Economic assessment of the impacts of climate change in Uganda: **Key results**

November 2015

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About this paper

This paper is based on a study commissioned by the Climate and Development Knowledge Network (CDKN) at the request of the Government of Uganda. It was funded jointly by CDKN and the UK Department for International Development (DFID), Uganda office. The work was coordinated locally and owned by the Climate Change Department (CCD) of the Ministry of Water and Environment. The study team was led by Le Groupe-conseil Baastel sprl (Baastel) and included a team of experts from Makerere University (Uganda), Metroeconomica (UK) and the University of Wolverhampton Centre for International Development and Training (CIDT) (UK). The study was highly participatory, and benefitted from valuable contributions from many people and organisations inside and outside of Government, from Uganda but also from Rwanda, Kenya and Tanzania. The Baastel consortium's full report 'Economic Assessment of the Impacts of Climate Change in Uganda' is available in full on www.cdkn.org. Its main authors were Anil Markandya (Metroeconomica), Courtenay Cabot-Venton (Baastel) and Olivier Beucher (Baastel).

Introduction

Uganda will need to manage the impacts of climate change carefully. Within the next 50 years, scientists expect average temperatures in Uganda to rise by around 2°C. Climate change is likely to cause an increase in extreme weather events such as floods, heat and droughts. While rainfall is expected to decrease slightly across the country, most significantly over Lake Victoria, the west and northwest – mainly highlands – are likely to become slightly wetter. In addition, rainfall is expected to be more erratic, unpredictable and intense, with shorter rainy seasons.

Uganda is already experiencing the impacts of climate variability and associated economic losses. For example, a drought in 2008 caused losses of approximately 3% of the value of all food and cash crops that year.[1] Two years later, the country suffered economic losses of US$470 m in food crops, cash crops and livestock as a result of the 2010/11 drought.[2] This equates to about 16% of the total annual value of these crops in 2011.

Uganda's First National Development Plan (2010–2015) recognises that climate change will affect most of its key economic sectors and that action on climate change is crucial if the country is to meet its goal to become a competitive, upper middle-income country by 2040 (Vision 2040). The Plan also recognises that, for development to be economically and socially sustainable, climate resilience must be at the heart of policies for growth and development, energy access and security, increased agricultural production, education and health. The National Climate Change Policy (NCCP) was completed at the end of 2013 (approved by Cabinet in April 2015). Priorities in the policy have been mainstreamed into the Second National Development Plan (2015–2020).

Against this backdrop, the Government of Uganda commissioned the Economic Assessment of the Impacts of Climate Change study. Its purpose is to provide the Government with economic evidence on the current and future costs associated with climate variability and predicted climate change, and the necessary adaptation measures for different sectors at both national and local scales. This evidence is intended to help policy-makers mainstream climate change and resilience into national and sectoral policies and develop the case for investing in adaptation. The study team engaged with around 200 stakeholders from the Government of Uganda and around 300 people from districts and civil society through face-to-face meetings, workshops, interviews and field missions.

Evidence from the study has already informed Uganda's Intended Nationally Determined Contribution (INDC) to the 21st Conference of Parties (COP 21) to the United Nations Framework Convention on Climate Change (UNFCCC) in Paris, France, in late 2015. The INDC outlines Uganda's commitment to climate adaptation and the mitigation of greenhouse gases as part of a new, universal global climate agreement that will be decided at the summit.

The 18-month study analysed the impact of climate change on four sectors at the national level:

- water
- infrastructure (transport and human settlements)
- agriculture, including livestock
- energy.

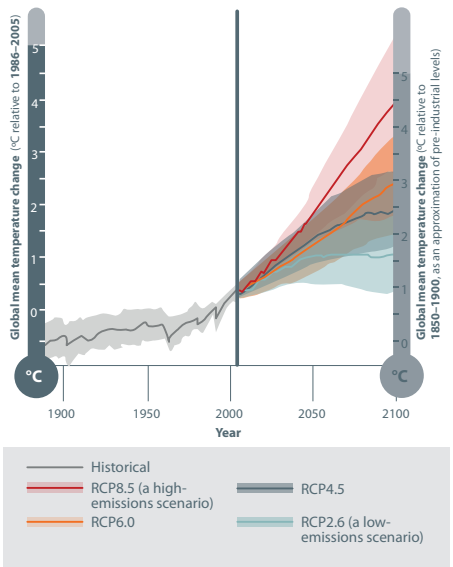
The study also examined the economic case for investing in climate adaptation for five local case studies across different regions of Uganda:

- Kampala urban area: infrastructure
- Bududa district in the region of Mount Elgon: coffee production
- three villages across different agro-ecological zones of the Karamoja region: agriculture
- the Mpanga river catchment: water and hydropower
- Kabale and Tororo districts: malaria prevalence.

