate significant increase in dry-season intensity in Africa. Arid and semi-arid regions of Africa cover 13 million square kilometre or 43% of the continent's land mass, where 270 million people or 40% of the continent's population live. Droughts and floods are already common occurrences, with some countries experiencing both within a year (Nyong, 2005). The Third Assessment Report of the IPCC clearly puts it as "Africa is the most vulnerable region to climate change, due to the extreme poverty of many Africans, frequent disasters such as droughts and floods, and agricultural systems heavily depend on rainfall" (IPCC, 2001).

One third of the people in Africa lives in drought-prone areas and is vulnerable to the impacts of drought (World Water Forum, 2000), and the IPCC estimates that, by the 2080s, the proportion of arid and semi-arid lands in Africa is likely to increase by 5 to 8% (ECA, 2000). Conversely, in Africa, several millions of people regularly suffer impacts from drought and floods. Droughts have mainly affected the Sahel, the Horn of Africa and Southern Africa, particularly since the end of the 1960s. Floods are also critical and impact on African development; recurrent floods in some countries are linked, in some cases, with ENSO events, for example in Mozambique. Even countries located in dry areas (Algeria, Tunisia, Egypt, and Somalia) have not been flood-safe (Obasi, 2005).

Climate change had been examined to have impacts on the growing periods on agricultural systems and possible livelihood implications; through changes in the onset of rain days and the variability of dry spells (Jones and Thornton, 2003). Climate change will also have impacts on livestock in Africa; higher temperatures are good for small farm animals like goat and sheep because they are heat tolerant, but by contrast, large farm animals like cattle are not heat tolerant. Increased precipitation is likely to be harmful to grazing animals because it implies a shift from grasslands to forests and in increase in harmful disease vectors and a shift from livestock to crops (Seo and Mendelssohn, 2006). In addition, all regions are likely to experience the adverse effects of climate change, but small island swatches and low-lying coastal areas are particularly vulnerable. Coastal settlements in for example, the Gulf of Guinea, Senegal, and Egypt and along the East and Southern African coast would be adversely affected by sea-level rise through flooding and coastal erosion). Sea-level rise will also affect the ecosystem resource goods and services provided by the 37,400 km^2 area of mangroves in Africa (Nyong, 2005; Conway, 2009).

The potential impacts of climate change on food security may be best understood in light of changes in Africa's livelihoods landscape. A trajectory of diversification out of agricultural-based activities, 'deagrarianisation' had been found in the livelihoods of rural people in many parts of sub-Saharan Africa. Lower reliance than previously expected reliance on food production as a primary source of people's food security contests the assumption that people's food security in Africa derives primarily from their own agricultural production (Bryceson, 2003). At the same time, however, for the continent as a whole, the agricultural sector, which is highly dependent on precipitation, is estimated to account for approximately 60% of total employment, indicating its crucial role in livelihoods and food security derived through food access through purchase (Slingo et al., 2005). Food security is likely to be affected by increased frequency and intensity of droughts and floods.

Gradual changes may also be a concern. Studies show that an increase in temperature by an average of 2°C would drastically reduce the area suitable for growing Robusta coffee in Uganda, where it is a major export crop (and most Ugandan livelihoods depend on the earnings), limiting it to the highlands only (Simonett, 1989). Haminton et al. (2005) also highlighted a number of other illustrative impacts that climate variability and change have on livelihoods and food access, many of which also impact on food availability and nutrient access aspects of food security. These impacts affect food security through altering or restraining livelihood strategies, while also affecting the variety of food available and nutritional intake.

Selected country cases from the United Nations Framework Convention on Climate Change (UNFCCC) submitted national communications

Climate change is expected to have adverse impacts on socio economic development of all nations, but the degree of impacts will vary across nations. Most developing countries including many African countries had submitted their first national communications to UNFCCC by the last quarter of 2005. A synthesis of the information on impacts and vulnerabilities on the forest ecosystems and forest-related sectors that were included in the national communications are given as follows:

Botswana

Groundwater accounted for 64% of all the water consumed in Botswana in 1990. The recharge of the water resource is highly sensitive to climate change; this has a consequential effect on the livelihoods of 80% of the population and many livestock that depend on boreholes and well fields. Over 50% of the rural livelihoods directly depend on the forest and woodland products, including medicines, fruits, and wild foods. This dependency is largely going to be affected in the future leading to increasing poverty. This is because, climate change will cause significant changes in prevalent vegetation and rangeland cover, and this consequently affects species types, composition and their distribution, as well as those who depend on them. 54% of Botswana households depend on livestock and their products for cash income and subsistence. Climate variability and extreme events like drought will affect the grazing of natural rangelands, resulting in stock mortalities.

