Greening Uganda's Growth

1 Trade Policy and Climate

Nhial Kuch and Margreti Mukanoheri

Introduction

The global shift towards sustainable development is fundamentally transforming how nations grow, trade, and innovate, with low-carbon technologies becoming a cornerstone of this transition. Greenhouse gas (GHG) emissions, predominantly from the manufacturing sector, have been widely recognized as major contributors to climate change and rising global temperatures. Without concerted action, global temperatures are projected to exceed 2°C above pre-industrial levels by the end of the 21st century, posing severe environmental and economic risks (Masson-Delmotte et al., 2019).

Against this backdrop, a significant trend in global trade is the rise of carbon-focused border tariffs in developed economies, where carbon-intensive goods are subjected to higher levies. This movement gained traction in July 2021 when the European Commission introduced a Carbon Border Adjustment Mechanism (CBAM), which will put a carbon price on imports of select high-emission products, with full implementation by 2026. Concurrently, the European Union has enacted stringent deforestation regulations aimed at blocking imports linked to deforestation and forest degradation.

These combined measures signal a broader shift in trade policy that could soon be mirrored by other governments, meaning countries like Uganda must anticipate these regulatory landscapes. The good news is that both the private sector and government are already working to support this transition. Programs like the Clean Development Mechanism (CDM) and the National NDC Support Programme are key in aligning policy, financing, and technology to help Uganda meet its climate goals and achieve sustainable growth.

From a trade policy perspective, Uganda needs to carefully assess how these changes will impact its exports, especially given the country's reliance on agricultural and natural resource-based products. The deforestation regulations could affect key exports such as coffee and timber, while the CBAM may target emissions-intensive sectors. Designing an effective response requires Uganda to integrate both environmental sustainability and economic competitiveness into its export strategy.

Policy adjustments should focus on promoting sustainable production practices across key sectors. One way to achieve this is through investment in low-carbon technologies and practices in agriculture and manufacturing. For example, Uganda could incentivize sustainable land management practices that align with the EU's deforestation regulations, ensuring that agricultural exports remain compliant and retain market access. Concurrently, the government could facilitate capacity-building initiatives for exporters to reduce the carbon footprint of their production processes, potentially offering tax incentives for firms that adopt green technologies.

Furthermore, Uganda should explore avenues to diversify its export base by promoting industries with inherently lower carbon footprints, such as clean energy products or eco-certified agricultural goods. These sectors could become a competitive advantage in an era where carbon-efficient production is increasingly valued in global markets. For Uganda, investing in low-carbon technologies is not only an environmental necessity but an economic opportunity. These investments can help reduce deforestation, increase access to affordable energy, and promote rural development while opening doors to job creation and partnerships in the growing global green economy, valued at $13.5 trillion.[1] By embracing technologies like solar, wind, and sustainable waste management, Uganda can become a regional leader in climate-smart development.

Finally, a broader policy framework could include partnerships with international organizations and development partners to finance the green transformation of Uganda's key export industries. Aligning domestic trade policies with global environmental standards not only ensures continued market access but also strengthens Uganda's positioning as a sustainable trade partner, potentially opening up new markets and investment opportunities. This comprehensive approach would help Uganda navigate the dual pressures of carbon-focused tariffs and deforestation regulations while fostering long-term economic growth.

Challenges Facing Uganda's Exports

Carbon Border Adjustment Mechanism (CBAM):

[1] The Boston Consulting Group (BCG) has highlighted the substantial economic opportunities associated with decarbonization and green investments, particularly focusing on China's efforts as an example of broader global trends. According to their analysis, China alone may require $13.5 to $15 trillion in investments to achieve its carbon neutrality goals by 2050. These investments span renewable energy, energy efficiency, electric mobility, and other low-carbon technologies.

The CBAM seeks to impose carbon tariffs on goods imported into the EU from countries with less stringent carbon pricing systems. The challenge for Uganda lies in reducing carbon emissions across its export sectors to avoid these tariffs while maintaining competitiveness. The EU's CBAM is designed to primarily impact imports in carbon-intensive sectors, including iron and steel, cement, aluminium, fertilizers, electricity, and hydrogen. These sectors are targeted due to their significant carbon footprints. For example, iron and steel production and aluminium manufacturing are highly energy-intensive, while cement and fertilizer production emit large amounts of carbon dioxide through both energy use and chemical reactions. Electricity imports and hydrogen production are also under CBAM, especially if they rely on fossil fuels. Presently, Uganda does not export much of the CBAM products to the EU, so the impact of the carbon tariff is anticipated to be negligible.

EU Deforestation Regulation (EUDR):

The EUDR aims to eliminate imports linked to deforestation, directly impacting Uganda's exports like coffee, timber, cocoa, and palm oil. If Uganda cannot demonstrate that these products are sourced without contributing to illegal deforestation, they may be barred from entering the EU market. With the EU being one of Uganda's largest trading partners, this regulation presents a significant risk to its agricultural and forestry exports.

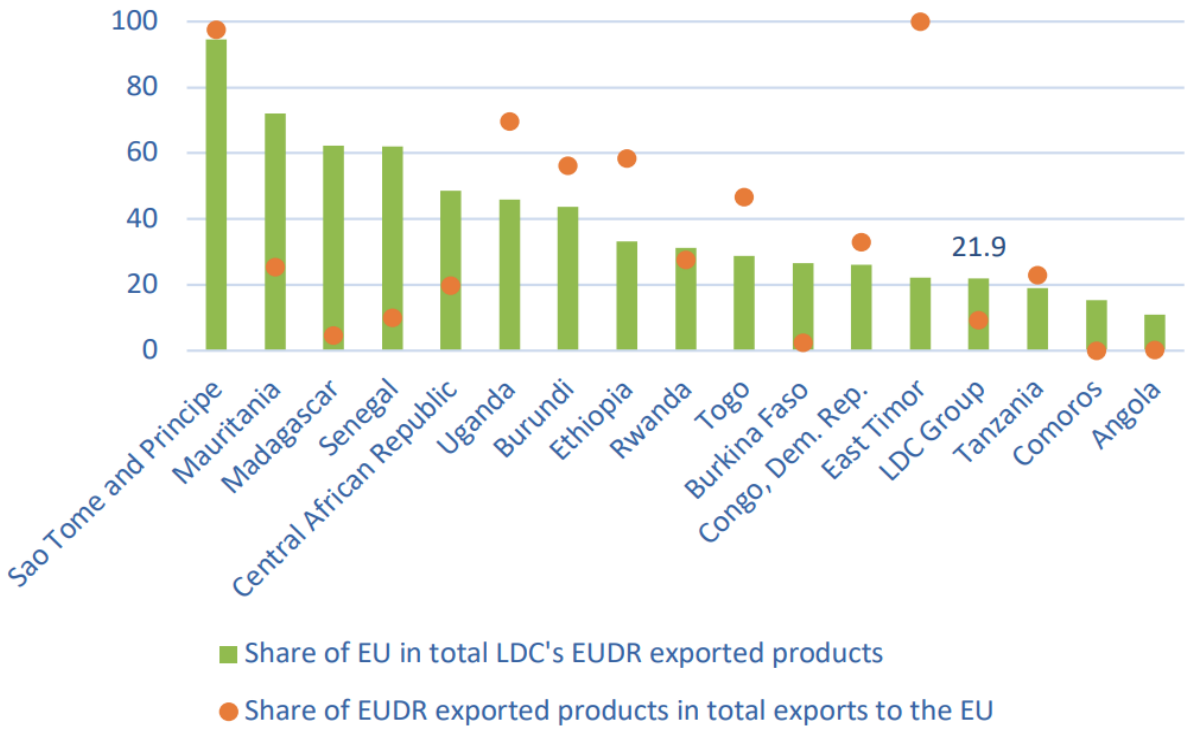


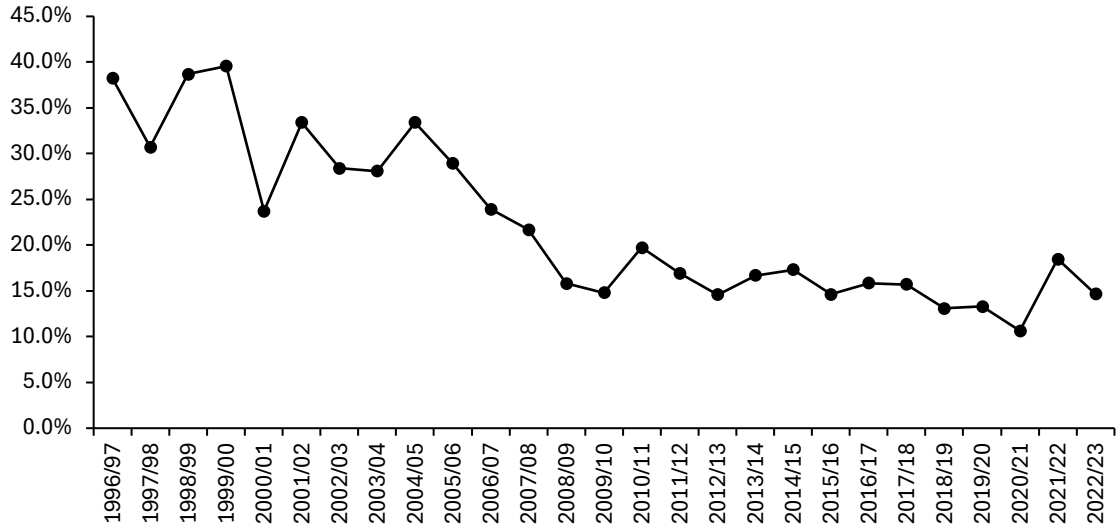
Figure 1: Absolute exposure of least developed countries to EUDR (%)
Source: Keane et al. (2024)

Keane et al. (2024) highlight that Uganda, along with other Sub-Saharan African nations like São Tomé and Príncipe, East Timor, and Ethiopia, faces significant exposure under the EUDR. As indicated in Figure 1 below, this vulnerability arises from the high proportion of exports covered by EUDR both to the EU market and as a share of their total global exports.

Ugandan exports to the EU

As shown in Figure 2 below, the EU has long been a major trading partner for Uganda, with the share of goods exported to the EU peaking at 39.6% in 1999/2000. However, this share has gradually declined over the past decade, reaching 14.7% in 2023, largely due to increased trade between Uganda, the rest of Africa, and the Middle East.

Figure 2: Share of Ugandan exports to the EU

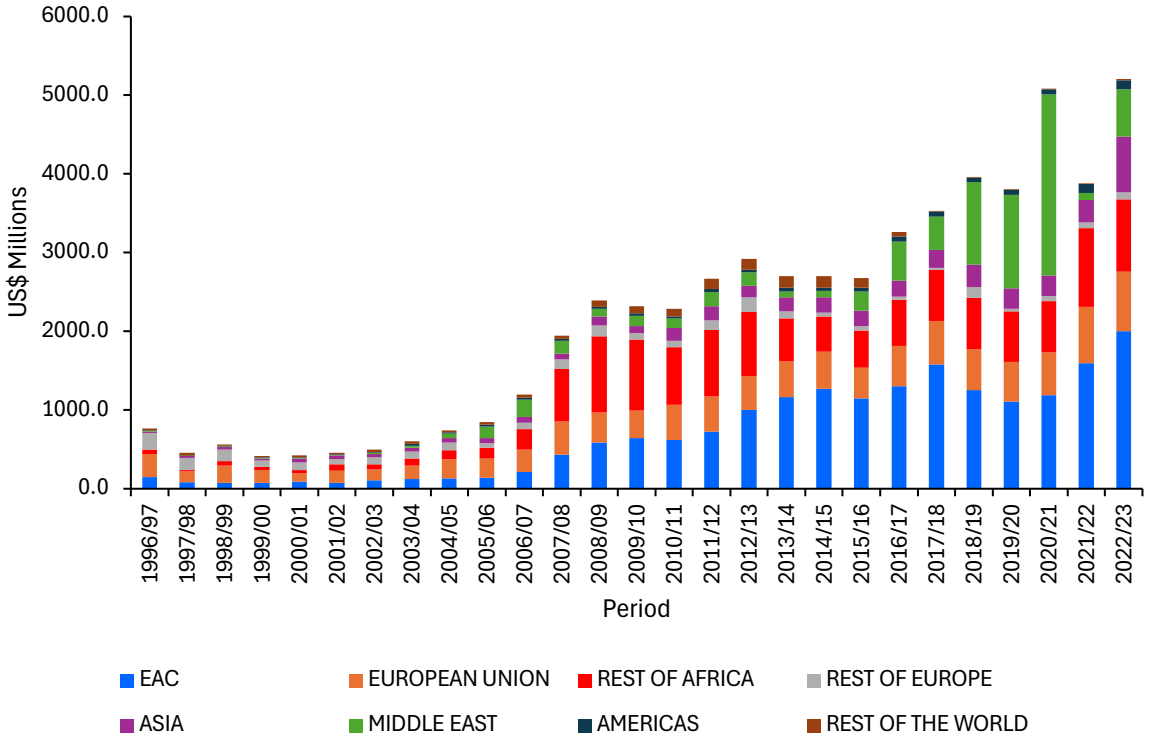


Source: Authors' analysis using composition of exports data from the Uganda Bureau of Statistics (UBOS)

Figure 3 shows that in 2023, Uganda's exports totalled $5.2 billion, with exports to the EU amounting to $762.7 million, accounting for about 14.7% of the total exports. To

assess the impact of EU's recent deforestation regulation, there is a need to further break down Uganda's exports to the EU based on SITC section codes.[2]

Figure 3: Ugandan exports by destination: 1996-2023



Source: Authors' analysis using direction of exports data from the Uganda Bureau of Statistics (UBOS)

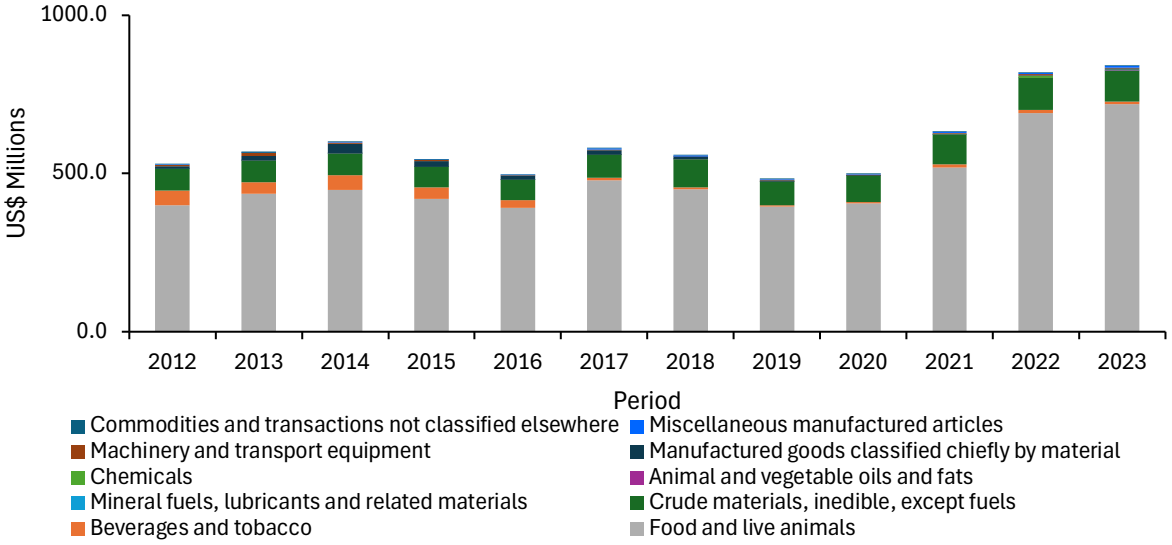
As shown in Figure 4 below, Uganda's exports of food and live animals to the European Union reached $719.2 million in 2023, with primary agricultural products like coffee, tea, mate, and spices comprising a significant portion. While this highlights Uganda's agricultural reliance and strong demand from the EU, these exports are at risk from the European Union Deforestation Regulation (EUDR), which

[2] The SITC code, or Standard International Trade Classification code, is a system established by the United Nations to categorize and classify goods in international trade. This classification helps governments and organizations organize trade data in a way that allows for accurate comparisons of trade statistics across countries and over time. The SITC structure divides products into sections, divisions, groups, and subgroups, beginning with broad categories and narrowing down to specific items. Sections are the broadest level, covering categories such as food, fuels, or machinery. Divisions break down these sections into smaller subcategories, like cereals or petroleum within food and fuel. Groups further divide these divisions, focusing on goods within each subcategory. Subgroups represent the most specific classification within a group, identifying individual goods.

may impose stricter requirements on goods linked to deforestation—potentially restricting Uganda's access to the EU market.

Uganda's second-largest export category to the EU consists of crude, inedible materials, including ores and minerals, which may also be impacted by the EUDR. Although Uganda prepares to export crude oil in 2025, the regulation is unlikely to affect these exports since China and the Middle East are expected to be the primary markets for Ugandan oil.

Figure 4: Ugandan exports to the EU by SITC section: 2012 - 2023



Source: Authors' analysis using EU's Eurostat international trade data

Trade policy implications for Uganda

Uganda's export portfolio is remarkably diverse, with key commodities contributing significantly to the nation's economy. Among these, coffee stands out as the leading agricultural export. According to the Uganda Coffee Development Authority (UCDA) Annual Coffee Export Report for 2023, Uganda is Africa's second-largest coffee exporter, generating $1,143.82 million in export earnings during the fiscal year 2023/24. However, coffee production has been linked to deforestation and land-use changes, making it particularly vulnerable to European Union deforestation regulations. Promoting sustainable coffee farming practices is essential to address these environmental challenges and maintain market access.

Tea is another important export, contributing over $70 million annually to Uganda's economy. While tea has a relatively low carbon footprint, the industry must prioritize sustainable farming practices to secure access to premium markets and enhance global competitiveness.

The fish and aquaculture sector also plays a critical role in Uganda's exports, generating around $180 million annually through the export of Nile perch and other fish products. However, the sector faces significant risks from overfishing and water pollution, threatening its long-term sustainability. Strengthening sustainable fisheries management practices is crucial to preserving aquatic ecosystems and maintaining the industry's viability.

In addition to agriculture and aquaculture, Uganda's horticulture sector is steadily expanding. According to the Uganda Flower Exporters Association's *Horticulture and Floriculture Industry Overview 2023*, the flower industry alone generates approximately $40 million annually, with the European Union serving as its primary market. Enhancing the sector's competitiveness by adopting eco-friendly farming practices can help Uganda maintain access to premium markets while addressing environmental challenges.

Gold and other minerals also contribute significantly to Uganda's export earnings, with gold exports valued at over $1.7 billion in 2023.[3] However, unsustainable mining practices have a substantial environmental impact, posing risks to market access and compliance with international standards. Aligning mining operations with global environmental benchmarks can help mitigate these challenges and attract responsible investments.

Timber is another key export for Uganda, but it is strongly associated with deforestation, which raises serious sustainability concerns. Shifting toward certified sustainable forestry practices is essential to balance the economic benefits of timber exports with the need to protect the environment and ensure long-term market viability.

Overall, while Uganda's export sectors demonstrate impressive diversity, they also face critical environmental and sustainability challenges. Addressing these issues through sustainable practices and compliance with global standards will not only

[3] Uganda Bureau of Statistics' 2023 *Gold Export Revenue Report*

secure Uganda's position in international markets but also contribute to preserving the nation's natural resources for future generations.

Strategic policy directions to mitigate the impact of EUDR

Promote sustainable agriculture and forestry practices

Agriculture, which contributes 24% of Uganda's GDP and employs over 70% of its population, faces significant environmental and economic risks due to unsustainable practices. Transitioning to sustainable agriculture offers a pathway to mitigating deforestation-related risks, boosting productivity, and complying with stringent EU environmental standards.

Key strategies include adopting eco-friendly farming practices such as agroforestry, which enhances biodiversity and sequesters carbon, and soil conservation techniques like terracing and crop rotation to improve soil fertility and reduce erosion. Promoting organic and fair-trade certifications can further enable Ugandan farmers to access premium international markets while enhancing global competitiveness.

Diversifying Uganda's export base is equally critical to reducing reliance on products vulnerable to EU deforestation regulations. By expanding into sectors less impacted by deforestation concerns and adopting environmentally friendly production practices, Uganda can strengthen its resilience to regulatory changes and continue to grow exports sustainably.

To support this transformation, the government should incentivize the adoption of sustainable practices through subsidies for organic certification, increased access to sustainable farming technologies, and investments in low-carbon agricultural solutions. Additionally, initiatives like reforestation and responsible timber harvesting can help Uganda align with EU deforestation standards, ensuring long-term access to global markets and sustainable economic growth.

Develop green energy exports

Uganda has abundant renewable energy resources, particularly in hydroelectric, solar, and biomass energy. By leveraging these resources, Uganda can diversify its exports into green energy solutions, which are in high demand globally. Exporting renewable energy and related technologies can significantly reduce reliance on traditional sectors like agriculture and mining, positioning Uganda as a leader in sustainable energy in the region. The government can, for example, facilitate public-

private partnerships (PPPs) to develop renewable energy infrastructure and offer tax incentives for firms investing in green energy. Uganda should also seek to export clean energy technologies to countries looking to meet their own sustainability goals. Uganda can tap into EAC energy markets by exporting energy to South Sudan, Rwanda, and DRC.

Sustainable aquaculture and green manufacturing

Uganda's fish exports, particularly Nile perch, face challenges from unsustainable fishing practices and pollution in Lake Victoria, which threaten both the environment and export markets. To address these risks and comply with stringent EU standards, Uganda must adopt eco-friendly aquaculture practices. Controlled fish farming, improved water quality monitoring, and stricter enforcement of sustainable fishing practices can help preserve aquatic biodiversity while ensuring the long-term viability of the fisheries sector.

Similarly, Uganda's manufacturing sector needs to transition to low-carbon technologies to meet global requirements, such as the Carbon Border Adjustment Mechanism (CBAM). Key strategies include shifting to renewable energy sources, like hydro and solar power, and retrofitting factories with energy-efficient equipment to reduce emissions. These measures will not only help Uganda align with international standards but also enhance the competitiveness and sustainability of its industrial sector.

Expand export markets beyond the EU

Papageorgiou and Spatafora (2012) demonstrate how export diversification can lead to economic resilience and reduced vulnerability to external shocks, which is particularly relevant for countries like Uganda that rely heavily on agricultural exports. Diversifying Uganda's export base is essential to meet EU standards while also exploring opportunities in non-EU markets, particularly in Asia, Africa, and the Middle East. These regions often have less regulatory scrutiny, allowing Uganda to reduce dependency on EU demand and maintain a diverse export portfolio. Strengthening bilateral trade agreements with countries in these regions that align with Uganda's agricultural and manufacturing strengths, along with establishing new trade routes, can help facilitate market access through diplomatic and commercial channels.

To ensure long-term trade resilience, Uganda must shift from reliance on primary commodities to value-added products and emerging sectors. Expanding the

production of eco-certified goods, such as organic tea, flowers, and sustainably sourced fish, can capture premium prices in environmentally conscious markets, enhancing Uganda's competitiveness.

In addition, increasing domestic value addition is a crucial strategy for boosting export earnings. By processing raw materials locally, such as transforming coffee into roasted beans or manufacturing finished goods from sustainably harvested timber, Uganda can significantly increase the economic value of its exports.

Emerging sectors also present a growth opportunity for Uganda. The global demand for clean energy products like solar panels and biofuels positions Uganda to become a key player in renewable energy technologies. Furthermore, promoting sustainable tourism and ecotourism can diversify revenue sources while preserving Uganda's natural heritage and tapping into the growing global interest in eco-friendly travel.

Develop green certifications for exports

To facilitate entry into the EU market despite the challenges posed by the CBAM and EUDR, Uganda should develop and promote national green certifications. These certifications would assure international buyers that Ugandan products, such as coffee, cocoa, and timber, are sustainably sourced and have a minimal environmental impact. Action: Partner with international certification bodies to establish and promote green certification standards for Ugandan exports. This will allow Ugandan products to meet international sustainability benchmarks and enhance their attractiveness in global markets.

Financing the Green Transformation

Achieving a green export transformation in Uganda will require access to robust and innovative financing mechanisms. These mechanisms can support the transition to sustainable practices while enhancing the country's competitiveness in global markets. Several key strategies can play a pivotal role in securing the necessary resources for this transformation.

First, Uganda can leverage international development aid, such as funding available through the European Green Deal, which supports sustainable development initiatives. These resources can be directed toward projects that promote renewable energy, sustainable agriculture, and eco-friendly industrial practices. Collaborating

with international donors and aligning projects with global sustainability goals can maximize the benefits of such funding opportunities.

Another viable financing avenue is the promotion of carbon offset projects, such as reforestation, afforestation, and conservation initiatives. By participating in carbon credit markets, Uganda can generate additional revenue while contributing to global climate objectives. Such projects not only enhance environmental sustainability but also create jobs and support rural communities, making them a win-win solution for economic and ecological goals.

Attracting private sector investment, particularly foreign direct investment (FDI), in green technologies is also crucial for scaling up sustainable industries. Uganda can create an enabling environment for investors by offering policy incentives, such as tax breaks for green projects, and improving infrastructure to support the deployment of renewable energy, green manufacturing, and sustainable supply chains. A clear, investor-friendly regulatory framework will also boost confidence in Uganda as a destination for green investments.

Blended finance models, which combine public and private sector funding, offer a powerful way to enhance the impact of green investments. For example, Uganda could establish public-private partnerships to develop green industrial zones focused on low-carbon manufacturing and energy-efficient technologies. Public funds can be used to de-risk these investments, encouraging greater private sector participation, and amplifying the scale of green projects.

References

Chandaria, K., Duso, M., Frédeau, M., Nielsen, J., Pamlin, D., & Pieper, C. (2021). The Next Generation of Climate Innovation. *Boston Consulting Group, March*, *22*.

European Commission. *Eurostat: International Trade Database*. Accessed 6 Dec. 2024, https://ec.europa.eu/eurostat.

Keane, J., Agarwal, P., Mendez-Parra, M. and Debowicz, D. (2024). Avoiding a 'green squeeze': supporting Least Developed Countries navigate new greening trade measures. *ODI Working paper. London*

Masson-Delmotte, V., Zhai, P., Pörtner, H. O., Roberts, D., Skea, J., Shukla, P. R., ... & Waterfield, T. (2019). Global warming of 1.5 C. *An IPCC Special Report on the impacts of global warming*, 1, 93-174.

Papageorgiou, C., & Spatafora, N. (2012). Economic diversification in LICs: Stylized facts and macroeconomic implications. International Monetary Fund.

Uganda Bureau of Statistics. (2023). *Gold Export Revenue Report*

Uganda Coffee Development Authority. (2023). *Annual Coffee Export Report*

2 Green Finance in Uganda: Unlocking Sustainable Growth

Maria Orjuela Pava

Introduction

Green finance broadly refers to the strategic allocation of financial resources toward projects and initiatives that foster environmental sustainability and mitigate the adverse impacts of climate change. This includes funding for a range of activities, such as renewable energy initiatives, climate-resilient infrastructure, sustainable agriculture, and pollution reduction. According to the World Economic Forum (2020), the concept also extends to financial products and services that embed environmental, social, and governance (ESG) considerations into lending, investment strategies, and decision-making processes, promoting responsible financial practices and encouraging the adoption of low-carbon technologies. Thus, serving as a powerful catalyst for economic transformation.

In the last years, green finance has experienced exponential growth mostly driven by the urgent need to mitigate the effects of climate change and accelerate the transition to a more sustainable global economy. Key mechanisms which have underpinned this tendency include:

i. **Carbon markets** – By assigning a monetary value to carbon emissions and creating a system where emissions can be traded as credits, carbon markets are a pivotal mechanism to reduce greenhouse gas (GHG) emissions. These markets operate on the principle of cap-and-trade or carbon offsetting, enabling entities to either limit their emissions within an established cap – compliance markets– or purchase carbon credits to offset excess emissions – voluntary markets–. The structure encourages investment in cleaner technologies and promotes sustainable practices by making the cost of pollution tangible.

ii. **Sustainable investment funds –** These funds allocate capital to companies and projects that meet defined ESG standards. Hence, aiming to promote corporate responsibility, lower environmental risks, and support long-term financial and social growth. In 2020, global sustainable investment surpassed $35 trillion, making up more than a third of total assets under management (GSIR, 2020). This strategy helps reduce exposure to risks related to climate change, labor issues, and governance failures that could affect financial performance. They have also shown

resilience, frequently outperforming traditional funds during volatile market periods.

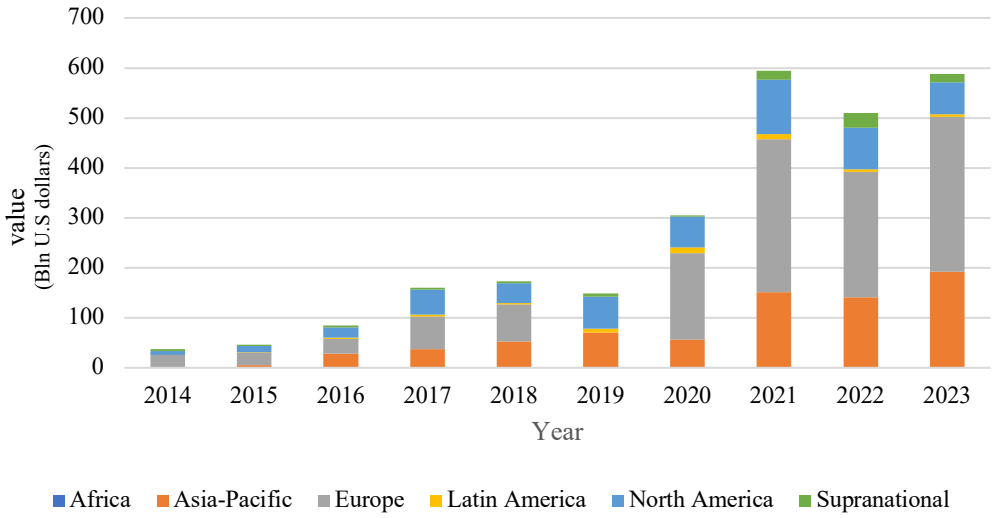
iii. **Debt-for-nature (DFN) swaps** – In essence, these are financial arrangements in which a portion of a country's foreign debt is forgiven or reduced in exchange for commitments to invest in environmental conservation projects. Through this mechanism, a creditor country or institution agrees to cancel part of the debtor nation's debt, and in exchange, the debtor country redirects the equivalent amount -often in local currency- towards decarbonizing the economy, investing in climate-resilient infrastructure, or protecting biodiverse forests or reefs. This approach not only provides financial relief but also strengthens a nation's capacity to address climate change and ecological challenges.

Globally, debt-for-nature swaps have proven instrumental in preserving some of the world's most biodiversity-rich regions, particularly in Latin America and Sub-Saharan Africa. Since the 1980s, over $1 billion in debt has been swapped for nature conservation, with countries like Costa Rica and Madagascar benefiting from significant environmental protection through these mechanisms (World Economic Forum, 2024).

iv. **Green bonds** – Green bonds are debt securities issued to raise funds for projects with positive environmental impact. Like traditional bonds, issuers -either governments or organizations- raise capital from investors, offering regular interest payments and repaying the principal at maturity. The key difference is that their proceeds are specifically used for sustainable projects. Therefore, channeling capital into initiatives that address environmental challenges while providing solid financial returns.

Over the past decade, these have emerged as a cornerstone of the green finance landscape. For instance, the global issuance of green bonds increased from $37 billion in 2014 to a peak of $633 billion in 2021 (Figure 1). Although a slight decline followed in 2022, when issuances dropped to $487 billion, the market quickly recovered, reaching $620 billion in 2023. This upward trajectory emphasizes the critical role that green bonds play in driving investments toward sustainability.

Figure 1 - Value of green bonds issued worldwide from 2014 to 2023
(in billion U.S. dollars)



Source: Author's elaboration using data from https://www.statista.com/statistics/1289406/green-bonds-issued-worldwide/.

As global investors seek to balance financial returns with environmental responsibility, green finance instruments, such as those previously discussed, are set to expand considerably. This evolution reflects a broader understanding that sustainable financial practices are not merely supplementary but are becoming a core component of building low-carbon, future-proof economies. Hence, positioning as core pillars of the global efforts to address climate change and promote eco-friendly development that withstands economic and environmental challenges.

