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Reappraisal of the Climate Change Challenge in the Congo Basin and Implications for the Cost of Adaptation

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Abstract

The consensus on the reality of climate change is unequivocal. With the IPCC projecting that global greenhouse gas emissions will increase by 25–90% between the years 2000 and 2030, further warming and induced changes in the global climate system shall impact on many physical and biological systems. The Congo Basin countries are already experiencing climate change. Some local and regional studies have identified increasing temperatures, increasing wetness, significant variations in inter-seasonal and intra-seasonal climate, increase in floods and threats of landslides. Less sophisticated climate models have shown that Congo Basin countries will experience increases in rainfall of around 7.3% by 2050 and 13.5% by 2100. More sophisticated models predict significant increases in average annual precipitation up to 200 mm in the eastern portion of the Basin. The temperature change predictions between 2010 and 2050 consistently show that temperatures could rise by 1–3°C. Congo Basin countries' vulnerability to climate change is owed to their geographical location, reliance on resources sensitive to climate and the low adaptive capacity of firms, households and the states. The most vulnerable people in the subregion are the urban poor and small-scale farmers. The most vulnerable sectors are agriculture, health, energy, coastal zones and water resources. Possibly the forests could be severely affected in the long run. There is need for urgent action. Tasks and activities will encompass managing natural resources, better resource management, and changes in laws, programmes, policies and investments. A potential national adaptation investment strategy for the Congo Basin countries will overlap with traditional development concerns and provide an opportunity to increase efficiency of the developmental efforts. New and additional financial resources shall be required to supplement current development plans, to ensure they are resilient to climate effects. This additional resource is the price for or cost of adaptation.

Keywords: climate change, Congo Basin, vulnerability, cost of adaptation

1. Introduction

The Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC, 2013) finds beyond reasonable doubt that the Earth's climate is warming. Since the 1950s, the rate of global warming has been unprecedented compared to previous decades and millennia. The IPCC finds with 95% certainty that human activity, by increasing concentrations of greenhouse gases (GHGs) in the atmosphere, has been the dominant cause of the observed warming since the mid-20th century. Surface temperatures have already increased by 0.5-2°C over the past hundred years. The AR5 presents strong evidence that warming over land across Africa has increased over the last 50-100 years. The Congo Basin is largely implicated in the climate change discussion, not only on the risk and vulnerability to the effects of climate change, but also on the potentials for mitigation and adaptation policies. Along with warming surface waters, deep water temperatures which reflect long-term trends of the large East African lakes in the Congo Basin have warmed by 0.2 to 0.7°C since the early 1900s (IPCC, 2013).

The six countries of the Congo Basin (Cameroon, Central African Republic, Gabon, Democratic Republic of Congo, Equatorial Guinea and Republic of Congo) are home to significant portions of tropical forest which plays a key role in the Earth's carbon cycle. The forest lying between 300 and 1000m above sea level with average annual rainfall between 1600 and 2000 mm, and even much higher (3000 to 11000 mm) along the coasts between Cameroon and Gabon, it covers approximately 80 % of the Congo basin with more than half classified as dense forest, which represents the largest tropical forest surface in the world after Amazonia (CBFP, 2006). In fact, Congo Basin forests hold the large carbon stocks, and its vast tropical rainforest is a true natural treasure, home to over a thousand species of plants and hundreds of species of mammals, birds, reptiles, and amphibians (FAO, 2005). The Congo Basin rainforest is therefore important nationally and regionally to climate change adaptation, through climate regulation and ecosystem resilience, but also globally from a mitigation perspective (FAO, 2007; Gullison et al., 2007).

Figure 1. Congo Basin Forest in Central Africa (Source: enchantedlearning.com)

Since the industrial revolution, the concentration of GHG emissions in the atmosphere has climbed sharply and is now higher than at any other time in the last 400,000 years. Based on the premise that GHG emissions arise from natural processes as well as anthropogenic activities such as the use of fossil fuels, industrial processes (e.g., cement production), agriculture, deforestation and land-use changes, the Congo Basin countries are signatory to the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC) which sets binding obligations to reduce emissions of greenhouse gases (GHGs) and promote adaptation in vulnerable societies. The Kyoto Protocol and the Conference of the Parties (COP) of the UNFCCC are indications of the consensus on the reality of climate change, based on scientific evidence that climate change is driven more by anthropogenic factors, rather than natural changes. According to the IPCC (2013), the current rate of global warming is 2°C per century, and this rate is projected as a lower range for the remainder of the 21st century. The potential consequences of such climate change include increased average temperatures, greater frequency of extreme temperature events, altered precipitation patterns, and sea level rise. Developing countries such as those of the Basin, where the dominant economic activities are related to agriculture, forestry, and fishery which are in turn inherently linked to climate, will be seriously impacted. The aim, therefore, of this paper is to appraise the economics of climate change and the costs of adaptation on the countries in the basin.

2. Economics and Geographic Vulnerability of the Congo Basin

The vulnerability of the basin to current climate variability is aggravated by multiple stresses and low coping capacity. The most vulnerable people are the urban poor and small-scale farmers. The most vulnerable sectors are agriculture, health, energy, coastal zones and water resources. Agriculture is the mainstay of the economies in the Congo Basin, accounting for almost 40% of regional gross domestic product (GDP), and employing more than 60% of the work force. The agriculture is largely dominated by traditional low input-low output subsistence systems, hampered by many factors, including poor road infrastructure and poor public policies (Russell et al., 2011). Despite its significance in terms of employment and contribution to the GDP, the agricultural sector in Congo Basin countries is largely underperforming in comparison with those of other tropical regions, with poor results for most agricultural indicators (e.g., land productivity, work productivity, use of fertilizers, use of improved varieties, etc.). In terms of food security, malnutrition affects approximately two thirds of the region's population. The reliance on food imports is endemic. Nonetheless, the basin still supports livelihoods for more than 75 million people from more than 150 ethnic groups who rely on local natural resources for food, nutritional, health and livelihood needs.

The natural environment is threatened by poaching of wildlife, water pollution, deforestation (chiefly due to land conversion to agriculture by indigenous farmers and refugees' excavation for space), and environmental damage due to mining of precious minerals. The Congo Basin population is expected to double between 2000 and 2030, leading to a total of 170 million people by 2030 - people in need of food, energy, shelter and employment (Grübler et al., 2007). Central African nations of the Congo Basin rank among the lowest in the world on most human welfare indicators and among the highest in population growth and fertility. In 2010, the population growth (%) for Cameroon was 2.19, Central African Republic 1.9, DRC Congo 2.71, Congo 2.54, Equatorial Guinea 2.79 and Gabon 1.87. The resulting increase in food and energy demand being met by different strategies – import increases, domestic production increase, efficiency gains- have different implications on forests. As in other developing regions, the urbanization process is intensifying in the Congo Basin with unprecedented rural-urban exodous into cities like Kinshasa, Brazzaville, Lubumbashi and Bangui. Low literacy rates and lack of education, particularly among women, are recognized factors in the high fertility rates and are critical issues facing both conservation and human development in the subregion. Despite recent improvements in economic performance, poverty remains significant. The incidence of poverty is high, ranging between 40 - 70% (UNDP, 2007). Inequality, unemployment and infant mortality also remain high, which makes meeting the Millennium Development Goals a serious challenge. Recent manifestation of the global economic recession since 2007 has also constrained economic growth for the region, with some slight improvements in 2011.

