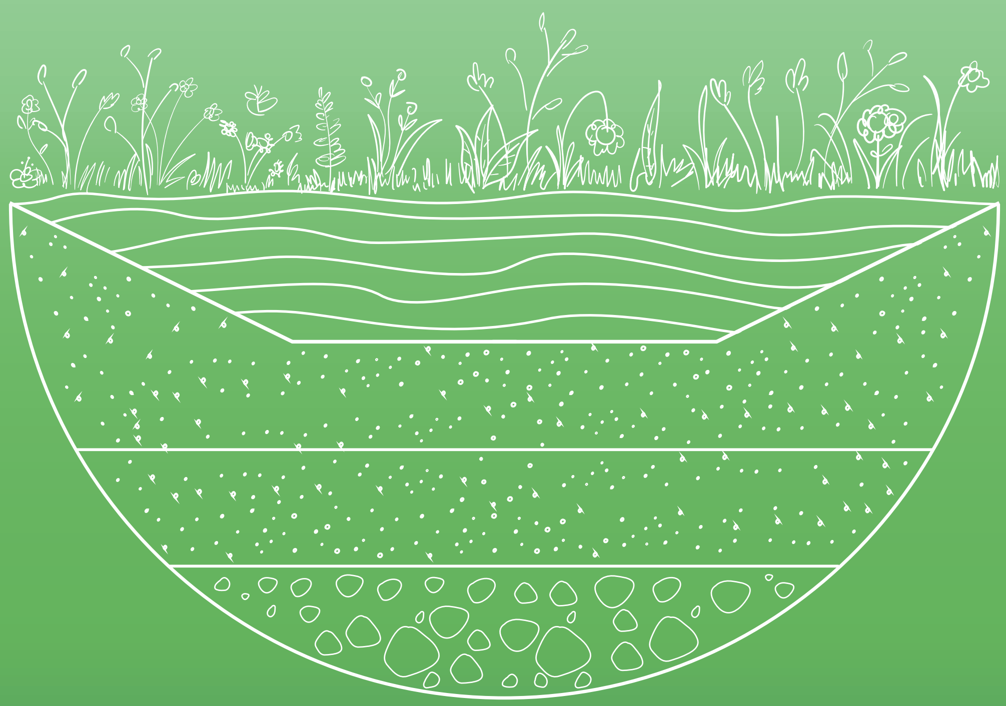

Towards implementing urban Nature-based Solutions in Zambia and Mauritius

Technical Report

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Citation

United Nations Environment Programme Copenhagen Climate Centre (UNEP-CCC). 2025. Towards implementing urban Nature-based Solutions in Zambia and Mauritius. Technical report. Copenhagen, Denmark.

Acknowledgements

This report was authored by Geronimo Gussmann, Ethel Mudenda and Darmen Ellayah. Reviews were provided by Clara Camarasa, Talat Munshi, Julia Rocha Romero, Federico Antonio Canu, Lakshmi Bhamidipati (UNEP-CCC) Yulia Rubleva, Alexander Forbes (UNEP) Rajaram Luximon (Ministry of Environment, Solid Waste Management and Climate Change, Mauritius).

This technical report was developed in the context of the project "Implementation of Urban Nature-based Solutions for Mitigation and Adaptation" funded by the Ministry of Foreign Affairs of Denmark.

Design and Layout

Formato Verde.

List of Contents

List of Tables

List of Figures

List of Boxes

EXECUTIVE SUMMARY

Climate change and rapid urbanization are central challenges to sustainable development in cities of low- and middle-income countries. Nature-based Solutions can address these challenges and offer environmental and social benefits over traditional engineered solutions, and in practice co-exist and positively complement engineered solutions. However, the uptake of NbS in urban planning remains limited and implementation faces several barriers. The need to create enabling environments that incentivize the use of NbS as well as making clear investment cases to attract finance for NbS is omnipresent.

Against this backdrop, this technical report conducted a review of scientific and selected grey literatures to understand central climate impacts and risks in two heavily climate impacted African countries – Zambia and Mauritius – to gauge how Nature-based Solutions could address the identified climate impacts and risks in urban areas there.

KEY MESSAGES:

- **Urban areas in both Mauritius and Zambia face increasingly severe climate-related challenges.** In Zambia, flooding, flash floods, and droughts are central concerns, with recent flash floods in Lusaka in early 2025, highlighting the urgency of these issues. Similarly, Mauritius is struggling with flash floods and heat stress, particularly in Port Louis, where rainwater runoff from elevated areas has caused extreme flood events, disproportionately affecting vulnerable communities.

- **Nature-based Solutions such as permeable pavements, infiltration measures, rainwater harvesting, urban gardens, and bio-retention systems, offer promising approaches to enhancing climate resilience in cities.** These solutions provide environmental and social co-benefits compared to conventional grey infrastructure, making them central tools for sustainable urban development.

- **To advance the implementation of Nature-based Solutions, creating enabling environments that incentivize the use of such measures is a necessary first step.** This includes developing clear investment cases and enhancing policy frameworks.

1 INTRODUCTION

1.1 Climate change and urbanization challenge sustainable development

The challenges of climate change and rapid urbanization present central obstacles to sustainable development in cities of low- and middle-income countries (LMIC). Urban Nature-based Solutions (NbS) receive growing attention as potential remedies for these challenges because they offer environmental and social co-benefits in comparison to conventional grey or engineered solutions. However, discussions around NbS have been driven by experiences from high-income countries and the literature has yet to catch up to integrate experiences from LMIC, where knowledge on NbS remains mostly fragmented. Nevertheless, the United Nations Environment Program (UNEP) among other international organizations has started supporting LMICs in paving the way towards implementing NbS which is a complicated endeavor because of data scarce environments, lack of finance and little exposure to NbS.

This technical report aims to add experiences of LMIC to the literature by presenting a literature review conducted in the context of the "Implementation of Urban Nature-based Solutions for Mitigation and Adaptation" project by the UNEP Copenhagen Climate Centre (UNEP-CCC) which creates enabling environments for urban NbS in Zambia and Mauritius[1]. Both countries are among the most vulnerable to climate change impacts and risks. However, knowledge about observed climate change impacts and projected risks is scattered across different scientific and grey literatures and it remains unclear how NbS can contribute to reducing climate impacts and risks there. Hence, this raises the central research question: What are observed climate impacts and projected future risks in Zambia and Mauritius and how can urban Nature-based Solutions address them in the capitals Lusaka and Port Louis?

1 See here for more information on the project: https://unepccc.org/project/implementation-of-urban-nature-based-solutions-for-mitigation-and-adaptation/

To answer this question, this technical report conducts a desk review of relevant scientific and grey literatures. Based on this, the report identifies central climate impact and risk categories for both countries and suggests potential urban NbS that can address them, while providing further co-benefits in support of ongoing development challenges. The results aim to support local and national decision-making, e.g., to identify and suggest measures for potential NbS projects. The insights of this publication extend beyond Mauritius and Zambia and are broadly applicable, making it a valuable resource for practitioners in the field of NbS.

1.2 Enabling urban Nature-based Solutions

NbS are actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems, which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human wellbeing, ecosystem services and resilience and biodiversity benefits (UNEA 2022). This integrates approaches like green infrastructures, ecosystem-based adaptation, and ecosystem services. However, while there are various definitions next to the one the report introduces above, terminologies are often used interchangeably, and only limited efforts have been made to establish a mutual understanding. Jones *et al.* (2022) provide a notable suggestion for a typology of urban green infrastructures which distinguishes between components like gardens, parks, amenity areas, other public spaces, constructed green infrastructures like green roofs, hybrid green infrastructures for water, water bodies and other non-sealed urban areas, demonstrating the panorama of possible NbS. Nevertheless, given the broad variety of contexts and objectives of NbS, terminological and definitory unclarities will remain. This technical report uses the definition from above.

The vital role of NbS to tackle both impacts from climate change and biodiversity loss is well established, particularly for climate change adaptation. For example, the sixth assessment report (AR6) of the IPCC lists NbS, effective governance and adaptation finance as key enablers for reducing adaptation gaps (IPCC, 2023). While NbS are often seen as important contributors to climate mitigation e.g., via afforestation, the overall mitigation effect of NbS in the urban context is rather small (IPCC 2022). Hence, the focus of NbS in cities is often on adaptation to climate change and their co-benefits. For instance, greening urban areas as an adaptation measure reduces heat risks but also contributes to human health and well-being and improves biodiversity (Augusto *et al.* 2020). However, NbS do face limits in their ability to reduce climate risks and increase resilience and there remains substantial uncertainty in the literature about the long-term effectiveness of NbS particularly under high-end climate change scenarios (Gómez Martín *et al.* 2021).

Urban NbS offer sustainability advantages in comparison to conventional grey or engineered solutions that often characterize the development pathways in LMICs, particularly in Africa (Güneralp *et al.* 2017). This has been demonstrated by a variety of studies, analyzing the effectiveness of NbS in different European and LMIC contexts (Mungur *et al.* 2020, Acreman *et al.* 2021, Kõiv-Vainik *et al.* 2022, Vogelsang *et al.* 2023). In addition, the literature also addresses questions of implementation (Kalaba 2016, Raymond *et al.* 2017, Cohen-Shacham *et al.* 2019, Wickenberg *et al.* 2021, Hamel and Tan 2022, Pan *et al.* 2023). Within this focus, the literature has developed and assessed different barriers to implementation. The general barriers are economic (e.g. negative cost/benefit ratios) technical (e.g. limited expertise or information) governance (e.g. inadequate policy mixes) and finance barriers (e.g., difficulties accessing sufficient financial resources for implementation)(Favero and Hinkel 2024). This technical report focusses on the latter.

Finance barriers are a leading cause for adaptation gaps and particularly for limited NbS uptake in cities (United Nations Environment Programme 2024). The current finance flows to NbS are dominated by the public sector with approximately US$200 billion per year which is only a third of the levels needed to reach climate, biodiversity, and land degradation targets by 2030, with a lack of private finance accounting for the major missing share (United Nations Environment Programme 2023). Two of the central finance barriers for urban NbS are difficulties in coordinating funding between public and private financiers and in capturing the value of the social and environmental benefits that NbS provide, next to the direct economic benefits (Toxopeus and Polzin 2021). Addressing the former finance barriers, the literature has started developing business models for nature-based solutions (Mayor *et al.* 2021). Identifying value-capture arrangements and using innovative financing mechanisms like Green Bonds, Ecotourism user fees or betterment levies are seen as a promising first step to attract more private investments (Favero and Hinkel 2024). Addressing the latter finance barrier, La Notte (2024) suggests the use of the System of Environmental and Economic Accounts, which can account for the environmental and social benefits NbS provide but has found limited application for now. In general, there is a financial case for using NbS, particularly, if accounting for the non-monetary social and environmental co-benefits of NbS but even without, NbS are cost-effective, e.g., for reducing disaster risks (Vicarelli *et al.* 2024).

The literature addressing NbS in Africa, including small island developing states (SIDS) like Mauritius, is still in its infancy. Both single country case studies and regional analyses remain scarce. Some notable exceptions, however, demonstrate the potential of NbS in African countries and regions. For example, Acreman *et al.* (2021) provide evidence for the effectiveness of NbS for water management. Buckland *et al.* (2023) suggest succulent plants as a climate resilient alternative crop in sub-Saharan Africa. And Nzabarinda *et al.* (2025) provide evidence for the benefits of forest conservation and afforestation in terms of climate change mitigation. Nevertheless, relative to the benefits NbS could provide for making current development pathways in Africa more sustainable and climate-resilient, NbS remain understudied. This is particularly true for urban areas and to a lesser extent peri-urban areas, as most of the research and implementation experiences with NbS focus on rural areas for now. Peri-urban areas can be important entry points for NbS that can support the resilience of cities, as they often host informal settlements where people are even more vulnerable to the impacts of climate change (Thorn *et al.* 2021).

1.3 Methodology

This technical report conducts a desk review of the scientific and selected grey literatures by analysing the observed impacts, projected risks, and experiences of NbS in Zambia and Mauritius. To identify potential NbS measures, the report takes three analytical steps. The steps are as follows:

1. We conducted a scoping review of existing scientific and grey literatures to identify observed climate change impacts and projected risks in Zambia and Mauritius (n=123). We divided the review of the climate impacts and risks into the following 9 impact categories, summarized from the IPCC (2023a): Ecosystems and biodiversity, Food systems & food security, Water systems and water security, Risks from sea-level rise, Health and well-being, Migration and displacement, Human vulnerability, Cities, settlements & infrastructure and Economic sectors. We omit risks from sea-level rise in our review for Zambia because it is a landlocked country. We searched ScienceDirect and Google scholar databases using the keywords from the impact categories above combined with the two countries and "climate" OR "impact" OR "risk". Given the fragmented body of literature that we found, we opted to complement the keyword search strategy with additional snowball sampling from referenced studies, including government statistics data.

2. We continued to conduct a scoping review of existing scientific and grey literatures to identify previous experiences with NbS and implemented NbS measures in both Zambia and Mauritius. We divided the review into seven categories again expanding on those used by the IPCC: Forests, Wetlands, Urban NbS, Policy & Regulations, Ecosystem-based adaptation, Agro-ecological farming and NbS funding and finance. We again searched ScienceDirect and Google scholar databases using the keywords from the NbS categories above combined with the two countries and "nature-based" OR "ecosystem" OR "green infrastructure". We complement the keyword search strategy with additional snowballing from referenced studies, including the grey literature.

3. In the third and last step, we synthesized our findings from the first two steps to identify knowledge gaps and infer potential NbS measures that address the central climate impact and risk categories per country. We identified the central climate and risk categories per country with a qualitative analysis of the robustness and availability of literature per category and triangulated these sources with the grey literature. We then compared the existing NbS experiences and implemented NbS measures in both countries to identify potential linkages with ongoing activities and checked to what extent ongoing activities are related to the identified central climate impact and risk categories. Lastly, we followed the typology provided by Jones *et al.* (2022) to identify concrete NbS measures that address the identified central climate impact and risk categories, and ideally build on existing implementation experiences.

