GLOBAL CENTER ON ADAPTATION

MINISTRY OF FOREIGN AFFAIRS OF DENMARK
Danida

Nature-based Solutions Compendium for Urban Resilience in Kenya

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City Climate Finance Gap Fund

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Global Facility for Disaster Reduction and Recovery

Authors & Acknowledgments

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List of abbreviations and acronyms

ASAL – Arid and Semi-Arid

CASCADE – Catalyzing Strengthened Policy Action for Healthy Diets and Resilience

CBA – Cost Benefit Analysis

CBD – Central Business District

CBK – Central Bank of Kenya

CBO – Community-based organizations

CCTV – Closed-Circuit Television

CFAs – Community Forest Associations

CIDP – Country Integrated Development Plan

CPF – Country Partnership Framework

DLI – Disbursement Link Indicator

DRR – Disaster Risk Reduction

EbA – Ecosystem-based Adaptation

Eco-DRR – Ecosystem-based Disaster Risk Reduction

E&S – Environmental and Social

EMCA – Environmental Management and Coordination Act

FAR – Floor Area Ration

FOWK – Friends of Ondiri Wetland Kenya

GCA – Global Center on Adaptation

GDP – Gross Domestic Product

GeoIKP – Geospatial Information Knowledge Platform

GIS – Geographic Information System

Gok – Government of Kenya

HDP – High-Density Polyethylene

ICRR – Implementation Completion Results Report

UHI – Urban Heat Island

IDeP – Integrated Development Plan

IPF – Investment Project Finance

IUCN – International Union for Conservation of Nature

IUWM – Biomimicry and Integrated Urban Water Management

KADP – Kenya Accountable Devolution Program

KDI – Kounkuey Design Initiative

KDSP – Kenya Devolution Support Program

KeNHA – Kenya National Highways Authority

KenUp – Kenya Urban Program

KFS – Kenya Forest Service

KIIs – Key Informant Interviews

KISIP – Kenya Informal Settlements Improvement Project

KSP – Kenya National Spatial Plan

KT – Kaya Tembo

KURA – Kenya Urban Roads Authority

KUSP – Kenya Urban Support Program

LID – Low-Impact Development

LCZ – Local Climate Zone

MC – Minimum Conditions

MCA – Multi-Criteria Analysis

List of abbreviations and acronyms

MoU – Memorandum of Understanding

NACCFA – Conservancy Community Forest Association

NbS – Nature-Based Solutions

NDC - Nationally Determined Contribution

NEMA – National Environment Management Authority

NETFUND – National Environmental Trust Fund

NGO – Non-Governmental Organization

NMT – Non-Motorized Transport

NMS – Nairobi Metropolitan Services

NUDP – National Urban Development Policy

PAD – Program Appraisal Document

PDO – Program Development Objective

PforR – Program for Result

POM – Program Operations Manual

PS – Performance Standard

RA – Results Area

SDHUD – State Department of Housing and Urban Development

SSA – Sub-Saharan Africa

SuDS – Sustainable Urban Drainage Systems

ToR – Terms of Reference

UA – Urban Areas

UAC – Urban Areas and Cities

UACA – Urban Areas and Cities Act

UDG – Urban Development Grant

UIG – Urban Institutional Grant

UTNWF – Upper Tana-Nairobi Water Fund

VUMA – Vijana Usafi na Maendeleo

VICCO – Viwandani Comprehensive Community Organization

WB – World Bank

WB – World Bank

WGPP – Wote Green Park Project

WSUD – Water Sensitive Urban Design

Executive Summary

Executive Summary

Understanding Nature-based Solutions (NbS) in Kenya

Nature-based Solution is an operational approach, an umbrella framework to address societal challenges combining conservation approach of ecosystem with biodiversity and human well-being as primary objectives (IUCN, 2016). In Kenya, urban areas face multiple challenges, combining rapid population growth, accelerated urbanization, insufficient urban infrastructure and increasing urban climate vulnerability with exacerbated climate hazards like flooding, droughts, and heatwaves. Secondary cities where growth has recently started, can seize pivotal moment in their development to leverage NbS for a resilient and more inclusive urban development.

Kenyan Enabling Environment for NbS

Kenya's policy and regulatory framework is essential for integrating NbS into urban planning and development. As part of the "enabling environment“, it plays a pivotal role in either promoting or limiting the integration of NbS into urban projects and policies. The integration of NbS into Kenyan secondary cities requires a careful alignment of urban planning, climate change, and biodiversity frameworks to ensure their effective development.

The national framework provides a foundation for integrating NbS yet overlapping responsibilities among institutions hinder effective implementation. The Constitution (2010) and Kenya Vision 2030 guide urban planning and development as well as climate resilience. Laws like the Climate Change Act (2016) and Urban Areas and Cities Act (2011) promote sustainable development but overlapping roles complicate NbS integration.

Multiple actors at national, county, and municipal levels are responsible for urban planning and development, but effective NbS integration requires clear strategy, better coordination, and stronger local capacity. National ministries, county governments, and municipalities play key roles. However, they face challenges with limited resources, technical capacity, etc. A more coordinated approach is needed to enable municipalities to play a central role in implementing NbS.

NbS development requires a clear and integrated city vision as well as a multi-stakeholder approach to deliver their multiple potential benefits. The current framework lacks cohesion, making it difficult for municipalities to implement integrated, long-term strategies. Strengthening coordination across institutions is essential for successful NbS adoption.

Public participation is also a key component of Kenya’s governance and essential in NbS development, but civil society and professional organizations face capacity constraints. Civil society is increasingly engaged in resilient urban development through participatory approaches, to integrate local needs into planning and foster private sector’s engagement. Professional bodies also hold a pivotal role in standardizing and promoting good practices. However, these institutions face significant limitations, as much of urbanization occurs without professional design, oversight, or certified advice. Enhancing their role will be essential for developing NbS in urban areas.

NbS development in Kenya benefits from diverse external funding sources, supported by various stakeholders at state and local levels, though challenges in compliance and technical requirements remain for county actors. NbS development in Kenya is supported by multiple external funding sources. Key contributors include multilateral development banks NGOs, and bilateral cooperation frameworks. Notable projects funded through these avenues include the Kenyatta Avenue Green Corridor, one the Compendium case study, or the Safari Green Building Index. Counties access funding via equitable share transfers from the national government and conditional grants tied to specific urban development programs, such as KUSP1 and KUSP2. These grants are often restricted in use and are linked to the achievement of measurable results, influencing the NbS development in Kenyan cities. KUSP2, in particular, offers an opportunity for more resilient and inclusive urban development, increasing the potential for municipalities to adopt NbS solutions. However, the complexity of compliance systems and technical requirements may limit the ability of local actors to fully benefit from these funding opportunities.

NbS Compendium for NbS replicability and scalability

The NbS Compendium aims at enhancing the understanding of NbS and the characteristics of scalable NbS families for promoting urban resilience in Kenyan secondary cities, as well as to provide recommendations for NbS implementation into upcoming projects. It provides actionable guidance to local stakeholders for identifying the replicability potential of existing NbS initiatives, assessing their scalability, and maximizing their benefits in the Kenyan urban context.

The NbS Compendium also facilitates knowledge dissemination and sharing across stakeholders, aiming to improve understanding and foster NbS mainstreaming. By doing so, it promotes informed decision-making in urban planning and development, ensuring that NbS solutions are better integrated into local governance structures.

Kenyan NbS Inspiring Cases

The NbS Compendium draws lessons from 12 selected NbS projects selected from an Inventory of existing NbS cases in Kenyan urban contexts. Eleven NbS projects, representing ten distinct NbS families from World Bank's Catalogue (2021), were selected for running a gap analysis. This assessment, based on data from field missions, key informant interviews (KIIs), expert elicitation, and desktop research, identifies inspiring features of the projects as well as critical features to improve scalability for each NbS family. While the methodological framework is consistent across cases, the situational nature of each NbS family's efficiency and applicability means that the cases cannot be directly compared.

The NbS Compendium seeks to enhance understanding and guide the scalability and replicability of NbS in Kenyan secondary cities, using existing inspirational NbS projects as a foundation. The study delves into eight strategic components to evaluate the potential for replicability and scalability of these projects and identify inspirational features: the response to climate change, benefits for the environment, biodiversity, and soil; the implementation process and technical features; operational and maintenance implications; financial schemes and sustainability; monitoring and evaluation systems; legal, regulatory, and policy frameworks; and stakeholder engagement and social inclusion processes. All of these key features need to be factored in to reach a systemic approach to NbS implementation.

This gap analysis helps identify project features that can be leveraged to promote NbS development across Kenya, as well as areas for improvement to enhance scalability. By examining these eight strategic components, the NbS Compendium contributes to reinforcing NbS understanding among stakeholders and provides a structured framework for evaluating NbS projects. It serves as a tool for ensuring the effective adoption and scaling of NbS, particularly in urban areas, by aligning projects with the necessary conditions for success.

The main results of this gap analysis and a synthetic overview of the conditions for uptake of these NbS families are presented in the following pages.

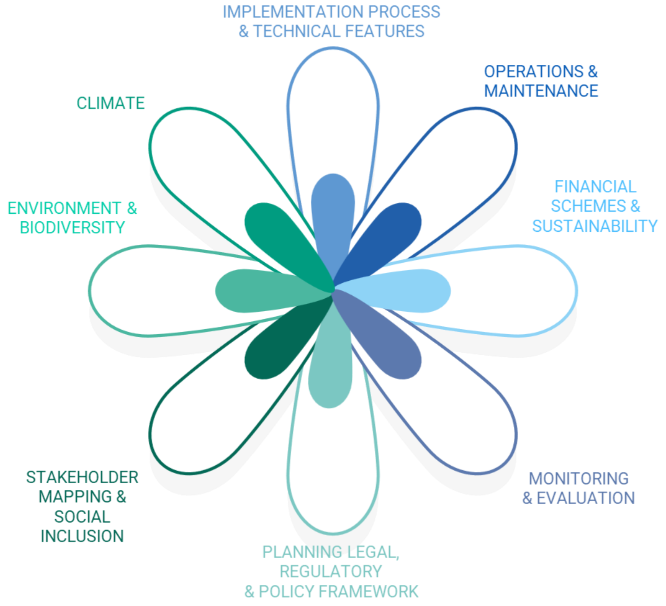


Figure 1 - The eight strategic components for NbS case gap analysis (Source: SUEZ Consulting, 2024)

NbS Compendium Cases Gap Analysis Overview

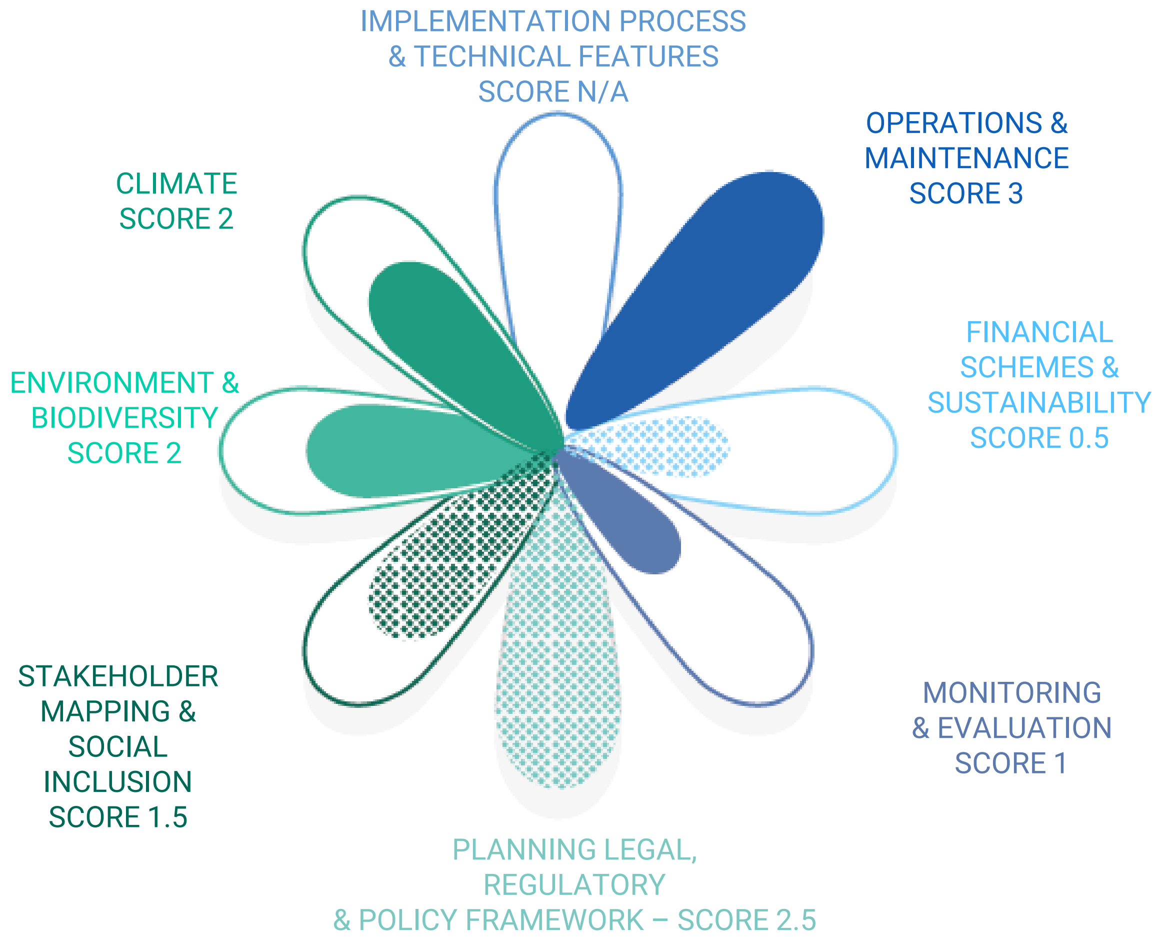
The project analysis consists of 8 components, represented in an evaluation flower to assess the NbS project's maturity and potential for replication in Kenya. Each component includes two equally weighted criteria, with scores ranging from 0 to 3 to assess process mastery and benefits. Score definitions: 0 = insufficient data, 1 = ad hoc elements, 2 = preliminary study, 3 = comprehensive study. For Kaya Tembo Forest, some assessments are marked as N/A. Intermediate scores (0.5, 1.5, 2.5) are indicated by dotted petals, as are components with a score of 0 for any criterion.