All the nations in the basin are dependent on extractive industries (oil, mining, timber, wildlife and other non-wood forest products (NWFPs) for a large percentage of their GDP, almost all their foreign exchange and much of their tax revenues. Though rich in minerals and home to a vast potential of natural resources and mineral wealth; however, predatory mineral extraction, which has flourished with armed conflicts reduced government's access to revenue from such resources. These have impacted the provision of adequate physical infrastructure and provided a difficult business operating environment. Well capitalized and technically competent multinational corporations dominate most extractive industries except artisanal gold and diamond mining. The region's forests are a major determinant of local and national economic growth with revenues generated from logging, mining, hunting, fishing and trade in other NWFPs. The timber industry is an important source of national revenues and employment in all countries in the subregion and will be a major determinant of the future state of forests in the basin (Brunner & Ekoko, 2000). Timber exports contribute at least 40% of national GDPs. Export of primary wood products from Cameroon, the Central African Republic, the Congo, the Democratic Republic of the Congo and Gabon generated US$995 million in 2003 (ITTO, 2005).

The Congo Basin forests also provide ecological services to both local and global populations through their capacity to store huge amounts of carbon. Like tropical forests which harbor one-fourth of the total terrestrial carbon stock found in the vegetation and soil (Houghton et al., 2001), the estimate for total carbon stored in the Basin is almost 60 billion metric tons, the largest portion of which is contained in the Democratic Republic of Congo (table 1). Biomass carbon accounts for about 63% of the total carbon stocks, followed by soil carbon (20%), deadwood (5%), and litter (1%). As far as change in carbon stocks is concerned, it has been more pronounced in deadwood over the last two decades. So far, the annual rate change in carbon stocks has been relatively modest (FAO, 2011).

Table 1. Carbon stocks in the Congo Basin Forests, 1990 – 2010 (Source: FAO, 2011)

	Total carbon stock (million tons)			*Annual change rate (%)*	
	1990	*2000*	*2010*	*1990–2000*	*2000–10*
Carbon in biomass	37,727	36,835	35,992	−0.24	−0.23
Carbon in deadwood	3,115	2,923	2,664	−0.64	−0.92
Carbon in litter	665	648	634	−0.26	−0.22
Carbon in soil	18,300	17,873	17,452	−0.24	−0.24
Total carbon stock	59,807	58,279	56,742	−0.26	−0.27

Vulnerability in the Basin and subregion is further characterized by environmental factors (e.g. coastal erosion, soils, water and forest resources), as well as economic and social parameters (Tshimanga & Hughes, 2012; Zhang et al., 2006; Hulme, 1992). The vulnerability of the coasts is due to erosion in low-lying coastal areas, floods caused by high tides and river floods. A significant level of pollution is from contaminants, including heavy metals, sewage and solid waste, and damage ecosystems. In terms of agriculture, soils are significantly degraded due to climate change, increasing population and migratory movements resulting from the repeated conflicts. Its immense hydrographical basin of more than 3,822,000 km², and a series of bodies of water covering more than 86,000 km² could be an asset in cushioning against potential dryness in some parts of the subregion. Unfortunately, in urban centres water supply cannot meet the demand. The problem is further aggravated by climatic variability (Ally, 2005), and serious pollution of the rivers from which drinking water is drawn.

3. Climate Change in the Congo Basin

3.1 Projected Climate Change and Societal Impacts

Climate anomaly patterns in Central Africa and in Congo Basin in particular play significant roles in determining interannual and longer climate variability for countries in the subregion (Kamenga, 2003; Kodiawila, 2000; Kandi, 1996). Inter-annual variability of temperature in the last century has averaged less than 5% across climate zones and from January to December. By comparison, the coefficient of variability of monthly rainfall has been very significant (Mahinga, 2004; Mbokolo, 2003). During this century, temperatures in the subregion as in the African continent are likely to rise more quickly than in other land areas, particularly in drier regions (Hulme et al., 2001). Temperature increase for Africa as a whole is projected to range from 0.2°C per decade to more than 0.5°C per decade. Equatorial countries such as DRC, Gabon, Cameroon, Uganda, and Kenya might be about 1.4°C warmer. Under a high CO_2 emissions scenario, AR5 documents that average temperatures will rise more than 2°C, the threshold set in current international agreements, over most of the continent by the middle of the 21st century (IPCC, 2013). In AR4, as shown in figure 2 below, existing scenarios (Note 1) suggest that GHG emissions may reach concentrations of between 450 ppm and 550 ppm of Carbon Dioxide equivalent by mid-century and may be as high as 600-650 ppm by the end of this century (IPCC, 2007). This will cause further warming and induce changes in the global climate system. It is highly likely that this will translate into temperature rises of between 1°C and 6°C by the end of the century, with an average between 2°C and 4°C. These high emissions scenarios also point to feedback effects that may lead to more intense and more frequent changes in weather patterns (IPCC, 2007).

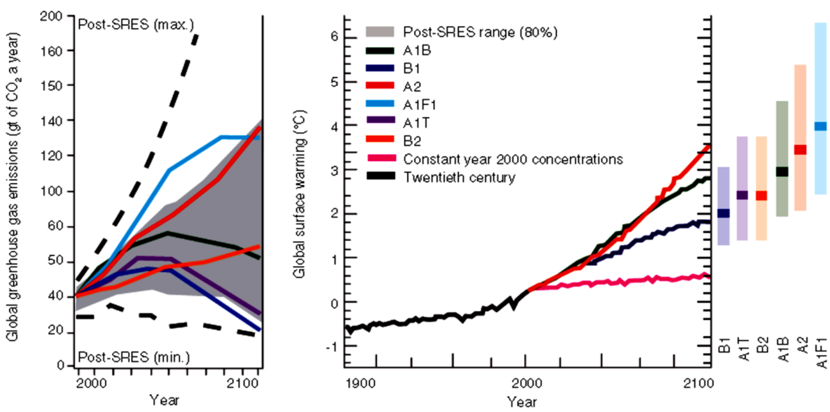

Figure 2. Greenhouse Gas Emissions and Temperature Scenarios (Annual Gt of CO_2 eq and Centigrade degrees)

Soure: Intergovernmental panel on Climate Change (IPCC), Climate Change 2007- The Physical Science Basis. Contribution of Working Group I to the Fouth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, 2007.

The AR5 presents four scenarios - Representative Concentration Pathways (RCPs) - of different levels of emissions of greenhouse gases from the present day to 2100. In all scenarios, carbon dioxide concentrations are similarly higher in 2100 than they are today. In the next few decades, warming will be the same in all scenarios. In the longer term, in all except the low-emissions scenario, global warming at the end of the 21st century is likely to be at least 1.5°C. In the two higher emissions scenarios, global warming is likely to be 2°C (IPCC, 2013). In the second lowest emissions scenario, global warming is more likely than not to be 2°C.

Regardless of future emissions, the world is already committed to further warming, largely due to past emissions and inertia in the climate system. The continued emission of greenhouse gases will cause further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive and irreversible impacts for people and ecosystems. The IPCC (2013) warns that if global society continues to emit greenhouse gases at current rates, the average global temperature could rise by 2.6-4.8°C by 2100.