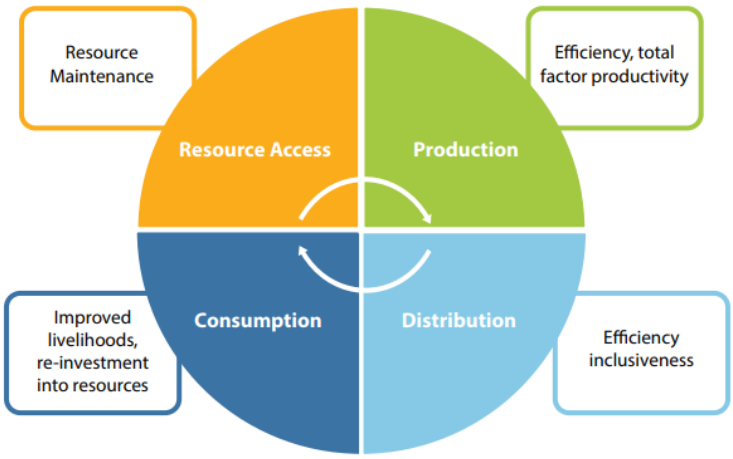
The latter is especially relevant for Africa, which is uniquely positioned at the crossroads of opportunity, growth, and profound climate vulnerability. Many African economies are heavily dependent on climate-sensitive sectors such as agriculture, energy, and minerals extraction. Yet, the continent's abundant natural resources present significant potential for transformative sustainable growth. Leveraging green finance can enable these countries to develop climate-resilient infrastructure, enhance renewable energy access, and promote sustainable land management practices, thus harmonizing economic growth with environmental conservation. Moreover, with the region experiencing some of the most severe impacts of climate change, including prolonged droughts and flooding, the urgency for innovative financial solutions that prioritize sustainability is more pressing than ever.

Green Finance in Uganda: Overview

Green finance in Uganda has been gaining traction as the country recognizes the importance of aligning economic development with environmental sustainability to facilitate a successful transition to a green economy. While the potential benefits of green growth are vast – offering far-reaching economic, social, and environmental benefits-, the financial commitment can be daunting. Acknowledging this, the country has taken notable steps to mobilize green finance as an integral part of its comprehensive development strategy, the *Uganda Vision 2040*. This proactive approach has aimed to bridge the financial gap and ensure that sustainable practices are embedded in the country's economic framework, paving the way for long-term prosperity and resilience.

As its transformative agenda anticipates, Uganda's green economy is set to drive sustainable economic growth through the eradication of poverty, social inclusion, improvements in human welfare and the creation of employment opportunities whilst preserving healthy, functioning natural ecosystems. This is further operationalized through the *Uganda Green Growth Development Strategy (UGGDS) 2017/18 – 2030/31*, a comprehensive roadmap designed to include green growth principles across key economic sectors – agriculture, energy, urban development, and natural resource management. As illustrated in *Figure 2*, the UGGDS emphasizes four interconnected components for shaping a green economy: **Resource Access, Production, Distribution, and Consumption**. For instance, resource access guarantees that natural assets are preserved and adequately utilized, production improves efficiency and productivity, while distribution and consumption encompass inclusivity and reinvestment, creating a cyclical model that encourages economic growth and environment conservation.

Figure 2 – Conceptual Framework for Green Growth Development Strategy (UGGDS)



Source: The Uganda Green Growth Development Strategy, National Planning Authority (NPA): https://faolex.fao.org/docs/pdf/uga184391.pdf

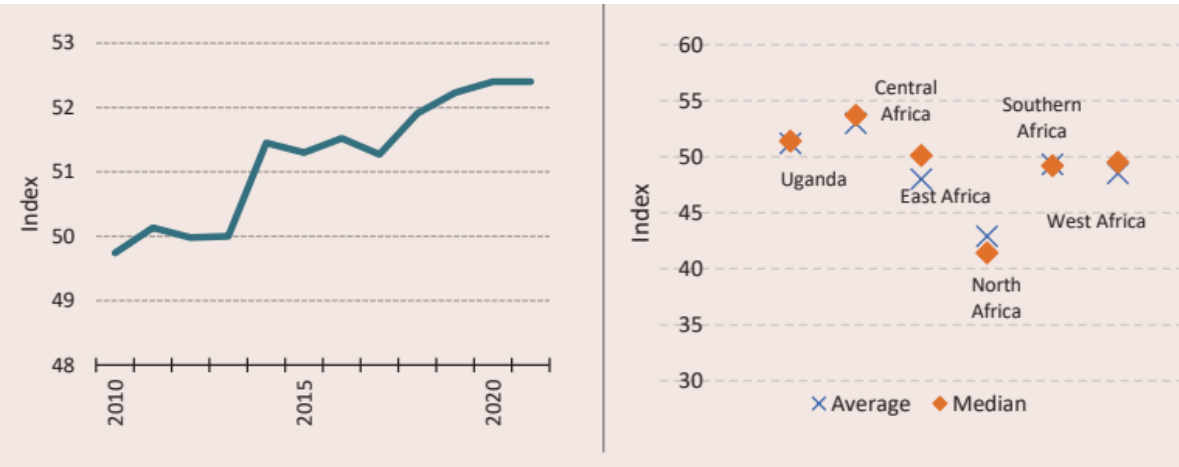
Equally, the UGGDS underscores the pivotal role of finance as a catalyst for this transformation, identifying a diverse array of instruments that currently support Uganda's green economy initiatives. Some of those include environmental taxes and levies; compliance charges; local government fees; biodiversity offsets; payment for ecosystems services (PES); international funds; revenue and benefit sharing and resource access; subsidies; and private sector contributions (AfDB, 2023). Despite limited leveraging due to their fragmented, project-based, donor-driven, and often ad hoc nature, the UGGDS attempts to harmonize and streamline these green mechanisms, promoting greater coherence and sustainable, long-term financial solutions. By aligning these efforts with global sustainability goals, Uganda can be better positioned to attract and manage the financial resources required to drive a transformative shift toward a resilient and inclusive economy.

Figures 3a and 3b provide a quantitative snapshot of the country's performance towards green growth. Figure 3a depicts the evolution of its Green Growth Index from 2010 to 2020. Over the past decade, the score has steadily increased, reflecting consistent improvements in environmental sustainability, efficient resource utilization, and policies oriented towards green objectives. Particularly, it has climbed from approximately 49 in 2010 to over 52 by 2020, showcasing the nation's strong commitment to integrating green finance and sustainable development principles into the national strategy.

In contrast, Figure 3b offers a broader comparative perspective by placing Uganda in a continental context. While the index score is close to the East African median, it outperforms several regions, including North, West, and Southern Africa. This positions it as a frontrunner and competitive force within Africa's sustainability landscape. A key factor behind this leadership lies in the country's significant strides in the energy sector, driving both environmental and economic benefits (GGGI, 2022). Moreover, its proactive efforts in natural capital protection and efficient and sustainable resource use have been complementary. This performance is further reinforced by initiatives to enhance green finance mechanisms, particularly through the development of **carbon markets** and the mobilization of **private sector finance** – .

Figure 3a – Green Growth Index, Uganda

Figure 3b – Green Growth Index, by region



Source: GGGI (2022).

Uganda's Carbon Market – Key Insights

Uganda is one of the most active participants in Africa's carbon market, with over 33 million carbon credits issued through i.) the Clean Development Mechanism (CDM) and ii.) Voluntary Carbon Market (VCM) standards.

CDM:

As of December 2022, the country's CDM portfolio included 189 registered projects designed to drive climate adaptation and mitigation efforts through the reduction of carbon emissions. These activities span three major areas:

- *Energy Efficiency (96):* Focusing on distributing improved cookstoves which could reduce biomass consumption and enhance indoor air quality.
- *Water Purification (58):* Centering on access to clean water through advanced purification methods. This eliminates the need to boil water over open fires, conserving resources.
- *Renewable Energy (6):* Building small hydroelectric power plants to generate clean electricity and reduce reliance on fossil fuels.

Collectively, these CDM activities have resulted in the reduction of over 16 million tons of carbon dioxide emissions (Certified Emission Reductions, or CERs). By 2025, the government aims to cut an additional 106 million tons of emissions through these.

VCM:

Uganda's engagement with the VCM is equally robust, hosting 92 registered activities across multiple standards:

- *Gold Standard (GS):* 78 activities, primarily in energy efficiency through cookstove and clean water technologies, have issued over 10.6 million credits.
- *Verra's Voluntary Carbon Standard (VCS):* 13 projects on agriculture and energy efficiency, which have registered approximately 3.6 million Verified Carbon Units (VCUs).
- *Plan Vivo:* The "Trees for Global Benefits" project, operational since 2003, has delivered over 2.4 million credits, emphasizing community-led reforestation efforts.

Source: Author's elaboration using 'Eastern Africa Alliance On Carbon Markets And Climate Finance (2023)' report.

The country is posed to actively pursue future opportunities in the global carbon markets by preparing for participation under Article 6[4] of the Paris Agreement. To this extent, it is developing the necessary frameworks and regulatory measures to transition existing CDM activities and scale up new initiatives. Therefore, attracting investment and bolstering climate resilience. It is worth mentioning that the the latest Nationally Determined Contribution (NDC) highlights the instrumental role of carbon markets in achieving Uganda's climate objective. With a mitigation target of 24.7% below the Business-As-Usual (BAU) emissions by 2030, the nation will require approximately USD 28.1 billion; most of it expected from climate finance tools, carbon market mechanisms, and investments from the private sector. This aligns closely with the broader role of the private sector in green financing. While its contribution has been growing, it remains relatively low compared to its potential (Carbon Market Report, 2022).

Private Sector Financing for Climate and Green Growth

The cost of climate inaction in Uganda is forecasted to increase dramatically, far outweighing the investment needed to adapt to current climate pressures. Estimates indicate that the annual cost of inaction, which by 2025 is projected in the range of $3.1-5.9 billion, could rise to $18-27 billion in 2050, driven primarily by unmet irrigation and biomass demand (MWE, 2015). Addressing this challenge will require Uganda to mobilize 'new and additional' financial resources over the next years, drawing on effort from all stakeholders, including international financial institutions, multilateral development banks, and most critically, the *private sector*.

Current Flows

According to the African Development Bank Report (2023), Uganda registered an average climate finance inflow of $785 million in 2019/20 – a significant improvement from the $146 million received between 2010-2011. These funds were mainly directed toward agriculture, forestry, and other land uses, cross-sectoral, and energy systems, collectively accounting for 73% of the total financing. However, the contribution from the private sector remained low, sourcing only 3.4% (nearly $26.5 million). This stands in contrast to regional counterparts like Djibouti (24.2%), Kenya (19.9%) and Rwanda (11.2%). Most of the country's climate finance

[4] Article 6 encourages international collaboration through carbon trading, enabling countries to meet their climate goals more efficiently.

instead comes from the public sector 26.9% and multilateral development finance institutions 61.0%, with the remaining from bilateral and other institutions.

To address this imbalance, and in line with the improvement of the GGI, the Government of Uganda is fostering innovative financial mechanisms to stimulate green investments and broaden the private sector participation. Initiatives such as the Yield Uganda Fund, managed by Pearl Capital, the Uganda Energy Credit Capitalization Company, and the Agricultural Credit Facility administered through the Bank of Uganda, are essential in this effort. These mechanisms are promoting access to funding and providing crucial support for small and medium enterprises (SMEs) - the backbone of Uganda's economy. SMEs are suited to led green innovation, create jobs, and generate wealth, making them instrumental players in achieving sustainable development. To unlock their potential, affordable and accessible financing remains essential, enabling SMEs to champion green growth while contributing to Uganda's socio-economic transformation.

Other instruments such as green and sustainable bonds, which have been deployed indirectly through multilateral development banks to support targeted projects like hydropower and rural electrification, further reinforce the scenario. Furthermore, private equity and venture capital, as well as blended finance mechanisms – including guarantees and credit lines – have shown promise in de-risking green investments across key economic sectors such as energy, agriculture, and transport. However, to scale up these effectively, Uganda must address underlying challenges and leverage opportunities. Simplifying regulations, introducing incentives, strengthening institutional capacities and improving governance will also be key to ensuring that green finance projects are viable and impactful.

Challenges for Strengthening Green Finance in Uganda

Despite holding immense potential to drive sustainable development and address the pressing challenges of climate change, the implementation and further strengthening of green finance in Uganda face significant hurdles that undermine its effectiveness and scalability. Addressing these barriers requires targeted policy interventions, innovative financial instruments, and stronger partnerships across public and private sectors. This section outlines some of the key barriers that are not only hindering the mobilization of adequate resources but also impacting on the inclusivity and accessibility of existing green finance mechanisms. Hence, making it difficult to realize the full potential of sustainable growth in the country.

High cost of capital and limited financial market development

Uganda's financial sector struggles to provide affordable capital for green investments, largely due to high credit risk and an underdeveloped market. With average lending rates at 21.3% over the past decade and inflation averaging 5.9%, the real cost of borrowing is prohibitively high, deterring businesses from pursuing green initiatives (AfDB, 2023). This, paired with the information asymmetry, which widens the gap between lenders and borrowers, and the sector's limited capacity and appetite to offer long-term financing, reduces the efficiency of financing mechanisms, complicating investments in capital-intensive green projects - such as renewable energy or sustainable agriculture. Tackling the latter requires deepening financial markets, introducing blended finance instruments, and building institutional capacity which attract and manage green-focused investments.

Limited local demand and weak regulatory frameworks for innovative green mechanisms – carbon markets

As highlighted before, Uganda has made remarkable progress in generating carbon credits. However, the domestic consumption of these remains negligible when compared to regional counterparts such as Kenya, where mandatory offset requirements for businesses have been integrated to boost local demand (The National Council for Law Reporting, 2024). This reliance on international buyers has exposed the market to global fluctuations and price volatility, creating an unstable foundation for long-term growth. Furthermore, the absence of regulation for carbon markets across the country, including weak project validation and monitoring systems, has undermined investors' confidence whilst raising concerns about the reliability of the carbon credits generated within it.

Regulatory uncertainty and governance gaps

Uganda's volatile tax policies and fiscal regime pose create an unpredictable investment environment. This is particularly problematic for green finance projects which tend to require long-term planning typically spanning 3-5 years. Instability deters potential investors, undermining the viability of blended finance mechanisms, and hampering public-private partnerships. Additionally, the high tax burden – which according to the AfDB (2023) report is estimated at 45-55% of the final product price - further discourages investment by rising operational costs.

Governance challenges, including limited institutional capacity, exacerbate these issues, leading to delays and inefficiencies in project implementation.

Low awareness and technical capacity shortfalls

There is significant lack of technical expertise, awareness, and comprehensive understanding of the benefits of green finance among key stakeholders in Uganda, including businesses, financial institutions, and policymakers. This knowledge gap leads to missed opportunities for investments in transformative projects such as renewable energy, sustainable agriculture, and energy efficiency. Furthermore, both public and private sectors often struggle with the technical capacity to design, implement, and manage complex green finance initiatives. For instance, a study by SEED (2022) highlighted that many Ugandan institutions lack the expertise to identify and access green finance mechanisms, develop bankable projects, effectively negotiate financing agreements, or evaluate project outcomes, which could support their growth and sustainability efforts. This technical deficit is particularly pronounced in rural areas, where much of Uganda's green project potential lies untapped. Overcoming the latter requires targeted interventions, capacity-building and training programs, as well as knowledge-sharing platforms that foster collaboration and thrive innovation in green finance.

Nevertheless, amidst these challenges lie numerous opportunities awaiting exploration. By identifying those and implementing strategic policy recommendations, Uganda can position itself to overcome existing barriers, attract investments, and accelerate the transition toward a green and resilient economy.

Opportunities and Policy Recommendations

For Uganda, green finance offers a transformative opportunity to propel sustainable development while addressing the urgent environmental challenges that threaten its primary economic sectors. With a heavy reliance on climate-sensitive industries such as agriculture and energy, mobilizing green finance is vital for enhancing resilience to climate-related shocks, ensuring food security, improving energy access, and safeguarding infrastructure against future climate risks. This shift in financial strategy presents new pathways for *inclusive* economic advancement and positions Uganda to align with global sustainability efforts. To harness these opportunities, the country must reinforce its regulatory frameworks, design attractive incentives for private sector participation, and nurture partnerships that draw in international investment. Such steps will not only strengthen Uganda's

stance in the green finance ecosystem but also bolster its role as a leader in regional and global sustainability efforts, promoting progress that extends beyond national borders.

Develop and align an in-detailed climate finance strategy

A comprehensive Climate Finance Strategy, which aligns with the existing Uganda's Green Growth Strategy (UGGS), could be developed to streamline the implementation and monitoring of green finance initiatives across the country. It should build on the conceptual framework of the UGGS, further incorporating detailed financial mechanisms, investment targets, and stakeholder roles to enhance resource mobilization for climate action. For instance, by emphasizing an integral approach that includes public, private, and international funding sources, it can help to address gaps in technical capacity and regulatory challenges.

Additionally, this strategy must focus not only on clear priorities for green investments, such as renewable energy, sustainable agriculture, and water resource management, but also on specific action plans to promote innovative financial instruments -like green bonds, blended financing, and carbon markets-. Hence, ensuring that these mechanisms are adapted to Uganda's unique economic and institutional context.

By aligning the new Climate Finance Strategy with UGGS, the country can create a unified vision for green growth that maximizes synergies between existing initiatives and new opportunities, fostering a cohesive and impactful approach to green development.

Enhance the uptake of innovative green finance mechanisms

Uganda must prioritize the adoption and scaling of green finance mechanisms to mobilize resources for developing a green economy. Some of these include debt instruments (green and SDG bonds), carbon finance, and debt-for-nature swaps; all of which have the potential to bridge the financial gap in climate-resilient investments and align with global sustainability goals.

While green bonds have been used indirectly through multilateral development banks (MDBs) to support a limited set of projects -such as the Baseruka Hydropower Project and Rural Electrification Access - there is substantial potential to expand their use across the country. By offering tax incentives and regulatory

support, their issuance can be encouraged, targeting a wider range of initiatives, from renewable energy to nature protection. A supportive policy framework, accompanied by the operationalization of clear policies which provide specific technical capacity and favorable market conditions, would enhance investor confidence. Thus, helping to meet the financing needs of large-scale green initiatives.

Similarly, strengthening the existing carbon market can unlock revenue streams and drive climate action. However, developing a robust ecosystem with clear regulations for carbon credit generation, certification, and trading is imperative. This would incentivize businesses to reduce greenhouse gas emissions by monetizing their green efforts, stimulating local demand while leveraging international markets to finance additional green projects.

Lastly, debt-for-nature and climate swaps present a unique opportunity to reduce Uganda's debt burden while advancing environmental conservation. To ensure a successful uptake, the country must establish enabling conditions, including targeted awareness campaigns, capacity-building initiatives, and streamlined regulatory processes. By aligning current policies with global best practices, Uganda can unlock the transformative potential of these mechanisms, positioning itself as a leader in green finance within the region.

Foster Public-Private Partnerships

Public-Private Partnerships (PPPs) are instrumental for de-risking green investments and scaling up climate-resilient projects in Uganda. By sharing financial burdens and operational responsibilities, whilst leveraging the strengths of both the public and private sectors to fund and implement sustainable initiatives, PPPs can unlock significant financing for green growth and promote socio-economic development. This is particularly crucial in Uganda, where high borrowing costs and infrastructural challenges deter private sector engagement. Focusing on areas like renewable energy, climate-smart agriculture, and early warning systems for climate disasters could have a significant impact. For instance, collaborations between the government and private companies can drive investments in solar farms, mini-hydro plants, and off-grid energy solutions, addressing both energy access and environmental concerns. Furthermore, agroforestry initiatives and irrigation systems can benefit from shared expertise and funding under PPP arrangements.

To foster effective PPPs, the country requires a conducive environment through clear regulatory frameworks, incentives for private participation, and mechanisms for accountability and transparency. Strengthening institutional capacity to manage and oversee partnerships is equally vital, ensuring that projects are efficiently executed and deliver measurable benefits.

Strengthening governance and monitoring frameworks for green finance

Uganda should establish robust governance structures to ensure the efficient and impactful implementation of green finance. This involves developing monitoring frameworks tailored to climate-related investments, along with transparent oversight and tracking mechanisms. These are essential for enhancing the evaluation and effectiveness of financing initiatives such as REDD+ (Reducing Emissions from Deforestation and Forest Degradation) and Nationally Appropriate Mitigation Actions (NAMAs). By doing so, the country can improve accountability and build trust among diverse stakeholders, including investors, donors, and local communities.

To achieve the above, it is instrumental to define clear criteria for project selection, implementation, and evaluation, ensuring that funds are allocated to high-impact initiatives aligned with the current climate strategy. Operationalizing these frameworks requires investment in capacity-building programs for government agencies and financial institutions, equipping them with the technical expertise needed for governance and monitoring. Moreover, the adoption of digital tools and platforms to track fund allocation and project outcomes in real-time can further strengthen transparency and reduce inefficiencies.

Advance Regional Collaboration for Climate Financing

Uganda should look for strategies to enhance regional collaboration within the East African Community (EAC), mobilizing cross-border climate finance. Joint initiatives, such as regional green bonds or unified carbon credit markets, can attract larger-scale investments and encourage economies of scale in project implementation and evaluation. Engaging with neighboring countries on shared climate-related challenges will foster unique opportunities for sustainable growth across the region, streaming international funds, facilitating knowledge-sharing, and centralized coordination for climate financing efforts.

References

African Development Bank. (2023). *Climate finance readiness in Uganda*. Taken from https://www.afdb.org/sites/default/files/documents/publications/cfr_uganda_web.pdf

GIZ. (2022). *Uganda Green Banking*. Taken from https://www.giz.de/de/downloads/giz2022-en-uganda-green-banking.pdf

World Economic Forum. (2024). *Climate finance and debt-for-nature swaps*. Taken from https://www.weforum.org/stories/2024/04/climate-finance-debt-nature-swap/

Advocates Coalition for Development and Environment (ACODE). (n.d.). *Enhancing green finance access for green growth*. Taken from https://www.acode-u.org/uploadedFiles/enhancing-green-finance-access-for-green-growth.pdf

Food and Agriculture Organization (FAO). (n.d.). *National Environment Act 2019*. Taken from https://faolex.fao.org/docs/pdf/uga184391.pdf

SEED. (2024). *Policy brief: Prototypes for the Uganda Green Finance Strategy*. Taken from https://seed.uno/system/files/2024-05/Policy-Brief-Prototypes-for-the-Uganda-Green-Finance-Strategy.pdf

Ministry of Finance, Planning and Economic Development. (2023). *Green Recovery Action Plan*. Taken from https://www.finance.go.ug/sites/default/files/2023-02/Green%20Recovery%20Action%20Plan.pdf

Global Sustainable Investment Alliance. (2020). *2020 Global Sustainable Investment Review*. Taken from https://www.gsi-alliance.org/wp-content/uploads/2021/08/GSIR-20201.pdf

Eastern Africa Alliance on Carbon Markets And Climate Finance. (2022) *Carbon markets report*. Taken from https://climatefinanceinnovators.com/wp-content/uploads/2023/06/Carbon-Report_-Uganda_2023_Rev03_single.pdf

3 Investing in Climate-Resilient Infrastructure

Albert Musisi and June Nyakahuma

Introduction

One of the primary ways that climate change will impact the Ugandan economy will be through the destruction of capital, particularly physical infrastructure. The decline in stock and quality of infrastructure that climate change brings negatively affects the output of Uganda's core sectors and total factor productivity. Maintaining and repairing infrastructure that has been damaged, as well as building new climate-resilient infrastructure, will require considerable budget resources; hence, assessing the economic impact of climate damage to infrastructure and implementing policy interventions to mitigate or adapt is crucial to sustaining economic growth and incomes. This chapter analyses the financial impacts of climate change on infrastructure, its implications for productivity and future growth, and proposes policies aimed at enhancing infrastructure resilience.

Climate Risks and Vulnerabilities in Uganda

Climate change is already disrupting physical infrastructure in Uganda, impacting food security, water resources, agriculture, energy, health, ecosystems, and more. Uganda ranks 36th in vulnerability to climate change and just 163rd in readiness and given the high rates of population growth and urbanisation, the situation is likely to get even more challenging with time (NG-GAIN). Moreover, the damages from climate change are potentially dire—an economic assessment of the 2022 NDC suggests that without adaptation measures, the annual costs of climate change could rise to as high as $5.9 billion within a decade, over 10 percent of current GDP.

Table 1: Vulnerability and risk assessment ratings for different sectors

Sector	Vulnerability Rating	Risk Rating
Agriculture (crop and livestock)	4.07	4.18
Built Infrastructure	3.27	3.83
Business	3.75	4.00
Energy (Excluding transport)	3.40	3.40
Fisheries	3.00	4.00
Forestry	3.25	4.25
Health	3.67	3.33
Manufacturing	3.00	3.00
Mining and Quarrying	3.00	4.00
Transport	3.20	3.80
Water	4.63	4.75
Ecosystems	5.00	5.00

While built infrastructure has a moderate level of vulnerability, it has a slightly higher risk rating, suggesting it faces significant challenges, including aging structures, inadequate design standards, and exposure to hazards such as flooding and heat stress. Additionally, resource constraints limit the ability to upgrade or maintain resilient systems, while interdependencies among infrastructure networks mean disruptions in one area can cascade into others. Rapid urbanization and data gaps further exacerbate these risks, highlighting the need for comprehensive strategies to strengthen infrastructure resilience.

Challenges to updating Uganda's Infrastructure

Road and Transport Infrastructure

Climate change affects both the construction and maintenance of road infrastructure, requiring resilience integration at every development stage. Uganda's road network provides vital connectivity between rural and urban areas but faces significant climate-related challenges. Extreme weather events damage roads, bridges, and riverine infrastructure, while chronic underfunding for maintenance accelerates deterioration. The sector prioritizes rehabilitation and upgrades over periodic and routine maintenance, though all categories remain underfunded.

The maintenance funding gap illustrates this challenge clearly. While the road maintenance backlog required USD 1,154 million in FY 2019/20 and USD 1,161

million in FY 2020/21, actual budget allocations reached only USD 186 million and USD 190 million, respectively—approximately 16 percent of identified needs. In FY 2021/22, the government targeted rehabilitation of 31,110 km of national roads and 90,974 km of District, Urban, and Community Access Roads (DUCAR), but budget constraints limited achievement to 55 percent of targets, creating a backlog of 50,144 km. The May 2023 destruction of the Katonga Bridge along the Kampala-Masaka Highway exemplified the economic costs of climate vulnerability, severing Uganda's connection to Rwanda and Tanzania and disrupting regional trade flows.

The government has initiated several measures to enhance climate resilience in transport infrastructure. The updated NDC (2021) prioritizes building climate-resilient roads, bridges, water, and rail transport systems, alongside revising design codes and regulations to climate-proof strategic infrastructure. The Ministry of Works and Transport (MoWT) has implemented specific technical adaptations, including incorporating a 12-20 percent climate change factor into hydrology and modeling design for roads and bridges, conducting Environmental and Social Impact Assessments before project implementation, and selecting materials capable of withstanding wider temperature ranges.

Infrastructure design standards are being systematically updated to address climate risks. Design manuals for urban roads and bridges now account for projected increases in flooding and storm surges, while existing assets undergo retrofitting to improve climate resilience. The reconstruction of the Katonga Bridge incorporated climate projections for water volumes in determining design specifications, location, and material selection to enhance resilience against future flooding events.

Operational interventions include elevating infrastructure to mitigate flooding, expanding drainage capacity, upgrading ditches and culverts with concrete encasement to prevent washouts, and promoting permanent structures like bridges and box culverts over large-diameter pipe culverts. The ministry has standardized 900mm diameter culverts as the minimum size for cross culverts to facilitate maintenance and reduce clogging. At landing sites, piers with varying heights accommodate fluctuating water levels, while enhanced protection measures for bridges and drainage structures channel water flow to prevent erosion.

The Central Materials Laboratory in Kireka and the Mount Elgon Labour-Based Training Center are conducting research on climate-resilient construction materials, including trials with cobblestones, probase, and improved asphalt and

concrete mixtures. Nature-based solutions complement engineered approaches through revegetation programs, slope stabilization using retaining walls and stone pitching, and wind protection measures against rockslides and erosion along transport corridors. Community engagement efforts address human activities that compromise infrastructure integrity, particularly sand mining and rice cultivation near bridges and drainage structures.

The 2022 IMF Public Investment Management assessment identified the compilation of maintenance methodologies and acceleration of routine maintenance as high-priority reforms. However, the absence of established methodologies for estimating maintenance needs constrains efficient resource allocation. Integrating climate considerations into maintenance strategies—including drainage upgrades, durable materials selection, and nature-based solutions—represents a critical pathway for enhancing infrastructure resilience. Systematic climate-responsive maintenance extends infrastructure lifespan and generates substantial medium-term savings by reducing rehabilitation requirements. Rwanda's experience in developing comprehensive maintenance estimation frameworks offers relevant lessons for strengthening Uganda's infrastructure management systems.

A compelling example from Rwanda demonstrates the economic case for preventive maintenance (IMF 2022). For a road rehabilitation project that required an investment of RWF 140,000,000, the annual routine and preventative maintenance cost was calculated at 3 percent of the construction cost, equalling RWF 4,200,000 per year. Over 8 years, the total maintenance investment would amount to RWF 33,600,000. In contrast, without proper maintenance, the same road would require significant rehabilitation after 8 years of use, costing at least 50 percent of the replacement value—approximately RWF 70,000,000. This comparison reveals that preventative maintenance costs are roughly 50 percent lower than rehabilitation expenses, resulting in actual savings of RWF 36,400,000 or more over the 8 years. This example underscores how proactive maintenance strategies can dramatically reduce long-term infrastructure costs while ensuring continuous service delivery.

Urban Infrastructure

Non-climate stressors, such as inadequate infrastructure to accommodate a growing population, exacerbate vulnerability to climate change and natural disasters. With an urbanization rate of 5.4%, a larger portion of the population now

resides in urban areas, placing pressure on already strained infrastructure and the limited availability of land (World Bank 2021).

Kampala, as the largest and fastest growing city in Uganda, illustrates these challenges. Kampala regularly experiences severe flooding due to heavy rains, which damages roads, disrupts transportation, and causes significant economic losses. According to a 2022 World Bank study, Kampala experiences an average annual loss of $49.6 million due to flood-related damages alone, impacting over 170,000 residents and putting more than 10% of jobs and major roads in flood-prone areas at risk. In severe cases, such as extreme flood events, damages can escalate to $101.4 million, impacting nearly 30,000 buildings. Urban development trends, including expansion into wetlands and floodplains, poor drainage maintenance, and increased waste mismanagement, exacerbate flooding risks.

Moreover, a case study by the Ministry of Water and Environment (MoWE) estimated that by 2050, damages from flooding alone on infrastructure in the Kampala urban area were projected to double, reaching US$203 million, driven by a growing population and the increasing value of assets over time. The adaptation cost estimates were substantial, ranging between US$3.3 billion and US$3.7 billion from 2015 to 2050. These estimates focused solely on infrastructure and excluded other relevant sectors such as health, water supply, and ecosystem degradation. Adaptation measures, such as revising building codes, protecting wetlands, and improving drainage systems, were highlighted as cost-effective solutions.

Strategic interventions are being implemented to address the increasing frequency and intensity of climate-related events in Kampala. The city has implemented comprehensive strategies, including sustainable land use, green infrastructure, and climate-sensitive designs, to mitigate risks such as flooding and rising temperatures. Initiatives such as improved drainage networks, flood-resilient housing, and eco-friendly public transportation are bolstered by participatory planning to address socio-economic disparities. Transportation projects, including the Bus Rapid Transit system and the refurbishment of the Kampala-Malaba Metre-Gauge railway, aim to reduce emissions and enhance climate-proof infrastructure. Flood management, supported by nature-based solutions through restoring wetlands like Lubigi and expanding drainage systems, is crucial in reducing vulnerabilities. Green infrastructure and energy-efficient building regulations further enhance resilience while addressing urban heat and stormwater challenges. Guided by the Kampala Climate Change Action Strategy, these measures are creating a more inclusive and sustainable urban environment.

Energy Infrastructure

Uganda's energy sector is heavily reliant on hydropower, which accounts for approximately 80 percent of the country's electricity generation. However, climate change poses significant risks to hydropower production due to altered river flows, fluctuating water levels, and prolonged droughts, which reduce energy generation capacity. Additionally, the transmission and distribution grids face significant risks from natural hazards, such as flash floods, landslides, and earthquakes. Flooding near Lake Albert and Lake Kyoga poses a severe threat, placing 11 percent of the distribution network at high risk. Investing in resilient energy infrastructure is therefore crucial for ensuring reliable electricity access nationwide.

This vulnerability underscores the importance of diversifying energy sources, including the expansion of solar, wind, geothermal, and biomass energy, to enhance resilience and energy security. However, these alternative energy sources also require significant infrastructure investments. Solar and wind energy require large-scale generation facilities, battery storage systems, and an expanded transmission network to integrate them into the national grid. Similarly, geothermal energy demands extensive exploration, drilling, and specialized power plants, while biomass energy relies on processing plants and efficient distribution systems.

Ensuring these investments are climate-resilient is critical to achieving long-term energy sustainability. This involves strengthening grid infrastructure to withstand extreme weather events, incorporating decentralized energy solutions to reduce system vulnerability, and safeguarding facilities against climate impacts. Additional measures include reinforcing transmission towers, installing underground cabling in high-risk areas, and developing flood-resistant substations. These climate-proofing strategies, combined with diversification efforts, can enhance the reliability and sustainability of Uganda's energy sector despite increasing climate variability.