Project response to climate risks - score
Project adaptation to local climate conditions and hazards (present and future) - score

Project response to environmental risks (e.g., pollution, biodiversity) - score
Environment and urban biodiversity benefits - score

Stakeholder engagement & consultation strategy - score
Socio-economic benefits and inclusion of vulnerable group - score

Planning and development strategy - score
Regulatory and land tenure strategy - score



Design and implementation process - score
Key features of the technical design - score

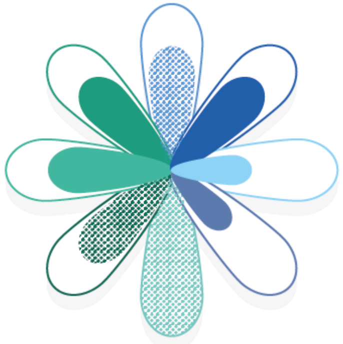
Roles and responsibilities - score
Operation & Maintenance plan - score

Project costs, revenue generation and funding - score
Integrated financial plan and project sustainability - score

Key existing indicators - score
M&E system and knowledge dissemination - score

NbS Compendium Cases Gap Analysis Overview

Case #1 Eldoret Arboretum

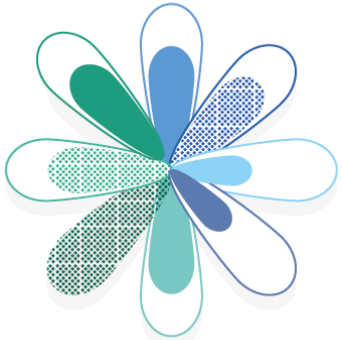


Case #2 Living Smiles

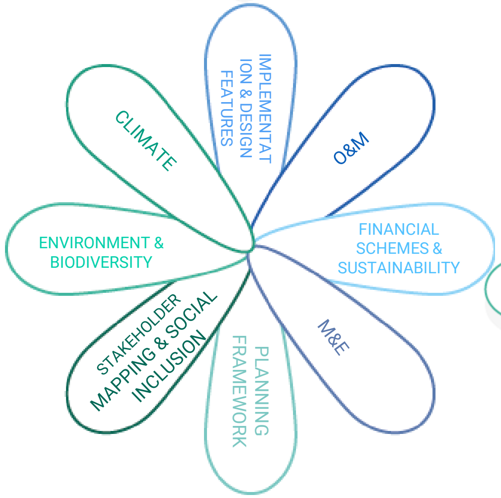
Case #3 Ondiri Wetland

Case #4 Malindi Waterfront Park

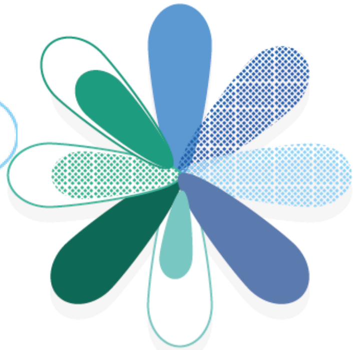
Case #5 Bangladesh Mangrove Restoration Project



Case #6 Kaya Tembo Forest



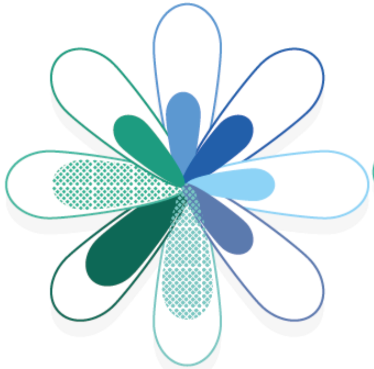
Case #7 Saint John's Community School



Case #8 Upper Tana-Nairobi Water Fund

Case #9 Kansoul Farm

Case #10 John Michuki Memorial Park



Case #11 Green Corridors

<u>Note</u>:
Level 0 : no data or insufficient data available | Level 1: first elements (*ad hoc*) but disparate, without a proper justification | Level 2: preliminary study but lack of comprehensiveness | Level 3: comprehensiveness (full study)
Given the specific nature of Kaya Tembo Forest, some assessment result in N/A (not applicable)
Intermediate scoring (0.5, 1.5, 2.5) are marked with dotted petal, as well as component having a criterion with a score 0

NbS Compendium Cases Conditions for Uptake

Case 1. Open Green Space – *Eldoret Arboretum*

The Eldoret Arboretum integrates environmental and social goals to address urban challenges like urban heat. It uses native species for reforestation and promotes community involvement through cultural and recreational spaces.

Key inspirational features:

- **Native vegetation**: Promotes biodiversity and climate action through native tree species.
- **Cultural integration**: Features like nature trails and the "Wall of Legends" foster community pride.
- **Positive social impact**: Strengthens rehabilitation program for prisoner through maintenance working opportunities.

Key improvement area for replicability:

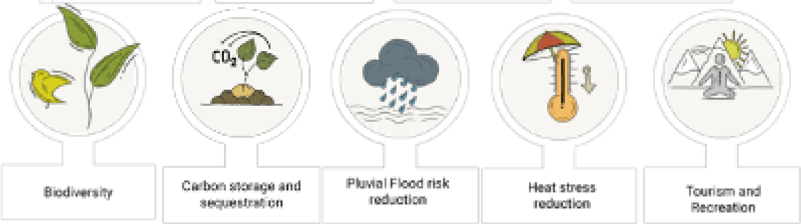
- **Urban and ecological integration**: Incorporate parks into urban plans with proper mandates and resources, completed with specific sectoral policies.
- **Community engagement**: Involve vulnerable groups in park management and design.
- **Sustainable funding mechanism**: Use green bonds and eco-tourism for financial sustainability.
- **Public awareness**: Educate citizens on the benefits of green spaces.

Figure 2 – A view of Eldoret Arboretum (Source: SUEZ Consulting, 2024)

Urban setting	CBD – Eldoret City
NbS case category	Green infrastructure
Climate context	Subtropical highland

Addressed risks

Benefits



NbS Compendium Cases Conditions for Uptake

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Case 2. **Terraces and Slopes** – *Living Smiles (Earth Bunds)*

The Living Smiles project combats land degradation using bunds, a low-cost and adaptable technique that stabilizes soil, reduces erosion, and enhances water retention, particularly in arid regions.

Key inspirational features:

- **Low-cost implementation**: Uses local materials, ensuring affordability and replicability.
- **Community ownership**: Actively involves local communities in restoration efforts.
- **Scalability**: Easily adaptable to various terrains and climates.
- **Ecosystem restoration and adaptation to arid and semi-arid climates:** drought-resistant grasses stabilize soil, improve biodiversity, and enhance water cycles.

Key improvement area for replicability:

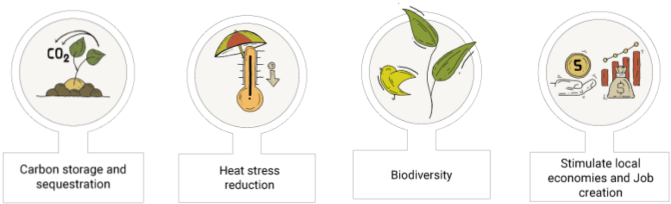
- **Suitable terrain**: Ensure adequate rainfall and deep soil for bund effectiveness.
- **Training**: Integrate communities need skills in construction and maintenance.
- **Restoration policies alignment:** Develop partnerships.

Figure 3 – A site after the construction of bunds and after revegetation (Source: https://ourworld.Justdiggit.org/en/chapter/water-bunds)

Urban setting	Rural – Chyulu Hills, Kuku Ranch
NbS case category	Green infrastructure
Climate context	Hot semi-arid

Addressed risks

Benefits



NbS Compendium Cases Conditions for Uptake

Case 3. **Natural Inland Wetlands** – *Ondiri Wetland*

The Ondiri Wetland exemplifies the value of wetlands in water purification and biodiversity. It uses a structured management plan, focusing on community involvement and regular monitoring to restore and protect wetlands.

Key inspirational features:

- **Ecosystem restoration**: Combines reforestation and erosion control for wetland health.
- **Management plan**: A structured plan offers a replicable framework for other wetlands.
- **Community involvement**: Local groups play a vital role in conservation.

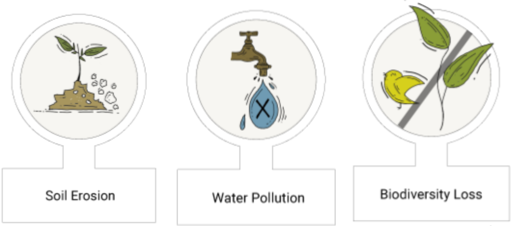
Key improvement area for replicability:

- **Wetland assessment**: Consider local climate impacts for tailored maintenance.
- **Standardized management plans**: Create evidence-based restoration plans at county level.
- **Engagement and policy support**: Empower communities and enforce wetland laws.

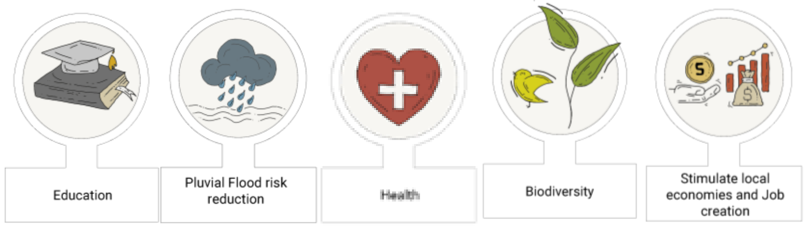
Figure 4 – Vegetable gardens and the swamp in the Ondiri Wetland (Source: SUEZ Consulting, 2024, https://www.youth4nature.org/blog/ondiri-blog)

Urban setting	Peri-urban – Kiambu County
NbS case category	Green infrastructure
Climate context	Subtropical highland

Addressed risks



Benefits



NbS Compendium Cases Conditions for Uptake

Case 4. Sandy Shores – *Malindi Waterfront Park*

The Malindi Waterfront Park revitalizes a coastal area, blending green infrastructure with recreational spaces. It serves as a model for integrating ecological restoration with urban renewal to boost tourism and community engagement.

Key inspirational features:

- **Green infrastructure**: Uses vegetation for environmental and aesthetic benefits.
- **Tourism and economic growth**: Combines restoration with tourism-driven revitalization.
- **Social benefit**: Promotes social cohesion through recreational spaces.

Key improvement area for replicability:

- **Coastal resilience**: Propose hybrid solutions, like vegetated berms, to mitigate coastal risks.
- **Climate adaptation**: Focus on erosion and saltwater impacts through NbS strategies.
- **Clear roles and responsibilities:** Establish clear responsibilities between various stakeholders for project success, separate design, construction, operation and maintenance responsibilities.

Figure 5 - A view of Malindi Waterfront park (Source: SUEZ Consulting, 2024)

Urban setting	Formal – Malindi City
NbS case category	Hybrid infrastructure
Climate context	Tropical dry savannah

Addressed risks

Benefits

NbS Compendium Cases Conditions for Uptake

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Case 5. **Mangrove Forests** – *Bangladesh Mangrove Restoration Project*

The Bangladesh Mangrove Restoration Project demonstrates how restoring mangrove ecosystems can protect coastlines and provide socio-economic benefits. Community-led efforts integrate alternative livelihoods like aquaculture and eco-tourism.

Key inspirational features:

- **Community-led restoration**: Local communities manage restoration and maintenance.
- **Livelihood diversification**: Eco-tourism and aquaculture reduce dependency on mangrove resources.
- **Global awareness**: Engages local communities in global restoration efforts.