Nevertheless, this technical report has some limitations. The report only considered English publications for our desk review. This potentially excludes local knowledge, published in other languages. Furthermore, a systematic review of complementing grey literature was out of scope of this study. Hence, the recommendations presented in this technical report are intended as a first stepping stone for further detailed analysis and ground-truthing.

We organize the report as follows. The results and a synthesis of this analysis for Mauritius are detailed in the second section, followed by results and synthesis for Zambia in the third section. We then conclude with overarching recommendations in the fourth section.

2 ZAMBIA

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Box 1 Country context Zambia

Zambia is a rapidly urbanizing low-income country in Southern Africa. A large part of the Zambian economy depends on extracting natural resources, e.g., via mining or forestry. Zambia experiences a sub-tropical climate and while the climate is highly variable, the country has seen increasing impacts from climatic extremes, e.g., droughts, seasonal floods and flash floods, extreme temperatures, and dry spells. These impacts negatively affect the agriculture and electricity sectors (Worldbank 2024). The capital city Lusaka covers an area of 418 km², situated in a farming region with about 3 million inhabitants in Lusaka province (Zambia Statistics Agency 2022).

2.1 Results

There is a fragmented body of literature (n=63), addressing observed impacts, projected risks and NbS responses in Zambia. In the reviewed categories, water and food systems and the agricultural sector have found significant scholarly attention in Zambia, while knowledge gaps relating to (i) health and well-being, (ii) migration and displacement (iii) cities, settlements, and infrastructure and (iv) NbS overall remain.

2.1.1 Observed impacts and projected risks

2.1.1.1 Ecosystems and biodiversity

Ecosystems and biodiversity in Zambia are particularly under pressure from human activities. Climate impacts and future risks are less studied. The focus of the literature is predominantly on forests. In fact, while there are some studies that assess land use cover changes due to, e.g., deforestation (Phiri *et al.* 2019, Dietz *et al.* 2023, Chishaleshale *et al.* 2024, Chundu *et al.* 2024), there are few studies that assessed future climate risks for ecosystems and biodiversity in Zambia, with the NDCs 2021 and the NAP 2023 partially covering them.

Driven by human activities, forest cover relative to total land area declined from 63.3% in 2000 to 60.3% in 2020, while the red list index (indicates extinction risk of biological species) remained stable around 0.9 between 2000 – 2024 (UNSDG 2024). To protect the biodiversity-rich forests, Zambia established 480 forest reserves with an estimated combined total area of 74,361 km^2 and 20 national parks covering 63,630 km2 (Government of the Republic of Zambia 2014).

2.1.1.2 Food systems and food security

Food security in Zambia has improved and the proportion of population suffering from hunger decreased from 50.1% in 2001 to 35.4% in 2022 (UNSDG 2024), there is little climate-related knowledge in this context, particularly studies assessing future risks for food systems are scant.

The literature addressing observed impacts of climate change on Zambian food systems reports on farmer perceptions and statistical analyses. Zambian farmer perception of climate variability points towards negative impacts on the food systems and food security (Mubaya *et al.* 2012). Specifically, the increasing frequency, intensity and duration of erratic rainfall poses a challenge for the Zambian agriculture sector. Matchaya *et al.* (2022) conduct a regression analysis of Zambia's crop estimates and rainfall, confirming that dry spells, excessive floods, incidence of water logging are all detrimental to crop productivity.

2.1.1.3 Water systems and water security

Water availability and drought are a major concern in Zambia (Marcantonio 2020). While the availability of potable water for the population increased from 47.0% in 2000 to 68.2% in 2022 (UNSDG 2024), climate impacts and risks on water systems in Zambia grow.

In terms of observed impacts, Zambia experiences water shortages and drought, particularly during the dry season (September-October). These shortages can be partially attributed to climate change. For example, in the Rufunsa District (North East of Lusaka) Kanema and Gumindoga (2022) analyzed the impacts of climate change under Representative Concentration Pathways (RCP) 4.5 and 8.5 on groundwater availability using general circulation models and find decreasing precipitation in the district. Local populations also perceive droughts to intensify. In fact, the 2019 drought in the Zambezi River Basin can be seen as the worst in several decades (Hulsman *et al.* 2021). Further water resource protection is necessary to ensure freshwater availability and to protect the biodiversity associated with freshwater systems (Lehner *et al.* 2021, Rivers-Moore *et al.* 2021).

In terms of projected risks, Mwela *et al.* (2024) evaluate catchment water resources in the Luwombwa sub-catchment in Zambia through statistical analysis of water demand and allocation scenario modelling and find a projected 20% decrease of water availability under an high-end climate scenario (4°C by 2100) and an overall downward trend of water availability in Zambia driven by climate change rather than land use changes. This decrease of water availability is closely connected with changing rainfall patterns. Chisanga *et al.* (2023) conduct a trend analysis of rainfall patterns from 1981 to 2022 and find overall negative decadal rainfall trends in the agro-ecological regions in Zambia. The Lusaka region can also expect more erratic rainfall patterns, i.e., more rain during the rainy season and less rain outside of the rainy season (Iradukunda *et al.* 2023).

2.1.1.4 Health and well-being

Initiatives like the "One Health" approach touch upon climate-related health risks (Munyeme *et al.* 2024) but scientific literature and assessments addressing climate and health remain unavailable to us. In fact, the report finds no specific literature addressing climate risks or impacts on health and well-being in Zambia. Nevertheless, national health indicators show that overall population health and well-being have improved over the last years (UNSDG 2024).

The number of vulnerable households without access to basic services like water and sanitation in Lusaka City has continued to increase thereby exacerbating the possibility of waterborne diseases aggravated by drought and flooding (Lusaka (Zambia) and Environmental Council of Zambia 2008). The intermittent availability of municipal water has led to use of water from other sources including unsafe boreholes and shallow wells. In addition, insufficient drainage in the city increases the risk of disease incidence (ibid.).

2.1.1.5 Migration and displacement

Climate migration and displacement receive a surging amount of attention in the scientific literature focusing on climate impacts and risks in Africa. Various studies estimate future climate mobility in Africa, but numbers vary drastically and often remain guesswork (Gemenne 2011). Here, the report focusses on country-specific studies that have a higher informative value but are less abundant.

There are no official records on climate or environmental migration in Zambia. While the International Organization for Migration (IOM) reports on the number of people affected by extreme events and disasters that can drive environmental migration and particularly internal displacement, it also does not report on actual climate or environmental migration in Zambia (IOM 2019). Filling this gap, Mueller *et al.* (2020) use census data over a 22-year period and a fixed-effects regression model to estimate climatic effects on migration in Zambia, Botswana and Kenya. The study demonstrates that climate anomalies affect mobility in Zambia, e.g., increases in precipitation patterns also lead to increases in migration (more rain can be favorable for agricultural production and hence job creation) which is different to Kenya and Botswana where increases in precipitation reduce migration (ibid). Interestingly, internal migration - specifically towards urban areas - in Kenya and Botswana increases with decreasing rainfall as people living in rural settings internally migrate to cities to find work. This is different in Zambia where precipitation shortfalls are associated with less migration to cities. Hence, not supporting claims that climate change is widely contributing to urbanization across Africa (Mueller *et al.* 2020).

Other studies have found evidence of climate-induced population trapping in Zambia which refers to populations who want to move but cannot do so despite growing risks from climate change (Nawrotzki and DeWaard 2018). Particularly, low-income districts in Zambia are associated with this climate-related immobility, highlighting the need for in-situ adaptation support.

Studies addressing displacement, e.g., following extreme weather events in Zambia are rare. Solely Simatele and Simatele (2015) used field observations to understand how extreme weather events trigger displacement in rural Zambia and find that some Tonga speaking communities report displacement after droughts and floods, e.g., from Kalomo, Choma, Monze and Sinazongwe Districts in the Southern Province to Mukonchi and Lunchu Settlements in the Central Province.

2.1.1.6 Human vulnerability

Social inequalities produce significantly different levels of vulnerability to climate change in Zambia. In general, living conditions and, thus, human vulnerability in Zambia have improved over the last two decades, with the proportion of the urban population living in informal settlements decreasing from 63.8% in 2000 to 48.3% in 2022 (UNSDG 2024). However, inequalities – particularly income inequality across a rural-urban divide – have grown (UN 2015). This divide materializes in the urban population being mostly associated in the "formal" sector and the rural population in the "informal" sector of the Zambian economy with the latter accommodating relatively more vulnerable groups. Hence, poverty and vulnerability are more evident in rural areas (ibid).

Cities in Zambia have seen rapid urbanization accompanied by negative consequences for human vulnerability against climate change impacts, particularly for low-income households. For example, the air quality in urban areas in Zambia has decreased significantly. In 2019, the annual population-weighted average mean concentration of fine suspended particles exceeded the maximum level for safety set by WHO by 94% (UNSDG 2024). While clean air is critical for human health, climate change worsens harmful ground-level ozone which can further degrade air quality in Zambia. Moreover, the increasingly erratic rainfall, flooding and inadequate drainage systems have made it easier for cholera bacteria to contaminate water sources, thereby increasing the disease's transmission in vulnerable communities and, thus, posing a threat to public health (Gulumbe *et al.* 2024).

Focusing on rural areas, Makondo and Thomas (2024) conduct a quantitative poverty and vulnerability assessment in Zambia by constructing a vulnerability index in two agro-ecological zones and find high vulnerability indications in both zones with female and child-headed households as most vulnerable.

2.1.1.7 Cities, settlements and infrastructure

Informal settlements in Lusaka have a higher likelihood of being negatively affected by impacts of climate change as well as being increasingly exposed to climate risks, e.g., due to unclear land tenure (Ono and Muya 2024). Addressing these causes of vulnerability and increasing climate risks could be supported by transdisciplinary learning among local actors (McClure *et al.* 2023). We find no further literature addressing climate impacts and risks in cities, settlements, and infrastructure in Zambia.

2.1.1.8 Economic sectors

The Zambian economy is predominantly based on the extraction of natural resources, particularly through mining and forestry as well as on agriculture. However, climate impacts like rainfall variability and droughts already negatively affect the availability of electricity (decline of hydropower) and agricultural production (Worldbank 2024).

The agricultural sector is particularly at risk from climate change impacts, which is a major challenge for Zambia aiming to increase food security. The main crop season lasts from November to April and is highly dependent on rain. While early studies assessing the economic impacts of climate change on agriculture in Zambia remained largely inconclusive (Jain 2007), impact assessments have since progressed and demonstrate the vastly negative climate impacts on agriculture in Zambia.

Mulungu *et al.* (2021) use crop yield and weather data from 1981-2011 to assess the historical impacts of climate change on crop yields and global circulation models to project future risks and find a significant negative relationship between temperature increases and bean and maize yields. Looking at future climate risks using HadGEM-ES2 climate models, the authors project a 25% decrease for maize and 34% decrease for bean yields by 2050 driven by temperature increases that offset positive gains from rainfall increases (ibid). However, the climate impacts on agricultural production are crop and region-specific. Chilambwe *et al.* (2022) also simulate historical and future crop yields in Zambia and find the negative impacts on maize differ by region where projected mean yield changes of maize in the Eastern Province remain within the range of historical variability, indicating that maize in this region might be less impacted by climate change. Nevertheless, particularly small farms can reach autonomous on-farm adaptation limits, i.e., exchanging crops that are more resilient to climate impacts might not be enough to offset the negative yield effects of climate change (Wineman and Crawford 2017). This adaptation limit is predominantly caused by droughts (Ngoma *et al.* 2024).

A prominent tourist destination in Zambia are the Victoria Falls. Here, climate change may decrease the attractiveness for future tourists e.g., by threatening wildlife and causing more extreme weather events (Dube and Nhamo 2018).

2.1.2 NbS Responses

There is little scientific knowledge and evidence for NbS responses to the observed climate impacts and projected risks outlined above.

2.1.2.1 Urban NbS

The scientific knowledge reporting on the implementation of NbS in urban areas in Zambia is scant. This limited scholarly focus on urban NbS is not Zambia-specific but spans across Africa. For example, Okello *et al.* (2024)

conduct a systematic review of 143 NbS responses in the water sector in Africa's arid and semi-arid lands, including Zambia, and find only a single study in Zambia, showcasing the low level of research engagement. Particularly, urban NbS remain understudied. Out of 492 African case studies addressing water issues reviewed by Acreman *et al.* (2021), only 13 explicitly referred to NbS of which five were urban and eight were categorized as rural.

Adding to this limited knowledge base, the literature reports on specific challenges for implementing NbS like green infrastructures in informal settlements or community campaigns for sustainable development (Nyakalale and Madimutsa 2021). For example, Douglas (2018) discusses emerging challenges for using green infrastructure in urban informal settlements in Africa that are often situated in risk-prone areas and argues that, e.g., improving drainage with grey or green infrastructures there quickly becomes politically contested and socially resisted. Moreover, limited and decreasing water supply in urban areas can become a major limitation for implementing urban NbS, including Lusaka (Hambulo Ngoma *et al.* 2019) because the irrigation needs of newly planted green cover would compete with other water uses. Geological characteristics of Lusaka's dolomite formation, i.e., hard schist soils can further complicate the potential implementation of nature-based drainage systems like sponge city concepts (Singh *et al.* 2018). Nevertheless, the public Lusaka Water Supply and Sanitation Company, identified green-blue infrastructures and NbS as prospective means to reduce flooding in the city, e.g., using tree trenches, bioswales and rain gardens as potential measures (Lusaka Water Supply and Sanitation Company 2023).

On a positive note, Banda *et al.* (2023) identified tree species that are best suited for urban greening based on their carbon sequestration rates and ability to combat air pollution in Kitwe, Zambia and find multiple suitable species (Bauhinia variegata, Toona ciliate, Gmelina arborea, Eucalyptus grandis, and Delonix regia).