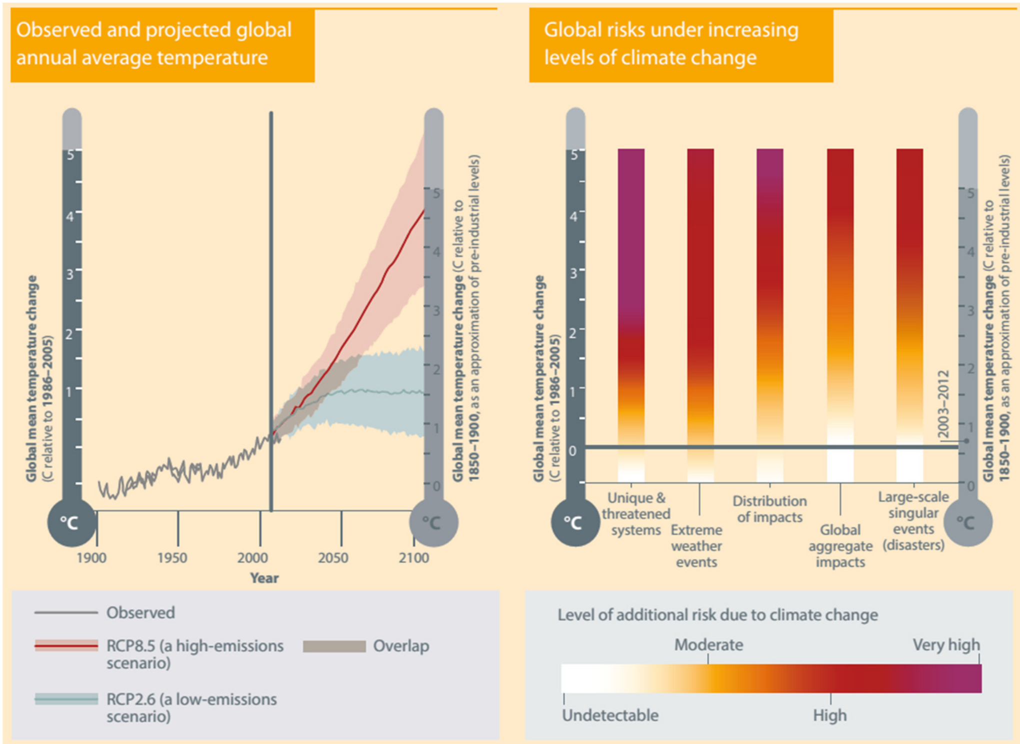

Figure 3. Global warming in the last century and projected global warming to 2100 (IPCC, 2013)

General Circulation Model experimental projections for the Congo Basin in particular show temperature increase from +2 to 4.5°C by 2100. According to these projections, Congo Basin will warm more than the mean global temperature response, approximately 1.5 times as much. Almost all models agree that Congo Basin will be extremely hot all year round. Congo Basin has a high likelihood to become wetter by 2100, as most projections agree on increasing precipitation. Tadross et al. (2005) project changes in extreme precipitation events for the subregion. In Christensen et al. (2007) the Sahara region and southern Africa are projected to warm up more strongly than central Africa region of the Congo Basin, with the strongest warming in sub-Saharan Africa to be found in southern Africa.

Anecdotal evidence report some visible effects of climate change in certain parts of the subregion. Using the less sophisticated Magic Schengen software, some analysis has shown that countries in the heart of the Congo Basin forests like the DRC will experience increases in rainfall of around 7.3% by 2050 and 13.5% by 2100 (Congo, 2002, 2006). However, the rainy season will become shorter for regions further away from the equator (where rainfall will be more abundant). Average annual temperature will vary between 24 and 26°C, with extreme values of between 30 and 35°C in the Congo basin and between 15 and 20°C in the uplands. Significant drier conditions are expected in the west and east regions of the basin. Using more sophisticated models, predictions of average annual precipitation changes in the Congo Basin countries through 2050, vary from one climate model to another. From downscaled GCMs in the IPCC AR4, the MIROC (Model for Interdisciplinary Research on Climate) predicts increases of up to 200 mm in the eastern portion of DRC, while drier areas will be found around Kinshasa. The CSIRO (Commonwealth Scientific and Industrial Research Organization) model shows patches of rainfall reduction of up to 150 mm annually, with a large patch in the northeastern portion, as well as in the northwest. The temperature change predictions between 2010 and 2050 are more consistent between models than are the precipitation predictions, although there are differences. The MIROC and CSIRO show that temperatures could rise by 1–3°C. The CSIRO model projects very modest increases for most of the country, averaging 1.4°C, while the MIROC model projects slightly higher temperatures (IPCC, 2007).

The Climate Service Centre (2013) conducted a regional climate change assessment over the greater Congo basin region. The major findings indicate that for the near surface air temperature, all assessed models agree on a substantial warming towards the end of the century in all seasons of the year regardless of the underlying scenario. On an annual basis a warming in the range of +1.5 and +3°C for the low and in the range between +3.5 and +6°C for the high emission scenario can be considered to be likely towards the end of the 21st century. In general projected temperature increase is slightly above average in the northern parts of the Congo Basin and slightly below average in the central parts. For total precipitation, for all zones some models project an increase in annual total precipitation and some project a decrease. If the full range of projected changes in annual total precipitation is considered, all models agree on a change not higher than ±30% towards the end of the 21st century for most parts of the domain with a general tendency of a slight increase in future annual total precipitation. However, in the dryer northern part of the Congo Basin, a larger increase in annual total precipitation (full range up to about +75%) is projected, mainly related to the northward expansion of the tropical convection zone, which was already described in the scientific literature.

Increasing deforestation in the Congo Basin will reinforce climatic risks (Justice et al., 2001; Semazzi & Song, 2001; Polcher & Laval, 1994). According to FAO (2000, 2005, 2007) and Megevand (2013) deforestation in the Congo Basin has accelerated in recent years, largely associated with expansion of subsistence activities (agriculture and energy) and concentrated around densely populated areas. The Intergovernmental Panel on Climate Change (IPCC) has estimated that deforestation is responsible for 17% of GHG emissions and that protection of forest cover can help in the fight against global warming. Akkermans et al. (2014) studied the regional climate impact of a realistic future deforestation in the Congo Basin. With respect to the impact of increased GHG concentrations and deforestation on temperature, they note that the warming signal resulting from deforestation is generally restricted to the deforested area. The average increase in ground surface temperature over the entire area where deforestation is expected to occur amounts to 0.658^{o}C, while specifically the districts of Mongala and Equateur are projected to be on average 0.778^{o}C warmer. Akkermans et al. (2014) conclude that there is a good correlation between the warming signal and the deforestation pattern in the Congo Basin. In the case of precipitation, Akkermans et al. (2014) modeled precipitation decreases on average by 2.6% in the deforested areas and by 3.4% in Mongala and Equateur. They note in particular over the coastal deforestation hot spots (Republic of the Congo, Gabon, and Cameroon), changes in precipitation extend beyond the deforested areas due to both the monsoon circulation and a deforestation-induced increase in moisture advection from overseas. In contrast, a consistent local precipitation decrease is projected for the deforestation hotspots in and around Mongala and Equateur, given the limited influence of synoptic-scale circulation compared to the coastal hotspots, and because deforestation induces a heat low in this zone, which further inhibits air transport out of the deforested area.