The study assessed the impacts of climate change under two scenarios, both derived from the work of the Intergovernmental Panel on Climate Change (IPCC). The first scenario represents medium-to-low concentrations of greenhouse gas emissions and associated levels of warming (known as the Representative Concentration Pathway or RCP 4.5, see Figure 1). While this is not the lowest scenario produced by the IPCC, this is a more ambitious trajectory than suggested by the collective pledges submitted by governments to the UNFCCC in 2015. The second scenario assessed by the study looks at a high emissions scenario (known as RCP 8.5, see Figure 1). For more about the science of climate change impacts on natural and human systems across Africa under these different scenarios, please see CDKN's guide *The IPCC's Fifth Assessment Report: What's in it for Africa?*[3]

Although studies of this nature have limitations due to the availability of data and the modelling approaches used, the study makes a significant contribution to the economic evidence available in support of climate change adaptation. It reinforces the need for urgent action on many measures that are already listed in Uganda's National Climate Change Costed Implementation Strategy.

Figure 1. Four scenarios for global greenhouse gas emissions from CDKN's guide



Source: CDKN (2014)[3]

The graph maps Representative Concentration Pathways or RCPs of greenhouse gases in the atmosphere against projected global temperature change.

Key messages

1. **Development prospects will only be reached if the impacts of climate change on Uganda are mitigated.**

2. **The impacts of climate change are expected to be felt across all the sectors and local areas studied**, to varying degrees.

3. **The cost of adaptation is high:** estimated at around US$406 m over the next five years (2015–2020). On an annual basis, this amounts to about 5% of net official development assistance received and 3.2% of total government revenues (excluding grants).

4. **The cost of inaction is 20 times greater than the cost of adaptation:** inaction is estimated at between US$3.1 bn and 5.9 bn per year by 2025, which is more than 20 times the proposed adaptation budget.

5. **The economic case for adaptation is clear:** many of the adaptation measures proposed in the study are 'no regrets' investments, in that they are valid even in the absence of climate change.

6. **Considering the co-benefits** strengthens the case for adaptation further, for example improved livelihoods, health and access to energy; these represent strong investments in the development of Uganda's future.

The results of the study will support the development of a Climate Change Law for Uganda in 2016, the integration of climate change into sectoral policy and development plans, and the implementation of the Second National Development Plan (2015–2020). The results will also support the integration of climate change into Local and District Development Plans. All these actions will be essential to the delivery of Uganda's international climate change commitments and to achieving Vision 2040.

Water

Uganda's growing population and its rising need for food, water and energy are likely to increase water demand almost ten-fold by 2050. At the same time, an increasing incidence of drought will reduce water availability. As a result, Uganda is likely to face severe water shortages during most months of the year. There are many benefits associated with taking action through additional investments in climate adaptation in the water sector.

Climate change is already affecting water availability in Uganda and the trend towards increasing water scarcity is expected to continue. This will affect households, agriculture, fisheries, forestry and tourism as well as the production of energy, water transport, sanitation and health.

Between 2010 and 2050, the demand for water is expected to increase almost ten-fold, from 408 million cubic metres per year to 3,963 million cubic metres per year.[4] Under current investment plans, the demand will not be met, and the economic loss reflected by the unmet demand is calculated by the study to be US$5.5 bn per year. This is a conservative estimate and the losses could be even greater, depending on people's willingness to pay.

The study also examined the economic effects of drought on the water sector. Each drought lasts for around three years, and the damage per drought cost around US$237 m per year during the past decade. About three-quarters of the costs arise from a shortage of water for irrigation. The next largest costs relate to water use by livestock, followed by domestic consumption and industry requirements.