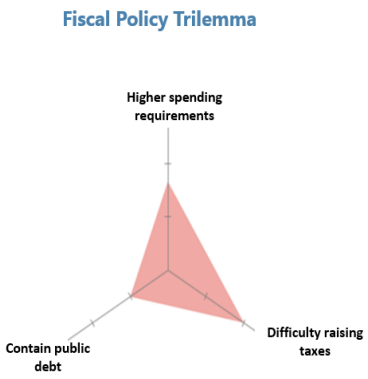
Fiscal Challenges of Climate-Resilient Infrastructure

Public capital or infrastructure can be categorized into two types based on resilience to climate-related events: standard capital and resilient or adaptation capital. The advantage of ‘resilient’ capital is that it has lower depreciation rates and is designed to withstand and recover from extreme weather events. As a result, these projects require higher initial fiscal costs and capacity from personnel. Generally, climate-resilient infrastructure also requires updating zoning and

building codes and executable plans for efficient post-disaster recovery strategies to keep costs down and restore functionality quickly after events.

The benefits of investing in climate-resilient infrastructure span multiple time horizons. Short-term benefits include maintaining operational continuity and uninterrupted service delivery. Medium-term advantages involve enhanced project resilience, enabling infrastructure to withstand climate damage and usage demands. Long-term returns emerge through reduced lifecycle costs, as consistent operation and maintenance prevent minor issues from escalating into major repairs. Well-maintained infrastructure additionally stimulates economic growth, attracts investment, and contributes to socio-economic development. Analysis indicates that without resilient infrastructure, disasters could reduce GDP by 1 percent and create financing requirements equivalent to 2.7 percent of GDP through reconstruction costs and reduced tax revenues in Uganda. However, investing in disaster-resilient infrastructure before disasters occur can reduce these economic losses by two-thirds and nearly halve the resulting financing gap (IMF, 2022).

Despite clear benefits, governments face significant fiscal constraints, embodied in the fiscal policy trilemma, which captures the challenge of balancing three competing objectives when funding climate-resilient infrastructure: increased spending needs, limited capacity to raise taxes, and the imperative to contain public debt. Building climate-resilient infrastructure requires substantial upfront investment, straining public finances while delaying immediate economic returns. Simultaneously, climate change reduces labour and capital productivity, slowing growth and weakening revenue collection. As productivity declines, the shrinking tax base provides fewer resources for building, operating, and maintaining climate-resilient infrastructure, while governments balance these demands against other development priorities. Consequently, governments often resort to borrowing, further complicating debt management. This illustrates the fiscal policy trilemma's complexity, where governments navigate trade-offs between investing in resilience, raising revenue, and maintaining fiscal sustainability.



Navigating this trilemma requires careful cost-benefit analysis and innovative approaches. Effective strategies include exploring alternative financing mechanisms such as public-private partnerships or green bonds, implementing policy reforms to enhance fiscal efficiency, phasing resilient infrastructure development to distribute costs over time, and prioritizing investments in the most critical and vulnerable sectors. These approaches help manage inherent trade-offs, enabling strategic investments in climate-resilient infrastructure that support long-term economic stability and growth while addressing fiscal constraints.

Policy Recommendations

Increasing financing for climate-resilient infrastructure is crucial for mitigating the impacts of climate change and ensuring sustainable development. Uganda's updated Nationally Determined Contributions (NDCs) indicate that approximately USD 28.1 billion is required by 2030 to achieve its mitigation targets. This substantial funding gap underscores the need for innovative and diversified financing strategies, some of which are explored below.

Public Sector Approaches

Mobilizing Finance for Climate-Resilient Infrastructure: Advocating for grants and concessional financing represents a critical pathway for funding climate-related infrastructure expenditure. International collaboration can support climate-resilient infrastructure development through multiple channels: engaging with Multilateral Development Banks (MDBs) for funding and technical assistance, accessing global climate funds such as the Green Climate Fund (GCF) and the Adaptation Fund for large-scale projects, and establishing bilateral agreements to facilitate knowledge exchange, technology transfer, and financial support. The

IMF's Resilience and Sustainability Fund offers additional opportunities to mobilize resources for climate action. Ensuring adequate funding for road maintenance requires innovative financing approaches. Capitalizing the Road Fund through dedicated revenue streams could allocate resources for routine maintenance, which prevents more costly repairs and rehabilitations during and after extreme weather events. This approach ensures infrastructure, particularly roads, remains in good condition and capable of withstanding climate-related stresses such as flooding and erosion.

International experience demonstrates the potential of fuel levies as dedicated funding mechanisms. In Namibia, the Road Fund Administration (RFA) capitalizes the Road Fund primarily through a fuel levy charged on every litre of petrol and diesel sold, mandated by the Road Fund Administration Act (Act 18 of 1999). Revenue from this levy supports routine maintenance, rehabilitation, and upgrades of the road network, providing a dedicated and consistent funding source that enhances the country's capacity to maintain and improve infrastructure. Liberia established its National Road Fund (NRF) following the 2016 National Road Fund Act, becoming operational in 2018. The government introduced a fuel levy of 25 cents per gallon in 2016, increasing to 30 cents per gallon in the 2018/2019 budget. These funds target road maintenance and rehabilitation projects. However, implementation challenges have emerged, including significant arrears from petroleum importers—over US$15 million in unpaid levies since 2022—which constrain the NRF's operational capacity. These examples illustrate that while fuel levies can provide sustainable funding for road maintenance, their effectiveness depends on consistent collection and allocation practices, as well as mechanisms to prevent revenue shortfalls. Implementing similar strategies in Uganda could enhance the sustainability of road maintenance funding, provided robust systems are established to manage and safeguard these resources. The success of such mechanisms requires strong institutional frameworks, transparent governance structures, and effective enforcement to ensure compliance and prevent revenue leakage.

In the National Development Plan IV (2025/26 - 2029/30), the Government of Uganda aims to explore various financing mechanisms to support climate-resilient infrastructure development, including innovative financing options. Infrastructure bonds could enhance access to financing from both domestic and international capital markets, thereby funding essential investments in roads, bridges, energy, and water systems. Additionally, the introduction of Sukuk bonds, based on Islamic banking principles, could attract capital from investors, particularly in the Arab

world, for both public and private infrastructure projects. Blended finance approaches will also be explored to combine public and private sector investments while reducing risks for private investors. Furthermore, green finance instruments, such as green bonds and sustainability-linked loans, will be introduced to encourage investment in environmentally friendly and climate-resilient infrastructure, supported by financial incentives like tax breaks or lower interest rates. An example is South Africa, which has utilized green bonds to finance climate-resilient infrastructure. The City of Cape Town issued a green bond in 2017, raising ZAR 1 billion (approximately $74 million) to fund projects such as water management systems, renewable energy, and flood prevention infrastructure. This initiative demonstrates how infrastructure bonds can be leveraged to address climate adaptation and mitigation needs while promoting sustainable urban development.[5] While bonds improve access to financing and provide a funding option, they are a form of debt, and their viability depends on the fiscal space available, which can potentially pose significant challenges to debt sustainability.

Integrating disaster risk financing into national budgeting frameworks can help secure consistent funding for emergency response, repair, and reconstruction activities, thereby reducing the long-term economic impact of disasters. These strategies can be complemented by innovative insurance products, such as catastrophe bonds[6] or parametric insurance, which provides rapid, targeted financial support in the event of disasters. To reduce the fiscal impacts of natural disasters, the Government of Uganda has implemented several measures, including a contingency fund mandated by the Public Financial Management Act (2015), a national agricultural insurance scheme, and a road fund financed through road user charges for infrastructure maintenance. However, the contingency fund remains underfunded, consistently receiving less than 0.2% of the budgeted amount due to budget constraints. This has led to a reliance on ex-ante mechanisms such as budget reallocations, supplementary budgets, and humanitarian aid. In collaboration with the World Bank, the Government is developing a disaster risk financing strategy aimed at reducing its reliance on reactive funding while enhancing fiscal management.

[5] Catastrophe bonds **allow entities exposed to natural disaster risk, to transfer a portion of that risk to bond investors**. Catastrophe bonds operate similarly to insurance, paying out when a disaster event meets specific predefined criteria (e.g., a specified earthquake magnitude), as per the World Bank Group (2021)

Private Sector Engagement

Increased engagement with the private sector is also an essential part of investing in climate-resilient infrastructure. Some ideas of how the government can engage and work with the private sector are below.

Public-Private Partnerships (PPPs) offer mechanisms to leverage private investment and expertise in developing climate-resilient infrastructure. Uganda has established a comprehensive PPP framework through the PPP Act of 2015 and subsequent regulations, though implementation faces challenges, including limited understanding of PPPs, political interference, and an immature domestic financial market (Bagenda & Ndevu, 2024). The World Bank's Knowledge Module on PPPs for Climate-Resilient Infrastructure emphasizes that integrating resilience can add approximately 3 percent to upfront costs but generates returns four times the initial investment while reducing service disruptions. Successful climate-smart PPPs require embedding climate considerations across the project cycle—from upstream planning through operations and maintenance—rather than treating resilience as an add-on. The IMF's 2024 assessment notes that Uganda's PPP guidelines need updating to systematically incorporate climate change considerations, particularly in project appraisal and risk allocation frameworks.

Risk Mitigation Instruments are essential for reducing perceived investment risks and attracting private capital. The African Development Bank's Africa Climate Risk Insurance Facility for Adaptation (ACRIFA) aims to mobilize USD 1 billion in concessional capital to develop climate insurance solutions, addressing the 97 percent insurance protection gap for African smallholder farmers. These instruments include parametric insurance products that trigger automatic payouts based on predefined weather events, credit guarantees that reduce lender exposure, and first-loss provisions that protect senior investors. The World Bank's Disaster Risk Financing and Insurance Program demonstrates that well-designed risk transfer mechanisms can reduce post-disaster financing gaps by up to 50 percent (World Bank, 2024). For Uganda specifically, developing domestic insurance markets and establishing contingency funds could help manage the estimated 2.7 percent of GDP financing requirement that disasters typically create.

Corporate Social Responsibility (CSR) initiatives increasingly integrate climate resilience into investment strategies. International experience shows that companies operating in climate-vulnerable sectors—particularly agriculture, energy, and logistics—are incorporating adaptation measures to protect supply

chains and operations. In Uganda, domestic banks like Centenary Bank have developed climate-responsive agricultural lending products, while companies like Equator Seeds Limited invest in climate-resilient seed varieties that benefit entire value chains. The Public-Private Infrastructure Advisory Facility's Climate Resilience and Environmental Sustainability Technical Advisory (CREST) provides technical support to help governments structure projects that align private sector CSR objectives with national climate adaptation priorities. Effective CSR engagement requires clear metrics for measuring resilience outcomes and transparent reporting frameworks that demonstrate both business and societal benefits.

Conclusion

Uganda, like many other countries, faces challenges in securing resources to finance its climate commitments as outlined in the Nationally Determined Contributions. Limited infrastructure worsens these challenges, necessitating trade-offs between mitigating the impacts of climate change and effectively adapting to them, given the fiscal constraints and competing development priorities. However, the policy recommendations outlined in this paper, including pursuing climate finance through international cooperation, improving road maintenance, leveraging innovative financing mechanisms to unlock scarce capital, and promoting public-private partnerships (PPPs), could increase access to capital to bridge the financing gap. By implementing these strategies, Government can increase financing for climate-resilient infrastructure, better safeguard communities against climate risks, and promote sustainable development.

References

African Development Bank. (2023). The Africa Climate Risk Insurance Facility for Adaptation (ACRIFA). https://www.afdb.org/en/topics-and-sectors/initiatives-and-partnerships/africa-climate-risk-insurance-facility-adaptation

African Development Bank. (2024). Climate Action Window - Third call for proposals. https://www.afdb.org/en/topics-and-sectors/initiatives-and-partnerships/adf-climate-action-window/call-proposals-climate-action-window

Bagenda, B., & Ndevu, Z. (2024). Principal risks associated with public-private partnership projects in Uganda. SAGE Open, 14(2). https://journals.sagepub.com/doi/full/10.1177/1087724X231167326

Climate Bonds Initiative. (2021). Green bonds in South Africa: How green bonds can support South Africa's energy transition.

De Bettencourt, M., et al. (2013). Building resilience: Integrating climate and disaster risk into development. World Bank.

GlobalDev. (2024). Briefing note: Infrastructure in the Kampala urban area.

Government of the Republic of Uganda. (2015). Uganda's intended nationally determined contribution (INDC).

Government of the Republic of Uganda. (2022). Updated nationally determined contribution (NDC).

International Institute for Sustainable Development. (2024). Private sector investment in a changing climate: Resilient rice value chain development in Uganda. https://www.iisd.org/projects/private-sector-investment-changing-climate-resilient-rice-value-chain-development-uganda

International Monetary Fund. (2022a). Uganda public investment management assessment.

International Monetary Fund. (2022b). Uganda: Selected issues paper.

International Monetary Fund. (2024). Uganda: PFM climate assessment - Public investment and fiscal risks management. Technical Assistance Reports, 2024(007). https://www.elibrary.imf.org/view/journals/029/2024/007/article-A001-en.xml

Ministry of Water and Environment. (2015). Economic assessment of the impacts of climate change in Uganda.

Ministry of Works and Transport. (2021). National transport and logistics policy.

Ministry of Works and Transport. (2022). National integrated transport master plan (2022-2040).

Ministry of Works and Transport. (2025). Draft general road designs and specifications.

Organisation for Economic Co-operation and Development. (2018). Climate resilient infrastructure.

Organisation for Economic Co-operation and Development, World Bank, & UN Environment. (2024). Infrastructure for a climate-resilient future.

Public-Private Infrastructure Advisory Facility. (2024). How do we link private sector participation and climate-resilient infrastructure right now? World Bank Blogs. https://blogs.worldbank.org/en/ppps/how-do-we-link-private-sector-participation-and-climate-resilient-infrastructure-right-now

World Bank. (2022). Kampala: Disaster risk and climate resilience strategy.

World Bank. (2024a). Delivering climate-resilient infrastructure through the private sector. World Bank Blogs. https://blogs.worldbank.org/en/ppps/delivering-climate-resilient-infrastructure-through-private-sector

World Bank. (2024b). Disaster Risk Financing and Insurance Program (DRFIP). https://www.worldbank.org/en/programs/disaster-risk-financing-and-insurance-program

World Bank Group. (2021). Building sovereign financial resilience in middle-income countries.

World Bank Group. (2024). Climate-smart PPPs: Public-private partnership resource center. https://ppp.worldbank.org/public-private-partnership/energy-and-power/climate-smart-ppps

4 Implications of Green Taxation in Uganda

Joel Muhinda and Liam Carson

Introduction

Green or environmental taxation refers to taxes on activities or products harmful to the environment, designed to promote sustainable practices and reduce environmental degradation. Covering areas such as energy, transport, pollution, and natural resource use, these taxes aim to encourage clean technologies, reduce negative externalities, and generate funds for climate action. By supporting the transition to low-carbon, climate-resilient economies, environmental taxes contribute directly to achieving the Paris Agreement's goal of limiting global warming to 1.5°C.

For Uganda, which aims to multiply its GDP tenfold over the next 10–15 years (FY 2024/25–FY 2029/30), the balance between economic growth and environmental sustainability is increasingly critical. Fiscal pressures are high: Uganda's budget deficit widened to 9.5% of GDP in FY 2020/21 due to COVID-19-related revenue declines and increased health and social spending. Although consolidation efforts reduced the deficit to 5.5% of GDP by FY 2022/23, it remains above the 3.0% target set by the country's second Charter for Fiscal Responsibility, to be achieved by FY 2025/26.

At the same time, Uganda faces one of Sub-Saharan Africa's lowest revenue-to-GDP ratios—13.7% in FY 2023/24. The Domestic Resource Mobilization Strategy aims to raise this to 16–18% by the end of FY 2023/24. In this context, green taxes offer a dual opportunity: strengthening fiscal health while advancing environmental sustainability. Hereon, this chapter will discuss the current environmental levies in. Uganda, areas for reform, and the implications for the economy.

Environmental Excise Duties in Uganda

At present, Uganda has a number of excise duties in place with the aim of addressing negative environmental externalities. Although the excise duty regime is partly used as a revenue-raising tool, it is also the case that policymakers use these taxes to curb excessive consumption or business activity deemed to have a harmful

socioeconomic impact. This is also the case when it comes to excise taxation to curb activity associated with excessive pollution.

Uganda's most significant environmental taxes, by revenue yield, are its fuel duties. As of FY 2024/25, duties are set at UGX 1,550 per litre for petrol, UGX 1,230 for diesel, and UGX 200 for kerosene. While excise rates are not automatically indexed to inflation, inflation considerations inform periodic adjustments. Together, these fuel duties generated 1.59% of GDP in FY 2023/24—accounting for 57.1% of total excise duty revenue and 11.8% of overall tax revenue.

Beyond fuels, Uganda also imposes an environmental tax on plastic packaging under the Excise Duty Act, introduced in FY 2021/22 to replace a narrower tax on plastic bags. Set at USD 70 or 2.5% of the value (whichever is higher), the tax includes a refund mechanism for manufacturers that recycle plastics, aiming to promote greener production practices. Despite its broader scope, this tax raised just 0.014% of GDP in FY 2023/24.

Additionally, a one-off excise duty of UGX 200,000 is levied on motorcycles at registration, intended to curb the environmental impact of the widespread use of motorcycle taxis ("boda-bodas"). However, anecdotal evidence suggests weak enforcement, with collections amounting to only 0.01% of GDP in FY 2022/23.

Environmental Levies in Uganda

The environmental levy is the final major green tax in Uganda. This levy is imposed primarily on vehicle imports and is applied only once at the time of importation. The rationale for the tax is to encourage the importation of newer vehicles, which typically are associated with lower emissions, and discourage the importation of higher-polluting older vehicles. (In reality, it is important to note that the correlation between vehicle age and emissions is far from perfect.)

The environmental levy has been subject to several reforms over the past couple of decades. When it was initially imposed in FY 2006/07, the environmental levy was set at 10% for cars older than eight years, and this rate was raised to 20% in FY 2008/09. The next major reform to this regime occurred in FY 2015/16, when the environmental levy was split into two age-differentiated bands – a 35% rate for imported vehicles between the age of five and ten years and a 50% rate for those vehicles above ten years old.

Figure 1: Car Import Policy by Age Group by Fiscal Year

Period	Policy Approach	1–4 Yrs	5–9 Yrs	10–14 Yrs	15+ Yrs
2006–2008	Initial phase	0%	10%	10%	10%
2008–2015	Moderate restrictions	0%	20%	20%	20%
2015–2017	Increased restrictions	0%	35%	50%	50%
2017–2018	High restrictions	0%	50%	50%	50%
2018–2024	Ban on oldest vehicles	0%	50%	50%	Banned

Tax Incentives

Uganda also uses tax expenditures to encourage environmentally friendly economic activity, primarily through the Stay of Application (SoA) and Duty Remission Scheme (DRS) mechanisms. These tools allow Uganda to deviate from the EAC Common External Tariff by reducing import duties on key industrial inputs. The DRS provides product-specific relief, while the SoA suspends duties for select Uganda-based firms. Although both require EAC-level approval, this has not posed a significant barrier in recent years.

Beyond raising revenue and addressing negative environmental externalities, green taxes can serve as instruments for structural transformation. By incentivizing shifts toward cleaner, more productive economic activities, environmental taxation can help support long-term economic growth.

How To Reform Existing Environmental Taxes In Uganda

Fuel Duty Reform

Fuel duties are the logical starting point for environmental tax reform in Uganda, as excise taxes on petrol and diesel are the country's largest environmentally related revenue source. When setting fuel duty rates, policymakers should consider the full internalization of fossil fuel consumption's negative externalities—pollution, health damages, climate change, and other social costs that are not reflected in market prices.

Internalizing these costs means ensuring that the price of fuel reflects its true societal harm. For example, if burning a liter of diesel imposes UGX 1,000 worth of environmental damage, the buyer should pay an additional UGX 1,000 at the pump. This approach incentivizes reduced consumption, cleaner technologies, and ensures that polluters, not society at large, bear the associated costs.

Using an IMF (2023) model, the environmentally efficient prices for petrol and diesel in Uganda are estimated at UGX 5,869 and UGX 5,893 per liter, respectively. As of February 2025, retail prices are UGX 4,983 for petrol and UGX 4,659 for diesel—meaning that current prices are approximately UGX 900 to UGX 1,200 per liter below efficient levels.

To close this gap, excise duties would need to rise sharply: from UGX 1,550 to UGX 2,450 per liter for petrol and from UGX 1,230 to UGX 2,430 per liter for diesel. This would harmonize the tax rates for petrol and diesel, departing from Uganda's current policy of lower diesel taxes aimed at supporting the agriculture and transport sectors. Environmentally, a harmonized approach is justified, as both fuels cause similar levels of harm.

Projected revenue gains from these duty increases are substantial. Accounting for a behavioral response (lower fuel consumption due to higher prices), the proposed hikes would generate an additional UGX 1.64 trillion—equivalent to 0.71% of GDP in FY 2025/26—with UGX 773.8 billion from petrol and UGX 861.8 billion from diesel.

This revenue windfall raises important policy choices. One option is earmarking, allocating fuel duty revenues for specific purposes such as improving road infrastructure or investing in climate-resilient transport systems. Earmarking can enhance public trust by linking taxes to visible benefits, as seen in the U.S. Highway Trust Fund model.

However, earmarking also has drawbacks: it reduces fiscal flexibility, risks inefficient spending, and can create pressure to earmark other revenue streams, potentially undermining budgetary discipline. Policymakers must weigh these trade-offs carefully. Even without formal earmarking, transparent communication about how additional revenues will be used—especially to benefit public transport or protect vulnerable groups—can help secure political support for reform.

We also need to point out that overnight tax hikes as extreme as this are likely to be economically damaging – reform needs to be more gradual. Our modeling suggests

that raising excise duties as proposed would immediately increase petrol prices by 16.7% and diesel prices by 23.9%. Given fuel's role as an intermediate good in transport, agriculture, and industry, such abrupt increases could trigger second-round inflationary effects, curtail consumer spending, depress investment, and sharply slow economic growth. Politically, such steep hikes would also be highly contentious.

Policymakers must also consider whether to remove the VAT exemption on fuel, currently Uganda's largest VAT exemption. Introducing the standard 18% VAT on fuel would instantly increase pump prices by 18%, compounding the economic risks described above. Additionally, from a tax administration perspective, the current system—where excise duties are collected at customs—is simpler and more efficient than administering VAT on fuel.

Bearing all of this in mind, policymakers may prefer to continuously increase the excise duty on fuel products by UGX 200 per liter on an annual basis. Ideally, this would continue until the rates levied on petrol and diesel align with their environmentally efficient levels. This is likely to be a five- to six-year process (depending on fluctuations in global oil prices).

Environmental Levy Reform

The environmental levy is a far less important source of revenue compared to the fuel duties, but there is still a need for reform. Introduced to curb pollution from older, high-emission cars, the levy had mixed results: while it reduced imports of certain vehicle age groups, it inadvertently increased demand for even older, more polluting vehicles.

Research by Forster and Nakyambadde (2020) found that the levy's current structure made vehicles just over the age threshold disproportionately expensive, while much older vehicles—despite technically facing higher taxes—remained cheaper in absolute terms. For many low-income consumers, upfront cost was the decisive factor, leading to a substitution toward 15+ year-old vehicles (many of which, though officially banned from import, remained in circulation). This perverse outcome worsened the environmental quality of Uganda's vehicle fleet.

A smarter levy design is needed. Instead of focusing solely on age, the tax should vary by fuel efficiency or engine size, which are stronger proxies for emissions. Larger-engine vehicles, which emit more pollutants, should face higher levies, while

smaller, more efficient models should face lower rates. Uganda could draw from frameworks such as the EU's emissions standards to develop a tiered system that rewards cleaner technologies.

Additionally, the levy should differentiate by vehicle type. Hybrid vehicles could receive reduced rates, and fully electric vehicles could face zero or near-zero levies. However, given that even electric vehicles contribute to congestion, a small but positive levy rate could be justified to balance emissions goals with traffic management.

Enforcing the existing ban on vehicles older than 15 years remains critical. Although enforcement has historically been weak, maintaining the ban sends an important policy signal and helps keep the most polluting vehicles out of Uganda's fleet.

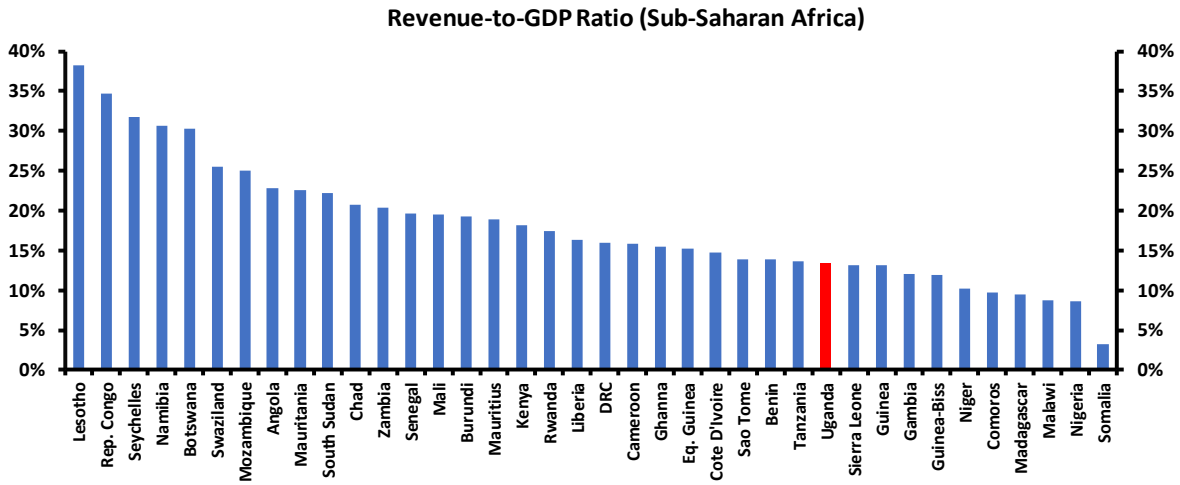
Overall, these reforms would transform the environmental levy from a blunt instrument into a more targeted, incentive-compatible policy tool, better aligned with Uganda's environmental and economic objectives.

Following this discussion of existing green taxes, Chapter 3 will now turn to the potential benefits of introducing new and innovative green tax instruments.

Economic Implications Of New Green Taxes

Revenue Generation

Uganda's revenue-to-GDP ratio, recorded at 13.7% for FY 2023/24, remains below the Sub-Saharan Africa average (***see chart below***) and falls short of the Domestic Resource Mobilization Strategy's target of 16-18% by the end of FY 2023/24. Implementing green taxes on activities that harm the environment, like carbon emissions and plastic use, presents a viable solution to this shortfall. Such taxes not only generate new revenue streams that could support public services, reduce the fiscal deficit, and fund infrastructure projects but also ensure broader tax compliance across sectors, including the informal economy (World Bank). This approach could potentially reduce reliance on traditional taxes that distort economic behaviour, such as employment tax, income tax, and VAT, thereby harmonizing fiscal health with environmental sustainability.



Source: UNUWider Government Revenue Dataset, URA via MoFPED;
Note: Latest datapoint is 2022, excl. Uganda, for which FY 23/24 figure used This dataset reports total revenue.

Introducing targeted green taxes—such as a carbon tax on industrial and transport emissions or a tax on single-use plastics—would align Uganda with successful international practices and enhance its fiscal capacity. South Africa's carbon tax, introduced in 2019, generates approximately $133 million annually by incentivizing cleaner industrial practices. Similarly, Colombia's carbon tax supports reforestation and renewable energy projects. Adopting such models could help Uganda advance both its fiscal and environmental goals.

Green taxes are relatively easy to administer, collected at the source from a limited number of taxpayers, minimizing evasion and reducing administrative costs. Countries like Sweden and Norway have shown that robust monitoring systems can seamlessly integrate emission-based taxes into existing frameworks, supporting sustainable development and environmental management.

Uganda's economy has demonstrated strong post-pandemic recovery, with GDP growth reaching 6.0% in FY 2023/24, up from 3.0% in FY 2019/20. Green taxes offer an opportunity to further amplify this momentum by opening new revenue streams, encouraging innovation, and driving shifts toward cleaner technologies. Experiences from countries like Kenya, where green tax incentives have supported the growth of the solar energy sector, highlight the potential for green fiscal policies to foster sustainable industries, create jobs, and attract international investment.

Moreover, green taxation could enhance Uganda's competitiveness in global trade. Aligning domestic practices with international environmental standards, such as the EU Green Deal and carbon border adjustment mechanisms, would strengthen Uganda's position in export markets and attract eco-conscious investors. By proactively adopting green taxation, Uganda would improve its international reputation as a leader in environmental responsibility, opening up new trade and investment opportunities and driving long-term economic development.

Environmental Implications of New Green Taxes

Green taxes offer a powerful tool for reducing pollution in Uganda by imposing costs on activities that generate environmental harm, such as carbon emissions and plastic waste. By making fossil fuels like petrol and diesel more expensive through carbon taxes or higher excise duties, the government can incentivize shifts toward renewable energy sources like solar, hydro, and wind. Countries such as Sweden and Denmark have demonstrated that carbon taxes can significantly reduce emissions without compromising economic growth. Uganda could achieve similar outcomes, improving air and water quality, public health, and environmental sustainability.

Green taxes also promote the sustainable management of natural resources. Taxing activities such as charcoal burning and firewood use could encourage a transition to cleaner alternatives, preserving forests and helping to mitigate climate change. Revenue from such taxes could be used to fund renewable energy initiatives, including solar energy and biogas, offering a sustainable path away from environmentally harmful practices.

International experience reinforces the effectiveness of green taxes. The World Health Organization reports that carbon taxes in countries like Germany and the UK have lowered air pollution and improved health outcomes. Similarly, Colombia has directed carbon tax revenues toward reforestation and biodiversity conservation. Uganda could replicate these models by earmarking green tax revenues for environmental restoration and climate resilience programs.

Social Implications Of New Green Taxes

Green taxes would also deliver major public health benefits by reducing pollution-related illnesses, particularly respiratory and cardiovascular diseases. Given that low-income groups are often the most vulnerable to pollution, cleaner air would

have a strong pro-poor impact, especially in urban centers like Kampala. Improved air quality would lower healthcare costs, enhance productivity, and support broader economic growth.

However, green taxes can be regressive if poorly designed, disproportionately burdening low-income households. To address this, Uganda could follow Sweden's model by using part of the green tax revenue to subsidize vulnerable groups, ensuring an equitable distribution of benefits. Careful policy design will be critical to balancing environmental goals with social equity, avoiding the risk of exacerbating income inequalities and fostering a more inclusive development path in line with Sustainable Development Goal 16.

The next section will now turn to discussing the practical challenges Uganda may face in implementing new green tax measures.

Challenges In the Implementation of Green Taxation

The successful implementation of green taxation in Uganda will largely depend on **public acceptance.** Green taxes, such as carbon taxes, aim to reduce pollution and combat climate change, but they often impose financial costs on industries and households. Industries reliant on carbon-intensive processes and products, such as those producing polythene bags, may face operational challenges, while poorer households—who spend a larger portion of their income on essentials like fuel, electricity, and transport—may have a disproportionate impact. Global examples, like the 2008 yellow vest protests in France and the rejection of carbon tax measures in Switzerland in 2021, highlight the difficulties of garnering public support when green taxes are perceived as burdensome. To mitigate such resistance, Uganda must prioritize public awareness campaigns, clearly communicating the environmental and economic benefits of green taxes. Effective education efforts can help build trust and address misconceptions, fostering broader acceptance of these policies.

Green taxes also risk exacerbating inequality if not designed carefully. Low-income households, particularly those relying on fossil fuels like firewood for energy, could bear a greater financial burden under green taxation policies. For example, transitioning such households to cleaner alternatives like LPG would impose additional costs, creating an unsustainable economic strain. This could lead to increased energy poverty and hinder Uganda's progress toward Sustainable Development Goals (SDG) 1 (poverty alleviation) and SDG 7 (access to clean

energy). To address these challenges, Uganda should adopt social compensation mechanisms such as rebates, subsidies, or exemptions for essential goods. These measures can help ensure that the benefits of green taxes are equitably distributed, protecting vulnerable populations while promoting environmental goals.

Finally, the successful administration of green taxes requires robust institutional capacity. Uganda's tax authorities, including the Uganda Revenue Authority, need adequate resources, technical expertise, and modern monitoring technologies to design, implement, and oversee green tax systems effectively. Setting appropriate tax rates, preventing evasion, and ensuring compliance will require targeted staff training and clear regulatory frameworks. Integrating green taxes into existing fiscal policies will also help streamline their implementation. Uganda can draw on lessons from countries like Sweden and South Africa, where administrative systems were strengthened to manage green taxes efficiently. Collaborating with international experts and adopting best practices can further enhance Uganda's capacity to administer green taxes, ensuring their effectiveness in achieving environmental and fiscal objectives.

Case Studies and International Comparison

Sweden's carbon tax, introduced in 1991, remains a landmark example of effective green taxation. It significantly reduced greenhouse gas emissions while supporting economic growth through increased revenues. Sweden's success is attributed to its comprehensive approach, combining substantial investments in climate and energy research, robust environmental monitoring systems, and widespread public education on climate change. These efforts, alongside taxing the carbon content of fossil fuels, spurred investments in renewable energy and demonstrated the potential for green taxes to drive sustainable economic transformation.