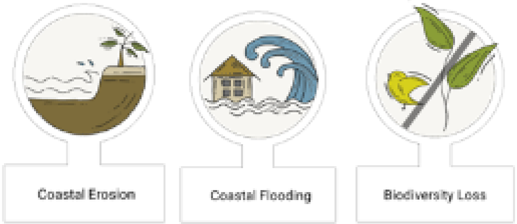
Key improvement area for replicability:

- **Community capacity-building**: Provide training for local ownership and long-term sustainability.
- **Alternative livelihoods opportunities**: Encourage income-generating activities (e.g., beekeeping, aquaculture, eco-tourism) to reduce resource pressure.
- **Financial incentives**: Use Payment for Ecosystem Services (PES) and climate funds to finance restoration.

Figure 6 – Community members planting seedlings at the Bangladesh mangrove forest (Source: SUEZ Consulting, 2024)

Urban setting	Formal – Tudor Creek, Mombasa
NbS case category	Green infrastructure
Climate context	Tropical dry savannah

Addressed risks



Benefits

NbS Compendium Cases Conditions for Uptake

Case 6. **Urban Forests** – *Kaya Tembo Forest*

Kaya Tembo Sacred Forest integrates ecological preservation with cultural heritage. It demonstrates how sacred forests can play a vital role in both environmental conservation and community resilience.

Key inspirational features:

- **Cultural significance**: Preserves cultural practices while addressing ecological challenges.
- **Locally-led management framework**: Local communities manage the forest to ensure ecological health.
- **Biodiversity and water conservation**: Contributes to soil stabilization and water conservation.

Key improvement area for replicability:

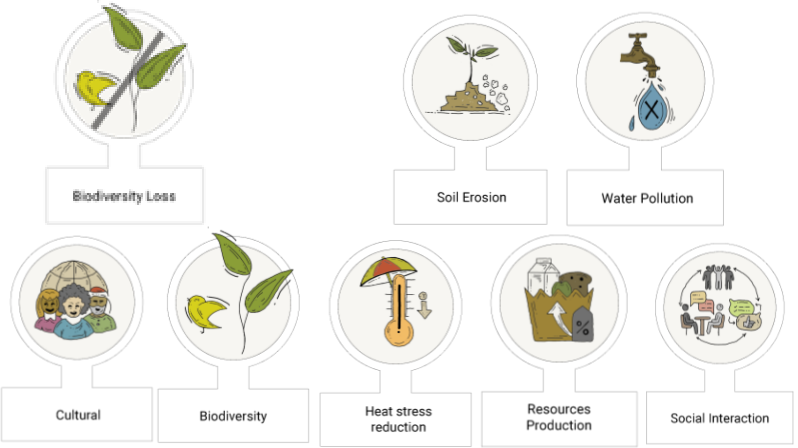
- **Specific protection policy**: Apply specific provisions for natural forest conservation and sustainability.
- **Collaborative governance**: Involve local authorities and communities in forest management to ensure adaptative capacity of the Kaya ecosystem.
- **Financial mechanisms**: Explore local carbon mechanisms opportunities and partnerships to support conservation.

Figure 7 – A view of Kaya Tembo Forest (Source: SUEZ Consulting, 2024)

Urban setting	Peri-urban – Dongo Kundu, Likoni sub-County, Mombasa
NbS case category	Green infrastructure
Climate context	Tropical dry savannah

Addressed risks

Benefits



NbS Compendium Cases Conditions for Uptake

Case 7. Bioretention Areas – *Saint John's Community School*

The rain garden at St. John's Community School improves stormwater management and provides environmental and social benefits, particularly in underserved informal urban areas.

Key inspirational features:

- **Vulnerable population improvement**: Enhances the health and safety of local students.
- **Community-led design**: Ensures the design meets community needs and fosters ownership.
- **Multi-functionality**: The rain garden supports stormwater management, aesthetics, and environmental education.

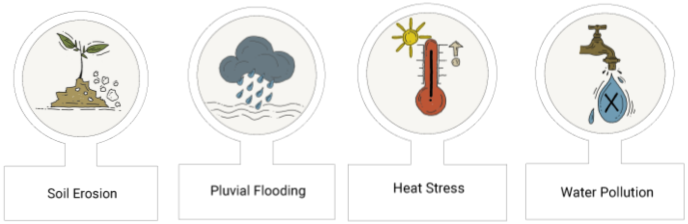
Key improvement area for replicability:

- **Pilot projects replication pathway**: Explore pilot rain garden projects to refine designs and scale solutions.
- **Policy integration**: Include NbS in urban infrastructure upgrades and settlement planning.
- **Tailored technical features**: Customize designs to local soil conditions and space constraints.

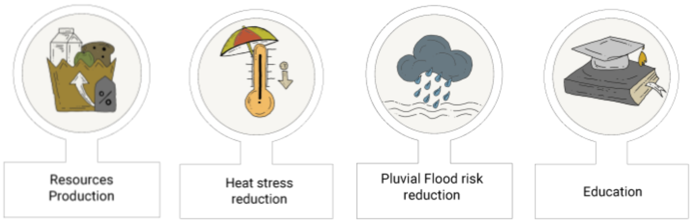
Figure 8 – Installation of green landscaping and rain gardens at St. John's Community School.(Source: https://www.kounkuey.org/projects/realising_urban_NbS)

Urban setting	Informal – Southeast Kibera, Nairobi
NbS case category	Hybrid infrastructure
Climate context	Subtropical highland

Addressed risks



Benefits



NbS Compendium Cases Conditions for Uptake

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Case 8. River and stream renaturation – *Upper Tana-Nairobi Water Fund (Upper Tana-Nairobi Water Fund)*

The UTNWF uses a pioneering funding model to finance NbS at the watershed scale, restoring rivers and streams to enhance water security and ecosystem health through public-private partnerships.

Key inspirational features:

- **Mixed NbS portfolio**: Combines terracing, agroforestry, and riparian restoration.
- **Public-private partnerships**: Engages various stakeholders for shared conservation benefits.
- **Replication potential**: Serves as a model for similar projects in Kenya and Africa.

Key improvement area for replicability:

- **Financial adaptation**: Update continuously financial plans to meet evolving challenges.
- **Pilot sites**: Use pilot projects to refine practices and demonstrate benefits.
- **Farmer incentives**: Engage small farmers early to ensure participation and long-term success.

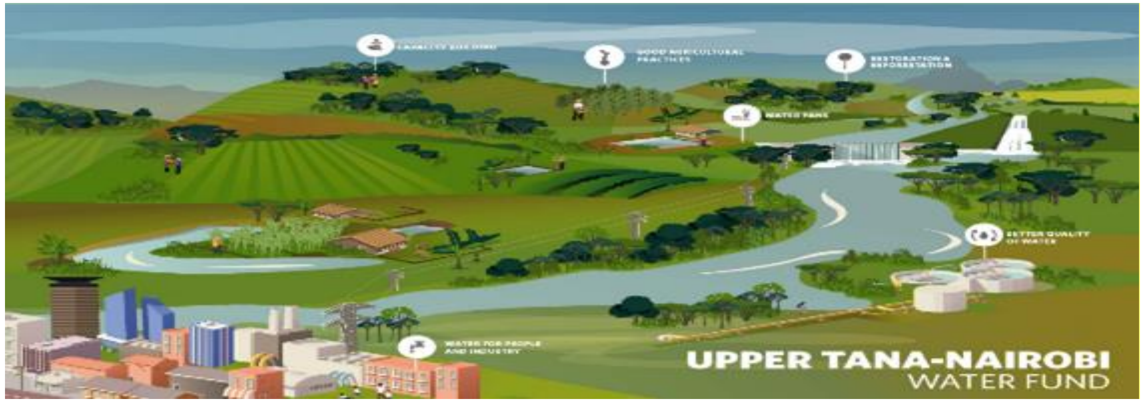
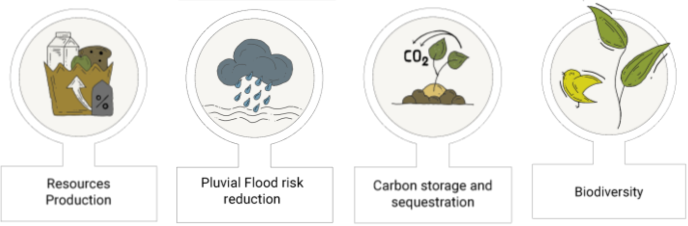


Figure 9 – Aspects of the Upper Tana-Nairobi Water Fund project (Source: https://nairobiwaterfund.org/water-funds-in-africa/)

Urban setting	Peri-urban – Tana River
NbS case category	Policy/Programmatic
Climate context	Subtropical highland

Addressed risks

Benefits



NbS Compendium Cases Conditions for Uptake

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Case 9. **Urban Farms** – *Kansoul Farm*

Kansoul Farm uses space-efficient farming techniques to combat food insecurity and youth unemployment in informal settlements, promoting ecosystem restoration through urban agriculture.

Key inspirational features:

- **Space-efficient techniques**: Uses sack and vertical farming to optimize limited space.
- **Circular sustainability**: Emphasizes composting, water management, and minimal land use.
- **Community impact**: Provides fresh produce and strengthens social cohesion through cooperative farming.

Key improvement area for replicability:

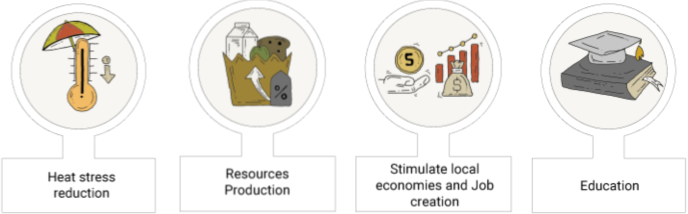
- **Climate adaptation**: Design farms to withstand climate change impacts, especially in dense urban areas.
- **Policy support**: Strengthen urban agriculture policies at the city level to incentivize farming in underserved areas.
- **Community empowerment**: Provide training in sustainable farming to ensure long-term success.

Figure 10 – VICCO's Farm (Source: A Few Years Later -Transforming Nairobi's Informal Settlements Through Urban Farming – HealthyFoodAfrica https://healthyfoodafrica.eu/blog/a-few-years-later-transforming-nairobis-informal-settlements-through-urban-farming/)

Urban setting	Informal – Viwandani, Sinai area, Nairobi
NbS case category	Resource production
Climate context	Subtropical highland

Addressed risks

Benefits



NbS Compendium Cases Conditions for Uptake

Case 10. River Stream Renaturation – *John Michuki Memorial Park*

John Michuki Park integrates river stream renaturation with urban green space development, restoring riparian areas and creating recreational spaces for the local community.

Key inspirational features:

- **NbS combination**: Combines river restoration with green space to provide ecological and social benefits.
- **Land control**: Prevents land-grabbing through strategic management by Kenya Forest Service.
- **Public engagement**: A communication campaign changes perceptions of the park from a dumping ground to a valued community space.

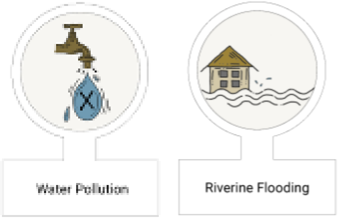
Key improvement area for replicability:

- **Broader ecological integration**: Expand the project to enhance biodiversity and ecosystem benefits.
- **Climate risk assessment**: Ensure the project is resilient to climate impacts, such as riverbank erosion.
- **Collaborative governance**: Develop a shared monitoring and maintenance framework among stakeholders.

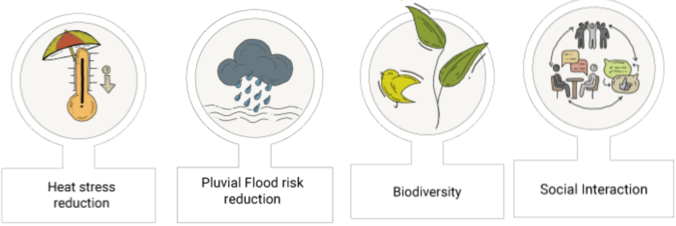
Figure 11 – Recent pictures of John N. Michuki Conservation Park (Source: SUEZ Consulting, 2024)

Urban setting	Formal – Nairobi
NbS case category	Green infrastructure
Climate context	Subtropical highland

Addressed risks



Benefits



NbS Compendium Cases Conditions for Uptake

Case 11. Green Corridors – *Nakuru Green Corridors*

Nakuru Green Corridors enhance urban sustainability by integrating tree-lined avenues and pedestrian pathways to manage stormwater, improve mobility, and support biodiversity.

Key inspirational features:

- **Optimizing Non-Motorized Transport (NMT):** Incorporates tree canopies and permeable pavements to manage stormwater and regulate urban temperatures.
- **Community involvement**: Engages local stakeholders in the design process to ensure the project addresses community needs.
- **Multi-functionality**: Green corridors provide both ecological and social benefits.

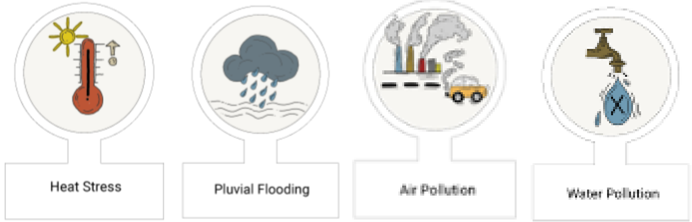
Key improvement area for replicability:

- **Policy integration**: Integrate green corridors into urban development plans and specific sectoral policy such as sponge-city plan to avoid piecemeal development.
- **Maximize NbS**: Adapt NMT infrastructure to enhance biodiversity and stormwater management.
- **Avoid land-use conflicts**: Use co-design approaches to balance public space functions and ecological needs.