The largest overall economic losses are anticipated to be in the Lake Victoria, Albert Nile and Lake Kyoga watersheds. These values underline the need for further investment in water supply infrastructure in Uganda; with or without climate change the economic losses are of a significant magnitude.

Droughts are set to become more frequent in the decades ahead, meaning that adaptation action to safeguard Uganda's water supplies should be a top priority. Adaptation measures include:

- improving the efficiency of water use, to reduce demand
- improving water storage, to increase supply
- reducing water losses during extreme weather events.

Adaptation priorities

The study concludes that significant benefits will accrue from taking action on adaptation in the water sector. There is a strong economic rationale for pursuing the water programmes laid out in Uganda's National Climate Change Costed Implementation Strategy.

The study found that three main programmes in the Government's Costed Implementation Strategy[5] would reduce the unmet demand for water and/or reduce economic losses from drought, and generate at least a 10% rate of return while doing so:

- Programme A, which focuses on improvements in water use efficiency
- Programme B, which addresses water supply issues for agriculture and industry
- Programme C, which sets up an integrated water resources management system that would help reduce losses from droughts and floods.

Together, these account for 92% of the implementation strategy. Investing in these programmes makes economic sense.

Agriculture

Climate change will have a major impact on the production of Uganda's leading export crops. By 2050, the value of the coffee crop could fall by half due to contraction of the area that can support its production. By contrast, climate change impacts on food crops and livestock are projected to be relatively small – although the specific impacts will vary from crop to crop.

The costed activities already suggested for Uganda's agriculture sector represent sound investments that will help to deal with current climate variability. New measures to deal with future climate change should be tested right away.

Agricultural exports are a key area of concern. Significant impacts on the Arabica coffee-growing area are predicted due to climate change. Production of Arabica and Robusta coffee may fall by 50% by 2050; an illustrative estimate of the cost of these losses is around US$1,235 m. Estimates of impacts on tea-growing areas indicate significant loss of value, while some potential loss of cotton production is also projected. Together these results indicate that, if no action is taken on climate adaptation, Uganda's agricultural exports and their value may be strongly affected by climate change in the period to 2050. The total costs are in the range of US$134–196 m by 2025 and US$641–938 m by 2050.

Economic losses for food crops predicted by 2050 are somewhat less and are not likely to be more than US$1.5 bn. Using Government projections for assumed economic growth, this would be less than 0.2% of GDP in that year; however, different crops are affected in different ways.

Estimated impacts on livestock production are quite small in all cases (1 or 2%). However, this modelling is only for yield and area, whereas the key impacts on livestock may come from other climate change factors, in particular droughts, floods and diseases.

Looking at extreme events, droughts and floods appear to affect crop yields to a greater extent than does slow-onset climate change. Reducing the risks associated with extreme events needs urgent action, making it a priority in terms of adaptation. It should also be stressed that the increased risk of flooding and droughts both now and in the future will occur in areas of poverty and therefore these events have serious consequences for local economies and food security. The Karamoja case study (see page 13) demonstrates this quite clearly.

Adaptation priorities

The highest priority is to address immediate threats to the agriculture sector caused by droughts and floods.

The Government of Uganda, in its National Climate Change Costed Implementation Strategy, has identified eight areas of adaptation action in the agriculture sector, with a proposed budget over the next 15 years of around US$297 m. These strategic measures will deal with current climate variability and can be justified in economic terms on these grounds. They are 'no regrets' investments that will provide benefits today, irrespective of future climate change.

Evidence about effective adaptation measures from other studies and other countries does not guarantee that implementing the measures in Uganda will be cost-effective and successful. The implementation strategy will need to be evaluated at national level, with costs and benefits being assessed at the local level.

A further challenge is to start piloting and testing adaptation actions that will make Uganda's agriculture sector resilient to future changes in climate. It will take time to develop cost-effective programmes that are suitably tailored to specific regions and crops.

