ASSESSING THE EFFECTIVENESS OF CLIMATE ADAPTATION INTERVENTIONS IN EAST AFRICA

Technical Report

NOVEMBER 2024

Prepared by The Africa Research and Impact Network (ARIN)

ABOUT ARIN

The Africa Research and Impact Network (ARIN) is a leading organisation dedicated to addressing Africa's key development challenges, including climate change, sustainable agriculture, and inclusive economic growth. ARIN conducts rigorous research to assess the impacts of climate change and adaptation interventions, working closely with policymakers to turn evidence into actionable strategies (ARIN empowers researchers, policymakers, and communities to tackle climate challenges through capacity building and knowledge sharing. ARIN drives real-world impact and contributes to a more resilient and sustainable future for East Africa. More about ARIN can be found **here.**

ABOUT FCDO

The Foreign, Commonwealth & Development Office (FCDO) is a leading UK government department dedicated to promoting international relations and supporting sustainable development. As a key partner in this study, the FCDO's invaluable funding and expertise have been instrumental in advancing research and policy initiatives focused on addressing climate change and fostering resilience in East Africa. Their support has enabled collaborations that enhance the effectiveness of adaptation strategies, ultimately contributing to the well-being of communities in the region. More information about the FCDO and its work can be found **here.**

ABOUT EARIH

The East Africa Research and Innovation Hub (EARIH) is an initiative funded by the FCDO aimed at promoting research and innovation across East Africa. EARIH focuses on critical areas such as climate change, health, and agriculture, supporting both research and start-up ecosystems to drive sustainable development. Through this initiative, the FCDO seeks to strengthen regional research capacities, support innovators, and address local challenges with global impacts, including food security and environmental resilience. More about EARIH **here.**

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ABBREVIATIONS AND ACRONYMS

AfDB:	African Development Bank
ASUWSDP:	Arusha sustainable urban water and sanitation delivery intervention
BMZ:	Federal Ministry for Economic Cooperation and Development
BRCWE-Uganda:	Building resilient communities, wetland ecosystems and associated catchments in Uganda
CRI:	Climate Resilient Infrastructure
CSA:	Climate Smart Agriculture
DRR:	Disaster Risk Reduction
EARIH:	East Africa Research and Innovation Hub
EWS:	Early Warning Systems
FAO:	Food and Agriculture Organization of the United Nations
FCDO:	Foreign Commonwealth and Development Office
FGD:	Focused group discussion
GCF	Green Climate Fund
GEF	Global Environment Facility
GDP:	Gross domestic product
GIZ:	Deutsche Gesellschaft für Internationale Zusammenarbeit
IKI:	International Climate Initiative
ICAM-Tanzania:	Implementation of concrete adaptation measures to reduce vulnerability of livelihood and economy of coastal communities in Tanzania
IPCC:	Intergovernmental Panel on Climate Change
JICA:	Japan International Cooperation Agency
KCCAP:	Kenya Climate Change Adaptation Programme
KII:	Key informant interviews
L.E.A.D.:	Locate Evidence, Evaluate Evidence, Assemble Evidence, Inform
LLA:	Locally Led Adaptation
NAP:	National Adaptation Plan
NbS	Nature based Solution
NDC:	Nationally Determined Contribution
NEMA:	National Environmental Management Authority
NGO	non-governmental organisation
PCSA-Rwanda:	Promoting Climate Smart Agriculture for improved rural livelihoods and climate resilience in the climate-vulnerable Eastern Province of Rwanda
PPP:	Public-private partnership
UCLG:	United Cities and Local Governments
UNFCCC:	United Nations Framework Conventions of Climate Change
WEFE:	Water–Energy–Food–Ecosystems (WEFE) Nexus

ACKNOWLEDGEMENTS

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Additionally, we acknowledge the contributions of multilateral development banks, including the GEF, GCF, Adaptation Fund, World Bank, and AfDB, as well as bilateral agencies such as FCDO, JICA, BMZ, IFAD, GIZ, USAID, and IKI. We also recognize the support of NGOs, private sector platforms, and government agencies in East Africa. Their collective assistance has been instrumental in the successful completion of this report.

EXECUTIVE SUMMARY

Background

East Africa is highly vulnerable to the effects of climate change due to its reliance on climate-sensitive sectors and a lack of necessary institutional, technological and financial adaptive capacities to build resilience. The region faces increasing temperatures, erratic rainfall patterns and extreme weather events, which amplify vulnerabilities across all key sectors. This is attributed to the region's diverse geography, varying microclimates and socio-economic contexts. Despite some progress in integrating adaptation into national policies, such as nationally determined contributions (NDCs) and national adaptation plans (NAPs), critical gaps remain in policy implementation and investment in climate adaptation. Specifically, there is a lack of robust evidence on what interventions are more effective in addressing vulnerabilities and what opportunities exist for scaling up investments. Specific questions require attention, notably: whether initiatives are making a positive difference for vulnerable communities; and whether they are achieving their desired impact, i.e., promoting equity and providing good value for money. This report synthesises findings from a study commissioned by the UK Foreign, Commonwealth & Development Office (FCDO) through the East Africa Research and Innovation Hub (EARIH) to assess the effectiveness of adaptation interventions in nine East African countries: Kenya, Tanzania, Uganda, Rwanda, Burundi, Ethiopia, Eritrea, Somalia and South Sudan. The study aimed to inform the FCDO adaptation priorities in the region by generating robust evidence on what works to build resilience to climate impacts.

This study defines effective adaptation interventions as those with a high likelihood of achieving their intended goals. We considered the diverse goals of adaptation interventions, encompassing the extent to which they achieve certain outcomes as detailed in Singh et al. (2022). These indicators acknowledge the spectrum of effective adaptation, covering both process-based and outcome-based approaches. Within this framework, effective adaptation entails: minimising costs and maximising economic benefits, supporting the attainment of material, subjective and relational well-being, and reducing vulnerability while enhancing adaptive capacity, particularly for the most vulnerable and at-risk populations.

Methodology

The study used a two-phase approach:

1. **Phase 1**: A scoping exercise mapped climate adaptation interventions from various databases across key sectors (agriculture, food security, water security and management, nature-based solutions (NbS), disaster risk reduction and resilient land management). Intervention documents and policy frameworks were reviewed, and the interventions were characterised in terms of their activities, the technologies and innovations being applied, community engagement in risk reduction and the reported impacts of these interventions. This was complemented by a systematic literature review of both published and relevant policy documents to identify the state of evidence on the effectiveness of different practices and existing gaps needing further research.
2. **Phase 2**: Case studies from an empirical investigation in Kenya, Rwanda, Tanzania and Uganda were conducted, using focus group discussions (FGD) and key informant interviews (KII) with intervention implementers, policy makers, beneficiaries and funders to assess the effectiveness of selected adaptation interventions.

Key Findings

The study identified 242 adaptation interventions across East Africa, with most situated in Kenya. These focused primarily on agriculture (36%) and water security and land management (21%). Significant gaps in investment were apparent, particularly in countries like South Sudan, Djibouti, Rwanda and Somalia. The uneven distribution may be influenced by a range of factors, including but not limited to, donor interests, political stability and governance issues. These gaps hinder progress in critical sectors such as NbS, climate-resilient infrastructure and disaster risk reduction, where investment levels are low relative to the risks these sectors face. Some of the key findings from the analysis are:

1. **Policy and investment gaps**: While national policies, such as NDC and NAP, have integrated climate adaptation, notable gaps exist in sectors such as NbS, land management, disaster risk reduction and climate-resilient infrastructure. These gaps are contributing to imbalanced investment, where well-funded sectors (e.g., agriculture and water) may not sufficiently address the risks in underfunded sectors, potentially undermining overall adaptation efforts. An integrated, multi-sectoral approach is necessary to address these interlinked risks effectively.

2. **Integrated, nexus approach**: Interventions that integrate multiple sectors, such as the Water–Energy–Food–Ecosystems (WEFE) Nexus, NbS and climate-smart agriculture (CSA) practices, have proven to be effective. These interventions offer co-benefits across sectors, leveraging synergies between water, energy and food security that reduce costs and maximise impact. This overcomes challenges of operating in silos, where work is often impeded by institutional and funding fragmentations. For example, the results indicated that water management practices, such as micro-irrigation and rainwater harvesting, along with CSA) and agroforestry, had positive outcomes in building climate resilience.

3. **Climate resilient infrastructure (CRI):** This is a critical area of adaptation given the increasing vulnerability of people and infrastructure to climate-related disasters, such as flooding. The ability of infrastructure to recover fast from climatic shocks is an important aspect of effective functionality. Therefore, CRI should be established with the right standards, considering the magnitude of climatic risk.

4. **Financing for adaptation**: The economic impact of interventions (profitability) and their market value are not assessed due to a lack of economic evaluation frameworks. Grants remain the dominant financing mechanism for adaptation in East Africa. While essential for addressing immediate vulnerabilities, long-term sustainability requires innovative financing models that attract private sector investment and measurable economic returns, including an improvement in the socio-economic status of communities. However, diversified funding sources, including market-driven models, are needed to support the scaling of successful interventions. Additional investment in value chains and technology efficiency is critical to enhancing productivity, thus accelerating the transition from social to economic impacts.

5. **Capacity building**: Capacity building interventions, including targeted training, demonstration sites and farmer field schools, were effective across all sectors. However, simply equipping beneficiaries with knowledge and skills is insufficient. Effective adaptation requires sustained support, local leadership and long-term investments beyond the intervention life cycle. Local ownership and community leadership are critical to enhancing the impact of adaptation interventions. Thus, an integrated approach to managing the relationship between people and ecosystems enhances both the process-based and outcome-based effectiveness of interventions.

6. **Social protection and institutional support**: Social protection mechanisms, such as cash transfers and asset restocking, are vital to strengthening resilience, especially among vulnerable populations. However, limited evidence is available on the effectiveness of these financing models, and further studies are needed to establish their role in fostering long-term resilience. Policies that strengthen local institutions and promote community resource management are also key enablers for effective adaptation.

7. **Ecological impacts and NbS**: Nature-based solutions (NbS), such as agroforestry, soil conservation and wetland restoration, contributed positively to both ecological and socio-economic outcomes. However, these interventions are often underfunded and undervalued by communities, which focus more on immediate livelihood benefits. Greater awareness and better tools for monitoring ecological impacts would highlight the full benefits of NbS.

8. **Regional and knowledge gaps**: The evidence base for adaptation interventions is uneven, with the most rigorous studies focusing on agriculture. The findings showed significant knowledge gaps in sectors such as water security, climate-resilient infrastructure and NbS. Furthermore, regional disparities in research exist, with some countries, like Burundi and Somalia, being less studied. This limits the ability to design contextually appropriate interventions in these areas.

Whilst East Africa has begun to include climate adaptation in national policies, gaps in knowledge investment and sectoral coordination remain barriers to effective adaptation. The most successful interventions adopt an integrated, multi-sectoral approach, combining agricultural, water, energy and ecosystem management to maximise co-benefits. Capacity building, community engagement and institutional strengthening are essential to ensure these interventions are sustainable and impactful. However, the effectiveness of these interventions is highly contextual, dependent on the specific vulnerabilities of each community or region.

Recommendations

Based on the research analysis, this report recommends:

1. **Promote integrated, nexus-based approaches**: Prioritise interventions that integrate multiple sectors, particularly water, energy, food security and ecosystems. These interventions should leverage synergies and co-benefits to maximise their impact across the region.

2. **Address policy and investment gaps**: Investment in mainstream climate adaptation across all sectoral policies will help close the gaps in sectors like NbS and climate-resilient infrastructure. Investing in underfunded sectors and ensuring equitable resource distribution will help mitigate cross-sectoral risks.

3. **Strengthen long-term financing models**: Develop innovative financing models that move beyond grant funding to attract private sector investment. This involves exploring blended finance mechanisms and market-driven approaches to ensure the sustainability of adaptation interventions.

4. **Enhance capacity-building and local leadership**: Continue to support capacity-building interventions, with a focus on local leadership and community-driven solutions. Long-term investments and sustained support are essential for translating skills into real-world climate resilience.

5. **Address knowledge gaps**: Future research should fill the knowledge gaps in sectors like water security, NbS, and climate-resilient infrastructure. Rigorous studies on the

effectiveness of social protection mechanisms and financing innovations are needed to strengthen the evidence base.

6. **Encourage community engagement and policy coherence**: Effective adaptation requires strong community participation, stakeholder collaboration and alignment with national policies. There is need to support the institutionalisation of adaptation at local levels and promote policies that facilitate community-driven adaptation strategies.

7. **Develop adequate guidelines and indicators for gender analysis and implementation**: There is lack of clear guidelines/protocols for gender intersectionality analysis in interventions and mainstreaming gender considerations in practice. Consequently, consideration of gender issues in adaptation interventions weakens as interventions transition from design to actual implementation. There is need to develop adequate guidelines and indicators for gender analysis and mainstreaming in the implementation and monitoring of interventions.

Conclusion

East Africa's climate adaptation landscape is complex, but significant opportunities exist to scale up effective interventions. By prioritising integrated, nexus-based approaches, addressing policy and investment gaps and strengthening local capacities, the region can build a more resilient future. The effectiveness of interventions is highly contextual and dependent on the needs of stakeholders, long-term funding and institutional capacity to ensure success and sustainability in the face of increasingly severe climate risks.

INTRODUCTION

1.0 INTRODUCTION

East African communities, especially those facing poverty, gender or other social inequalities, are at the forefront of experiencing the devastating impacts of climate change, affecting their livelihoods, food security and well-being. Although Africa contributes only 4% of global greenhouse gas (GHG) emissions (UN, 2006; IEA, 2022), the continent is already experiencing significant climate risks and is projected to face even greater challenges in the future. East Africa in particular, is at greater risk of climate change than are other African regions due to overdependence on climate-sensitive sectors, low adaptive capacities and the lack of the necessary institutional, technological and financial capacity to reduce emissions and build resilience against climate change (Doku et al., 2021a; 2021b; Mekonnen et al., 2021; Phiri & Doku, 2024).

While adaptation efforts are underway to respond to the glaring impacts, these responses are impeded by a lack of robust evidence on what interventions are more effective in addressing vulnerabilities and what opportunities exist for scaling up investments. Key questions that need to be addressed: Are initiatives making a positive difference for vulnerable communities? And are they achieving their intended goals such as promoting equity and providing good value for money? Without clear answers, valuable resources can be wasted and progress towards a more resilient future can be hindered.

This intervention aimed to bridge this gap by generating evidence on the effectiveness of adaptation interventions across East Africa to inform future investments**.** The study, funded by the UK Foreign, Commonwealth & Development Office (FCDO) through its East Africa Research and Innovation Hub (EARIH), has three key objectives: i) to identify priority adaptation sectors and interventions; ii) to understand the factors influencing the adoption of different interventions and the specific needs of marginalised groups; and (iii) to map the landscape of key funders driving adaptation efforts in East Africa. By thoroughly investigating and analysing the focus and effectiveness of current interventions, we can inform future strategies for building resilient communities, ensuring effectiveness across all African nations. This will pave the way for more investments to scale up action equitably and sustainably for all East Africans challenged by climate change.

The following sections provide an overview of climate change in East Africa, outline the methodology used in this study and present findings from the mapped adaptation interventions. This includes a synthesis of evidence and empirical examples demonstrating the impacts of selected interventions. Based on the literature and case studies, the study offers key recommendations to inform future adaptation efforts in East Africa. While this study used a mix of methods to gather data from literature, experts and empirical cases, the empirical approach was exploratory. The assessment did not involve a detailed cost-benefit analysis and impact evaluation of interventions to inform the extent of impact and effectiveness of these interventions. Throughout the report, therefore, signposts where additional evidence might be required have been included. Overall, the report presents a useful foundation upon which further assessment of specific sectors or approaches can be anchored.

1.1 Background to Climate Change in East Africa

East Africa has a diverse climate, ranging from hot desert regions to cooler wetter highland regions, and large variability in seasonal rainfall (Richardson et al., 2022). The impacts of these extreme climate events manifest across various sectors, including water security and management, education, human health, animal health, agriculture and food security, nature and biodiversity, livelihoods and the overall economy (Klein et al., 2014; Nyasimi et al., 2014; Jayne

et al., 2018; Richardson et al., 2022). These impacts are often exacerbated by existing poverty, social inequalities and unforeseen disasters such as the COVID-19 pandemic.

The most important economic and livelihood sectors of East Africa, especially agriculture and water, are largely at risk of climate change. Agriculture remains the most climate-sensitive and impacted sector in East Africa. Over 70% of the region's population are small-scale farmers dependent on rain-fed agriculture for their livelihoods, and the sector provides 40% of the gross domestic product (GDP) (Adhikari et al., 2015). The agriculture sector is vulnerable to climate risks due to rising temperatures and increasing precipitation variability (Richardson et al, 2022). According to the Drought in East Africa Report (2022), the severe impact of prolonged droughts on soil moisture and crop yields leads to annual and seasonal crop failures for rural small-scale farmers in the region. The report further estimates that approximately 70 million people in the region are exposed to drought risks due to frequent failed rainy seasons. Successive failures in the rainy season from 2018 to 2022 particularly affected agricultural productivity, food and nutritional security in arid and semi-arid regions and the highlands of Kenya, Ethiopia, Sudan, Uganda, Ethiopia and Somalia (UNFCCC, 2020). Due to this drought, 23 million people in Kenya, Ethiopia and Somalia faced severe food shortages and another 2.3 million were internally displaced, resulting in a record 264,000 people displaced across borders[1,2,3].

The impacts of climate change on agriculture are further linked to significant economic losses. The agriculture sector employs over 80% of the population in the region, hence accounting for approximately 25–40% of the GDP of East African Community Partner States[4]. An example is Uganda where the Ministry of Water and Environment Uganda (2015) estimated that the costs of climate change on agriculture could reach US$273 billion between 2010 and 2050. Another is the estimated reduction in Ethiopia's GDP by about 3% if declines in agricultural productivity were to continue (Dickon Pinner et al., 2020).

The water sector is also severely affected. The major water sources in East Africa, such as Lakes Edward, Albert, Kivu, Victoria, Tanganyika and Malawi, have experienced temperature rises of between 0.2 and 0.7°C, affecting water quality and availability, exposing an increasing number of people to water stress. The Mara River Basin flowing between Kenya and Tanzania is increasingly facing water resource stress due to high water demand and urbanisation (Roy et al., 2018). Inadequate water resources not only affect water availability and quality for domestic utility but pose further risks to agricultural productivity and nutritional well-being for both rural and urban households (Ackerl et al., 2021).

Climate change is also driving unexpected shocks and disasters, leading to significant damage to infrastructure and economic uncertainties. Sea level rise, especially in the coastal zones of Kenya, Somalia and Tanzania (World Bank, 2015), pose a risk for flooding in low-lying cities, notably Mombasa and Dar es Salaam (World Bank, 2021). Floods in urban areas destroy infrastructure, roads, and health facilities, contaminate water and have been linked to an increase in vector-borne diseases, such as cholera and malaria, among others. In rural areas, floods cause livestock deaths and crop losses, destruction of homes, soil erosion and land degradation. In Kenya, for example, the economy loses between 2% and 2.8% of GDP annually due to these events (Government of the Republic of Kenya, 2018). According to the East Africa 2023 Economic Outlook (AfDB, 2023), long-term economic growth in East Africa could fall to below 5% annually by 2030 because of climate impacts. These pressures on GDP have a direct

[1] https://www.unrefugees.org/news/horn-of-africa-food-crisis-explained/
[2] https://www.who.int/publications/m/item/situation-report-greater-horn-of-africa-food-insecurity-and-health-grade-3-emergency-1-february-31-march-2023
[3] https://www.who.int/publications/m/item/situation-report-greater-horn-of-africa-food-insecurity-and-health-grade-3-emergency-1-february-31-march-2023
[4] https://www.eac.int/agriculture

effect on micro, small and medium enterprises (MSME), which make up over 80% of businesses in East Africa and upon which most households rely for livelihoods and resilience (Atela et al., 2020). Furthermore, unexpected disasters such as locust invasions are becoming rampant due to temperature changes and are causing economic uncertainties amidst the ensuing impacts of climate change. The recent locust invasion during 2018–2022, for example, was the worst in 25 years in Ethiopia and 70 years in Kenya (Mullie et al., 2023). These scenarios indicate that East Africa's economies are not only highly vulnerable to climate change, but these risks are also imminent and require the adoption and implementation of rapid response adaptation and mitigation actions.

Beyond the economic impacts on various sectors, climate change significantly affects the social assets of different groups, creating intersectional vulnerabilities that require consideration when designing adaptation interventions. Evidence shows that women are often more vulnerable to climate change due to societal norms that limit their access to resources, coupled with their high dependence on agriculture and the MSME sector — both of which are climate-sensitive sectors. Similarly, youth and children, who form the majority of the population in East Africa (UNICEF, 2020), are vulnerable to the impacts of climate change on health and education. For example, more than 10 million children living around Lake Victoria are exposed to flooding and the risk of waterborne diseases (UNICEF, 2020). Job security for the youth is also increasingly threatened by climate change. In Uganda, over 12 million casual labourers, predominantly young people, are at risk of losing their jobs due to climate impacts on the country's coffee industry (Global Centre on Adaptation, 2021).

1.2. Adaptation efforts

Addressing these impacts of climate change, and vulnerability, remains an area of focus, given the crucial role these sectors play in the socio-economic landscapes of countries in the region (Maina & Parádi-Dolgos, 2024). However, East Africa's adaptive capacity, as measured by the Climate Resilience Index (CRI)[5], is relatively low compared to that of other African regions (AfDB, 2022). The region's CRI score is 25.0, which is significantly lower than Southern Africa's score of 43.6 and Northern Africa's score of 63.5 (see **Figure 1a**). The CRI varies between East African countries—from 18.3 to 28.9, with Djibouti, Kenya and Tanzania scoring highest, and South Sudan achieving the lowest CRI[6] (see **Figure 1b**).

[5] The Climate Resilience Index is calculated as **RI = (ACI*TCI)/(EI*SI)**; where RI: climate resilience index, ACI: adaptive capacity index, TCI: transformative capacity index, EI: exposure index and SI: sensitivity index. The index is derived by considering GDP as well as readiness and vulnerability to climate change.