High population growth rates ultimately also affect the subregion. All countries in the Congo Basin except Gabon (which has relatively high urbanization and per capita income) have high population growth rates and a predominantly young population. Some internal drivers pushing deforestation include improved transport infrastructure, improved agricultural technologies, and decrease in woodfuel consumption. External drivers have been the increase in international demand for meat, and increase in international demand for biofuel. Overall, the most significant driver of deforestation has been forest clearing for agriculture (Potapov et al., 2012; Norris et al., 2010), mainly in the form of shifting cultivation (Russell et al., 2011). The ensemble of projections are bleak, because with increasing human population growth rates, the demand for agricultural land in the Congo basin may increase by 100% the next 20 years (Zhang et al., 2006).

Given these challenges, climate change may become a contributing factor to conflicts in the future, especially related to resource scarcity (e.g. scarcity of productive land) in the Congo Basin. It might also have significant negative impacts on food security and biodiversity (endemic species could succumb to climate stress and mountain species will see their habitat shrink). In addition, vector borne and waterborne diseases, such as malaria and schistosomiasis, could increase. The projections above clearly demonstrate the need for adaptation. Thus, different sectors of the economy shall be vulnerable to this change, with agriculture, health, energy, coastal zones, and infrastructure and water resources being more vulnerable. The Overseas Development Institute (ODI) and Climate and Development Knowledge Network (CDKN) (2014) observe that climate change impacts across these areas of concern will increase risks of food insecurity and the breakdown of food systems, increase risks of loss of rural livelihoods and income due to insufficient access to drinking and irrigation water and reduced agricultural productivity, particularly for farmers and pastoralists. Risks due to extreme weather events leading to breakdown of infrastructure networks and critical services such as electricity, water supply, and health and emergency services are also linked to these areas of concern (McMichael et al., 2004).

Climate change, without doubt, represents one of the principal challenges facing the Congo Basin, and requires sustained stewardship for mitigation and adaptation. The moral case for addressing climate change has been raised by the Roman Catholic Pope Francis (2015) in a *Papal Encyclical* on the need to act against climate change calling it a global problem with far reaching environmental and social consequences - especially for the poor, and stressed, ‘we all share the responsibility to protect and care for the Earth, our common home, for today's and for future generations.’ More important, there is need for prompt action. There are therefore possible investments that could be made, both in the short-term and long-term (Dlugolecki, 2007; Ebi, 2007; Kirshen, 2007; McCarl, 2007; Nicholls, 2007). According to the IPCC (2007), the benefits of strong and early action on adaptation far outweigh the economic costs of inaction. The estimated cost of inaction is equivalent to between 5-20% of global GDP per year, whilst the costs of adapting to the worst impacts are around 1% of global GDP per year. The World Bank (2010d) finds that current climate related losses in developing countries are between 1-2% of annual GDP. This figure is expected to increase markedly by 2030 under a scenario of high climate change.

3.2 Adaptation Choices

The cycle of climate changes over the past 2 million years has had a profound influence on the forests of the Congo basin. Given the importance of the Congo basin, several recent studies have probed the vulnerability of the region to climate change and the nature and controls on climate variability. The IPCC identifies five main areas of concern as temperatures rise, as well as the additional climate-related risks. At even relatively low levels of warming of 1 to 2°C, many unique natural systems are threatened and food production, human health and water resources could be negatively impacted in regions such as the Congo Basin. The IPCC concludes that large-scale warming, of around 4°C or above, will increase the likelihood of severe, pervasive and irreversible impacts to which it will be difficult to adapt. Adaptation strategies for future climate change are going to be of crucial importance, particularly for food production, human health and water resources.

The AR5 observes that climate change is having a negative impact on crop and agricultural food production. Recent development gains in the Congo basin have been in such climate sensitive sectors. Economically, many of the inhabitants of the subregion depend for food, fibre and income on primary sectors such as agriculture, forestry and fisheries, which are affected by rising temperatures, rising sea levels and erratic rainfall. Climate change thus poses challenge to growth and development. The IPCC (2014) highlights the key risks to Africa in general of climate change as being stress on water resources, reduced crop productivity, and changes in the incidence and geographic range of vector- and water-borne diseases. While some environmental, economic and cultural systems within the basin are already at risk from climate change, the severity of the consequences increases with rising temperatures. Climate change thus challenges fundamental social and economic policy goals such as growth, equity and sustainable development. The IPCC reckons that adaptation will bring immediate benefits and reduce the impacts of climate change.

Adaptation could be autonomous and/or planned adaptation. Autonomous adaptation is adaptation that is reactive to climatic stimuli, and undertaken as a matter of course without the intervention of a public agency. On the other hand, planned adaptation can be reactive or anticipatory, i.e., undertaken before impacts are apparent. The governments in the subregion will have to exploit means and ways to plan adaptation to protect private and public property. Hence, given the potential negative impacts from climate change, the governments would have to look beyond autonomous adaptation, and proactively plan on how much money that would be required for their countries to make the necessary adaptations to climate change.

Adaptation, however, is only one part of the overall response to climate change. Adaptation and development approaches can go hand-in-hand, and can in fact reinforce each other. Even after taking action on adaptation, communities in the Congo basin will have to deal with some climate-related risks. It is therefore important to integrate adaptation and mitigation strategies into long-term development planning, after proper costing. Agrawala and Frankhauser (2008) identify the total cost of climate change consists of three elements:

a. the costs of mitigation (reducing the extent of climate change),
b. the costs of adaptation (reducing the impact of change), and
c. the residual impacts that can be neither mitigated nor adapted to. Recall that, adaptation will not reduce impacts to zero, since there may be substantial residual damages which adaptive efforts may not have been able to contain. Communities in the basin will have to bear the consequences of the residual cost.

As noted in figure 4, climate change impacts represent a cost to society (referred to as the costs of climate change*)*. Adaptation may reduce these costs, but not completely, such that there will always be residual damage costs. The difference between the cost of climate change without adaptation and the residual cost of climate change after adaptation is the gross benefit of adaptation. In the advent of climate change, governments in the subregion will have to make policy that reduces damages and maximizes the benefits of adaptation. While various National Communications on Climate Change elucidate significant cause and effects of climate change on the nation states, however, the focus of their National Adaptation Plans of Actions (NAPAs) is a small part of the many activities that are required to build resilience against climate change. There is therefore need for comprehensive assessment of the economics and cost of adaptation in the basin, and for budgetary allocations that enhance adaptation; mindful that autonomous 'reactionary' adaptation will be inadequate and thus planned 'anticipatory' adaptation shall be necessary to avoid expected negative impacts.