Ethiopia

Climate change may have far reaching implications for Ethiopia for various reasons. Its economy mainly depends on agriculture, which is very sensitive to climate variations. A large part of the country is arid and semiarid and is highly prone to desertification and drought. It has also a fragile highland ecosystem, which is currently under stress due to population pressure. Forest, water and biodiversity resources of the country are also climate sensitive. Vector-born diseases, such as malaria, also affect Ethiopia, which are closely associated with climate variations. It is critical that Ethiopia should carefully consider and prepare for possible impacts of climate change. The country had experienced environmental problems such recurring droughts, high rate of deforestation, soil degradation and loss, over-grazing, etc., which may be exacerbated by climate change.

Gambia

A country with a predominantly agrarian economy, the agricultural sector alone provides employment for about 75% of the labour-force, and an estimated 67% of total household income. Environmental degradation and inappropriate land use systems increase Gambia's vulnerability to the variability of climatic change. The suitability of the habitats of many biological organisms (flora and fauna) will be highly reduced under the projected climate change scenarios. Migratory species may be vulnerable because they require separate breeding, wintering and migration habitats. More so, ponds and other inland water bodies for spawning are indispensable components of a balanced aquatic environment. During the drought years, many of these ponds and inland water dry out, leading to reductions in fish populations. Those that survive the drought are threatened with pollution (pesticide run-offs and plant discharges). Also, with about 80% of the energy supply for domestic use in Gambia coming from forest resources, the vulnerability analysis showed that the forest resources will tend to the dry forest category but some tree species may not be able to survive the projected climate change scenarios.

Republic of Congo

The climate scenarios used by the Republic of Congo indicate increases in both mean temperature and rainfall, particularly in coastal regions. The National Communication includes a flood risk analysis, which shows that floods are one of the main climate change-related impacts in this country. With regard to forest ecosystems, Congo analysed salinization effects in coastal areas and effects in mangrove areas over a large part of its territory. It also analysed the consequences of rainfall decrease and temperature increase in the Niari valley, and the relationship between these changes and the proliferation of fire, as well as changes in the structure and functioning of forest ecosystems present in that area.

Malawi

During the rainy season, tornado type wind systems cause a lot of physical damages of forest plantations and other natural forests as happened in 1993/94 rainy season over the Zomba Plateaux. High maximum temperatures and very low relative humidity during the dry season exacerbate bush fires that destroy plantations and natural forests. Deforestation through conversion of forests cropland or rangelands is a major concern in Malawi. An estimated loss of 50,000 ha of forest is recorded annually. Severe drought incidents have so far afflicted the wildfire in Southern Africa, including Malawi; impacts of temperature increases and precipitation deficits can be variable, but are certainly harmful. Climate change could induce a decline of Nyala (*Tragelaphus angasi. G*), which is a key species in Lengwe National Park, because these species could not adapt to climate induced habitat changes.

Uganda

The problems of droughts, soil erosion and siltation are expected to become more frequent and more severe with the impending climate change. Crop vulnerability to climate variability and climate change is dependent on ecological zone. There is high uncertainty in onset and cessation of rainfall seasons. This coupled with high evaporation rates, particularly in Northern Uganda, affects agricultural production. Productivity of Uganda's grasslands and livestock is dependent on climate and will therefore be affected by climate variability and climate change.

VULNERABILITY OF THE FOREST AND DEPENDENT LIVELIHOODS

Climate change will interfere with African rural livelihoods at many levels; this interference is expected to produce both negative and positive effects on the rural poor, with the negative effects being more significant. According to Eriksen and Naess (2003), livelihoods are linked with natural resource management and poverty reduction. They argue that natural resources are used as sources of livelihoods, but livelihoods represent the way that people deal with both poverty and vulnerability. As climate change is expected to have marked effects on natural resources, climate change is intricately connected to livelihoods.

Vulnerability had been defined as the degree to which a system is susceptible to harm owning to exposure to a perturbation or stress, or is unable to cope with adverse effects of climate change, including climate variability and extremes (IPCC, 2001). Vulnerability is believed to be a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity (Eakin and Luers, 2006; Adgers, 2006). The vulnerability of a given system, natural or human, depends on the impacts it is exposed to and its resilience to accommodate these impacts. The vulnerability of forest ecosystems is not just related to the direct and indirect impacts of climate change. The interrelations among natural and human systems imply that impacts on one system will affect other systems. A clear example of this is the pressure exerted on forest ecosystems by the demand for agricultural land. If climate change results in soil degradation and this lead to some soils becoming unsustainable for agriculture, further deforestation will be necessary to provide new farmlands (Robledo and Forner, 2005). Land degradation (defined as the reduction in the capability of the land to support a particular use) is a major problem in Africa; with about 66% of the continent being desert or dryland, and 73% of the agricultural drylands already degraded; the African continent is aware of its vulnerability to the adverse impacts of climate variability and change. Recognised forms of land degradation include soil erosion, salinization, soil contamination, loss of soil organic matter, decline in nutrient levels, acidification, and loss of soil structure (Kassas, 1995).