Energy

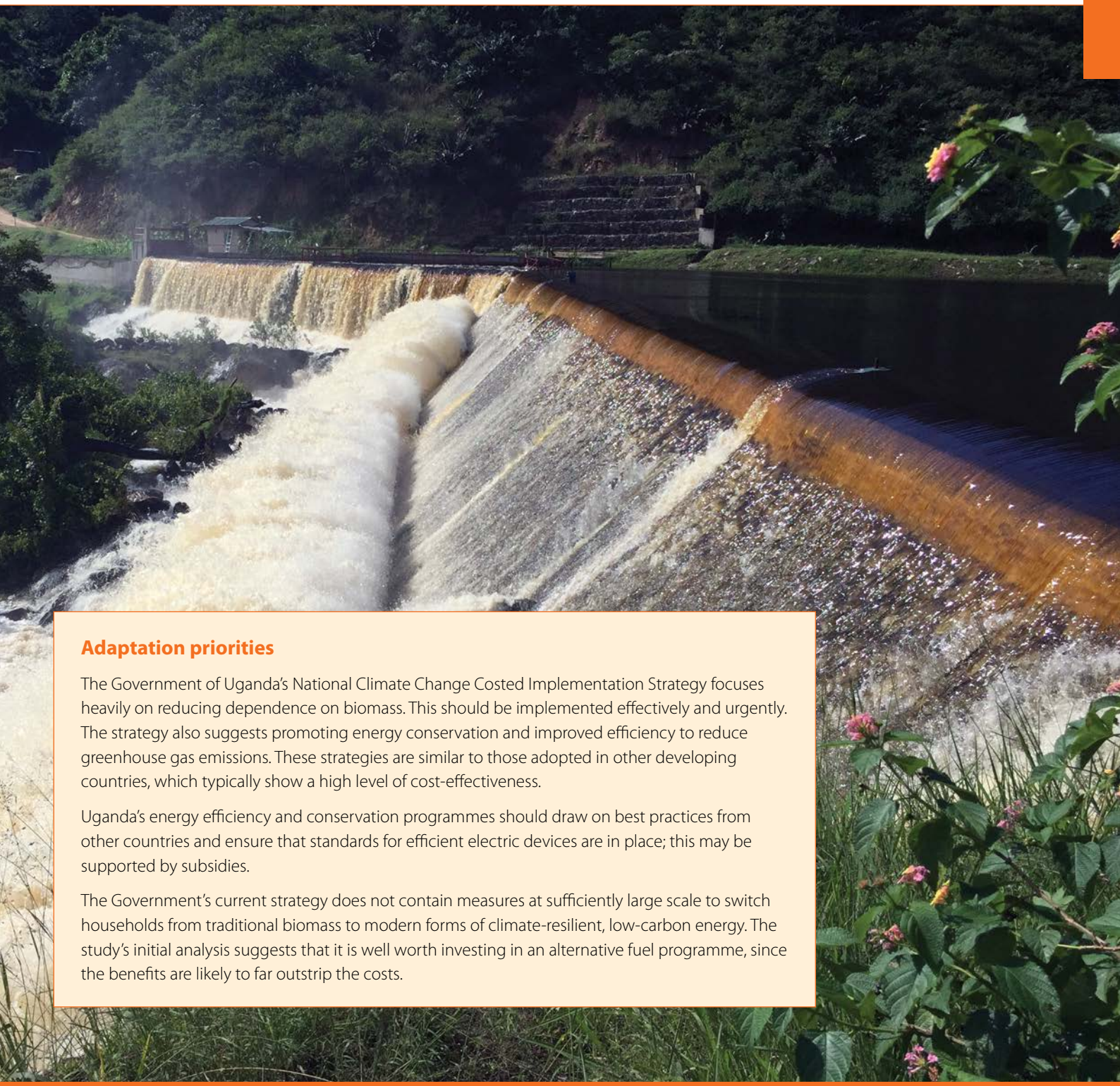
Uganda relies largely on biomass energy and, by 2050, this is likely to be in short supply. There will also probably be less potential for hydropower development due to a reduction in rainfall and water availability. The country will need to develop alternative energy sources to meet future demand and there is a major opportunity to develop low-carbon and climate-resilient energy.

Energy in Uganda is supplied largely by traditional biomass, with electricity and other fuels playing a very small role. The current balance between supply and demand for biomass, however, is very fragile and the study predicts a large deficit in biomass in the 2020s and beyond. Not only will demand for fuel increase, but climate change itself will almost certainly reduce the availability of biomass – even though it is hard to quantify by how much. Business as usual is not an option, and the country will need to seek alternative energy sources.