[6] Climate Resilient Index

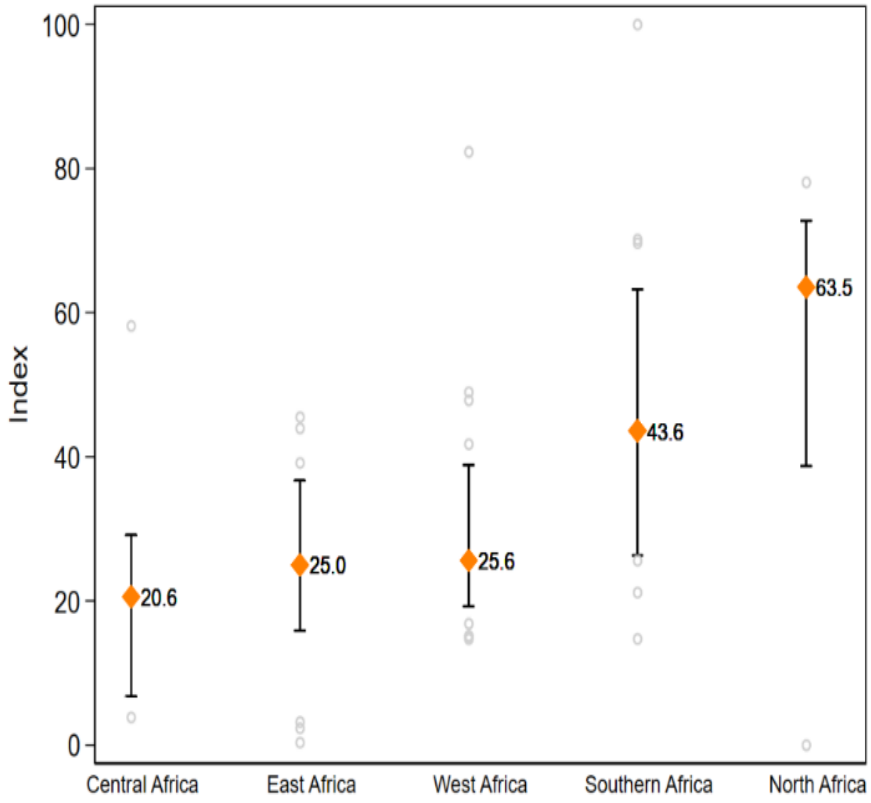


Figure 1a: Climate Resilience Index scores across regions. Source: AfDB (2022).

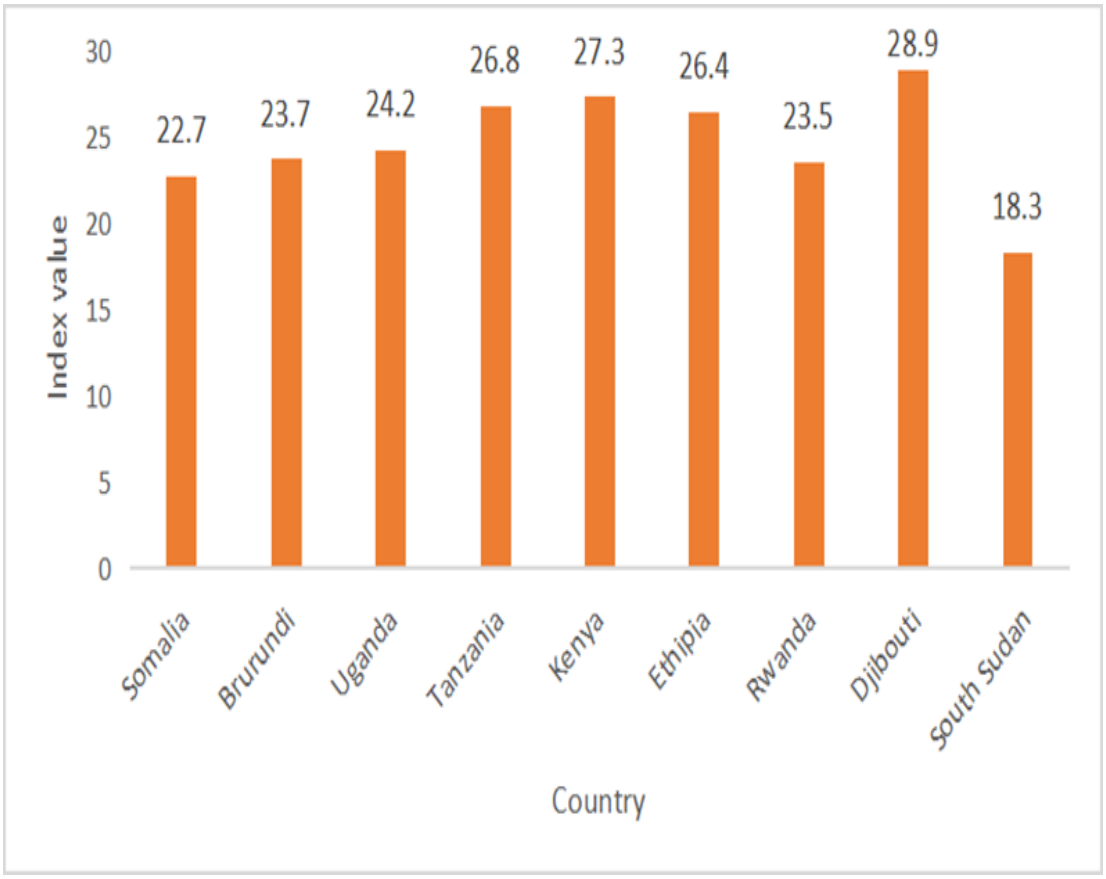


Figure 1b: Climate Resilient Index scores for East Africa (2010–2019); Source: AfDB (2022)

Efforts to enhance the region's adaptive capacity are underway. Global and national policies are already prioritising community-driven approaches through, for example, locally led and inclusive adaptation (LLA) interventions to address specific intersectional vulnerabilities (GEF, 2011). The LLA approach advocates for community-driven climate action, including decision-making, technology adoption, financing and tailored responses to specific vulnerabilities (Soanes et al., 2017). Recognising the diverse impacts of climate change within communities, LLA could empower communities by devolving decision-making, finances, and resources (Soanes et al., 2017). The decentralisation of decision-making empowers communities to prudently respond to climate change in ways that reflect their specific challenges and opportunities for sustainable adaptation actions. As part of catalysing such local adaptation actions, the COP26 agreements (Glasgow Climate Pact) aimed to increase adaptation funding to US$50 billion annually, targeted at scaling up adaptation for the most vulnerable communities, including women and marginalised people (UNFCCC, 2021).[7]

To date, several LLA practices have been deployed in different countries in East Africa. These include adopting sustainable agricultural practices, investing in renewable energy sources, restoring ecosystems, developing climate-resilient infrastructure, and mobilising indigenous knowledge to address deforestation and biodiversity loss (Klein et al., 2014; Nyasimi et al., 2014; Jayne et al., 2018; Kaudia et al., 2022; Richardson et al., 2022). As already highlighted, these efforts are, however, impeded by a lack of robust evidence on what interventions are more effective in addressing vulnerabilities and what opportunities exist for scaling up investments. Specific questions require attention, notably: whether initiatives are making a positive difference for vulnerable communities; and whether they are achieving their desired impact, i.e., promoting equity and providing good value for money. Without clear answers, valuable resources can be wasted, and progress towards a more resilient future can be hindered. This study aims to bridge this gap by generating evidence on the effectiveness of adaptation interventions across East Africa.

[7] https://unfccc.int/sites/default/files/resource/cop26_auv_2f_cover_decision.pdf

METHODOLOGY

2. METHODOLOGY

2.1. Geographical and thematic scope

The study focused on nine countries in East Africa (**Figure 2**) and analysed interventions in four key sectors or themes critical to East African economic development and livelihoods: agriculture and food security; water security and management; nature-based solutions and regenerative land management; and disaster risk reduction (DRR), encompassing drought and flood risk reduction in both rural and urban areas.

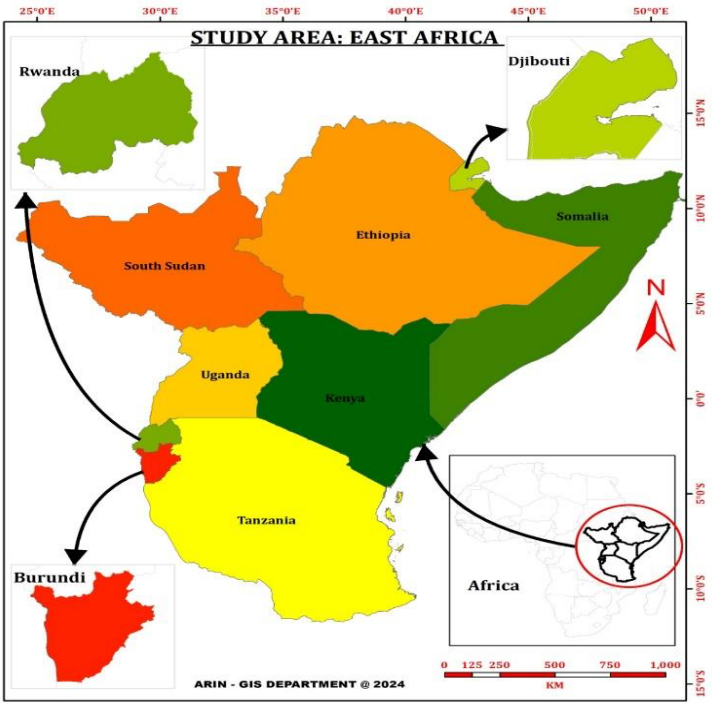


Figure 2: Countries in East Africa targeted by the study

2.2. Analytical framework

Effective adaptation: 'Effective adaptation' can have different outcomes and be understood differently by various stakeholder groups. This study defined effective adaptation interventions as those with a high likelihood of achieving their intended goals. We considered the diverse goals of adaptation interventions, encompassing the extent to which they achieve certain outcomes as detailed in Singh et al. (2022) (see **Table 1**, column 1). These indicators acknowledge the spectrum of effective adaptation, covering both process-based and outcome-based approaches. Within this framework, effective adaptation entails: minimising costs and maximising economic benefits, supporting the attainment of material, subjective and relational well-being, and reducing vulnerability while enhancing adaptive capacity, particularly for the most vulnerable and at-risk populations. Assessing all the 11 indicators within the study's resource and time constraints can be complex. Therefore, through stakeholder consultations during inception dialogues, the 11 indicators were refined into 5 key categories (see **Table 1**, column 2).

Table 1: Indicators of effectiveness

Singh et al. (2022) indicators of effectiveness	Modified indicators for the study
(1) Promote ecosystem-based adaptation (2) Facilitate community-based adaptation (3) Improve well-being (4) Reduce vulnerability and enhance adaptive capacity (5) Enhance resilience (6) Maximise economic benefits	(1) Technological practices and impacts
(7) Promote sustainable adaptation (8) Avoid maladaptation	(2) Financing models (3) Adoption and sustainability
(9) Achieve adaptive governance	(4) Governance and policy
(10) Ensure equity and justice	(5) Gender and social inclusion
(11) Promote transformation	Not assessed

Evidence appraisal: Evidence appraisal was conducted to understand how effectiveness has been assessed and to identify associated gaps in accuracy, relevance and methodological robustness. Specifically, we applied the Locate Evidence, Evaluate Evidence, Assemble Evidence, Inform Decisions (L.E.A.D.) framework. The L.E.A.D. framework prioritises assessing how evidence answers practical questions, enabling us to evaluate the relevance of existing evidence concerning informed decision-making.

2.3 Data collection

Figure 3 presents the three phases of this study. The inception phase involved a consultative and iterative process between the Africa Research and Impact Network (ARIN) and FCDO to establish the study's objectives, scope, timelines and methodology. Data collection was conducted across Phases 1 and 2.

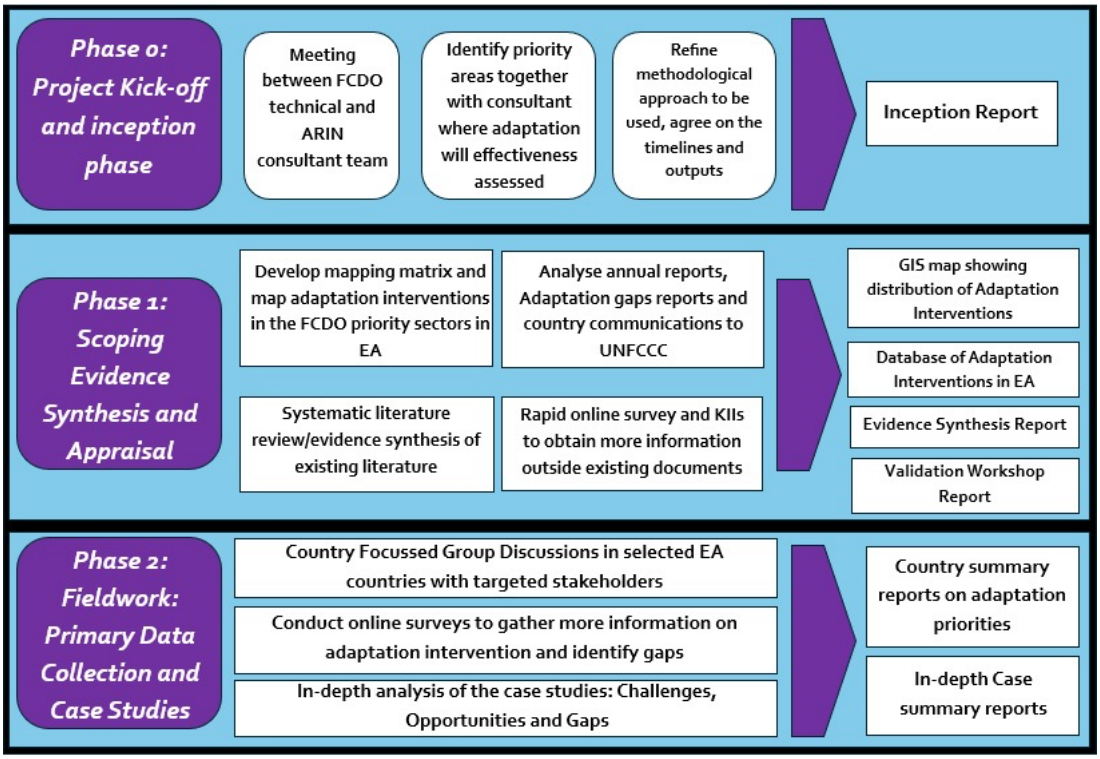


Figure 3: Framework for data collection

Phase 1 involved an initial scoping exercise to understand the adaptation of the investment landscape in East Africa. This phase included mapping adaptation interventions across the region within the four key sectors outlined in section 2.1. Information on interventions funded by multilateral agencies was reviewed using their respective databases such as those of the Global Environmental Facility (GEF), Global Climate Fund (GCF), Adaptation Fund, World Bank and African Development Bank (AfDB). Additionally, interventions funded by bilateral agencies — FCDO, Japan International Cooperation Agency (JICA), Federal Ministry for Economic Cooperation and Development (BMZ), International Fund for Agricultural Development (IFAD|), International Climate Initiative (IKI), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), United States Agency for International Development (USAID) and the Bill & Melinda Gates Foundation — and other private sector and non-governmental organisation (NGO)-led platforms, were analysed. Intervention documents and websites were examined to characterise the interventions in terms of their activities, applied technologies or innovations, community engagement efforts, and reported impacts.

To further understand the evidence surrounding the effectiveness of interventions, a systematic review of both published and relevant policy documents was conducted. These documents were located by using boolean and keywords such as “adaptation interventions” OR “projects” AND “disaster risk reduction” AND “Kenya”. The review aimed to identify the current state of evidence on different adaptation interventions and existing knowledge gaps requiring further research attention. To validate the preliminary intervention mapping and evidence synthesis, a virtual regional consultative workshop was held on 28 February 2024.

Building on Phase 1, primary research was conducted in Phase 2 across Kenya, Rwanda, Tanzania and Uganda where relevant case studies (**Figure 4**) were identified based on the insights from the scoping phase and a set of criteria (Text Box 1). The selected case studies are briefly described in Annex 4 (Case study description).

Text Box 1: Case study selection criteria

Thematic focus: selected case studies fell within the priority thematic areas identified in phase 1, including agriculture and food security, water security and management, nature-based solution and resilient land management, Disaster Risk Reduction (DRR) and climate-resilient infrastructure.
Multi-country implementation: case studies operating in more than one country were prioritised to enable comparative analysis of effectiveness across contexts and potential for scaling across these contexts.
More than (two) 2 years of intervention implementation period: case studies or interventions that had been implemented for more than 2 years were prioritised to ensure validity of data based on lived experiences.
Data availability and accessibility: case studies/interventions with readily available and accessible data on their respective archives and sources were prioritised to enable timely and valid implementation of the study.
***Potential for Investment*:** case studies that adopted practices that revealed potential for investments were prioritised to enable a deep dive into the investment opportunities.

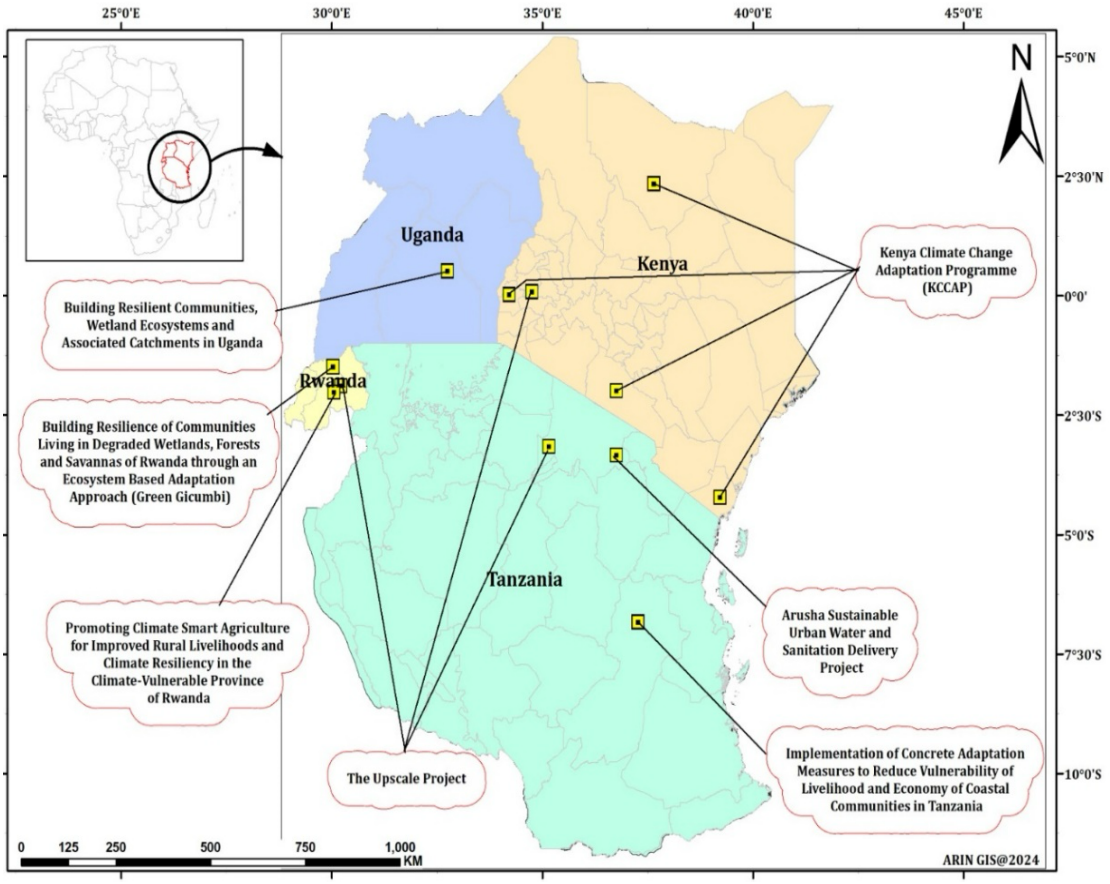


Figure 4: Case studies interventions analysed for the study

The seven case study interventions were analysed using country focus group discussions (FGD). One FGD was carried out in each of the four selected countries of East Africa. The country focal partners identified at least 15 stakeholders per FGD with a representation across the 4 scoped thematic areas. The targeted sectors were the ministries of Agriculture, Environment, Forestry and Water; meteorological departments; disaster risk reduction agencies; relevant private industries; the NGO; community-based organisations (CBO); research institutions; and academia. Discussions were guided using an FGD topic guide designed to capture both the general perceptions of stakeholders and actual experiences from practical interventions.

Key informant interviews (KII) were carried out with intervention implementers (n = 7), policymakers (n = 4), funders (n = 2) and intervention beneficiaries (n = 33). A KII questionnaire was designed to capture lived experiences on the impacts of interventions and the process through which these impacts are achieved, including how communities are involved in the intervention design, implementation and benefit sharing; the extent to which they feel the interventions/interventions are contributing to building resilience equitably and sustainably; and key challenges and opportunities for enhancing effectiveness/impact, among others. The indicators developed by Singh et al. (2023) to assess effectiveness informed the design of the KII questionnaire to determine the extent to which interventions achieve their objectives and results for different social groups, including inclusiveness, fairness and justice, transparency and accountability; efficiency (minimising cost and maximising benefits) and delivering on normative goals/objectives (e.g., improved well-being, enhanced resilience, reduced vulnerability and avoided maladaptation); and sustainability.

The thematic focus of the case study analysis was informed by the scoping study which revealed that interventions that combine several practices in an integrated way, i.e., connecting different

sectors like the Water–Energy–Food–Ecosystems (WEFE) Nexus, NbS and climate-smart agriculture (CSA) practices, as well as climate resilient infrastructure, hold potential for impact. Evidence reveals that an integrated or nexus approach connects multiple sectors, leveraging their synergies and delivering multiple benefits to community livelihoods, economy and ecosystems[8].

The data was transcribed using MAXQDA software and analysed through the grounded theory approach, which involved coding the information into key themes and illustrative quotes or case experiences (Hopkins, 2007).

2.4. Methodological limitations

This study used a mix of methods, namely literature review, stakeholder engagements and rapid empirical assessment of case studies; these approaches were exploratory. The empirical assessment did not involve detailed cost-benefit analysis and rigorous impact evaluation of interventions to inform the extent of impact and effectiveness of these interventions, although we reviewed studies from the literature that used these methods. Additionally, interventions whose impact is assessed via case studies are largely based on the perception of beneficiaries rather than the actual measurement of these impacts. As such, it is possible that beneficiaries were subjective in their judgement of impacts. To account for this potential bias, we have presented the elements of impacts as 'perceived impacts by the beneficiaries'. Throughout the report, we have included signposts where adequate evidence might be lacking and indicated where additional evidence might be required to validate certain claims. Overall, the report presents a useful foundation on which to anchor further assessment of specific sectors or approaches.

[8] https://www.gwp.org/en/GWP-Mediterranean/WE-ACT/Programmes-per-theme/Water-Food-Energy-Nexus/the-nexus-approach-an-introduction/

OVERVIEW OF ADAPTATION INTERVENTIONS IN EAST AFRICA

3.0 OVERVIEW OF ADAPTATION INTERVENTIONS IN EAST AFRICA

3.1. Geographical distribution of adaptation interventions in East Africa

Figure 5 shows the distribution and sectoral focus of the 242 adaptation interventions identified from the 9 countries of East Africa. Most interventions were found in Kenya (n = 81), followed by Uganda (n = 65). South Sudan and Djibouti had the fewest interventions (n = 18 each) (**Figure 6**). The numbers show some indicative imbalance in the distribution of interventions — somehow influenced by the geographical interests of funders, political stability, governance issues and, potentially, the study's methodological bias towards some databases. About 35.9% (n = 87) of the interventions identified focused on agriculture and food security and 21.1% (n = 71) on water security and management. The implementation period for interventions ranged between 1 and 13 years, with most interventions (75%, n = 252) implemented within 5 years or less.