Figure 12 – A104 Highway, Nakuru (Source: Nakuru City)

Urban setting	Green corridors – Nakuru
NbS case category	Green infrastructure
Climate context	Warm-summer Mediterranean

Addressed risks



Benefits

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Six cities' urban challenges and NbS prioritization assessment

Insights from six cities are provided to assess the potential for Nature-based Solutions development in Kenyan secondary cities. A city assessment was conducted in Kisumu, Mandera, Kilifi, Eldoret, Wote, and Nakuru, selected for their diverse urban and climate contexts, to identify conditions conducive to NbS development. The assessment includes a high-level overview of each city's urban profile and climate risk exposure, covering key geographic, demographic, and institutional characteristics, economic drivers, land-use patterns, urban challenges, climate zone, hazards, and climate projections. This analysis provides a foundational understanding of the cities' urban challenges and climate vulnerabilities.

The assessment also evaluates each city's NbS development potential, considering alignment with urban planning frameworks, ongoing NbS initiatives, and findings from the World Bank's NbS Opportunity Scan (NBSOS). The methodology includes reviewing the integration of climate resilience and environmental protection into planning documents, as well as examining existing NbS initiatives and conducting Key Informant Interviews (KIIs). The NBSOS contributes by offering municipal-level spatial analysis of climate hazard assessment and screening of NbS families that are the most relevant given these urban development challenges.

The assessment highlights key barriers to NbS implementation, such as financial, technical, and regulatory constraints. Additionally, the report links potential NbS opportunities in each city to relevant case studies from the NbS Compendium, offering practical examples and lessons learned from similar urban contexts. A summary table presents the NbS development opportunities for each city, with a focus on four emerging NbS families, rather than well-established practices. This assessment draws from several sources, including a literature and policy review of key planning documents, KIIs with city officials, and results from the NBSOS, which provides spatial modeling to identify NbS interventions that could mitigate hazards like heat and flooding.

Figure 13 – An aerial view of Mandera town where trees have been planted along the road
(Source: Mandera History – County Government of Mandera)

Figure 14 - Aerial view of Nakuru City
(Source: 19677.pdf, 2022)

Recommendations for NbS Implementation

The recommendations section highlights key and focused recommendations for enabling the integration of Nature-based Solutions into upcoming infrastructure projects. Drawing from lessons learned in existing NbS cases, cities' assessment and challenges identified in the enabling environment drivers, these recommendations offer actionable insights for improving the planning, design, and execution of NbS initiatives. It completes gaps in existing guidance, namely AECOM Resilient Infrastructure Guidelines (2023). This approach aims to facilitate the integration of NbS into infrastructure projects, making it easier for stakeholders to adopt NbS principles.

The recommendations aim at drawing a general framework to facilitate NbS project at each stage of the project cycle as well as expanding on four key enabling environment drivers for NbS development. Though drawing from NbS Compendium NbS cases (link with the NbS Compendium cases are stressed when appropriate) and related NbS family, these recommendations are not specific to any NbS family. 37 recommendations are identified at municipality- and national- levels, and at the different main steps of the project cycle (planning, project identification and design, construction and operation and maintenance, monitoring and evaluation).

The recommendations focus on aligning four enabling environment drivers with NbS development, complementing the technical aspects of implementation. The four enabling environment drivers are: (i) identifying knowledge generation and technical requirements, (ii) fostering the inclusion of stakeholders, (iii) strengthening institutional capacities and ensuring adequate resources and (iv) integrating policies and regulations.

Key features of NbS in the context of resilient infrastructure are emphasized:.

- The report stresses the importance of connecting NbS projects with the ecosystems that support urban development, highlighting the potential for ecosystem services.
- It also underscores the need for sustainability, ensuring NbS solutions remain effective in the long term, especially in the face of climate change.
- The preservation and restoration of existing NbS are highlighted as essential, with strategies incorporated at every stage of the project cycle.
- Finally, the report acknowledges the interdisciplinary complexity of NbS, emphasizing the need for a holistic approach to its implementation to bridge the gaps between various fields of expertise.

An overview of the key recommendations at each project cycle phase is presented in the following pages.

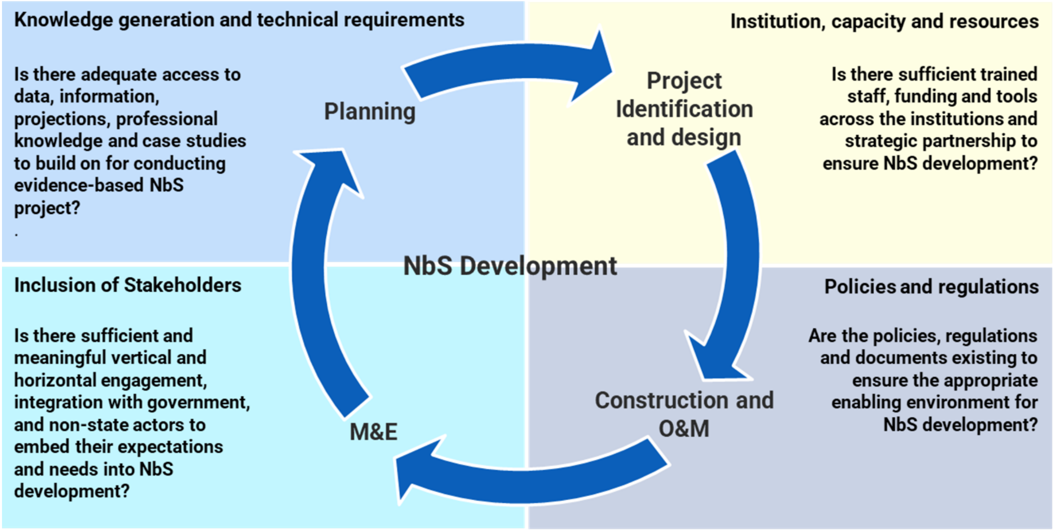

Figure 15 - Project cycle and the four enabling environment drivers (and associated methodological questions) (Source: SUEZ Consulting, 2024)

Recommendations overview

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PLANNING — PROJECT IDENTIFICATION & DESIGN — CONSTRUCTION, OPERATION & MAINTENANCE — MONITORING & EVALUATION

Knowledge generation and technical requirements	#1 Clarify the objectives and contents of environmental baseline for long-term strategic and sectoral planning	Muni. / Cou.	
	#2 Develop evidence-based land-use and investment prioritization strategy	Municipality	P
Inclusion of stakeholders	#1 Develop awareness raising platforms and channels with local stakeholders	Municipality	
	#2 Encourage ownership of local stakeholders	Municipality	
	#3 Identify and support the development of community-level climate resilience initiatives	Municipality	P
Institution, capacity and resources	#1 Ensure coordinated actions under climate change umbrella	Muni. / Nat.	
	#2 Reinforce collaboration between urban planning county departments and city-level authorities	Muni. / Cou.	P
	#3 Shift urban planning from solution-centric to problem-centric approaches	Muni. / Nat.	
Policies and regulation	#1 Enforce NbS as a national initiative	National	P
	#2 Transition municipal plans from guidance documents to comprehensive urban planning tools	Municipality	
	#3 Recognize and formalize community initiatives to enhance urban planning policies	Municipality	

Institution — Level of implementation

P — Identified as priority by the stakeholders

Recommendations overview

GLOBAL CENTER ON ADAPTATION

PLANNING — **PROJECT IDENTIFICATION & DESIGN** — CONSTRUCTION, OPERATION & MAINTENANCE — MONITORING & EVALUATION

Knowledge generation and technical requirements

- #1 Foster interdisciplinary expertise to advance NbS development — Muni. | Nat. | P
- #2 Develop a cost-benefit analysis (CBA) framework to prioritize large-scale NbS development — Muni. | Nat.
- #3 Ensure inclusive design — Municipality

Inclusion of stakeholders

- #1 Adapt NbS projects to community-level scope and capacity through co-design and multi-functional design following local necessities and interests — Municipality

Institution, capacity and resources

- #1 Clarify roles and foster collaboration for NbS integration — Muni. | Nat. | P
- #2 Enhance municipal capacity to support NbS projects and integration — Municipality
- #3 Strengthen the role of professional bodies in enhancing technical standards for NbS development address — Nat.
- #4 Land tenure challenges through public-private partnerships for NbS Development — Muni. | Nat.

Policies and regulation

- #1 Integrate environmental quotas and incentives in development control to foster NbS implementation — Muni. | Nat.
- #2 Strengthen the role of environmental and social impact assessment (ESIA) to drive NbS adoption and resilience-oriented investments — National | P

Institution — Level of implementation

P — Identified as priority by the stakeholders

Recommendations overview

GLOBAL CENTER ON ADAPTATION

PLANNING — PROJECT IDENTIFICATION & DESIGN — **CONSTRUCTION, OPERATION & MAINTENANCE** — MONITORING & EVALUATION

Knowledge generation and technical requirements

#1 Activate local supply chains for NbS construction and long-term management — Muni. | Cou. | P

Inclusion of stakeholders

#1 Preserve and enhance the social value of public spaces through NbS development — Municipality

#2 Encourage the participation of local communities in O&M activities — Municipality

Institution, capacity and resources

#1 Pursue coordinated action initiated at the planning throughout construction and O&M — Municipality | P

#2 Develop O&M plans to ensure O&M planning, responsibilities, financial sustainability, and clear management guidance from the NbS design phase — Municipality | P

#3 Develop O&M capacity building programs — National

Policies and regulation

#1 Enhance NbS inspection and enforcement at the local level — Municipality

Institution: Level of implementation

P: Identified as priority by the stakeholders

Recommendations overview

GLOBAL CENTER ON ADAPTATION

PLANNING — PROJECT IDENTIFICATION & DESIGN — CONSTRUCTION, OPERATION & MAINTENANCE — **MONITORING & EVALUATION**

Knowledge generation and technical requirements

- #1 Develop a robust monitoring framework to evaluate NbS performance and benefits — Municipality
- #2 Implement an adaptive management framework for NbS — Municipality

Inclusion of stakeholders

- #1 Tap into citizen sensing data potential — National — P
- #2 Foster partnerships with Kenyan research institutions for advanced impact analysis and knowledge dissemination — Muni. — Nat.

Institution, capacity and resources

- #1 Design an appropriate framework for monitoring and evaluation — Municipality — P
- #2 Harness labelling initiatives for NbS as an adaptation measure to attract funding — National — P

Policies and regulation

- #1 Establish a national NbS monitoring framework to track outcomes across sectors — National — P
- #2 Implement a resilience scorecard to evaluate NbS integration in municipal plans — Municipality
- #3 Develop community-led NbS impact assessment tools — Municipality

Institution: Level of implementation

P: Identified as priority by the stakeholders

Preliminary checklist for municipalities

This flowchart presents a detailed checklist of the key tasks and actions required for the development of a NbS project at the municipal level in Kenya, structured across the four main phases of the project cycle. Each phase is broken down into specific steps, with priority recommendations highlighted based on stakeholder input. These recommendations are designed to facilitate the smooth execution of tasks and strengthen the enabling conditions necessary for NbS development. By incorporating these insights, the flowchart aims to provide a practical guide for municipalities, ensuring that the necessary actions are taken at each stage of the project cycle to promote successful NbS outcomes.

PLANNING

- ❑ Use a spatial prioritization framework to map NbS that need to be protected, restored and created #2
- ❑ Engage with local communities where NbS opportunities exist to choose sites suitable for NbS implementation within target communities #3
- ❑ Strengthen coordination and clarify roles and responsibilities between county-level and city-level planning mechanisms #2
- ❑ Elaborate comprehensive planning document #2

PROJECT IDENTIFICATION & DESIGN

- ❑ Identify NbS opportunities #2
- ❑ Define project goals and outline the scope for NbS with the support of an adequate technical advisory committee
- ❑ Set up a project team gathering the required expertise #1 #1
- ❑ Collect project related data (climate, environment, local stakeholders…) #2
- ❑ Identify required permits and ensure regulatory compliance before construction #2

CONSTRUCTION, OPERATION & MAINTENANCE

- ❑ Incorporate local socio-economic development criteria #1
- ❑ Engage the community during and after construction #2
- ❑ Evaluate various NbS construction methods (e.g., phased vs. full-scale implementation) #1 #2
- ❑ Integrate both construction and O&M cost in evaluation criteria
- ❑ Elaborate a comprehensive checklist for inspecting NbS based on NbS family guidelines #1

MONITORING & EVALUATION

- ❑ Establish baseline information and monitoring framework #1
- ❑ Identify sources of potential data to build the project indicators, and centralize these data sources #1
- ❑ Implement a management framework that allows room for adaptative measures #2

Introduction

Nature-based Solutions: An Overview

Nature-based Solutions (NbS) is a relatively recent term, first introduced by the World Bank in 2008. Following a slow paradigm shift towards a more proactive management and protection of ecosystems in order to address societal challenges (Cohen-Shacham et al, 2019), NbS are defined by the International Union for Conservation of Nature (IUCN, 2016) as “actions to protect, sustainably manage, and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits.”