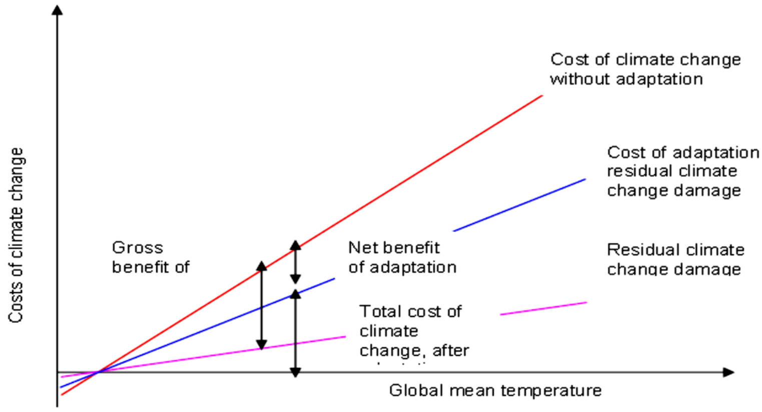

Figure 4. The costs and benefits of adaptation (Source: Agrawala and Frankhauser 2008)

3.4 Potential National Adaptation Investment Strategy for the Basin

Climate change responses will clearly overlap with traditional development concerns and provide an opportunity to increase efficiency of the developmental efforts. As noted in Tables 2a and 2b, there are sector-based options and choices which Congo Basin countries could employ for both short-term and long-term adaptation. Adaptation measures typically range from discrete adaptation (interventions for which adaptation to climate change is the primary objective) to climate-smart development (i.e. interventions to achieve development objectives that also enhance climate resilience).

Efforts towards comprehensive sustainable development, will require "new and additional" resources to supplement current development plans, to ensure they are resilient to climate effects. We may therefore refer to these additional resources as the price for or cost of adaptation. In other words, adaptation costs may be seen as 'additional to the costs of development'. Hence, the cost of measures undertaken to do more, do different things, and doing things differently are included. Faced with this situation, the Congo Basin countries will have to budget and seek for finances to implement the following measures as the first major steps to help reduce vulnerability, promote adaptation and increase overall resilience of the country:

A. Agriculture: intensify agricultural research and extension service effort (i.e. transfer of technology) related to improved crop and livestock varieties; reinforce crop and land/soil management and or conservation activities, build reservoirs and irrigation water distribution systems for year-round agriculture; and improve on food security (supply, affordability and nutritional quality).

B. Water resources: monitoring of the water resources, particularly those of the River Congo system and its tributaries; development of watersheds for control of the surface run - off; and protection of the water resources against pollution.

C. Energy: protect important energy production infrastructure, undertake assessment of water supplies that can be used to produce energy, develop energy efficiency and conservation programs and promote alternative energy use.

D. Health management: reinforcement of the medical personnel's professional capacities, community sensitization, education and training programmes, and raising of awareness on emerging diseases, sensitization on prevention techniques for reducing the increased incidences of endemic diseases e.g. malaria (popularization of the use of anti - mosquito grids, use of impregnated window screen, eradication of mosquito deposits, mosquito eradication on a national scale).

E. Coastal zones: delineation of building and residential areas, research/monitor the coastal ecosystem and protection of seaport installations particularly at Matadi in the DRC (e.g. long-life defence infrastructure in anticipation of sea-level rise), protecting coastal landscapes for amenity or ecological reasons, protection of public and private property against more intense storms

F. Ecosystem and land management: Development of reforestation and soil conservation programmes, Development and propagation of more efficient agro‐sylvo pastoral management methods, promotion of renewable energies and domestic fuels as substitution for ligneous fuels, promote participative and community management of natural resources by the civil society and the rural communities.

G. Meteorological service refurbishment: Rebuild capacity of meteorological service workers, better equip meteorological services, develop early warning systems and disaster preparedness, introduce flood and drought monitoring and control system, train multidisciplinary and multi-sectoral team on climate analysis, develop and maintain an updated database on hydro-climatic parameters to evaluate the vulnerability and adaptation of key sector.

H. Infrastructure development: improvements of the physical structural elements that may facilitate the flow of goods and services (e.g. roads of all sizes, bridges, railways, airports, ports, electric power systems, telecommunications, water, sewerage and drainage/waste-water management systems); improvements in social infrastructure (e.g. public transport, health care, education and emergency services) and institutional infrastructure.

Recent studies e.g. have noted that adaptation costs as a percentage of national income (or GDP) could be considerably higher in sub-Saharan Africa than in any other region, largely due to low income levels of these countries and the high investments required to adapt. This is also true for the Congo Basin countries. Providing actual estimates of the costs for these measures requires detailed studies for each sector. However, for the purpose of this appraisal, it is important to review the findings of previous evaluations in other countries and regions to provide circumstantial insights on the potential costs of adaptation for countries in the subregion.

Table 2a. Sectoral Impacts of Climate Change in the Congo Basin

Sector	Potential Economic & non-Economic Consequences	Low Regrets Investment	
		Short term (5 -10 years)	Long-term (beyond 10 years)
Agriculture	– Change in agricultural productivity, in terms of quantity and quality. – Change in agricultural practices, through changes of water use (irrigation) and agricultural inputs such as herbicides, insecticides and fertilizers. – Land degradation and associated effects.	– Construct small-medium size irrigation facilities. – Improve access to loans and micro-credit. – Build entrepreneurial skills to generate off-farm income. – Better utilization of short season, drought resistant crops to prepare for drought and floods. – Promote practice of soil conservation agriculture. – Promote more credit and financial services for agro-businesses.	– Improve water storage to use excess water from wet years. – Build storage facilities. – Promote improved processing and value addition. – Promote integrated agriculture.
Water	– Change of total water flows (probabilities of extreme high or low flow conditions). – Change in seasonal runoff regimes. – Change in groundwater-surface water interactions. – Change in water quality.	– Better water resource management and irrigation. – Encourage rainwater harvesting – Promote improved water use efficiency – Conduct afforestation and improved land use practices. – Undertake farm-scale water storage facilities.	– Increase water transfer from the Congo river basin to meet the needs of the urban population. – Provide deep wells to provide drinking water for people and animals.
Energy	– change in generation potential – Increases in energy demand. – Disruption and damage to energy delivery systems. – Reduction in efficiency of power production.	– Protect important energy production infrastructure. – Improve assessment of water supplies that can be used to produce energy. – Promote energy efficiency and conservation programs.	– Promote alternative energy use. – Create a Smart Grid to maximize the efficiency of electricity distribution.
Health	– Frequent Heat Waves.	- Monitor emerging health risks.	– Improve health care,

	– Effects from extreme weather Events e.g. disruption of public health infrastructure. – Reduced Air Quality. – Frequency of Climate-Sensitive Diseases. – Other Heath Linkages.	- Plan urban adaptation strategies, such as planting trees to minimize heat buildup in cities and manage storm water. - Prepare emergency response plans – Improved early warning of climatic hazards. – Improve public communication during specific health risks such as extreme heat events or low air quality days. - Better education and sensitization of the masses.	social services, and social support for all people. – Enhance health delivery strategies.