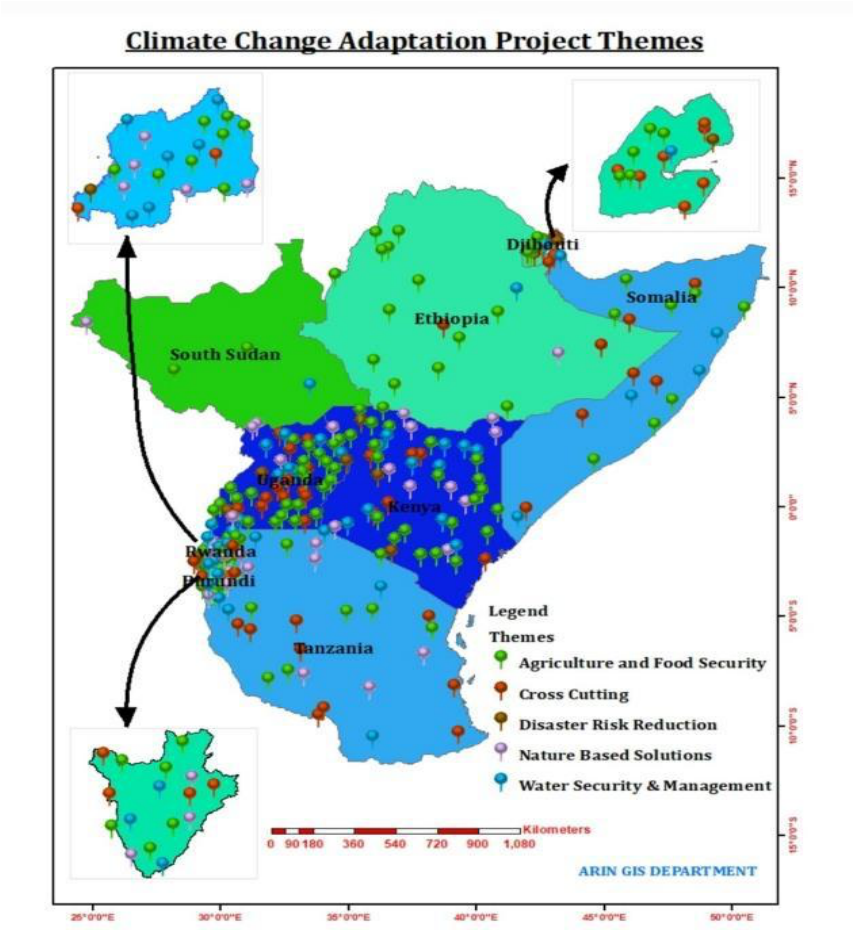


Figure 5. Spatial distribution of: (a) total identified adaptation interventions; and (b) interventions per thematic area (n = 242).

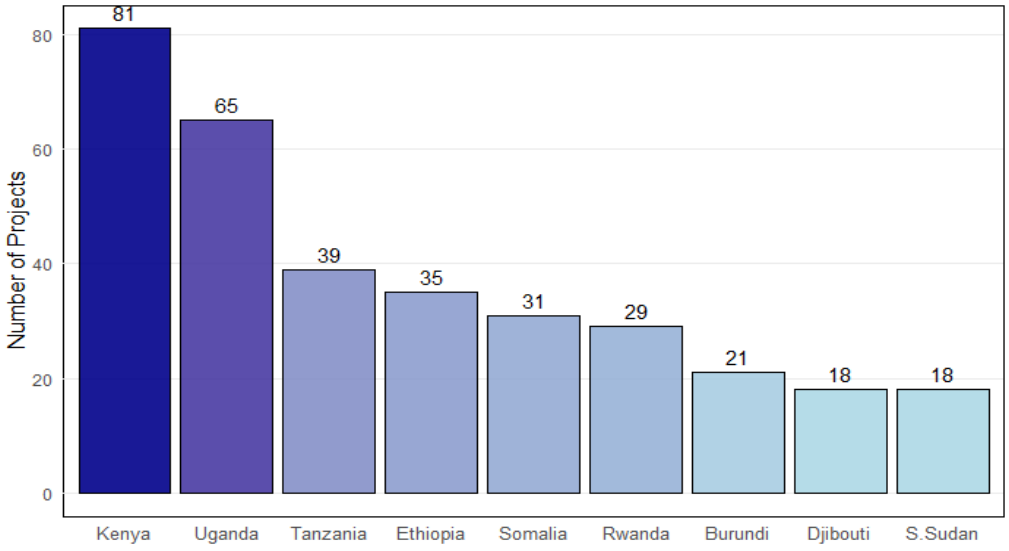


Figure 6: Number of adaptation interventions identified per country

Most of the funding for the mapped interventions was from multilateral sources, including portfolios under the United Nations Framework Convention on Climate Change (UNFCCC) (e.g., the Adaptation Fund, Green Climate Fund (GCF), Global Environmental Fund (GEF)) and multilateral development banks, including the World Bank and African Development Bank. Bilateral funding for some interventions was also identified, especially by developed countries agencies, e.g., JICA, USAID, UK-Aid, BMZ, IKI and GIZ supporting interventions.

The mean annual budget of mapped interventions is £4,032,614 (GBP), with significant variation. The smallest intervention had an annual budget of £21,787, and the largest had a budget of £60,108,259 annually. **Figure 7** illustrates the variation in intervention costs per country[9], showing the widest variations in Burundi and the lowest in South Sudan.

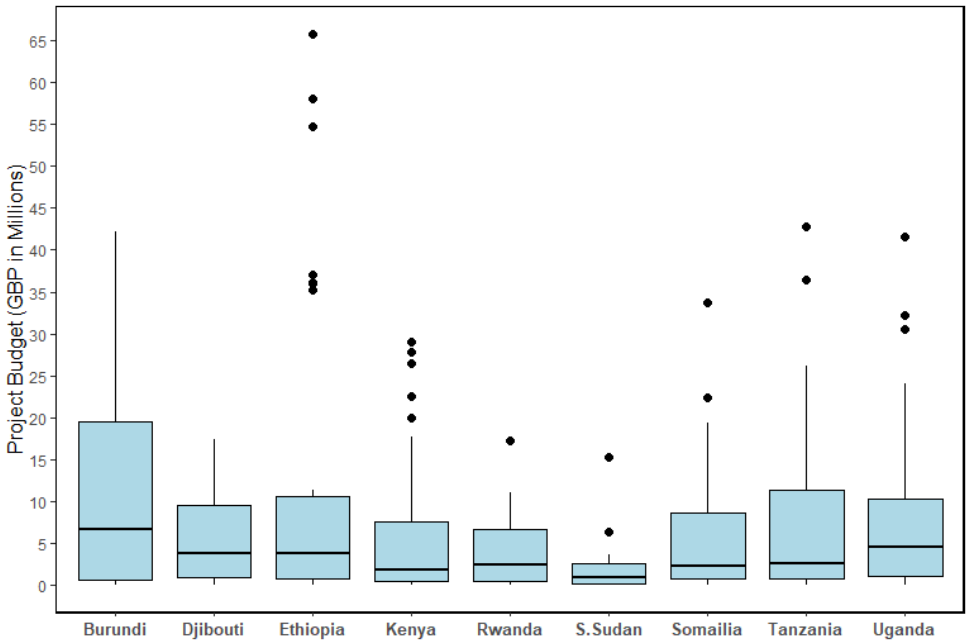


Figure 7: Annual intervention budget per country

[9] Eight interventions with budgets exceeding the maximum reported here (i.e. outliers) are not represented in this figure.

About 90% of the funding for the interventions was in the form of grant financing; equity and loans accounted for less than 5%. The prevalence of grant funding implies that adaptation funding in the region relies on public funds and activities are yet to tap into private sector funding. Benefit transfers and non-market transactions are frequently encouraged by grant financing. Reliance on grant funding may deter the creation of novel business plans that draw in private funding for promising technology. As a result, shifting adaptation interventions from intervention-based efforts to sustainable business models is a challenge that might compromise the long-term efficacy of these interventions. The short intervention implementation durations (usually five years or fewer) further exacerbate the situation.

Efforts are underway to mobilise private sector financing and investments for adaptation through multilateral development banks and flagship programmes like the AfDB Adaptation Accelerator Programme. While the programmes hold promise for private sector adaptation support, there is need to invest in institutional preparedness and capacity building to facilitate the adoption of private financing instruments for promising practices.

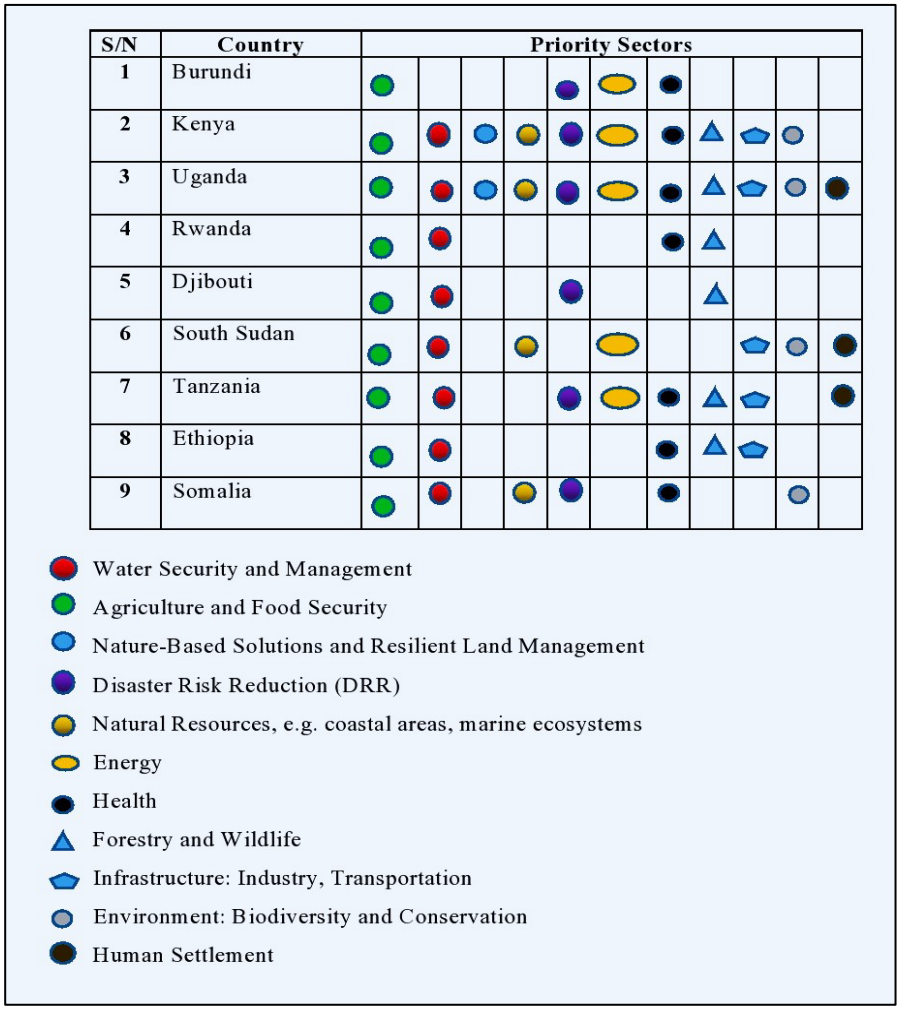
3.2. Overview of adaptation interventions in policy

The national adaptation plans (NAPs) and nationally determined contributions (NDCs) of countries in East Africa were reviewed to identify prioritised sectors and activities outlined in these policies and to determine whether these priorities were aligned with current risks and existing interventions. **Table 2** presents a summary of the priority sectors identified. Agriculture, food security, and water security and management were the most common sectors identified in the policy documents. The previous sections highlight that agriculture and water security are among the sectors most affected by climate change thus, the policy priorities seem to be aligned with the critical risks. However, the NAPs and NDCs lack adequate evidence, detailed data and implementation plans for the relevant technologies and practices (Knapen et al., 2006; Richardson et al., 2022).

Some notable differences exist in the types of practices/interventions identified in policies from different countries. For example, Burundi, Rwanda, Djibouti and Somalia's NAP and NDC documents omit human settlement and infrastructure, and Rwanda, South Sudan and Ethiopia have not considered natural resource management (NRM), despite the significant role played by NRM in their economies and livelihoods. Nature-based solutions and land management are mentioned only in the NAP and NDC documents in Kenya and Uganda, and health is omitted from South Sudan and Djibouti’s NDC. These notable differences in sectoral priorities are largely shaped by a country’s economy, resource interests, risks faced or even unintended omission. Nonetheless, the prominence of agriculture and food security as a priority sector across all the countries is attributable to the sector's role in contributing to livelihoods and economies across the region and the significant climate risk faced by this sector.

While there could be similar sectors identified across the countries, specific activities, technologies and innovations proposed within these sectors differ. For example, in the agriculture and food security sectors, some countries have listed activities such as irrigation, intensive agriculture and animal husbandry while others focus on the introduction of drought-resistant species, integration of water resource management and early warning systems.

Table 2: Priority sectors in the NDC and NAP per country (Source: Illustration done by ARIN)



Notes: Rwanda faces significant risks such as floods and landslides but lacks adequate disaster risk reduction (DRR) measures, human settlement or infrastructure considerations within its NDC and NAP. South Sudan and Djibouti do not prioritise health in their respective policy documents. (Source: Assessment of sectoral priorities in NDC and NAP documents).

3.3 Overview of studies on adaptation interventions

A systematic literature review and evidence synthesis was undertaken to establish the state of evidence on adaptation effectiveness and identify evidence gaps that require attention. Through rapid search, 235 studies were initially identified of which 112 were considered for rapid content review. Most of the studies retrieved focused on Kenya (19.6%, n = 22) and Uganda (13%, n = 15). Burundi and Somalia had the fewest studies (2.68%, n = 3 and 0.89%, n = 1 respectively). Studies with a regional focus, i.e., covering multiple countries, were 38% (n = 42). Thematically, most of the studies focused on agriculture and food security, NbS, and water security and management; very few studies were found on health (**Table 3**). Studies examining agriculture and food security primarily focused on CSA practices, covering a range of activities, including livestock management, crop management, sustainable land management and climate information services.

Practices identified under the water security and management theme include integrated water management, water governance and planning, and the application of indigenous knowledge

systems and local knowledge to water adaptation. In addition, hydrological modelling and simulation to predict future scenarios and inform planning and policy review or change and the impacts of water security on livelihoods were identified as well.

Practices under NbS that have received attention in the literature include forest ecosystems, integrated urban management, NbS for livelihood management and mainstreaming ecosystem-based adaptation into policies (see also Kalantari et al., 2018; Lokidor et al. 2023). Flood risk reduction, early warning systems and hydrological modelling are among the key practices identified within the DRR theme.

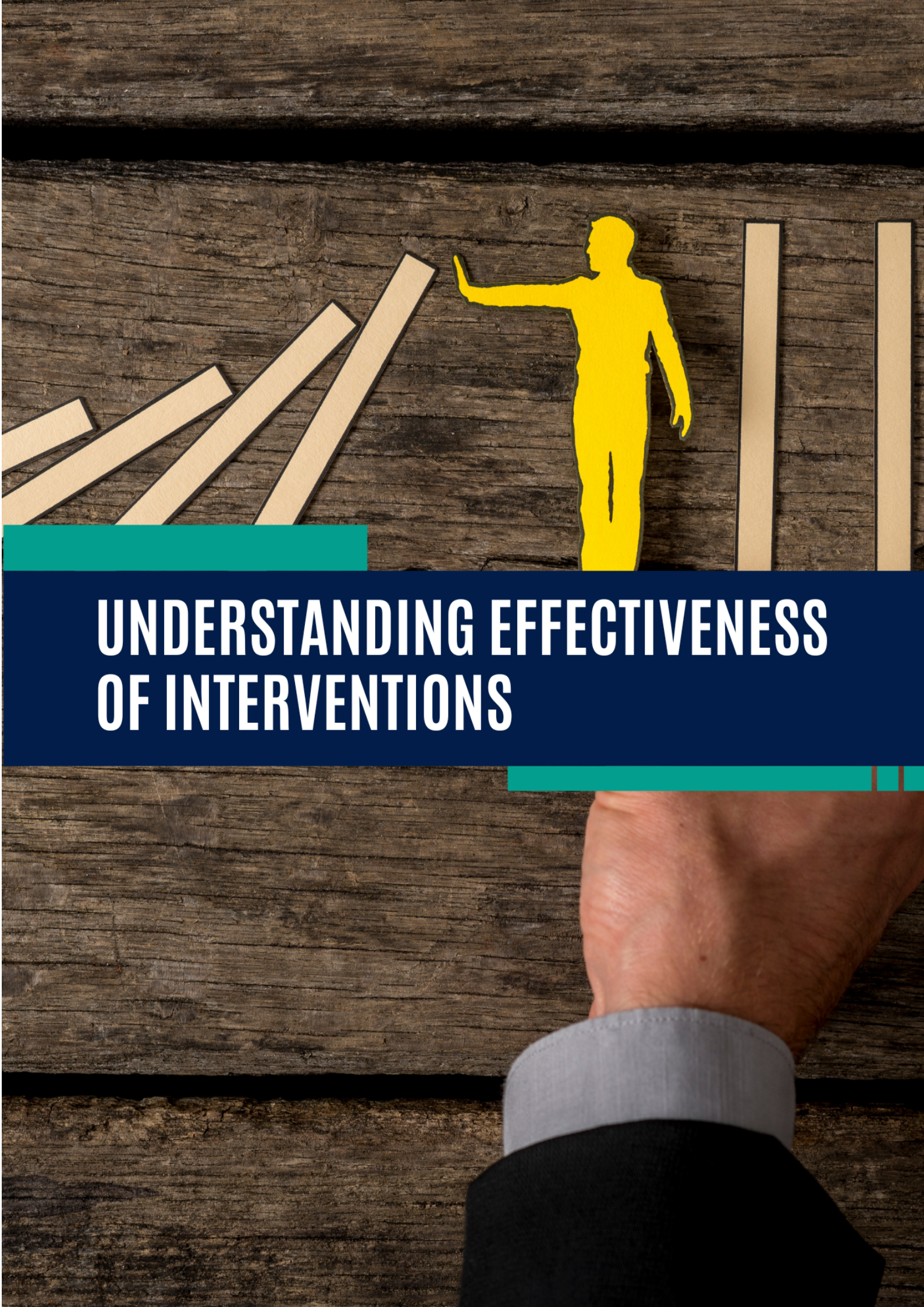
The emerging statistics reveal inequalities in available studies or evidence on adaptation practices across countries. Somalia and Burundi were less studied. This is attributed to a range of reasons, including political instability, limited governance capacity, priorities in donor funding, resource constraints and lack of data. The evidence gap resulting from this unevenness in studies could limit the understanding of which adaptation interventions could be effective in the less studied countries, yet these countries face severe vulnerabilities exacerbated by other socio-political shocks.

Table 3: Adaptation intervention per thematic area

S/N	Thematic Area	Adaptation Interventions Activity	Selected References
1	Agriculture and Food Security	-Climate-smart Agriculture (CSA), e.g., agroforestry, inter-cropping, crop rotation -Livestock Management -Crop Management -Financial Investment -Sustainable Land Management -Community and Livelihood Resilience -Climate Information Services	Bayala et al. (2012), Zougomere et al. (2021), Recha et al. (2022), Radeny et al. 2020), Kuyah et al. (2023)
2	Water security and Management	-Integrated Water Management -Water Governance and Planning -Indigenous Knowledge System -Hydrological Modelling	Banda et al. (2022), Moges et al. (2013)
3	Nature Based Solutions (NbS)	-Ecosystem-based Adaptation (EbA) -Integrated Urban Management -NbS for Flood management -EbA Mainstreaming into Policies	Viguola et al. (2015), Musonda et al. (2015), Locateli et al. (2015)
4	Disaster Risk Reduction	-Flood Risk Reduction in Urban Settlement -Early Warning Systems (EWS) -Information Climate Services -Risk and Governance -Hydrological Modelling -Drought Risk Adaptation -Urban Development Plans and Policies	Ackerl et al. (2023), Steynor et al. (2023), Giller et al. (2015), Hartman et al. (2022)
5	Climate Resilient Infrastructure	-Urban Governance and Planning - EWS	Charisa et al. (2016), Nabutola (2006)

The next section explores the effective practices highlighted in the literature and empirical insights from the field (case studies), focusing on how they achieved specific outcomes

underpinned by the five practices, such as an improvement in well-being (e.g., crop yield), efficiency (value for money), equity, justice, transparency and accountability. We also examine the practices, technologies and behaviours that contribute to these outcomes. The assessment specifically addresses evidence on technological, capacity building, financing and policy practices within each theme or sector.



UNDERSTANDING EFFECTIVENESS OF INTERVENTIONS

4.0 UNDERSTANDING EFFECTIVENESS OF INTERVENTIONS

This section presents insights on the effectiveness of adaptation interventions and associated practices based on literature review and empirical case study assessments. The insights are organised across various thematic sectors, namely agriculture and food security, integrated water management, NbS, disaster risk reduction and climate-resilient infrastructure. As noted in the methodology section, the study adopted the Singh et al. (2022) framework of effectiveness which outlines 11 indicators. However, to minimise overlap and assess the indicators effectively within the study's resource and time constraints, the 11 indicators were refined into 5 key categories based on stakeholder consultations during the study's inception: 1) Technological practices and impacts; (2) Governance and policy; (3) Financing models; (4) Adoption and sustainability; and (5) Gender and social inclusion. Critical areas with potential investment returns have been highlighted in ***bold italics*** at various points within the text.

4.1 Agriculture and food security

Most interventions aimed at improving resilience, agriculture and food security are labelled as climate-smart agriculture (CSA) initiatives. The Food and Agriculture Organization of the United Nations (FAO) defines CSA as an agricultural approach that tackles food security and climate challenges simultaneously. It contributes to three goals: sustainably increasing agricultural productivity and incomes; adapting and building resilience to climate change; and reducing and/or removing greenhouse gas emissions (mitigation) where possible (FAO, 2013). Studies evaluating the effectiveness of CSA interventions in East Africa and elsewhere have focused primarily on assessing the extent to which CSA meets these goals.

a) Technological practices and impacts

The CSA approach covers a broad range of practices, technologies and innovations, such as improved livestock management, crop management, sustainable land management, agroforestry, conservation agriculture and crop rotation. A systematic review and meta-analysis of CSA practices in Tanzania and Uganda by Lamanna et al. (2016) found positive outcomes for both productivity and adaptation indicators across all considered CSA practices. However, there was no explicit categorisation of the outcomes into short, medium or long-term effects.

> **Text box 2:** Climate-smart agriculture **(**CSA) practices such as planting drought-tolerant crop varieties, adjusting planting dates and cultivating diverse crops in Ethiopia have led to increased food security. The significant potential of agroforestry in enhancing adaptation to climate change within the agriculture sector has been observed in Isiolo, Kenya (Quandt, 2020), Siaya and Vihiga counties in western Kenya (Kuyah et al., 2019), and the Eastern Arc Mountains (EAM) of Tanzania (Mkonda et al., 2017).

Several studies highlight how CSA practices have wider social and economic benefits. For example, rice intensification in Tanzania (Alem et al., 2015), agroforestry in Kenya (Thorlakson & Neufeldt, 2012), and irrigation and improved fallow and trash lines in Uganda (Kato et al., 2010) are noted for reducing production risks by enhancing environmental well-being and potentially increasing productivity. Regarding economic feasibility, Akinyi et al. (2022) examined various

CSA practices[10] in five countries in sub-Saharan Africa, including Kenya and Ethiopia. They found that CSA practices were profitable across all countries, as measured by net present values, internal rates of return and benefit-cost ratios, with payback periods ranging from 1–2 years. Climate information services, as a cross-cutting intervention, are critical for determining which practices to adopt and when.