Denmark's waste tax, implemented in 1987, similarly shows the power of targeted environmental taxation. By making waste disposal more expensive, Denmark halved landfill use and doubled recycling rates since the mid-1980s. Complementary policies—including packaging taxes, mandatory recycling requirements, and deposit-refund systems for bottles—further incentivized sustainable waste management practices and improved hazardous waste handling.

Experiences from Colombia and South Africa illustrate the adaptability of green taxes to different contexts. Colombia's 2017 carbon tax has funded reforestation and renewable energy initiatives, while South Africa's 2019 carbon tax has

supported sustainable industrial transitions. Both cases highlight how green taxes can address specific environmental challenges while advancing broader sustainability goals.

Kenya's use of tax incentives to grow its solar energy sector further emphasizes the role of fiscal policy in driving green technology adoption and reducing fossil fuel dependency. Together, these international examples offer important lessons for countries like Uganda aiming to design or enhance green taxation strategies to achieve environmental and economic objectives.

Policy Recommendations

Recognizing the potential of green taxes to address environmental challenges more directly, there is a growing movement in many countries, including Uganda, to expand and enhance green taxation frameworks. This expansion aims to more effectively tackle issues like plastic waste reduction, promotion of renewable energy, and curbing of carbon emissions. However, the development and implementation of such policies in Uganda require careful planning and extensive public consultation to ensure that environmental objectives are met without adverse economic repercussions, balancing the need for environmental stewardship with economic growth and public acceptance. To ensure the effective implementation of green taxes in Uganda, several strategic recommendations can be tailored to meet the nation's specific environmental and economic needs:

1. ***Increase Fuel Duties by UGX 200/litre every year:*** At present, retail prices of petrol and diesel are around UGX 900/litre and UGX 1200/litre below their environmentally efficient levels. Policymakers should gradually increase the excise duties levied on these products until retail prices align with their efficient levels. Earmarking the revenue windfall arising from these fuel duty hikes for investments in road improvements, climate-resilient infrastructure, or public transport systems should be considered, but policymakers must be acutely aware of some of the drawbacks associated with earmarking.
2. ***Reform the Environmental Levy on Used Imported Vehicles:*** Policymakers could consider varying the environmental levy depending on both the age and efficiency (e.g., engine size) of the imported vehicle. They could also consider a lower rate for hybrid and fully electric vehicles, while ensuring that the ban on vehicles older than 15 years remains in place.
3. ***Extensive Climate Research and Observation:*** Uganda should prioritize comprehensive climate research and systematic observation by investing in

climate and energy research within its budget. This involves supporting research at higher education institutions and focusing on key areas such as climate models, natural resources, and ecosystem services. Enhanced understanding of local environmental challenges will better inform policy decisions and enable the development of effective green taxes tailored to Uganda's specific context.

4. ***Adapt Deposit-Refund Systems:*** Drawing inspiration from Denmark's successful deposit-refund systems, Uganda can introduce similar mechanisms for bottles and other recyclable materials to promote recycling and reduce landfill waste. By implementing a system where consumers pay a deposit at the time of purchase and receive a refund upon returning the empty bottles, Uganda can significantly reduce its plastic waste and encourage recycling behaviors among its population.
5. ***Public Awareness and Support:*** It is crucial to launch extensive public awareness campaigns to educate both the populace and businesses about the benefits of green taxes. These campaigns should articulate how such taxes can reduce pollution, encourage sustainable practices, and fund vital environmental projects. Engaging communities through workshops and diverse media platforms will help build support for green taxes, ensuring broader acceptance and compliance.
6. ***Enhance Administrative Capacity:*** For green taxes to be effective, they must be implemented alongside robust administrative support. This includes training for staff at tax collection and environmental agencies, utilizing modern technology to track tax payments, monitor environmental impacts, and manage data efficiently. Uganda must develop clear and strong regulatory frameworks to ensure that green taxes are fair, support innovation, and are sustainable without overburdening citizens and businesses.
7. ***Setting Appropriate Tax Rates:*** The government should carefully assess the tax rates and structures to ensure they are effective without driving businesses to lower-tax jurisdictions. Green tax rates should be set high enough to promote sustainable practices and reduce pollution but remain reasonable to avoid excessive burdens on businesses and consumers, thereby supporting economic stability.
8. ***Phased Implementation and Reinvestment of Revenues:*** Green taxes should be introduced gradually, allowing time for industries and citizens to adapt. Additionally, the revenues collected from these taxes should be reinvested into projects that further environmental goals, such as renewable

energy initiatives, healthcare improvements related to environmental diseases, and broader environmental conservation efforts.

9. ***Social Compensation Mechanisms:*** To mitigate any regressive impacts of green taxes, Uganda should implement social compensation mechanisms such as subsidies, rebates, or direct cash transfers. These measures will help protect low-income households from the financial strain of transitioning to greener alternatives, ensuring that the implementation of green taxes contributes to equitable economic development.

Conclusion

Green taxes offer Uganda a transformative opportunity to address both fiscal and environmental challenges. By adapting international best practices to the local context, Uganda can design a green tax system that aligns economic and environmental goals, supporting sustainable development. Well-structured green taxes can reduce pollution, promote sustainable practices across sectors, and generate significant revenues that can be reinvested into further green initiatives.

However, success will depend on transparent implementation, strong public engagement, and strategic reinvestment of revenues. Uganda must strengthen administrative capacity, ensure that the tax burden is equitably distributed across socio-economic groups, and actively build public support. Lessons from countries like Sweden, Denmark, and Colombia offer valuable insights for tailoring Uganda's approach to its unique economic and environmental context.

Beyond introducing new green taxes, Uganda should also reform existing environmental taxes. The environmental levy on imported used vehicles should be restructured to better achieve its pollution-reduction goals. Additionally, gradual and continuous increases in fuel excise duties are needed to raise petrol and diesel prices to their environmentally efficient levels, fully internalizing the social costs of fossil fuel consumption.

By pursuing these reforms, Uganda can create a balanced green tax framework that strengthens fiscal sustainability, drives environmental improvements, and supports long-term economic growth.

References

1. Definitions: Google and articles below
2. The politics of green taxation [Lena Maria Schaffer1]
3. Which policy instruments attract foreign direct investments in renewable energy? [Ronald Wall, Stelios Grafakos, Alberto Gianoli & Spyridon Stavropoulos]
4. On the green and innovative side of trade competitiveness? The impact of environmental policies and innovation on EU exports [Valeria Costantini a, Massimiliano Mazzanti]
5. Do environmental provisions in trade agreements make exports from developing countries greener? [Clara Brandi a, Jakob Schwab a, Axel Berger a, Jean-Frédéric Morin]
6. Ecological Tax Reform in Denmark: history and social acceptability [Jacob Kloka, Anders Larsenb, Anja Dahlc, Kirsten Hansen]
7. Green fiscal reform in Sweden: Econometric assessment of the carbon and energy taxation scheme [Stanislav E. Shmelev, Stefan U. Speck]
8. Environmental Taxation and Public Health Issues [Cordelia Onyinyechi Omodero
9. Department of Accounting, College of Management and Social Sciences, Covenant University Ota, Ogun State 110001, Nigeria]
10. Green Taxes in Africa: Opportunities and Challenges for Environmental Protection, Sustainability, and the Attainment of Sustainable Development Goals Favourate Y. Mpofu
11. Domestic Revenue Mobilization Strategy
12. Charter for Fiscal Responsibility
13. Switzerland: CO2 Act Amendment Rejected by Voters
14. World Bank Data on SSA
15. African Development Bank. (2024). Kenya's green energy investments: A case study. African Development Bank.
16. Colombian Ministry of Finance. (2020). The carbon tax in Colombia: An instrument for environmental protection and fiscal sustainability.
17. European Commission. (2023). Green taxation in the EU: A review of policy and its impact on the economy.
18. Haites, E., et al. (2018). Lessons from Carbon Tax Implementation. Climate Policy Journal.
19. International Monetary Fund (IMF). (2023). Uganda: Selected issues.

20. Rydge, J. (2015). Implementing Effective Carbon Pricing. The New Climate Economy.
21. South African Government. (2019). Carbon tax policy implementation: Reducing emissions and ensuring sustainability.
22. URA. (2023). Tax administration and reform in Uganda: Progress and challenges. Uganda Revenue Authority.
23. World Bank. (2019). State and Trends of Carbon Pricing 2019.
24. World Health Organization (WHO). (2023). Air pollution and public health: The global impact.
25. Matheson T, Mylonas V, 2023. “IMF: Technical Assistance Report – Uganda Tax Expenditure Evaluation and Reform”
26. Forster F, Nakyambadde D, 2020 (IGC). “Managing Old Vehicle Imports Into Uganda”

5 Integrating Climate Change into Budgetary and Planning Processes

Sam Mugume Koojo and Racheal Nuwamanya

Introduction

Climate risk is now a core macro-fiscal concern. Embedding it in Uganda's planning and budgeting across preparation, execution, and evaluation has the potential to both limit future losses and unlock low-carbon growth opportunities (Sikhosana & Nzewi 2024). This chapter draws on recent evidence, practitioner insights, and international experience to show how climate considerations can be systematically integrated into government finances and reviews the steps Uganda has already taken.

The need is pressing as rising temperatures, shifting rainfall, and more frequent extreme weather events are already slowing growth and eroding public assets. Ring-fencing funds for adaptation—resilient infrastructure, drought-tolerant crops, improved water management, stronger disaster response—protects communities and the budget, while targeted investments in renewables, energy efficiency, and other low-carbon technologies accelerate Uganda's economic transition (Yurchyshena 2024; Walczak 2023). Together, these measures safeguard fiscal stability and advance sustainable development goals.

Policy options for climate-smart budgeting in Uganda

Integrating climate considerations into the budgeting process helps in planning for sustainable economic growth, and can be undertaken through the following mechanisms:

Adding climate change to the project selection criteria. Line ministries can be required to incorporate adaptation and mitigation measures in the project preparation cycle, starting from the initial/concept note stage to approval stage (GCCA, 2011). Uganda's current project selection criteria do not include climate change interventions among key requirements for a project to qualify into the pipeline of projects (MoFPED, 2021).

Involving line agencies: Line ministries should be actively involved in the process or exercise of integrating climate considerations in the budget process because

they are “best placed to determine how resources should be applied to achieve policy objectives in the area of competence” (World Bank, 2021). In Uganda, line Ministries, Departments, Agencies (MDAs), and Local Governments (LGs) are entirely involved in the budgeting process by providing annual budgets in line with financial ceilings and guidance issued in Budget Call Circulars (BCCs). The BCCs require MDAs and LGs to plan for climate change interventions.

Engaging all required parties on their roles and responsibilities. There is a need to engage all required parties in the climate change agenda, ranging from administrative to political (C40 Cities Climate Leadership Group, 2023). This would establish clear roles for each of the involved parties. The administrative would involve the Ministry of Finance and other MDAs that are involved in the budgeting process, whereas the political end would be vital given the pivotal role that Politicians play in approving the National budget and sensitizing their communities on national matters. This would minimize backlash from the population about budget allocations to climate change interventions.

Using inter-agency committees. Sectoral committees can translate national climate goals into line-agency budgets (World Bank 2014). Under Uganda’s Programme-Based Budgeting, introduced in FY 2022/23, Programme Working Groups (PWGs) bring together the MDAs and Local Governments that contribute to each programme. PWGs review draft budgets, apportion funds, and check that every agency has built climate actions—required in the Budget Call Circulars—into its work plan. Agencies must also report progress to the PWG, allowing climate-related spending and results to be consolidated in a single programme report and scrutinized by MoFPED.

Improve Budget Systems. Since FY 2023/24, the Programme Budgeting System includes dedicated item codes for mitigation and adaptation outlays. MDAs and LGs must tag any climate-related line with these codes; budgets submitted without them are automatically flagged for revision. The codes create a hard gate in the approval workflow, ensure climate spending is visible at every stage, and generate data that MoFPED can use to monitor execution and evaluate impact over time.

Build technical capacity. Sustained skills development is essential for climate-smart budgeting. MDAs and Local Governments need training in screening projects for climate risk, valuing mitigation and adaptation benefits, and applying cost–benefit or cost-effectiveness tools that meet international standards. Short courses could be paired with on-the-job mentoring, sector-specific toolkits, and a help desk

within the Budget Directorate. Partnerships with universities, the National Planning Authority, and development partners can supply data, analytical models, and refresher workshops. Over time, certification requirements for key budget officers would embed these competencies into the public service, ensuring that climate considerations remain embedded in project design, appraisal, and expenditure monitoring.

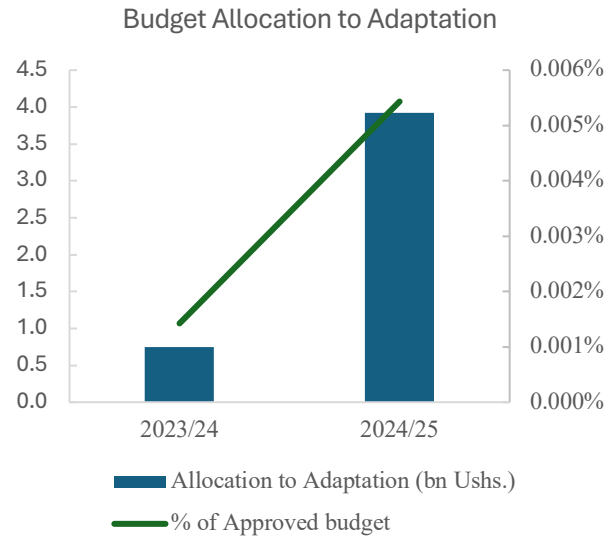
Current Efforts

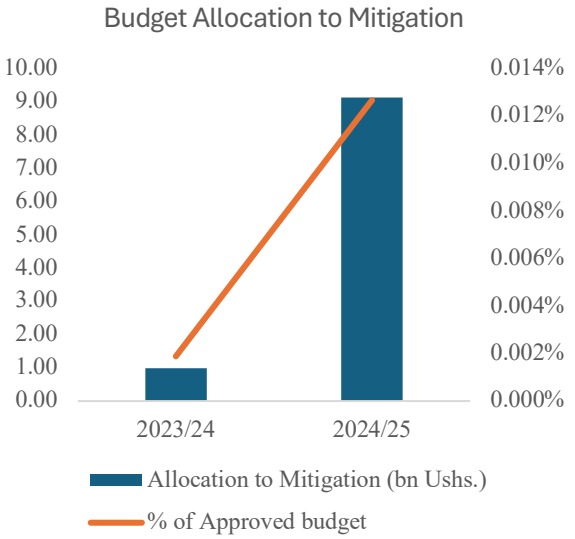
To effectively integrate CC into planning and budgeting frameworks, the Ugandan government can continue to draw on existing frameworks that embed climate goals directly into budgets and plans. Chief among them are the Climate Public Expenditure and Institutional Review (CPEIR), Climate Budget Tagging (CBT), and the Climate Change Financing Framework (CCFF). These tools offer step-by-step methods, data templates, and good-practice benchmarks for aligning financial planning, spending, and evaluation with mitigation and adaptation objectives.

Since FY 2022/23, Uganda has moved quickly to embed climate priorities in its public finances. The shift began with the adoption of Programme-Based Budgeting, which created the Natural Resources, Environment, Climate Change, Land and Water Management programme to advance Vision 2040's "green and clean environment" goal; ministries and local governments under this umbrella now fund tree planting, irrigation schemes, meteorological services, and other resilience measures. Building on this reform, MoFPED rolled out Climate Budget Tagging (CBT) in FY 2023/24 to satisfy Section 30 of the National Climate Change Act.

The Programme Budgeting System gained dedicated item codes for mitigation and adaptation, and every entity must attach these tags to relevant lines and submit a Certificate of Compliance to Climate Change with the Budget Framework Paper. Updated Budget Call Circulars make the tags compulsory—budgets that omit them are returned for revision—thereby forcing agencies to reckon with climate risk in their core activities. Early data suggest the approach is working. Tagged allocations rose from 0.0004 percent of GDP for adaptation and 0.0005 percent for mitigation in FY 2023/24 to 0.002 percent and 0.004 percent, respectively, in FY 2024/25, signaling growing political commitment to a climate-resilient fiscal framework.

Figure 1: Trend in Budget Allocations to Climate Change Adaptation and Mitigation Measures





Source: MoFPED Approved Budget Estimates, FY 2023/24 & 2024/25

The draft Fourth National Development Plan (NDP IV) retains the Natural Resources, Environment, Climate Change, Land and Water Management Programme, mandating it to cut climate vulnerability, restore forests and wetlands, and secure a clean, productive environment. While the Programme remains the hub for climate action, other programmes will also budget their own mitigation and adaptation activities through the new item codes. To deepen integration, Uganda can draw on structured tools such as the Climate Public Expenditure and Institutional Review (CPEIR), Climate Budget Tagging (CBT), Climate-Change Financing Frameworks (CCFF), and National Adaptation Plan (NAP) processes, which provide clear methods and benchmarks for embedding climate priorities,

boosting transparency, and using funds more efficiently. Yet international experience shows these frameworks succeed only when sequenced and adapted to a country's fiscal systems and technical capacity. Uganda should therefore conduct a thorough diagnostic before deciding which methodology—or combination of methodologies—to adopt and in what order.

Case Studies

Uganda can learn lessons from several countries that have already integrated climate change into their budgetary processes.

Bangladesh is often highlighted as a leading example of integrating climate change into its budgetary processes. The country has systematically mainstreamed climate considerations through developing a Climate Fiscal framework. The country has also introduced a Climate Budget Tagging system to identify and track climate-related expenditures across various sectors. This system helps in monitoring climate finance and ensures that resources are allocated effectively to priority climate actions. Since the first climate budget in FY 2017/18, every ministry and division is required to weight each budget line for its mitigation or adaptation relevance; the tags now cover 25 entities and six thematic pillars from the Bangladesh Climate Change Strategy and Action Plan. Tagged data are published each year in their Climate Financing for Sustainable Development report, giving Parliament and civil society a clear view of climate outlays. The latest report shows climate-labelled allocations rising to BDT 422 billion in FY 2025—10.09 % of the national budget and 0.75 % of GDP—up from roughly 7-8 % when tagging began.

Budget tagging is linked to the Annual Development Programme (ADP), which contains a dedicated climate chapter; this has channeled spending toward cyclone-resilient roads, solar home systems, and large-scale disaster-risk-reduction projects. Development-focused execution is strengthening: the share of tagged funds actually disbursed for development projects has climbed from 40 % in FY 2016 to 67 % in FY 2025. The gender dimension is also embedded through a Climate & Gender Action Plan and gender-responsive climate budgeting guidelines. International partners have rewarded these reforms—Bangladesh became the first Asian country to access the IMF's Resilience and Sustainability Facility, with US$220 million linked directly to its climate-budget framework in 2024.

However, having a dedicated section is a good practice, but it isn't satisfactory on its own; the issues of climate change, being development-oriented, should appear

in every sector of the economy. Current trends are running away from a specific sector targeting climate change, but as a whole of government approach, and the justification for making ministries of finance get more involved in these actions, as far as planning and budgeting is concerned, but the respective line ministries with expertise in implementation take on the projects and activities.

The Philippines has integrated climate change into its budgetary processes in response to its vulnerability to natural disasters. The Climate Change Act of 2009 established the Climate Change Commission to coordinate the integration of climate considerations into national and local planning. The government created the People's Survival Fund (PSF), a dedicated mechanism within the national budget that finances local government climate adaptation projects. The country also implements climate budget tagging to track, classify, and monitor climate expenditures, ensuring funds reach priority climate actions.

Rwanda is another country that has aligned its financial planning with climate and development goals through its Green Growth and Climate Resilience Strategy (GGCRS), which is embedded in the national development planning process. The government established the Environment and Climate Change Fund (FONERWA) within the national budget to finance mitigation and adaptation activities. Rwanda uses climate budget tagging to track expenditures and ensure resources reach priority climate actions while enhancing transparency in climate finance. These efforts have helped Rwanda balance economic growth with environmental protection, mobilize domestic and international climate finance, and achieve greater policy coherence with national climate goals.

Mexico, on the other hand, has integrated climate change into its budgetary processes through the General Law on Climate Change, which mandates climate considerations in national and sub-national planning and budgeting. The country operates a climate budget tagging system to track and monitor climate expenditures within the national budget. Mexico's Climate Change Fund, integrated into the national budget, provides financial resources for mitigation and adaptation projects across sectors.

These cases demonstrate common approaches for climate integration into the budget, yet also how design choices affect results. Each country established a legal foundation for climate budgeting. Bangladesh's Climate Fiscal Framework (2014, updated 2020) requires 25 ministries to report climate financing annually. The Philippines' Climate Change Act (2009) created a Climate Change Commission and

mandated climate mainstreaming in budgets. Rwanda embedded climate goals in its 2011 Green Growth Strategy with finance ministry guidelines for budget tagging. Mexico's General Law on Climate Change (2012) requires federal entities to integrate climate considerations into annual budgets.

All four countries use budget tagging to track climate spending, but implementation quality differs significantly. The Philippines tags every program and project, with climate allocations reaching around 9-12% of the 2024 budget. Bangladesh reports that climate-labeled development spending has risen to 67% of outlays, up from 40% in 2016. Rwanda uses Rio-marker scores and publishes an annual Climate Budget Statement, but estimates it needs to nearly double allocations to meet 2030 targets. Mexico tags MXN 234 billion (2.7% of total spending), though civil society analysis suggests only one-quarter has clear climate relevance—highlighting the risks of loose tagging standards.

Each country, moreover, created dedicated financing mechanisms with mixed results. Bangladesh channels funds through its Annual Development Programme, which includes a climate chapter for resilient infrastructure and renewable energy. The Philippines operates the People's Survival Fund, a ₱1 billion adaptation facility that has approved six local projects. Rwanda's FONERWA has mobilized US$250 million for 46 projects and plans to issue green bonds. Mexico's Climate Change Fund, while integrated into the budget, faces low disbursement and weak coordination, demonstrating that governance matters as much as legal status.

Uganda, for its part, has taken steps to integrate climate change into planning and budgeting through its green growth strategy, NDCs, NAPs, and sector-specific climate plans. The country has developed a disaster risk assessment tool for priority selection and budget tagging tools to monitor climate expenditures. It has also expanded its use of macroeconomic modeling tools, including extensions of the Social Accounting Matrix (SAM), to evaluate economic impacts from climate shocks. However, these interventions remain disintegrated and need harmonization to be effective. And, unlike the case studies discussed, Uganda lacks a dedicated climate fund for either central or local government use, limiting its ability to channel resources systematically toward climate priorities.

Challenges

Integrating climate data into budgeting processes is crucial for effective climate action. However, this integration is fraught with numerous institutional and

technical barriers. These challenges can hinder the systematic incorporation of climate considerations into financial planning and evaluation, potentially compromising the effectiveness of climate policies and strategies.

In some countries, Climate change may not be a top priority for political leaders, especially when there are immediate economic or social issues demanding attention. In addition, effective integration of climate data requires strong leadership and commitment at the highest levels of government to drive the necessary policy and institutional changes.

The cross-cutting nature of climate change demands coordination across multiple sectors and agencies, but fragmented institutional frameworks typically produce siloed approaches and incoherent strategies. Overlapping mandates among institutions create confusion and inefficiencies in the budgeting process. In fragile states, these challenges are compounded by limited institutional capacity to manage climate risks alongside other pressing development needs (IMF, 2024a).

Most institutions lack personnel trained to analyze and incorporate climate data into budgets, limiting their capacity to develop and monitor climate-informed budgeting frameworks. Data gaps persist, particularly regarding local-level climate impacts, vulnerabilities, and emissions (World Resources Institute, 2013). Limited analytical tools and methodologies compound these challenges, while the uncertainties inherent in climate projections complicate integration efforts.

Financial constraints further restrict capacity building, data collection, and tool development. Many developing countries are already allocating significant portions of their budgets—up to 5 percent of GDP in some African countries—to climate adaptation from their own resources, leaving little room for necessary system improvements (UN ECOSOC, 2023). This is a particularly relevant constraint in Uganda at the moment, where the cost of raising and servicing debt is high, and the debt is above 50 percent of GDP and increasing.

A critical challenge is also the timing mismatch between budget cycles and climate planning. Annual or biennial budgets struggle to accommodate climate investments that require decades-long planning horizons. Additionally, most climate budget tagging systems focus only on direct expenditures, excluding tax expenditures and subsidies (such as fossil fuel subsidies) and failing to identify spending that may have negative climate impacts. Even where tagging exists, it typically occurs after

programs have been planned and budgeted, with little evidence that this data actually influences resource allocation decisions (World Bank, 2021).

Addressing these barriers requires coordinated action across multiple levels. Political leaders need education on the importance of climate-informed budgeting to build champions at all government levels. Institutional reforms should improve inter-agency coordination, establish clear mandates, and define responsibilities for climate data integration.

Governments must establish clear indicators and metrics to track progress and ensure accountability in aligning financial planning with climate objectives. These indicators and metrics help track progress, evaluate the effectiveness of integration efforts, and ensure accountability in aligning financial planning with climate objectives. By systematically monitoring these indicators, governments and stakeholders can assess the effectiveness of their climate budgeting efforts, ensure transparency and accountability, and make informed adjustments to enhance the alignment of financial planning with climate objectives.

Conclusion

Addressing climate change through adaptation and mitigation requires transforming national planning and budgeting processes to incorporate climate considerations systematically. While climate-integrated budgets typically require higher upfront investments than conventional budgets, accounting for medium and long-term benefits—including avoided climate damages, enhanced productivity, and reduced reconstruction costs—demonstrates their economic viability. Clear communication of these cost-benefit analyses to policymakers and stakeholders throughout the budget process is essential for building support and maintaining momentum for reform.

Countries can draw on existing international frameworks to guide climate budget integration, but these must be adapted to local institutional contexts, capacity constraints, and development priorities. Success depends on strong coordination across government, with ministries of finance playing a central leadership role in aligning climate commitments with fiscal realities. This requires ensuring that Nationally Determined Contributions (NDCs) and National Adaptation Plans (NAPs) are not standalone documents but are fully integrated with national development plans and reflected in annual budget allocations. The ultimate goal is a unified approach where climate and development objectives are inseparable—where every

development plan is inherently climate-smart, and every budget decision considers climate risks and opportunities.

Countries that successfully mainstream climate into their budgeting processes position themselves not just to manage climate risks, but to capture the economic opportunities of the global transition to resilience and sustainability. In this way, climate budgeting becomes not a burden but an investment in long-term prosperity and economic stability.

References

C40 Cities Climate Leadership Group. (2023, April). How to use climate budgeting to mainstream climate action across the city government. C40 Knowledge Hub. https://www.c40knowledgehub.org/s/article/How-to-use-climate-budgeting-to-mainstream-climate-action-across-the-city-government?language=en_US

Fahmida, K., & Syed, Y. (2024). Climate budget in Bangladesh: Balancing needs and building resilience.

GCCA. (2011, October 22). Module 8: Mainstreaming climate change in the budgetary process. Global Climate Change Alliance.

Ghimire, D. (2023). Towards equity and inclusion: Analyzing gender equality and social inclusion in Nepal's budgeting process – A comprehensive review. KMC Research Journal, 7, 36-56.

Government of Uganda. (2021). National Climate Change Act. Government of Uganda.

Government of Uganda/National Planning Authority. (2024). Draft fourth national development plan (NDPIV), 2025/26 - 2029/30. National Planning Authority.

International Monetary Fund. (2023). Scaling up climate finance for emerging markets and developing economies. https://www.imf.org/en/News/Articles/2023/02/28/sp022823-scaling-up-climate-finance-for-emerging-markets-and-developing-economies

International Monetary Fund. (2024a). Capacity development: IMF annual report 2024. https://www.imf.org/external/pubs/ft/ar/2024/what-we-do/capacity-development/

International Monetary Fund. (2024b). Kenya: Technical assistance report - Climate module of the public investment management assessment. Technical Assistance Reports, 2024(009). https://www.elibrary.imf.org/view/journals/019/2024/009/article-A001-en.xml

Marinheiro, C., et al. (2024). The climate dimension of fiscal policy sustainability: Best practices in green budgeting and lessons for Portugal. [Journal name needed], 195-218.

Ministry of Finance, Planning and Economic Development. (2021, May). Selection criteria for projects to enter into the public investments plan after appraisal by the development committee. MoFPED.

Sikhosana, N., et al. (2024). Gender-responsive budgeting in climate change financing: A panacea for confronting climate change vulnerability in South Africa? [Journal name needed], 21-34.

UN Economic and Social Council. (2023). End structural, financial roadblocks for developing countries to tackle climate crisis, sustainably transform infrastructure, speakers tell Financing for Development Forum. https://press.un.org/en/2023/ecosoc7120.doc.htm

Walczak, M. (2023). The role of budgeting in the strategic planning process in an enterprise. Humanities & Social Sciences Reviews, 11, 30-33.

World Bank. (2014). Moving toward climate budgeting. World Bank Group.

World Bank. (2021). Climate change budget tagging: A review of international experience. World Bank Group. https://openknowledge.worldbank.org/handle/10986/35174

World Resources Institute. (2013). Monitoring climate finance in developing countries: Challenges and next steps. https://www.wri.org/research/monitoring-climate-finance-developing-countries-challenges-and-next-steps

Yurchyshena, L. (2024). Adaptation of the financial planning and budgeting system to the modern model of university development. Business Inform, 3, 316-322.

6 Crop adaptation to climate change-induced changes to agricultural productivity in Uganda

Tessa Bold and Vera Kågström

Introduction

The Ugandan economy remains heavily dependent on rain-fed agriculture. According to the Uganda National Household Survey (UNHS) 2019/20, 68 percent of the working population is employed in agriculture, and the sector contributes 24 percent to national GDP (UBOS, 2022). This chapter examines the potential impacts of climate change on agricultural productivity, with a focus on attainable yields for key crops produced in Uganda. Using data from the Global Agro-Ecological Zones (GAEZ) database, we first document historical climate patterns in Uganda. We then assess projected climate conditions and crop yield potential under different Representative Concentration Pathway (RCP) scenarios developed by the Intergovernmental Panel on Climate Change (IPCC). By combining historical and projected climate data with yield simulations, the analysis highlights both the risks and opportunities that climate change poses for Uganda's agriculture, with implications for food security and development strategies.

The results show that Uganda's climate is expected to become hotter and wetter under most models and RCPs. When translated into agronomic yield predictions, the impacts are heterogeneous: relatively modest on average for many crops, positive for some, and negative for others—most notably maize. While uncertainty increases over longer forecast horizons, these findings are consistent with other prominent studies, which similarly project hotter and wetter conditions and modest average yield changes. However, the crop-level differences are striking: maize yields, Uganda's third most common crop, are projected to fall significantly—by as much as 30 percent under severe scenarios—while banana and coffee yields may increase, suggesting that crop-switching could serve as a viable adaptation strategy.

These results should be understood in the context of Uganda's already low agricultural productivity and rapid population growth. Raising yields through improved inputs and a shift toward higher-value produce offers considerable economic opportunity, as shown by recent research (Bold et al., 2022). At the same time, moving labor out of agriculture and into manufacturing and agribusiness can help close Uganda's productivity gap with advanced economies (Lagakos & Waugh, 2013), while also accommodating the shifts in agricultural suitability brought about by climate change (Nath, 2023).

GAEZ Data and Modelling Assumptions

As a preface to the analysis, this section discusses the data sources and modeling assumptions that underpin the results. The analysis relies on the Global Agro-Ecological Zones (GAEZ) database, produced by the United Nations Food and Agriculture Organization and the International Institute for Applied Systems Analysis (Fischer et al., 2021). Two categories of data are used: climate data and attainable yield data.

Climate data

Historical climate data are drawn from the GAEZ database, which integrates multiple sources: the Climatic Research Unit TS v3.21 datasets (Harris et al., 2014), the Global Precipitation Climatology Centre Full Data Reanalysis Product Version (Schneider et al., 2011), and the EU WATCH Integrated Project (Weedon et al., 2011).

For future climate, we use GAEZ projections based on the Intergovernmental Panel on Climate Change's Fifth Assessment Report (IPCC, 2014). These projections cover four Representative Concentration Pathways (RCPs)—RCP 2.6, RCP 4.5, RCP 6.0, and RCP 8.5—spanning 2011 to 2100. The scenarios represent progressively severe climate outcomes: from stringent mitigation of greenhouse gas emissions (RCP 2.6) to a "business-as-usual" path characterized by persistently high emissions (RCP 8.5). Each RCP scenario is modeled using multiple climate models rather than a single one, to enhance robustness and reduce reliance on any one specification. Because models differ in structure and assumptions, their projections vary. To capture a central tendency, the ensemble mean—the average across models—is also included in the analysis.

Estimates of attainable yield

For the second part of our analysis, we use data on agricultural productivity from the GAEZ database. GAEZ provides detailed estimates of crop yield (in dry weight kg per hectare) for specific crops at specific locations.