Table 2b. Sectoral Impacts of Climate Change in the Congo Basin

Sector	Potential Economic & non-Economic Consequences	Low Regrets Investment	
		Short term (5 -10 years)	Long-term (beyond 10 years)
Coastal zone	– Cost of altered navigation opportunities. – Change to cultural value of the water environment. – Costs due to inundation, flood and storm damage. – Costs from Wetland loss (and change). – Costs from Erosion (direct and indirect morphological change).	– Protect key investments like ports and harbours at Matadi. – Protect livelihood of the fishing community.	– Design new infrastructure keeping adaptation in mind.
Ecosystem	– Change in habitat Characteristics. – Change in instream and riverine habitats and species. – Significant declines in biodiversity due to rising temperatures are expected to occur in most parts of the country especially the western regions where most of the park estates are located. – Lower resilience of ecosystems to other global environmental changes.	– Minimize human disturbances, in particular, slash & burn agriculture. – Remove or control invasive species. – Protect watersheds and natural forest corridors. – Manage wildfire risk with controlled burns and thinning.	– Better planning and management of forest, fish, and other natural resources. – Promote biodiversity and landscape diversity. – Collaborate across borders to create habitat linkages. – Improve monitoring of ecosystems to respond more quickly to outbreaks of diseases and pests that threaten native species.
Infrastructure	- Impacts on production infrastructure - Disruption of distribution infrastructure e.g. roads, railways, etc.	- Review road design and protection of road shoulders. - Build better Dams and irrigation channels. - Improve roadways - Improve communication infrastructure - Improve hospitals and schools.	– Increase maintenance of feeder roads to increase access to rural areas. – More robust buildings and good quality housing. – Relocating critical business facilities.

3.3 Lessons from Adaptation Cost Experiences from other Countries and Regions

The IPCC (2014) notes that the economic impacts of climate change in Africa are likely to be significantly higher than in other world regions and they could be significant in the short-term, with estimates that the costs could be equivalent to 1.5 - 3% of GDP each year by 2030 in Africa. Impacts (and benefits) will be unevenly distributed across countries and between sectors. Estimates of the costs of adaptation have been made by the World Bank (2010a,b,c,d); World Bank (2006), the United Nations Framework Convention on Climate Change (UNFCCC, 2007); Oxfam (2007), UNDP (2007), Stern (2006), McKinsey (2009), Mendelsohn et al. (2006) and Mendelsohn

(2006a,b). These cost estimates have been used as the basis for discussion regarding the levels of investment needed for adaptation to climate change. They have been influential in the debate concerning funding for climate change and it is important, therefore, that we examine the lessons therein for the Congo Basin countries. The World Bank's global study on adaptation costs (World Bank, 2010a,b,c,d) found the price tag of adapting to climate change in developing countries to be US$ 75-$100 billion per year for the period 2010 to 2050. While this equals only 0.2% of the projected GDP of all developing countries, it is as much as 80% of total current Overseas Development Assistance. For Sub-Saharan Africa, the study estimated annual adaptation costs of US$ 14 - 17 billion. The country studies were done to help decision makers better assess climate change risks and design appropriate adaptation strategies. Of the seven countries, three are in Africa - Ethiopia, Ghana and Mozambique.

Like some Congo Basin countries, Ghana with similar endowment is dependent on climate-sensitive sectors (rain-fed agriculture, forestry, and hydropower). The World Bank notes that, for Ghana without adaptation real GDP could be 2–7% lower than the baseline by 2050. There is significant impact on agriculture, including cocoa which is a big contributor to national income and a major source of livelihood for farmers. Coastal damage is estimated to be US$ 6 million a year by 2030. By 2050, annual average outputs of the country's water and energy sectors are expected to decline by 3–6%. Because of these impacts on key sectors, real household consumption is expected to drop by 5 – 10% by 2050. Rural households are likely to suffer greater reductions, primarily because of lower agricultural yields. Figure 5 shows that in Ghana, under dry conditions and without adaptation the three key sectors experience losses of about US$ 2 billion per sector, and the welfare loss is almost US$ 3 billion. Under wet conditions, the welfare is significantly larger at US$ 4 billion without adaptation. The lesson is that governments should not rush into making long-lived investments in adaptation unless there is more certainty about future climate variability. According to figure 4, there is a vast difference in the benefits of adaptation under different climate scenarios. In `Ghana wet' (more precipitation), investing in agriculture, hydro, and education results in substantial benefit, while in `Ghana dry' (a drier future), losses result even with adaptation. In each case, cost of adaptation equals the damage from climate change as seen in the `no adaptation' scenario. It is better to undertake low-regret actions as outlined above rather than rush into large investments.

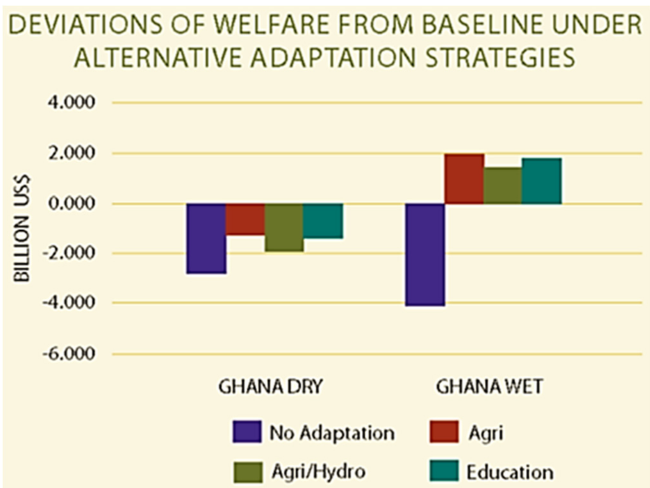

Figure 5. Cost of Adaptation in Ghana (Source: World Bank, 2010a)

Ethiopia, which is similarly heavily dependent on rain-fed agriculture and has historically been prone to extreme weather variability and major droughts accompanied with famines, its geographic location and topography make it highly vulnerable to the impacts of climate change. World Bank projections show that without adaptation, GDP is likely to decline between 2 – 10%. Climate projections show that both severe flooding and droughts will become more frequent. Agriculture, which accounts for 47% of Ethiopian GDP, is particularly sensitive to these variations. Climate change will make growth rates more variable, significantly affecting the poor. The impact also varies across regions. In particular, the cereal-based highland zone will experience losses in yields. As observed noted in figure 6, adaptation significantly lowers welfare loss under extreme dry and wet conditions. In other words, adaptation to climate change is cost effective. Adaptation reduces welfare losses due to climate change by as much as 50% and lowers income variability. Figure 6 reveals that the cost of fully offsetting climate change impacts range in Ethiopia from US$1.2 billion to $5.84 billion per year over 40 years.