2.1.2.2 Forests

Forest cover in Zambia decreases, predominantly driven by human activities, e.g., agricultural expansion (see 4.1.1) and weak policy implementation (Kalaba 2016). To understand whether NbS responses using forests are feasible, Richardson *et al.* (2021) conduct a system dynamics modelling exercise to assess whether a sustainable intensification of agriculture would be possible while conserving forests. The authors find the rising demand for wood fuels for cooking and heating, particularly charcoal in urban areas, will likely continue to cause deforestation and conclude that changes towards more sustainable intensification of agricultural practices are unlikely to conserve forest areas (ibid). This finding challenges afforestation as a NbS response and unearths a self-enforcing dynamic relating to deforestation and climate change impacts (Frietsch *et al.* 2023). In fact, Kalaba *et al.* (2013) find that rural households rely on the ecosystem services provided by forest, particularly after extreme weather events, however, in order to cope with the impacts of extreme weather, charcoal production and sale are the most widely used strategies, leading to further deforestation.

2.1.2.3 Wetlands

Zambia has eight Ramsar sites, i.e., protected wetlands with a combined total area of 40.305 km^2 (Government of the Republic of Zambia 2014). These sites and other areas like river floodplains provide many ecosystem services and economic value for the inhabitants, including water supply to urban centers like the Kafue River for Lusaka. However, wetlands (like forests) face increasing degradation. For example, over 24% of the Barotse Flood Plain area in Western Zambia experienced land use changes from 1980 – 2020, driven by climate variability (48,5%) and human activities (51,5%) (Banda *et al.* 2023)

2.1.2.4 Policy and regulations

There is a growing national policy mix addressing NbS. Particularly, five core policies offer potential for advancing the implementation of NbS. These policies are (i) the Eight National Development Plan (8NDP)[2], (ii) the Second National Biodiversity Strategy and Action Plan (NBSAP - 2)-2015-2025 (iii) the National Green Growth Strategy 2024-2030 (iv) the National Adaptation Plan (NAP) 2023 and (v) the Nationally Determined Contributions (NDC) 2021.

The 8NDP addresses "Environmental Sustainability" as a strategic development area for the first time in the history of Zambian national development plans (Zulu and Simenti-Phiri 2022). Within this strategic development area, "Strategy 1: Strengthen climate change adaptation" NbS are listed as one out of seven Programs. According to the plan, the Zambian government will promote NbS in communities to enhance climate change adaptation with activities like water harvesting, integrated water resources management and climate smart agriculture.

2 Eight National Development Plan 2022-2026

Zambia's NBSAP-2 lists relevant policies and regulations that are potentially supportive of NbS (see p. 6 Table 2)[3]. The NBSAP-2 explicitly lists "nature-based tourism development" as a key area of interest but makes no further direct mention of NbS. A detailed analysis of the remaining policies listed in the NBSAP is out of scope of this study here.

The National Green Growth Strategy 2024-2030 states the need for including NbS in infrastructure development, circular economy and emphasizes strengthening water management with nature-based approaches in watershed and water catchment areas[4]. Zambia also joined the Great Green Wall Initiative and developed a national action plan to combat desertification by restoring and afforesting forest areas.

The NAP[5] details adaptation actions to droughts, floods, heat and storms and outlines central areas for implementing NbS. However, while the NAP does not use the term NbS, it directly refers to ecosystem-based adaptation for guiding adaptation actions (see e.g., p. 55 and p. 59).

The NDCs outline ambitious targets for NbS, including green infrastructures to address deforestation, biodiversity loss and water management (see 3.1.1 and 3.1.2).

We find a small body of scientific literature studying NbS-related policy and regulations, suggesting that NbS have not yet entered planning stages in Zambia. In contrast, climate change policies and particularly climate change adaptation policies have found some attention which can also help to inform future NbS policy. Mainstreaming climate considerations into existing Zambian policy has been slow (Pilli-Sihvola and Väätäinen-Chimpuku 2016, Vincent and Colenbrander 2018). Moreover, progress to harmonize legislation and policy frameworks that relate to climate change adaptation, mitigation, disaster risk reduction and municipal integrated development plans has been criticized as slow (Banda *et al.* 2022). The resulting regulatory void is sometimes filled by 'interface bureaucrats' who play a key role shaping the implementation of policy and filling the regulatory void on the ground (Funder and Mweemba 2019). Similarly, while the environment protection legislation for infrastructure projects is deemed adequate, it is sometimes disregarded during the actual implementation of projects causing negative environmental effects (Zulu *et al.* 2022).

2.1.2.5 Ecosystem-based adaptation

Reports or literature on ecosystem-based adaptation responses to climate change in Zambia are largely absent. However, pilots ecosystem-based adaptation strategies and measures are being implemented adjacent to the Bangweulu and Lukanga wetlands (two Ramsar sites) by the Ministry of Green Economy and Environment in collaboration with local district administrations and local communities, under a GEF funded and United Nations Environment Program (UNEP) implemented project (UNEP 2021).

2.1.2.6 Agro-ecological farming

The body of literature addressing agro-ecological farming or related topics in Zambia is substantial. Given the climate impacts on the agricultural sector described above, research in the areas of conservation agriculture (focus on soil health and sustainable practices), climate smart agriculture (focus on climate resilience and emissions reduction), crops and water use has developed a robust knowledge base.

Conservation agriculture can address declining soil fertility driven by expansive agricultural practices and climate change impacts (Thierfelder *et al.* 2013). Particularly smallholder farms can benefit from conservation agricultural practices, e.g., changing seeding and mulching practices (Somanje *et al.* 2017, Omulo *et al.* 2024). However, the adoption of conservation agriculture in Zambia is limited but could potentially be sped up by introducing crop yield insurances to address the risk aversion of smallholder farms to change their practices (Simutowe *et al.* 2024).

Climate smart agricultural practices address the increasing stress on agricultural production, stemming from climate change impacts (Ngoma *et al.* 2021). This includes NbS. For example, the cultivation of drought-adapted succulent plants can serve as a NbS in sub-Saharan Africa (Buckland *et al.* 2023). Using succulent plants instead of traditional crops could (i) reduce land degradation, (ii) increase agricultural diversification and provide both economic and environmentally sustainable income through derived bioproducts and bioenergy,

3 CBD Strategy and Action Plan
4 National Green Growth Strategy 2024-2030
5 National Adaptation Plan 2023

(iii) help mitigate atmospheric CO2 emissions and (iv) increase soil sequestration of CO2 (ibid). Concretely, Buckland *et al.* (2023) find that the prickly pear cactus (ficus-indica) and the milk bush (euphorbia tirucalli) are suitable to grow in Zambia under Share Socioeconomic Pathways (SSP) SSP1 2.6, SSP2 4.5, SSP3 7.0 and SSP5 8.5 for 2081–2100. Such crops can be used as alternatives for livestock fodder, for bioenergy production and as alternative food sources. Particularly, Zambia is coined as a 'hotspot of opportunity' for succulent cultivation (ibid).

International organizations like the Food and Agriculture Organization (FAO) conduct capacity building activities directly with Zambian farmers to promote climate smart agricultural practices and NbS. For example, over 250 farmer field schools were established to train Zambian farmers in climate smart agricultural practices, boosting yields and incomes while helping conserve forests (World Bank 2021). These capacity building activities also extend to efficient water use in the Zambian agriculture sector, e.g., enhancing the efficiency of water usage in paddy fields for rice production (FAO 2022).

2.1.3 NbS funding and finance

There are two studies addressing NbS funding and finance in Zambia and no official numbers for cash flows into relevant areas like conservation, restoration, or climate change adaptation. Nevertheless, some estimates of natural assets exist. Estimated revenues from fisheries amount to $51-$135 million between 2002-2007, $396m/year from wood production and $17 billion/year by 2017 from mineral resources (Mwitwa *et al.* 2018). Furthermore, annual estimated values of GHG sequestration range from $16-30 per ha per year and the value of forest pollination services was estimated to be in the order of $74 million per annum (ibid). Revenue streams in the biodiversity sector are based on penalties, licensing, environmental impact assessments, fees, and charges (ibid). It is unknown whether efforts are underway to improve data collection on NbS finance in general.

In general, the largest proportion of climate finance flows in Zambia are from public financing sources accounting for 92 %, with private sector flows accounting for 8 % (AFDB 2023). This is expected to increase drastically in the coming years, given the Climate Investment Fund (CIF) recently endorsed over $34 Million for NbS in Zambia as part of their nature, people and climate investment plan for Africa's Zambezi river basin region (Climate Investment Fund 2024). Other sources of funding relate to 'corporate social responsibility', which, e.g., finance the Zambezi River Source Restoration Project.

Valuation of ecosystem services to support the uptake of NbS are unavailable. This posits a key barrier to attracting private investments for NbS. Addressing this barrier, Vorlaufer *et al.* (2017) conduct a discrete choice experiment to elicit preferences of smallholder farms for ecosystem service payments which aim to reduce deforestation and find in-kind agricultural inputs to be valued higher than direct cash payments. In other words, smallholder farms who intend to clear forests for agriculture could receive in-kind payments like seeds, goods, or training rather than cash for the amount of ecosystem services they would conserve. This is an important insight for the development of future NbS business models. Financial instruments for environmental protection in the mining sectors offer further valuable insights for NbS funding and finance. Wambwa *et al.* (2024) compare financial assurance instruments with the objective to promote responsible mining in Zambia and South Africa (e.g. sustainable closing of mines) and find that payments into the Environment Protection Fund are effective to incentivize sustainable mining practices but face technical challenges as commercial banks are often unwilling to guarantee such payments. As guarantees are an important finance mechanism, this points towards potential difficulties for attracting NbS finance.

2.2 Synthesis

2.2.1 Observed impacts and projected risks

The body of literature addressing observed impacts and projected risks in Zambia, as reviewed in this technical report, is rather fragmented, making it difficult to infer concrete implications for NbS. Table 1 condenses key results per impact and risk categories for Zambia. It is important to note that these results are based on the available scientific literature, which may contain gaps.

Impact and risk categories	Synthesis
Ecosystems and biodiversity	Impacted from deforestation and agricultural expansion. Limited knowledge on projected risks.
Food systems and food security	Negative impacts from erratic rainfall and resulting drought.
Water systems and water security	Drought and declining rainfall observed and decreasing groundwater availability projected.
Sea-level rise	-
Health and well-being	Little climate change related knowledge. Air quality in urban areas worsens aggravated by climate changes.
Migration and displacement	Impacted from rainfall variability. No environmental displacement data.
Human vulnerability	Rural areas relatively more vulnerable than urban areas. No projections.
Cities, settlements and infrastructure	Informal settlements with higher exposure to climate impacts. Unclear land tenure exacerbates risks.
Economic sectors	Agriculture faces main impacts and risks.

Table 1 Synthesis and comparison of observed impacts and projected risks in Zambia

Generally, in Zambia, *food systems and food security* in combination with the agriculture sector and water systems appear as key impact and risk areas. While the literature reports relatively more climate impacts in these areas, they require attention in any case given the current development pathway Zambia is on. The situation in Zambian urban areas is different. There, flooding and drought are central risk areas although they remain understudied. Particularly, water management is a major concern for Lusaka.

These identified impact and risk areas offer a first step towards understanding where NbS can prioritize support for mitigation and adaptation efforts. Particularly, water management in the contexts of flood/drought in Lusaka appear as most pressing climate impacts NbS could address.

2.2.2 NbS responses, funding and finance

The body of literature addressing NbS responses and finance in Zambia reviewed in this technical report is small, making it difficult to evaluate existing experiences with NbS. Nevertheless, table 2 condenses key results per NbS response.

NbS responses	Synthesis
In forests	Implementation of forest reserves and national parks. Challenged by demand for charcoal (mostly in rural areas).
In peatlands	Eight Ramsar sites protect wetlands and peatlands. But climate variability and human activity drive land use change.
Blue carbon	-
In urban areas	No explicit NbS responses.
Policy and regulations	8NDP mentions NbS. But no comprehensive integration and mainstreaming of NbS into policy and regulations.
Ecosystem-based adaptation	Wetland restoration pilots in Bangweulu and Lukanga wetlands (two Ramsar sites).
Agro-ecological farming	Pilot projects building capacity in climate smart agriculture (e.g., field schools by FAO).
Finance	No official data on finance and funding flows for NbS. Some ecosystem service evaluations (e.g., fisheries, forests, and pollination) and financial mechanisms for biodiversity conservation (e.g., penalties, licensing, and fees).

Table 2 Synthesis of NbS responses and finance in Zambia.

The review of the scientific literature demonstrates that NbS implementation is still in its infancy and knowledge gaps loom large. Particularly, urban NbS experiences are largely missing – at least in the literature. Nevertheless, we identified key NbS experiences that illustrate the first steps taken.

The ecosystem-based adaptation projects in Lukanga and Bangweulu wetlands (both Ramsar sites) serve as great examples for NbS because they aim to improve biodiversity, livelihoods and reduce climate impacts. The few pilot projects for climate smart agriculture reflect the overall focus on agriculture in Zambia but also match the impact and risk profile of Zambia we identified above with key climate impacts and risks projected in the food system category.

Generally, the limited NbS experience is not surprising given the development priorities in Zambia. Nevertheless, it also becomes clear that the role of global climate funds and other international mechanisms that could support NbS in both countries are quite important against the backdrop of limited NbS finance available. This is also true for private sector engagement and attraction of private investments for NbS, especially considering ecosystem service valuations and financing mechanisms like user fees or green bonds. For this, connecting financial mechanisms that incentivize the use of NbS with national policies should become a priority to create an enabling environment for NbS.

2.2.3 Potential for urban NbS

Based on the synthesis above, we identified potential implementation cases for urban NbS in Lusaka. Table 3 provides an overview of the main climate impact/risk categories and NbS experiences as well as potential NbS and respective barriers as identified from the literature.