Some studies (e.g., Nguyen et al., 2013) have also shown that agroforestry, as a CSA practice, contributes to increased farm profitability by diversifying and improving output per unit area within tree, crop and livestock systems, protecting against the detrimental effects of wind or water flow, and introducing new products that contribute to the financial diversity and flexibility of farming enterprises. Long-term agronomic experiments in Ethiopia's drylands have shown that conservation agriculture[11], which is prominent in East Africa due to high rainfall variability, can increase grain yield compared to conventional agriculture (Araya et al., 2016). Conservation agriculture promotes adaptation to climate variability in both high and low-rainfall areas (Below et al., 2010; Kabirigi et al., 2015). Social experiments comparing adaptation outcomes between participating and non-participating social units (individuals, households, villages) corroborate findings from agronomic experiments.

Weather-based crop insurance is emerging as an innovative intervention in agriculture and food security[12],[13]. Ntukamazina, et al., (2017) state that weather-based crop insurance models are critical in stabilising farm incomes by addressing crop production risks associated with climate shocks. Their design relies on meteorological data (Mabhaudhi et al., 2025) to trigger payouts to farmers affected by hydrological disasters or drought (Wodaju, et al., 2023).

The recurrence of climate risks and their devastating impacts in East Africa has led to a growing number of crop microinsurance firms that rely on data to calibrate and enhance farmers' insurance contracts. For instance, the Kenyan microinsurance company Pula has taken a keen interest in developing weather-based crop insurance products to insulate farmers from losses that stem from climate risks and thus catalysing their recovery capacity (Masiza et al., 2022). The Rwandan Kilimo Salama has been offering similar insurance services to over 73,000 farmers in Rwanda and Kenya[14]. It has made payouts to approximately 10,000 farmers affected by climate shocks in Kenya[15]. In Uganda, weather-based crop insurance premiums have been significantly discounted below market rates due to their innovative approach to online assessment and compensation of farmers who may have experienced losses from climatic risks (Atino, 2020). This process has been piloted with banana farmers through the NDC Action project[16] that trained them on picture-based insurance[17]. Picture-based insurance involves geo-tagging damaged crops with smartphones and forwarding them to the crop insurer for assessment and compensation. As such, innovative approaches that lead to significant discounting of crop insurance premiums have led to an increased adoption of the intervention among Ugandan farmers.

[10] CSA practices evaluated included the use of improved seed, weeding, alternate wetting and drying in rice cultivation, selecting proper harvesting dates, proper storage bags during harvest, proper management of storage facilities, minimum tillage, mulching, crop rotation and intercropping.
[11] Conservation agriculture is based on three basic principles: the lowest possible soil disturbance, permanent organic cover and crop diversification (FAO, 2015).
[12] https://su-plus.strathmore.edu/server/api/core/bitstreams/ee2150ac-10e7-4019-9fdf-7304fc2e7db1/content
[13] https://oops.uni-oldenburg.de/5907/1/diss-alinda_final.pdf
[14] https://www.artemis.bm/news/kilimo-salama-weather-index-microinsurance-scheme-expands-to-rwanda/
[15] https://www.artemis.bm/news/kilimo-salama-weather-index-microinsurance-scheme-expands-to-rwanda/
[16] https://www.unep.org/ndc/about/what-we-do
[17] https://unepccc.org/innovative-picture-based-insurance-solution-boosts-climate-resilience-for-ugandas-smallholder-banana-farmers/

Overall, there is an increase in the uptake of weather-based crop insurance as an adaptation intervention among farmers who have access to CSA services (Gichuki et al., 2023). This is aimed at protecting their agricultural investments from climate shocks and catalysing their recovery capacity. Studies conducted by Madaki et al., (2022) and Aina et al., (2024) provide evidence that insured farmers realise more profits and have an enhanced recovery capacity against climate shocks contrary to their uninsured counterparts. Notably, the effectiveness of weather-based crop insurance is entirely reliant on the quality of the meteorological data being utilised for the dissemination of its service (Mabhaudhi et al., 2025). This underscores the need for collective investments by relevant stakeholders in establishing the necessary infrastructure to collate quality meteorological data. The dissemination of accurate and timely meteorological data, as well as prompt payout to farmers safeguards the credibility of the intervention while fostering trust in crop insurance as an adaption option. The scaling of weather crop-based insurance as an adaptation strategy also depends on the affordability of premiums and, crucially, farmers' understanding of how the system works. This necessitates innovative approaches that raise awareness and incentivise uptake, such as providing farm inputs, climate information and post-harvest capacity building. Governance is also critical in ensuring the integrity of weather-based insurance as an innovative adaptation option. Government agencies must establish compliance monitoring systems to hold insurance firms accountable and sanction those that fail to issue payouts to farmers (Madaki et al., 2022).

Capacity building is becoming an important practice in CSA in East Africa. Capacity building aims to equip farmers with the knowledge and skills to appreciate and adopt new agricultural practices and technologies (Juvvadi et al., 2013; Kalimba & Culas, 2020; Beal et al., 2021; Kirina et al., 2022). Although the evidence synthesis identified limited causal evidence on the impact of these interventions, some promising examples exist. For example, established farmer field schools (FFS) train communities, including women and children, on climate-resilient technologies such as drought-resistant crops and agroforestry techniques. The Mwangaza Field School in Tanzania exemplifies this approach. It provides training and opportunities for self-learning within FFS fields, enabling farmers to learn how to hard pans, use organic fertilisers, and become trainers themselves (Omwenya et al., 2011).

In Somalia, farmer field schools (FFS) were deployed in the Biyoole project[18] to enhance the capacity of farmers in managing drought-tolerant crops such as maize and sorghum, particularly within Jubaland's local communities. Through the FFS initiatives, the project has reached a wide range of farmers equipping them with skills to adopt and manage drought-tolerant seeds. As a result, participating farmers have reported increased yields compared to those using traditional seed varieties

Another study deployed social experiment methodology to assess the impact of capacity-building interventions delivered by a Global Climate Change Alliance (GCCA+) intervention in Tanzania. These interventions included financial and business education, FFS and extension services for the uptake of CSA technologies. While the intervention increased training opportunities and information access for participating households, the study found no significant increase in income or assets (livestock, market access). This is likely because the intervention ended before participants could fully translate acquired knowledge into action (Gaworek-Michalczenia et al., 2022). In addition, limited local leadership hindered the development of socio-technical synergies between introduced technologies and local farming systems, thus limiting their effectiveness (Atela, 2012; Kirina, 2022; Ogunyiola et al., 2022).

[18] https://documents1.worldbank.org/curated/en/099400109052271549/pdf/P17762705cb7c305708d7708188b0d7516e.pdf

Therefore, putting acquired skills into practice requires sustained support, local leadership and long-term investments beyond intervention lifespans. These are key enablers that are often missing from intervention designs. More experimental studies are needed to bridge the gap between acquired skills and practical application.

While most studies reviewed provide general indications of social, ecological and economic impacts[19], empirical research from case studies reveals that the social impact of interventions is determined to a significant degree by their alignment with the key vulnerabilities of target communities.

The pressing livelihood needs of vulnerable communities often overshadow the intended economic and ecological impacts of interventions. The case studies revealed that the social impact of interventions on livelihoods is driven primarily by the contextual vulnerabilities of communities. The Kenya Climate Change Adaptation Intervention, addressing water supply and distribution, was highly valued by beneficiaries because it tackled the priority vulnerability of water scarcity, which severely affects the pastoralist community in Kajiado, Kenya. The intervention supported water supply with multiple adaptation benefits, including improved health and sanitation, improved nutrition, enhanced capacity for fodder management (i.e., structures for fodder banking that are usable during the drought season), and increased social cohesion between households and communities due to reduced separation through nomadism. Similarly, the construction of a sump well in the River Tiva and an underground water storage system in Kitui (an arid ecosystem) improved water security and the production of high-quality, marketable fruits. In Marsabit County, improved storage facilities for livestock fodder, the sinking of boreholes, and the introduction of pigeon peas, cassava and sorghum as drought-resistant crops during dry seasons significantly reduced the number of people requiring food aid and safeguarded nutrition, particularly for children.

Furthermore, information gathered from the case studies revealed that the social impact of CSA can also be enhanced by not only targeting asset vulnerabilities but also addressing social vulnerabilities. This is particularly so when interventions are aimed at the most vulnerable social groups, such as women and children (also see gender inclusion section), who are disproportionately affected by climate change. For example, the adaptation village at Ololunga Primary School ensures that pupils have access to adequate and nutritious food from the school's farms. This improves their class performance and attendance due to a sustainable food supply from the school farms irrigated by the established water point at the adaptation village. The women can access water and are included in the village's Community Intervention Committee (CPC), where decisions on water management are made. Several other examples are available in the case study report (see Annex 4).

Addressing immediate vulnerability needs is therefore critical for social impact. However, misalignment or mismatch between the objectives of the interventions and local needs can often weaken the eventual impact and, in some cases, lead to maladaptation. Further, while interventions addressing prominent contextual social vulnerabilities might yield greater impact and be perceived by beneficiaries as effective, these social impacts require time to mature into economic returns. Specifically, transforming social impacts associated with agriculture and food security interventions into economic returns requires time to nurture the resilience and

[19] The term economic impacts is used here in reference to monetary benefits, such as income, to provide a clear distinction between social and economic impacts, e.g., water availability improvements might also signal an economic impact due to its effect on yield and ultimately incomes.

stability of these vulnerable communities so they can meet their immediate needs before being linked to markets. In other words, the adaptive capacity of communities that are food insecure due to frequent droughts, as in Kajiado County, should be enhanced to stabilise their food systems before being connected to markets to sell off any surplus. Therefore, additional investment in value chains and technology efficiency is paramount to enhancing productivity, which can accelerate the transition from social to economic impacts.

Despite the potential for ecological outcomes from agriculture and food security interventions, these outcomes are rarely prioritised or recognised by communities due to limited awareness and the greater attention given to livelihood and economic impacts.

Innovative agriculture and food security interventions have potential ecological benefits. For example, the Upscale Intervention promoting push-pull technology in Vihiga County, Kenya, has significantly reduced the need for pesticides, thereby reducing pollution, improving soil health through nitrogen-fixing leguminous *Desmodium*, and controlling soil erosion. According to the FGD findings, the ecological impacts of agriculture and food security interventions are often overlooked in assessments of intervention effectiveness due to a lack of community and policy interest, as well as a lack of assessment or monitoring tools designed to evaluate such impacts.

> ***Therefore, as part of understanding the effectiveness of agriculture and food security interventions, there is a need to develop monitoring frameworks that capture such ecological outcomes, which provide opportunities for linking resilience to payment for ecosystem services and additional resilience financing opportunities. Efforts through the CSA to generate carbon credits through CSA practices provide a good starting point and could be expanded to include a range of ecological outcomes.***

Despite the promising impacts of CSA as a practice, evidence further shows that trade-offs between the various CSA practices reduce the overall impact of CSA interventions.

Multiple trade-offs have been experienced and documented in the deployment of CSA in various contexts of East Africa. For example, irrigation can increase agricultural yield, especially in arid and semi-arid land (ASAL) regions, but it may reduce water availability for livestock. Lamanna et al. (2016) further identified some trade-offs between specific measures, such as livestock diversification and irrigation, which could affect the adoption of CSA and influence their outcomes. For example, whilst livestock diversity may boost resilience by distributing risk and improving food security, it requires significant amounts of water and land resources for grazing.

Furthermore, some of the CSA practices that are regenerative take a long time to yield benefits amidst demands for productivity and food security. This is demonstrated by experiences from the Upscale Intervention in Kenya. The intervention applies push-pull technology — a biological practice where *Desmodium* plant species are used to repel pests such as striga, fall armyworms and stem borers from a farm while the *Bracharia* plant species attract and trap pests out of the farm. However, while communities reported benefits of reduced pest infestation, the impacts were slowed down by the slow rate of vegetative regeneration. The Upscale Intervention also applied CSA practices, such as introducing drought-resistant crop varieties, implementing water-efficient irrigation techniques and integrating agroforestry systems in wetlands. While yields improved, scaling these interventions required additional innovation, such as enhanced water extraction and distribution systems. Therefore, a reflection on these trade-offs highlights the difficulties in reconciling production with sustainability in CSA techniques.

Given the trade-offs observed in the various CSA practices, Mutenje et al. (2019) recommend that integrated approaches combining several CSA practices can be effective by tapping into innovation opportunities and synergies across sectors and/or practices. In this, further evidence is needed on assessing the economic viability of integrating various CSA practices as well as exploring the socio-technical feasibility of integrated practices/technologies, including the incorporation of indigenous knowledge. Further, it is critical to investigate how new and modern technologies, such as intensification and mechanisation, can be effectively linked with CSA practices that advocate for natural regeneration to address urgent food security gaps.

b) Financing models

Financing models for CSA were assessed based on funding availability and conditionality of these funds. Funding availability involves the sources of financing available for CSA while conditionality involves the instruments for disbursing these funds. Studies on financing models for CSA have primarily focused on the types of financing available, advocacy for specific options and governance structures. In terms of financing instruments (conditionality), social protection programmes, such as weather-indexed crop insurance, asset restocking (including direct livestock provision) and cash transfers (Davies et al., 2009), are crucial financing mechanisms within the agriculture and food security sector.

Text Box 3: Examples of financing instruments applied in CSA

- Evidence from Kenya's Hunger Safety Net Programme (HSNP) and the Cash Transfer for Orphans and Vulnerable Children (CT-OVC) programme demonstrates the effectiveness of cash transfers.
- Assessing cases in Kenya, Uganda and Ethiopia, Ulrichs et al. (2016) highlight that these programmes significantly contribute to people's capacity to absorb the negative impacts of climate-related shocks and stresses on their livelihoods.
- A social experiment in Ethiopia found that the Productive Safety Net Program (PSNP) — a major social protection scheme — decreased household vulnerability to climate-induced shocks.
- Index-based insurance was also shown to mitigate climate change impacts in Ethiopia by encouraging increased household farm investments (Belissa, 2019).

There is growing advocacy for scaling up market-based or result-based financing approaches to adaptation, including Payment for Environmental Services (PES) schemes (FAO, 2010; Matthey, 2024). For example, in Uganda, smallholder farmers in the Mount Elgon region participate in a PES scheme that incentivises agroforestry practices for carbon sequestration. In Kenya, the REDD+ carbon intervention in Kasigau Corridor aims to protect a large expanse of dryland forest by offering local communities financial incentives in exchange for forest conservation. While suggestions exist to link carbon credits from CA to PES schemes, evidence on how PES supports adaptation remains limited. Some studies even suggest limited impacts of PES interventions on well-being and income (Nantongo et al., 2024; Duchelle et al., 2018). Nonetheless, further research is needed on how to strengthen the adaptation benefits of PES in CSA actions, including exploring sectoral synergies between agriculture, forests and land. The Community Markets for Conservation (COMACO) Landscape Management Intervention in Zambia, which promotes sustainable agriculture and forest conservation, exemplifies this approach.

Despite the increasing interest in adopting market-based instruments, empirical analysis of case studies reveals that adaptation interventions in East Africa still rely heavily on international

grants. This limits incentives to develop business ideas to attract market funds for sustainable financing of interventions.

In the case studies analysed, funding was mainly from international mechanisms, including the GCF, Adaptation Fund and the GEF. This trend is the same for the 242 interventions mapped at scoping, most of which are funded by international funds. The grants as a funding instrument, however, lack internal mechanisms to spur business development models to enable a transition to sustainable market financing beyond intervention timelines. This affects the wider sustainability and scalability of the interventions due to limited private sector involvement. Interventions, their impacts and opportunities are cut off at the end of the intervention cycle. The challenge of short-term intervention funding and limited scalability of practices is exacerbated by lack of national or regional adaptation learning platforms where lessons from completed interventions can be made available to inform future programming.

> ***There is need to invest in sustainable locally led adaptation learning platforms to support the incubation of best practices into business opportunities beyond intervention cycles. Emerging efforts such as the Locally-led Adaptation Metrics for Africa (LAMA) platforms, aiming to catalyse lessons sharing in the impacts and indicators of success for locally-led adaptation interventions, provide opportunities to help nurture and utilise best practices.***

There are, nonetheless, noticeable efforts by interventions that try to create market linkages for farm products, such as fruits, and develop local financing frameworks. In Rwanda, for example, the PCSA-Rwanda case study provided grants to farmers who had adopted CSA activities. It also linked farmers to markets through existing market channels and opportunities. This created an agricultural value chain that not only sought to ensure that small-scale farmers were food secure but also increased their incomes through a robust agribusiness model.

In the Upscale Intervention, the introduction of local community investment groups for table banking has been a bridge for most homesteads to acquire dairy cows to improve their food systems and diversify their nutrition. In the Uganda BRCWE (building resilient communities, wetland ecosystems and associated catchments) case study the extension services training was co-financed by the national government, enabling the intervention to exceed its target by approximately 169%.

> ***The market linkage and local financing frameworks, such as table banking, provide useful business opportunities but are small-scale and seasonal due to the pressing livelihood needs of these vulnerable communities. In addition, capital investment in the interventions is required to make them market-viable beyond social pressure.***

There is limited domestic funding for adaptation as most of the current funds are from international sources. This creates significant uncertainty in adaptation ambitions outlined in the NDC and NAP documents of East African countries.

While the Paris Agreement has emphasised the mobilisation of international financing, a huge gap exists in domestic funding for adaptation. Most of the case studies analysed did not receive any funding from their respective state actors. Only the BRCWE intervention in Uganda was co-financed by the national government. The limited domestic funding is a wider concern, with experts warning that over-dependence on external funding creates uncertainty in adaptation and impacts ambitions.

In terms of accessibility, there have been efforts to push for devolved funding for adaptation interventions in line with the locally led adaptation principles.

Devolved financing has been studied with particular interest in strengthening local structures to improve access to funding for local farmers. The County Climate Change Fund (CCCF) in Kenya, now scaled out nationally through the Financing Locally Led Climate Action (FLLOCA) programme, serves as an example. The CCCF facilitates the flow of climate finance to county/local governments and empowers local communities by enabling public participation in managing and using climate funds.

Studies indicate that the CCCF model delivers livelihood benefits necessary for building resilience to climate change. It also provides better value for money than nationally managed funds, as direct benefits from investments far exceed the costs of implementing the CCCF mechanism. Furthermore, the model enhances the inclusion and participation of local communities, while improving accountability and transparency in planning and implementing adaptation interventions (Crick et al., 2019; Adeninyi, 2023). Devolved financing can enhance both outcome-based indicators (e.g., costs, benefits, well-being and resilience) and process-based indicators of effectiveness (e.g., justice, equity, transparency and inclusion).

Therefore, the structures for devolved financing models need strengthening (e.g., strengthening local institutional capacities for fund management and tracking). However, further rigorous evidence from experimental and longitudinal causal studies is required to build a stronger case for these models.

c) Policy and governance

The policy support for CSA in East Africa is growing fast. However, stakeholders are concerned that some of the government plans respond more to international agendas than to local impact agendas. Consequently, such frameworks may not necessarily support or protect local impacts and the well-being of communities from adaptation interventions.

Policy and governance mechanisms play a crucial role in shaping the successful implementation of CSA adaptation strategies in the agriculture sector. A study by Nkonya et al. (2015) examined the effectiveness of policy interventions using case studies from four sub-Saharan African countries, including Uganda and Kenya. In Uganda, the study focused on the effects of government decentralisation and land tenure system reforms. In Kenya, it examined policies supporting agricultural research and development, along with creating an agricultural market environment that incentivises farmers to adopt sustainable land and water management practices. The findings revealed that policies implemented in both countries contributed to the development of stronger local institutions, ultimately leading to improved community resource management supportive of CSA.

The FGD findings revealed that countries are putting in place measures and frameworks that support agriculture and food security interventions and their associated impacts. For example, incentivising tree planting interventions in Kenya and promoting community-led processes through community water associations or forest user associations provide supportive legal frameworks for water, energy, food and ecosystems.

For CSA, governments in various regions have implemented policies aimed at addressing food insecurity and strengthening the agricultural economy, often promoting mechanised agriculture to increase productivity. However, international actors, such as the World Bank, often advocate for conservation agriculture practices that emphasise sustainable land use, including reduced reliance on synthetic fertilisers and carbon-intensive mechanisation (Atela, 2012). These contrasting strategies reflect broader debates in the agriculture sector about the most effective methods for increasing yields and building resilience, with some arguing that mechanisation directly enhances productivity, while others contend that conservation-focused approaches like

intercropping contribute to both productivity and environmental sustainability. Given these differing perspectives, there is an ongoing need to harmonise CSA strategies in ways that address both local food security priorities and global sustainability goals.

Weak linkages between national and subnational policy processes and the interventions being implemented were further noted. This often impedes the sustainability of adaptation outcomes.

Insights from the case studies corroborate the concern about institutional/policy fragmentation that impedes the effectiveness of interventions. Climate change policies and governance shape the effectiveness of adaptation interventions by enabling alignment and attracting additional public resources for action. For example, the KCCAP at Eselenkei village intervention in Kajiado County could benefit from the county's climate change fund for scaling the water infrastructure. This translates to improving water proximity to distant homesteads from the main water point and therefore improving the adoption uptake rate in CSA being practised at the Ololunga Adaptation Village. The extension of dykes along River Awaso in Homa Bay County could also benefit from the county climate change budget.

Weak linkages between national and subnational policy processes and the interventions being implemented were further noted. Discussions with intervention managers and policymakers indicated limited engagement with the policy process in the implementation of interventions. Intervention managers noted the bureaucracy involved in engaging policymakers in intervention implementation, thus delaying interventions being designed and executed within strict timelines.

> ***As policy bureaucracies often delay the timely implementation of intervention activities, establishing strong linkages between interventions and the policy environment is essential for achieving long-term sustainability of adaptation outcomes. Opportunities for public-private partnership (PPP) models could enhance connections with policy processes.***

In the Upscale Intervention, for example, the International Centre of Insect Physiology and Ecology (ICIPE), the implementing entity, partnered with the Homa Bay County Government to train 54 agricultural extension officers. These extension officers' capacity for push-pull technology was enhanced to accelerate uptake among farmers in the county. The public-private partnership (PPP) arrangements enabled multi-actor communities (MAC) in Ethiopia to facilitate the co-creation and mainstreaming of push-pull technology in agricultural policy instruments. This has enabled consideration of the technology in the county government climate plans.

Text Box 4: A successful example is *e-Soko*, an agricultural information service operating in Kenya, Tanzania, Uganda and Rwanda. Through mobile phone applications, SMS and online platforms, *e-Soko* provides farmers, traders and consumers with access to market prices, weather information and agricultural best practices. This service improves market efficiency by reducing information asymmetry (Tenge et al., 2014). Similarly, the Kenya Climate Data and Information Management System (KCDIMS), developed by the Kenya Meteorological Department, serves as a centralised repository for climate data, information, and tools.

While gaining importance recently, institutional support from relevant government departments, including agricultural extension officers, remains inadequate in East Africa. This kind of support is crucial for promoting livelihood diversification among farmers (William et al., 2012; Tesfaye et al., 2015). Karim et al. (2017) identified that institutional support for livelihood diversification is still insufficient and varies across the region. Effective and complementary institutions are needed to facilitate scaling-up efforts. These institutions can minimise challenges faced by

farmers, reduce adoption constraints and enhance the sustainability of scaling processes, ultimately leading to a greater societal impact from CSA practices and technologies.