African economies are particularly vulnerable to climate variability and climate change, because of their heavy reliance on exploitation of natural resources with agricultural sector being a major contributor. Over 85% of the population derives their livelihoods either directly or indirectly from natural-resource related activities (Nyong, 2005). Population pressure is another factor contributing to the low capacity of Africa to cope with adverse effects of climate change. Africa's population grew from 472 million in 1980 to 943 million in 2006 (the population doubled in about 25 years), and is expected to rise to 1.2 billion by 2020 (UN, 2008). Not surprising that in Africa today, tropical forests and rangelands are under threat from population pressures and systems of land use. In a continent where the population grows at a rate that is the same as the decline of the forest cover; vulnerability to adverse impacts of multiple stressor including climate variability and change becomes obvious. Generally, apparent effects of these threats include loss of biodiversity, rapid deterioration in land cover, and decrease of water availability through destruction of catchments and aquifers.

Changes in climate will interact with these underlying changes in the environment, adding further stresses to a deteriorating situation. A sustained increase in mean ambient temperatures beyond 1°C would cause significant changes in forest and rangeland cover; species distribution, composition, and migration patterns; and biome distribution. Rainfall is projected to increase in the highlands of East Africa and equatorial Central Africa; hence, some marginal lands would become more productive than they are now. However, these effects are

likely to be negated by population pressure on marginal forests and rangelands (IPCC, 2001).

Rural poor people tend to suffer more than others when extreme events like floods, tropical storms and landslides occur. This happens for three reasons. First, they live in areas and in shelters that are more susceptible to these extreme events. Second, they do not have the resources to cope with these events. Third, the poor in developing countries cannot depend on social opportunities like safety nets to cushion the impacts of extreme events (Sen, 1999). This is in agreement with the Millennium Ecosystem Assessment report by the World Resources Institute (1996), which notes that, rural poor people who depend on ecosystem services and products will be most vulnerable to climate change. The report states that due to shorter, drier growing seasons and more frequent drought, agricultural and fisheries productivities are projected to decrease. In a nutshell, the African continent is particularly vulnerable to the impacts of climate change because of factors such as widespread poverty, recurrent droughts, inequitable land distribution, and over-dependence on rain-fed agriculture. Although adaptation options, including traditional coping strategies, theoretic-cally are available, in practice, the human, infrastructural, and economic response capacity to effect timely response actions may well be beyond the economic means of some countries.

ADAPTATION, ADAPTIVE CAPACITY AND ADAPTATION STRATEGIES

Responding to climate change, as elaborated in Article 2 of the UNFCCC entails two strategies: (1) Mitigation: Controlling greenhouse gases to stabilize climate change at an acceptable limit, and (2) Adaptation: Adjustments to the impact of climate change given existing levels of greenhouse gases in the atmosphere. Mitigation is largely within the domain of the commitment of developed countries, which hold the greatest responsibility for climate change. Adaptation on the other hand, is a priority for developing countries, where mitigative capacity is low and vulnerability is high (Ayers and Huq, 2009).

Adaptation methods are those strategies that enable the individual or the community to cope with or adjust to the impacts of the climate in the local areas (Lemos et al., 2007). Such strategies will include the adoption of climate-change adapted resource management practises such as planting of early maturing crops, adoption of hardy varieties of crops and selective keeping of livestock in areas where rainfall had declined. They also include the use of technological products that enable the individual to function in the “new” condition. Obviously, adaptation strategies are expected to be many, and their combinations in various ways will be required in any given location (Nyong et al., 2007). Adaptive capacity is a key element of resilience. It is the capacity for renewal and reorganisation, and the element of learning in response to disturbance (Folke, 2006).

Table 1 presents a number of selected adaptation-related projects, programmes and initiatives that have been proposed or funded from the submitted National Adaptation Programmes of Action (NAPAs) to the UNFCCC. While some of these projects are already on-going, others have been proposed for the near future. These projects, if funded are expected to contribute to overall increasing adaptive capacity of many African countries (Table 1).