In the case of energy, the main costs arise from unmet biomass demand, which is expected to grow significantly even without climate change (with no climate change, the deficit of biomass is estimated at 1,710 million tonnes over the period 2010–2050). Climate change will add a plausible loss of 5 to 10% of domestic wood between 2020 and 2050, which would increase the costs of inaction from US$123.6 bn to between US$130 bn and 136 bn.

In addition, there is a possibility that hydropower potential will decrease due to a reduction in rainfall. The decline is estimated to be around 26% by 2050. The Government has a current programme of hydropower expansion, which may keep supply ahead of demand under such a scenario, although it is a very ambitious and resource-intensive programme associated with a high risk of complications and delays.

The estimated additional capital investment in hydro, nuclear and other electricity generation from now to 2050 is around US$83 bn. To meet these ambitions, the country will need to invest around US$1 bn in power, or around US$200 m per year, equal to about 1% of its GDP, in the first five years. In future years, the amounts increase very sharply.



Adaptation priorities

The Government of Uganda's National Climate Change Costed Implementation Strategy focuses heavily on reducing dependence on biomass. This should be implemented effectively and urgently. The strategy also suggests promoting energy conservation and improved efficiency to reduce greenhouse gas emissions. These strategies are similar to those adopted in other developing countries, which typically show a high level of cost-effectiveness.

Uganda's energy efficiency and conservation programmes should draw on best practices from other countries and ensure that standards for efficient electric devices are in place; this may be supported by subsidies.

The Government's current strategy does not contain measures at sufficiently large scale to switch households from traditional biomass to modern forms of climate-resilient, low-carbon energy. The study's initial analysis suggests that it is well worth investing in an alternative fuel programme, since the benefits are likely to far outstrip the costs.