Main climate impact/risk categories in urban areas	Urban NbS experiences	Potential for urban NbS	Potential barriers
Flooding and drought	None published	Increase green cover (parks), urban gardening, sponge city measures	Water availability for irrigation, lithography

Table 3 Key results and recommendations for potential urban NbS and barriers in Zambia

Drought and flooding negatively impact urban areas in Zambia, particularly in Lusaka. However currently, focus lies on responding to climate impacts in the agricultural sector and therefore in rural areas in Zambia. So far, no urban NbS (that we know of) have been implemented to address these impacts. This is a shortcoming because the following NbS can address both the urban climate impacts and risks while simultaneously offering co-benefits to address the general climate impacts, e.g., on food security.

The first potential urban NbS is increasing urban green cover. This can entail tree planting (paying close attention to suitable tree species), creation of park areas or other green areas that also help to increase air quality and relieve the load on existing flood management infrastructure by providing permeable surfaces. The second potential urban NbS is the development of urban gardens that also contribute to improving air quality, can enhance local biodiversity but also provide an additional source of food. The third potential for urban NbS is exploring sponge city measures to address both the increasing drought and flood problems.

Box 2 The Sponge City concept

The sponge city concept is an urban development approach that integrates water management with sustainable urban planning by mimicking natural hydrological processes (Chan *et al.* 2018). The goal is to reduce flood risk in cities and reduce urban heat islands, while promoting biodiversity and liveability. For example, sponge city measures entail combinations of permeable pavements, tree planting, infiltration measures, rainwater harvesting, creation of natural retention basins, riparian vegetation among further measures.

All these three potential NbS offer vast potential for sustainable development in Lusaka. However, they may also face some trade-offs that are already prevalent (International Resource Panel 2021). Any NbS that require irrigation are in competition for scarce water resources. Hence, potential pilot sites for these NbS require a relative abundance of water resources in Lusaka. Moreover, the hard soils in some of the dolomite formation in Lusaka could hamper the implementation of sponge city measures.

Recent policy developments could serve as leverage points for advancing the implementation of NbS in Zambia. The 8NDP by the Ministry of Finance and National Planning contains the strategic development area 3 "Environmental sustainability". There, NbS are listed as "will be promoted" among communities to enhance climate change adaptation like water harvesting, integrated water resources management and climate smart agriculture. Moreover, the 8NDP has a dedicated programme on NbS under the strategic development area 3. An additional potential leverage point is the National green growth strategy 2024-2030 by the Ministry of Green Economy and Environment. This strategy aims to strengthen NbS in watershed/water catchment areas under strategy's pillar 3 "natural capital". Engaging with these stakeholders to leverage these strategic considerations of the Zambian government can support the implementation of NbS.

3 MAURITIUS


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Box 3 Country context Mauritius

The Republic of Mauritius is a SIDS which includes Mauritius, Rodrigues, Agalega, Tromelin, Cargados Carajos and the Chagos Archipelago, including Diego Garcia. Mauritius became an upper middle-income country in 2020 and is located in the Southwest Indian Ocean (SWIO) with a population of about 1.3 million people. The main economic sectors are financial services, manufacturing, wholesale and retail trade and tourism. Given the small island geography, Mauritius is highly vulnerable to the impacts of sea-level rise and cyclones. (Worldbank 2024). The capital Port Louis has 106.332 inhabitants (Statistics Mauritius 2023).

3.1 Results

There is a substantial body of literature (n=60), addressing observed impacts, projected risks and NbS responses in Mauritius. However, while there has been a steady growth in scholarly attention for climate change related questions in Mauritius, knowledge gaps relating to (i) health and well-being, (ii) migration and displacement (iii) human vulnerability and particularly (iv) NbS remain. In contrast, risks from sea-level rise and the coastal environment, are well studied.

3.1.1 Observed impacts and projected risks

3.1.1.1 Ecosystems and biodiversity

Like in most other small island regions, ecosystems in Mauritius face several challenges resulting from human activities and climate change impacts (Lalljee *et al.* 2018). Improving land use governance is often seen as an effective leverage point to protect ecosystems and enhance biodiversity. While ecosystem degradation persists in Mauritius e.g., due to deforestation, Koenig and Deenapanray (2024) analyzed the environmental governance system using a qualitative approach and find that weak commons structures enable land use changes at loss of natural ecosystems and suggest natural capital accounting to improve land use governance. Nevertheless, there are currently 14.915 hectares of terrestrial protected areas (7,3% of total land area) and 13.953 hectares of marine protected areas in Mauritius (Statistics Mauritius 2023).

Coral reefs are integral parts of the ecosystems in small island regions, are rich in marine biodiversity (McClanahan *et al.* 2021a) and serve as coastal protection by reducing the energy of incoming waves. However, corals in Mauritius face increasingly hostile conditions due to oceanic temperature rise and acidification (Jogee *et al.* 2024), resulting in coral die-off and bleaching events (McClanahan *et al.* 2005, McClanahan and Muthiga 2021). For example, sea surface temperature rose by 0,66°C from 2003–2020 as compared to 1985–2003 period in Mauritius, which is 0.16 °C higher than the global average (Doorga *et al.* 2023). To put this into context, sustained exposure to sea temperatures 1°C above the respective coral species maximum can lead to coral bleaching and eventually die-off.

3.1.1.2 Food systems and food security

The area for production of food crops increased from 7.865 hectares in 2022 to 9.222 hectares in 2023 (Statistics Mauritius 2023). Overall, the literature projects increasing climate risks for food production in Mauritius, which is particularly detrimental in small island regions that already often rely on food imports. Using an equilibrium displacement model, Brizmohun (2019) assesses the effect of an 35% price increase of rice as anticipated with climate change on Mauritian government spending and finds that the government would be faced with an needed increase of 29% in food subsidies to maintain food security.

A further study using cross-sectional farm data estimates the economic impacts of a rise in mean temperature by 1 °C to be associated with a reduction in output value of USD 26.6 per acre per year in Mauritius (Sultan 2021). Going beyond rice, Ramlall (2014) analyses climate change impacts on different food crops, ranging from bananas, beans, brinjals, cabbages, chilies, creepers, groundnuts, mixed vegetables, pineapples to tomatoes and finds that particularly tropical cyclones negatively impact the production e.g. of tomatoes and chilies but also finds increased temperatures and humidity can positively impact yields of bananas and pineapples.

Fisheries is another important source of food security for communities in small island regions. However, fishers in Mauritius report the abundance of fish changed over the last two decades, driven by environmental challenges, e.g., the degradation of reefs. Fishers observed the frequency of torrential rain increased relative to 15 years ago, fish abundance is lower in winter and the diversity of fish species decreased (Appadoo *et al.* 2023). McClanahan (2021b) confirm the possible extinction of the Mauritian and Creole damselfishes by sampling and evaluating the populations of reef fish and corals in 119 reef sites around Mauritius. Additionally, the outlook for fisheries in Mauritius can be considered as highly vulnerable to climate change impacts. In a study across 31 small island nations, Teneva *et al.* (2023) combine projections of seafood demand and local catch under different climate change scenarios and find deficits in locally caught seafood and respective demand by 2050 in Mauritius.

3.1.1.3 Water systems and water security

In 2023, Mauritius received 4.742 million cubic meters of rainfall, 15,5% higher compared to 4.105 million cubic meters in 2022 (Statistics Mauritius 2023). Looking at a longer period, Doorga and Rovisham Singh (2022) conduct a geospatial analysis of precipitation patterns and temperature changes on Mauritius and find increasing rainfalls trends of 2.29 mm/year and above global average warming of 0.0216 °C/year over the 50-year period from 1971 to 2020. This increased rainfall can have negative impacts on water quality.

The availability of potable water is a major concern for small island regions, directly affecting the habitability of island communities, particularly those living on atoll islands (Storlazzi *et al.* 2018). But also, island communities living on volcanic islands like in Mauritius face decreasing freshwater availability. This is demonstrated by Boojhawon and Surroop (2021) who analyzed future freshwater availability in Mauritius constructing a freshwater vulnerability index which indicates a shift from moderate vulnerability from 2000-2015 to high vulnerability under their climate scenario for 2020-2050. Gungoa and Kebede (2024) confirm these negative impacts by analyzing the impacts of extreme flood events on physical and chemical water quality indicators of the five main aquifers in Mauritius over eleven years and find decreasing groundwater quality after a cyclone in terms of salinity and nitrate in the water.

Technological innovations in the Mauritian water sector are scarce but offer means to improve water securities, e.g., smart water applications (Sunkur *et al.* 2021).

3.1.1.4 Risks from sea-level rise

The coastline of Mauritius has a length of 322 km and consists mostly of sandy beaches bordered by fringing and barrier reefs (Cazes-Duvat and Paskoff 2004). Figure 1 shows local projected sea-level rise (SLR) in Port Louis for three different scenarios. The projections range from 0,42m (SSP1-2.6) to 0,72m (SSP5-8.5) and 0,86m (SSP5-8.5 low confidence) in 2100 (IPCC 2023b). The low confidence scenario indicates the potential effect of low-likelihood, high-impact ice sheet processes.

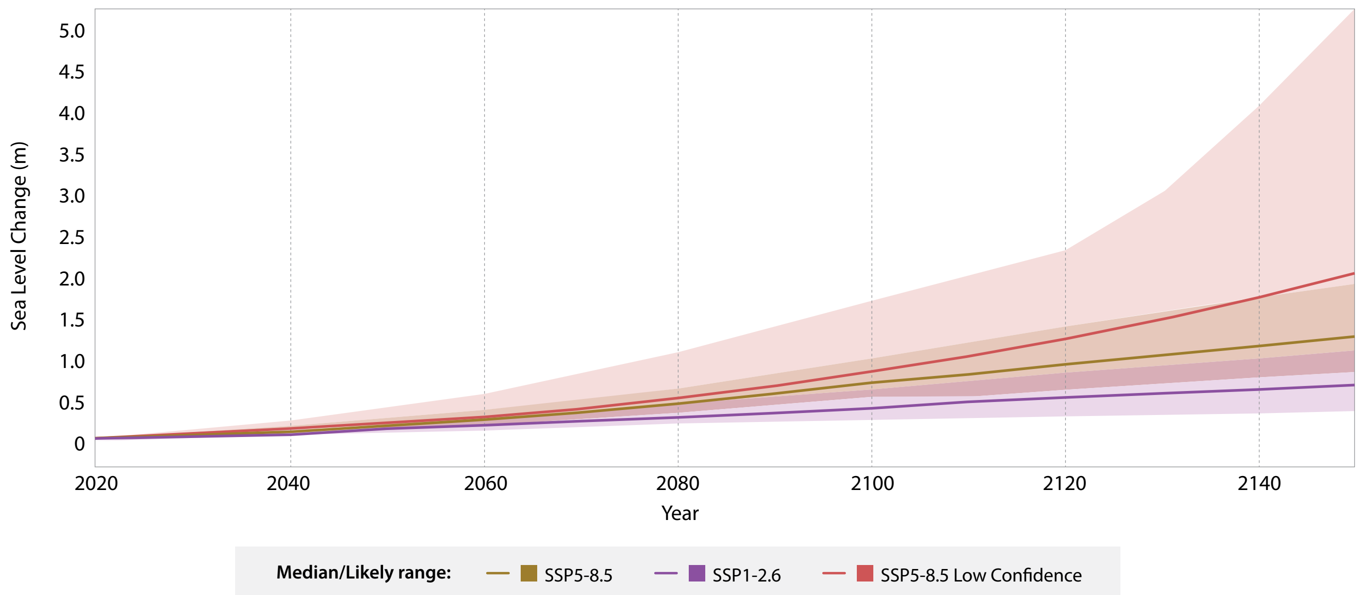

Figure 1 Projected Sea Level Rise in Port Louis. Shaded ranges show the 17th-83rd percentile ranges. Projections are relative to a 1995-2014 baseline.

Source: Sea Level Projection Tool – NASA Sea Level Change Portal

Impacts from SLR like the increasing frequency and intensity of coastal flooding, erosion and salinization of groundwater pose a growing challenge to Mauritian policy and communities who already adapt to SLR (Duvat *et al.* 2020). For example, in the village of Flic en Flac a hotel was moved inland by 30m due to erosion of the beach (Duvat *et al.* 2020). In fact, beach erosion is a central coastal risk. Onaka *et al.* (2015) find that 23% of Mauritian beaches experience erosion, while 22 sites (3,400 people and 1,100 buildings) were affected by storm-induced flooding. Well-known examples of cases where measures were implemented to combat erosion are Trou Aux Biches and Mont Choisy Beach (Bheeroo *et al.* 2016). Ongoing work by the Bureau de Recherches Géologiques et Minières (BRGM) currently assesses projected submersion and erosion risks for Mauritius in 2050 and 2100, adding important knowledge for coastal adaptation planning.

Governing adaptation to sea-level rise in small islands regions is complex because coastal risks are driven by both sea-level rise and anthropogenic drivers like poor development planning and lack of coordination between public and private actors. Anisimov *et al.* (2020) confirm this governance challenge for Mauritius by reviewing pilot coastal adaptation projects implemented by the national government and find that the effectiveness of the adaptation measures could be further improved by strengthening the role of evidence and risk assessments. More recently, international cooperation supported the mainstreaming of biodiversity into coastal management (UNDP 2022).

3.1.1.5 Health and well-being

The health impacts of climate change in Mauritius have found relatively little attention in the scientific literature. There is one dated study that analyzed potential human health consequences of climate change in Mauritius using participatory methods which finds limited capacities to conduct vulnerability assessments and recommends improving this capacity, e.g., with capacity building measures, additional research and community awareness raising (Ebi *et al.* 2006).

The grey literature tries to fill this knowledge gap. For example, the World Health Organization (WHO) Special Initiative on Climate Change and Health in SIDS publishes country profiles on health and climate change, including Mauritius. The country profiles provide a summary of available evidence on climate hazards, health vulnerabilities, health impacts and progress to date in the Mauritian health sector's efforts to realize a climate-resilient health system and makes the key recommendation to develop a national health and climate change plan (WHO 2021).