NbS is an operational approach, an umbrella framework to address societal challenges combining conservation approach of ecosystem with biodiversity and human well-being as primary objectives (IUCN, 2016). Indeed, these underlying concepts have been in practice for some time and NbS encompass several well-established proximate ideas. At the urban scale, these ideas include (depending on geographical location and disciplinary focus): Sustainable Urban Drainage Systems (SuDS), Water Sensitive Urban Design (WSUD), Low-Impact Development (LID), Blue-Green Infrastructure, Green Infrastructure, Ecosystem-based Adaptation (EbA), Ecosystem-based Disaster Risk Reduction (Eco-DRR), Holistic or Regenerative Landscape Management, Biomimicry and Integrated Urban Water Management (IUWM), (International Union for Conservation of Nature (IUCN) (2020), Wendling et al., (2021) and Fletcher et al. (2014)), to name a few.

NbS are characterized by the associated ecosystem services, the direct and indirect benefits natural processes provide to people (World Bank, 2021). They use “the power of functioning ecosystems as infrastructure” (IUCN, 2020) to mitigate urban challenges. This includes provisioning services, regulating services, cultural services or supporting services (IUCN, 2020). NbS offer numerous benefits to urban areas, addressing various societal challenges including disaster risk reduction and climate resilience. They contribute to biodiversity restoration, create recreational opportunities, improve human health, enhance water and food security, and support community well-being and livelihoods. NbS differ from Nature-derived Solutions (e.g., renewable energy production) and Nature-inspired Solutions (e.g., innovative design modelled on biological structure).

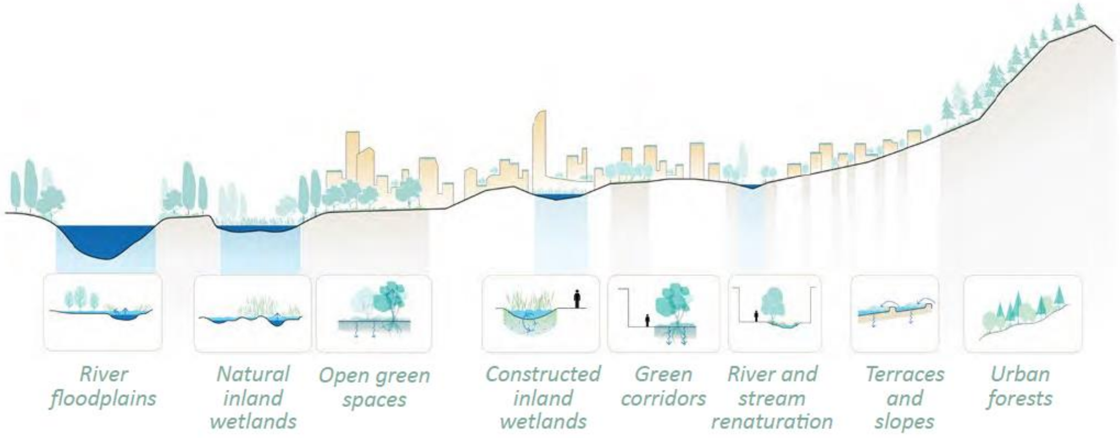


Figure 16 – Schematic section of NbS at the city scale (Source: World Bank, 2021)

Ecosystems are at the heart of NbS approaches and therefore protection of existing ecosystems should always come first among all NbS initiatives (before creation of new green spaces or modiying ecosystems), as a fundamental principle. A hierarchy of approaches under NbS umbrella is defined by the World Bank's (2021) as well as in the 2021 Nature Conservancy paper "Protect, Manage, and Then Restore Lands for Climate Mitigation" (Cook-Patton et al., 2021) as an overarching policy approach when developing new projects or programs.

This strategic approach emphasizes the importance of evaluating opportunities and developing adequate tools to first strengthen the protection of existing natural ecosystems within urban environments to maintain their critical functional and biodiversity values. Protecting and sustaining existing ecosystems such as wetlands, riparian areas, and urban forests is essential to maintain their vital biodiversity values, securing ecosystem services and reducing risks associated with urban development in high-hazard zones like floodplains. Long-lasting ecosystems are also often part of cultural heritage of local populations. To do so, all measures to secure such areas, starting from mapping, zoning to development control enforcement measures but also mechanisms or public policies to make these spaces accessible to the public (increasing the feeling of attachment), are critical and should be embedded in urban planning and development practices before looking at NbS as a specific stand-alone project.

Nonetheless, while the protection is paramount, it is also essential to adopt a comprehensive strategy that includes restoration and creation initiatives across the urban environment to seize the opportunity in a constrained context to reintroduce natural elements in urban open areas. The restoration of degraded ecosystems can improve their functionality and ecosystem service delivery, by addressing issues such as deforestation and habitat loss. Simultaneously, creating new NbS can further enhance urban resilience byre-introducing ecosystems within urban environments. While considering protection as the foundation, planners and city-makers should evaluate opportunities for restoring degraded ecosystems and creating new solutions that complement and enhance existing natural assets across the urban settings, to effectively coordinate resilience efforts.

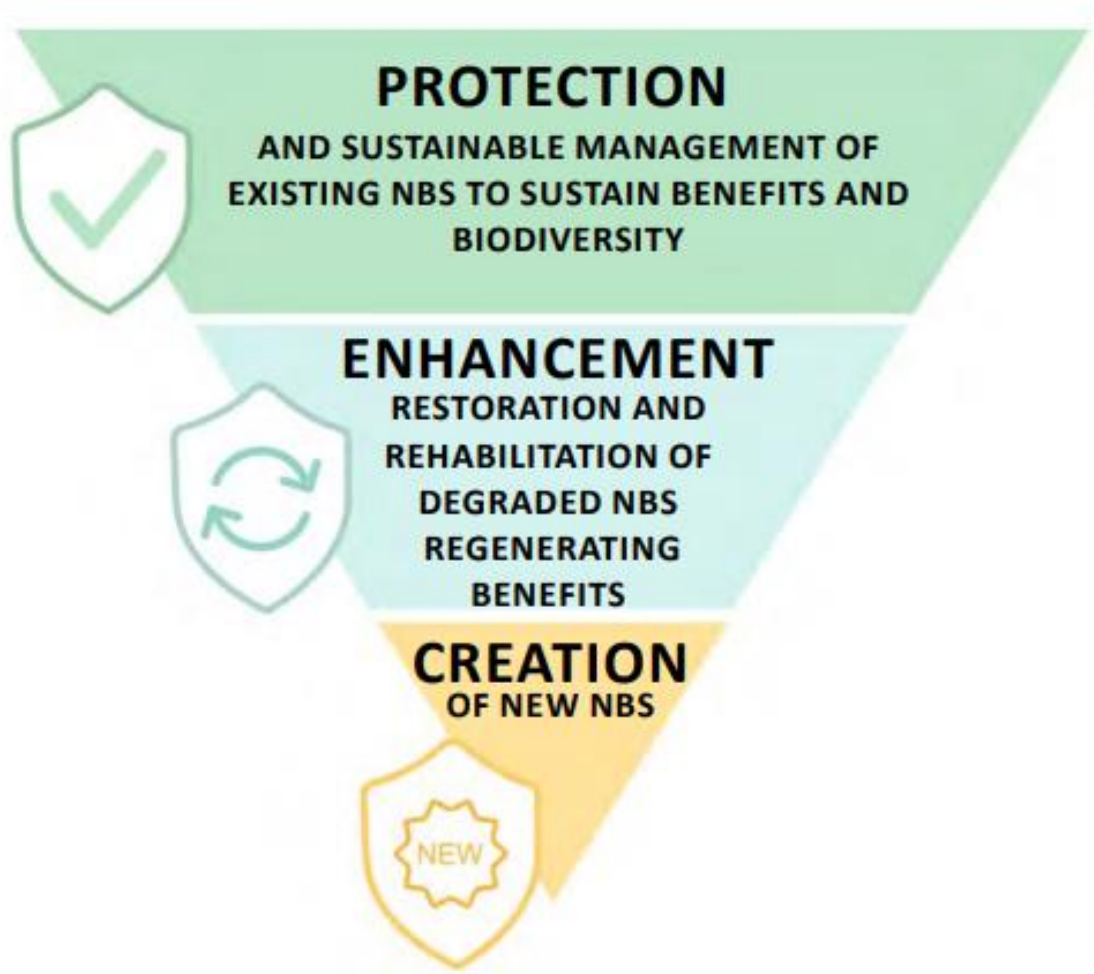


Figure 17 – A hierarchy of approaches under the nature-based solutions umbrella (Source: World Bank, 2021)

Furthermore, the design, development, and implementation of NbS projects differ from gray infrastructure. Conversely, gray infrastructure “refers to built structures and mechanical equipment” (World Bank, 2021), even if they can be embedded within natural ecosystems (e.g., watersheds, coastal ecosystems). Meanwhile, as a conservation approach of ecosystem aiming at addressing societal challenges, NbS are site- and context-specific, while crossing usual physical, institutional, administrative, and operational boundaries (IUCN, 2016). The temporality of their implementation (i.e., expertise to mobilize, environmental studies, maintenance costs, and long-term sustainability) add a level of complexity compared to gray infrastructure model that needs to be strategically planned for.

Effective and inclusive NbS development and long-lasting sustainability require a transparent and equitable decision-making process. This involves a wide range of local stakeholders, including riverine communities. It implies to adopt an intersectional approach to enhance the positive outcomes of the ecosystem services for all, and, moreover, to limit the risks of adverse impacts. NbS are embedded in different knowledge systems, both expert and traditional ecological knowledge. These underlying power dynamics need to be understood and overcome to better take into account the needs and expectations of vulnerable and marginalized groups (i.e., women, youth, elderly, refugees, people with disabilities marginalized ethnic or religious groups). For instance, to enhance conservation and functioning of ecosystems, NbS projects should not modify or reduce ecosystem services (e.g., traditions, culture, resource production) for another community.

NbS are multi-purpose and can be defined at different scales (i.e., neighborhood, city, catchment), but always with a landscape and land use approach, well integrated into the existing landscape and mindful of current and future land uses and associated conflicts. NbS rely on a cross-sectoral collaboration to go beyond the traditional siloed utilities sectors (e.g., energy, water production, transport) and to provide multiple benefits to people. In addition, they also involve new technical skills (e.g., ecologist, landscape architect), and reinforce the role of some expertise (e.g., Environmental and Social (E&S) safeguards, stakeholder engagement) and transversal management skills.

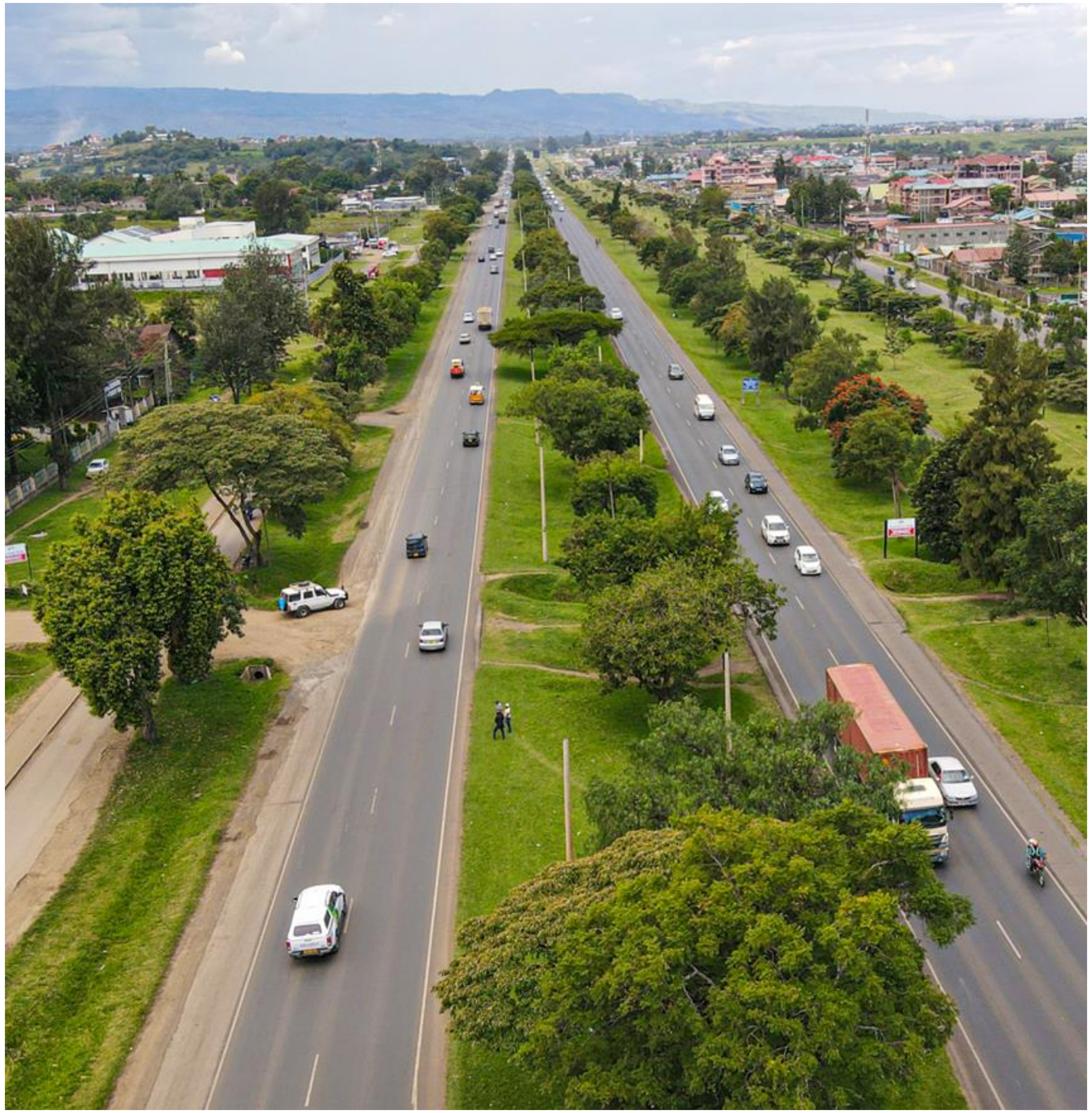


Figure 18 – NbS as hybrid infrastructure in Nakuru – Green Corridor along A104 Highway (Source: Nakuru City)