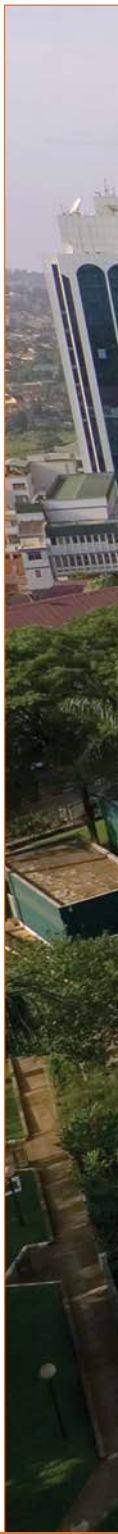
Infrastructure

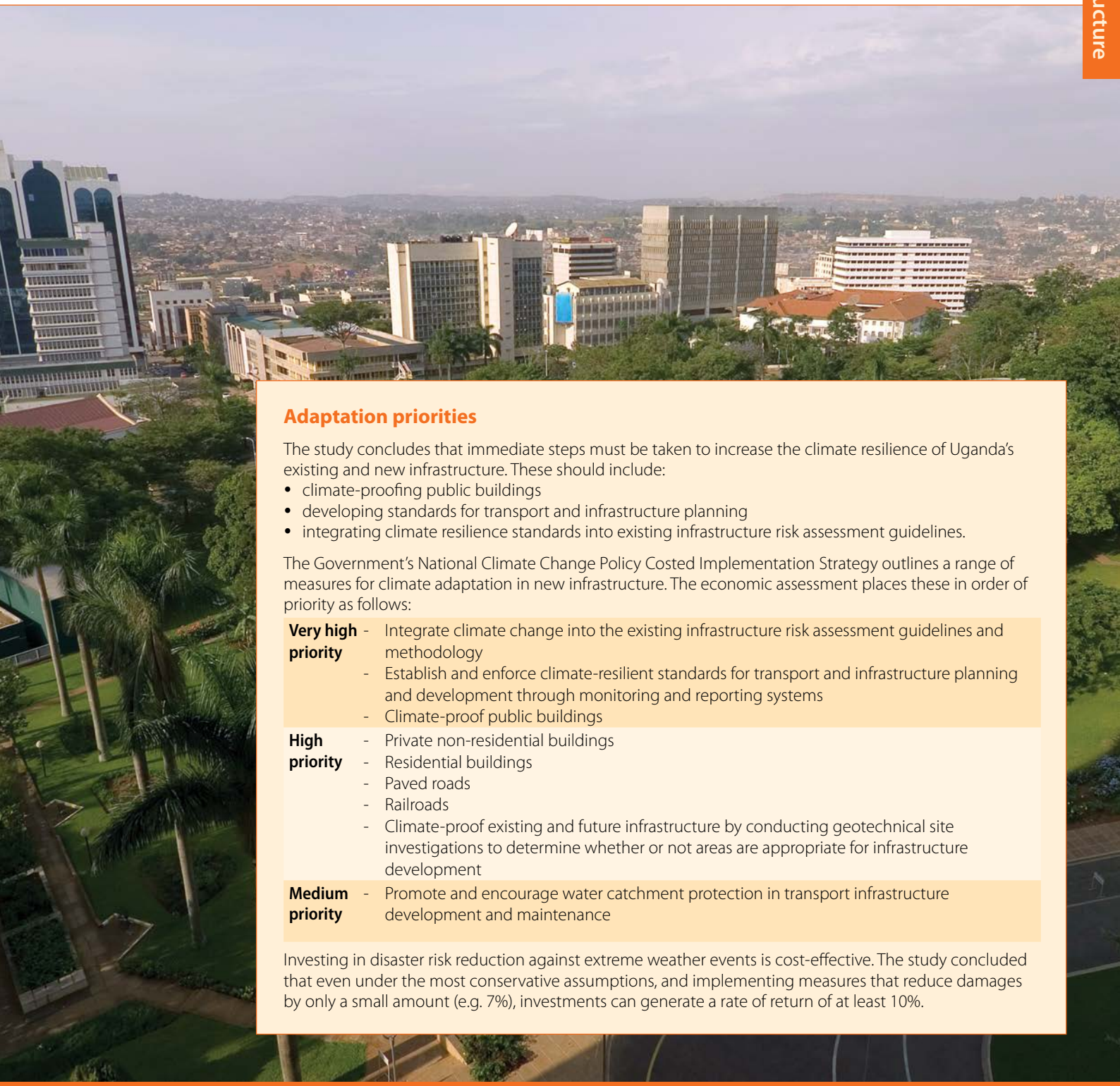
Uganda's infrastructure needs to become more resilient to the effects of the weather and climate, both current and future. Residential buildings are most at risk, but transport systems are also likely to be affected. The costs of measures to mitigate and adapt to climate risks in the infrastructure sector are small compared to those required to repair damage, therefore investing in adaptation has a strong economic rationale and climate-proofing public buildings and developing standards for transport and infrastructure planning should be an urgent priority for the Government.

Uganda's infrastructure is already suffering from the effects of extreme weather events; this includes residential and other private buildings; public buildings such as schools, hospitals and government offices; and facilities such as ports, airports, roads, railways and bridges. Since climate variability is likely to increase in the future, this is an urgent issue that should be addressed now. There are two impacts from climate change on infrastructure: one is through lost resilience to increased temperature and rainfall; and the other is through damage caused by extreme events.

On the first, the study found that major costs arise from loss of resilience in residential buildings, followed by public buildings and non-residential buildings. Together these account for 96% of the costs of lost resilience. Estimated costs could reach US$60–76 m in 2025, rising to US$347–621 m in 2050.

Damages caused by extreme events include loss of life and injury, damage to property, costs related to dislocation and inconvenience, and disaster relief. The study found that a doubling in the frequency of extreme events every 25 years under climate change would result in damages of between US$68–429 m by 2025 and up to US$938–3,236 m by 2050. This is equivalent to 0.1–0.4% of GDP in 2050. These are figures for average expected damages. An extreme event similar to the El Niño floods in 2007 would cost significantly more.





Adaptation priorities

The study concludes that immediate steps must be taken to increase the climate resilience of Uganda's existing and new infrastructure. These should include:

- climate-proofing public buildings
- developing standards for transport and infrastructure planning
- integrating climate resilience standards into existing infrastructure risk assessment guidelines.