3.1.1.6 Migration and displacement

Climate migration in Mauritius is barely studied, indicating a lack thereof. Gemenne and Magnan (2010) conducted a detailed assessment in multiple sites in Mauritius and find mostly internal migration with environmental stressors not being dominant drivers of these migratory flows. While later studies found examples of disaster-related displacements in Mauritius, still little quantitative data exists on migration flows and displacement (Sultan 2017). Nevertheless, a global assessment of coastal migration projects that 3.300 to 34.000 people in Mauritius could face autonomous migration (not government-led) until 2100, depending on SLR scenarios, because they would live on land that lies below the 1-in-1 year flood return level (i.e. annually flooded) (Lincke and Hinkel 2021).

3.1.1.7 Human vulnerability

Mauritius faces impacts and increasing risks from climate change, including tropical cyclones, floods, droughts and sea-level rise that also drive human vulnerability (Doorga 2022). In fact, Mauritius experienced 22 extreme weather events between 1960- 2022, each causing socio-economic damage costing USD 160-245 million on average (1.5-2.3% of GDP)(International Monetary Fund. African Dept. 2022).

Mauritius faces increasing flood impacts in urban and peri-urban areas, aggravated by inequality driven vulnerability. For example, Chacowry *et al.* (2018) used a mixed method approach to study the recovery and resilience of a flood-prone community living in a peri-urban area of Port-Louis from 2008 to 2014 and find that social inequity and environmental injustice hindered recovery among low-income households after extreme flood events in the city.

As a side note, limited data availability has obstructed studying human vulnerability to climate change. Usefully, Tang *et al.* (2023) developed a high-resolution climate dataset with long temporal coverage that can help to identify past climate change and its impacts in Mauritius to support the development of adaptation and NbS strategies[6].

6 A digital elevation model of Mauritius with a resolution of 10 m is available at the Ministry of Housing and Lands (Sadien *et al.* 2024). Further climate info and data can be requested at the Mauritian Met office Climate Information and Data of Mauritius. A land cover map is published by Koenig *et al.* (2024).

3.1.1.8 Cities, settlements and infrastructure

Cities, settlements and infrastructures in small island developing states (SIDS) in the southwest Indian Ocean (SWIO) basin, including Mauritius, are particularly vulnerable to climate impacts and already face significant challenges due to climate variability and extreme weather events like tropical cyclones (Leroux *et al.* 2024). For example, cyclone Belal crossed Mauritius in January 2024 and damaged infrastructure and settlements, underscoring the need for identifying floodplains and flood-prone areas. Addressing this need, Sadien *et al.* (2024) conducted a long-term flood risk assessment with a GIS-based flood model for Mauritius to simulate inundation areas and quantify the assets exposed to flooding and find the 50-year flood event to inundate 6.2% of the land area in Mauritius. Further maps of flood prone areas are available from the Land Drainage Authority of Mauritius.

Next to coastal flooding, Mauritian cities and infrastructures face increasing frequencies and intensities of pluvial flooding from torrential rainfalls. This increase is further complicated by the topography of the island and most infrastructure being situated on the flat plain where rainwater run-off accumulates from the higher elevated regions (Nowbuth *et al.* 2024).

3.1.1.9 Economic sectors

Increasing climate change risks also affect tourism activities in Mauritius. This is problematic because tourism is a key economic sector and particularly extreme flood events, erosion and environmental degradation in coastal areas put income from tourism at risk. In Mauritius, stakeholders confirm this as they consider the risks posed by climate change as potentially catastrophic for the tourism sector (Dhoomun *et al.* 2022). Moreover, Mauritian legal and policy frameworks in the tourism sector have been criticized for not yet integrating climate change risks (Mahadew and Appadoo 2019). Addressing this criticism, activities to increase the long-term resilience of the tourism sector against the impacts of climate change are currently underway.

3.1.2 NbS responses

There is overall little scientific literature that reports on or analyses NbS responses to the observed impacts or projected risks of climate change.

3.1.2.1 Forests

Literature that provides evidence or analyzed the proactive use of forests as carbon sinks or towards another NbS goal in Mauritius is unavailable. Nevertheless, Mauritius did not exhibit significant variation in forest cover from 1992 to 2020, while over 77% of other African countries lost forest cover in this period (Nzabarinda *et al.* 2025). When looking at shorter and more recent periods, the total forest area decreased from 47.002 hectares in 2022 to 41,997 hectares in 2023 (Statistics Mauritius 2023). This decrease occurred in privately owned forest areas (47,6% of total forest area is privately owned). More than half of the state-owned forest area was afforested, showing that there is previous experience with afforestation (ibid). This is also reflected in the Forests and Reserves Act (1983) and the National Forest Policy (2006) with the latter emphasizing the role of forests in mitigating the effects of climate change and in carbon sequestration.

Importantly, the national Forestry Service promotes the establishment of urban and peri-urban forests with a first pilot peri-urban forest created at Grand River North West (GRNW) in 2017, which is located in the vicinity of Port Louis and along the GRNW river.

3.1.2.2 Peatlands

There is no literature on NbS responses involving peatlands.

3.1.2.3 Blue carbon

Mangroves are a key NbS for small island regions to adapt to SLR because they protect marine biodiversity, serve as carbon sinks, support livelihoods, and reduce disaster risks. For Mauritius, Sunkur *et al.* (2023) conducted a literature review and find that the two local mangrove species Rhizophora mucronata Lam. and Bruguiera gymnorrhiza (L.) Lam. offer advantageous characteristics for restoring degraded mangrove sites in Mauritius.

In a subsequent study, Sunkur *et al.* (2024) used remote sensing to examine the spatial variability of mangroves in Mauritius, particularly in Le Morne and Ferney, and found a notable increase in mangrove cover at both sites which they attribute to a nationwide mangrove afforestation program that started in 1995 and is still ongoing. Additionally, a UNDP funded project planted 20.000 mangroves in the region of Grand Sable[7].

Acceptance and direct involvement of local communities is key for successful NbS projects. Chacowry (2023) confirms this by studying two community-based measures in Le Morne and Ferney that included mangrove restoration. However, NbS responses including mangroves, corals

7 Climate change adaptation programme in the coastal zone in Mauritius

and seagrass meadows are under growing stress from marine litter which threaten the health of these important ecosystems (Rambojun *et al.* 2024).

Knowledge and concrete examples of coral restoration and gardening in Mauritius remain scarce. While some pilot studies using land-based and ocean-based coral nurseries have conducted successful coral gardening experiments (Pillay 2011) and species-analyses (Tiddy *et al.* 2021), questionnaires from Grand Baie, Albion, Flic en Flac, Belle-Mare and Blue Bay indicate that local populations are well aware of the coral health decline and are willing to engage in restoration activities (Nazurally 2013).

In its 2024-2028 country programme, UNDP aims to advance new innovative solutions to fund blue carbon ecosystems, including mangroves, salt marshes and seagrass beds in Mauritius (UNDP 2024a).

3.1.2.4 Urban NbS

There is no evidence or documentation of implemented urban NbS measures like green roofs or green facades, e.g., to reduce heat stress. However, different assessments of the effectiveness of such measures for Mauritius exist. For example, Kaudeer and Venkannah (2023) assess future heat stress in residential buildings in Mauritius across different climate scenarios and find that under RCP 8.5 discomfort levels in Port Louis can increase by 15%, rendering natural ventilation methods insufficient and showcasing the need for further cooling measures. In fact, Mungur *et al.* (2020) confirm the effectiveness of green roofs in the tropical environments of Mauritius to reduce the heat and enhance the thermal performance of buildings using on site measurements of weather data and indoor temperatures.

3.1.2.5 Policy and regulations

Different national policies address NbS. Particularly, five core policy documents offer potential for advancing the implementation of NbS. These policies[8] are (i) the National Climate Change Adaptation Policy Framework (NCCAPF) 2021 (ii) the Climate Change Act 2020 (iii) the Nationally Determined Contributions (NDC) 2021 (iv) the Environment Act 2024 and the National Biodiversity Strategy and Action Plan (NBSAP) 2017.

The NCCAPF puts a central focus on the potential of NbS for adaptation, as well as green job creation and emphasizes the key role of NbS and ecosystem-based adaptation approaches in all Mauritian adaptation and mitigation actions. For example, the sectoral strategy and action plan for climate change of the NCCAPF aims to mainstream climate change in the infrastructure and disaster risk reduction sectors by developing detailed technical guidelines for adaptation measures, focusing on NbS.

The Climate Change Act makes indirect references to NbS but establishes adaptation to climate change as, both, adjustments in natural and/or human systems. The NDCs (2021) also emphasize the potential of NbS for adaptation and meeting the nationally determined emission targets. The Environment Act offers potential for supporting NbS finance (see. 4.2.3). Lastly, the NBSAP makes provisions for the setting up of sustainable incentives for biodiversity conservation and restoration programs to reward pro-biodiversity actions, outcomes, and/or stewardship on restoration. For this, Mauritius aims to align the NBSAP with the Global Biodiversity Framework targets, of which target eight aims to minimize the impacts of climate change on biodiversity and build resilience, and target eleven aims to restore, maintain and enhance nature's contributions to people. This alignment would promote the adoption of NbS and/or ecosystem-based approaches.

Apart from these national policies, the successful implementation of NbS also depends on the support and capacity of local governance actors like local governments, civil society and non-governmental organizations which are often scarce in small island regions. Williams *et al.* (2020) confirm this for Mauritius as they find a lack of local capacity to implement climate change adaptation measures, conducting a local governance assessment. Potentially contributing to this, is a lack of central and subnational government regulations, especially relating to land-use or building codes that address potential climate concerns for infrastructure projects (International Monetary Fund. African Dept. 2022). However, ongoing work on a Wetland Bill, supplemented by a "National Parks and Conservation Service (NPCS) Needs Assessment" from 2023 could serve as an important piece of regulation in support of NbS (UNDP 2024b).

8 Available at Climate Change Information Centre (CCIC).

3.1.2.6 Ecosystem-based adaptation

There is no scientific literature that reports on ecosystem-based adaptation responses to climate change in Mauritius. Nevertheless, pilot projects like the Ridge to Reef Project funded by the European Commission in Mauritius make first steps towards a broader application of ecosystem-based adaptation.

3.1.2.7 Agro-ecological farming

To respond to the impacts on Mauritian food systems and food security, traditional knowledge paired with agro-ecological farming is often put forward as a NbS. For example, Ramborun *et al.* (2021) assess the effects of using traditional fertilizers on crop yield for three successive crop cycles in Vacoas and find that a combination of tillage-mulch-fertilizer provided the best results. While this is an important first step towards agro-ecological farming, it remains unclear to what extent these traditional fertilizers remain effective under climate change. In fact, climate-smart agriculture does not appear in the agriculture-related policy and regulations of Mauritius (Hardowar 2020).

Responding to the negative trends in the fisheries sectors appears challenging for Mauritius (Teneva *et al.* 2023). Using seaweeds and algae as alternative sources for nutrients could serve as an alternative (Bekah *et al.* 2023). Furthermore, first oyster aquaculture farming pilot projects were implemented in the villages of Poste de Flacq and Grand Gaube to improve food security (UNDP 2024b).

3.1.3 NbS funding and finance

The body of literature reporting on NbS funding and finance in Mauritius is small. The statistics department, in general, does not report on cash flows into relevant areas like conservation, restoration or adaptation (Statistics Mauritius 2023). Nevertheless, actual total climate change expenditure in Mauritius averages 2% of GDP per year, of which adaptation accounts for around 1,6% of GDP (International Monetary Fund. African Dept. 2022). However, to meet 2030 climate targets, authorities would need to spend on average 3,6% of GDP per fiscal year over the period 2015-2030, leaving a potential financing gap of 1,6% of GDP per year on average (around USD 180 million per year) (ibid). Climate-related debt instruments, such as green bonds could narrow this gap, combined with efforts to gain greater access to global climate funds.

A key barrier to attracting private investments for NbS is the difficulty to value the non-economic benefits of NbS in monetary terms. Addressing this barrier, a valuation of ecosystem services was carried out for two of the island's freshwater reservoirs Mare Longue and Mare aux Vacoas (Koenig and Deenapanray 2024). The value of the water catchment ecosystems is estimated to be around USD 63 million over a 25-year period using a discount rate of 3%. There is no knowledge of further monetary evaluations in Mauritius (ibid). Another non-monetary approach to value ecosystem services from 2013 used ecosystem natural capital accounting (ENCA) which is a method that quantifies losses of natural capital in bio-physical terms (ibid).

A promising financing mechanism in small island regions are ecotourism user fees. In Mauritius, the government promotes eco-tourism as an alternative livelihood to fishing and, thus, offers potential for including this financing mechanism in the development of NbS business models (Hattam *et al.* 2020). There is further potential in the recent Environment Act from 2024 which foresees "Environment Protection Fees". These fees could serve as revenue streams for the implementation of NbS. Nevertheless, funders and financers should insist on careful site selection and good governance practices to ensure NbS achieve their intended outcomes and support vulnerable communities first (Browne *et al.* 2024).

3.2 Synthesis

3.2.1 Observed impacts and projected risks

The literature on observed impacts and projected risks in Mauritius remains in its initial stages, posing challenges to draw definitive conclusions for NbS. Table 4 summarizes key findings per impact and risk category for Mauritius. Note, these results are based on the available literature which is likely to have gaps.