The GAEZ data is not based on observed yields from agricultural production. Instead, it is calculated with the help of an agro-ecological modelling framework. This model estimates yield for a particular crop as a function of

local agro-climatic and agro-edaphic conditions, specific requirements of the crop and crop management. Among the factors of the local environment that are considered are climate variables such as temperature and precipitation, soil quality, and terrain. Some of the crop-specific requirements that are taken into account are crop water requirements and crop calendars. By taking in data on all of these parameters and simulating the growth process of the crop in a given location, the model produces an estimate of attainable yield - the maximum yield achievable for a specific crop, at a given location, under the location's environmental conditions and the crop's environmental requirements.

For forecasts, the model assumes that farming is carried out using advanced, highly productive methods. This includes using modern high-yield crop varieties, mechanized equipment, and optimal amounts of fertilizers, pesticides, and other inputs, as would be typical in large-scale commercial agriculture. We use crop yield estimates that are produced under the assumption that all crops are rain-fed.

Importantly, the model is designed to estimate attainable yields under average climate conditions, rather than conditions of a specific year. To achieve this, it uses climate data averaged over 30-year reference periods, which provide a stable representation of long-term climatic trends. For example, the estimates for the 1981–2010 period reflect the average climate conditions observed during those three decades. This approach ensures that the attainable yield estimates represent the potential productivity under typical conditions for a given reference period, rather than year-to-year variations. The estimates are also calculated at a fine geographical scale, with location-specific projections produced for grid cells of approximately 10 by 10 kilometers. These detailed estimates account for variations in agro-climatic and agro-edaphic conditions across Uganda. In each grid cell, the attainable yield is estimated for the portion of land classified as cropland in 2009–2011[7], independent of which crops are actually grown on that land. While the analysis reports aggregated country-level averages of attainable yields, these values are based on detailed, location-specific data.

[7] Cropland classification is based on the FAO's GLC-Share database (Latham et al., 2014) and GMIA v5 (Siebert et al., 2013).

Since attainable yield is estimated as a function of climate, it is possible to estimate future attainable crop yields based on predicted future climate. GAEZ provides estimates of attainable yield for the years 2011-2100 for the four climate change scenarios used in the fifth IPCC report. This enables us to analyze how attainable yields might evolve in different climate change scenarios.

It is important to note that the GAEZ estimates of attainable yield are conceptually different from actual yields observed in agricultural production. While actual yields are influenced by factors such as farming practices, market access, and resource availability, attainable yield represents the maximum productivity possible under ideal conditions—assuming modern crop varieties, optimal inputs, and advanced farming techniques are used.

In summary, the GAEZ model predicts how climate change affects maximum potential yields under different climate change scenarios, under given environmental conditions, crop-specific requirements and for given crop management assumptions. We use these predictions as indicators of how climate change will impact actual future crop yields in Uganda, in a scenario where advanced, highly productive methods are used in the agricultural sector.

The historical evolution of climate in Uganda

Figure 1 presents trends in temperature-related metrics averaged across three thirty-year periods: 1961–1990, 1971–2000, and 1981–2010. Panel (a) shows a gradual decline in the length of the growing period—the period of time when temperatures remain above 5°C and soil moisture is sufficient for crop growth. This has shortened from approximately 318 days in the earliest period to around 310 days in the most recent period. Even small reductions in the length of the growing season can have meaningful implications for planting cycles and harvests. Panel (b) indicates a marked rise in the number of days with temperatures exceeding 35°C, climbing from close to zero in the earliest period to more than three days in the most recent. While this remains a relatively small share of the year, the upward trend points to mounting heat stress risks for crops and farm labor.

Panels (c) and (d) demonstrate that there are no recorded instances of days exceeding 40°C or 45°C across any of the three periods, with values

consistently at zero. This suggests that Uganda has not yet faced the most extreme heat thresholds observed in other regions.

Taken together, these findings highlight that there has been a gradual shortening of the agricultural growing season and a rising frequency of moderately extreme heat days. And while Uganda has not yet encountered the most severe heat extremes, these incremental changes already signal growing pressures on agricultural productivity and underscore the importance of forward-looking adaptation strategies.

Figure 2 Historical Temperature Regime, 30-year averages

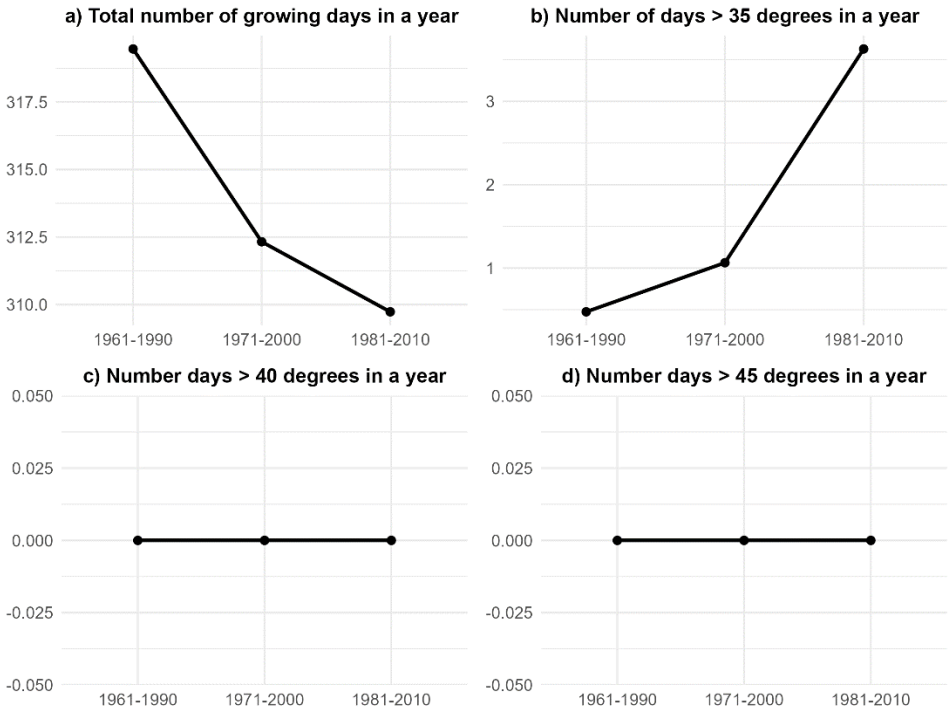


Figure 2 presents trends in precipitation-related metrics averaged across the same three thirty-year periods: 1961–1990, 1971–2000, and 1981–2010. Panel (a) shows that the longest consecutive dry spell during the growing season has lengthened, rising from an average of 9.5 days in 1961–1990 to more than 11 days in 1981–2010. Longer dry spells during the growing season can create critical stress periods for crops, even if rainfall is adequate on average. Panel (b) records a steady decline in the overall number of dry days during the growing season, falling from roughly 140 days in the earliest period to about 100 days in

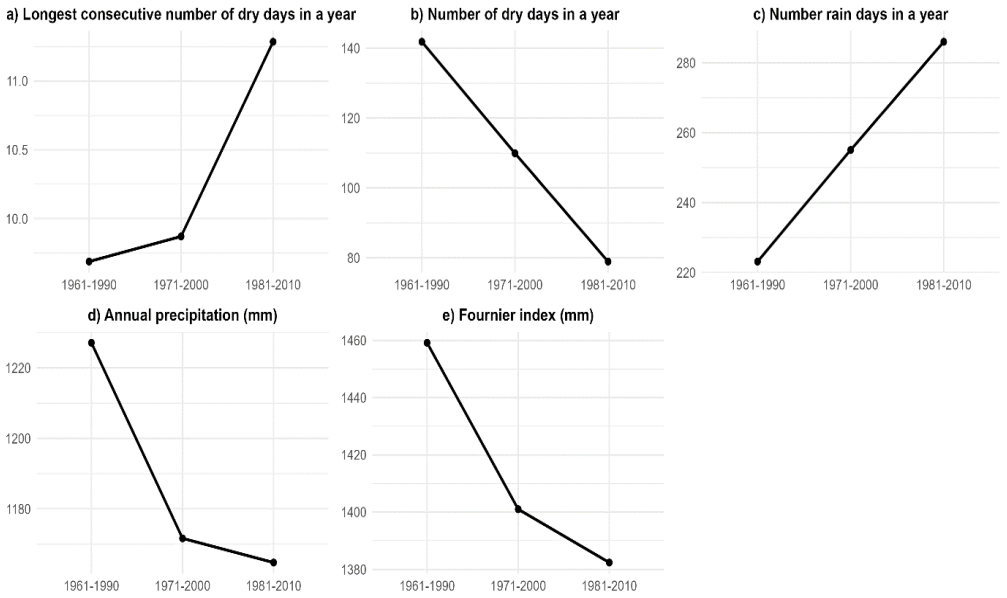
the most recent. Consistent with this trend, panel (c) indicates a sharp increase in the annual number of rain days, rising from about 220 days to more than 280 days over the same horizon.

Panel (d) illustrates that, despite the increase in rainy days, total annual precipitation has declined, dropping from over 1,220 mm in 1961–1990 to below 1,180 mm in 1981–2010. This implies that rainfall is becoming more frequent but lighter in intensity on average.

Finally, panel (e) plots the modified Fournier index, which measures how rainfall is distributed throughout the year. If rainfall were evenly spread across months, the index would equal total annual precipitation; if it all occurred in a single month, the index would be twelve times higher. The index shows a downward trend across the three periods, broadly consistent with the observed decline in total precipitation.

Together, these results point to important shifts in Uganda's rainfall patterns: more rainy days but lower overall rainfall, lighter intensity, and longer single dry spells during the growing season. These changes suggest a greater risk of water stress for crops despite more frequent rainfall events, underscoring the need for improved water management and resilience strategies in agriculture.

Figure 2. Historical Moisture Regime, 30-year averages



Overall, the analysis suggests that Uganda's temperature and moisture regime has changed neither dramatically nor necessarily malignly over the last 60 years. We now turn to climate projections under different scenarios for climate change until 2080.

Climate forecasts for Uganda from the 2020s until the 2080s

Figure 3 displays projections of future climate for Uganda, showing trends in annual temperature- and precipitation-related metrics averaged across three thirty-year periods: 2011–2040, 2041–2070, and 2071–2100. Overall, the projections suggest a relatively stable outlook for Uganda's moisture regime across most climate models and RCP concentrations. For the longest consecutive number of dry days during the growing period, most models—though differing in absolute levels—predict a reduction across all RCPs, in contrast to the historical trend of increasing dry spells. Importantly, these projections show little sensitivity to the severity of the emissions pathway. Similarly, the total number of dry days and rain days is expected to remain broadly stable across time and scenarios. This contrasts with historical experience, where dry days declined and rain days increased. It should be noted, however, that there is significant variation in levels across models. Only two climate models (HadGEM2-E5 and IPSL-CM5A-LR for the longest consecutive dry days; HadGEM2-E5 and MIROC-ESM-CHEM for dry days and annual rain days) predict near-term outcomes that overlap with historically observed averages (1981–2010).

Most models forecast relatively stable annual precipitation, with slight increases under higher RCPs. An exception is IPSL-CM5A-LR, which projects sharp rises—around one-third under RCP 4.5 and RCP 6.0, and nearly two-thirds under RCP 8.5. This diverges from the historical pattern of declining rainfall. The Modified Fournier Index also rises under these projections, and more strongly than total precipitation, suggesting rainfall will become increasingly concentrated in shorter periods.

With respect to the temperature regime, the number of hot days is projected to rise substantially, with particularly dramatic increases under high-emission scenarios in the MIROC-ESM-CHEM model. Taken together, the projections indicate that while Uganda's growing period for the reference crop is likely to remain stable—or even lengthen slightly under higher RCPs—the agricultural sector will face mounting challenges from increased heat exposure and greater concentration of rainfall.

Overall, the climate change projections for Uganda point to relatively moderate long-term trends, though these diverge from historical patterns. It is important to stress, however, that such averages obscure the increasing variability of weather and the growing likelihood of extreme events. As a result, the attainable yield projections presented below—which are based on these long-term climate averages—do not fully capture the risks to crops arising from heightened variability and climate extremes.

Projections for attainable yields in six major crops

We next assess the impact of climate change on attainable yields for six major crops in Uganda: banana/plantain, cassava, maize, beans, sweet potato, and Arabica coffee. The first five are the most widely produced crops (UBOS, 2022), while coffee is a leading export. Figure 4 compares projected changes in attainable yields under four climate scenarios to baseline yields estimated for the reference period 1981–2010.

As with the climate projections discussed earlier, results show considerable uncertainty, with significant variation across models. This uncertainty grows over time, with projections for the latter part of the century diverging more sharply. The severity of the emissions pathway also amplifies trends: positive yield changes observed under low-emission scenarios (e.g., RCP 2.6) become more pronounced under high-emission scenarios (e.g., RCP 8.5), while negative trends similarly intensify.

Average attainable yields for banana and coffee are projected to increase substantially. Both crops show early gains that stabilize under the low-emission pathway, while under high emissions, yields continue to rise through the century. In contrast, yields for cassava, sweet potato, and beans are projected to remain broadly stable, with modest positive trends. An exception is the IPSL model, which produces unusually large increases for cassava and sweet potato under RCP 4.5; the underlying drivers of this outlier remain unclear and merit further investigation. By contrast, maize shows consistent yield declines across all scenarios, with losses becoming more severe later in the century.

Taken together, these projections suggest that a gradual shift away from maize and toward crops such as banana and coffee could serve as a potential adaptation strategy. However, given the significant model uncertainty—particularly regarding whether climate change ultimately benefits or harms banana and coffee—such strategies must be approached cautiously and supported by ongoing monitoring and research.

Figure 3 Temperature and moisture regime forecasts, 30-year averages

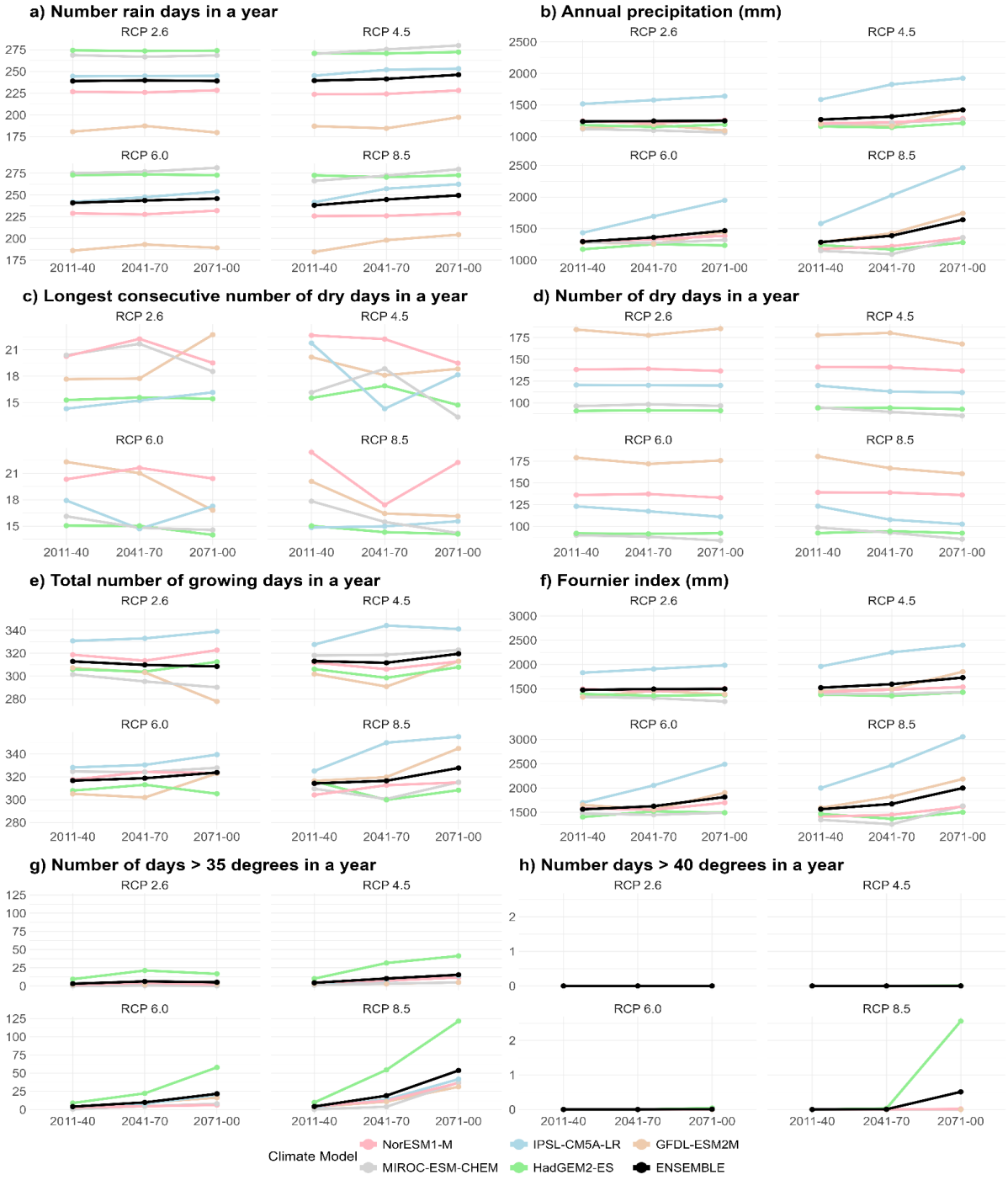
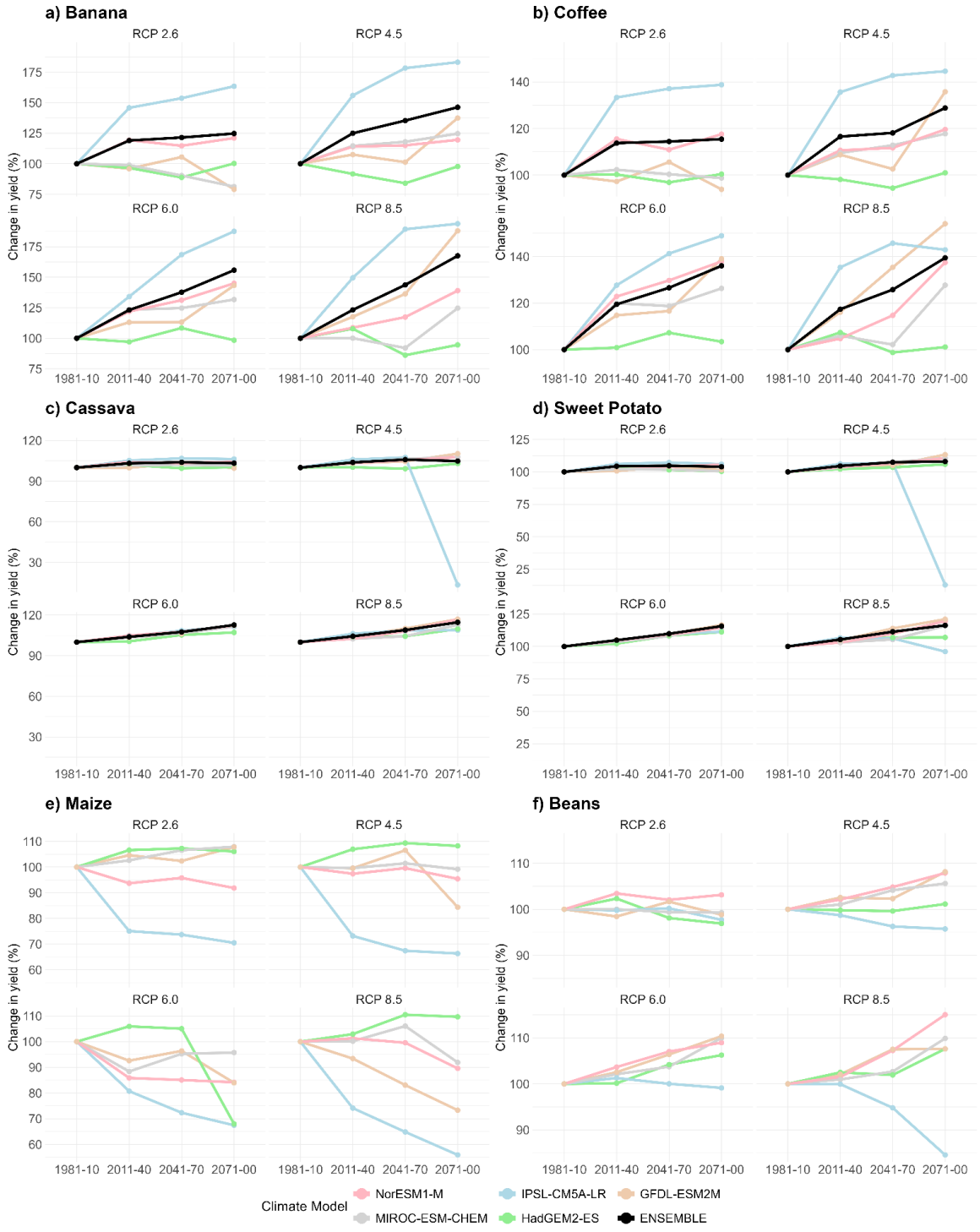

a) Number rain days in a year
b) Annual precipitation (mm)
c) Longest consecutive number of dry days in a year
d) Number of dry days in a year
e) Total number of growing days in a year
f) Fournier index (mm)
g) Number of days > 35 degrees in a year
h) Number days > 40 degrees in a year
RCP 2.6
RCP 4.5
RCP 6.0
RCP 8.5
2011-40
2041-70
2071-00
Climate Model
NorESM1-M
IPSL-CM5A-LR
GFDL-ESM2M
MIROC-ESM-CHEM
HadGEM2-ES
ENSEMBLE

Figure 3 Projected attainable yield under different climate change scenarios[8]



[8] Ensemble predictions of attainable yields were not available for maize and beans.

Intensifying agriculture

For the attainable yield estimates based on 1981–2010 climate data, the GAEZ database also provides a separate set of estimates for each crop under the assumption of subsistence farming practices rather than industrialized production techniques. These "low input" estimates reflect traditional farming methods, including the use of local cultivars, labor-intensive techniques, and minimal application of fertilizers or pest control. Figure 5 compares these low-input yields to the "high-input" estimates, which assume industrialized methods and modern technologies. This contrast provides insight into how far Uganda's productivity frontier could shift with broader adoption of improved farming practices. In this context, the "productivity frontier" refers to the maximum attainable yield under given conditions. The gap between low-input and high-input yields therefore, illustrates the potential for technological and input-driven improvements in agricultural productivity.

To place these projections in context, we also include average observed crop yields for 2009–2011[9], drawn from FAO's global statistical database (FAOSTAT, 2024)[10][11]. It is important to note, however, that attainable and observed yields are calculated differently and are therefore not directly comparable. Attainable yields represent averages across all croplands in Uganda, while observed yields are calculated only over land actually cultivated with that specific crop. If crop allocation is influenced by land suitability, observed yields may appear higher than attainable yields. Ideally, one would compare observed yields to attainable yields averaged only over the land on which a crop is grown, but such disaggregated data are unavailable.

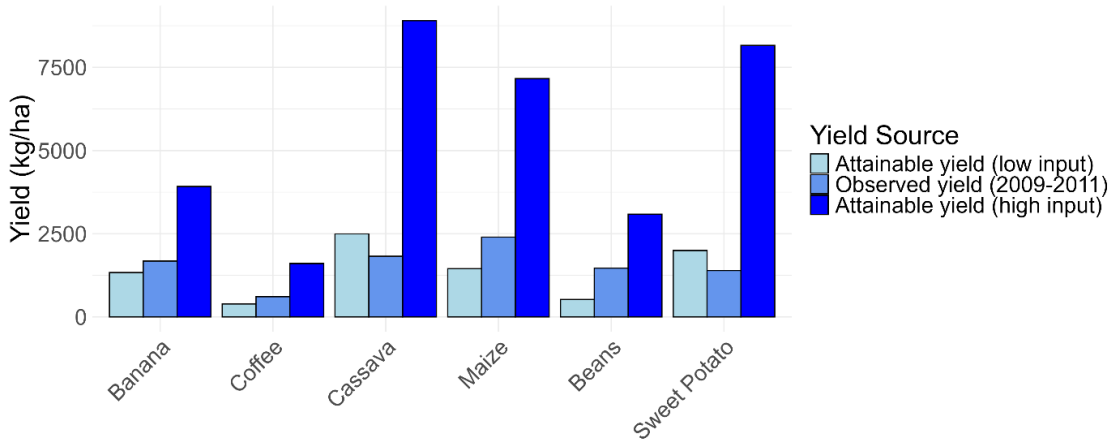
With these caveats in mind, the comparison of observed yields to attainable yields remains instructive. It highlights both the gap between actual productivity and the low- versus high-input frontiers, and the potential gains Uganda could achieve by adopting more advanced production techniques.

[9] The time period is chosen to match the one used for cropland classification for the GAEZ data.

[10] In contrast to GAEZ, FAOSTAT report yields for banana and plantains separately. In for this comparison, banana-yields from FAOSTAT are used.

[11] FAOSTAT reports banana, cassava and sweet potato yields in fresh weight. We convert these yields to dry weight by multiplying with (1 – moisture content) for each crop, based on moisture content.

Figure 5. Attainable and observed yield at baseline



Observed yields for banana, cassava and sweet potato have been converted from fresh to dry weight

Across all six crops, the data reveal a substantial gap in attainable yields between subsistence farming and modern, industrialized practices. There is also a significant gap between current observed yields and the attainable yields achievable under modern practices. These findings suggest that Uganda has considerable potential to improve agricultural productivity by transitioning to modernized farming systems.

Average attainable yields increase by 190–490 percent when moving from "low-input" to "high-input" levels, with maize and beans showing the greatest responsiveness. Comparing observed yields to high-input attainable yields shows similarly large gaps across all six crops.

The gap between low-input attainable yields and observed yields may reflect differences in crop management—for example, higher use of improved seeds, fertilizer, or equipment than assumed under the subsistence scenario. As discussed earlier, it may also reflect crop allocation, since farmers often plant crops on more suitable land, producing higher yields than the national average. More detailed analysis would be needed to separate the effects of crop allocation from those of input use. Nonetheless, taken together, the results suggest that large productivity gains could be achieved through broader adoption of modern inputs and practices.

Finally, while we used 2009–2011 observed yields to align with the reference period of the attainable yield data, it is worth noting that more recent figures show mixed

trends. Maize and banana yields in 2023 remain at similar levels to the earlier period, while coffee, cassava, and bean yields are markedly lower.

Limitations and discussion

There are some important limitations to our analysis. These mainly have to do with the choice of using model-based yield data and of the applicability of the GAEZ-data to the conditions in Uganda. Model-based assumptions. Estimating crop yields through models requires numerous assumptions about how environmental conditions, crop characteristics, and management practices interact. Both plants and human management systems are complex, and these interactions are difficult to model accurately. Certain limitations of the GAEZ model have already been flagged, including incomplete consideration of factors such as soil and vegetation degradation and declines in water quality and availability. The model incorporates the effects of management practices (e.g., fertilizer, pesticide, and equipment use) only in a limited way. It is also better suited to capturing changes in long-term averages, such as rising mean temperatures, than the impacts of climate variability, which often drive agricultural risks year-to-year.

Generality of agronomic data: Because GAEZ is designed for global application, it relies on broad generalizations about crop requirements. As a result, environmental thresholds for some crops may not be perfectly calibrated to Uganda's agro-ecological conditions, which can compromise accuracy.

Focus on modern production: GAEZ primarily provides yield estimates under modern, fully industrialized farming practices. This means it cannot model a "status quo" scenario where subsistence farming continues to dominate Uganda's agricultural system through the 21st century. Yield outcomes under such a scenario could look dramatically different, leading to different conclusions about crop suitability.

Data updates: The most recent GAEZ release (2021) includes historical climate and yield data only up to 2010. All subsequent results therefore rely on climate projections rather than updated observed data, which may reduce precision.

Despite these limitations, the results we present are broadly consistent with other sources. For climate, GAEZ projections for Uganda match the World Bank's Uganda Climate Risk Report (2020), which also forecasts rising temperatures, more hot days, and increases in rainfall and rainfall intensity. For yields, the GAEZ projections

for maize align closely with meta-analyses of process-based climate models. Challinor et al. (2014), based on 1,700 simulations, estimate maize yield reductions of 5–20 percent in tropical regions for local mean temperature increases up to 5°C. Similarly, Knox et al. (2012), reviewing 1,144 studies, find an average maize yield decline of around 5 percent across Africa, though with high variation—including predictions for Kenya ranging from yield doubling to a 50 percent decline. The one study available for Uganda predicts a decline of about 20 percent, consistent with the GAEZ results.

For other crops, however, GAEZ projections are less pessimistic than some alternative assessments. The World Bank's Uganda Climate Report—drawing on the Ministry of Water and Environment's analysis—foresees significant reductions in the suitability of Arabica coffee production. The impact on Robusta coffee, which remains Uganda's dominant variety, has been less studied.

Finally, we reviewed other literature to assess how the increased climate and weather variability expected under climate change—though not captured in the GAEZ projections—could affect agricultural yields in Uganda. Ray et al. (2014) examine the role of climate variability in driving yield variability globally. They find that maize yields in Uganda are less variable (coefficient of variation 0.10–0.15) than in neighboring Kenya (0.15–0.25) and Tanzania (0.25–0.50). Moreover, in Uganda only 15–30 percent of the variation in maize yields is attributable to climate variability, compared to 60–70 percent in Kenya.

Overall, there remains substantial uncertainty about the long-term impacts of climate change on yields, given both model limitations and the complexity of crop–climate interactions. However, evidence from multiple studies indicates that Uganda occupies a relatively distinct position within East Africa. Its more temperate climate and higher average altitude appear to provide some protection, leaving the country less exposed to the most severe impacts of climate change than its neighbors.

Summary and Policy Recommendations

We have shown that Uganda's climate is predicted to become both hotter and wetter under most climate models and RCPs. When these climate predictions are then fed into agronomic models to predict yields, several things stand out:

1. Climate change impacts are predicted to be relatively modest on average for most crops; however, with important variation across the climate models used.
2. Expectedly, there is a huge variation and uncertainty across models and simulations that increases the longer the forecast horizon.
3. Across a wide range of models and scenarios, maize, the third most common crop in the country, is predicted to experience sizeable yield losses, up to 30% in the most negative scenarios, with coffee and banana predicted to see yield increases in most scenarios. This suggests crop switching as an important mitigation strategy.

These predictions should be read against the general background of agricultural productivity in Uganda, which is low and stagnant, coupled with a robust population growth of 3% per annum, implying that the population will have doubled by 2050. We therefore also emphasize the continued need to modernize agriculture. The gains in yield to be expected from this (predicted to be of the order 200% or more) – possibly combined with crop switching -- present a good opportunity to protect against the yield losses predicted to arise from climate change and other risks to food security and prosperity. Below, we discuss some policy options that could be relevant for the Ugandan government to consider in light of the results of our paper and the economic situation Uganda finds itself in.

However, Bold et al. (2017) suggest that encouraging farmers to adopt hybrid seeds and modern fertilizers is challenging due to farmers' low trust in the quality of these products available locally. Both Bold et al. (2017) and Barriga and Fiala (2020) demonstrate that fertilizer and seed quality in Uganda are generally poor. Barriga and Fiala attribute this low quality mainly to inadequate storage and mishandling practices. They argue that policy interventions should therefore prioritize improvements in storage and handling rather than investing in costly certification schemes. Furthermore, even if input quality issues were addressed, farmers might still find it difficult to afford modern agricultural technologies because profitability remains limited.

Improving Input Quality and Technology Adoption*:* As the climate becomes more volatile, encouraging the adoption of higher-quality inputs and climate-resilient technology in agriculture. This is important for increasing agricultural productivity in Uganda more broadly and speaks to the challenge of low adoption of yield-enhancing technologies, which has been a persistent concern for policymakers throughout SSA. In Uganda, the latter is closely linked to farmers' distrust of input quality. Evidence shows that a significant share of inputs on the agricultural market is substandard—for example, Bold et al. 2017 found that fertilizer from local

retailers in Uganda contains about 30% less nutrients than labeled, and hybrid maize seed may contain less than 50% genuine improved seed. Such low-quality inputs result in near-zero or even negative returns for farmers, rationalizing their hesitancy to invest in them. To break this low-adoption trap, policymakers could enact measures that improve input quality and rebuild farmers' confidence in technology, such as implementing testing and certification for seeds and fertilizers at multiple points in the supply chain. Additionally, the introduction of input verification tools can empower farmers – for example, scratch-off codes and SMS verification on seed packages have been piloted to assure buyers of authenticity (Michelson et al., 2021). Such innovations, alongside public awareness campaigns about quality-improved inputs, can increase farmers' willingness to pay for and adopt modern technologies once they are confident in their effectiveness.

***Improve Storage and Handling in the Input Supply Chain**:* Alternatively, research has also found that seed quality in Uganda often deteriorates after leaving breeder facilities, largely due to poor storage and handling, rather than intentional fraud (Barriga & Fiala, 2020). High temperature or moisture during transport and at local shops can drastically reduce seed germination rates, which will be worsened by climate change. Policies should support better handling practices – for instance, training agro-dealers in proper storage techniques and investing in distribution infrastructure (like cooled storage or airtight containers for seeds). By reducing post-production spoilage of inputs, these steps would ensure farmers receive seeds with the high viability intended by breeders.