The Government's National Climate Change Policy Costed Implementation Strategy outlines a range of measures for climate adaptation in new infrastructure. The economic assessment places these in order of priority as follows:

Very high priority	- Integrate climate change into the existing infrastructure risk assessment guidelines and methodology - Establish and enforce climate-resilient standards for transport and infrastructure planning and development through monitoring and reporting systems - Climate-proof public buildings
High priority	- Private non-residential buildings - Residential buildings - Paved roads - Railroads - Climate-proof existing and future infrastructure by conducting geotechnical site investigations to determine whether or not areas are appropriate for infrastructure development
Medium priority	- Promote and encourage water catchment protection in transport infrastructure development and maintenance

Investing in disaster risk reduction against extreme weather events is cost-effective. The study concluded that even under the most conservative assumptions, and implementing measures that reduce damages by only a small amount (e.g. 7%), investments can generate a rate of return of at least 10%.

Evidence from the case studies

Action that is good for climate adaptation and resilience in the future is also good for development today.

These case studies from across Uganda highlight some of the sectoral themes developed at national level in the economic assessment. In most cases, further analysis is needed to reach robust conclusions on the economic justification for adaptation actions in these demonstration areas. However, the case studies show that many 'no regrets' measures are available and how these may help Uganda to adapt to climate change and advance its development.

Karamoja and Mount Elgon regions: agriculture

The Karamoja region is highly dependent on agriculture and this makes its residents particularly vulnerable to climate impacts. Recent droughts have wiped out 50–100% of crop yields for affected households, while some villages have also experienced serious flooding. The exact future impacts of climate change are uncertain, but extreme events could result in losses to the agriculture sector of between 9 and 32% by 2050.

The Karamoja study scrutinised agricultural practices and climate vulnerabilities in three different agro-ecological zones: Abim district (arable zone: mixed crop farming); Napak district (arable and pastoral zone: sorghum and livestock) and Amudat district (pastoral zone). The study team estimated the total impact of recent droughts on the value of crop yields and livestock sales. They found that livestock production and incomes can be hit badly by drought when water supplies dry up, and when there is an increased incidence of disease. However, the overall impacts are generally less wide-ranging compared with crop production.

The study found some evidence for the importance of holding livestock to provide greater resilience to extreme weather events. Modellers at the International Food Policy Research Institute (IFPRI) found that, by 2050, the value of current crops in the Karamoja region could be significantly affected by climate change. For example, maize could suffer up to 12% reduction in yield and beans up to 20%. This highlights the risks to investment in agriculture in the light of plans to expand crop production in the region. Large losses in recently introduced crops in Lopedot indicate the high risks attached to such plans. There should be more research at district level to assess the risks to investment in crops from climate impacts and the level of support needed to boost resilience in both the arable and livestock sectors in affected villages.

The Mount Elgon region is heavily dependent on coffee production and is one of the most vulnerable in Uganda to climate variability. Yields and quality of coffee crops have been declining over the last 30 years, partly due to poor management practices and partly because of an increase in the frequency of droughts, landslides and floods. Climate change is expected to result in higher temperatures, changes in rainfall, more extreme weather events and lower coffee yields. An analysis compared the costs and benefits of 'business as usual' and 'climate-smart agriculture' scenarios under current conditions and under changing climate conditions. The analysis demonstrates that there is an economic case for investing in climate-smart agriculture – defined as tree-planting, mulching and trench conservation – and an accompanying programme of institutional support, even in the absence of expected climate change. These are preliminary findings that should be interrogated through further research.

Mpanga river basin: water and hydropower

The Mpanga river basin is a good example showing how the effects of climate change could lead to greater tensions over the access to scarce water for different uses. Climate models show that rainfall may decrease and temperature may rise significantly by the middle of the century. This could lead to conflict in the river basin over the use of water for hydroelectricity generation or water supply to homes and businesses.

The study tried to put an economic value on the impact of climate change on energy and water supply. It found that the most significant impacts on water supply are likely to fall in the Rushango area of the river catchment due to water demand in the area and the expected impacts of climate change. Annual losses to the water sector in Rushango could amount to between US$45,000 and 79,000 by 2035 or could be twice this, based on the population's willingness to pay.