Impact and risk categories	Synthesis
Ecosystems and biodiversity	Marine ecosystems like mangroves and reefs face significant impacts. No projections.
Food systems and food security	Food crops (mainly rice) projected to face increasing damages and abundance of seafood also projected to decrease.
Water systems and water security	Decreasing groundwater quality but increasing rainfall trends.
Sea-level rise	Beach erosion in many areas of the coast. Projected sea-level rise between 0.42m and 0.86m until 2100.
Health and well-being	Little climate change related knowledge.
Migration and displacement	Some internal displacement after extreme events. 3,300-34,000 potential coastal migrants due to sea-level rise until 2100.
Human vulnerability	Low-income households disproportionally impacted by floods and cyclones. No projections.
Cities, settlements and infrastructure	Urban areas vulnerable to coastal, pluvial and compound flooding.
Economic sectors	Tourism and fisheries are key risk sectors.

Table 4 Synthesis and comparison of observed impacts and projected risks in Mauritius

Key impact and risk areas are the *marine ecosystems and risks stemming from sea-level rise,* which reflects the geographic situation of Mauritius being a SIDS. For urban areas, however, the coast often also plays a key role but *flooding* from other pluvial or fluvial sources and heat stress add to the central impact and risks areas. Particularly pluvial flooding is a major concern in Port Louis given its geographic location where rainwater runoff from the elevated areas around the city has caused extreme flood events.

The identified impact and risk areas offer a first step towards understanding where NbS can prioritize support for mitigation and adaptation efforts. Particularly, pluvial flooding in Port Louis appears as one of the most pressing climate impacts NbS could address.

3.2.2 NbS responses, funding, and finance

The body of literature addressing NbS responses and finance in Mauritius reviewed in this technical report is also rather small, making it difficult to make inferences from the existing experiences with NbS. Table 5 lists key results per NbS responses.

NbS responses	Synthesis
In forests	Pilot peri-urban forest established in vicinity to Port Louis in 2017. And previous, large-scale afforestation experiences (50% of state-owned forests were restored).
In peatlands	-
Blue carbon	Multiple mangrove restoration and afforestation activities. Pilot projects for coral restoration. Seagrass restoration plan in preparation.
In urban areas	No explicit NbS responses but research addressing urban heat, particularly demonstrating future heat stress in residential buildings.
Policy and regulations	Different national policies including the NDCs and NCCAPF reference NbS.
Ecosystem-based adaptation	Implicit NbS responses e.g., mangrove afforestation (see blue carbon).
Agro-ecological farming	First steps towards agro-ecological farming taken. Pilot projects in the fisheries sector. But climate smart agriculture not yet mainstreamed in policy.
Finance	Low resolution data for climate change expenditure available. No NbS-related finance statistics. Some ecosystem service evaluations e.g., freshwater reservoirs. Ecotourism user fees and "environment protection fees" as potential financing mechanisms for NbS.

Table 5 Synthesis of NbS responses and finance in Mauritius.

Urban NbS experiences are largely missing – at least in the literature. Nevertheless, we identified some key NbS experiences in both countries that illustrate the first steps taken.

Key NbS experiences relate to the large-scale and long-term mangrove restoration initiatives and programmes which are joined by some coral restoration experiments and pilots in agro-ecological farming. The long-term experiences with mangrove restoration demonstrate the long experience with coastal/marine NbS in Mauritius and matches the risk profile of Mauritius as a small island region. Notably, the establishment of a peri-urban forest in the vicinity of Port Louis is a great example of a first step towards seizing the direct and co-benefits of NbS.

Evidently, while Mauritius has made first steps in the implementation of NbS, it is also clear that the role of global climate funds and other international mechanisms that could support NbS is quite important against the backdrop of limited NbS finance available. This is also true for private sector engagement and attraction of private investments for NbS, where bankable business models for upscaling NbS is largely absent.

3.2.3 Potential for urban NbS

Based on the synthesis above, we identified potential implementation cases for urban NbS in Port Louis. Table 6 provides an overview of the main climate impact/risk categories in urban areas and NbS experiences as well as potential urban NbS and respective barriers as identified from the literature.

Main climate impact/risk categories in urban areas	NbS experiences	Potential for urban NbS	Potential barriers
Pluvial flooding, heat.	Peri-urban forest	Sponge city measures (permeable pavements, infiltration measures, rainwater harvesting, creation of natural retention basins)	Social acceptance, topography

Table 6 Key results and recommendations for potential urban NbS and barriers in Mauritius.

Pluvial flooding and the respective run-off from elevated areas around the city as well as heat stress are key concerns for Port Louis. However, we find no implementation of urban NbS that address these concerns. This is problematic because the city is regularly affected by floods. For example, the regions La Poudrière, La Chaussée, Place d'armes streets and the surroundings frequently experience rapid water set-up and flooding. Hence, there is potential for exploring sponge city measures in Port Louis as well. Thus, the overwhelmed flood management infrastructure could be relieved with some of the measures like riparian vegetation, retention basis and rainwater harvesting, while offering co-benefits in terms of lowering air temperature which in turn also relieves the growing heat stress. A central barrier to implementation of these NbS relates to the question of social acceptance of the measures. Sometimes, NbS measures are contested by decision-makers and local communities because they are different from the conventional grey infrastructures. Active participation and communication can address some of these potential concerns and need to be integrated in project designs. Moreover, the island topography can reduce the effectiveness of sponge city concepts because of SLR driven groundwater rise.

A concrete leverage points for NbS in Mauritius is the NCCAPF. Nevertheless, the recently implemented Environment Act 2024 and NDCs could also offer some leverage for NbS. There, NbS are indirectly addressed via environmental conservation.

4 CONCLUSION

This technical report has reviewed the scientific and selected grey literatures addressing climate impacts and risks as well as NbS responses and finance in Zambia and Mauritius to serve as a starting point for the co-production of urban NbS-implementation knowledge. In total, we reviewed 123 publications and identified some major gaps in the literature. A key gap that looms large for both countries are risk assessments that project future climate change risks. Adding to this, we find the NbS literature in both countries is still in its infancy. Nevertheless, we identified some potential for implementing urban NbS based on the limited scientific evidence available.

Drought but most importantly flooding negatively impact urban areas in Zambia, particularly Lusaka. To address this with NbS, the report recommends to further explore the potential of increasing urban green cover, bio-retention basins, permeable pavements and urban gardens. This includes careful consideration of potential barriers that could hamper the implementation of such NbS like limited water availability for the irrigation of these NbS and the lithography in some areas of Lusaka where hard soils render the implementation of sponge city concepts and respective infiltration measures potentially difficult. Nevertheless, the co-benefits of increasing green cover, bio-retention basins, permeable pavements and urban gardens can also contribute to some of the development challenges Lusaka faces like food security (urban gardens).

Pluvial flooding (in the future potentially compound flooding) and heat stress are key concerns in Port Louis. To address this with NbS, the report recommends to further explore the potential of sponge city concepts that can address both concerns, managing excess run-off and contributing to reduced urban temperatures by evaporation. But also here, questions of social acceptance need to be carefully addressed when further exploring such NbS to ensure successful implementation as this has been reported as a barrier in Port Louis before.

Taken together, this technical report has identified knowledge gaps, potential NbS measures and potential barriers for Lusaka and Port Louis. To move closer to implementing NbS in these cities, it is essential to develop financing arrangements that capture the value of the ecosystem services these potential urban NbS could provide, in conjunction with improving the governance of NbS, e.g., with efforts to build capacity and mainstream NbS in sectoral policies.

LIST OF REFERENCES

- Acreman, M., Smith, A., Charters, L., Tickner, D., Opperman, J., Acreman, S., Edwards, F., Sayers, P., and Chivava, F., 2021. Evidence for the effectiveness of nature-based solutions to water issues in Africa. *Environmental Research Letters*, 16 (6), 063007.
- AFDB, 2023. *Country Focus Report 2023 Zambia Mobilizing Private Sector Financing for Climate and Green Growth*.
- Anisimov, A., Magnan, A.K., and Duvat, V.K.E., 2020. Learning from risk reduction pilot projects for enhancing long-term adaptation governance: The case of Mauritius Island (Indian Ocean). *Environmental Science & Policy*, 108, 93–103.
- Appadoo, C., Sultan, R., Simier, M., Tandrayen-Ragoobur, V., and Capello, M., 2023. Artisanal fishers in small island developing states and their perception of environmental change: the case study of Mauritius. *Reviews in Fish Biology and Fisheries*, 33 (3), 611–628.
- Augusto, B., Roebeling, P., Rafael, S., Ferreira, J., Ascenso, A., and Bodilis, C., 2020. Short and medium- to long-term impacts of nature-based solutions on urban heat. *Sustainable Cities and Society*, 57, 102122.
- Banda, A.M., Banda, K., Sakala, E., Chomba, M., and Nyambe, I.A., 2023. Assessment of land use change in the wetland of Barotse Floodplain, Zambezi River Sub-Basin, Zambia. *Natural Hazards*, 115 (2), 1193–1211.
- Banda, B., Van Niekerk, D., Nemakonde, L., and Granvorka, C., 2022. Legal and policy frameworks to harmonise and mainstream climate and disaster resilience options into municipality integrated development plans: A case of Zambia. *International Journal of Disaster Risk Reduction*, 81, 103269.
- Banda, D.A., 2023. A GIS-Based Assessment of Land Cover Changes and Tree Species Suitability for Urban Greening Policies in the City of Kitwe, Zambia. *Green Energy and Environmental Technology*, 2.
- Bekah, D., Thakoor, A.D., Ramanjooloo, A., Phul, I.C., Botte, S., Roy, P., Oogarah, P., Curpen, S., Goonoo, N., Bolton, J., and Bhaw-Luximon, A., 2023. Vitamins, minerals and heavy metals profiling of seaweeds from Mauritius and Rodrigues for food security. *Journal of Food Composition and Analysis*, 115, 104909.
- Bheeroo, R.A., Chandrasekar, N., Kaliraj, S., and Magesh, N.S., 2016. Shoreline change rate and erosion risk assessment along the Trou Aux Biches–Mont Choisy beach on the northwest coast of Mauritius using GIS-DSAS technique. *Environmental Earth Sciences*, 75 (5), 444.
- Boojhawon, A. and Surroop, D., 2021. Impact of climate change on vulnerability of freshwater resources: a case study of Mauritius. *Environment, Development and Sustainability*, 23 (1), 195–223.
- Brizmohun, R., 2019. Impact of climate change on food security of small islands: The case of Mauritius. *Natural Resources Forum*, 43 (3), 154–163.
- Browne, K.E., Razafiarimanana, C., and Jogannah, R., 2024. Informal institutions and "Imperfect Equity" in internationally financed adaptation in Madagascar and Mauritius. *World Development*, 181, 106678.
- Buckland, C.E., Thomas, D.S.G., Jägermeyr, J., Müller, C., and Smith, J.A.C., 2023. Drought-tolerant succulent plants as an alternative crop under future global warming scenarios in sub-Saharan Africa. *GCB Bioenergy*, 15 (10), 1287–1308.
- Cazes-Duvat, V. and Paskoff, R., 2004. *Les littoraux des Mascareignes, entre nature et ameńagement*. Paris, France: L'Harmattan.
- Chacowry, A., 2023. Meeting the challenges to climate change adaptation: an NGO community-based successful projects in Mauritius. *GeoJournal*, 88 (4), 4081–4094.
- Chacowry, A., McEwen, L.J., and Lynch, K., 2018. Recovery and resilience of communities in flood risk zones in a small island developing state: A case study from a suburban settlement of Port Louis, Mauritius. *International Journal of Disaster Risk Reduction*, 28, 826–838.
- Chan, F.K.S., Griffiths, J.A., Higgitt, D., Xu, S., Zhu, F., Tang, Y.-T., Xu, Y., and Thorne, C.R., 2018. "Sponge City" in China—A breakthrough of planning and flood risk management in the urban context. *Land Use Policy*, 76, 772–778.
- Chilambwe, A., Crespo, O., and Chungu, D., 2022. Climate change impacts on maize and soybean yields in Zambia. *Agronomy Journal*, 114 (4), 2430–2444.
- Chisanga, C.B., Nkonde, E., Phiri, E., Mubanga, K.H., and Lwando, C., 2023. Trend analysis of rainfall from 1981-2022 over Zambia. *Heliyon*, 9 (11), e22345.
- Chishaleshale, M., Chirwa, P.W., Zekeng, J.C., and Syampungani, S., 2024. How do socio-economic characteristics of communities influence resource use and forest cover in the Cryptosepalum forest of North-western Zambia. *Heliyon*, 10 (8), e28658.
- Chundu, M.L., Banda, K., Lyoba, C., Tembo, G., Sichingabula, H.M., and Nyambe, I.A., 2024. Modeling land use/land cover changes using quad hybrid machine learning model

in Bangweulu wetland and surrounding areas, Zambia. *Environmental Challenges*, 14, 100866.