> ***Therefore, there is need for policy shifts towards a multisectoral policy agenda and mainstreaming adaptation consideration across sectors. Most agriculture, food and nutrition sector policies in East African countries require more deliberate integration and collaboration among stakeholders, sectors and institutions (Amwata et al., 2020; Mungai et al., 2020). Commendable efforts exist, e.g., policies and institutions for environmental management and climate change, that can be strengthened through mainstreaming and enhanced implementation (Liwenga et al., 2014).***

d) Adoption and sustainability

Affordability and community ownership are key enablers of the adoption of CSA technological practices, but these require sustained engagement and empowerment programmes.

The ability to afford adaptation assets and meet short and medium-term operational costs is crucial for the long-term adoption of interventions. Strengthening local financing opportunities, such as credit facilities, insurance and table banking initiatives, is essential for enabling community members, especially women, to access and operate technologies promoted by interventions. KCCAP, the water security intervention in Eselenkei village, Kajiado County, has proven cost-efficient due to its low maintenance and operating costs. Public participation in the intervention's implementation has fostered co-ownership of the initiative through the formation of the CPC, which has instilled a sense of stewardship among the local community. This co-ownership also played a key role in preventing the vandalism of water infrastructure.

In the Upscale Intervention in Kenya, sustained efforts to engage the local community by sensitising them to the benefits of Push-pull technology in their farms has facilitated adoption. Awareness creation and capacity building are often conducted through demonstration farms, thus minimising the chances of maladaptation. In this context, maladaptation refers to errors such as interchanging the positions of *Brachiaria* grass and *Desmodium* on the farm or using incorrect measurements between the two plant species. The introduction of local community investment groups for table banking has also bridged the gap for many homesteads, enabling them to acquire dairy cows to improve food systems and diversify their nutrition. Furthermore, local communities are provided with high-yielding seeds, such as maize, beans, and vegetables like black nightshade, for cultivation.

In South Sudan, Mvolo County, an FCDO-funded initiative aimed at increasing food security and income among vulnerable farmers embraced farmer field school to enhance and catalyse the adoption of adaptation actions. Specifically, agricultural extension workers leveraged the FFS platform to train small-scale farmers on crop calendar tools, effective use and preparation of organic fertilizers and post-harvest management practices [20]. These skills have been instrumental in increasing agricultural productivity thus enhancing the livelihood of respective households in Mvolo county. In addition, considering the relatively low literacy levels among adult farmers in Mvolo County, the extension workers integrated mathematical and quantitative literacy education in an agricultural context. This approach empowered adult farmers to communicate effectively while commercializing their produce at a profit. Besides this, recognising South Sudan as a Fragile State, the adoption and sustainability of the adaptation actions were founded on peacebuilding initiatives. The peacebuilding curriculum was integrated into the adult literacy classes to foster reconciliation and meditation skills among the local

[20] https://feedtheminds.org/feed-the-minds-making-a-differimproved-farming-increased-literacy-skills-and-peacebuilding-processes-in-south-sudan/?utm

community[21].

In Somalia, Abdi et al. (2024) report that the introduction of drought-tolerant seeds among rural communities often encounters resistance, primarily due to a lack of effective awareness campaigns facilitating the transition from traditional to drought-tolerant seeds. Additionally, insecurity in conflict-prone areas frequently impedes meaningful adaptation progress against climate shocks, as displacement of communities and destruction of crop fields hinder agricultural development (Lahti,2023)

Case study analysis further revealed that interventions mainly emphasised the adoption of practices as per the intervention plans with little emphasis on scaling up and sustained adoption beyond intervention timelines.

Sustainability in interventions can take different pathways, including policy, and technological and knowledge sustainability. Most case studies analysed focused on technological sustainability, i.e., through promoting or pushing for the adoption of technologies amongst community members as per intervention plans. However, this push is widely confined to the intervention plans and timelines. This approach to promoting adoption is relatively technocentric and devoid of socio-technical feasibility of practices within the community, knowledge and policy structures. This challenge is further exacerbated by the disconnect between intervention implementation and policy processes. For example, farmers in Vihiga County are being sustainably supplied with high-yielding maize, beans, peas and vegetable seeds yet there are limited long-term investments and policy support for water management skills thus exposing farmers to drought risks despite the high-yield seeds.

Overall, community ownership of sustainable agriculture and food security interventions is an ongoing process that requires continuous engagement, empowerment and incentives. Institutionalising community engagement through village committees or resource committees provides structures to enhance ownership and co-creation of solutions. In some contexts, existing community structures offer valuable foundations on which to build, although the philosophy of these local institutions may need rebranding to address and align with the new challenges arising from climate change and other external shocks.

Some of the barriers and opportunities for sustainable adoption of innovative agriculture and food security practices, as identified during the FGD, include:

- *Cultural barriers to accepting and adopting new technologies:* Introducing new technologies or approaches within the agriculture and food security nexus may face resistance due to cultural inertia and the reluctance to deviate from established norms and practices. For example, communities in Uganda have well-established traditional practices and land-use systems related to the management of water, energy, food and natural resources. To this end, community engagement through local leaders by extension officers in Uganda's Teso-sub region is gradually steering the local farmers from using traditional maize and bean seeds to drought-resistant varieties.

- *Limited access to finance:* Lack of availability and accessibility of financial resources (e.g., grants, loans or investment funds) can hinder the implementation and scale-up of agriculture and food security interventions. This is particularly challenging for small-scale farmers, CBO and local enterprises that may lack the necessary collateral or credit history to secure funding.

[21] https://feedtheminds.org/feed-the-minds-making-a-differimproved-farming-increased-literacy-skills-and-peacebuilding-processes-in-south-sudan/?utm

- *Inadequate research on local needs:* Lack of clear understanding of local needs, priorities and constraints regarding the adoption of agriculture and food security interventions, results in interventions that are insufficiently tailored to the unique circumstances of different communities and landscapes. This is often attributed to the paucity of robust, context-specific research and data on the local environmental, social, and economic conditions that can inform the design and implementation of agriculture and food security interventions in Uganda.

- *Institutional barriers:* Poor governance and coordination are barriers to the effective implementation of agriculture and food security interventions. In the water sector, influential individuals often do not comply with water use policies. There is also a lack of coordination between national and local levels in implementing interventions, and some communities do not comply with government policies on ecosystem preservation.

- *Social and cultural barriers:* Social and cultural barriers include a lack of community empowerment. Motivation, volunteering and individual participation in ecosystem preservation and adaptation interventions were identified as insufficient.

Opportunities for sustainable adoption include:

- *Continuous community engagement*: This includes regular community meetings, FGD and participatory monitoring. Such engagement fosters a sense of ownership and commitment among community members, allowing for valuable feedback and reflective adaptation.

- *Capacity building and training*: Empowering the community with the necessary knowledge and skills to independently operate and maintain interventions is key to their sustainability.

- *Integrating traditional knowledge with scientific approaches*: Aligning interventions with the local socio-cultural context by incorporating traditional knowledge alongside scientific methods can create more sustainable and culturally relevant solutions.

- *Active roles for national and local leadership*: National and local leadership should play active roles in strengthening policy and institutional support to ensure the longevity of interventions.

- *Continuous monitoring and evaluation:* Regular monitoring and evaluation are essential to ensure interventions are achieving their intended impacts and can be adapted as needed for long-term success.

e) Gender and social inclusion (GESI)

Whereas agriculture and food security interventions are designed with gender and social inclusivity considerations as key outcomes, the operationalisation of GESI in practice is shaped by several underlying demographic and cultural orientations that need to be understood and considered:

Vulnerabilities and how effectively they are addressed are influenced by the social intersectionality of gender. Different types of interventions impact different social groups differently. Under the KCCAP, inclusivity in managing the water infrastructure was enhanced by

intentionally incorporating six women, nine youths and eight men in the CPC. These inclusivity criteria were stressed by the delivery body, the National Environment Management Authority (NEMA) and adopted by the community leaders in the village.

Yet, despite the construction of the solar-powered borehole at the village providing relief to the immediate local community, women and girls multiple kilometres away are disadvantaged in accessing the water point. The harsh temperatures force them to fetch water in the early morning or late evening, making them vulnerable to attacks from wildlife and sexual harassment. To this end, the community needs to invest in water distribution infrastructure to enable all homesteads and groups — especially women and girls — to access water. By implementing a centralized water distribution infrastructure, the underground water table in the area can be preserved by minimising the drilling of numerous nearby boreholes, which often leads to over-extraction of groundwater. Such infrastructure offers an opportunity for the conservation and monitoring of the water table, thereby informing policies for effective water management.

A further positive example is in Kitui with the promotion of drought-tolerant mangoes through the KCCAP. Most of the beneficiaries are women, girls and youth who receive training on the grafting of seedlings and husbandry. This has ensured inclusivity among these vulnerable groups.

The two Tanzania case studies incorporated gender aspects in the design and implementation of its components. The intervention implementers indicated that gender-disaggregated indicators were included in their results frameworks. The tailored training of the different stakeholder categories was also inclusive, targeting men, women and youth. In the Sea Wall intervention, the distribution of *jiko* cooking stoves in three urban districts of Dar es Salaam engaged women groups from the participating districts and reduced the time devoted to food preparation (a traditionally female role), while lowering local demand for biomass fuel, such as charcoal.

In other interventions such as the Upscale Intervention, youth were enthusiastic about the push–pull technology, reflected in high uptake among this group. This is partly because the technology is relatively cheap, reliant on local resources and effective against pests. Push-pull technology is also suitable for traditional farming which is largely done by women. However, discussions during the capacity-building sessions, highlighted that most women do not own parcels of land due to the patriarchal nature of their communities. This denies them the ability to deploy the technology, thereby slowing the adoption rate and expected impacts.

To this end, achieving gender and social inclusion (GESI) in agriculture and food security should be intentionally pursued and monitored within programme activities. Actions that can help achieve this include an inclusive participatory needs assessment strategy to provide platforms for the voices of women and other social groups to be heard. For example, the CPC in the KCCAP provided a platform to amplify their voices on the unique challenges they experienced due to the impacts of climate change whilst identifying any possible solutions. Discussions with the CPC members revealed that women were actively engaged in identifying the potential site for the Ololunga Adaptation Village where the water point was eventually established. This happened because women in the village bore the societal burden of ensuring their households had water at any given time. According to the NEMA field officer, the KCCAP project integrated GESI variables in its baseline assessment at the beginning of the project and this enabled effective monitoring and learning on GESI outcomes and lessons. The data was leveraged to determine the extent to which women-headed households benefitted from the adaptation village. In addition, all-women FGDs were held regularly to provide a safe space for them to confidently articulate their unique challenges.

In the PCSA-Rwanda case study, mandatory GESI training for CSA intervention officers was conducted to enhance their capacity and understanding of social inclusion while executing components of the intervention. These components included gender and social analysis tools, and the development of inclusive monitoring, evaluation and learning (MEL) tools. Beneficiaries reported that PCSA-Rwanda provided a safe space to express their adaptation needs and they were actively involved in the implementation phase. The safe spaces were mainly created by having women-only FGDs. From these discussions, relevant and unique adaptation actions tailored to build their resilience were conceptualised and executed. As such, these engagement strategies contributed effectively to enhancing women's resilience against climate risks. To amplify women's voices in climate adaptation, the beneficiaries reported that the intervention set aside leadership quotas for women. Women's leadership capacities were enhanced through training which covered specific gender and leadership modules. As a result of this approach, there is an emerging cohort of women from eastern Rwanda who are empowered to design effective gender-responsive climate actions.

Similar GESI training was included in the U ganda BRCWE case study , where 26% of the participants trained were women and girls. Women and girls in the Kabale, Kanungu and Ntungamo districts took on capacity-building training in technical skills for off-farm activities that leveraged the International Labour Organization (ILO) methodology for rural economic empowerment. One key outcome was to link at least 50% of women and youth to green jobs hence enhancing their respective household incomes.

Additionally, in Somalia, the Building Resilience in Somalia project[22] has implemented strategies to empower women economically and to overcome cultural norms that limit their land ownership rights. One such strategy is the introduction of village saving and loan associations which provide women with financial resources to engage in agricultural activities, thereby securing their families' livelihoods. Additionally, cash-for-work programs targeting women have been employed to enhance economic empowerment and active participation in adaptation efforts. For instance, in the Puntland region, women have been engaged in rehabilitating water points, creating income opportunities while contributing to community resilience against climate shocks (Said, 2024). Therefore, empowering women through these initiatives is pivotal in enabling them to make autonomous decisions on adopting effective adaptation strategies for their households.

The initiative on increasing food security and income among vulnerable farmers located in Mvolo County, South Sudan, integrated Village Savings and Loans as an instrument for fostering financial security for both men and women. By saving earnings from the sale of their produce, farmers enhanced their capacity to qualify for soft loans from their respective groups. Many leveraged these loans to establish small businesses leading to a gradual improvement in the quality of life within their respective households[23]. Similarly, the building resilience through asset creation and enhancement (BRACE) project[24] in South Sudan successfully promoted gender equality by enabling women to sell their agricultural produce in markets and share the revenue with their husband.

Therefore, while agriculture and food security are designed with GESI considerations as key outcome areas, their operationalisation is shaped by several underlying demographic and cultural orientations that need to be understood and considered. In other words, achieving

[22] https://concernusa.org/project-profiles/building-resilient-communities-in-somalia/?utm_source=chatgpt.com
[23] https://feedtheminds.org/feed-the-minds-making-a-differimproved-farming-increased-literacy-skills-and-peacebuilding-processes-in-south-sudan/
[24] https://iati.fcdo.gov.uk/iati_documents/D0006005.pdf

GESI in practice should be intentionally pursued and tracked as part of affirmative action.

4.2 Water security and management

Water is the primary medium through which climate change has an impact on people, ecosystems and economies (Sadoff & Muller, 2009). The Drought in East Africa Report (2022) highlights that approximately 16.2 million people across the Horn of Africa struggle to access clean water. Interventions addressing water insecurity are therefore a sound early adaptation strategy, delivering immediate benefits to vulnerable and underserved populations while advancing the Sustainable Development Goals (SDGs) and strengthening systems and capacity for longer-term climate risk management. Despite this, water management remains poor across East Africa. The following sections explore various interventions and practices that contribute to water security and management.

a) Technological practices and impacts

Several technological practices under water security and management were identified from the literature. These included integrated water management which is a coordinated approach to managing water, land and related resources to maximise economic, social and ecological processes, ensuring benefits are distributed equitably and sustainably (Allan et al., 2013). This approach is a crucial adaptation strategy for addressing water insecurity caused by droughts or flooding (Allan et al., 2013; Cameron and Katzschner, 2017). According to Leal Filho et al. (2022), the most frequent actors responding to water challenges in East Africa include individuals or households (32%), local governments (15%) and national governments (15%) who often adopt a range of behavioural, technological and institutional shifts to respond the challenge.

Additionally, micro-irrigation schemes are used, such as small, motorised pumps, drip kits, treadle pumps, and rope and washer pumps (Nakuwaka et al., 2018). These technologies are replacing the less efficient flood irrigation, which is associated with water wastage (Nakuwaka et al., 2018). Micro-irrigation schemes can be adopted in various smallholder farmer contexts with minimal procedural requirements like approval processes. They are also water-saving, as they deliver water directly to the plant root zone, minimising evaporation and runoff losses as happens with flood irrigation. Finally, they are manageable, as they often require less technical expertise and lower investment than large-scale irrigation interventions (Fujiie et al., 2011; Pavelic et al., 2013). However, these practices require sustained support from farmers to realise sustainability and scalability for a business case.

Rainwater harvesting during the rainy season can ease water supply difficulties and save water costs during dry periods (Mati et al., 2006). Initiatives include *in situ* rainwater harvesting, where farmers adopted techniques like *fanya juu* trenches to capture and store rainwater on their land, improving resilience to climate variability (Kibassa, 2013); and rooftop harvesting, where communities collect rainwater from rooftops using techniques like hanging cloths for collection and drainage (Ahamada, 2018). For example, Dar es Salaam in Tanzania has the potential to harvest approximately 5 million cubic metres of rainwater annually from buildings (Mati et al., 2006). Additionally, collecting and storing runoff through constructed wetlands can support rain-fed agriculture, which is crucial in countries like Rwanda, where 90% of agriculture relies on rainfall (Billman, 2014).

In Somalia, water scarcity is a significant challenge, with minimal annual rainfall averaging around 200mm. Bojer et al., (2024) affirm that drip irrigation systems have proven to be effective

in water resource management. For instance, the World Bank-funded Biyoole project [25] introduced drip irrigation in the Gabiley region, aiming to empower local communities to effectively utilise the drip irrigation system while increasing their crop productivity[26]. Evaluation reports indicate that farmers experienced significant reduction in water usage and an increment in their crop yields compared to the traditional methods of irrigation such as flood irrigation. This significant success was largely attributed to the active participation of the community members throughout the project's conceptualization to implementation stages. However, in other context, similar drip irrigation initiatives faced challenges. In Jowhar District for example, limited success was observed due to inadequate technical capacity among local communities to operate and maintain the drip irrigation equipment and associated solar systems (Maow, 2023. This experience underscores the need to avail necessary technical assistance in deploying such technologies to ensure their sustainability and effectiveness.

While different specific practices hold some promise for impact, this impact is felt and shaped by other key sectors such as energy, ecosystems and agriculture.

In the four focus countries selected in East Africa, Kenya, Uganda, Tanzania and Rwanda, stakeholders noted that water security interventions are often capital-intensive, exposing vulnerable communities to the adverse effects of drought. Thus, leveraging innovative resource mobilisation for low-cost renewable energy, such as wind and solar, to power boreholes and wells is key to improving water access for vulnerable communities and ensuring the success of agriculture and food interventions. The FGD responses also highlighted that while the energy–water nexus is critical, the level of impact is context-specific, depending on geography, policies and economic orientation. For more examples, please refer to the case study and country FGD reports (**Annex 3**).

Both literature and stakeholder engagements point to the need to embrace innovations like the WEFE Nexus, and climate-smart Water, Sanitation, and Hygiene (WASH) programmes, alongside food security, nutrition and health interventions that benefit vulnerable groups, are promising areas for enhancing effectiveness of adaptation in multiple sectors.

> ***The WEFE innovation is of particular interest to many stakeholders engaged in this study. Initiated by the World Economic Forum (WEF) in 2011, WEFE provides a holistic approach to address the interrelated challenges of water, energy, food and environmental security in the context of climate change and sustainable development. The WEFE Nexus provides a framework for understanding interactions between human activities and the environment, promoting coordinated management and use of natural resources across sectors (de Andrade et al., 2020). It identifies interlinkages, trade-offs and synergies between water, food, energy and forests, previously considered separately.***

Despite the potential effectiveness of WEFE interventions, some empirical experiences reveal that these practices can be complex in practice, given the diverse interests and governance underpinning WEFE-linked resources in practice.

[25] https://biyoole.mop.gov.so/
[26] https://biyoole.mop.gov.so/

The effectiveness of WEFE interventions is also demonstrated by the empirical insights from case study interventions. There are case examples of interventions that are already utilising the WEFE approach albeit with some challenges. For example, the Green Gicumbi project in northern Rwanda where solar-powered desalination units and energy-efficient cooking stoves were introduced to reduce reliance on traditional energy sources and address the energy needs of coastal communities towards food security. Similarly, the Arusha Sustainable Urban Water and Sanitation Delivery Project (ASUWSDP) introduced energy-efficient technologies and renewable energy solutions to power water supply and sanitation infrastructure. This included the installation of solar-powered pumping systems and the use of energy-efficient treatment processes. These interventions aim to reduce the energy consumption and carbon footprint of water and sanitation services while also improving the reliability and resilience of mechanical systems. Solar-powered pumps for the drilled boreholes were also utilised in the PCSA-Rwanda case study to provide clean water to residents in the Eastern Province.

While WEFE practices promise optimal benefits, practical implementation can be complex due to conflicting resource governance structures. The experiences from the KCCAP and the Upscale Intervention in Kenya reveal this complexity. The KCCAP aims to promote effective adaptation in Eselenkei village, Mosiro Ward, Kajiado County, through the establishment of an adaptation village model with a solar-powered water supply from a borehole. While this has enabled the local communities to access clean and sustainable water year-round for household use and their livestock, the distribution of this water through pipes is impeded by conflicting regulations around private and communal land ownership.

> ***Therefore, there is need to promote local ownership and locally led ideas in a structured manner to enhance the feasibility of these interventions within existing social structures.***

Some efforts towards strengthening local leadership in water management were noted but these are significantly impeded by lack of technical capacity to handle equipment.

In the KCCAP, for example, the water security intervention in Eselenkei village advocated for the formation of a CPC that promoted a sense of ownership among the local community and the formulation of water resource management bylaws. However, the dissemination of repair and maintenance technical skills in the water infrastructure is yet to be done. In the event of an electrical fault or mechanical breakdown of the borehole equipment, a technician must be sent from Nairobi, which is time-consuming. This was experienced in the Musro Adaptation Village, where the local community remained without water for approximately four months due to an electrical fault in their solar-powered borehole. In addition, the water infrastructure had no way to monitor the water table to inform sustainable water resource management policies in the area.

> ***Therefore, enhancing local technical capacity to address water infrastructure is critical for the effective implementation and sustainability of water-related adaptation interventions.***

b) Policy and governance

A study by Okumu et al. (2024) highlighted the crucial role of policies and institutions (e.g., rules, regulations and agencies), in managing the established water-food-energy ecosystem interlinkages and fostering synergies along the value chain in the Mt Kenya catchment. The study emphasises the urgent need to address food, water, forest and energy security alongside climate change to achieve sustainable development goals in the region, especially since these countries heavily rely on agriculture for livelihoods.

Some countries in East Africa are already developing policies and institutional arrangements to support integrated water management. Kenya's legal framework, for example, provides a good example of attempts to promote community-led innovations as part of integrated institutional arrangements for water and related sectors under WEFE. The Water Act of 2002 and the 2016 amendment to the Constitution's Water Act envision community participation through water resource users associations (WRUA) (Baldwin et al., 2015). A study by Jawuoro et al. (2017) highlights the effectiveness of these associations in Kiserian (Kajiado County) in improving water security and management through river desilting, tree planting and riverbank stabilisation.

Another example of emerging good practices on integrated institutional arrangements for WEFE is the water intervention funded by the Austrian Development Cooperation and implemented by the International Union for Conservation of Nature (IUCN) in the Habarow-Saka catchment, Garissa County, Kenya. Through stakeholder engagement (including WRUA, NGO and government officials), the intervention developed an Adapted Sub-Catchment Plan (ASCMP) and bylaws to support sustainable land and water resource management and community drought resilience (Nyachieo, 2016). However, Mwendwa (2014) points out that lack of coordination, capacity gaps and political interference can hinder the effectiveness of WRUA in water governance.

Enabling innovations such as WEFE requires integrated institutional arrangements and governance that support the engagement of different stakeholders, particularly communities and sectors.