Arguably, the necessity for adaptation to climate change transcends beyond the need for enhancing the adaptive capacities of the local households and communities that depend on the forest, but also the need to sustain the industries that depend on the forests as well. In Africa, forest ecosystems support biodiversity, and plant and wildlife habitat, which form the pillars of ecotourism in the continent. This ultimately reduces the recreational potential and activities of the people, and possible loss of income to households and government. For instance, adaptation strategies such as restoration of degraded soil, forest lands and wetlands; biodiversity conservation, would not only be critical for livelihood security of the rural poor, but also for ecotourism. At the core of adaptation and adaptive capacity, is the concept of resilience, which encompasses the abilities of countries, communities, households and even individuals to cope with climate change (Conway, 2009). Even where there might exist uncertainties on the magnitude and frequency of climate impacts, building or enhancing resilience of the social system should still be a priority in adaptation.

CONCLUSION

Impacts of climate change will vary in degrees and magnitudes across African forest ecosystems and forest-related sectors, but most will affect the rural livelihoods of Africa. Given that the enormous forest resources of Africa are major sources of livelihoods in Africa, as climate variability and change continue to have adverse effects on the forests, the long-established livelihood-based relationship between people and forests will consequently be affected. More so, the fact that the impacts of climate variability and change on the African forest ecosystems and their services will be unevenly distributed over space and time implies that climate change is likely to cause additional inequalities, thus disproportionately affecting the poor. Adaptation is Africa’s most viable option for dealing with the confronting risks and multiple stresses of climate change. Increasing Africa’s adaptive capacity to the impacts of climate variability and change will urgently require commitment at local, national and international levels. National commitment may entail putting climate

Table 1. Summary of some selected forestry-related adaptation projects in Africa.

Adaptation strategies	Countries covered	Status
Early warning system		
Setting up surveillance and warning system on the risky climate situation, on the entire national territory	Comoros	Future
Improving climate monitoring to enhance early warning capability and decision-making	Malawi	Future
Improvement of early warning system against climate induced disasters and hazards	Lesotho	Future
Mastering early warning system	Rwanda	Future
Capacity building		
Strengthening local agricultural innovation systems in less favoured and high potential areas of the country.	Tanzania and Malawi	On-going
Evaluating the efficacy of radio drama as a means to strengthening the capacity of smallholder farmers to adapt to climate change.	Nigeria	On-going
Adaptation-based capacity building in alternative energy services and promotion of non-agricultural activities.	Rwanda	Future
Capacity building and policy reform to integrate climate change in sectoral development plans.	Eritrea, Lesotho	Future
Building adaptive capacity to cope with increasing vulnerability due to climatic change.	Zambia and Zimbabwe	On-going
Coping strategy		
Lack of resilience in African smallholder farming: Enhancing adaptive capacity of local communities to pressures of climate change.	Malawi, Kenya, Uganda, Mali, Ghana, Zambia and Cameroon	On-going
Coping with drought and climate change. Climate change adaptation, Southern and East Africa.	Ethiopia, Kenya, Mozambique, Zimbabwe.	On-going
Ecosystem conservation		
Institutional reinforcement of the structure responsible for nature conservation.	Mauritania	Future
Conservation, restoration and rehabilitation of degraded wetlands, soils and forest lands.	Comoros and Lesotho	Future
Construction of soil water conservation structures on rangelands (2500 ha).	Eritrea and Rwanda	Future
Conservation and protection of lands against erosion and floods at district level in vulnerable regions.	Benin and Madagascar	On-going
Vulnerability and adaptation of forest-related systems to ensure food security and reduce poverty.	Morocco	On-going
Climate change adaptation mechanisms for rural communities in two contrasting ecosystems – plains and mountains.	Sudan	Future
Environmental conservation and biodiversity restoration as a coping mechanism for rangeland protection under conditions of increasing climate variability.	Mauritania	On-going
Adaptation strategies	Countries covered	Status

Table 1. Contd.

Others		
Planning, Preparation and Implementation of National Adaptations Programme of Actions (NAPAs).	Most African Countries.	On-going
Improvement of knowledge of the resource and its sustainable management.		
Preparation and implementation of woody combustible substitution national strategy to combat deforestation and put a brake on erosion due to climate change.	Rwanda	Future

Source: NAPAs submitted to UNFCCC.

change issues as immediate priority along with other challenges such as poverty reduction and economic development. International commitment to Africa might involve funding adaptation projects, assisting with capacity building, providing technical expertise in institutional governance architecture, technology transfer, etc. Capacity building emphasizes the need to build on what exists, to utilize and strengthen existing capacities, rather than arbitrarily thinking of starting from the scratch (Nyong, 2005).

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