- Climate Investment Fund, 2024. *Nature, people and climate investment plan for Africa's Zambezi river basin region*.
- Cohen-Shacham, E., Andrade, A., Dalton, J., Dudley, N., Jones, M., Kumar, C., Maginnis, S., Maynard, S., Nelson, C.R., Renaud, F.G., Welling, R., and Walters, G., 2019. Core principles for successfully implementing and upscaling Nature-based Solutions. *Environmental Science & Policy*, 98, 20–29.
- Dhoomun, L., Hytten, K.F., and Perry, P., 2022. Perceptions of climate change and climate change policies within the tourism sector in Mauritius. *Journal of the Indian Ocean Region*, 18 (1), 36–59.
- Dietz, J., Treydte, A.C., and Lippe, M., 2023. Exploring the future of Kafue National Park, Zambia: Scenario-based land use and land cover modelling to understand drivers and impacts of deforestation. *Land Use Policy*, 126, 106535.
- Doorga, J.R.S., 2022. Climate change and the fate of small islands: The case of Mauritius. *Environmental Science & Policy*, 136, 282–290.
- Doorga, J.R.S., Pasnin, O., Dindoyal, Y., and Diaz, C., 2023. Risk assessment of coral reef vulnerability to climate change and stressors in tropical islands: The case of Mauritius. *Science of The Total Environment*, 891, 164648.
- Douglas, I., 2018. The challenge of urban poverty for the use of green infrastructure on floodplains and wetlands to reduce flood impacts in intertropical Africa. *Landscape and Urban Planning*, 180, 262–272.
- Dube, K. and Nhamo, G., 2018. Climate variability, change and potential impacts on tourism: Evidence from the Zambian side of the Victoria Falls. *Environmental Science & Policy*, 84, 113–123.
- Duvat, V.K.E., Anisimov, A., and Magnan, A.K., 2020. Assessment of coastal risk reduction and adaptation-labelled responses in Mauritius Island (Indian Ocean). *Regional Environmental Change*, 20 (4), 110.
- Ebi, K.L., Lewis, N.D., and Corvalan, C., 2006. Climate Variability and Change and Their Potential Health Effects in Small Island States: Information for Adaptation Planning in the Health Sector. *Environmental Health Perspectives*, 114 (12), 1957–1963.
- FAO, 2022. *Efficient agricultural water use and management in paddy fields in Zambia*.
- Favero, F. and Hinkel, J., 2024. Key Innovations in Financing Nature-Based Solutions for Coastal Adaptation. *Climate*, 12 (4), 53.
- Frietsch, M., Zafra-Calvo, N., Ghoddousi, A., and Loos, J., 2023. Advancing protected area effectiveness assessments by disentangling social-ecological interactions: A case study from the Luangwa Valley, Zambia. *Conservation Science and Practice*, 5 (8), e12974.
- Funder, M. and Mweemba, C.E., 2019. Interface bureaucrats and the everyday remaking of climate interventions: Evidence from climate change adaptation in Zambia. *Global Environmental Change*, 55, 130–138.
- Gemenne, F., 2011. Why the numbers don't add up: A review of estimates and predictions of people displaced by environmental changes. *Global Environmental Change*, 21, S41–S49.
- Gemenne, F. and Magnan, A., 2010. The Other Migrants Preparing for Change: Environmental Changes and Migration in the Republic of Mauritius.
- Gómez Martín, E., Máñez Costa, M., Egerer, S., and Schneider, U.A., 2021. Assessing the long-term effectiveness of Nature-Based Solutions under different climate change scenarios. *Science of The Total Environment*, 794, 148515.
- Government of the Republic of Zambia, 2014. *ZAMBIA'S SECOND NATIONAL BIODIVERSITY STRATEGY AND ACTION PLAN (NBSAP -2)*.
- Gulumbe, B.H., Chishimba, K., Shehu, A., and Chibwe, M., 2024. Zambia's battle against cholera outbreaks and the path to public health resilience: a narrative review. *Journal of Water and Health*, 22 (12), 2257–2275.
- Güneralp, B., Lwasa, S., Masundire, H., Parnell, S., and Seto, K.C., 2017. Urbanization in Africa: challenges and opportunities for conservation. *Environmental Research Letters*, 13 (1), 015002.
- Gungoa, V. and Kebede, S., 2024. Climate variability impact on groundwater quality in Small Island Developing States: Mauritius Island as a case study. *Frontiers in Water*, 6, 1432908.
- Hambulo Ngoma, Byman Hamududu, Hangoma, P., Samboko, P., Munguzwe Hichaambwa, and Kabaghe, C., 2019. Irrigation Development for Climate Resilience in Zambia: The Known Knowns and Known Unknowns.
- Hamel, P. and Tan, L., 2022. Blue–Green Infrastructure for Flood and Water Quality Management in Southeast Asia: Evidence and Knowledge Gaps. *Environmental Management*, 69 (4), 699–718.
- Hardowar, S., 2020. A Review of Climate-Smart Agriculture in Mauritius: Moving Towards a Landscape Approach. *In*: V. Venkatramanan, S. Shah, and R. Prasad, eds. *Global Climate Change: Resilient and Smart Agriculture*. Singapore: Springer Singapore, 15–31.
- Hattam, C., Evans, L., Morrissey, K., Hooper, T., Young, K., Khalid, F., Bryant, M., Thani, A., Slade, L., Perry, C., Turrall, S., Williamson, D., and Hughes, A., 2020. Building resilience in practice to support coral communities in the Western Indian Ocean. *Environmental Science & Policy*, 106, 182–190.

- Hulsman, P., Savenije, H.H.G., and Hrachowitz, M., 2021. Satellite-based drought analysis in the Zambezi River Basin: Was the 2019 drought the most extreme in several decades as locally perceived? *Journal of Hydrology: Regional Studies*, 34, 100789.
- International Monetary Fund. African Dept., 2022. Mauritius. *IMF Staff Country Reports*, 2022 (224), 1.
- International Resource Panel, 2021. *Urban Agriculture's Potential to Advance Multiple Sustainability Goals: An International Resource Panel Think Piece*. Nairobi: United Nations Environment Programme.
- IOM, 2019. *Migration in Zambia: A Country Profile 2019*.
- IPCC, 2022. *Climate Change and Land: IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems*. 1st ed. Cambridge University Press.
- IPCC, 2023a. *Climate Change 2022 – Impacts, Adaptation and Vulnerability: Working Group II Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. 1st ed. Cambridge University Press.
- IPCC, 2023b. *Climate Change 2021 – The Physical Science Basis: Working Group I Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. 1st ed. Cambridge University Press.
- Iradukunda, P., Mwanaumo, E.M., and Kabika, J., 2023. Hydroclimatic trend analysis and projection in Africa tropical urban regions: Cases of Lusaka, Zambia and Kigali, Rwanda. *Urban Climate*, 52, 101680.
- Jain, S., 2007. An Empirical Economic Assessment of Impacts of Climate Change on Agriculture in Zambia.
- Jogee, S.Y., Gopalsing, S., Jeetun, S., Ricot, M., Taleb-Hossenkhan, N., Mattan-Moorgawa, S., Kaullysing, D., Wijayanti, D.P., Suzuk, Y., Casareto, B.E., and Bhagooli, R., 2024. Variable prevalence of diseases and compromised health conditions on hard corals around Mauritius Island, Western Indian Ocean. *Bulletin of Marine Science*.
- Jones, L., Anderson, S., Læssøe, J., Banzhaf, E., Jensen, A., Bird, D.N., Miller, J., Hutchins, M.G., Yang, J., Garrett, J., Taylor, T., Wheeler, B.W., Lovell, R., Fletcher, D., Qu, Y., Vieno, M., and Zandersen, M., 2022. A typology for urban Green Infrastructure to guide multifunctional planning of nature-based solutions. *Nature-Based Solutions*, 2, 100041.
- Kalaba, F.K., 2016. Barriers to policy implementation and implications for Zambia's forest ecosystems. *Forest Policy and Economics*, 69, 40–44.
- Kalaba, F.K., Quinn, C.H., and Dougill, A.J., 2013. The role of forest provisioning ecosystem services in coping with household stresses and shocks in Miombo woodlands, Zambia. *Ecosystem Services*, 5, 143–148.
- Kanema, E.M. and Gumindoga, W., 2022. Effects of changing climate on the groundwater potential: A case of Chongwe and Rufunsa Districts along the Chongwe River Catchment, Zambia. *Physics and Chemistry of the Earth, Parts A/B/C*, 127, 103192.
- Kaudeer, B.N. and Venkannah, S., 2023. Influence of the climate change on natural ventilation use in residential buildings in the tropical island of Mauritius. *Indoor and Built Environment*, 32 (6), 1078–1094.
- Koenig, X.G.H. and Deenapanray, P.N.K., 2024. Land use and environmental degradation in the island state of Mauritius: Governance and problem conceptions. *Land Use Policy*, 146, 107332.
- Koenig, X.G.H., Deenapanray, P.N.K., Weber, J., Rakotondraompiana, S., and Ramihangihajason, T.A., 2024. Are Neutrality Targets Alone Sufficient for Protecting Nature? Learning From Land Cover Change and Land Degradation Neutrality Targets in Mauritius. *Land Degradation & Development*, ldr.5359.
- Kõiv-Vainik, M., Kill, K., Espenberg, M., Uuemaa, E., Teemusk, A., Maddison, M., Palta, M.M., Török, L., Mander, Ü., Scholz, M., and Kasak, K., 2022. Urban stormwater retention capacity of nature-based solutions at different climatic conditions. *Nature-Based Solutions*, 2, 100038.
- La Notte, A., 2024. How to account for nature-based solutions as the ecological assets that support economy and society. *Nature-Based Solutions*, 6, 100164.
- Lalljee, B., Velmurugan, A., and Singh, A.K., 2018. Climate Resilient and Livelihood Security – Perspectives for Mauritius Island. *In*: *Biodiversity and Climate Change Adaptation in Tropical Islands*. Elsevier, 403–431.
- Lehner, B., Katiyo, L., Chivava, F., Sichingabula, H.M., Nyirenda, E., Rivers-Moore, N.A., Paxton, B.R., Grill, G., Nyoni, F., Shamboko-Mbale, B., Banda, K., Thieme, M.L., Silembo, O.M., Musutu, A., and Filgueiras, R., 2021. Identifying priority areas for surface water protection in data scarce regions: An integrated spatial analysis for Zambia. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 31 (8), 1998–2016.
- Leroux, M.-D., Bonnardot, F., Somot, S., Alias, A., Kotomangazafy, S., Ridhoine, A.-O.S., Veerabadren, P., and Amélie, V., 2024. Developing climate services for vulnerable islands in the Southwest Indian Ocean: A combined statistical and dynamical CMIP6 downscaling approach for climate change assessment. *Climate Services*, 34, 100491.
- Lincke, D. and Hinkel, J., 2021. Coastal Migration due to 21st Century Sea-Level Rise. *Earth's Future*, 9 (5), e2020EF001965.
- Lusaka Water Supply and Sanitation Company, 2023. *Strategic Plan 2023-2027*.
- Lusaka (Zambia) and Environmental Council of Zambia, eds., 2008. *Lusaka City state of environment outlook report*. Lusaka, Zambia: Environmental Council.

- Mahadew, R. and Appadoo, K.A., 2019. Tourism and climate change in Mauritius: assessing the adaptation and mitigation plans and prospects. *Tourism Review*, 74 (2), 204–215.
- Makondo, C.C. and Thomas, D.S.G., 2024. Multidimensional poverty and vulnerability assessment in the face of climate change adaptation in developing economies: focus on ecosystem-based livelihoods in Zambia. *Environment, Development and Sustainability*.
- Marcantonio, R.A., 2020. Water, anxiety, and the human niche: a study in Southern Province, Zambia. *Climate and Development*, 12 (4), 310–322.
- Matchaya, G.C., Tadesse, G., and Kuteya, A.N., 2022. Rainfall shocks and crop productivity in Zambia: Implication for agricultural water risk management. *Agricultural Water Management*, 269, 107648.
- Mayor, B., Toxopeus, H., McQuaid, S., Croci, E., Lucchitta, B., Reddy, S.E., Egusquiza, A., Altamirano, M.A., Trumbic, T., Tuerk, A., García, G., Feliu, E., Malandrino, C., Schante, J., Jensen, A., and López Gunn, E., 2021. State of the Art and Latest Advances in Exploring Business Models for Nature-Based Solutions. *Sustainability*, 13 (13), 7413.
- McClanahan, T., Maina, J., Moothien-Pillay, R., and Baker, A., 2005. Effects of geography, taxa, water flow, and temperature variation on coral bleaching intensity in Mauritius. *Marine Ecology Progress Series*, 298, 131–142.
- McClanahan, T., Munbodhe, V., Naggea, J., Muthiga, N., and Bhagooli, R., 2021a. Rare coral and reef fish species status, possible extinctions, and associated environmental perceptions in Mauritius. *Conservation Science and Practice*, 3 (11), e527.
- McClanahan, T., Munbodhe, V., Naggea, J., Muthiga, N., and Bhagooli, R., 2021b. Rare coral and reef fish species status, possible extinctions, and associated environmental perceptions in Mauritius. *Conservation Science and Practice*, 3 (11), e527.
- McClanahan, T.R. and Muthiga, N.A., 2021. Oceanic patterns of thermal stress and coral community degradation on the island of Mauritius. *Coral Reefs*, 40 (1), 53–74.
- McClure, A., Patel, Z., Ziervogel, G., and Hardman, J., 2023. Exploring the role of transdisciplinary learning for navigating climate risks in African cities: The case of Lusaka, Zambia. *Environmental Science & Policy*, 149, 103571.
- Mubaya, C.P., Njuki, J., Mutsvangwa, E.P., Mugabe, F.T., and Nanja, D., 2012. Climate variability and change or multiple stressors? Farmer perceptions regarding threats to livelihoods in Zimbabwe and Zambia. *Journal of Environmental Management*, 102, 9–17.
- Mueller, V., Gray, C., and Hopping, D., 2020. Climate-Induced migration and unemployment in middle-income Africa. *Global Environmental Change*, 65, 102183.
- Mulungu, K., Tembo, G., Bett, H., and Ngoma, H., 2021. Climate change and crop yields in Zambia: historical effects and future projections. *Environment, Development and Sustainability*, 23 (8), 11859–11880.
- Mungur, M., Poorun, Y., Juggurnath, D., Ruhomally, Y.B., Rughooputh, R., Dauhoo, M.Z., Khoodaruth, A., Shamachurn, H., Gooroochurn, M., Boodia, N., Chooneea, M., and Facknath, S., 2020. A numerical and experimental investigation of the effectiveness of green roofs in tropical environments: The case study of Mauritius in mid and late winter. *Energy*, 202, 117608.
- Munyeme, M., Hamoonga, R., Chitambo, B., Ngoma, V., Maambo, B., Nalubamba, K.S., Knight-Jones, T., Caron, A., and Richards, S., 2024. Assessing One Health in Zambia: Necessity, Application and Operationalisation. *One Health Cases*, ohcs20240021.
- Mwelwa, D., Mwaanga, P., Nguvulu, A., Tena, T.M., and Taye, G., 2024. Assessment of Catchment Water Resources Allocation under Climate Change in Luwombwa Sub-Catchment, Zambia. *Heliyon*, e39962.
- Mwitwa, J., Mwila, R., and Mweemba, B., 2018. *Policy and Institutional Review for biodiversity conservation in Zambia*.
- Nawrotzki, R.J. and DeWaard, J., 2018. Putting trapped populations into place: climate change and inter-district migration flows in Zambia. *Regional Environmental Change*, 18 (2), 533–546.
- Nazurally, N., 2013. Coral farming – a questionnaire based prospect for coastal inhabitants' socioeconomic development in Mauritius. *Western Indian Ocean Journal of Marine Science*, 12 (1), 47–56.
- Ngoma, H., Finn, A., and Kabisa, M., 2024. Climate shocks, vulnerability, resilience and livelihoods in rural Zambia. *Climate and Development*, 16 (6), 490–501.
- Ngoma, H., Pelletier, J., Mulenga, B.P., and Subakanya, M., 2021. Climate-smart agriculture, cropland expansion and deforestation in Zambia: Linkages, processes and drivers. *Land Use Policy*, 107, 105482.
- Nowbuth, M.D., Spataru, C., Esteban, M., and Carvalho, P., 2024. Perception and community input towards flash flood management in Mauritius Island. *Natural Hazards*.
- Nyakalale, P. and Madimutsa, C., 2021. Challenges Facing the Implementation of the Green Movement in Residential Areas in Lusaka, Zambia. *Africa Journal of Public Sector Development and Governance*, 4 (1), 128–142.
- Nzabarinda, V., Bao, A., Tie, L., Uwamahoro, S., Kayiranga, A., Ochege, F.U., Muhirwa, F., and Bao, J., 2025. Expanding forest carbon sinks to mitigate climate change in Africa. *Renewable and Sustainable Energy Reviews*, 207, 114849.
- Okello, C., Githiora, Y.W., Sithole, S., and Owuor, M.A., 2024. Nature-based solutions for water resource management in Africa's arid and sem-arid lands (ASALs): A systematic review of existing interventions. *Nature-Based Solutions*, 6, 100172.