***Expanding market access for strategic crops**:* Many Ugandan smallholders face weak output markets that do not reward quality or productivity improvements. For instance, in local maize markets, farmers receive no premium for higher-quality maize (e.g., better dried or cleaned grain) – the price is essentially the same as for lower-grade output. Bold et al. (2022) document that when Western Ugandan farmers were assisted in improving their maize quality (through better post-harvest handling), the market return on those quality improvements was effectively zero. This lack of reward reduces farmers' incentives to adopt yield-boosting or quality-enhancing practices.

Connecting farmers to buyers who value quality is crucial: One successful model is to facilitate contracts or partnerships between smallholder farmer groups and large off-takers (such as food processors, breweries, or export firms) that offer a premium price for crops meeting certain quality standards. In an experimental study, Ugandan farmers given access to a premium maize buyer (along with training) responded by dramatically improving their output quality and yields; as a result, their profits from maize farming rose by 40–80% relative to control groups. Crucially, these income gains were driven not only by higher prices for top-grade

maize but also by productivity increases and even better prices for ordinary maize in the treatment villages. This suggests that introducing a high-quality market can have spillover benefits, stimulating competition and raising price levels more broadly. Policymakers could therefore invest in market infrastructure that links farmers to high-value markets—for example, supporting the establishment of maize milling facilities or coffee processing plants that pay for quality, or working with international buyers to source Ugandan produce under fair-trade or specialty labels. Export crops like coffee can particularly benefit from quality differentiation – Uganda should capitalize on such markets by improving grading systems and marketing Ugandan coffee in higher-value segments. Encouraging farmers to form or join cooperatives can also help them aggregate sufficient volumes and negotiate better terms with buyers seeking consistent, quality supply. Technology adoption has the potential to play a role in accessing premium markets as well. A pilot project funded by the IGC (now being rolled out into a larger study) looks at the impact of subsidizing solar-dryers for cassava and finds that the subsidies are cost-effective and have the potential to increase access to premium markets within Uganda—suggesting that insurance or access to finance could play a role in quality upgrading (Silver et al. 2024).

Conclusion

Uganda's agricultural future will be shaped largely by the challenges of low baseline productivity and climate change. According to our projections, while some crops, such as maize, face potentially significant yield declines, others, notably banana and coffee, may benefit from changing climatic conditions. This uneven outlook underscores both the risks and opportunities ahead. To safeguard food security and rural livelihoods, it would be useful for Uganda to focus on modernizing its agricultural systems—by improving the quality and reliability of inputs, facilitating climate-resilient crop choices, and strengthening output markets that reward productivity and quality.

References

Barriga, Alicia & Fiala, Nathan, 2020. "The supply chain for seed in Uganda: Where does it go wrong?," World Development, Elsevier, vol. 130(C).

Bold, T., Kaizzi, K. C., Svensson, J., & Yanagizawa-Drott, D. (2017). Lemon Technologies and Adoption: Measurement, Theory and Evidence from Agricultural Markets in Uganda. Quarterly Journal of Economics, 132(3), 1055–1100.

Bold, T., Ghisolfi, S., Nsonzi, F., & Svensson, J. (2022). Market access and quality upgrading: Evidence from four field experiments. American Economic Review, 112(8), 2518–2552.

Challinor, A.J., J.Watson, D. B. Lobell, S. M. Howden, D. R. Smith and N. Chhetri (2014). A meta-analysis of crop yield under climate change and adaptation. *Nature Climate Change*. DOI: 10.1038/NCLIMATE2153

Food and Agriculture Organization of the United Nations. (2024). *FAOSTAT: Database on agricultural production [Database]*. FAO.

Fischer, G., Nachtergaele, F. O., van Velthuizen, H. T., Chiozza, F., Franceschini, G., Henry, M., Muchoney, D., & Tramberend, S. (2021). *Global Agro-Ecological Zones v4 – Model documentation*. Rome, FAO. https://doi.org/10.4060/cb4744en

Gollin, D., Lagakos, D., & Waugh, M. E. (2014). The agricultural productivity gap. The Quarterly Journal of Economics, 129(2), 939–993.

Harris, I. P. D. J., Jones, P., Osborn, T., & Lister, D. (2014). Updated high-resolution grids of monthly climatic observations-the CRU TS3. 10 Dataset. *International journal of climatology*, *34, 623-642.*

Intergovernmental Panel on Climate Change. (2014). *Climate change 2014: Synthesis report*. Contribution of Working Groups I, II, and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (R. K. Pachauri & L. A. Meyer, Eds.). IPCC. https://www.ipcc.ch/report/ar5/syr/

Knox, J., Hess, T., Daccache A., & Wheeler, T. (2012), Climate change impacts on crop productivity in Africa and South Asia, *Environmental Research Letters*, https://doi:10.1088/1748-9326/7/3/034032

Latham, J., Cumani, R., Rosati, I., & Bloise, M. (2014). Global land cover share (GLC-SHARE) database beta-release version 1.0-2014. *FAO: Rome, Italy*, *29*.

Nath, I. (2025). Climate change, the food problem, and the challenge of adaptation through sectoral reallocation. Journal of Political Economy, 133(3), 789–835

Ray, D. K., Gerber, J. S., MacDonald, G. K., & West, P. C. (2015). Climate variation explains a third of global crop yield variability. Nature Communications, 6, 5989.

Schneider, U., Becker, A., Finger, P., Meyer-Christoffer, A., Rudolf, B., & Ziese, M. (2016). GPCC full data reanalysis version 7.0: Monthly land-surface precipitation from rain gauges built on GTS based and historic data.

Siebert, S., Henrich, V., Frenken, K., & Burke, J. (2013). Update of the Global Map of Irrigation Areas to version 5. *Project report*, *178*.

Silver J., Kato, M., do Nascimento Miguel, J., Ijala, A. R., & Silver, J. (2024). The effects of cassava drying technology on commercialisation and consumption smoothing. International Growth Centre.

Uganda Bureau of Statistics (UBOS). (2020). *Uganda Annual Agricultural Survey 2018*. Kampala, Uganda: UBOS.

Uganda Bureau of Statistics (UBOS). (2022). *Uganda Annual Agricultural Survey 2020*. Kampala, Uganda: UBOS.

Weedon, G. P., Gomes, S., Viterbo, P., Shuttleworth, W. J., Blyth, E., Österle, H., ... & Best, M. (2011). Creation of the WATCH forcing data and its use to assess global and regional reference crop evaporation over land during the twentieth century. *Journal of Hydrometeorology*, *12*(5), 823-848.

World Bank Group. (2020). *Climate Risk Profile: Uganda*. Washington, DC: The World Bank Group

7 Invest in the Protection of Vegetation in Uganda: Climate Change and Economic Growth

Milly Kaddu and Mary Teddy Nakyejwe

Introduction

Uganda has diverse vegetation cover that reflects differences in altitude, topography, and climate across different regions. The southwest region and shores of Lake Victoria have tropical rainforests with high biodiversity, while savanna grasslands dominate the central, northern, and western regions. Swamps and wetland vegetation dominated by papyrus reeds and other aquatic plants are found along lakes, rivers, and low-lying areas. Mountainous areas, particularly around Mount Rwenzori and Mount Elgon, have montane vegetation cover. This diverse vegetation cover supports rich ecosystems and biodiversity and provides critical ecosystem services.

However, rapid population growth and expanding land use are accelerating the conversion of natural vegetation into farmland, settlements, and fuelwood sources. Nationally, forest cover has declined from about 24% of Uganda's land area in 1990 to only 12% by 2020, an annual deforestation rate of roughly 80,000 hectares lost per year—among the highest rates globally. Such widespread loss of forests, wetlands, and other vegetation not only threatens biodiversity; it also undermines carbon sequestration, water regulation, and soil protection services, increasing Uganda's vulnerability to climate change. Frequent droughts and floods are also exacerbated when forests and wetlands are degraded, making communities less resilient.

The implications for Uganda's economy are significant. Natural capital—the stock of forests, wetlands, soils, and other natural resources—constitutes a large share of the nation's wealth and underpins almost every major sector and livelihood. The degradation of vegetation thus carries economic costs: deforestation and wetland loss jeopardize water supplies for agriculture and hydropower, reduce soil fertility needed for crop production, and threaten Uganda's appeal as a destination for tourism. This chapter examines how Uganda can invest in protecting and restoring vegetation in the context of climate change, and what these efforts mean for long-term growth. It reviews current trends and drivers of vegetation loss, highlights ongoing policies and initiatives, and explores policies to strengthen vegetation

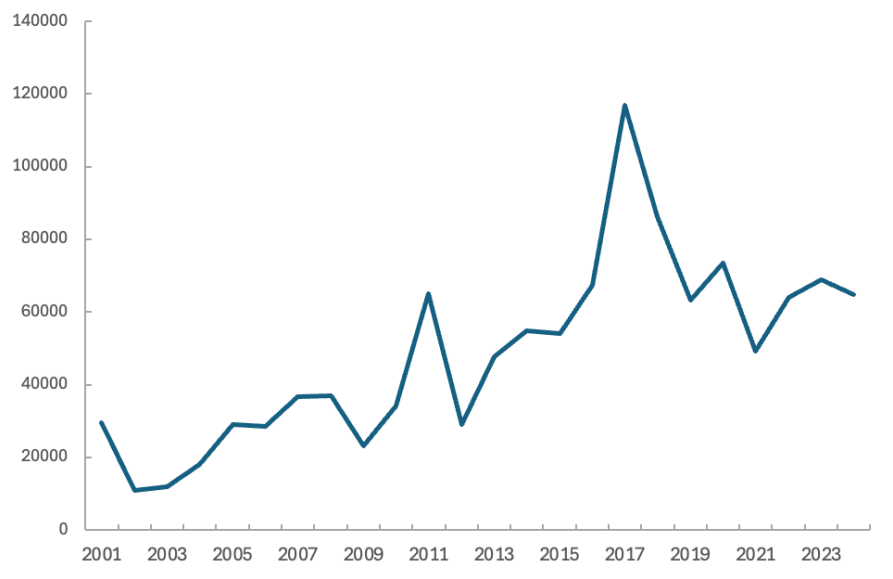
management for climate resilience, biodiversity conservation, and sustainable economic development.

Trends and Drivers of Vegetation Loss

Uganda's vegetation cover has been shrinking and changing under human pressure. Agricultural expansion is the biggest driver, as a growing population requires more food; forests, grasslands, and wetlands are often cleared for cultivation. Conversion to farmland and pasture is widespread, including within previously intact ecosystems. Charcoal production and fuelwood harvesting also contribute to deforestation, since biomass remains the primary energy source for most Ugandan households. This pressure is especially acute near urban centers and in woodlands of western and central Uganda, where unsustainable charcoal making has led to widespread forest degradation. Timber extraction (both legal and illegal)—driven by domestic demand and export markets—further exacerbates forest loss. Additionally, rapid urbanization is accelerating the clearance of peri-urban forests and wetlands to make way for housing and infrastructure around Uganda's expanding cities. Underlying these direct causes are enabling factors such as weak enforcement of land-use regulations and insecure land tenure, which have allowed encroachment even into nominally protected forests and parkland. Overall, a convergence of unsustainable land-use practices, such as agricultural encroachment, biomass demand, and logging, has driven a substantial loss of vegetation cover in recent decades.

Vegetation loss is not only affected by climate change but is also a factor that heightens Uganda's vulnerability to climate change. Healthy ecosystems play a pivotal role in mitigating climate-related risks, and their degradation removes natural protections. For instance, forests and wetlands act as carbon sinks, absorbing CO_2 from the atmosphere. When they are cleared or burned, not only is this storage capacity lost, but carbon is released, contributing to Uganda's greenhouse gas emissions. Figure 1 shows an increasing tree cover loss over time across the different canopy thresholds in Uganda. The trend was highest in 2017 and declined thereafter. Reports from the National Forest Authority and the World Bank attribute the decline in large part to the launch of the Uganda Green Growth Development Strategy in 2017.

Figure 1: Uganda's annual tree cover loss per hectare



Vegetation also supports climate adaptation and resilience. Forested watersheds and wetland systems regulate water flow by reducing the severity of floods and sustain river flow in dry seasons. Intact wetlands absorb excess rainfall and prevent flash flooding, while also replenishing groundwater to buffer against drought. Biodiversity is also affected through the loss of natural habitats for Uganda's wildlife, leaving species more vulnerable to extreme weather and shifting conditions.

This problem is evident from Uganda's weather patterns, with increasingly erratic rainfall and extreme events. Floods, landslides, and more frequent droughts in deforested highland areas, for example, have led to substantial pasture and agricultural loss (Kajumba, 2018). In contrast, areas with active reforestation or intact wetlands have shown better resilience to climate shocks (UNDP, 2017; Wandeba & Clayton, 2025).

Current Efforts Towards Vegetation Protection

Over the past two decades, the Ugandan government has tried to address these concerns by taking steps to curb deforestation and promote sustainable land use. Today, Uganda has a robust policy framework on promoting vegetation, forests, and biodiversity; however, there are continuing challenges in translating these plans and ideas into effective action on the ground. Key policies and institutional initiatives include:

National Biodiversity Strategy and Action Plan (NBSAP II, 2015–2025): Uganda's primary instrument under the Convention on Biological Diversity provides a strategic roadmap for conserving biodiversity, including forests, wetlands, and other ecosystems. It calls for protecting vegetation cover to maintain the country's rich biodiversity and ecosystem services. Implementation is shared by agencies such as the Uganda Wildlife Authority (UWA), National Environment Management Authority (NEMA), and the Ministry of Agriculture. This collaborative approach has yielded some successes, including strengthening protection for critical forest ecosystems like Bwindi Impenetrable National Park and creating community-based conservation programs involving local people in forest management. However, NBSAP progress reports note persistent challenges, such as pressures from agricultural expansion and other land conversion continue to threaten biodiversity outside protected areas, and limited resources and enforcement capacity hinder achievement of targets.

The National Forestry and Tree Planting Act (2003) and the ***Uganda Forest Investment Plan (UFIP)***, both of which are aimed at forest conversion with a focus on climate change mitigation through afforestation and reforestation. The UFIP is a national strategy for reducing deforestation through governance, landscape-level interventions, and private sector engagements. The Tree Planting Act provides the legal framework for forest management, including establishing Central Forest Reserves (CFRs) and regulating forest harvesting and trade. It also promotes tree planting on private and community lands. Under this Act, the National Forestry Authority (NFA) was created in 2004 to manage CFRs and spearhead reforestation, while District Forest Services were mandated to oversee local forest resources. A National Forest Plan (2011–2021) laid out strategies for sustainable forestry. In recent years, Uganda has also made international commitments to forest conservation. For example, the country's Nationally Determined Contribution (NDC) under the Paris Agreement sets targets for reversing forest loss and restoring deforested areas as part of climate mitigation, and Uganda joined the Bonn Challenge with a pledge to restore 2.5 million hectares of degraded forest landscapes by 2030. These policies explicitly link forest conservation with climate objectives and signal high-level commitment.

Uganda Green Growth Development Strategy (UGGDS), 2017–2030: In 2017, Uganda launched the UGGDS, an overarching framework for sustainable and climate-resilient economic. The UGGDS includes initiatives for reforestation, promotion of agroforestry, and reducing reliance on wood fuel by developing alternative energy sources. Since implementation began, there have been notable

achievements, including: the annual National Tree Planting Days, which have mobilized communities to plant millions of trees; the Ministry of Energy introduced a National Biomass Energy Strategy promoting efficient cookstoves and a transition to other energy sources (to ease pressure on forests). Uganda's National Development Plan III likewise recognizes natural capital as foundational for socio-economic transformation

The management of protected areas through the Uganda Wildlife Association (UWA) has also played a critical role in preserving the forests and vegetation cover that serve as habitats for Uganda's wildlife. Uganda has set aside roughly 18% of its land as protected areas, including 10 national parks, 12 wildlife reserves, and numerous forest reserves. UWA manages the parks and wildlife reserves, while NFA manages the forest reserves. Efforts have been made to strengthen on-the-ground protection in these areas – for example, increasing ranger patrols, clearly demarcating park boundaries, and engaging local communities in co-management of resources. In some well-managed protected areas, forest cover has stabilized or even slightly increased where enforcement is effective (GEF IEO, 2016). Remote-sensing studies indicate that parks like Kibale National Park have maintained their forest cover, in contrast to steep declines in surrounding unprotected lands (Atugonza et al., 2023).

Despite these efforts, enforcement and governance challenges persist. A comprehensive assessment by environmental civil society groups in 2015 found that implementation has lagged on policies geared towards accountability, effectiveness, and fairness (GEF IEO, 2016). The review highlighted frequent breaches of regulations, such as illegal timber harvesting, farming, or settlement encroachment inside reserves, due to insufficient funding and too few personnel. As a result, even some gazetted forest reserves have suffered degradation.

REDD+ and Carbon Finance: Uganda, through the Ministry of Water and Environment has participated in the REDD+ readiness process (Reducing Emissions from Deforestation and Forest Degradation) and is seeking results-based financing for verified emission reductions. Through the World Bank's Forest Carbon Partnership Facility (FCPF), Uganda is negotiating a program that would provide payments for reducing deforestation, essentially turning forest carbon sequestration into a revenue stream. If successful, this could incentivize conservation by monetizing one of the key ecosystem services of forests (carbon storage).

Payment for Ecosystem Services (PES) Pilots: Uganda is also exploring PES schemes where landholders are compensated for managing land in ways that provide ecosystem services. In a randomized controlled trial pilot between 2010 and 2013 in Hoima and Kibaale districts, private landowners received approximately US $28 per hectare per year to refrain from clearing natural forest for two years, with additional payments for planting trees. Villages in the PES treatment group showed significantly lower deforestation (2–5 %) compared to control areas (7–10 %)—demonstrating modest payments can lead to better retention of forest cover (Jayachandran et al., 2016). These lessons are informing larger efforts: for example, the approach of the Investing in Forests and Protected Areas for Climate-Smart Development (IFPA-CD), a project funded by the World Bank and run by the Ministry of Water, of purchasing farm-grown fuelwood can be seen as a form of PES.

Private Sector Engagement: Historically, commercial forestry in Uganda was limited, but this is changing as the private sector sees opportunities in sustainable timber production and tree crops. Engaging private landholders and businesses is crucial to complement government efforts, since a significant portion of Uganda's land is under private ownership. In this vein, the Ugandan government has introduced incentives through the Sawlog Production Grant Scheme (SPGS). Initiated in the mid-2000s with donor support, SPGS has been a pioneering effort to kick-start private forestry. It offered matching grants and technical support to farmers and companies for establishing timber plantations, mainly of fast-growing species like pine and eucalyptus. Under SPGS Phase I, participants received a grant (about UGX 600,000 per hectare, roughly half the planting cost) after independent verification that their plantation was successfully established and met quality standards. This performance-based grant approach proved very effective: within the first two years, around 1,700 hectares of new plantations were planted and verified, and thousands more hectares were in the pipeline. Demand from landowners far exceeded the scheme's initial targets, demonstrating that private farmers and investors were eager to plant trees if given the right support. Through subsequent phases of SPGS (Phase II and III), Uganda's private/commercial forest plantation estate grew to an estimated 100,000 hectares by 2020. This dramatic increase created a new domestic timber supply, which is now feeding a growing wood industry, reducing the need to import timber and helping to take pressure off natural forests that were previously overharvested for lack of alternatives.

Strategies and Policy Options

Protecting Uganda's vegetation cover in the face of climate change requires a multipronged strategy that combines regulation, economic incentives, community engagement, and integration of environmental concerns into economic planning. Building on Uganda's experiences and lessons from other countries, the following evidence-based policy options and strategies can be strengthened or considered.

Integrate Natural Capital into Development Planning: An important step towards protecting Uganda's vegetation is to incorporate the value of natural ecosystems into national accounting and policy frameworks. Uganda's economic assessments have relied on conventional metrics like GDP and sectoral outputs, with environmental considerations remaining secondary to economic policymaking. Uganda tracks environmental statistics through the Uganda Bureau of Statistics (UBOS) such as forest cover deforestation rates and land degradation, but these are typically seen as environmental issues rather than integral components of national economic performance; for example, Uganda recognizes the economic value of forests and wetlands in various reports but the contribution of these ecosystems to overall national wealth is not fully captured in economic assessments. Further, current policy frameworks for natural resource protection, including NEMA environmental assessments, the Uganda Wildlife Act, and the National Biodiversity Strategy and Action Plan, operate largely disconnected from national economic performance metrics.

However, Uganda is exploring Natural Capital Accounting approaches to better incorporate forests, wetlands, and wildlife into economic assessments. By adopting NCA and related tools (like "green GDP" indicators), policymakers can visualize the trade-offs between short-term output and long-term natural wealth. In practice, this means including forest and wetland accounts in national development plan monitoring and using indicators like forest cover, carbon stocks, and soil fertility next to GDP growth rates. Countries such as Costa Rica have successfully implemented payments for ecosystem services and seen forest cover rise – treating that increase as a gain in national assets – and several African nations (e.g. Rwanda, Botswana) use natural capital accounts to guide land use policy. For Uganda, mainstreaming natural capital considerations will encourage cross-sector integration: agriculture, energy, infrastructure, and finance plans will factor in ecosystem impacts and dependencies. It can also strengthen the case for international climate finance and partnerships. By clearly valuing and protecting its natural capital, Uganda aligns with global initiatives (like the post-2020 Global Biodiversity Framework and UN SEEA accounting framework) and could unlock

additional funding from sources such as the Global Environment Facility or REDD+ performance payments.

Promote Sustainable Agriculture and Agroforestry: As agriculture drives most deforestation in Uganda, intensifying production on *existing* farmland through agroforestry presents a critical solution. Agroforestry systems—integrating trees into farming through field boundaries, shade trees in coffee plantations, or farm woodlots—deliver benefits such as improved soil fertility through nitrogen fixation, reduced erosion, enhanced moisture retention, and diversified farm income through fruits, timber, and fuelwood.

Research demonstrates significant productivity gains from agroforestry. A meta-analysis of research covering sub-Saharan African agroforestry systems found that agroforestry practices increased crop yields in 77% of cases, with strong results from alley cropping, biomass transfer, and planted fallows (Kuyah et al., 2019). Evidence from rural Western Uganda suggests that households derive 26% of total household income from forests and environmental resources, with agroforestry systems providing additional carbon sequestration benefits valued at $28-114 per hectare annually (Wainaina et al., 2020). Uganda could scale these benefits by expanding its Climate Smart Agriculture Transformation Program with targeted interventions such as providing subsidized seedlings, strengthening agricultural extension services, and developing market linkages for agroforestry products. Kenya's Green Belt Movement demonstrates the potential impact, which has mobilized communities to plant over 51 million trees while improving agricultural productivity on degraded lands.

Land Use Zoning and Sustainable Land Management*:* Develop, implement, and enforce land use zoning policies that allocate land for specific uses and promote sustainable land management practices across different zones. Proper land zoning prevents land degradation by designating areas for conservation and restricting harmful practices (e.g., overgrazing and slash-and-burn farming). Ethiopia has successfully implemented land use zoning in areas prone to soil erosion and desertification, focusing on watershed management, reforestation, and sustainable grazing. These integrated sustainable land management practices have rehabilitated degraded lands and improved livelihoods, demonstrating the effectiveness of community-based approaches in reducing land degradation. Uganda could develop national and district-level land use plans by conducting a thorough mapping of land resources, ecosystem services, and land degradation risks. This would empower local governments to appropriately regulate land

conversion practices and foster more sustainable agricultural land management, ultimately benefiting the communities and environment.

Payment for Ecosystem Services (PES) Programs: Introducing direct economic incentives for conservation can motivate communities and landowners to protect and restore vegetation. A notable international success is Costa Rica's national PES program, which over the past few decades has been credited with doubling forest cover from around 21% to over 50% through a national PES program that compensates landowners for maintaining forest cover, restoring degraded lands, and preserving biodiversity. Uganda has already started experimenting with PES schemes in some areas, such as Kibaale District, where farmers receive payments for maintaining forest reserves and sustainable agriculture practices – evaluations of this initiative suggest it has potential, but scaling it up remains a challenge. Building on this, Uganda can establish a national PES framework with clear standards for what services are paid for, who pays, and how performance is monitored. Carbon sequestration is another potentially viable PES, whereby communities that engage in reforestation or avoid deforestation could be paid per ton of CO_2 kept out of the atmosphere (with funds coming from international carbon markets or climate finance). Watershed services are another, where hydropower companies or water agencies could fund PES to ensure their upstream watersheds are conserved. At the national level, a good place to start would be for the government to consider creating a national PES framework, which would include clear rules for how payments are made, what ecosystem services are prioritized, and how monitoring and verification will be conducted.

Empower Community-Based Natural Resource Management: Community-based land and forest management involves partnering with local communities as co-managers and giving them a stake in conservation. When communities have recognized rights over forests or rangelands and share in the benefits of sustainable use, they are more likely to protect those resources. Uganda has some community forestry initiatives, such as the Collaborative Forest Management agreements around certain forest reserves and community wildlife management areas, which could be expanded and strengthened. A broader Community-Based Natural Resource Management (CBNRM) approach would include legally recognizing community-managed forests and communal lands. The government could finalize and implement the **Community Forest Regulations** to provide a clear process for communities to register and manage forests on customary land. Experiences from other African countries underscore the value of this approach. In Tanzania, for instance, Participatory Forest Management has granted villages authority over

nearby forests, resulting in reduced illegal logging and improved forest regeneration. Similarly, in Botswana, community trusts manage wildlife areas and earn income from eco-tourism, which has reduced poaching and led to wildlife recovery. Uganda can tailor such models to its context. Around protected areas, ***Collaborative Forest Management (CFM)*** agreements between NFA and local groups might be scaled up—under CFM, communities might get controlled access to certain non-timber forest products or to plant on reserve land, in return for helping with patrolling and replanting. On Uganda's rangelands (e.g. in the cattle corridor of the northeast), community range management associations could be established to manage grazing pressure, reseed grasses, and prevent bushfires, thereby restoring degraded savannas. For CBNRM to succeed, capacity building and incentives are crucial: communities need training in sustainable resource use, support in developing alternative livelihood projects (beekeeping, eco-tourism, controlled harvesting of forest products like wild coffee or medicinal plants), and assurance that they will benefit from conservation (such as a share of park tourism revenue or PES payments as mentioned). The IFPA-CD project is already moving in this direction by supporting community forests and collaborative management pilots. By devolving some management responsibility and benefits to those who live with the resources, Uganda can tap into local knowledge and enthusiasm. This approach also tends to reduce conflicts – when communities feel ownership, they are less likely to engage in illegal exploitation and more likely to report outsiders who do. It is important that community institutions be **inclusive** (ensuring women, youth, and minority groups have a voice) and that traditional leadership structures are balanced with democratic decision-making to avoid elite capture. In summary, empowering communities transforms them from being seen as threats to forests into **front-line stewards** of the land. It leads to more durable conservation outcomes and shares the dividends of conservation (jobs, revenue, resource access) with those communities, contributing to poverty reduction and rural development.

Reforestation and Restoration: To reverse the trend of vegetation loss, Uganda will not only need to halt deforestation but also restore degraded lands. This would entail implementing large-scale reforestation and land restoration programs to reclaim degraded lands and restore vegetative cover, prioritizing planting native trees and enhancing soil fertility. Priority landscapes—such as deforested hills, overgrazed grasslands, and drained wetlands—could be identified for targeted restoration with measurable annual goals. Approaches can include natural regeneration, active tree planting with native or agroforestry species, and wetland

rewetting. For example, Ghana has invested in reforestation and afforestation projects, particularly focusing on restoring forest ecosystems and reducing the illegal harvesting of timber; efforts that have led to significant improvements in forest cover and carbon sequestration. Restoration efforts can be supported through national campaigns, political leadership, and community engagement. Uganda's participation in AFR100 and partnerships with donors and NGOs can mobilize funding and technical support.

Environmental education and awareness campaigns: Strengthen environmental education to promote a culture of conservation and sustainable land use. Uganda should integrate environmental topics into school curricula and expand initiatives like school woodlots and conservation clubs. Inspired by India's "Green Schools" model, such programs can raise environmental consciousness from an early age. Beyond schools, targeted outreach to farmers, local leaders, and businesses—through agricultural extension, community radio, and demonstration projects—can promote practical knowledge on soil conservation, agroforestry, and clean energy alternatives. Mass media campaigns in local languages and success stories from peer communities can reinforce behavior change. Enhancing environmental literacy will build public support for conservation efforts and improve the sustainability of land restoration and forest protection programs.

Conclusion

To conclude, protecting vegetation is not a trade-off with economic growth—particularly in Uganda, where forests, wetlands, and grasslands underpin key sectors like agriculture, energy, tourism, and water supply. Conserving these ecosystems helps maintain soil fertility and rainfall for farming, protects water sources and hydropower generation, supports eco-tourism, and reduces damage from floods and landslides. Restoration efforts can also create jobs and improve rural incomes. Many communities benefit directly from healthier environments and shared revenues. Continued investment in vegetation protection will require coordination across sectors and support from international partners, but the long-term gains—in terms of climate resilience, biodiversity, and economic stability—far outweigh the costs. With sound natural resource management, Uganda can pursue a development path that is both inclusive and sustainable.

References

Braatz, S. (2012). Building resilience for adaptation to climate change through sustainable forest management. In A. Meybeck, J. Lankoski, S. Redfern, N. Azzu, & V. Gitz (Eds.), Building resilience for adaptation to climate change in the agriculture sector (pp. 117–128). FAO/OECD.

Cavendish, W. (2003). Environmental income, rural livelihoods, and income inequality in western Uganda. CIFOR.

Food and Agriculture Organization. (2020). Global Forest Resources Assessment 2020: Uganda report. FAO.

Innovations for Poverty Action; Jayachandran, S., de Laat, J., Lambin, E. F., & Stanton, C. Y. (2016). Cash for carbon: A randomized controlled trial of payments for ecosystem services to reduce deforestation. Poverty Action Lab. https://poverty-action.org/sites/default/files/publications/jayachandran_etal_pes_rct.pdf

Jagger, P. (2012). Environmental income, rural livelihoods, and income inequality in western Uganda. Forests, Trees and Livelihoods, 21(2), 70–84. https://doi.org/10.1080/14728028.2012.698846

Kishaija, N., Adam, A. Y. F., & Heil, B. (2024). Land-use land cover changes and their relationship with population and climate in Western Uganda. Journal of Degraded and Mining Lands Management, 11(4), 6201–6212.

Kuyah, S., Whitney, C. W., Jonsson, M., et al. (2019). Agroforestry delivers a win-win solution for ecosystem services in sub-Saharan Africa: A meta-analysis. Agronomy for Sustainable Development, 39, 47.

National Forestry Authority. (2021). State of Uganda’s forests. Kampala: NFA.

Tumwebaze, S. B., & Byakagaba, P. (2016). Soil organic carbon stocks under coffee agroforestry systems and coffee monoculture in Uganda. Agriculture, Ecosystems & Environment, 216, 188–193.

Uganda Ministry of Water and Environment. (2018). National Biodiversity Strategy and Action Plan II (2015–2025). Kampala: MWE.

UNDP (United Nations Development Programme). (2017, November 29). Government of Uganda and UNDP launch implementation of a $44.26 million project to restore wetlands and build community resilience. ReliefWeb. https://reliefweb.int/report/uganda/government-uganda-and-undp-launch-implementation-4426-million-project-restore-wetlands

Wainaina, P., Minang, P. A., Gituku, E., & Duguma, L. (2020). Cost-benefit analysis of landscape restoration: A stocktake. CIFOR–ICRAF. https://www.cifor-icraf.org/knowledge/publication/23971/

Wandeba, A., & Clayton, F. (2025, July 8). In Uganda, deadly landslides force an agricultural reckoning. Yale Environment 360. https://e360.yale.edu/features/uganda-elgon-landslide-agroforestry

World Bank. (2019). Investing in Forests and Protected Areas for Climate-Smart Development Project: Project Appraisal Document (Report No. PAD____-UG). Washington, DC: World Bank.

World Bank. (2021). Uganda Natural Capital Accounting: Informing policy. Washington, DC: World Bank WAVES Program.

World Bank. (2022). Uganda Country Economic Memorandum: Greening growth. Washington, DC: World Bank.

WWF Uganda. (2020). Forest and biodiversity – Economic contribution of forestry and tourism. WWF Uganda Country Office Report.