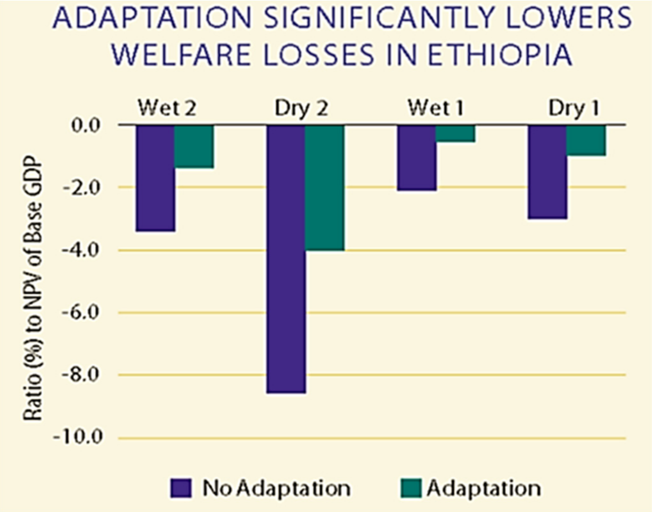

Figure 6. Cost of Adaptation in Ethiopia (Source: World Bank, 2010b)

Mozambique too is symptomatically vulnerable given its geography and economic structure. Agriculture makes up 40% of the nation's GDP. Fisheries are a crucial source of livelihood, employing around 60,000 people and representing about 40% of total export earnings. Mozambique is prone to severe droughts that have contributed to about 4,000 deaths between 1980 and 2000. The country is also prone to floods caused by tropical cyclones that come 3 - 4 times a year. Climate change is likely to make these extremes worse. The World Bank shows significant damage to roads and transport disruption, mainly due to flooding from the Zambezi river basin. The increase in temperature scenario shows greater damage to agriculture. Crop productivity will fall in all scenarios with central Mozambique being hardest hit. Climate change is expected to reduce yields of major crops by 2 - 4%. For Mozambique, cost projections show that without adaptation, GDP is likely to fall between 4 and 14%. These cumulative impacts from agriculture, energy, and infrastructure accumulate into significant declines in national welfare by 2050. Adaptation reduces damages substantially. As noted in figure 7, following investments in adaptation there are significant reductions in climate change damages. With small additional costs, sealing unpaved roads—a low regret option—would restore about one-fifth of the welfare loss as a result of climate change. Remaining welfare losses could be regained with better agricultural productivity or improvement in education.

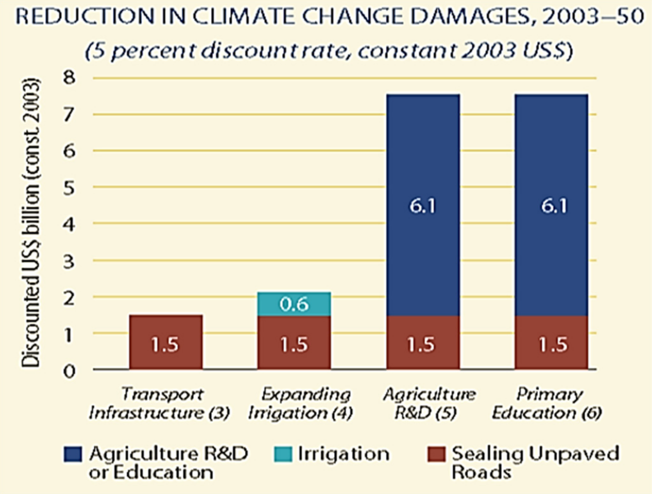

Figure 7. Cost of Adaptation in Mozambique (Source: World Bank, 2010c)

On a regional basis, for both climate scenarios, the East Asia and Pacific Region bears the highest adaptation cost, and the Middle East and North Africa the lowest. Latin America and the Caribbean and Sub-Saharan Africa follow East Asia and Pacific in both scenarios. On a sector breakdown, the highest costs for East Asia and the

Pacific are in infrastructure and coastal zones; for Sub-Saharan Africa, water supply and flood protection and agriculture; for Latin America and the Caribbean, water supply and flood protection and coastal zones; and for South Asia, infrastructure and agriculture. Figure 8 shows cost increasing over time, although falling as a percentage of GDP—suggesting that countries become less vulnerable to climate change as their economies grow. There are considerable regional variations, however. Adaptation costs as a percentage of GDP are considerably higher in Sub-Saharan Africa than in any other region, in large part because of the lower GDPs in this region. These are important lessons for the Congo Basin countries.

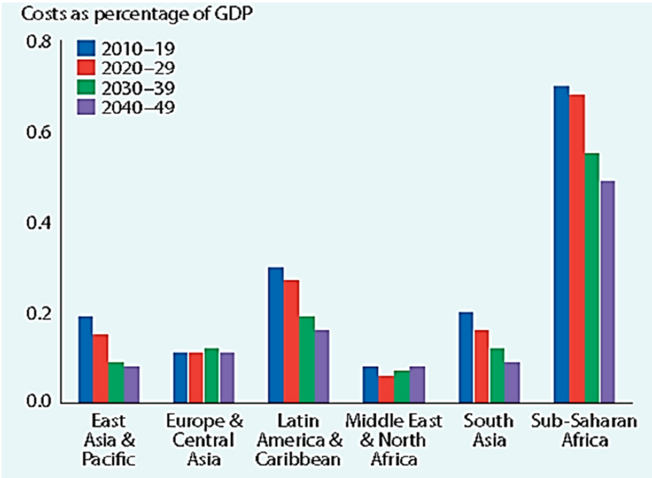

Figure 8. Total annual costs of adaptation as share of GDP, by decade and region (percent, at 2005 prices, no discounting) (Source: World Bank, 2010d)

Two climate change scenarios are tested in the World Bank study: (a) National Centre for Atmospheric Research (NCAR) – a wetter scenario; and (b) Commonwealth Scientific and Industrial Research Organization (CSIRO) - drier scenario. Both climate scenarios show costs increasing over time (table 3). Under the NCAR scenario, annual adaptation costs are $73 billion during 2010–19, rising 45 percent over the next 30 years to reach $106 billion in 2040–50. Under the CSIRO scenario, growth is more rapid, rising 67% over the entire period, from $57 billion a year in 2010–19 to $95 billion by 2040–50. Under the NCAR scenario, there is little variation in costs over the 40-year period in East Asia and Pacific and Latin America and the Caribbean. Costs grow most rapidly in the Middle East and North Africa, rising 1.6-fold over the four decades. The lesson for the Congo Basin countries is that the cost of adaptation may with climate change, whether under increased dryness or wetness. This is a motivation to act now, with "soft" and "hard" adaptation measures. Postponing adaptation will be costlier. In other words, given the vulnerabilities for Congo Basin countries, the opportunity cost of "doing nothing" will be more expensive.

The distribution of costs across income groups (based on incomes in 2008) shows that adaptation costs are fairly evenly divided across the three income groups (low, lower middle and upper middle-income countries), particularly under the NCAR scenario (table 5). Low-income countries have higher costs than middle- income countries under the CSIRO scenario. Adaptation costs as a percentage of GDP are highest in the low-income countries, but they are not lowest in the upper middle-income countries, as might be expected (see table 4). This is in part because China is in the lower middle-income group and grows very fast over 2010–40. The upper middle-income group is much smaller, and these countries have more infrastructures to protect. In summary, therefore, for low income developing countries like the Congo Basin countries, the cost of adaptation as a proportion of its national income (or GDP) would be larger than in some middle income countries like Ghana, Vietnam or South Africa, largely because of Congo Basin countries' low income and the high nominal value of investments required to adapt.