- Omulo, G., Daum, T., Köller, K., and Birner, R., 2024. Unpacking the behavioral intentions of 'emergent farmers' towards mechanized conservation agriculture in Zambia. *Land Use Policy*, 136, 106979.
- Onaka, S., Hashimoto, H., Nashreen Banu Soogun, S.R., and Jheengut, A., 2015. Coastal Erosion and Demonstration Project as Coastal Adaptation Measures in Mauritius. *In*: *Handbook of Coastal Disaster Mitigation for Engineers and Planners*. Elsevier, 561–577.
- Ono, H. and Muya, M., 2024. Relationship between land tenure and land use in unplanned settlements in Lusaka, Zambia. *Habitat International*, 143, 102985.
- Pan, H., Page, J., Shi, R., Cong, C., Cai, Z., Barthel, S., Thollander, P., Colding, J., and Kalantari, Z., 2023. Contribution of prioritized urban nature-based solutions allocation to carbon neutrality. *Nature Climate Change*, 13 (8), 862–870.
- Phiri, D., Morgenroth, J., and Xu, C., 2019. Long-term land cover change in Zambia: An assessment of driving factors. *Science of The Total Environment*, 697, 134206.
- Pillay, K.R.M., 2011. Adapting coral culture to climate change: the Mauritian experience. *Western Indian Ocean Journal of Marine Science*, 10 (2), 155–167.
- Pilli-Sihvola, K. and Väätäinen-Chimpuku, S., 2016. Defining climate change adaptation and disaster risk reduction policy integration: Evidence and recommendations from Zambia. *International Journal of Disaster Risk Reduction*, 19, 461–473.
- Rambojun, S., Ramloll, Y., Mattan-Moorgawa, S., and Appadoo, C., 2024. Are mangroves hotspots for marine litter among selected coastal ecosystems of Mauritius, an oceanic island in Western Indian Ocean? *Regional Studies in Marine Science*, 69, 103284.
- Ramborun, V., Facknath, S., and Lalljee, B., 2021. Indigenous/traditional climate-smart practices effects on soil fertility and maize yield in Mauritius agricultural system. *Journal of Agriculture and Food Research*, 3, 100096.
- Ramlall, I., 2014. Gauging the impact of climate change on food crops production in Mauritius: An econometric approach. *International Journal of Climate Change Strategies and Management*, 6 (3), 332–355.
- Raymond, C.M., Frantzeskaki, N., Kabisch, N., Berry, P., Breil, M., Nita, M.R., Geneletti, D., and Calfapietra, C., 2017. A framework for assessing and implementing the co-benefits of nature-based solutions in urban areas. *Environmental Science & Policy*, 77, 15–24.
- Richardson, R.B., Olabisi, L.S., Waldman, K.B., Sakana, N., and Brugnone, N.G., 2021. Modeling interventions to reduce deforestation in Zambia. *Agricultural Systems*, 194, 103263.
- Rivers-Moore, N.A., Paxton, B., Chivava, F., Katiyo, L., Phiri, H., Katongo, C., Thieme, M.L., Lehner, B., and Linke, S., 2021. Aquatic areas of ecological importance as inputs into surface water resource protection areas in Zambia. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 31 (8), 1983–1997.
- Sadien, M., Doorga, J.R.S., and Rughooputh, S.D.D.V., 2024. Assessment of tangible coastal inundation damage related to critical infrastructure and buildings: The case of Mauritius Island. *International Journal of Disaster Risk Reduction*, 104909.
- Simatele, D. and Simatele, M., 2015. Migration as an adaptive strategy to climate variability: a study of the Tonga-speaking people of Southern Zambia. *Disasters*, 39 (4), 762–781.
- Simutowe, E., Ngoma, H., Manyanga, M., Silva, J.V., Baudron, F., Nyagumbo, I., Kalala, K., Habeenzu, M., and Thierfelder, C., 2024. Risk aversion, impatience, and adoption of conservation agriculture practices among smallholders in Zambia. *Heliyon*, 10 (4), e26460.
- Singh, R., Bwalya, D., and Fu, D., 2018. *Feasibility and Adaptability of Sponge City Concept: a Case Study of Lusaka, Zambia*.
- Somanje, A.N., Crespo, O., and Zinyengere, N., 2017. Conservation Agriculture Among Farmers in Kalomo, Zambia. *In*: *Beyond Agricultural Impacts*. Elsevier, 77–99.
- Statistics Mauritius, 2023. Environment Statistics – Year 2023.
- Storlazzi, C.D., Gingerich, S.B., Van Dongeren, A., Cheriton, O.M., Swarzenski, P.W., Quataert, E., Voss, C.I., Field, D.W., Annamalai, H., Piniak, G.A., and McCall, R., 2018. Most atolls will be uninhabitable by the mid-21st century because of sea-level rise exacerbating wave-driven flooding. *Science Advances*, 4 (4), eaap9741.
- Sultan, R., 2017. *Assessing the climate change-migration nexus through the lens of migrants: the case of the Republic of Mauritius | PreventionWeb*. IOM.
- Sultan, R., 2021. Economic Impacts of Climate Change on Agriculture: Insights from the Small Island Economy of Mauritius. *In*: S. Moncada, L. Briguglio, H. Bambrick, I. Kelman, C. Iorns, and L. Nurse, eds. *Small Island Developing States*. Cham: Springer International Publishing, 137–158.
- Sunkur, R., Kantamaneni, K., Bokhoree, C., Rathnayake, U., and Fernando, M., 2024. Mangrove mapping and monitoring using remote sensing techniques towards climate change resilience. *Scientific Reports*, 14 (1), 6949.
- Sunkur, R., Kantamaneni, K., Bokhoree, C., and Ravan, S., 2023. Mangroves' role in supporting ecosystem-based techniques to reduce disaster risk and adapt to climate change: A review. *Journal of Sea Research*, 196, 102449.
- Sunkur, R., St. Flour, O., and Bokhoree, C., 2021. ICT TOOLS TO SUPPORT CLIMATE CHANGE ADAPTATION IN THE WATER SERVICES SECTOR: CASE STUDY MAURITIUS. *International Journal of Engineering Applied Sciences and Technology*, 6 (4).
- Tang, C., Morel, B., Singh, S., Graillet, A., Pergaud, J., Mugenga, R.I., Baraka, L., Leroux, M.-D., Jeanty, P., Delsaut, M., Cunden, T.S.M., Beeharry, G.K., and Lollchund, R., 2023. High-resolution dynamical downscaling experiment outputs

data over Reunion and Mauritius islands in the South-West Indian Ocean. *Data in Brief*, 51, 109665.

- Teneva, L., Free, C.M., Hume, A., Agostini, V.N., Klein, C.J., Watson, R.A., and Gaines, S.D., 2023. Small island nations can achieve food security benefits through climate-adaptive blue food governance by 2050. *Marine Policy*, 151, 105577.
- Thierfelder, C., Mwila, M., and Rusinamhodzi, L., 2013. Conservation agriculture in eastern and southern provinces of Zambia: Long-term effects on soil quality and maize productivity. *Soil and Tillage Research*, 126, 246–258.
- Thorn, J.P.R., Biancardi Aleu, R., Wijesinghe, A., Mdongwe, M., Marchant, R.A., and Shackleton, S., 2021. Mainstreaming nature-based solutions for climate resilient infrastructure in peri-urban sub-Saharan Africa. *Landscape and Urban Planning*, 216, 104235.
- Tiddy, I.C., Kaullysing, D., Bailey, D.M., Chumun, P.K., Killen, S.S., Le Vin, A., and Bhagooli, R., 2021. Outplanting of branching Acropora enhances recolonization of a fish species and protects massive corals from predation. *Coral Reefs*, 40 (5), 1549–1561.
- Toxopeus, H. and Polzin, F., 2021. Reviewing financing barriers and strategies for urban nature-based solutions. *Journal of Environmental Management*, 289, 112371.
- UN, 2015. *Zambia Country Analysis*.
- UNDP, 2022. *Mainstreaming biodiversity into the management of the coastal zone in the Republic of Mauritius*.
- UNDP, 2024a. *UNDP Mauritius Country Programme Document 2024-2028*.
- UNDP, 2024b. *UNDP Mauritius 2023 Annual Report*.
- UNEA, 2022. Nature-based solutions for supporting sustainable development.
- UNEP, 2021. *Zambia: Ecosystem-based Adaptation 2021-2025*.
- United Nations Environment Programme, 2023. *State of Finance for Nature 2023: The Big Nature Turnaround - Repurposing $7 Trillion to Combat Nature Loss*. United Nations Environment Programme.
- United Nations Environment Programme, 2024. *Adaptation Gap Report 2024: Come hell and high water - As fires and floods hit the poor hardest, it is time for the world to step up adaptation actions*. United Nations Environment Programme.
- UNSDG, 2024. *SDG Country Profile Zambia*.
- Vicarelli, M., Sudmeier-Rieux, K., Alsadadi, A., Shrestha, A., Schütze, S., Kang, M.M., Leue, M., Wasielewski, D., and Mysiak, J., 2024. On the cost-effectiveness of Nature-based Solutions for reducing disaster risk. *Science of The Total Environment*, 947, 174524.
- Vincent, K. and Colenbrander, W., 2018. Developing and applying a five step process for mainstreaming climate change into local development plans: A case study from Zambia. *Climate Risk Management*, 21, 26–38.
- Vogelsang, L.G., Weikard, H.-P., Van Loon-Steensma, J.M., and Bednar-Friedl, B., 2023. Assessing the cost-effectiveness of Nature-based Solutions under climate change uncertainty and learning. *Water Resources and Economics*, 43, 100224.
- Vorlaufer, T., Falk, T., Dufhues, T., and Kirk, M., 2017. Payments for ecosystem services and agricultural intensification: Evidence from a choice experiment on deforestation in Zambia. *Ecological Economics*, 141, 95–105.
- Wambwa, D., Mundike, J., and Chirambo, B., 2024. Assessing financial assurance instruments for climate change mitigation and adaptation: A comparative study of Zambia and South Africa. *Scientific African*, 25, e02303.
- WHO, 2021. *Health and climate change: country profile 2021: Mauritius*.
- Wickenberg, B., McCormick, K., and Olsson, J.A., 2021. Advancing the implementation of nature-based solutions in cities: A review of frameworks. *Environmental Science & Policy*, 125, 44–53.
- Williams, D.S., Rosendo, S., Sadasing, O., and Celliers, L., 2020. Identifying local governance capacity needs for implementing climate change adaptation in Mauritius. *Climate Policy*, 20 (5), 548–562.
- Wineman, A. and Crawford, E.W., 2017. Climate change and crop choice in Zambia: A mathematical programming approach. *NJAS: Wageningen Journal of Life Sciences*, 81 (1), 19–31.
- World Bank, 2021. *Climate Change Action Plan 2021-2025: Supporting Green, Resilient, and Inclusive Development*.
- Worldbank, 2024. World Bank Climate Change Knowledge Portal [online]. Available from: https://climateknowledgeportal.worldbank.org/ [Accessed 12 Nov 2024].
- Zambia Statistics Agency, 2022. *2022 CENSUS OF POPULATION AND HOUSING*. Lusaka, Zambia.
- Zulu, E., Zulu, S., Chabala, M., Musonda, I., Kavishe, N., and Chileshe, N., 2022. Challenges and advocated solutions for environmental protection legislation for building infrastructure projects in developing countries: Evidence from Zambia. *Project Leadership and Society*, 3, 100056.
- Zulu, K. and Simenti-Phiri, E., 2022. WHEN DID ZAMBIA START GOING GREEN?: ASSESSING THE ALLUSION TO AND INCLUSION OF CLIMATE CHANGE AND INCIDENTAL PHENOMENON IN DEVELOPMENT PLANNING POLICY FROM 1964 TO 2021. *Advances in Social Sciences Research Journal*, 9 (2), 326–342.

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