Other than integrated institutional arrangements, investing in accurate monitoring and data systems is also a key enabler. Deploying remote sensing and artificial intelligence for water quality and quantity monitoring can enhance preparedness for future risks. These advancements, along with early warning systems, can support WEFE and enable communities to adapt to shifting demographics and changing lifestyles in both rural and urban areas (see also Sakic et al., 2022).

c) Financing models

Investment in innovative financing models is crucial for improved water security and management. Public–private partnerships and water fund models such as The Nature Conservancy (TNC) model which involves investing in 'green' (natural) and 'grey' (built) infrastructure upstream, with recouped investments coming from reduced water treatment costs, thus showing promise. It promotes sustainable water management, community participation, and multi-sectoral and transboundary cooperation. Another example, the Upper Tana–Nairobi Water Fund invests in interventions like tree planting, riparian buffer zones and teaching farmers terracing techniques. These initiatives create a more reliable water supply, a healthier freshwater ecosystem and improved livelihoods for farming families (Schmitz, 2020).

4.3 Nature-based Solutions

Approaches underpinning NbS offer significant opportunities for enhancing cross-sectoral integration by leveraging the services of nature and healthy ecosystems to protect people, safeguard infrastructure, and support biodiversity, local livelihoods, and food and nutrition security[27]. These measures and technological practices can provide cross-cutting benefits for ecosystem-dependent sectors such as water, energy, food and biodiversity, while reducing

[27] https://iucn.org/our-work/nature-based-solutions

substantial amounts of greenhouse gas. Various NbS practices have been implemented across the region, demonstrating their practical application and benefits.

NbS for adaptation is instrumental in leveraging natural processes and ecosystems to address the impacts of climate change that are known to lead to biodiversity loss, food and water insecurity and disaster risks (United Nations Environment Programme, 2022). This section therefore articulates some of the NbS interventions adopted in the various case studies under Phase 2 of the study.

a) Technological practices and impacts

Various NbS practices in East Africa have been documented. Agroforestry is a dominant NbS intervention in East Africa, focusing on improving biodiversity while ensuring resilient and sustainable food production for vulnerable communities. This approach has led to several positive environmental outcomes, such as stable landscapes, reduced surface runoff, mitigated impacts of floods and favourable microclimate conditions. A groforestry also contributes to improved soil quality; higher retention of soil moisture (critical for high-yield crops and food security), addressing adverse effects of climate change through carbon sequestration; increased biodiversity; and improved adaptive capacity and resilience among smallholder farmers (Kuyah et al., 2016; Atela et al., 2017; Fuchs et al., 2022). Agroforestry practices such as contour hedgerows used in the highlands of Kenya (Angima et al., 2000) and Rwanda (Bucagu et al., 2013) have been shown to support soil conservation.

Additionally, ecosystem-based approaches aimed at restoring degraded ecosystems, such as ecosystem-based adaptation (EbA), have also been utilised as part of NbS. Practices, such as constructed wetlands and bunds in Rwanda (Cyamweshi et al., 2021); and riverbank stabilisation in Ethiopia (Nigatu et al., 2020), have been reported to support and promote rain-fed agriculture, particularly in areas where conventional drainage systems are absent, such as informal settlements and refugee camps (Mulligan et al., 2020).

In Somalia, particularly in the Jowhar Middle Shabelle region, land degradation is a pressing concern. A study by Ubeid (2023) assessed the impact of climate change on community livelihoods in this area, revealing that 19.4% of local community members consider afforestation a viable intervention for reclaiming degraded lands, while 22.8% emphasise the importance of sustainable forest management to prevent further degradation. These findings suggest that the most preferred Nature-based Solutions (NbS) in the Jowhar region are tree planting and significantly reducing deforestation[28].

While NbS practices have been adopted widely as part of rural livelihoods where forests and water bodies provide resources like energy and water, there are increasing opportunities for NbS in urban areas. Increasing urbanisation and the expansion of informal settlements have exposed urban centres to flood risks, for example, over 70% of Tanzania's population resides in informal settlements (Owusu et al., 2021). NbS practices are increasingly being adopted to combat this risk (Lokidor et al., 2023). Cases from Dar es Salaam, Kampala and Nairobi show how NbS interventions are mitigating both riparian and runoff floods, further enhancing urban agriculture. For example, Lwasa et al. (2014) highlight interventions in Dar es Salaam (Tanzania) and Kampala (Uganda) where urban agriculture such as sack and vertical farming in open spaces slowed runoff and mitigated flooding.

[28] https://irbackend.kiu.ac.ug/server/api/core/bitstreams/1efbb931-1ba0-4b79-8c22-e4f9115b5aa4/content

Other NbS practices in urban settings include creating green spaces, for example, the Ceteneray Park in Kampala and urban forests have proven effective in enhancing biodiversity and mitigating urban heat waves and flash floods. Initiatives in Kampala have made progress in incorporating NbS into urban planning and development, including the establishment of green spaces and the integration of natural infrastructure like urban forests and wetlands to mitigate flooding and heat stress. An example of such an intervention is the Kampala Urban Greening Initiative (KUGI) which is funded and implemented by the Kampala Capital City Authority. The initiative aimed to scale urban tree planting to restore degraded areas and wetlands, such as the Nsooba and Bwaise wetlands. The KUGI efforts also promoted urban agriculture for food security and the development of green roofs to minimise urban heat waves and improve air quality.

Further examples of NbS interventions include detention ponds to alleviate urban runoff in Dar es Salaam's Metropolitan Intervention (Mguni et al., 2016) and flood mitigation plans by NGO interventions to install drains in informal settlements in Kampala (Tukahirwa et al., 2010). The Mikoko Pamoja intervention, where communities are involved in the planting of mangrove trees and shrubs in degraded areas along the Kenya coast for carbon credit payment schemes, demonstrates effectiveness in mitigating floods, restoring degraded areas and improving livelihoods. Stronger community engagement can enhance the effectiveness of these initiatives, supporting their replication, scaling up and institutionalisation.

Insights from the field showed that enhanced impacts of NbS interventions can be achieved through harnessing synergies between people and ecosystem services to enhance process and outcome effectiveness. This is not limited to involving communities in intervention activities but also enhancing their capacity to understand NbS practices and values.

The relationship between people and ecosystems is critical in shaping the functionality of NbS. In East Africa, most households and communities already depend on nature for their livelihoods and income, ranging from soil for agricultural activities, water sources for water supply and forests for energy, particularly wood fuel among others. As such, effectively harnessing the people–nature nexus is a key area of NbS innovation. More specifically, people-driven restoration is critical for achieving desired impacts under NbS. This also requires strengthening people's capacity to invest, manage and benefit from nature. While case study beneficiaries reported a diversity of impacts, these impacts were enhanced in cases where communities were not only involved in the design and implementation of activities but also trained to understand the opportunities associated with NbS. For example, in the KCCAP coastal management efforts, especially in the Jimbo area, 1,000 mangrove trees were planted to control the shoreline aggression, and this was done with the help of the local communities. These restoration efforts have not only protected shorelines but also supported local fisheries by providing critical habitats for breeding.

In the other interventions, harnessing the synergies between different ecosystem services and co-benefits enhanced the outcomes. For example, push–pull technology in the Upscale Intervention has increased intercropping and biodiversity, hence enhancing ecosystem stability and resilience against climate risks such as drought. The BRCWE intervention is another example: approximately 38,000 hectares of wetlands were restored. This was achieved through participatory boundary demarcations between the wetland and catchment areas, removal of exotic trees, such as *Eucalyptus*, and vegetation blocking channels feeding the wetlands. This led to the restoration of two inlet streams into the wetlands. Through community leadership, the indigenous species of grasses and herbs growing along the edges of these wetlands were protected by the 126 km boundary demarcation in the Mushasha-Kankara Swamp forest, Buhweju District. To increase biomass productivity in the Kidubule wetland ecosystem, 80,000

saplings that are compatible with the wetland environment were planted and protected by community members to mitigate soil erosion in the area.

The Green Gicumbi project in Rwanda has mainly worked with local communities to deliver forest restoration by rehabilitating old forests. In addition to restoration, high quality tree seedlings were distributed and planted on community land to stabilise the hilly slopes against landslides. This intervention further encouraged sustainable forest management activities. Improved cooking stoves were also distributed to community members to reduce overreliance on firewood as cooking energy. The reducing vulnerability of livelihoods and economies of coastal communities in Tanzania intervention aimed to protect coastal communities by constructing sea walls and restoring vital ecosystems. One significant intervention was the rehabilitation of around 1,000 hectares of mangroves in Rufiji District, benefiting approximately 31,500 people. In addition, 1,260 hectares across two sites in Zanzibar and up to 3,000 m^2 of coral reefs were restored. These mangrove and coral habitats act as natural barriers, protecting against wave surges. The restoration used locally available, climate-resilient species and no-take zones were established to ensure the long-term sustainability of these ecosystems. The intervention also focused on building and rehabilitating sea walls; planting vegetation to safeguard key coastal assets like roads, buildings, ports and markets; rehabilitating storm drains to prevent flooding; and promoting energy-efficient cooking stoves to reduce deforestation.

Case studies further reveal that the people–nature relationship can also be strengthened by maximising the livelihood co-benefits associated with restoration efforts.

For example, the Mikoko Pamoja intervention in Kenya showcases the success of coastal restoration through mangroves by promoting carbon trading and credits to local communities, alongside other livelihood benefits. Coral farming, for example, supports fish populations, ensuring sustainable livelihoods for coastal communities, and provides protection against rising sea levels. Similarly, agroforestry interventions in East Africa have promoted the cultivation of fruit trees, herbs, and medicinal plants, which not only provide nutritious food but also enhance income and livelihoods, offering both environmental and economic gains. This demonstrates the dual benefits of NbS: delivering immediate economic returns while ensuring long-term environmental sustainability.

Therefore, participatory approaches to NbS, which prioritise maximising co-benefits and strengthening the people–nature relationship, are key innovations that can significantly enhance both environmental and social outcomes.

b) Policy and governance

Despite the potential of NbS in strengthening resilience of urban ecosystems against floods, promising NbS practices are yet to be fully integrated into urban development plans in East African cities.

Most NbS interventions require strong integrated institutional arrangements, multi-stakeholder engagement and, particularly, local leadership that strengthens the people–ecosystem nexus in sustainable ways. However, the limited capacities of local institutions can hinder the management of NbS activities, such as the protection of springs and earth dams (Agol et al., 2021). Poorly implemented or managed water resources infrastructure, for example, may not effectively store sufficient water for extended periods. Omwenga et al. (2019) highlight the importance of including NbS provisions in sub-national adaptation plans and policies to ensure structural and legal anchorage for local people's engagement in NbS activities. An example can be drawn from the Mt Elgon Ecosystem where the sub-national policies have integrated EbA approaches, such as agroforestry, terracing and the use of cover crops.

Integrating NbS into broader development frameworks could enhance their effectiveness and adoption, ensuring that NbS measures are embedded in wider development strategies and attract the necessary political and financial support. Furthermore, NbS can be more effective when integrated with technology and engineering principles (often referred to as grey infrastructure) for climate regulation, health, housing and transportation.

The Seedbio intervention, implemented in urban slums in Nairobi and Dar es Salaam, exemplifies the above suggested integration. The intervention has co-developed and built 7 intervention sites, integrating over 17 NbS interventions. The intervention also fostered a multi-actor regional community of practice, engaging collaborators in Ethiopia, Kenya, Rwanda, Uganda and Tanzania across various fields like community service, infrastructure, urban planning and management, construction, and risk and resilience management.

While policies relevant to NbS exist in the countries in East Africa, enhancing local NbS governance and leadership can facilitate the strengthening of the people–nature relationship for desirable NbS outcomes.

Local communities often possess deep, place-based knowledge of their natural environments and traditional resource management practices. Empowering communities to share and integrate this knowledge into NbS can lead to more culturally appropriate, context-specific and effective solutions. The Kenya Marine and Fisheries Research Institute (KMFRI) collaborated with the Lamu County government, the Department of Environment and local communities to implement the Mikoko Pamoja intervention, a community-based mangrove restoration intervention. The intervention drew on the traditional ecological knowledge of local communities, who had long-standing experience in managing and utilising mangrove ecosystems. This approach enabled the intervention to leverage the community's understanding of the local environment, species composition and traditional management practices, leading to successful mangrove rehabilitation and improved community ownership.

Another good example of local governance witnessed among communities was around Kenya's Kakamega Forest and the use of indigenous knowledge systems advocating for the promotion of medicinal and indigenous tree nurseries. The nurseries are meant to catalyse on-farm tree cultivation, easing pressure on the natural forest ecosystem. Stakeholders in the Kenya and Uganda FGD stressed the need for local capacity building to strengthen local leadership and governance. The enhanced capacities of these communities will give them a strong understanding of NbS and the ability to actively participate in their design and implementation. This will further enable them to develop a sense of ownership and commitment to these initiatives. In the long run, this will promote long-term stewardship and sustainable management of NbS interventions, ensuring their continued success and resilience. A good example of where the capacities of communities were enhanced is the Makueni Agroforestry and Climate-Smart Agriculture Initiative. In this intervention, according to the plenary session of the FGD, smallholder farmers were trained and supported to adopt agroforestry practices, including the integration of trees and shrubs into their farming systems. This was achieved through farmer field schools, and demonstration plots were used to build their capacity. The intervention led to increased agricultural productivity, improved soil health and enhanced climate resilience for the participating farming communities in Makueni County.

In Tanzania, Kenya and Rwanda, stakeholders have observed that NbS activities span multiple sectors and involve various stakeholders. This often led to overlapping governance frameworks, policy conflicts and resource wastage (see Atela et al., 2016). The need for multi-stakeholder coordination in NbS governance is crucial for enhancing synergies, efficiency and equity in

resource use. This involves bringing together government agencies, the private sector, civil society organisations, community groups and research institutions. Streamlining overlapping NbS mandates among government institutions is essential to limit inefficiencies caused by confusion among stakeholders. For example, in Tanzania stakeholders reported that many community forest management interventions are not optimally executed due to conflicting land use plans and inefficient coordination among partners such as apiculture interventions, local environment and agriculture departments and NGO interventions. This indicates the need for NbS multi-stakeholder consortiums to be formed in respective jurisdictions to improve efficiency and reduce the duplication of efforts.

A promising example of this multi-stakeholder approach is the Nairobi City Green Spaces and Biodiversity Conservation intervention[29]. This initiative brought together a diverse range of stakeholders, including the Nairobi City County government, private sector companies, community groups and environmental organisations. Through a collaborative approach to development and implementation, the intervention successfully executed a city-wide green strategy. Key achievements include the restoration of urban forests, the creation of green public spaces, and the active engagement of local communities in the maintenance and stewardship of these areas. The outcomes have been significant, contributing to improved air quality, enhanced urban biodiversity and increased recreational opportunities for Nairobi residents.

In terms of evidence gaps, most NbS studies focus on addressing water security, food security, climate change, human health and disaster problems in isolation rather than holistically. This highlights the need for more transdisciplinary studies to explore potential synergies between these sectors and their functionality and how different interventions might impact them. This will inform the integration of NbS into development policies and strategies. Overall, a lack of understanding of the implementation requirements of NbS in East Africa persists, primarily due to limited awareness among stakeholders, including policymakers (Lokidor et al., 2023). This can be attributed to the scarcity of monitored data on the performance of different approaches and the limited publication of best-practice case studies within the region (Debele et al., 2019).

Lack of public understanding and negative community perceptions can hinder NbS adoption (Wamsler et al., 2020). In addition, cultural constraints that influence community preferences and expectations can also play a role, as reported by Lechner et al. (2020). In some communities, for example, planting trees and forest management are cultural practices passed down through generations (Naima & Richard, 2016).

There is need to strengthen local NbS governance by raising public awareness and strengthening the local governance structures, such as community resources committees. This can also be accelerated through dialogue and joint plans with local authorities to strengthen linkages with existing governance structures.

c) Finance models

Local funding frameworks can help strengthen community-driven NbS and complement international funding mechanisms.

As with agriculture and food security, enhancing funding for NbS is critical. While the interventions analysed were dependent mainly on international funding, experience shows that

[29] https://kippra.or.ke/restoring-nairobi-to-a-green-city-in-the sun/#:~:text=The%20rehabilitation%20of%20Nairobi%20arboretum,green%20spaces%20in%20the%20city.

local funding frameworks hold some promise to strengthen community-driven NbS. For example, promoting *local funding opportunities* through corporate organisations and PPP, including corporate social responsibility initiatives, and funding of local groups can support groups of women and young people in carrying out these activities, thereby empowering them.

From the FGD findings, a promising recent initiative mentioned is the Ufanisi Community Environment Fund (UCEF), in Kakamega County, Kenya. This community-managed environmental fund was established by the Kakamega County government to support local NbS initiatives. The fund provides grants to community groups, women's organisations and youth-led initiatives to implement interventions such as community tree nurseries, agroforestry and ecosystem restoration. The groups highlighted further that UCEF has empowered local communities to take ownership of environmental management and develop sustainable livelihoods. One successful intervention supported by UCEF is the Shitochi Community Tree Nursery in Kakamega County, where a women's group has established a thriving nursery that produces and sells indigenous tree seedlings for local reforestation efforts. Safaricom, East Africa Breweries Limited (EABL) and Equity Bank Foundation have also promoted tree planting in degraded areas of Mau Forest through partnership with the Kenya Forest Service (KFS) and community forest associations (CFA). This underpins the role of the private sector in investing in various NbS for adaptation.

Given the role of people in driving effectiveness of NbS interventions and/or practices, there is need to support and strengthen local NbS financing frameworks across multiple ecosystem-based activities. This can be enhanced through locally led business models for ecosystem-based services, building on opportunities and lessons so far from the Payment for Ecosystem Services.

d) Adoption and sustainability

Enabling the adoption of NbS practices requires strengthening the institutional and cultural connections between local communities and ecosystems.

The main adoption enablers for NbS included deliberate efforts to engage the local communities in the implementation process, creating a sense of ownership in the intervention. For example, in the Upscale Intervention, the beneficiaries adopted peer learning processes to disseminate the technical know-how of setting up push–pull technology in their farms. In addition, peer-to-peer training on making organic manure and liming under this intervention was carried out to reduce the acidity of the soil which was caused by regular pesticide spraying and application of synthetic fertiliser over the years. As such, these processes, e.g., liming and application of the organic manure, have been credited with enhancing and maintaining the soil's carbon-to-nitrogen ratio, increasing its fertility and productivity of the soil. For coastal restoration interventions such as the KCCAP, communities were involved in planting 1,000 mangrove trees to stabilise the shorelines against erosion and sea levels rising. Since some community members are experts in deep-sea diving, they were engaged in coral reef restoration, leading to an increase in coastal aquatic life because of the restored habitats.

The Green Gicumbi Intervention trained community volunteers to provide extension services to farmers, significantly reducing maladaptation. Peer learning, especially regarding practical learning experiences, offered hands-on and tangible benefits of adaptation actions. This learning approach encouraged the local community to adopt new adaptation techniques, such as terracing across the slopes to build their resilience against landslides, soil erosion and floods.

The adoption of NbS is highly contextual and defined by the functionality of community engagement frameworks such as community intervention committees:

Interviews with local communities in Eselenkei Village, Kajiado County, revealed that local pastoralists are unable to adopt NbS adaptation practices such as afforestation and agroforestry due to water stress and competing domestic needs versus restorative uses. To this end, the adoption rate of some of the restorative NbS in the pastoralists' context is relatively low due to ensuing vulnerabilities. However, opportunities exist for natural restoration in pastoral ecosystems, including rotational grazing introduced at the Adaptation Village by NEMA and adopted by the CPC. Hence there is an improved pasture management framework within the village. Additionally, the adoption of peer learning through field schools and bringing social groups together to learn successful cases from each other through demonstrations (i.e., demo farms) have played a key role in enhancing adoption accordingly.

Knowledge awareness and peer learning among local communities are key in sustaining NbS impacts and learning.

Training local communities in implementing NbS and fostering peer learning can reduce reliance on extension services, which are often under-resourced. For example, the KCCAP Adaptation Village at Ololunga serves as a reference point for the local community on rotational grazing practices for rangeland management. Co-implementing this activity with local community members has fostered a sense of ownership and enhanced the sustained adoption of the intervention.

Furthermore, the ongoing provision of fruit tree seedlings and indigenous trees by NEMA under KCCAP for planting at both the Adaptation Village and surrounding homesteads has contributed to this effort. However, there is a need to invest in disseminating grafting skills among community members to ensure a continuous supply of quality seedlings and trees. Therefore, establishing local tree nurseries could be a viable solution.

During the KII process with a NEMA field officer working under KCCAP, it was proposed that the construction of a strategically positioned dam across the seasonal Eselenkei River could play a crucial role in reducing surface runoff, thereby accelerating the sustainable recharge of groundwater reservoirs. The proposed dam infrastructure would also contribute to regulating local temperatures and enhancing overall water security in the region.

Several key insights emerged from the FGD process on enhancing sustainability, many of which align with the enablers of adoption previously discussed. Developing inclusive policies and implementation plans at both national and local levels is vital. For example, in Samburu County, the local community, supported by local leadership, donated land to the Lewa Conservancy. This initiative has enabled the implementation of adaptation interventions aligned with NbS.

Multi-stakeholder partnerships are also essential, as they bring together diverse expertise, resources and perspectives to support NbS interventions. The Mikoko Pamoja intervention exemplifies this through its collaboration with local communities, scientific experts, local and national governments, and the international community, thereby enhancing co-creation and implementation of the activities.

Capacity building plays a critical role in ensuring the successful implementation and sustainability of NbS interventions. Effective monitoring and evaluation frameworks help track progress and adapt interventions as needed. Additionally, breaking barriers to the inclusion of different knowledge frames is crucial. Misconceptions about the value of indigenous knowledge and the tendency to prioritise external knowledge can hinder progress. Co-creation and sensitisation efforts, such as those seen in Eselenkei where the community embraced couch grass into their pastoral practices, are essential for integrating and valuing local knowledge.

Some of the barriers to the adoption of NbS, as identified during the FGD, include:

- *Capacity and knowledge gaps*: Many stakeholders, particularly community members, lack a comprehensive understanding of how NbS can enhance climate resilience and deliver multiple benefits. This knowledge gap hinders effective adoption and implementation.
- *Inadequate data and information*: The limited availability of localised, context-specific data and research on the effectiveness of NbS in various East African landscapes and communities hampers the ability to replicate and scale successful approaches.
- *Weak institutional coordination*: Effective NbS requires collaboration and coordination among government agencies, community organisations and other stakeholders. Weak institutional linkages and fragmented approaches can undermine the success and scalability of NbS initiatives. The absence of proper structures and personnel further impedes the implementation of nature-based activities.
- *Funding priorities driven by donors*: Many NbS interventions in Kenya depend heavily on international donor funding, which may not always align with the specific needs of the region. Donor priorities can skew funding towards certain types of NbS interventions or geographic areas, potentially neglecting other pressing issues or marginalised communities.
- *Insufficient financing*: There is a perceived scarcity of financial support specifically allocated for the implementation, maintenance and scaling of NbS interventions in Uganda. Challenges in accessing and mobilising climate finance at both the community and national levels contribute to this issue. These interventions are often seen as less tangible or measurable than conventional infrastructure interventions, making it difficult to attract private investment. The diverse range of ecosystem services and co-benefits provided by NbS can be challenging to quantify and translate into financial returns.

e) Gender and social inclusion

While social norms continue to drive gender inequalities in natural resource management, emerging models for gender representation and equitable benefits sharing can incentivise improved gender integration in NbS initiatives.