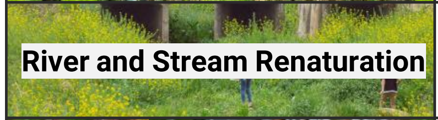
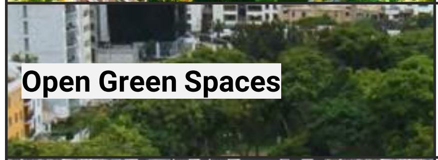
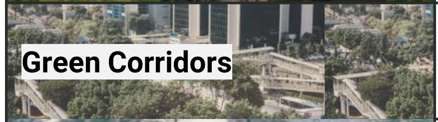
NbS also benefit from cross-stakeholder collaboration both in financing and in implementation (Hou-Jones X. et al, 2021). NbS development can be led by government, county, or municipality, as well as by communities or the private sector. For instance, government can facilitate the uptake of the project, the involvement of the different stakeholders, secure the planning process, and the maintenance/organizational scheme with the different actors. They can also facilitate pooling investment and partnerships across actors.

As an umbrella concept, the NbS tag covers a wide range of applications at different scale and in different contexts, for instance actionable green investment, rewilding and "passive" design initiatives or community-based resource production. To translate this diversity, especially in urban contexts, the World Bank's Catalogue of Nature-based Solutions for Urban Resilience (2021) identifies up to 14 NbS families: Urban Forests, Terraces and Slopes, River and Stream Renaturation, Building Solutions, Open Green Spaces, Green Corridors, Urban Farming, Bioretention Areas, Natural Inland Wetlands, Constructed Inland Wetlands, River Floodplains, Mangrove Forests, Salt Marshes, and Sandy Shores. Each family is associated with location suitability (type of city, scale), the approach (conservation, rehabilitation or creation), their functions and ecosystems services they provide (also called benefits).

Therefore, NbS can be implemented in various ways (also identified as "NbS categories" in the NbS Inventory). It can be a stand-alone investment, also called "green infrastructure". NbS can also be added or designed in an integrated manner to complement other solutions, increasing the efficacity and efficiency of gray infrastructure (IUCN, 2016; WB, 2021): this is referred to as a "hybrid infrastructure". Distinction is also made between green infrastructure and NbS dedicated to resource production and protection (for instance, urban farming). Finally, NbS can also be policy or programmatic, to encourage actions such as renaturation, biodiversity or conservation.

Figure 19 – Community-led NbS in Kibera St. John's Community School, Nairobi – Rain Gardens
(Source: Kounkuey Design Initiative (KDI))

NbS Families Classification

NbS Family	Example of NbS Type Relevant for the Urban Kenyan Context
 **Urban Forests**	Phytoremediation forest Ecological forest corridors Agroforestry
 **Terraces and Slopes**	Living smiles Wattle fences Vegetated gabions Retaining walls with vegetated planters
 **River and Stream Renaturation**	Bank and bed renaturation Stream daylighting River rehabilitation and clean-up
 **Building Solutions**	Extensive green roofs Intensive green roofs Ground-based green facades Facade-bounded greening
 **Open Green Spaces**	Pocket parks Natural playgrounds Climate-proof residential gardens Urban Parks
 **Green Corridors**	Street tree canopies Green avenues Urban green corridors
 **Urban Farming**	Raised beds Amphibious farming Floating farming Climate-proof residential gardens Aquaculture ponds Vertical gardens

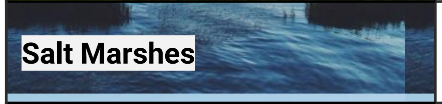
NbS Family	Example of NbS Type Relevant for the Urban Kenyan Context
 **Bioretention Areas**	Rain gardens Multifunctional detention ponds Retention ponds Bioswales Retention ponds Permeable pavements
 **Natural Inland Wetlands**	Wetland restoration and rehabilitation
 **Constructed Inland Wetlands**	Surface constructed wetlands Subsurface gravel wetlands Floating wetlands
 **River Floodplains**	Setback Levees Oxbow bypass
 **Mangrove Forests**	Mangrove restoration and rehabilitation
 **Salt Marshes**	Mud motoring Planting mats
 **Sandy Shores**	Beach nourishment and dune restoration Artificial reefs and submerged structures Reef restoration and rehabilitation

Figure 20 – NbS Families
(Source: Modified from World Bank, 2021)

Why do we need NbS for Kenyan cities?

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Rapid urbanization in Kenya has placed immense pressure on cities. The rate of urbanization was 4.3% a year between 2015-2022 (UN-Habitat), with 29% of its population living in urban areas in 2022 (World Bank). This share is expected to reach 50% by 2050 (UN-Habitat). Emerging secondary cities are particularly affected. As early as the 1970s, Kenya began promoting secondary cities, even if “a clearly formulated national urban policy or an urban and regional development policy” was not defined yet (Otiso, K. M., 2005). Following the launch of a devolved system of governance, the revised Urban Areas and Cities Act (2019) recognizes four level of urban areas, based on population number. However, as the urban areas keep expanding, this classification covers a variety of urban contexts and urban challenges.

This growing urbanization has put a strain on existing infrastructure, exacerbating environmental degradation, and increasing vulnerability to climate change impacts. Indeed, Kenyan cities face major development challenges. Urban poverty was estimated to about 34% in 2021. It disproportionately affects women-led households, people with limited education access and large families (KNBS, 2021). Access to infrastructure and service provision remains highly disparate, also due to land tenure issues and uncontrolled urban sprawl. Urban development ultimately leads to various environmental impacts. These effects include heightened air and water pollution, an increased risk of flooding, and the degradation of ecosystems, all of which can adversely affect the well-being of urban residents.

Additionally, presence of refugee populations also raises distinctive challenges in urban settings. The Refugee Act (2021) aims to convert refugee camps into urban settlement area, whereas refugee camps in Garissa and Turkana counties are currently managed separately for communities. Yet again, access to basic infrastructure remains insufficient. In the case of Kakuma, for example, only 10% of refugee and host community households benefit from access to electricity, and only 60% of host community households have access to water (World Bank and UNHCR, 2021).

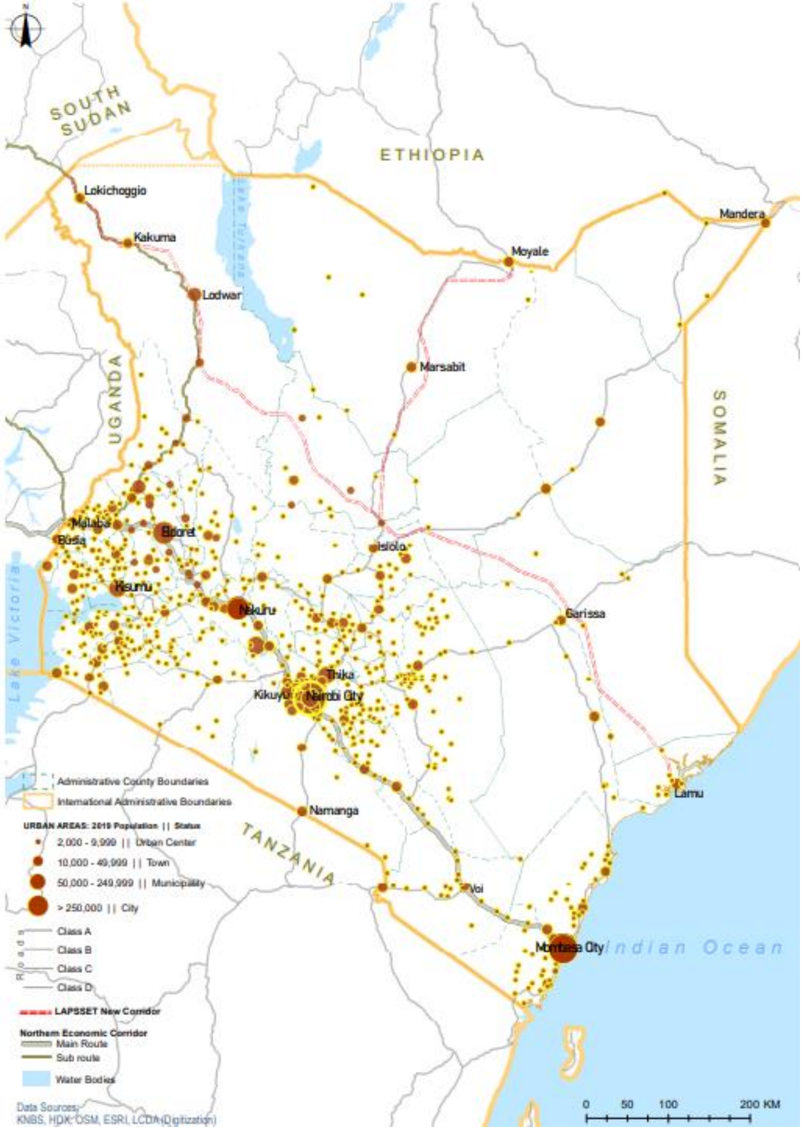


Figure 21 – Kenya’s Urbanization Geography
(Source: UN Habitat, 2022)

Due to climate change, the increased frequency and magnitude of hazards such as floods and droughts further exacerbated the pressure put on urban areas. The urban areas which are most affected by floods and extreme droughts are located in Arid and Semi-Arid (ASAL) zones, which make up 80% of the land area in Kenya. These areas endured severe droughts with widespread livelihood losses and massive displacement of populations. Additionally, 17 of the 47 counties are recognized as flood prone (IFRC, 2023) and urban flooding has become a frequent phenomenon due to climate change-induced heavy rains. Climate change is also influencing coastal urban areas in Kenya, particularly on shoreline erosion, coastal storms, flooding, and sea level rise.

In parallel, climate change related risks also worsened due to rapid urbanization and uncontrolled development. Unrestricted urban sprawl has not allowed for adequate planning to face increased climate risks, thus leading to encroachments on wetlands and blockage of waterways, and to an increase in impervious surfaces and loss of green spaces.

Therefore, it is a priority to protect and enhance the resilience of Kenyan secondary cities. The devastating floods in parts of Kenya, including Nairobi, in May 2024, resulted in the loss of life, the displacement of over 250,000 people, and damage to property and key infrastructure. This has underscored the urgent need to improve urban resilience in order to limit further damage and enhance overall quality of life. In the context of Nairobi, for instance, a path was taken towards promoting urban nature and renaturing the floodplains of Nairobi's three main rivers (OCHA, 2024). Similarly, the recent drought in Kenya severely impacted food security, with 4.4 million people facing high levels of Acute Food Insecurity in early 2023. Although the situation improved by late 2023, reducing the number to 2.8 million, food insecurity remains critical, highlighting Kenya's vulnerability to droughts and their impacts.