8 Urbanization and Sustainability: Fostering Green Development in Uganda

Maria Orjuela Pava

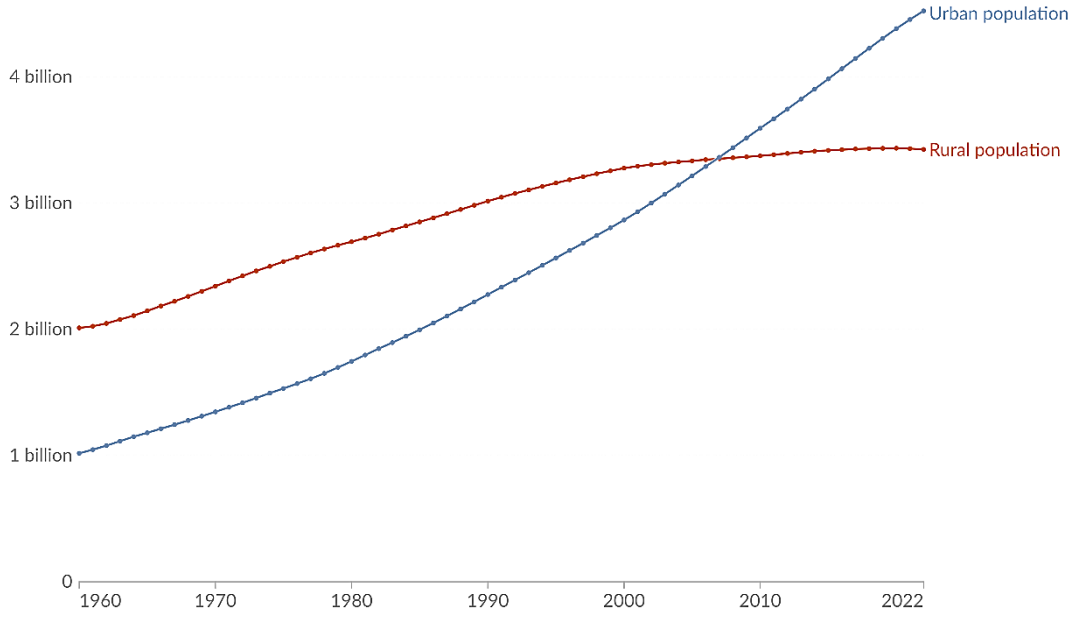
Introduction

Urbanization, marked by the growing share of a nation's population residing and engaging in economic activities within urban areas, stands as one of the most significant global phenomena of the twenty-first century. This transformative process has the potential to drive economic growth, boost productivity, and be a catalyst for development across societies. Nowadays, more than half of the world's population (56%) live in cities, with this figure projected to reach nearly 70% by 2050, underscoring the need for well-planned and effectively managed systems (World Bank, 2023).

This is in line with historic records, which have shown a profound demographic shift from rural to urban living in the past 6 decades. Figure 1 illustrates the accelerated pace of it. For instance, while the population in urbanized zones has grown exponentially from just over 1 billion people in 1960 to over 4 billion in 2022, the rural numbers have remained relatively stable, plateauing at around 3.4 billion. This tipping point – where urban surpasses rural agglomeration - highlights the transition in settlement patterns and the increasing dominance of urban areas as centers of human activity, innovation, and hubs in which challenges such poverty, inequality, and climate change can be addressed holistically.

In this context, *green urbanization* emerges as a vital framework for managing urban growth responsibly. By embedding environmental sustainability into city development, this approach fosters the adoption of resource-efficient infrastructure, renewable energy, eco-friendly transportation systems, and the preservation of green spaces. Therefore, providing a pathway for building climate-resilient communities, and mitigating the environmental and social pressures associated with the rapid expansion of urban landscapes.

Figure 1: Number of people living in urban and rural areas, World (billions)



Data source: Multiple sources compiled by World Bank (2024). Taken from: https://ourworldindata.org/urbanization

The latter is particularly relevant in Africa, a continent which is experiencing the fastest urban growth in the developing world, with an average annual rate of 3.5% over the past 20 years, according to the ECA (2024). The trend shows no signs of slowing and, by 2050, its urban population is expected to rise from 37% in 2000 to nearly 60%, reflecting a significant structural transformation across its economic activity. Major cities like Lagos, Nairobi, and Cairo are witnessing an accelerated extension, emphasizing the importance for comprehensive urban planning strategies that not only tackle immediate infrastructural and social demands but also anticipate future requirements. Efforts such as integrating smart city technologies, inclusive housing policies, and climate-resilient systems, will be critical in navigating the complexities of Africa's urban transition.

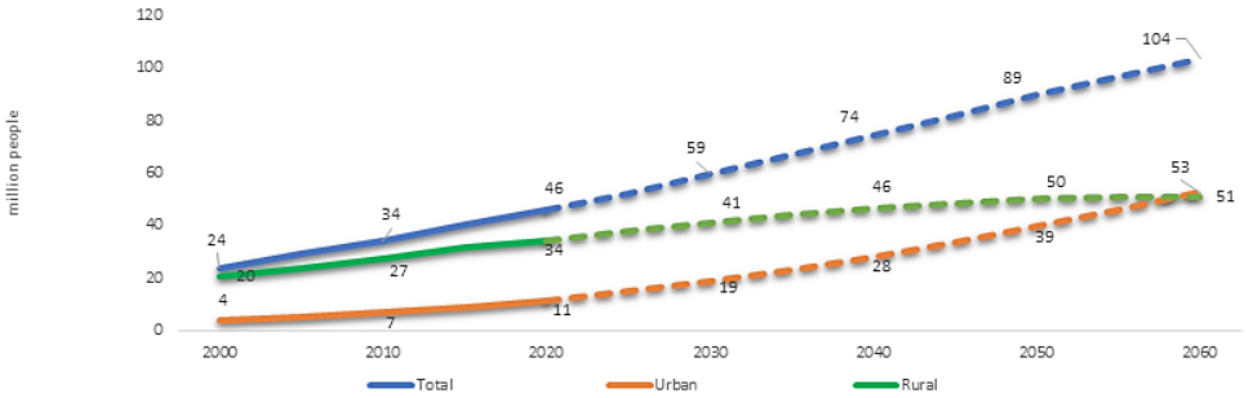
To this extent, Uganda, with its unique socio-economic context and Kampala at the forefront of this growth, offers a compelling case study into the potential benefits and challenges of embracing green urbanization. This chapter sheds light on how sustainable strategies can mitigate urban pressures while fostering long-term development in the Pearl of Africa.

Urbanization in Uganda

By 2060, Uganda's population is projected to reach 104 million, more than doubling its current size of nearly 50.7 million. Reflecting global patterns, this growth will likely coincide with a demographic shift from rural to urban living across the country (World Bank, 2021). As Figure 2 depicts, in 2020, approximately 34 million people resided in rural areas, while urban centers were home to around 11 million - roughly 25% of the total population at the time. However, the trend is expected to reverse in the coming decades with the country's urban population surpassing its rural counterpart for the first time in its history. In fact, projections indicate that by 2060, 53 million people will live in urban areas compared to 51 million in rural regions.

This dynamic will be driven by two key factors. First, *rural-to-urban migration* intensifying as households relocate in search of better economic opportunities, access to services, and improved living conditions. Urban centers, particularly the capital, will continue to attract migrants, offering employment prospects and enhanced amenities such as healthcare, education, and infrastructure. Second, the *disparity in fertility rates* between rural and urban areas will further influence the trend. Rural regions currently have an average fertility rate of 5.9 births per woman, compared to 4.0 in urban settings (World Bank, 2021), reflecting inequalities in access to education and family planning. Over time, lower fertility rates in these urban areas could accelerate the shift, as smaller family sizes can make resources more manageable, encouraging further migration from rural zones. Together, these dual forces illustrate the complex interplay driving Uganda's demographic transformation.

Figure 2: Number of people living in urban and rural areas, Uganda (millions)



Data source: The World Bank (2021). Taken from: https://blogs.worldbank.org/en/africacan/demographic-boom-explainer-ugandas-population-trends

State of Urbanization

Uganda's urban landscape consists of 11 cities, 31 municipalities, and 583 town councils, all of which have the potential to propel economic growth by providing job opportunities, fostering education, driving technological advancement, and acting as markets for industrial and agricultural products. However, urbanization across the Pearl of Africa lacked a clear policy framework until 2017, when the *National Urban Policy* (NUP) was introduced by the Ministry of Lands, Housing, and Urban Development. Throughout it, the Government of Uganda (GoU) recognized the importance of urban areas to the nation's Gross Domestic Product (GDP) and their role as hubs of innovation and entrepreneurship. Hence, committing to promote sustainable and organized urban development as part of its national agenda.

Overall, this policy aims to ensure planned urban growth that fosters integrated development and creates orderly and economically vibrant urban centers. Furthermore, it highlights a sustainable urbanization strategy which relies on networking human and social capital, leveraging Information and Communication Technologies (ICTs) whilst improving infrastructure to support long-term development. If effectively implemented, the National Urban Policy can transform Uganda's cities into inclusive, resilient, and innovative spaces that align with national and international goals.

This framework also accounts for the urban dynamism across the country, which reveals striking regional disparities. On the one hand, the *central region*, home to the nation's capital, holds the highest concentration of urban residents, benefiting from its status as the country's most developed region (Table 1). Despite its relatively small geographical size, Kampala itself stands out as a 'prime city', dominating the urban hierarchy with a population equivalent to the combined total of the remaining 10 newly created cities. On the other hand, the *eastern region* has emerged as the fastest growing in terms of urban agglomeration, with an increase of 11.5% over the last decade (NPDP). This has been largely driven by the establishment of hundreds of small trading centers, especially along transit routes such as highways and railroads, spurring economic activity and migration.

However, much of this growth has taken place in the form of unplanned settlements, slums, and pseudo-urban areas characterized by inadequate services and poor road networks (Ministry of Lands, Housing, and Urban Development, 2022). In contrast, UBOS (2014) reports that the western region has been the least agglomerated, with the rate of agglomeration over the past decade slower than in any other region of the country.

For instance, Uganda's National Urban Policy recognizes the above-mentioned trends and encourages a balanced and equitable urban development, aiming at ensuring that this growth is not only concentrated in Kampala but also extended to secondary cities and smaller urban centers. Therefore, nurturing integrated regional development. By doing so, the plan seeks to address uneven agglomeration patterns while reducing infrastructure and service delivery gaps.

Table 1. Urban population across regions

Region	Urban	Percent
Central	3,868,218	40.6%
Eastern	1,172,648	13%
Northern	913,096	12.7%
Western	1,471,902	16.6%
Uganda	7,425,864	21.4%

Data Source: UBOS (2014). Taken from Ministry of Lands, Housing, and Urban Development Report 2021/2022.

Looking ahead, urbanization in the country is projected to accelerate significantly. By 2050 it will likely account for nearly one-third of the total population. This growth, fueled by a 5.2% annual urbanization rate (compared to a national population growth rate of 3.2%) presents opportunities for economic transformation. Nevertheless, it also showcases the critical need for sustainable planning to address upcoming *challenges*, some of which are associated with Uganda's urban environmental settings and threaten the ecological and social health of cities. Key among these are the degradation of ecosystems, poor waste management, air pollution, and flooding.

Terrestrial ecosystems and wetlands

To date, urbanization has significantly impacted Uganda's terrestrial ecosystems, including forests, urban tree canopy, and wetlands, which are essential for supporting diverse wildlife and maintaining critical ecological functions.

According to the latest report from the Ministry of Lands, Housing, and Urban Development (2022), spatial analysis reveals a decline in undeveloped land within urban areas, with forests and open spaces being mostly converted for infrastructure and settlements. This has resulted in the loss of biodiversity, soil health, and vegetation cover. Compounding factors such as weak enforcement of land-use policies, agricultural expansion into urban fringes, and inadequate urban planning -which often prioritizes short-term development over long-term sustainability-, have intensified pressure on land resources and led to unsustainable practices that jeopardize the ecological balance of urban areas.

Additionally, urban wetlands – crucial for water filtration, stormwater absorption, and groundwater recharge - have been equally affected, declining to less than 10% of their original area. Encroachment, unregulated waste disposal, and pollution from industrial activities have disrupted these ecosystems, further diminishing their capacity to support urban agglomerations.

In response to these, Uganda has initiated efforts to protect and restore its natural ecosystems. Policies such as the *Wetlands Policy*[12] and the *National Environment Management Policy* aim to regulate urban land use and protect critical ecological zones. Meanwhile the National Forestry Authority has also launched tree-planting campaigns and urban greening projects, the government has been collaborating with international partners to promote sustainable urban planning and strengthen enforcement mechanisms.

Air quality

Air quality across Uganda's cities has deteriorated, driven largely by a combination of factors including vehicle emissions, burning biomass, industrial activities, and road dust. For instance, Kampala often records particulate matter - PM2.5 and PM10 - levels that exceed the recommended limits from the World Health Organization (IQAir, 2025). A study by the National Environment Management Authority (NEMA) reveals that over 60% of air pollutants in urban areas stem from

[12] National Policy for the Conservation and Management of Wetland Resources. Link to the policy here.

vehicle emissions, exacerbated by the high use of old, poorly maintained vehicles and unpaved roads. Additionally, the widespread use of charcoal and firewood for cooking contributes significantly to airborne particulate matter, particularly in low-income households.

The implications of this are profound, particularly in public health; exposure to polluted air is directly linked to a rise in respiratory illnesses such as asthma, bronchitis, and lung cancer, as well as cardiovascular diseases like hypertension and heart disease. The World Bank (2020) estimates that air pollution in Uganda contributes to over 31,000 premature deaths annually, with children under five and the elderly being the most affected.

Furthermore, the lack of national air quality standards and consistent monitoring hamper efforts to establish baselines and implement effective mitigation measures. Without clear guidelines or regular data collection, efforts to address air pollution remain fragmented and insufficient.

Waste management and urban drainage

According to UBOS (2022), more than half of the total waste generated across urban areas remains uncollected, often ending up in open spaces, drainage channels, or wetlands, that leads to blockages, flooding, and environmental degradation. Organic waste, which accounts for approximately 88% of urban waste, poses a particularly serious challenge; when improperly disposed of, it decomposes, releasing methane -a potent greenhouse gas- and leaching nutrients into water bodies, further degrading water quality (Ministry of House, Land, and Urban Development, 2022).

The repercussions of poor waste management ripple through various aspects of urban life. Blocked drainage systems exacerbate urban flooding, which not only damages infrastructure but also creates breeding grounds for waterborne diseases such as cholera and typhoid. Moreover, burning waste, a common practice in many urban centers across the country, releases toxic fumes that add up to air pollution. Equally, the economic costs are concerning: inefficiencies in waste collection and disposal decrease productivity as individuals face health-related disruptions, and the aesthetic appeal of urban areas diminishes, discouraging investment and tourism. Poorly managed waste systems also deter public confidence in urban governance, underscoring the urgent need for effective solutions country-wide.

Flooding

Flash floods are a significant challenge in Uganda's rapidly urbanizing cities, driven by an increase in impervious surfaces in ecologically sensitive areas such as wetlands, which leads to higher runoff and reduced water infiltration. Deteriorated drainage systems, sedimentation, and the dumping of waste into open culverts exacerbate the problem heightening flood risks in low-lying settlements. According to the Kampala Flood Mapping Technical Report (World Bank, 2018), over 170,000 households are regularly affected by flooding and the average annual cost of repairing the damage caused by floods in the capital is close to US$50 million (UNDP, 2023).

Efforts to address the issue are underway, with the public, private, and civil society stakeholders working collaboratively and looking for cross-sectoral flood management solutions. An example is the partnership between the UNDP Uganda Accelerator Lab, the National Environment Management Authority (NEMA), and Kampala Capital City Authority (KCCA). This initiative aims at tackling the impact of flooding in Kampala's informal settlements, applying collective intelligence methodologies. Hence, enabling communities to design low-cost and resilient drainage systems to overcome the impact of flooding across their livelihoods (UNDP, 2023).

Overall, as Uganda strives to achieve SDG 11[13] - to make cities and human settlements inclusive, safe, resilient, and sustainable -, addressing these environmental settings is imperative. Thus, sustainable urban planning, robust environmental management alongside green urbanization and investments, are essential to ensure that the benefits of urban expansion are realized without compromising ecological health and human well-being.

Current policies and initiatives

Aiming to balance rapid urban growth with environmental preservation and climate resilience, Uganda has been embracing green urbanization as part of its sustainable journey. Current policies, such as the above-mentioned NUP and Vision 2040 emphasize sustainable urban planning, green infrastructure, and eco-friendly industrialization as core components for planning and developing sustainable

[13] https://www.un.org/sustainabledevelopment/cities/

cities. These initiatives focus on enhancing public transport systems, improving waste management, and fostering energy efficiency in urban areas to reduce greenhouse gas emissions.

Efforts are also directed at embedding environmental considerations into urbanization processes. For instance, the Ministry of Lands, Housing, and Urban Development has been actively promoting sustainable urban housing policies through the *National Housing Policy* and the *Sustainable Urbanization and Housing Program Implementation Action Plan* (PIAP). These frameworks prioritize green building practices, land-use optimization, and the establishment of urban green spaces, seeking to curve the environmental impact of urban expansion whilst improving the quality of life in cities. To this extent, key strategies not only include the adoption of sustainable materials for infrastructure -incorporating energy-efficient designs and renewable energy technologies in housing construction-, but also the creation and preservation of spaces, such as parks, urban forests, and green corridors which can act as carbon sinks and help in regulating urban microclimates.

Blue-Green Infrastructure for Kampala's Flood Resilience

Blue-Green Infrastructure (BGI) refers to the integration of natural and semi-natural green spaces – such as wetlands, parks, green roofs, and rain gardens – within urban environments to naturalized water-flows. This strategic approach is recognized as a sustainable solution to manage stormwater, reduce flooding, and enhance resilience, capitalizing on multiple further benefits, such as improvements in air and water quality, aesthetics, biodiversity and amenity (Hoyer et al., 2011, Lawson et al., 2014).

In Uganda, particularly in Kampala, BGI has gained traction with the *Greater Kampala Integrated Flood Resilience Partnership* established in 2021. By bringing together a diverse group of stakeholders, including the Ministry of Water and Environment, KCCA, Uganda Manufacturers Association, Britannia Industries Ltd., and the Ngo ACTogther, the initiative aims to enhance urban resilience against flooding. This collaboration encourages investments in BGI solutions across key geographic areas such as Nalukolongo and Kinawataka, leveraging the benefits of urban green spaces and natural water systems. To date, some examples of the

implemented solutions include green roofs, retention ponds, and rainwater harvesting facilities (NatuReS, 2023).

In addition to BGI, Uganda is advancing green urbanization through transformative projects such as the *Greening Uganda's Urbanization and Industrialization* plan, which was launched in 2020. As part of the Inclusive Green Economy Uptake Program (Green-UP), financed under the 11th European Development Fund (EDF), its primary objective is to drive the country's transition toward an inclusive, green, and competitive low carbon economy. The latter through the creation of green jobs across multiple sectors outlined in the Uganda Green Growth Development Strategy (UGGDS).

The program also focuses on embedding green growth principles into city planning, incentivizing eco-friendly industrial practices and the implementation of waste management systems. As reported by GGGI (2023), significant milestones include i. integrating green building standards into the National Building Code, ii. Enhancing green growth in master plans for secondary cities such as Gulu, Mbarara, and Arua, and iii. formulating infrastructure investment plans that prioritize environmental sustainability.

Overall, these efforts have the potential to not only address pressing urban development needs but also pave the way for inclusive economic growth and the reduction of greenhouse gas emissions country-wide. However, Uganda's positioning as a model for green urbanization within the region remains a work in progress, hindered by critical barriers. Overcoming them will require sustained commitment, innovative solutions, and collaborative action from all stakeholders.

Challenges for green urbanization

Nowadays, the implementation of green urbanization strategies faces a variety of challenges including limitations in financial resources, technical expertise, and policy enforcement, as well as the complexities of urban governance and stakeholder coordination. Furthermore, the rapid pace of urbanization across the country has exacerbated existing gaps in infrastructure, housing, and public services, making it difficult to prioritize sustainability. This section delves into some of these challenges, aiming to provide a clearer understanding of the systemic

issues that must be addressed to align urban growth with environmental sustainability and social equity.

Limitations in financial resources

Uganda's capacity to implement green urbanization initiatives is constrained by insufficient financial resources, limiting progress on projects related to renewable energy systems, eco-friendly infrastructure -e.g. green housing-, and sustainable waste management. Local governments operate on budgets which are primarily allocated to immediate urban needs, such as immediate infrastructure and service delivery, constraining long-term green investments. Compounding the issue, the country often struggles to access international climate finance due to stringent eligibility requirements, co-financing, and complex application procedures, which exceed the technical and financial expertise of some institutions (Uganda Development Bank Limited, 2024).

Furthermore, the participation of the private sector in green projects remains modest. Meanwhile initiatives are sometimes perceived as high-risk and long-term, SMEs, which form a significant portion of Uganda's economy, lack of access to affordable credit further limiting innovation and the widespread adoption of eco-friendly solutions (Uganda Investment Authority, 2022). Addressing these financial gaps requires fostering public-private partnerships, exploring green bonds, and building capacity to access global climate funds effectively.

Lack of technical expertise

There is a significant shortage of technical expertise in Uganda to effectively design, implement, and maintain green urban solutions. The skills gap hinders progress in areas such as green building design, urban water management, and renewable energy infrastructure. For instance, a report by the GGGI (2021) revealed that many local governments and institutions struggle to integrate sustainability principles into urban master plans or develop and maintain nature-based projects effectively. This challenge is further exacerbated in secondary cities and rural-urban areas, where technical capacity is even more limited, leaving much of Uganda's green urban potential untapped. Closing this technical skills gap requires targeted investments, as well as fostering partnerships which can promote hands-on training and mentorship programs.

Complexities in urban governance and limited policy enforcement

Fragmented governance structures and overlapping mandates among local authorities often lead to inefficiencies in planning and execution of sustainable urban initiatives, which are further exacerbated by limited policy enforcement. While Uganda has introduced sustainability-focused policies, such as the Uganda Green Growth Development Strategy (UGGDS), compliance remains inconsistent due to weak monitoring mechanisms and resource constraints. For instance, urban planning regulations aimed at promoting green infrastructure often go unenforced, leading to unregulated development that undermines sustainability goals. By streamlining institutional frameworks, enhancing inter-agency coordination, and fostering transparency and accountability in urban governance, a supportive environment for green urbanization in Uganda can be created.

Low community engagement

Many local communities tend to lack awareness of the benefits and importance of sustainable urban practices, resulting in resistance and low uptake of projects related to urban greening, smart-technologies, or waste management programs, to name a few. Similarly, urban planning processes across the country frequently exclude public participation and community input, leaving residents feeling disconnected from decision-making. This lack of engagement not only diminishes the sense of ownership among communities but also leads to the implementation of solutions that may not reflect local needs or priorities.

Addressing the latter requires robust public awareness campaigns and targeted education on sustainability. Building trust and fostering collaboration between communities and urban authorities is crucial to ensuring green urbanization efforts which are inclusive, effective, and embraced by the people they aim to benefit.

Opportunities and policy recommendations

Unlocking the potential of green urbanization in Uganda offers a transformative opportunity to enhance the country's urban resilience and environmental sustainability journey, building cities that are more inclusive and climate resilient. Strategic policy interventions such as the effective implementation of land-use plans, increased funding for adoption of smart-city technologies, green financing, and community engagement in conservation initiatives, will be instrumental to accelerate progress within the country and set a benchmark for regional collaboration.

Promote green financing and foster Public-Private Partnerships (PPPs)

A robust framework for mobilizing financial resources and fostering collaboration between public and private stakeholders is required to enhance green urbanization across Uganda. For instance, green financing mechanisms, such as green bonds, debt-for-nature swaps, sustainable investment funds, and tax incentives, are fundamental for attracting investments in green urban projects. Besides providing capital, these tools reduce the financial barriers associated with implementing eco-friendly technologies and infrastructure. Thus, creating financial incentives which can encourage private sector participation, particularly for SMEs, which often face limited access to affordable credit for green initiatives.

Furthermore, encouraging the collaboration between government agencies, private companies, and NGOs through Public-Private Partnerships (PPPs), offer a strategic approach to complement green financing by leveraging the strengths of various stakeholders. PPPs can mobilize additional resources, share risks, and leverage technical expertise for successful project implementation. To fully realize their potential, Uganda must establish a supportive regulatory environment and build institutional capacity. This includes streamlining approval processes for green bonds, ensuring transparency in financial mechanisms, and creating a dedicated body to oversee the coordination.

Support circular economy practices and strengthen community engagement

On one hand, promoting the adoption of circular economy principles, such as recycling, upcycling, and the reuse of materials, can significantly optimize resource use and minimize the environmental footprint of urban development. By establishing incentives like tax breaks, subsidies, or recognition programs, firms can be encouraged to integrate these principles into the core of their business and production processes. Hence, accelerating the shift toward a more sustainable economy and creating opportunities for green innovation and entrepreneurship.

On the other hand, public awareness and community engagement are crucial not only for the development of green urban initiatives but also for promoting responsible environmental behavior. Targeted public education campaigns and participatory planning processes can empower households to be informed, build a sense of accountability and inclusivity, and ensure that urban projects align with local needs and priorities.

Strengthen and enforce Land-Use Planning

Effective and enforced land-use planning can contribute to ensure that urbanization is well-organized, environmentally sustainable, and inclusive. This includes zoning regulations which prioritize the allocation of land for green spaces, ecosystem conservation, and sustainable infrastructure development. Hence, preventing unregulated urban sprawl and reducing the strain on natural resources. A key component of this strategic approach refers to the integration of nature-based solutions into urban design, such as urban forests serving as carbon sinks, wetlands for flood control, or green corridors for biodiversity conservation.

These require robust clear regulatory and institutional guidelines, as well as adequate resource allocation for implementation and enforcement. Local governments can monitor land-use compliance, updating plans as needed to align with emerging challenges, while establishing digital mapping and geographic information systems (GIS) to support data-driven decision-making.

Adopt smart-city technologies for waste management and renewable energy integration

Harnessing smart-city technologies offers an innovative pathway to address waste management, flooding, and enhance renewable energy integration across Uganda's primary and secondary cities. Deploying intelligent systems, such as sensor-based waste collection and automated sorting technologies, can reduce inefficiencies and minimize environmental degradation. Targeted investments in smart waste management infrastructure, including real-time monitoring systems and AI-driven recycling technologies, can transform traditional waste systems into sustainable, high-performing models.

Simultaneously, integrating renewable energy solutions into urban systems is essential for reducing dependence on fossil fuels. Meanwhile smart-grid technologies can facilitate the efficient distribution of renewable energy, storage systems can enhance reliability. Incentives such as tax breaks, subsidies, and grants are alternatives to encourage the adoption of smart renewable energy technologies. To achieve the latter, Uganda should prioritize regulatory frameworks that encourage innovation, streamline public-private partnerships, and support capacity-building programs. This is likely to mitigate environmental risks and build sustainable and resilient cities to climate change and rapid urban agglomeration.

Sustainable urban mobility for air quality improvement

Sustainable transportation systems are essential to reducing reliance on fossil fuels, lowering emissions, and easing congestion. Investments in electric buses, dedicated cycling lanes, and pedestrian-friendly infrastructure – all of which are eco-friendly mobility options - can improve urban livability whilst benefiting the country's green economy. These efforts, complemented with a comprehensive approach to improving air quality, can accelerate the adoption of cleaner energy technologies encouraging behavioral change and creating healthier, more connected, and better equipped cities. Overall, expanding air quality monitoring programs for identifying the sources of pollution more effectively, introducing stricter vehicle emission standards, and disincentives such as higher taxes on older, polluting vehicles can further drive this transition.

References

IQAir. (n.d.). *World air quality*. (2025). Taken from https://www.iqair.com/

UN-Habitat. (2023). *Uganda country brief*. Taken from https://unhabitat.org/sites/default/files/2023/07/uganda_country_brief_final_en_1.pdf

World Bank. (2023). *Urban development: Overview*. Taken from https://www.worldbank.org/en/topic/urbandevelopment/overview

Ritchie, H., & Roser, M. (2024). *Urbanization*. *Our World in Data*. Taken from https://ourworldindata.org/urbanization

Green City Times. (n.d.). *Sustainable urban development*. Taken from https://www.greencitytimes.com/sustainable-urban-development/

Statista. (2024). *Urbanization rate in Africa from 2010 to 2022*. Taken from https://www.statista.com/statistics/1226106/urbanization-rate-in-africa/#:~:text=The%20urbanization%20rate%20in%20Africa,further%20in%20the%20coming%20years

United Nations Economic Commission for Africa. (2024). *Spotlight on urbanization in Africa*. Taken from https://www.uneca.org/eca-events/africa-urban-forum-2024/spotlight-urbanization-africa#:~:text=Urbanization%20on%20the%20African%20continent,in%202000%20to%20around%2060%25

African Union. (2024). *Africa Urban Forum: Concept note*. Taken from https://au.int/sites/default/files/newsevents/conceptnotes/43851-CN-FRENCH_-_Africa-Urban-Forum-Concept-Note.pdf

Ministry of Lands, Housing and Urban Development. (2022). *Uganda state of urbanization: Final draft*. Taken from https://mlhud.go.ug/wp-content/uploads/2023/12/Uganda-State-of-Urbanisation-Final-Draft-September-2022-new-1.pdf

World Bank Blogs. (2021). *Demographic boom: Explainer of Uganda's population trends*. Taken from https://blogs.worldbank.org/en/africacan/demographic-boom-explainer-ugandas-population-trends

United Nations Development Programme. (2023). *Employing community solutions for Kampala's flooding challenge*. Taken from https://www.undp.org/uganda/blog/employing-community-solutions-kampalas-flooding-challenge

Ministry of Lands, Housing and Urban Development. (2020). *Sustainable urbanization and housing: PIAP*. Taken from https://mlhud.go.ug/wp-content/uploads/2021/03/Sustainable-Urbanisation-and-Housing-PIAP.pdf

Uganda Investment Authority. (2020). *2019-2020 Uganda Investment Annual Report*. Taken from https://www.ugandainvest.go.ug/wp-content/uploads/2021/05/2019-2020-UGANDA-INVESTMENT-ANUAL-REPORT-FINAL.pdf?utm_source=chatgpt.com

Urbanet. (2023). *Flood resilience: Blue-green infrastructure solutions in Kampala*. Taken from https://www.urbanet.info/flood-resilience-blue-green-infrastructure-new-solutions-kampala/#:~:text=Kampala%20is%20one%20of%20Africa's,and%20decreased%20infiltration%20of%20water

Global Green Growth Institute. (2021). *Greening Uganda's urbanization and industrialization*. Taken from https://gggi.org/wp-content/uploads/2021/01/Brochure-Greening-Ugandas-Urbanization-and-Industrialization.pdf

ScienceDirect. (2018). *Sustainable land-use management: Implications for green urban growth*. Taken from https://www.sciencedirect.com/science/article/pii/S0169204618309770

Nature Stewardship. (2023). *Rainwater harvesting facilities for improved urban resilience in Kampala*. Taken from https://nature-stewardship.org/countries/uganda/rainwater-harvesting-facilities-for-improved-urban-resilience-to-flooding-in-greater-kampala/

Uganda Development Bank Limited. (2024). *Barriers and opportunities for sustainable urbanization*. Taken from https://www.udbl.co.ug/wp-content/uploads/2024/05/UDB-PB3_Barriers-and-Opportunities-NO.3.pdf

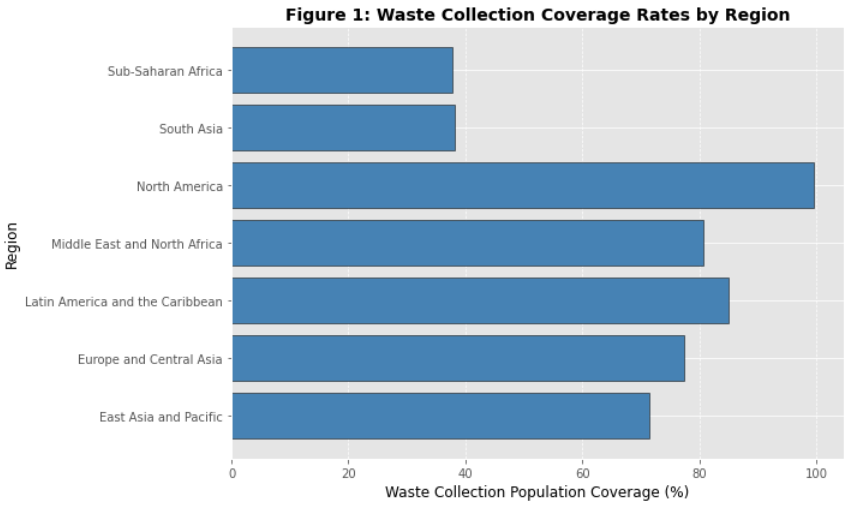
9 Circular-Economy Approaches to Municipal Solid-Waste Management in Uganda

Andrew Womer

Introduction

Waste is a ubiquitous part of modern economies, and its management is a core public service provided by governments. Beyond routine collection and disposal, governments often set standards, enforce regulations, and create incentives for reduction, reuse, and recycling. There are many forms of waste, ranging from agricultural to toxic industrial waste, but in this chapter, we focus on Municipal Solid Waste Management (MSWM)—the systems that handle everyday household and business waste. Particular attention is paid to Kampala, Uganda's largest city and biggest generator of municipal solid waste.

Because waste is an inevitable byproduct of economic activity, as countries grow, they tend to produce more waste per capita but manage that waste better, such that the externalities—the negative impacts on the economy and society—are less. This rule of thumb reflects regional patterns of waste production and management: Sub-Saharan African (SSA) countries produce the least amount of waste per capita but have the worst performing waste management systems, reflected in their lower average collection rates compared to other regions (Figure 1).