Improving gender integration in this context refers to deliberate gender inclusion in adaptation strategies that address respective adaptation needs to achieve equitable climate resilience outcomes. This was observed in a patriarchal society, such as the one at Eselenkei village, where women and young girls were included in the CPC, where discussions and decisions on the modalities of rotational grazing take place. In the Upscale Intervention, both women and youth were actively engaged in the learning and eventual adoption of the push-pull technology.

The long-term impacts of NbS interventions are enhanced through training on NbS practices whilst leveraging the strategic strengths of different social groups could enhance impacts.

The Upscale Intervention, for example, led to reported increases in soil health, enhanced biodiversity and water retention capacity due to nitrogen fixation by the *Desmodium* plant species. Furthermore, youth and women in many rural areas have been involved in restorative interventions, managing tree nurseries. Building on these skills for NbS could enhance job creation for young people and improve the livelihoods of women. For example, the Kibera tree nursery in Nairobi was mentioned during the FGD in Kenya. The initiative is led by a group of women who have transformed a degraded piece of land into a thriving nursery. The women grow

and sell a variety of tree seedlings, earning an income that provides for their household expenses and enables them to invest in their children's education. In addition to the economic benefits, the women have become active stewards of their local environment, leading community tree-planting campaigns and raising awareness about the importance of urban greening. The Kibera Tree Nursery has also fostered a sense of community pride and ownership, as the women have transformed a neglected space into a productive and visually appealing green space.

In the Green Gicumbi Intervention, women, young girls and youth were inclusively engaged during the needs assessment stage, alongside men. They extensively consulted on the intervention design, which aimed to build the resilience of the local community in the Gicumbi District. By involving these groups from the outset, the intervention implementers were able to incorporate their perspectives into the design, ensuring that their specific needs were addressed. This approach was particularly effective in enhancing resilience against extreme weather events, such as the frequent landslides during the rainy season. The Gicumbi Intervention also encouraged women to take on leadership roles in various community-based groups involved in co-implementing the intervention. This not only amplified women's voices but also highlighted their needs, such as access to clean water and knowledge in terracing. Consequently, NbS adaptation actions were tailored to reflect their priorities and address their sensitive needs. The inclusive approach led to the development and implementation of interventions that effectively addressed the unique challenges faced by these vulnerable groups.

Gender considerations in the BRCWE-Uganda intervention were evident when it came to constituting the wetland management committees in the Rubanda, Rukiga, Rubirizi, Kumi, Tororo, Butaleja, Budaka and Kaliro districts. To ensure women and youth inclusion and participation in the wetland management committee, several seats were reserved for them, ensuring inclusivity in the restoration efforts of the wetlands. Besides gender considerations in the wetland committees, 41% of the trained wetland conservationists were women. Therefore, the case study aimed to target women for the training, making them wetland restoration specialists. Peer-to-peer learning then took place in their social groups, resulting in the emergence of conservationists in the target districts.

The ICAM-Tanzania and ASUWSDP Intervention incorporated gender aspects into both the design and implementation of their activities. Engagement with intervention implementers during the KIIs process and analysis of intervention documents revealed that gender-disaggregated indicators were included in their results frameworks, indicating that the interventions were indeed gender-responsive. The targeted training for various stakeholder categories was inclusive, addressing men, women and youth. As a result, the distribution of improved cooking stoves to women's groups in three urban districts of Dar es Salaam led to a reduction in the time spent on food preparation and minimised household pollution. Despite the significant efforts to mainstream gender in NbS and the design of associated interventions, the approach by most interventions is relatively *ad hoc* in practice. The interventions lack clear guidelines on mainstreaming analysis of gender intersectionality and support practical considerations of gender issues. Consequently, consideration of gender issues in adaptation interventions weakens as interventions transition from design to actual implementation.

> ***Therefore, there is need to develop adequate guidelines for gender analysis and mainstreaming in the implementation of NbS interventions. Such guidelines should incorporate clear indicators for reporting progress and lessons emerging from gender and inclusion in NbS activities.***

4.4 Disaster risk reduction (DRR)

Disaster risk reduction (DRR) is critical for adapting to climate change by reducing vulnerability and increasing resilience to extreme weather events (IPCC, 2012; Nyandiko, 2020). Floods and droughts are frequent climate risks in East Africa, linked to the ripple effects of climate change (Bahal'Okwibale, 2018; Richardson et al., 2022). Rising sea levels, particularly along low-lying coastal zones, and landslides in Rwanda and Uganda, have caused significant losses and damage to vulnerable communities. Several DRR practices have been implemented in various East African contexts.

a) Technological practices and impacts

Several DRR practices in East Africa have been documented. Particular advancements have been made in climate services, early warning systems through forecast generation, capacity building, and equipping communities to understand and utilise climate information. A study by Gudoshava et al. (2024) reiterates that some countries in East Africa have established initiatives to disseminate climate information, including mobile phone applications. For example, Farm SMS in Tanzania (Kijazi et al., 2021), Plant Village in Kenya, which provides both text and television-based advisories, radio learning clubs in Rwanda and Ethiopia (Funk et al., 2023) and the Digital Agro-Climate Advisory Platform (Seid et al., 2020), among others.

Case studies, such as the ASUWSDP intervention, exemplify this notion in the sense that adequate resources and the right skill set were used to design and implement a comprehensive flood management system for Arusha. The flood management system included the construction of detention basins, retention ponds and drainage channels. This infrastructure was engineered to withstand increased rainfall and extreme weather events intervention under climate change scenarios, ensuring they could continue to function effectively in the face of climate impacts.

In the BRCWE-Uganda intervention, investments were made in climate information and early warning systems. This involved procuring equipment and software to train selected community members on the functionality of early warning systems (EWS). This was predominantly to improve the response to upcoming floods or drought seasons. The EWS initiates disaster preparation strategic plans to mitigate the impacts. In addition, the EWS infrastructure was augmented with the installation of automatic weather stations for collecting data that will be utilised in the region's climate modelling.

In the Green Gicumbi Intervention, collated data from EWS was leveraged to relocate vulnerable households to climate-resilient areas that are less susceptible to landslides and flooding. Relocation of vulnerable households points to an aspect of coordinated local governance in DRR whereby inclusivity and transparency in decision-making are critical as some residents in the district were afraid of losing their ancestral land. Besides this, the intervention adopted terracing agroforestry interventions to mitigate landslide disasters by planting tree species such as the *Calliandra*, which has an extensive, fast-growing and vigorous root network. Further, the intervention established check dams to control floods and soil erosion. This significantly reduced the flooding events that destroyed farms, caused injuries, displaced people and had a negative the mental health of flood victims. In efforts against drought and water scarcity, BRCWE-Uganda further constructed water retention facilities at the edge of the wetlands. Storage water facilities were also constructed for distribution within the households in the region. As a result, small-scale irrigation schemes were established in the Kabale, Pallisa, Namutumba, Kibuku and Butebo districts. For efficiency in water management, five water-saving irrigation schemes were also set up. As such, adequate investments towards these interventions not only enhanced the vulnerable communities' capacity against disasters but galvanised their food systems against

drought due to the already established infrastructure aimed to enhance the water security in respective districts.

Somalia is keen on developing its climate information services infrastructure by accelerating access to information via mobile platforms (Rigby et al., 2023). This initiative is being driven by the Somali Agro-Meteorological Information Service and FAO which aims to reach a wider population with climate information products such as advisories from their early warning systems (Abdulkadir, 2021). The climate information distributed to farmers is pivotal in providing farmers with timely information on planting schedules based on rainfall predictions (Rigby et al., 2023). However, this intervention is limited by inadequate telecommunication infrastructure in rural settings and conflict zones due to frequent incidences of vandalism. For instance, in conflict-prone regions, Al-Shabaab militants have banned the use use of mobile phones, thereby hindering the dissemination of climate information from the Somali Agro-Meteorological Information Service and FAO (Rigby, 2023).

In South Sudan, adaptation intervention on building resilience through asset creation and enhancement (BRACE)[30] aims to enhance disaster risk preparedness. Through active community participation, the project constructed flood control infrastructures such as dykes, water retention ponds and drainage channels to mitigate the impacts of flood disasters in Aweil counties. However, findings from the final evaluation report[31], reveal that the established flood control infrastructures were not adequately complemented by effective early warning systems. Further, the report reveals the quality of dykes' architectural design was not adequate thereby compromising the effectiveness of the infrastructure. Therefore, future disaster risk reduction infrastructures should undergo regular technical quality assurance audits to evaluate their effectiveness.

Overall, the effectiveness of DRR depends largely on the resilience of critical infrastructure and frameworks amidst extreme weather events, such as floods, rising sea levels, landslides and heat waves. Since the infrastructure is capital intensive, adequate financing and the right skill set play a major role in safeguarding the infrastructure against climate risks.

Capacity gaps in data collection, analysis and interpretation significantly hinder the ability to provide accurate and timely climate services for DRR response and preparedness (Gudoshava et al., 2024). Limited availability and accessibility of high-quality socio-economic data further impede the development of effective impact-based forecasts. Additionally, communicating and disseminating climate information to end-users remains a challenge, particularly for vulnerable communities with limited access to information.

Despite these challenges, some successful examples have been recorded of capacity building for DRR. An intervention in Tanzania has demonstrably enhanced stakeholder capacities through various initiatives. These include transboundary table top exercises on disaster risk response; training of trainers on mental health and psychosocial support in disasters; mentorship programmes for disaster response volunteers that integrate gender, vulnerable group needs and cultural diversity into DRR; convening DRR coordination working groups; and awareness-raising sessions on Community-Based Disaster Risk Management (CBDRM) for at-risk communities.

[30] https://iati.fcdo.gov.uk/iati_documents/D0006005.pdf
[31] https://iati.fcdo.gov.uk/iati_documents/D0006005.pdf

b) Policy and Governance

Recognising the severity of these disasters, the East Africa Community (EAC) partner states have opted for a coordinated and proactive approach to managing disasters in the region (Kamau, 2013). The EAC partner states enacted the East African Community Disaster Risk Reduction and Management Act of 2013. This Act aims to protect the rights of climate migrants, whether within the partner states or between and among them and to enhance institutional capacity. This, in turn, is expected to strengthen the adaptive capacity of vulnerable communities against climate risks. Consequently, the Act seeks to coordinate and mainstream adaptation intervention efforts by stakeholders in the region, thus avoiding duplication of efforts and minimising maladaptation.

Uganda's current DRR Strategic Plan showcases the potential for joint risk assessments, highlighting a promising avenue for collaborative action. Nevertheless, limited funding and low political commitment remain significant challenges, often leading to a reactive approach focused solely on response rather than preparedness (Omoyo et al., 2022). This hinders the potential of DRR to contribute to risk-informed solutions and achievement of the SDGs).

Somalia's National Disaster Risk Management Policy (2020)[32] has been central to the country's DRR efforts by providing a comprehensive framework tailored to address the various climatic shocks amidst its complex political status. The policy emphasises risk management targeted to mitigate the impacts of climate risk on vulnerable populations through contextualised prevention measures, preparedness, response recovery and reconstruction. These measures are hinged on effective capacity-building of government institutions at the national and local levels hence establishing a coherent federal framework in DRR. The policy orchestrates multi-sectoral approaches towards effective DRR efforts such as resource mobilisation, and averting duplication of disaster risk initiatives within the same localities. A case example of a DRR intervention project that has leveraged this policy is the Somalia Crisis Recovery Project[33]. This project aimed to mitigate the impacts of floods and catalyse disaster recovery among vulnerable populations. Its objectives are aligned with various national policies such as the National Disaster Risk Management Policy and the National Recovery and Resilience Framework[34] therefore earning the political goodwill it needs to realise its potential. Considering the above, findings from the respective case studies revealed that the effectiveness of DRR interventions is hinged on a coordinated approach towards adaptation actions that seek to engage the local leadership, invest and adopt innovation options such as early warning systems (EWS), and enhance ecosystems-based strategies to strengthen natural defences against disasters.

Insufficient attention has been paid to the identification, reduction and management of other connected disaster risks including pandemics and climate, which require not just reactive measures but also preparedness for future risks (Chen et al., 2021). To address this, there is a need for effective climate solutions anchored to collaborative efforts across governments, local communities, experts and other local stakeholders (Aylett, 2015; Broto, 2017). A study conducted in Magomeni Suna settlement in Tanzania on flooding in urban settlements noted that to enhance household adaptive capacity to flood hazards, policy measures towards enhancing social networks and community actions for flood adaptation are necessary.

John (2020) recommends enhancing multi-institutional involvement and promoting local livelihoods to improve household adaptation to floods. An example is the Spatial Planning Area

[32] https://www.preventionweb.net/media/97400/download?startDownload=20250121
[33] https://scrp.gov.so/project-overview/?utm_source=chatgpt.com
[34] https://faolex.fao.org/docs/pdf/som230205.pdf

(SPA) approach in Nairobi which has been held up nationally and internationally as a progressive example of community-informed, government-led slum upgrading and resilience building. The SPA process provides a collaborative platform to drive innovative DRR actions by bringing together multiple sectors and stakeholders to develop a locally-led community plan. Other case studies, such as the Building Climate Resilience for the Urban Poor programme (BCRUP), a new flagship programme launched by the Government of Kenya and the United Cities and Local Governments (UCLG), pursue a multi-sectoral approach to risk mapping and development of resilience planning. The BCRUP programme draws cases and learning from 12 African countries and aims to strengthen local leadership towards resilience planning. However, investments in skills to enhance co-creation between policy priorities and local needs is required.

Considering the above, findings from the respective case studies revealed that the effectiveness of DRR interventions is hinged on a coordinated approach towards adaptation actions that seeks to engage the local leadership, invest and adopt innovative options and enhance ecosystems-based strategies to strengthen natural defences against disasters.

c) Finance models

Various financing models for DRR have been established within current climate financing portfolios. The GCF, for example, uses DRR as one of the sectors/themes that can benefit from international domestic climate funding. Nonetheless, much of the DRR funding is drawn from the broader infrastructure funding established by multilateral entities. For example, the Sovereign disaster risk finance enshrined in the Africa Union's African Risk Capacity (ARC) since 2012[35] provides parametric insurance to disaster-sensitive developments. This accelerates the financial response capability of individual countries towards recovery actions from disasters, such as drought, while preserving their fiscal balances (Iyahen and Syroka, 2018). In the case of fragile states such as Somalia, there are close linkages between financial models and humanitarian aid by multilaterals such as the World Bank, and European Union (Quevedo, et al., 2023). The political instability in such states diminishes private sector investments in various adaptation interventions thus most of these fragile states are dependent on public and humanitarian funds (Quevedo, et al., 2023).

Many resilience-building interventions are integrated into humanitarian support efforts, including peacebuilding and emergency evacuations. While the humanitarian model is critical for addressing immediate crises, it often emphasizes reactive emergency responses over proactive risk preparedness and management. This focus can limit the development of long-term resilience in affected communities. For instance, organizations like Mercy Corps have recognized this limitation and shifted their strategies from solely providing short-term aid to developing broader socio-economic infrastructures that encourage long-term improvements in community well-being. They define "resilience" as the capacity of communities to learn, cope, adapt, and transform in the face of shocks and stresses.

Therefore, considering this financial model, East African countries are encouraged to integrate insurance in their DRR strategies.

In addition, PPP is important in DRR financing. This is an innovative model that seeks to enhance resource mobilisation from private and public entities in executing various DRR strategies. In Uganda, for example, PPP was leveraged to build climate resilient infrastructure, such as drainage systems to mitigate the recurrent flash floods in Kampala city (Akena, 2023). In the

[35] https://www.arc.int/about

partnership, private entities provided funding and engineering expertise to redesign the city drainage, and construct a storm water management basin, while the local government provided incentives such as tax breaks and land use rights. Similarly in Rwanda, the Ireme Invest initiative[36] was co-financed by the government and the European Investment Bank, Sweden and the Global Climate Partnership fund. The initiative sought to scale and accelerate the construction of green infrastructure such as renewable energies (solar energy) and climate-resilient infrastructure to withstand climate shocks such as floods.

The PPP financing model also enables access to technical support in executing DRR strategies. However, experience in Uganda reveals that PPP driven financing of DRR can be challenged by complexity in the contractual process driven by conflicting interests between profit generation expected by the private entities versus provision of public goods. Further, most PPP agreements sideline the local communities: they do not integrate the needs of these communities needs in the funding design and delivery.

Therefore, while promising financing for DRR, governments in East Africa should establish policy frameworks to align interests in PPP while actively engaging vulnerable populations in designing interventions against climate risks.

d) Adoption and sustainability

The adoption and sustainability of various DRR practices is key for impact and sustainability. The DRR strategies should stem from the needs assessment of vulnerable communities, considering their socio-economic and environmental status. Aligning these strategies with the development agenda of local governments is key with regards to budget allocation and political goodwill. The role of indigenous knowledge in the adoption and sustainability of DRR interventions is critical. For example, indigenous knowledge of pastoral communities such as Somali, Borana and Afar, in Ethiopia have been integrated in EWS (Hussein, 2019). Local knowledge such as environmental patterns that include animal and plant behaviour is synthesised and integrated in meteorological data over the centuries. This has empowered Ethiopia's pastoral communities to take timely disaster preparedness actions. Water harvesting infrastructure known as *kebele* belonging to the Afar community in Ethiopia has further been utilised in the construction of modern tanks with larger capacity[37].

e) Gender inclusion

Effective DRR strategies in respective local contexts often rely on information from different gender/social groups. Drought disasters, for example, affect different gender groups differently. The roles played by women and girls, e.g., fetching clean water and preparing food, is affected the most by drought. Further, in most rural settings and informal urban settings, access to education for girls is affected significantly during disasters, such as floods. Evidence further shows that men, especially those from pastoral communities, experience mental illness due to drought stress. Gender-sensitive DRR strategies are essential to ensure inclusivity and avoid exacerbating the impacts of disasters on certain gender groups, who are already facing underlying vulnerabilities.

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[36] https://www.rema.gov.rw/info/details?tx_news_pi1%5B%40widget_0%5D%5BcurrentPage%5D=10&tx_news_pi1%5Baction%5D=detail&tx_news_pi1%5Bcontroller%5D=News&tx_news_pi1%5Bnews%5D=647&cHash=b4194c5d7f1cdf81f55a489174d7be0c

[37] http://researchaffairs.haramaya.edu.et/wp-content/uploads/2017/10/building-zoa-HU-proceeding.pdf#page=121

Gender-responsive DRR strategies should further seek to enhance the capacity of marginalised groups, such as women and girls, by equipping them with the necessary skills and knowledge to understand and respond to disasters. Training them on interpreting data from EWS, designing respective disaster evacuation plans and first aid treatment should be central to their DRR empowerment programmes.

Therefore, the effectiveness of DRR strategies under gender is not only hinged on conducting a comprehensive needs assessment but also reflecting on avenues that promote skills and inclusive decision-making.

4.5 Climate-resilient infrastructure

Sustainable development of East Africa 's economy relies mainly on climate-resilient infrastructure that is key to ensuring the delivery of essential services. These services include health and education, delivery of market products and the overall reduction in vulnerability of the local communities.

a) Technological practices and impacts

Innovation in climate resilience is critical in ensuring urban and rural infrastructure remain functional amidst varying extreme climatic conditions. Several CRI practices have been documented in various studies. These include urban EWS and green infrastructure, among others (Nabutola, 2006; Charisa et al., 2016).

Intervention experiences reveal that the ability of CRI interventions to withstand extreme climatic events is a key part of their effectiveness. Initially, under KCCAP, NEMA established a water pan near Eselenkei River. However, the trapped water lasted for less than two months. This is attributed to the constant variability of climate conditions that accelerated the evaporation of the water. At this point, NEMA turned to sinking boreholes as an intervention for water security. This intervention has proven to be effective in arid semi-arid areas such as Kajiado so long as the water tables are monitored regularly by the Water Resource Authority to inform national and county policies on accessing and utilising water resources.

The construction of sea walls in Kilifi County against rising sea levels has been effective against ocean waves that are known to erode coastal lines. In Homa Bay County, the construction of dykes at River Asawo has been critical to mitigating the floods, however, due to limited funding, the construction of the dykes did not cover a considerable section of the riverbank. This exacerbated flooding downstream. These examples indicate that CRI has significant ecological impacts whilst potential social co-benefits can be enhanced.

The availability of clean water for the local community, has significantly improved health and sanitation, especially among school-going children in Ololunga Primary School. Moreover, the water infrastructure has enabled the school to implement feeding programmes, significantly improving overall student attendance and class performance. In addition, due to water availability, the school planted maize and beans to feed its growing population of students, maximising the cost-effectiveness of the intervention. Furthermore, the CPC formulated in the village promoted a sense of ownership and stewardship of their water infrastructure. To this end, shared water infrastructure has promoted peace and cohesion among the local community, creating a conducive environment for adaptation.

The beneficiaries of PCSA-Rwanda intervention received two cold rooms as part of the post-harvest infrastructure. This facility is critical for the storage of farm produce while significantly

reducing post-harvest losses. Furthermore, the facility guards the farmers against exploitation from brokers who often offer below-market rate prices for farm produce. The cold rooms also maintained the nutritional value and quality of the produce. The PCSA-Rwanda intervention empowered farmers with negotiation skills so they could fetch fair market rate prices, improving their household incomes through the profit margins. In addition, the intervention constructed a solar-powered irrigation system that was used to pump water to farms from the man-made dam. This solar-powered irrigation system was leveraged to irrigate farms located in hilly areas thus improving water proximity to the beneficiaries for both household and agricultural use.

The ICAM-Tanzania case study reported that the intervention, built groynes and dykes in seven locations along Tanzania's coast to stop the shores from eroding and prevent saltwater intrusion and flooding. This resulted in a total of 2,400 m of sea defence structures being built. It included investments in Zanzibar and five 100-m groynes in Kilimani to protect houses and crops from floods, and two 50-m segments of seawall in Kisiwa Panza that protect 300 villagers. The intervention drilled 10 boreholes and constructed 15,000-litre storage tanks for each borehole. Rainwater harvesting devices were installed to achieve at least a 20% increase in year-round water availability for local communities. The relocation of wells and the construction of rainwater harvesting devices benefited over 10,000 people in Bagamoyo District alone. Additionally, about 3,000 efficient cooking stoves were bought and distributed to households to address the issue of deforestation of mangroves for fuel.

Successful interventions include the construction of climate-resilient water storage and distribution systems, including dams and reservoirs designed to withstand droughts and floods; rainwater harvesting and groundwater recharge systems; water treatment and desalination plants powered by renewable energy; and development of EWS and emergency response plans for water infrastructure to mitigate climate-related risks. Others include climate-proof bridges and road designs, proper drainage systems, green infrastructure in building codes, renewable energy transport facilities and fibre optic networks for improved communication. Climate-proof bridges are also suspended above wetlands and rivers to promote and preserve biodiversity and the continued benefit of the ecosystem services to the community.

Reflecting on the empirical experiences, enhancing the value of CRI in building resilience in cities in developing countries, will require improving urban infrastructure, creating more effective and pro-poor structures of governance, and building the capacity of individuals and communities to understand the functionality of CRI interventions (also see Dodman, 2009). Systematic integration of green infrastructure (GI) concepts in urban planning is an essential approach. This can help link GI to governance and rights-based conceptualisation, with potential to unlock more resourceful paths for sustainable, green and inclusive urban development.

b) Financing CRI

Urban areas in East African face several challenges related to the financing of urban infrastructure interventions, including strain on central and local government funding due largely to insufficient public funds and weak governance (Nabutola, 2006). This is compounded by the need for additional technical know-how to design and implement resilient infrastructure to service the mounting city requirements and rising demand resulting from the increasing population (Chirisa et al., 2016). Despite this, some of the factors that can make African cities more resilient include the presence of robust urban infrastructure, good governance and legal frameworks, participatory approaches for multi-stakeholder interactions and replicability of best practices.