However, this is dwarfed by the foreseeable economic losses to the hydroelectricity sector in the river basin under a changing climate. Based on calculations of lost load from a study in Kenya, the Uganda economic assessment finds an annual cost to the energy supply sector of US$25–98 m by 2030–2035.

The costs of adaptation are uncertain and more research is needed to develop robust cost estimates. Further, additional data on river flows are needed throughout the catchment. Thus, the following recommendations are preliminary and subject to further assessment. The study team ranked the cost-effectiveness of adaptation actions in order as follows, beginning with the 'low hanging fruit':

- Promote and participate in water resource regulation among users to ensure the availability of water for hydropower production.
- Conduct further research to determine the potential impacts of climate change elements on the country's power supply chain and act on the findings.
- Diversify energy sources by promoting the use of alternative renewable energy (e.g. solar, biomass, mini-hydropower, geothermal and wind) that is less sensitive to climate change (and concurrently provides climate mitigation benefits, contributing to sustainable development).
- Promote and participate in water catchment protection as part of hydroelectric infrastructure development, including through such measures as soil conservation, agroforestry, etc.

Kampala: urban infrastructure

Uganda's capital city, Kampala, is home to the majority of the country's built infrastructure. Scientific projections of future climate in the city are imprecise, but suggest there will be a higher incidence of rainfall, putting Kampala at risk of flooding. The cost of inaction is high, with estimates for the cost of flooding alone suggesting annual damages rising from US$1–7 m in 2013 to US$33–102 m by 2050. Adaptation measures would mitigate some of these costs considerably.

Policies, plans and regulations must be designed to mainstream climate change adaptation. Specifically, plans developed under Kampala's Physical Development Plan (2012) must be revised in light of the climate projections provided in this study in order to increase Kampala's resilience. Building codes should be revised urgently in light of climate projections, promoting bio-climatic designs and the use of appropriate materials.

There is an opportunity to mainstream adaptation into Kampala's Low Carbon Development and Climate Resilient (LCDCR) strategy. It is critical that adaptation is considered fully, and that consideration of low carbon development does not leave behind the impacts of unavoidable climate change. The LCDCR strategy should also guide public investment and incentivise significant and appropriate private investment in adaptation.

Kampala should urgently climate-proof its infrastructure (in line with the overall findings regarding infrastructure resilience, see page 10). Land use plans and building codes, the enforcement systems and the investments for climate-proofing infrastructure need to take into account the particular characteristics of the city, especially the fact that about 60% of its inhabitants live in informal settlements. Furthermore, there are significant opportunities to strengthen the application and enforcement of such tools as environmental impact assessments, especially regarding the protection of wetlands.

Kabale and Tororo districts: malaria prevalence

Malaria is endemic in 95% of Uganda and poses significant economic and social costs. In both districts studied, the costs associated with malaria could more than double as a result of population increase and predicted changes in the climate, when these two factors are considered together. In Tororo, the economic cost of malaria may rise from a range of US$8.7–221 m annually at present to a range of US$20.1–560.5 m in 2050. In Kabale, the costs associated with increased malaria infections are expected to increase from between US$0.7–15.8 m annually in the current period to between US$1.55–41.7 m in 2050.

Any policy to respond to malaria in Uganda will face both climate and socioeconomic changes (and other changes not addressed in this report, including behaviour change). The strength of the policy effect depends on whether the climate impact on malaria is low or high. For Tororo, the climate change-associated costs range from US$0.66–65.9 m in 2050; for Kabale, the climate change-associated costs range from US$0.04–6.2 m in 2050. The numbers depend on the climate scenarios and values used. In many areas, investment in further preventative measures against malaria will be worth the investment on the basis of the future population-related impacts alone.

Adaptation options such as long-lasting insecticide nets, indoor residential spraying, clearing of breeding sites and proper treatment have been shown to have benefits that far outweigh the costs when they are properly targeted. Additional cost-effective adaptation actions include information dissemination, particularly to high-risk areas, revised planning regimes to help control malaria prevalence, and measures for early warning. The spatial differentiation in malaria risk suggests there is no 'one-size-fits-all' policy for malaria, and hence there is a need for comprehensive disease vulnerability assessments and action planning across districts.

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