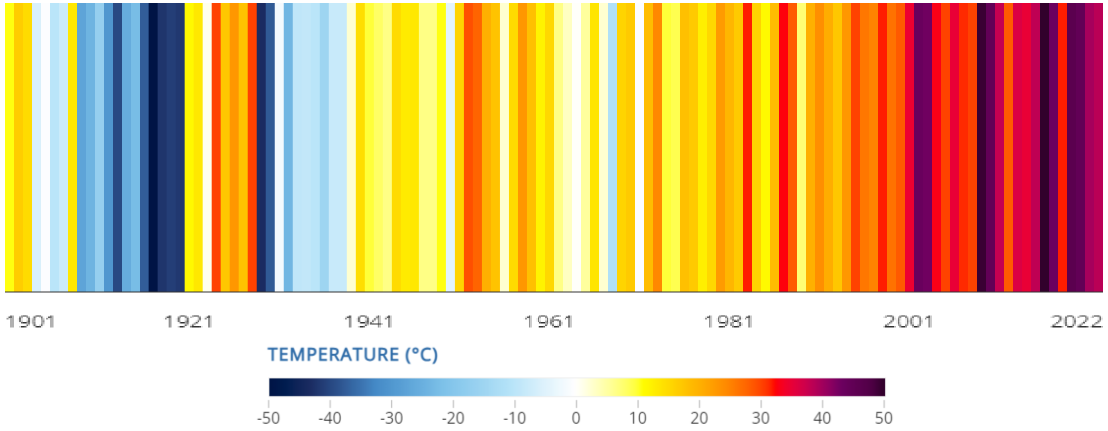


Figure 22 – Observed Annual Average Mean Surface Air Temperature, 1901-2022
(Source: WB Climate Knowledge Portal - Kenya)

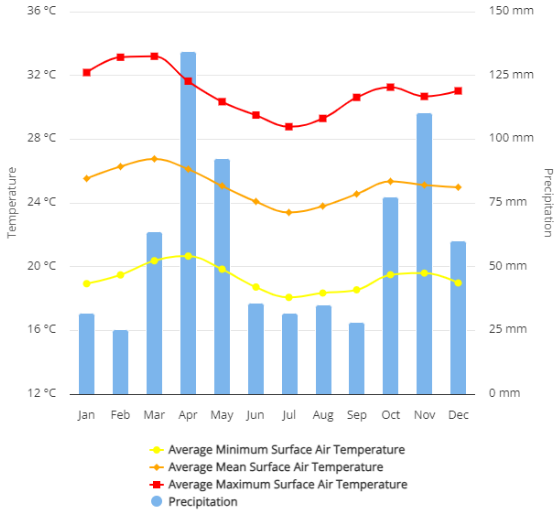


Figure 23 – Monthly Climatology of Selected Climate Indicators in Kenya 1991-2022
(Source: WB Climate Knowledge Portal - Kenya)

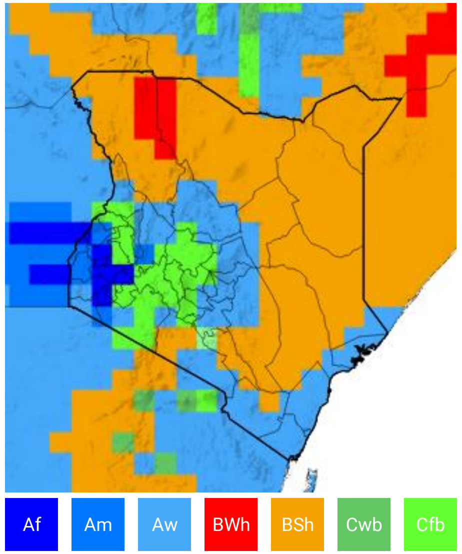


Figure 24 – Köppen-Genger Climate Classification of the Kenyan Climate Zones
(Source: WB Climate Knowledge Portal - Kenya)

In the face of growing urban development, the shift to a decentralized system of governance in Kenya marked a turning point in the institutional management of cities and municipalities. It was enshrined in the Constitution of 2010 and operationalized by the Urban Areas and Cities Act (UACA) of 2011. This change in governance gave county governments the power to establish and oversee urban areas, leading to the creation of 97 municipalities and the establishment of urban councils for 70 urban centers.

Moreover, the government has taken several legal and policy commitments regarding climate change, which means urban resilience now heavily relies on the capacity of local institutions to implement change. The National framework for climate change includes: the Climate Change Act (2016); the National Climate Change Action Plan (2018-2022); the mainstreaming of climate change mitigation in planning documents through the National Spatial Plan (2015-2045) and ongoing adoptions of National Disaster Risk Management Framework and Strategy. Consequently, building climate-resilient urban areas depends on bolstering urban institutions and enhancing their capacity to design, implement, and enforce effective urban resilient planning, development control strategies as well as resilient urban infrastructure and deliver the associated services to their population.

However, despite these significant advances, there is a persistent need for institutional strengthening to enhance the effectiveness of local urban institutions. Indeed, although many urban plans have been adopted, they often lack adequate corresponding implementation frameworks, rendering them ineffective. Additionally, urban sprawl increases the costs associated with infrastructure development and maintenance, while threatening the environment.

Additionally, the progress of the devolution process appears to be disparate. Some counties have already largely invested in infrastructure and are more advanced on environmental protection, climate change adaptation and improvement of the quality of life. For example, Kisumu County Integrated Climate Change Issues to its 2018-2022 and 2023-2027 Integrated Development Plans and invested in urban green spaces within Kisumu City.

To address these challenges, the often-diverging goals of environmental protection and development projects need to be overcome to build a common resilient development path. Policymakers increasingly recognize the role of nature-based solutions as instrumental for this synergy.

Kenyan secondary cities, where growth is still in its infancy, can seize on NbS as an opportunity to strengthen their resilience to climate change and already pave the way for more resilient urban development. NbS can offer cost-effective strategies to boost urban resilience against climate hazards like flooding, drought, and heatwaves. By integrating green spaces, restoring ecosystems, and managing water bodies, NbS improve environmental quality, support biodiversity, and create economic opportunities, enhancing the global living conditions for the urban populations and making them essential for the sustainable development of Kenya's urban centers.

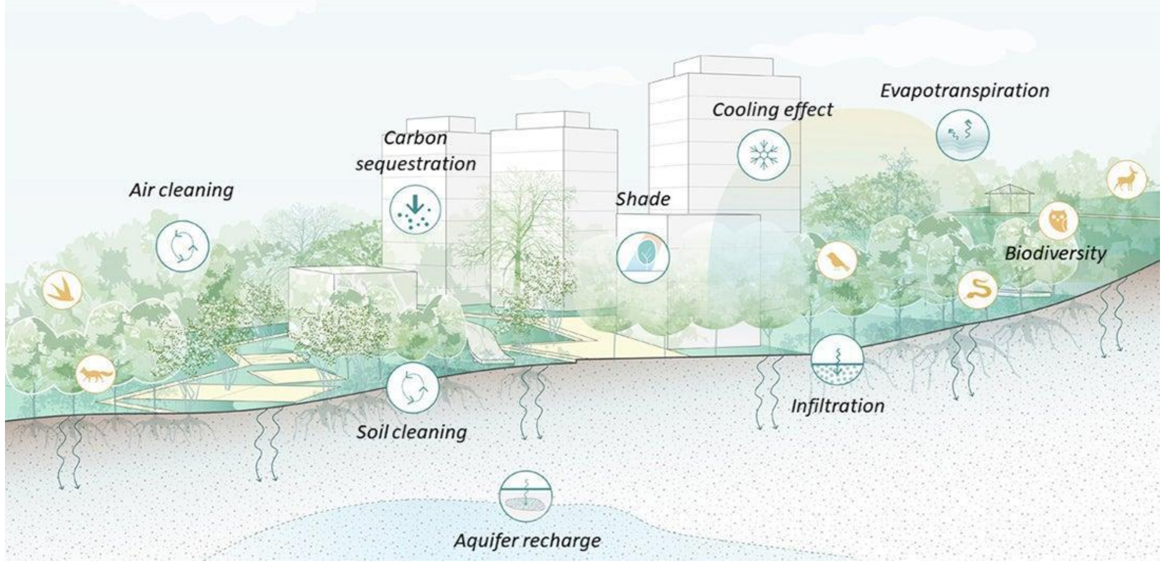


Figure 25 – NbS can be optimized for addressing climate resilience and biodiversity outcomes (Sources: World Bank/GFDRR, 2021; designs by Felixx Landscape Architects and Planners)

NbS in Kenyan Cities: Findings from NbS Inventory

The NbS Inventory of NbS initiatives revealed 26 examples that demonstrated the range of NbS families and implementation trends in diverse Kenyan urban environments. It aimed to generate knowledge, inspire local stakeholders, and provide a reliable resource for the replication and scaling of successful NbS strategies. Through a literature review, 26 sites were shortlisted, of which, 14 were selected for field visits, and 12 sites were investigated through desktop study. The projects spanned different climate zones, landscapes — urban (including central business district, formal, and informal), peri-urban, and rural — and represented 9 NbS families. Additionally, the integration of NbS within the First Kenya Urban Support Program (KUSP1) investment program and "missed opportunities“ were critically evaluated based on literature review, policy review and expert knowledge.

Findings suggest that Kenya demonstrates growing innovation in terms of NbS in urban areas integrated a diversity of solutions and stakeholders. There is a concentration of NbS in Nairobi, which is evident in both formal and informal urban settings. Scale of implementation mainly involves catchment and neighborhood-level interventions. Most of the solutions implemented are Open Green Spaces and Bioretention Areas. This study also showed an emerging tendency towards hybrid infrastructure solutions, integrating natural blue-green elements within traditional grey engineering. Finally, NbS initiatives are rarely conceived as intentional NbS from the outset. However, there is wide diversity of stakeholders involved, from governmental organizations to NGOs, international bodies, Community-based organizations (CBOs) and private sector.

Overall, the NbS Inventory underscored the opportunity for NbS expansion across Kenya’s secondary cities, by enhancing scalable solutions and encouraging diverse implementation scales. Hybrid infrastructure NbS happens to be a flexible and scalable solution in Kenya. They vary in scale and provide many benefits including rehabilitation opportunities, by retrofitting existing urban spaces without requiring complete overhauls. However, challenges include the technical complexity of designing and maintaining hybrid systems, which requires interdisciplinary expertise and measurement tools. It should also be stressed that the diversity of implementation scales is a strength for NbS expansion in Kenya. Indeed, various benefits can stem from different implementation scales, and scalable solutions can emerge. Effective policy frameworks should encourage the integration of small-scale cases into larger and more comprehensive strategies.

However, it showed NbS development, operational implementation and final impacts could be strengthened and diversified through further refinement and exploration of complementary solutions based on better data availability and systematic assessments and monitoring. NbS development also require new tools, methodologies and expertise. For instance, building code and urban design guidelines could be revised to improve the enabling conditions for NbS development in formal urban settings. In informal settlements, implementing NbS requires participatory planning and specific capacity-building activities to a wide range of stakeholders, as challenges can arise out of unclear land tenure and resources constraints. Additionally, proper implementation mechanisms are needed to capture maintenance costs as well as revenue opportunities and labor dynamics.

Additionally, it highlighted a knowledge building and dissemination gap to be overcome, as it inherently constraints NbS implementation and scaling. The lack of comprehensive financial and technical data, as well as systematic assessments and monitoring, limits operational effectiveness. Data is sparse and inconsistently available for many of the cases reviewed, for larger projects and community-led projects. This same data and information gap impedes knowledge development and distribution among stakeholders, further exacerbating the data and expertise deficit impeding successful NbS deployment. Although numerous NbS initiatives are underway, they lack further distribution of information, tools and best practices. Capacity surrounding NbS could be improved among local stakeholders, as benefits are insufficiently quantified, post-construction monitoring is weak and there is generally a confusion around NbS terminologies and features.

The NbS Compendium and Recommendations for Implementation aim to deepen these preliminary findings towards enhancing effective appropriation of NbS by Kenyan stakeholders. It provides gap analysis and actionable guidance for KUSP2 investments framework as well as any NbS initiative in Kenyan secondary cities.

Enabling environment

Which policy and regulatory framework?

Understanding Kenya's policy and regulatory framework is essential for the successful integration of NbS into urban planning and development. This framework outlines the roles, responsibilities, and interactions between different levels of government and stakeholders, influencing how policies are created, executed, and tailored to local contexts. As part of the "enabling environment", it plays a pivotal role in either promoting or limiting the integration of NbS into urban projects. It ensures alignment with national objectives and facilitates local adaptations that enhance resilience and climate responsiveness.

The integration of NbS into Kenyan secondary cities requires a careful alignment of urban planning and development, climate change, and biodiversity frameworks to ensure their effective development. The urban planning and development framework is a key element for integrating NbS into cities, addressing urban challenges, and anchoring NbS within a specific territory. However, recently, climate change-related issues have been addressed through a distinct political and regulatory framework, which plays a critical role in strengthening the development of NbS as climate adaptation solutions and potential carbon sinks. One of the unique characteristics of NbS is their positioning at the intersection of several specific political and regulatory frameworks, including urban planning and development, climate change, and the emerging biodiversity framework. The cross-cutting consideration of these frameworks is essential, and their alignment is crucial to support the sustainable and comprehensive development of NbS.

Kenya's political and regulatory framework is structured around three institutional levels - national, county, and local - and underpinned by key legislative and strategic documents.

- **At the national level, Kenya's framework for urban planning and development is anchored in the 2010 Constitution and Kenya Vision 2030, with climate resilience being integrated into planning processes since 2016.** The Constitution grants the government authority over urban planning (Article 66) and establishes the National Land Commission (NLC) to oversee planning activities (Article 67), while also prioritizing devolution to transfer significant planning powers to county governments.