Capacity building is a critical component of climate-resilient infrastructure as it empowers communities with knowledge and skills to sustainably manage resources and adapt to changing

conditions. For example, in Rwanda's Green Gicumbi Intervention, training programmes conducted by field assistants on managing dams at Muvumba stream and the Akagera River fostered community ownership as they were empowered to manage the water infrastructure. Similarly, Tanzania's ICAM case study, and the sea wall construction intervention, targeted training and resources for alternative income-generating activities, such as seaweed farming, small-scale aquaculture and eco-friendly handicraft production. This led to the expansion of the range of livelihood opportunities, making the communities less dependent on a single, climate-sensitive source of income, improving their overall economic well-being and resilience.

The main point of capacity building for local communities in climate resilient infrastructure is to equip them with the knowledge, skills, and resources needed to manage, maintain and adapt infrastructure sustainably. This ensures long-term resilience to climate impacts while fostering community ownership and enhancing their ability to respond effectively to future challenges. This approach was adopted in South Sudan's adaptation intervention on building resilience through asset creation and enhancement (BRACE)[38], leveraged cash transfers as a means to create community assets. Under this model community members received cash or food aid as a reward for identifying and participating in building CRIs such as water retention ponds or irrigation canals against flood and drought disasters. This innovative model of ensuring community participation entrenched a sense of ownership of community assets- potentially enhancing adoption and sustainability. In addition, co-identification and participation of the local community in building assets played a critical role in fostering cohesion hence mitigating intra and inter-conflicts. The project's final evaluation report[39] highlights a significant shift in the selection process, transitioning from a limited menu of adaptation initiatives to a free-choice model operationalized through community participatory forums. Furthermore, the cash or food transfer framework strengthened social ties by reducing migration, as families no longer had to relocate in search of economic opportunities.

The ICAM-Tanzania intervention also focused on capacity building and skills development programmes that specifically targeted women and marginalised community members. These initiatives enhanced their technical, organisational and leadership capabilities. By doing so, the programmes empowered women and marginalised groups to actively engage in the operation and maintenance of adaptation-related infrastructure. They were also involved in the governance and management of natural resources, fostering a more inclusive and resilient approach to coastal adaptation.

> ***Reflecting on the foregoing experiences, opportunities for enhancing effectiveness in CRI involve improving urban infrastructure and building the capacity of individuals and communities to address these new challenges and move beyond them (also see Dodman, 2009). Systematic integration of green infrastructure (GI) concepts in urban planning is an essential approach to tackle major current and future challenges in addition to linking GI to governance and rights-based conceptualisation, which will have the potential to unlock more resourceful paths for sustainable, green and inclusive urban development. Most importantly, strengthening the resilience of CRI is critical in ensuring urban and rural infrastructure remains functional amidst varying extreme climatic conditions.***

c) Adoption enablers and impediments

Climate-resilient infrastructure is capital-intensive, making the availability of adequate funding

[38] https://iati.fcdo.gov.uk/iati_documents/D0006005.pdf
[39] https://iati.fcdo.gov.uk/iati_documents/D0006005.pdf

a key factor in ensuring the effectiveness of interventions. CPC often provide local governance for adaptation interventions, fostering stewardship among community members for assets, such as the solar-powered boreholes constructed by NEMA through the KCCAP.

In Uganda's BRCWE intervention, the key enablers for adopting climate-resilient infrastructure were primarily the training of 130 farmer groups on the operations and maintenance of irrigation infrastructure, including water retention centres, water storage assets and technical skills for ensuring water efficiency. Stewardship of climate-resilient infrastructure often depends on whether the asset addresses the community's immediate needs. This highlights the importance of conducting a consultative needs assessment with the community at the centre of the discussions. For example, in Eselenkei village, where water scarcity was a major challenge, the establishment of a solar-powered borehole was well received, as it met their immediate water needs. Similarly, the construction of the Kilifi Sea Wall addressed the urgent need to protect locals from sea encroachment, which had already claimed their lands and ancestral homes, gradually eroding their culture as they faced displacement.

Sustaining CRI practices is crucial. However, the sustainability of water assets is threatened by a lack of local capacity to handle technical issues. No one in the village is currently trained to address electric or mechanical faults in the solar-powered borehole, which poses a significant risk to its continued operation. There is an urgent need to build the capacity of young people in the village to repair and maintain the infrastructure, presenting a clear opportunity for investment in skills development.

In Somalia, the Strengthening Pastoralist livelihoods through effective anticipatory Action project (PASSAGE)[40], is aimed at enhancing resilience among the pastoral communities. This is through establishing infrastructures for climate modelling designed to generate and relay climate advisory services to local communities especially pastoralists [41] . The success of these infrastructures in promoting anticipatory action was enabled by the co-creation of the infrastructures with the local communities and government hence cultivating a sense of ownership among the end beneficiaries. Additionally, training local communities on maintaining and managing the infrastructures further enhanced ownership and sustainability.[42]

Empirical experiences shared during FGD sessions and case study analysis highlight some of the barriers to sustainable adoption of CRI practices:

i. *Policy and regulatory challenges*: While policies, regulations and standards related to CRI development and investment exist, gaps or inconsistencies hinder effective implementation. The absence of clear guidelines, incentives or mandates for incorporating climate resilience into infrastructure complicates planning and decision making. Weak enforcement of existing policies, particularly those related to climate change adaptation and disaster risk management, further impedes progress.

ii. *Socio-cultural and institutional* factors: Resistance to change and reluctance to adopt unfamiliar climate-resilient technologies and practices among end-users and local communities pose significant challenges. This is compounded by isolated approaches and poor coordination among government agencies and stakeholders involved in

[40] https://clareprogramme.org/project/strengthening-pastoralist-livelihoods-through-effective-anticipatory-action-passage/
[41] https://idrc-crdi.ca/en/project/strengthening-pastoralist-livelihoods-greater-horn-africa-through-effective-anticipatory?utm_
[42] https://www.icpac.net/documents/848/GHACOF66_REPORT_8CcbRpD.pdf

infrastructure planning. Insufficient engagement with local communities in designing and implementing CRI interventions also limits ownership and long-term success.

iii. *Financing gaps*: Limited access to affordable financing hinders development, especially for small-scale and community-based CRI interventions. The allocation of public funds for CRI is often insufficient due to competing development priorities. Additionally, the high upfront costs and long payback periods associated with CRI can deter private sector investment.

iv. *Capacity and knowledge gaps*: Many stakeholders, including government officials and local communities, lack the technical and institutional capacity to design, implement and maintain CRI interventions. Moreover, a lack of awareness among policy makers, intervention developers and the public regarding the benefits of CRI, coupled with insufficient data on climate risks and the performance of resilient technologies, hampers evidence-based decision-making.

d) Gender and social inclusion

To realise the effectiveness of adaptation interventions in the context of climate-resilient infrastructure, women and young people should be integrated into the management of the assets. This inculcates a sense of responsibility among the vulnerable demographic groups in ensuring water infrastructure is not vandalised for selfish reasons. To this end, CPC provided the local governance aspects in adaptation interventions, hence instilling stewardship among community members and their assets, such as the solarised boreholes constructed under KCCAP.

In Rwanda, the successful adoption of climate-smart agriculture in the PCSA-Rwanda intervention, was driven by the role of well-seasoned community champions. These champions were integral in disseminating knowledge about climate-smart agriculture and its associated technologies. By enhancing extension services, they played a pivotal role in demonstrating the effective use of solar-powered irrigation equipment and facilitating the uptake of new farming techniques.

SUMMARY AND RECOMMENDATIONS

5.0 SUMMARY AND RECOMMENDATIONS

The results from Phases 1 and 2 reveal that East Africa re is highly vulnerable to climate risks across all key economic and social sectors. While efforts have been made to tackle these risks through mainstreaming adaptation into national policies such as NDC and NAP documents, there are policy gaps in some countries. This manifests in critical sectors such as NbS and resilient land management, disaster risk reduction, energy, infrastructure and human settlements, natural resources and environment (e.g. marine systems and coastal areas, biodiversity and conservation) not being adequately accommodated into policy frameworks.

Similarly, regional gaps in investment exist, with fewer adaptation interventions in some of the highly vulnerable countries, including South Sudan, Djibouti, Rwanda and Somalia. Agriculture and water security have received the most funding, with fewer interventions for NbS, disaster risk reduction and climate-resilient infrastructure. Considering the interconnectedness of climate risks and impacts across sectors, such sectoral imbalance in investment could hamper adaptation progress where unaddressed risks in the underfunded sectors amplify risks and impacts in the relatively well-funded sectors. An integrated approach to adaptation is therefore required.

This report further confirms the dominance of grant financing as the main financing vehicle for adaptation. While grants are important, especially in such vulnerable and resource constrained regions as East Africa, long-term sustainability of adaptation interventions will require the development of innovative business models that attract private financing for promising technologies.

Turning to the effectiveness of adaptation interventions, this report highlights a variety of practices, technologies and behaviours as effective strategies for building climate resilience. In the agriculture sector, for example, extensive scholarly evidence exists for the effectiveness of CSA practices for enhancing agricultural productivity, food security and building climate resilience. Similarly, in the water sector, water management practices such as micro-irrigation schemes and rainwater harvesting were found to be effective. Within NbS, practices such as agroforestry and soil and water conservation had positive environmental, productivity and climate resilience outcomes, such as protection from floods. Within disaster risk reduction, effective practices and technologies include forecast generation and early warning systems.

Capacity building interventions that aim to equip beneficiaries with the knowledge and skills to appreciate and adopt new practices and technologies were also shown to be effective adaptation strategies across all sectors. While limited evidence was found on the effectiveness of these interventions in the literature, the respective country FGD sessions and case study analysis found strong support for capacity building interventions such as targeted training, demonstration sites and farmer field schools, across all the sectors of the selected countries (Kenya, Uganda, Rwanda and Tanzania). However, skills alone are insufficient to build climate resilience in vulnerable populations, as putting the acquired skills into practice requires sustained support, local leadership, and long-term investments beyond intervention lifespans. These key enablers are often missing from intervention designs.

Financing is another intervention type that was explored, identifying social protection in terms of cash transfers as a key intervention for building climate resilience. While others, including weather-indexed crop insurance, asset restocking and devolved financing were also identified, literature on the effectiveness of these and other financing models in fostering climate resilience effectiveness is more limited. The use of cooperatives to access agricultural credit, table banking and direct contracting of intervention beneficiaries to undertake intervention activities were identified in the case studies. However, insufficient information exists on the effectiveness of

such financing innovations as most of the case studies lacked a specific component for financing their intervention designs and the FGD did not tackle this issue adequately. Overall, further rigorous evidence from experimental and longitudinal causal studies is required to build a stronger case for these models.

Importantly, policies can contribute to the development of strong local institutions, ultimately leading to improved community resource management. Further, the literature review established that although countries in East Africa have developed policies and institutions, several gaps remain in mainstreaming climate change considerations into sectoral plans and programmes. For example, the case studies and FGD sessions revealed key policy gaps, especially in the NbS and climate-resilient infrastructure sectors. Closing these policy gaps will be vital for fostering effective adaptation. In addition, there was strong support for community participation, stakeholder collaboration and institutionalisation of adaptation action across all sectors and countries. Further understanding and accounting for contextual vulnerabilities in intervention designs was identified as a lever for effective adaptation. These are key enablers for effective adaptation.

Finally, we noted gaps in the current knowledge. First, most of the rigorous evidence was available only for the agriculture sector, with far fewer studies covering water. Even within agriculture, most research was focused on understanding the effectiveness of interventions based on output-based criteria (such as yield). Far fewer studies existed on process-based outcomes, such as community participation, governance, gender, inclusiveness and equity. For NbS and climate-resilient infrastructure, the case study analysis and country FGD were a major source of information, suggesting large evidence gaps in those sectors. Finally, we recorded regional disparities in the knowledge base, where countries such as Burundi and Somalia, are less studied. This limits understanding of the effectiveness of interventions in diverse regional contexts, compromising the proper design of adaptation interventions in such settings.

This report makes the following overall recommendations based on the research analysis:

1. **Promote integrated, nexus-based approaches**: Prioritise interventions that integrate multiple sectors, particularly water, energy, food security and ecosystems. These interventions should leverage synergies and co-benefits to maximise their impact across the region.

2. **Address policy and investment gaps**: To close the gaps in sectors like NbS and climate-resilient infrastructure, institute investment in mainstream climate adaptation across all sectoral policies. Investing in underfunded sectors and ensuring equitable resource distribution will help mitigate cross-sectoral risks.

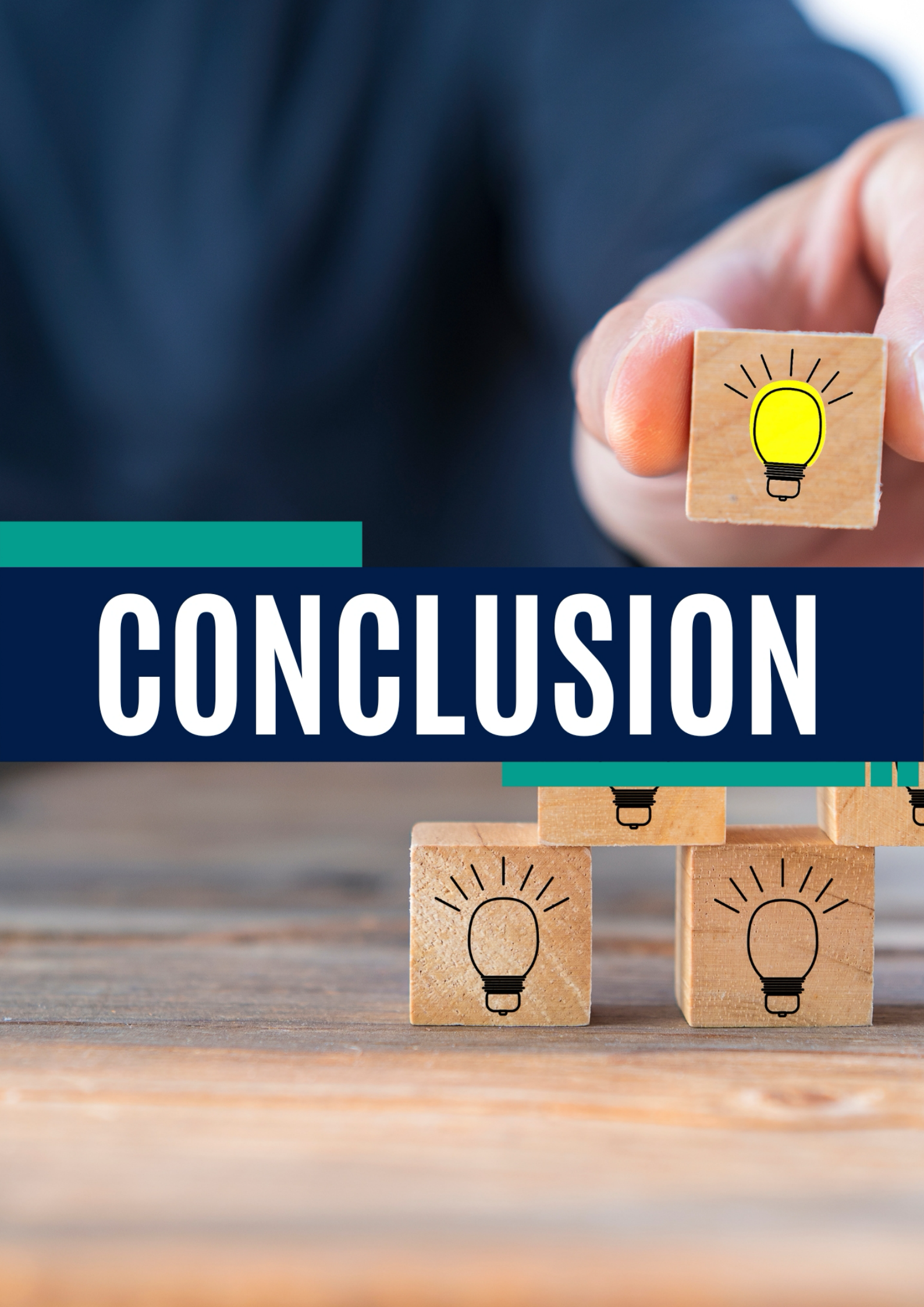
3. **Strengthen long-term financing models**: Develop innovative financing models that move beyond grant funding to attract private sector investment. Blended finance mechanisms and market-driven approaches should be explored to ensure the sustainability of adaptation interventions.

4. **Enhance capacity building and local leadership**: Continue to support capacity building interventions, with a focus on local leadership and community driven solutions. Long-term investments and sustained support are essential for translating skills into real-world climate resilience.

5. **Address knowledge gaps**: Future research should fill the knowledge gaps in sectors like water security, NbS and climate-resilient infrastructure. Rigorous studies on the effectiveness of social protection mechanisms and financing innovations are needed to strengthen the evidence base.

6. **Encourage community engagement and policy coherence**: Effective adaptation requires strong community participation, stakeholder collaboration and alignment with national policies. Supporting the institutionalisation of adaptation at local levels and promoting policies that facilitate community-driven adaptation strategies would help resolve this issue.

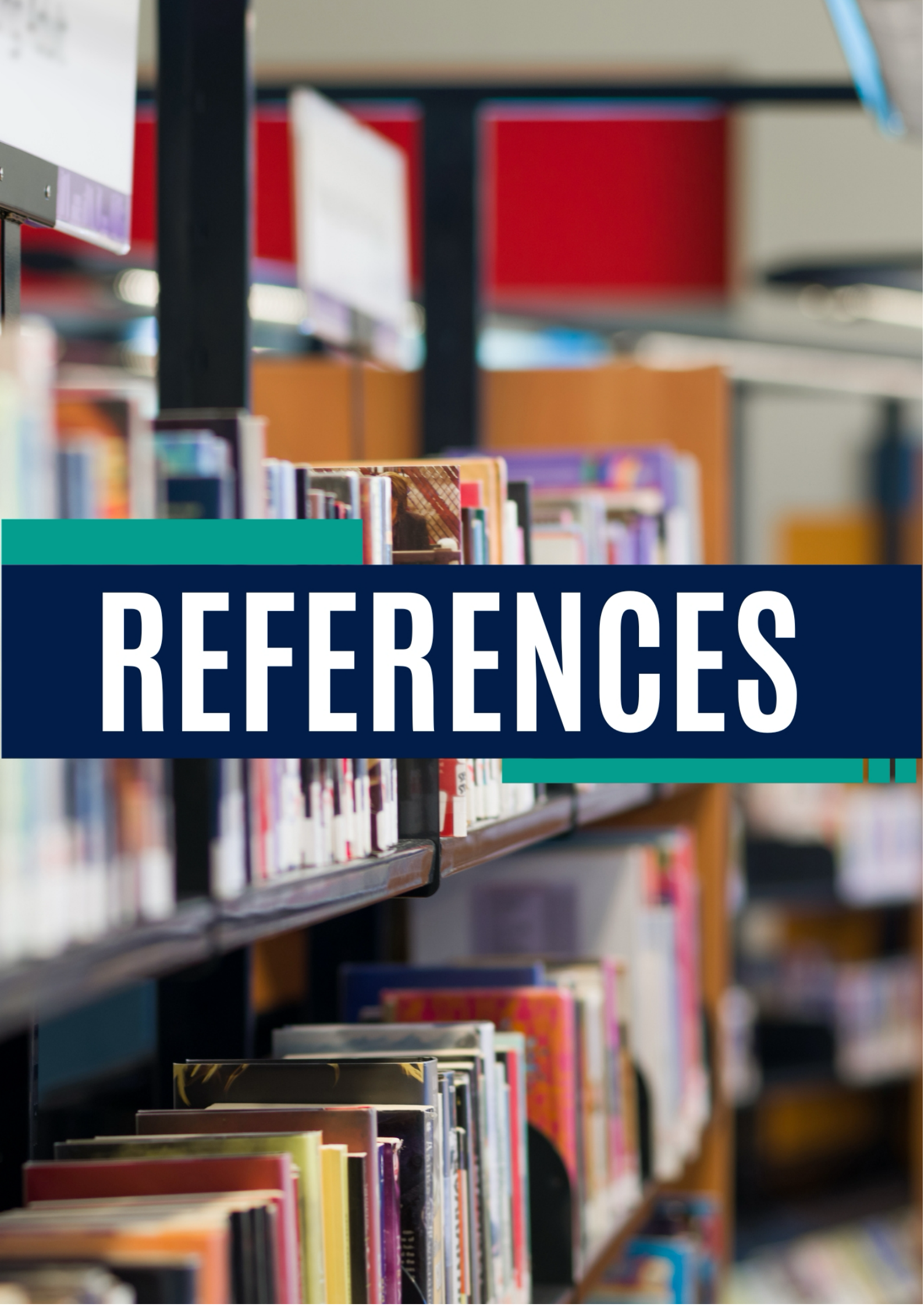
7. **Develop adequate guidelines and indicators for gender analysis and implementation**: There is lack of clear guidelines to mainstream analysis gender intersectionality in intervention context and support practical considerations of gender issues. Consequently, consideration of gender issues in adaptation interventions weaken as interventions transition from design to actual implementation. The solution is to develop adequate guidelines and indicators for gender analysis and mainstreaming in the implementation and monitoring of interventions.



CONCLUSION

6.0 CONCLUSION

East Africa's climate adaptation landscape is complex, but significant opportunities exist to scale up effective interventions. By prioritising integrated, nexus-based approaches, addressing policy and investment gaps and strengthening local capacities the region can build a more resilient future. The effectiveness of interventions is highly contextual and dependent on the needs of stakeholders, long-term funding and institutional capacity to ensure success and sustainability in the face of increasingly severe climate risks. While the study used a mix of methods to gather data from literature, experts and empirical cases, these approaches were not exhaustive enough to document detailed impact and effectiveness of adaptation interventions. Nonetheless, this study presents a useful foundation upon which further assessment of specific sectors or approaches can be anchored.



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8.0 ANNEXES

Annex 1: Data collection tools

a. Focus group discussion guide
b. Key informant guide
c. Intervention assessment matrix

Annex 2: Database

a. Adaptation interventions in East Africa.

b. Literature database (bibliography)

Annex 3 Country synthesis reports

a. Scoping report
b. Case study synthesis report
c. Focus group discussion reports

Annex 4 Case studies summaries

A. Kenya Climate Change Adaptation Programme (KCCAP)
B. The Upscale Intervention
C. Building resilience of communities living in Degraded wetlands, forests and savannas of Rwanda through an Ecosystem-Based Adaptation Approach (Green Gicumbi)
D. Promoting Climate Smart Agriculture for improved rural livelihoods and climate resilience in the climate-vulnerable Eastern Province of Rwanda (PCSA-Rwanda)
E. Building resilient communities, wetland ecosystems and associated catchments in Uganda (BRCWE-Uganda
F. Implementation of concrete adaptation measures to reduce vulnerability of livelihood and economy of coastal communities in Tanzania (ICAM-Tanzania)
G. Arusha Sustainable Urban Water and Sanitation Delivery Intervention (ASUWSDP)

Annex 5 Video and photo gallery

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