Table 3. Total annual costs of adaptation for all sectors, by region and period, 2010–50

(US $ billions at 2005 prices, no discounting) (Source: World Bank, 2010d)

Period	East Asia and Pacific	Europe and Central Asia	Latin America and Caribbean	Middle East and North Africa	South Asia	Sub-Saharan Africa	Total
National Centre for Atmospheric Research (NCAR, wettest scenario							
2010–19	22.7	6.5	18.9	1.9	10.1	12.8	72.9
2020–29	26.7	7.8	22.7	2.0	12.7	17.2	89.1
2030–39	23.3	10.8	20.7	3.0	13.5	19.2	90.5
2040–49	27.3	12.7	23.7	5.0	14.3	23.2	106.2
Commonwealth Scientific and Industrial Research Organization (CSIRO), driest scenario							
2010–19	16.4	3.9	11.6	2.4	11.9	10.3	56.5
2020–29	20.1	4.7	13.1	2.6	17.5	13.3	71.3
2030–39	20.9	6.4	20.2	3.0	17.7	20.0	88.2
2040–49	21.0	7.6	22.8	3.9	15.3	24.1	94.7

Table 4. Total annual costs of adaptation, by country income groups and decade, 2010–50

(2005 prices, no discounting) (Source: World Bank, 2010d)

	Low income		Lower middle income		Upper middle income		Total	
Period	Amount ($ billions)	Share of GDP (percent)	Amount ($ billions)	Share of GDP (percent)	Amount ($ billions)	Share of GDP (percent)	Amount ($ billions)	Share of GDP (percent)
National Centre for Atmospheric Research (NCAR), wettest scenario								
2010–19	26.2	0.39	25.2	0.16	21.4	0.19	72.8	0.22
2020–29	33.6	0.33	30.0	0.13	25.4	0.17	89.0	0.19
2030–39	34.2	0.23	28.2	0.09	28.2	0.15	90.6	0.14
2040–49	39.3	0.18	34.4	0.08	32.5	0.14	106.2	0.12
Commonwealth Scientific and Industrial Research Organization (CSIRO), driest scenario								
2010–19	23.4	0.35	17.4	0.11	15.6	0.15	56.5	0.17
2020–29	30.7	0.34	22.6	0.11	15.7	0.13	71.2	0.16
2030–39	36.4	0.27	28.6	0.09	17.9	0.12	88.2	0.14
2040–49	39.2	0.18	29.0	0.07	23.2	0.11	94.7	0.11

4. Inference and Policy Recommendations

These studies have overarching lessons for the near-term and the longer term that may offer useful guidance for policy-makers in the Congo Basin countries. The policy pointers emerging from these case studies include:

a. Economic development is a central element of adaptation to climate change. Some projects, e.g. irrigation are good for development as well as adaptation. Infrastructure investment should be the first line of defense against climate change impacts. While economic development is key to adaptation but it should not be business as usual. Figure 9 highlights that green growth measures (e.g. sustainable exploitation of natural resources), environmentally or eco-friendly transformative processes should be the corner stone for a new comprehensive economic development plan. Such a development is one that is climate-smart. This will require that climate-sensitive projects within the development agenda, will need to be subjected to climate-robustness tests; and the economy will need to be diversified away from climate sensitive sectors like agriculture into other activities. This can be done by skills upgrading and promoting eco-friendly transformation of agricultural products.

b. There is need to invest in human capital, develop institutions, and avoid incentives that encourage development in locations exposed to severe climate risks. Adaptation will require a different kind of development—such as breeding crops that are drought and flood tolerant, climate proofing long-lived infrastructure to make it resilient to climate risks. For example, in DRC, there is need to look at ports like Matadi and make sure it is climate-proofed.

c. Start with actions that make sense even without climate change. In Africa, studies show that expanding the road system and increasing the share of paved roads would yield high return by lowering transport costs and expanding markets. They lessen flood impacts and enhance farmers' ability to respond on changes in agriculture. Brazaville, Kinshassa, Libreville and other cities in the Congo Basin countries need new and stronger infrastructure even without climate change. New roads with better drainage systems can help prolong the roads' life and improve municipal water management. A more climate-resilient road network can avoid costly disruptions of communication links and supply chains.

d. Prioritize both capital intensive (physical) adaptation as well as soft (institutions and policies) adaptation. For example, city planning, land use planning provision of social security programmes, strategies directed toward increasing coping mechanism at the household level, better education, skills training or crop insurance programs. Both hard (requiring investments) and soft adaptation (building institutions and policy) may be required for Congo Basin countries. This reinforces the need to mainstream climate change adaptation into all sectors of the economy. Soft measures (institutions and policies) are potentially powerful as it takes time and more resources to provide the infrastructure for hard (capital-intensive) options.

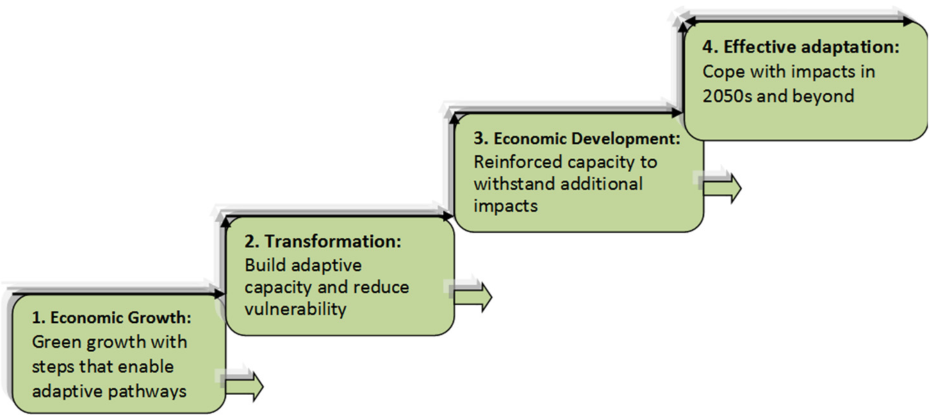

Figure 9. Economic development is a central element of effective adaptation to climate change (Source: Author's conceptualization)

5. Conclusion

Even if GHG concentrations were to be stabilized immediately, climatic processes and feedback timescales will make anthropogenic warming continue for centuries. This global warming will be superimposed on decadal climate variability, particularly in Africa's Congo Basin. Dealing with the unavoidable impacts of climate change in the Congo Basin requires proactive planning for adaptation. The governments of the subregion are signatory to the United Nations Framework Convention on Climate Change and other environmental conventions and are therefore aware of the numerous challenges that climate change poses. Furthermore, 'National Strategy and Action Plans for Climate Change and Variability' and the 'National Communications on Climate Change' have been developed for these countries. Even with these steps, however, very few projects are being implemented that focus on climate change adaptation. Most studies for the subregion are focused on climate change mitigation, but these are ad-hoc and not integrated into other development planning processes. The current appraisal raises awareness on the urgency for budgetary planning to enhance Congo Basin countries' adaptive capacity and build resilience to climate change, thereby lowering the risks that climate change poses to the limited hard-won development gains in the subregion. While adaptation has limits, in that it addresses only known impacts and only in the near term, however, governments in the subregion must not wait until science provides comprehensive costing for each country of the subregion or economic sector, before we can produce detailed sectoral plans for adaptation.

Notes

Note 1. Scenario A1 assumes rapid population and economic growth in conjunction with the introduction of new, more efficient technologies; scenario A1F1 is based on the intensive use of fossil fuels; in scenario A1T, non-fossil forms of energy predominate; in scenario A1B, there is a balanced use of all energy sources; and in scenario A2, there is slower economic growth, less globalization and a steadily high rate of population growth. Scenarios B1 and B2 assume some degree of emissions mitigation through more efficient energy use and more suitable technologies (B1) and better-positioned solutions (B2).

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