What a Waste Global Database (2018), World Bank Group

This is very much the case for Uganda, and like many other SSA countries, Uganda's economy and population are also growing rapidly, and people are moving more and more to urban areas. Urbanization is a central part of the picture when it comes to waste management challenges. Uganda's cities and their infrastructure are not able to handle the increased number of residents and city dwellers, also, in part because their increased productivity produces more waste than their rural counterparts. Moreover, municipal budgets are squeezed, and revenue mobilization is perennially inadequate.

The combination of these factors has put immense pressure on MSWM in Kampala and Uganda's secondary cities, leading to poor collection rates and, consequently, numerous economic and societal costs.

These costs can be broken down into a few categories:

- Public health
- Environmental
- Economic

Environmentally, poor MSWM results in higher levels of air, water, and soil pollution. Uncollected waste often ends up in the streets, waterways, and open dumpsites, releasing toxins into these environments after waste material breaks down. Moreover, to get rid of waste, people resort to waste burning (often plastic), which releases particulate matter in the air, increasing the level of PM2.5 concentration. Additionally, low collection rates lead to the overburdening of landfills, which can release leachate that can seep into groundwater that is used for drinking among locals around landfills. Global Climate change is a key variable as well. Waste burning releases greenhouse gases, thereby increasing carbon emissions, and the increase in extreme weather events, for example, heavy rainfall and flooding, threatens waste management infrastructure.

On the public health side, pollution in the water and air from practices like open dumping and waste burning contribute to air and water pollution that have been shown to increase disease and reduce cognitive function. Poor women and children are the worst affected by waste-related pollution because they are the ones who frequently handle practices like waste burning and picking up uncollected waste. These waste-related externalities are part of a broader negative regional trend; deaths from pollution-related causes have risen by 36 percent in SSA between 1990 and 2013.

The effects of poor MSWM on the economy are often downstream of these impacts on public health and the environment. The increase in mortality risk and disease resulting from higher levels of pollution results in increased healthcare costs, reduced work hours while ill, and lower productivity from illness and reduced cognitive function in high pollution environments. Local governments also have to reallocate resources to tackle issues and crises arising from poor waste management, diverting funds from essential services and development projects. Nowhere is this truer than with the collapse of Kiteezi, Kampala's only sanitary landfill, in August 2024, which killed over 30 people. Kiteezi had been overcapacity since 2015, in part because this was essentially the only destination for formally collected waste collection, and the government was unable to complete a replacement landfill, a project that has experienced perennial setbacks and cost overruns. And the inability of the government to complete a replacement not only led to the collapse. This failure not only caused the tragic loss of lives and destruction of property but also forced the city to divert resources toward investigating the disaster, compensating affected families, and increasing the costs of waste collection for Kampala residents as their waste was transported to Kitikolo, a landfill further away in Mukono.

In part because of the Kiteezi disaster, MSWM has become an urgent policy priority for policymakers, but efforts to develop a national strategy and policy agenda long precede it. In this chapter, we will focus on policy solutions related to the **adoption of circular economy principles**—*reducing waste and increasing the lifecycle of waste material*. Circular economy (CE) practices in waste management are a subset of the broader waste-to-resource approach to waste management, which includes waste-to-energy processes.

The waste management hierarchy is a convenient way to think about these and other methods of disposal, as shown in Figure 2. At the top of the pyramid—the most preferred options—are CE disposal methods: recycling and composting, followed by waste-to-energy and sanitary landfilling.

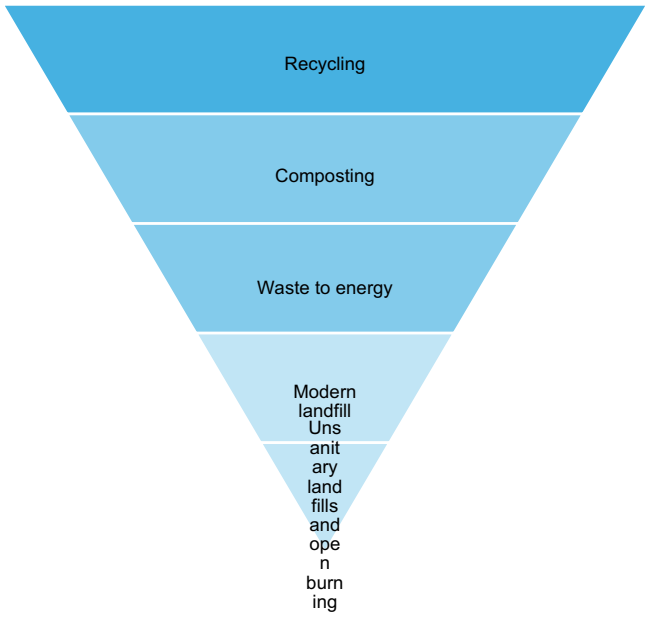


Figure 1: The hierarchy of waste management

At the bottom are unsanitary landfills and open burning—unfortunately, these are currently the prevalent disposal methods in Uganda. With the closure of Kiteezi, no sanitary or *modern* landfills are left; instead, unsanitary landfills, open burning, and dumping dominate.

Because of their high position on the waste hierarchy, increasing recycling and composting could be a natural goal for policymakers. There is also very little recycling or composting in Uganda—NEMA has estimated that just 4 percent of plastic waste is recycled; therefore, making even a small amount of progress could be high-value added. Circular economy methods are particularly well-suited to Uganda, as they align with the country's institutional capacity, human capital, financial resources, and climatic conditions. They are also highly efficient: repairing, refurbishing, or remanufacturing waste requires only 15-20% of the energy needed to produce new products, making it a cost-effective and resource-saving approach. CE approaches also offer an opportunity for large-scale job creation for low-skill workers, generating productive, higher value-added jobs. Some examples in other African city contexts will be given in the following chapters (CtW brief).

Of course, there is a great deal of waste which cannot be processed using CE practices and landfilling will need to absorb an increased amount of waste if the formal waste collection rates are to increase. This is well understood by policymakers in Uganda, but land use issues, technical capacity, corruption, and financing constraints have limited progress on this front. It was known that the Kiteezi landfill was overcapacity, and plans were made to secure a new landfilling site, though the acquisition of the land only came four months after Kiteezi's collapse.

Waste-to-energy technologies, which are above landfilling but below CE practices, are indeed a compelling way of offloading waste from landfills and finding productive use for it, and this has been promoted by leaders of the Kampala Capital City Authority (KCCA) as the way forward. However, these are highly capital-intensive technologies and require a level of institutional capacity and skilled labour that may be difficult to sustain. This is especially true in municipalities other than Kampala, which have smaller populations and a lesser tax base to support such investments. This chapter will not discuss the opportunities and challenges of a waste-to-energy plant, but the experience of Addis Ababa, which set up Africa's only plant to date, could be a useful case study to inform policymakers.

Now, the core question is how to craft a circular economy policy agenda that builds on the current MSWM system in Uganda. The government and private sector have already made progress here. Increasing the circularity of Uganda's waste management systems are incorporated into the national policy agenda—the National Development Plan III (NDP III) set the goal of increasing waste collection coverage across the country from 30 to 50 percent and recognizes the need "reduce waste generation through prevention, reduction, recycling, and reuse to transition towards a circular economy." The National Environmental Management Authority (NEMA), which is responsible for environmental standard setting and setting the national policy agenda, has published policy documents and has incorporated circular economy (CE) ideas into its strategy. In 2023, they tackle the question of plastic circularity in their *National Strategy for the Management of Plastic Pollution (2023-2028)* and provide an overview of a policy agenda. In it, NEMA even refers to the waste management hierarchy as a guide to informing plastics waste management, though the discussion on specific policies and a cross-country comparison is missing.

As such, this chapter hopes to explore policy recommendations on circular economy approaches to MSWM with reference to policy experiments in SSA and other developing countries to invite a practical discussion on policy agenda. The chapter will be organized from hereon as follows:

- Overview of Municipal Solid Waste Management in Uganda
- Policies to Improve Waste Separation
- Fostering the Circular Economy

Waste Management Systems in Uganda

Municipal solid waste management (MSWM) in Uganda's urban areas unfolds within a decentralized governance framework, granting local municipal authorities significant autonomy over how collection, transportation, and disposal are organized. National policies such as the National Solid Waste Management Policy (2009) and the Public Health Act and the Local Governments Act provide overarching guidelines, but their implementation depends on the financial and technical capacity of local authorities. This has produced a patchwork of strategies across the country, with Kampala presenting one of the more developed—yet still strained—models, and secondary cities experimenting with adaptive, community-oriented approaches to make up for limited resources and infrastructure.

Analytically, it is worth thinking about Kampala and secondary cities as distinct categories. Kampala has over ten times the population of the second largest city, and as a result, has more resources and technical capacity, as well as a much more challenging waste management situation. This chapter will focus mostly on Kampala, not only because of its centrality to the Ugandan economy, but because little research has been done on secondary cities' waste systems. In part this reflects secondary cities' lesser capacity to fund and conduct research. This is where less expensive but helpful studies, such as a stakeholder analysis, could be a useful first step to forming a policy and research agenda.

In the Greater Kampala Metropolitan Area (GKMA), the formal waste management system operates under a two-pronged Public Private Partnership (PPP) established in 2014, where waste collection responsibilities are divided between the Kampala Capital City Authority (KCCA) and private companies. KCCA collects about 70 percent of the formally managed waste, primarily serving the poorest residents who cannot afford to pay for waste collection services. Meanwhile, private companies are responsible for the remaining 30 percent of waste collection, focusing on areas

not covered by KCCA and charging residents for their services. This dual system reflects an effort to extend service coverage, but gaps remain significant due to inconsistent oversight, limited infrastructure, and low willingness or ability to pay for private services.

Overall, just 40 percent of the total waste generated in Kampala is formally collected, leaving a vast majority unmanaged. Uncollected waste is often disposed of through illegal dumping, accumulating in informal dumpsites, streets, and waterways, or burned openly. This is particularly common in poorer communities, where inadequate waste management infrastructure and services leave residents with few alternatives. The environmental and health impacts of these practices are profound: open dumping pollutes soil and water, while waste burning releases toxic pollutants and particulate matter, contributing to respiratory illnesses and other health risks.

Waste separation in Kampala remains minimal, further complicating efforts to extract value from waste. At the household level, separation at source is rare, and mixed waste accounts for the majority of what enters the collection system. This lack of segregation reduces the potential for recycling and resource recovery, as much of the waste becomes contaminated or difficult to process. Approximately 70 percent of Kampala's waste is organic, originating from households, markets, and restaurants, yet only a fraction is processed or valorized. Organic waste, if separated and managed effectively, could be transformed into compost, animal feed, or briquettes, offering both environmental and economic benefits. Instead, most of this waste ends up in dumpsites or is burned, missing opportunities for sustainable utilization.

Private and informal sector actors play a critical role in recycling efforts, though these activities are largely uncoordinated and small-scale. Informal waste pickers, for example, recover recyclables such as plastics, metals, and paper from streets, dumpsites, and even the Kiteezi landfill, which was until its closure Kampala's only designated disposal site. These materials are sold to brokers or directly to recycling businesses, though the lack of centralized facilities and formal systems limits the efficiency and profitability of these efforts. Recyclable materials like metals and plastics are highly sought after, but their recovery rates remain low due to inadequate sorting and processing infrastructure.

Outside the capital, secondary cities such as Gulu, Mbarara, Jinja, and Masaka face similar pressures but operate with fewer resources. Decentralization grants their

municipal councils the authority to devise local solutions, and the scarcity of funds and equipment often leads these councils to try more inclusive, community-based approaches—which so far have had limited success. In Gulu, communal skip containers formed the backbone of the system. Residents bring their household waste to these central points, and municipal crews periodically emptied the skips and transported the contents to an open dumpsite. Although this approach helped consolidate waste and establish predictable collection routes, limited equipment and maintenance budgets frequently caused skips to overflow. Over time, however, Gulu's authorities and community members began exploring ways to refine the system: supporting local groups to encourage better sorting at home, involving neighborhood leaders in identifying collection hotspots, and building trust so that residents feel more inclined to use designated skips rather than resort to informal dumping. Such small-scale adaptations signal a gradual shift toward more collaborative, locally informed solutions.

Mbarara, Jinja, and Masaka offer similar stories. With their municipal councils also facing funding shortfalls and infrastructural backlogs, top-down mandates alone have often proved insufficient to ensure regular collection or enforce by-laws. In response, these secondary cities have leaned on local NGOs, neighborhood associations, and informal recyclers to fill in the gaps. Mbarara has experimented with small composting projects that depend on households voluntarily separating organics, while Jinja has benefited from short-term donor interventions that fostered dialogue among citizens, informal pickers, and small businesses. Masaka's efforts to introduce user fees for collection, paired with community sensitization sessions and advisory committees that include local residents, reflect attempts to weave bottom-up input into the operational fabric of MSWM. While these initiatives rarely achieve immediate, transformative results—recycling rates remain low, equipment is still inadequate, enforcement is patchy, and open dumping persists—they mark a subtle but meaningful move toward a model in which local knowledge, civic participation, and negotiated responsibilities between municipalities and their residents become part of everyday waste governance.

Policies to improve waste separation

Waste-to-resource markets are downstream of the capacity for a waste management system to separate waste. The more reusable waste you can procure from the bulk of waste produced daily, the larger the market for local products using waste as an input. And consistency is key: companies need to have inputs for their production processes consistently—that is, separation and aggregation of reusable

waste has to be done in a way that is predictable so that companies can procure such material without disruptions to their business plans. Moreover, waste mixing should be minimal, as many reusable waste materials degrade in quality when mixed with other types of waste. This is especially true for organic, paper, and cardboard waste, and less true for items like plastic and glass bottles.

In these respects, the waste separation has a long way to go in Uganda. In Kampala, somewhere between 4-10 percent of waste is reused in some way, which is low compared to peer cities within the EAC—Nairobi, for example, reuses or recycles 45 percent of its waste. Waste is also separated largely by the informal economy, by waste pickers, who operate on the streets, markets, landfills, and the many illegal dumpsites that are scattered around the city. In other words, waste is separated after it is disposed of and (largely) mixed with other waste materials, except for glass bottles, which have a high value as a recyclable and are largely unaffected by incidental waste mixing.

Moving to waste separation at the source of waste—households, businesses, and markets—is the most promising policy solution to increasing the rate of recycling and building the supply chains for a local circular economy. At the moment, there is some informal system of waste separation at the source in markets in Kampala, especially in plastics and metals, but this is, to the author's knowledge, unexamined by academic or policy research. At the household level, there is essentially no waste separation at the household level, the largest producer, which seems a natural target for policy.

In Kampala—and throughout Uganda's other municipalities—households do little to no waste separation, with the exception of glass bottles, which tend to be recycled by all sources of waste due to its high value as a recyclable. In some countries, households do separate waste, but it is mixed once collected—but in Uganda, the opposite is true; garbage collectors will often separate mixed household waste on the way to the landfill to supplement their income. However, this is done inconsistently, on a small scale, and only for the most valuable items (mostly plastic water bottles).

Waste separation is largely done by informal waste pickers who collect recyclables from landfills, open dump sites, streets, waterways, and even bins prior to collection. Waste pickers operate independently or under contract to dealers, who transport recyclables to processing facilities (GGGI 2018). The informal sector is likely to remain involved in the waste management system for the coming decades,

and this chapter will discuss ways to improve its involvement. However, they still separate waste after it is mixed, and this is especially a problem for waste materials such as paper, cardboard, and organic waste, which, once mixed with other waste by households, is difficult to recuperate value from further down the waste processing chain.

Information for households and other sources of waste is critical for the success of waste management interventions. Giving households and businesses information about changes in waste segregation policies has been shown in policy experiments to increase participation dramatically. Wahedra and Nie 2023 studied a waste segregation intervention in Bangladesh that provided a mix of information and the provision of trash bags/bins across several control groups. In the first treatment group, the researchers provided only a 'one shot' of information to households through a brochure that detailed how to separate solid waste into organics and inorganics and the national strategies for waste segregation. This information-only intervention increased waste segregation by 30 percent, suggesting that sensitisation on waste segregation could have significant society-wide effects on waste segregation. Although information-based intervention studies are lacking in SSA, studies in Asian developing economies tend to support this strong effect of information on segregation among households (UNDP 2021).

Providing bins for different waste types (e.g., recycling, compost, etc) in tandem with a campaign of community engagement is one policy option for increasing source-level separation. Lack of access to bins and a belief that recycling is not important have been shown in other countries to be constraints to getting households to properly dispose of and separate their waste (Oyekale 2018). Several evaluations have shown that providing bins can increase recyclable waste and improve cost recovery. In Maputo, an intervention that provided waste bins for recyclable and non-recyclable waste resulted in sixteen times more recycling for treated households compared to control groups.

The Wahedra and Nie 2023 study in Bangladesh also illustrates how carefully designing any bin policy to address the constraint at hand is important. As mentioned, they provided information to households on waste segregation in their first control group. In the second and third control groups, they provided plastic bags for one-time use for storing inorganic waste and dustbins, respectively. While serving the same purpose—enabling the separation of organic and inorganic material—the dustbin, likely because of its relative permanence and lower friction to use, was much more (how much more?) successful in getting households to

separate their waste. The presence of the dustbin, in contrast to plastic bags, which can be stored away easily and forgotten about, appears to have acted as a nudge on households.

As with other policies, providing separate bins needs to be considered with respect to the institutional capacity of the government and local attitudes. Experimentation is also key—piloting projects with a clear way to scale in concert with local stakeholders is important to making projects scale.

The case of coloured plastic bags in eThekwini (aka Durbin) is illustrative. In eThekwini, the municipality developed a color-coded bag system for household waste separation: orange bags were provided for cardboard, paper, and plastic materials; clear bags were designated for glass bottles and cans; and blue bags were used for garden green waste. After conducting initial trials with private contractors, the municipality's waste management plan for 2016-2021 made a commitment to expand this multi-bag separation at source system, including extending it to the CBCs. However, this initiative has faced significant setbacks due to challenges in the tendering and contracting processes for both the supply and collection of recycling bags. As waste collection services have become increasingly unreliable, residents have grown more frustrated. The situation has been further complicated by emerging corruption scandals in the waste management sector, leading to mounting public pressure to make this service a renewed priority (ODI paper).

Other studies have demonstrated that engagement with community leaders and informational feedback improve waste separation and the overall level of hazardous waste in the treated communities (Dutta-Powell, 2023). Getting community is critical to helping to educate and encourage residents to use the waste bins as intended, as well as establishing community norms that discourage the theft of bins, which has proved to be an issue for policy implementation in other country contexts.

Establishing waste banks could be considered to increase waste separation at the household and community level. Waste banks are community-driven facilities where residents deposit sorted recyclable waste in exchange for money or other incentives. Waste banks operate at the local level, often managed by community members, NGOs, or private sector companies, and serve as collection points for materials like plastics, paper, and metals. The initial setup costs are relatively low, involving expenses for a basic structure, weighing scales, and storage containers.

Setting up waste banks in other countries has generally required financing either from the government, NGOs or multilateral institutions alongside public government initiative.

Waste banks have been particularly successful in developing Asian countries such as Indonesia, Loas and in Thailand, where they were first established in 2006, and are now being expanded into some SSA contexts like Nigeria (MIT Solve).They have been shown only enhance recycling rates but also create economic opportunities for low-income communities, ease the pressure on local landfills and reduce environmental degradation (Williams and Millington 2019) The presence of waste banks in communities also can act as an educational tool, teaching residents about sorting practices and reinforcing the importance of recycling (Miezah et al. 2015; Dhokhikah and Trihadiningrum 2020).

Fostering the Circular Economy

Developing a local market for circular economy products, be it recycled plastic, compost or used textiles could have many positive spillovers. Creating market incentives to reuse waste will reduce the waste burden and reduce collection costs (Stahel, 2016), in addition to creating jobs and commercial opportunities for the private sector. Creating products out of waste material is also relatively energy efficient, needing only 15-20 percent of the energy used to create entirely new products (Hauser and Lund 2003).

Exporting plastic, largely to China, was a main avenue for recycled materials to be commercialized, which Uganda participated in. This all changed in 2018 when China banned the importation of most waste products, completely disrupting the global market and as a result Uganda's plastic waste exports have declined by 25% since 2018. This decline came as Uganda's overall trade increased by more than 20%. Other importers of plastic waste may follow China by imposing bans or tariffs—Thailand has just announced a ban that will be enacted in January 2025—further reducing export options. While there are exceptions to this trend, notably Kenya's increasing demand for recycled paper and cardboard material, the general trajectory lends itself to trying to create opportunities for the domestic processing of waste products in Uganda. Improving waste separation, as well as collection rates, are core to creating business opportunities for recycled waste, as discussed. In the following sections, this chapter explores other ways policymakers can foster the domestic market for CE products.

Composting

Organic waste management presents both significant challenges and opportunities in Uganda, particularly in urban areas like Kampala where it constitutes approximately 70% of municipal solid waste. Composting requires a relatively low initial investment, depending on the plant designs, though it processes less waste (about 250 tonnes) per day than other methods like incineration (CtW).

Composting appears to be a straightforward win-win when it comes to Municipal Waste Management. Most solid waste produced in Kampala and throughout Uganda is organic waste and it can be used in fertilizers at relatively low processing costs. Being in a tropical environment with higher temperatures allows for faster decomposition of organic waste, an advantage that Uganda and many other SSA countries have. However, this advantage is lost if organic waste is not segregated and collected together with other organic waste soon after being produced (Wahedra and Nie 2023).

Thus far, there has been little national or municipal policy directed at increasing composting in Uganda, but last year NEMA and the Ministry of Water began a dialogue with the International Institute for Applied Systems Analysis to co-develop a national strategy. KCCA and other municipal governments could consider developing their own strategies for composting as part of a broader effort to increase waste-to-resource

Unlike recycling, in Uganda there does seem to be widespread awareness of composting and its importance. Nsimbe et al conducted a study in Masaka in 2018 which found that around 90 percent of households knew about and believed composting to be important, but just 11 percent of households composted themselves. The large gap between the awareness and practice of composting suggests that inadequate infrastructure and processes for composting are holding back progress. Indeed, often communities, households and even restaurants in Uganda have taken to producing compost with their own waste owing to poor waste collection services (Rothenberger et al. 2006). This pattern of community knowledge combined with awareness and positive sentiment towards composting is found across SSA urban and peri-urban settings. The question then is how can policymakers break through the constraints of infrastructure and logistical support that have limited the expansion of composting?

The economic viability of composting remains a key challenge and stimies the participation of private sector actors. Waste separation at source, as discussed in the previous section is critical for organic waste, which loses much of its economic worth when mixed with other materials. It also reduces the costs of transportation and processing for composting companies as separation allows for composted and recyclable materials to more easily be aggregated for easier bulk access for the private sector. In Uganda, prices for organic fertilizers in the market also remain low compared to synthetic nitrogen-based fertilizers, potentially limiting the growth of organic compost-based fertilizers. Policies that consider required blending of compost and synthetic fertilizers alongside setting up local waste-source to farm supply chains could be ways to work around that challenge.

The success story of "Bikuuta" (matooke peels) demonstrates potential. In Kampala, small restaurants and hotels, especially in high population neighborhoods like markets and slums, are large generators of matooke peels. Brokers buy the waste from small restaurants and sell it to organized groups of roadside brokers (GGG). These groups sell their inventory to farmers to use as animal feed or convert it into compost or mulch to improve soil quality. These private sector actors are mostly informal, and challenges to the business include lack of storage, high costs of transportation, and lack of technology and know-how to add value to the waste. Most roadside brokers also do not have permanent locations and are sometimes evicted from the premises by KCCA.

As with other informal actors, finding a way for government to cooperate with them—not necessarily recognizing them formally, which could drive out their participation—could be a cost-effective strategy for kickstarting the composting industry in Kampala. A good place to start is by targeting strategic collections of organic waste in areas such as produce markets, restaurants and hotels. KCCA and other municipal governments around Uganda can also help build the market by surveying the existing local (and mostly informal) market for compost and seek to build demand among potential buyers, including via certification systems that can help build confidence in product quality (Kaza and Bhada-Tata, 2018). Starting small and scaling up successful pilots Yet composting has a limited record of large-scale operation in Africa and Latin America, with Asian developing countries having the best records and suitability for composting (CtW).

Incineration would unlikely be a feasible option due to high moisture content of municipal solid waste generated in Kampala, estimated at about 70% with a low calorific value of organic waste generated in the city. This reinforces the importance

of developing appropriate solutions for the local context while addressing the fundamental challenges of waste separation, collection infrastructure, and market development.

Recycling

When it comes to plastics, public-private partnerships (PPPs) have proven effective in advancing recycling efforts in Uganda. Plastic Recycling Industries (PRI), Coca-Cola Beverages Africa, and the KCCA have collaborated to establish ten plastic waste collection centers across Kampala. KCCA provides land for the centers, while PRI invested UGX 175 million (USD 49,000) in construction costs. Community-based organizations (CBOs), made up of women and youth, operate these centers, handling tasks such as collecting, cleaning, and packing plastics. Early results are promising: the Rubaga center supplies PRI with 10 tons of plastics per month after six months of operation, while the Makindye center, operational for four months, supplies three tons. As the centers scale up, Rubaga is projected to supply 4–6 tons of plastic per week, generating annual revenues of UGX 120 million (USD 33,000).

Uganda's recycling industry includes over 30 companies, primarily focused on PET, HDPE, and polypropylene. PET, the most recycled plastic, is exported as flakes, but companies like PRI operate at only 50% capacity due to insufficient raw materials. Domestic processing could expand the production of value-added products, such as polyester fibers for clothing or baling straps, reducing reliance on exports and boosting local industries. However, the high cost of recycling facilities and fragmented domestic value chains remain barriers.

Starting a dialogue with the construction industry on the use of construction material with locally recycled plastic is a path starting to be pursued in other SSA countries. A pilot project being rolled out in Kenya, Cameroon and Senegal that is a cooperation between the UN and the Norwegian startup Othalo is using 75 percent of local plastic materials and transforming it into modular construction materials with local labor, eight tonnes of plastic can create a four-story, 60-square-meter building. One production line can produce 2,800 housing units annually.

Reducing the amount of non-recyclable plastic (and increasing the use of recyclable material) through plastic bans bans are another policy lever which has been tried in many low-income countries. While plastic bag bans in low-income countries have shown mixed results, a meta-analysis by Knoblauch et al. (2018) found that such bans generally lead to reduced plastic bag use and environmental

littering, though effectiveness varies widely based on policy design, enforcement stringency, and the availability of affordable alternatives. Plastic bag bans have been tried out by several of Uganda's neighbors– Rwanda, Kenya, and Tanzania have all have them. Studies have shown that in these contexts, successful implementation hinges on three key factors: strict enforcement, public education, and support for environmentally friendly alternatives (Behuria, 2021; Kalina et al., 2019). A 2009 ban on polythene bags of less than 30 microns in Uganda has faced weak enforcement, with over 30 polythene recycling plants continuing operations. Enforcing such a ban has tradeoffs though, as these plants employ over 3,000 workers and produce 2,500 tons of recycled material annually.

References

Aryampa, S., Maheshwari, B., Sabiiti, E., Bateganya, N. L., & Bukenya, B. (2019). Status of waste management in the East African cities: Understanding the drivers of waste generation, collection, and disposal and their impacts on Kampala City's sustainability. *Sustainability, 11*(19), 5523. https://doi.org/10.3390/su11195523

Behuria, P. (2021). The politics of governing plastic waste in Africa: Comparing Rwanda and Kenya. *Journal of Modern African Studies, 59*(2), 223–252. https://doi.org/10.1017/S0022278X21000150

Dias, S. M. (2016). Waste pickers and participatory policy-making: A baseline for reuse and recycling. *Environment and Urbanization, 28*(2), 735–753. https://doi.org/10.1177/0956247816665512

Dhokhikah, Y., & Trihadiningrum, Y. (2020). Community-based waste management through waste banks and its impact on the circular economy. *Journal of Cleaner Production, 275*, 122734. https://doi.org/10.1016/j.jclepro.2020.122734

Dutta-Powell, R., Court, C., & Clark, A. (2023). Interventions for effective waste management and segregation: Evidence from a randomised controlled trial in the Changzamtog district of Thimphu, Bhutan. *Cleaner Waste Systems, 6*, 100121. https://doi.org/10.1016/j.clwas.2023.100121

Global Green Growth Institute. (2018). *Value chain analysis report and investment options study on municipal solid waste management (MSWM) in*

Kampala. https://gggi.org/site/assets/uploads/2019/03/GGGI-Value-chain-analysis_FINAL-Report_GGGI-Copy-Edited-Version.pdf

Hauser, W., & Lund, R. (2003). *The remanufacturing industry: Anatomy of a giant*. Department of Manufacturing Engineering, Boston University.

Hosono, T., & Aoyagi, K. (2018). Effectiveness of interventions to induce waste segregation by households: Evidence from a randomized controlled trial in Mozambique. *Journal of Material Cycles and Waste Management, 20*(2), 1143–1153. https://doi.org/10.1007/s10163-017-0677-2

Kalina, M., Tilley, E., Ali, F., Nowaseb, J., Largent, L., & Elias, S. (2019). Effectiveness of enforcement mechanisms and social pressure on plastic bag regulations: A comparative analysis of Botswana and Namibia. *Sustainability, 11*(19), 5152. https://doi.org/10.3390/su11195152

Kaza, S., Yao, L., Bhada-Tata, P., & Van Woerden, F. (2018). *What a waste 2.0: A global snapshot of solid waste management to 2050*. World Bank. https://openknowledge.worldbank.org/handle/10986/30317

Kibuye, H., Wamunga, D., Obonyo, E., & Kinobe, J. R. (2021). Public perception and compliance to plastic bag ban in Kenya: The case of Nairobi metropolitan area. *Science of The Total Environment, 786*, 147468. https://doi.org/10.1016/j.scitotenv.2021.147468

Knoblauch, D., Mederake, L., & Stein, U. (2018). Developing countries in the lead—What drives the diffusion of plastic bag policies? *Sustainability, 10*(6), 1994. https://doi.org/10.3390/su10061994

Miezah, K., Obiri-Danso, K., Kádár, Z., Fei-Baffoe, B., & Mensah, M. Y. (2015). Municipal solid waste characterization and quantification as a measure towards effective waste management in Ghana. *Waste Management, 46*, 15–27. https://doi.org/10.1016/j.wasman.2015.09.009

MIT Solve. (n.d.). *Waste bank*. https://solve.mit.edu/challenges/resilient-ecosystems/solutions/51564

Mwesigye, P., Mbogoma, J., & Bashwira, R. (2019). Challenges and opportunities of waste-to-energy technologies in sub-Saharan Africa. *Renewable and Sustainable Energy Reviews, 100*, 195–206. https://doi.org/10.1016/j.rser.2018.10.024

Nielsen, T. D., Holmberg, K., & Stripple, J. (2019). Need a bag? A review of public policies on plastic carrier bags – Where, how and to what effect? *Waste Management, 87*, 428–440. https://doi.org/10.1016/j.wasman.2019.02.025

Nzeadibe, T. C., & Anyadike, R. N. C. (2012). Solid waste governance innovations: An appraisal of recent developments in the informal sector in waste collection and recycling in Nigeria. *Habitat International, 36*(1), 161–168. https://doi.org/10.1016/j.habitatint.2011.07.002

Oyekale, A. S. (2018). Determinants of households' involvement in waste separation and collection for recycling in South Africa. *Environment, Development and Sustainability, 20*(6), 2343–2371. https://doi.org/10.1007/s10668-017-9993-x

Pires, A., & Martinho, G. (2019). Waste hierarchy index for circular economy in waste management. *Waste Management, 95*, 298–305. https://doi.org/10.1016/j.wasman.2019.06.014

Stahel, W. R. (2016). The circular economy. *Nature, 531*(7595), 435–438. https://doi.org/10.1038/531435a

Tsai, W. T., & Chou, Y. H. (2006). An overview of renewable energy utilization from municipal solid waste (MSW) incineration in Taiwan. *Renewable and Sustainable Energy Reviews, 10*(5), 491–502. https://doi.org/10.1016/j.rser.2004.09.005

UN-Habitat. (2020). *UN-Habitat aims to use plastic waste to support housing for all*. https://unhabitat.org/news/2020/un-habitat-aims-to-use-plastic-waste-to-support-housing-for-all

United Nations Development Programme. (2021, March 31). Right intervention encourages behavior change in waste segregation. *UNDP Bhutan*. https://www.undp.org/bhutan/right-intervention-encourages-behavior-change-waste-segregation

United Nations Environment Programme. (2020). *Waste management outlook for Africa*. UNEP.

Williams, N., & Millington, A. (2019). Recycling initiatives and waste banks: An economic analysis in Sub-Saharan African cities. *Waste Management, 85*, 12–19. https://doi.org/10.1016/j.wasman.2019.01.005

Wilson, D. C., Velis, C., & Cheeseman, C. (2006). Role of informal sector recycling in waste management in developing countries. *Habitat International, 30*(4), 797–808. https://doi.org/10.1016/j.habitatint.2005.09.005

World Economic Forum, Ellen MacArthur Foundation, & McKinsey & Company. (2016). *The new plastics economy: Rethinking the future of plastics*. World Economic Forum.