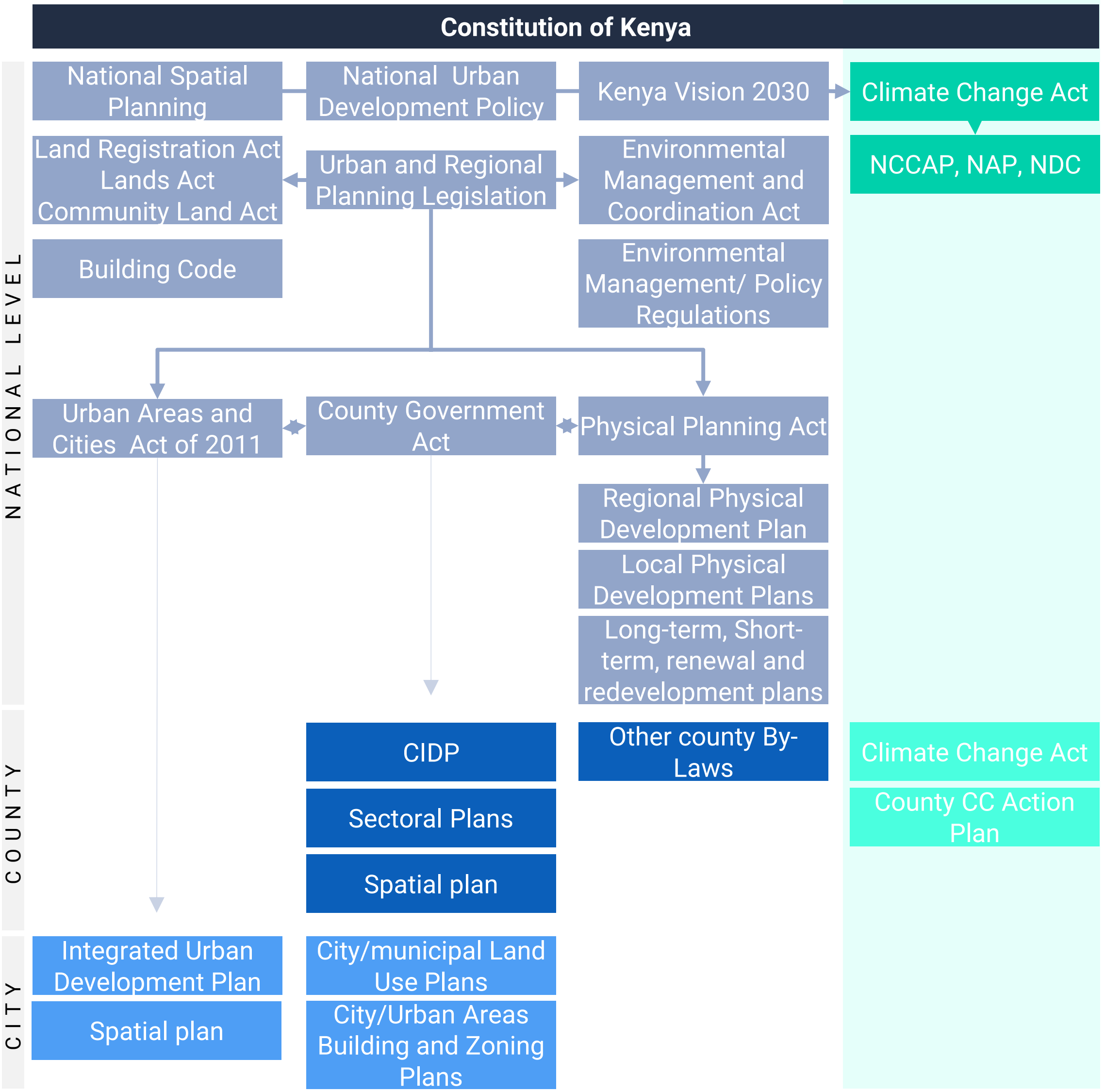


Figure 26 – Policy and regulatory framework for climate-resilient urban planning in Kenya
(Source: Analysis of SUEZ Consulting, 2024 based on UN Habitat, 2018 and other policy documents)

Kenya Vision 2030 (2008) outlines the strategic development path for Kenya, focusing on urban planning and development and capacity-building to address rapid urbanization. Additional sectoral policies and plans contribute to define the urban and land planning and development framework, such as the National Urban Development Policy (2016) to promote sustainable urban growth. Since 2016, the Climate Change Act and Climate Risk Management Framework for Kenya require climate resilience mainstreaming into urban planning and development at all levels. The successive National Climate Change Action Plans, National Adaptation Plans (NAP), and Nationally Determined Contributions (NDC) are also integral components of Kenya's policy framework on climate change. They contribute to the country's overall strategy for addressing climate impacts and promoting resilience across sectors.

Several acts also mandate the creation of specialized agencies to set sector-specific standards and guidelines that play a role to foster a resilient urban planning and development. For example, the Environmental Management and Coordination Act (EMCA, 1999) established the National Environment Management Authority (NEMA), which is responsible for formulating and enforcing national environmental protection goals, including regulatory oversight in urban development projects.

- **At the county and local levels, the Urban Areas and Cities Act (2011, revised in 2019) and the County Governments Act (2012) establish the legal framework for local planning**. They provide legal foundations for local urban management at the county and municipal/city level, defining responsibilities for urban and physical planning. They also set the key documents and plans required for their implementation, notably the County Integrated Development Plans (CIDP) at county level and Integrated Urban Development Plans (IDEP) at municipality/city level. While aligning with the broader urban planning and development framework, they outline local strategic vision and integrate local economic, social, environmental, and spatial planning, to ensure coordinated growth and resource allocation. They can be supplemented by local land use plans, building and zoning plans, or sectoral plans. Counties also adopt local County Climate Change Act and develop 5-year Climate Change Action Plans (CCCAPs).

Kenya's political and regulatory framework involves multiple actors – from public institutions to private actors and citizens - at the national, county, and city levels. Institutional actors are responsible for defining strategies and policies, managing resources, and overseeing implementation, while the 2010 Constitution promotes the adoption of a participatory approach at key stages of planning, involving other important stakeholders from civil society.

At national level, urban resilience policy and regulatory framework is led by ministries, departments, and parastatal agencies.

- The Ministry of Lands and Physical Planning oversees land resources to support socio-economic development, formulating policies, managing public land, and ensuring orderly land use through spatial planning aligned with Vision 2030. Similarly, the State Department for Housing and Urban Development (SDHUD) directs policy and coordination for housing and urban development, providing strategic guidance to strengthen urban resilience and align initiatives with national priorities.
- Regional Development Authorities (RDAs) drive growth in underserved areas by implementing infrastructure, agriculture, and social projects, such as the Lake Basin Development Authority's water supply initiatives. RDAs coordinate with county governments to align efforts, stimulate economic growth through resource management and partnerships, and address environmental challenges by ensuring compliance with regulations.
- National agencies are responsible for implementing nation-wide sectoral policies, coordinating various government functions, and ensuring service delivery across different sectors. For instance, the NEMA oversees environmental protection by developing regulations, reviewing EIAs and issuing licenses for approved projects, enforcing compliance, and promoting public awareness. It integrates environmental considerations into national development plans, monitors conditions, and conducts research to inform sustainable policies. The NLC manages public land for national and county governments, recommends policies, oversees land use planning, and addresses land injustices. The NLC is also in charge of developing land information systems.

At county level, governance includes County Assemblies and Counties Executives. The County Assembly legislates for county functions, oversees the County Executive's accountability, represents constituents, and approves key appointments, budgets, and plans. The County Executive, led by the Governor, implements laws, manages administration, coordinates development projects, formulates policies, and reports to the assembly on governance and budget matters. Additionally, the county level also has County Departments which role in implementing policies and delivering services at the county level in Kenya. Each department is typically headed by a Chief Officer who reports to the County Executive Committee Member (CEC) responsible for that specific area.

At municipal/city level, the Urban Areas and Cities Act grants local planning authority and disaster management to urban boards. The City/Urban Board is responsible for developing policies, land use management, infrastructure development, and regulatory oversight, ensuring service delivery and budget management. The City Manager, appointed by the Board, oversees day-to-day operations, implements policies, manages staff and resources, and monitors financial health, reporting regularly to the Board.

The relationship between counties and municipalities is guided by a cooperative framework outlined in the Constitution and relevant legislation. County governments delegate specific functions, such as service delivery and infrastructure development, to municipalities. Solid waste management and disaster management are among the first functions devolved to municipalities.

Civil society is increasingly engaged in resilient urban development through participatory approaches, to integrate local needs into planning and foster private sector's engagement. The 2010 Constitution enshrines public participation as a fundamental principle of governance, mandating that all government planning and spending include community input. The role of professional organizations still varies, with the level of recognition largely dependent on the profession: for example, engineering professions are well-established, while emerging professions such as landscape architects are still developing.

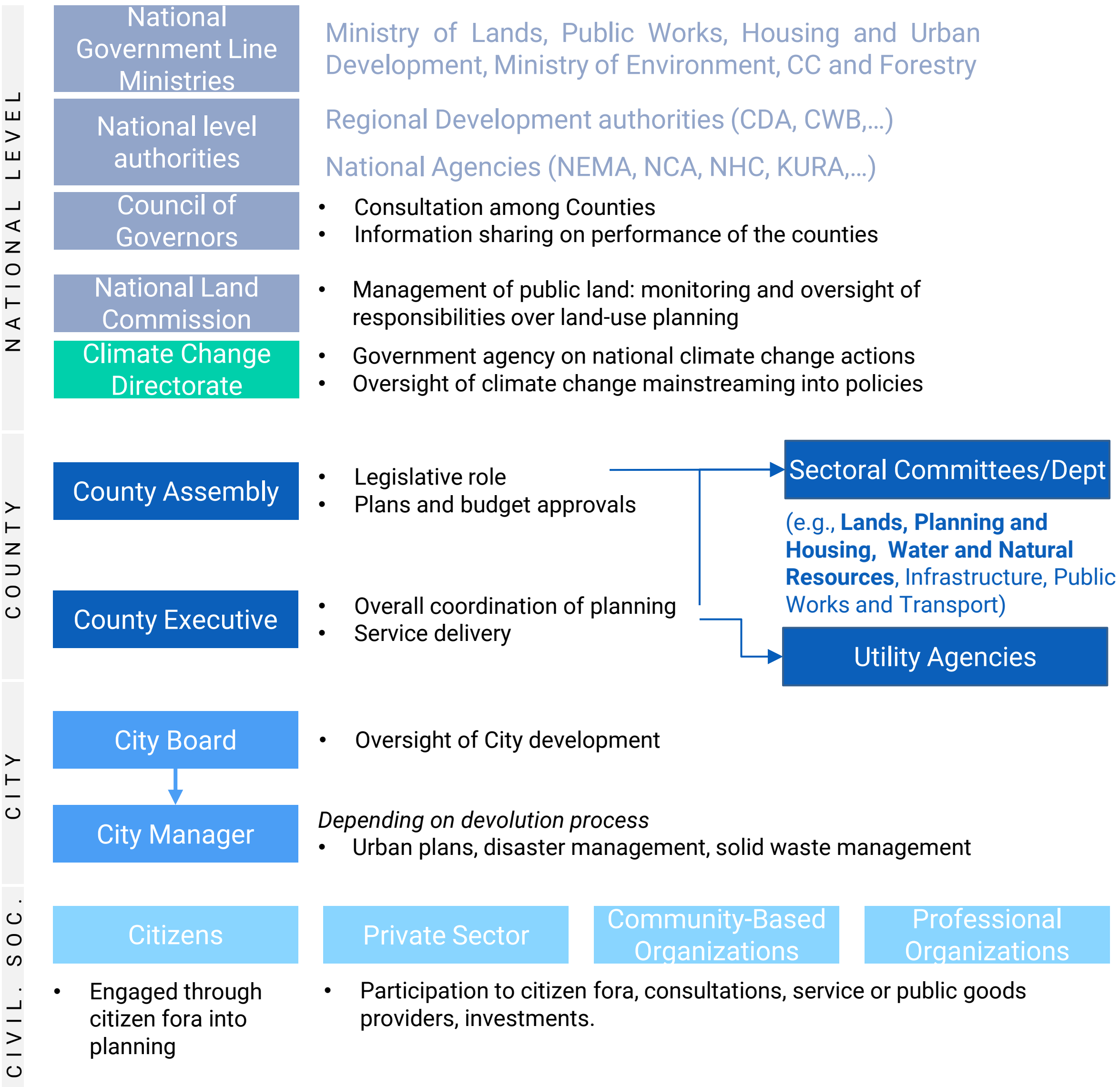


Figure 27 – Organizational scheme of Kenyan stakeholders involved into climate-resilient urban planning (Source: Analysis of SUEZ Consulting, 2024 based on UN Habitat, 2018 and other policy documents)

Critical role of institutional arrangements

While Kenya has established a detailed framework to integrate urban planning and climate change, the capacity of this framework to effectively enable the development of NbS in Kenyan cities remains unclear. Despite numerous laws, strategies, policies, and structures at various levels regarding urban planning and climate resilience, the framework appears overly complex and fragmented, with unclear intersections between institutional mandates, resulting in overlapping responsibilities, confusion, and inconsistency.

NbS development requires a clear and integrated city vision as well as a multi-stakeholder approach to deliver their multiple potential benefits. NbS development is based on multi-stakeholder collaboration, which could be led by municipalities, to leverage both the long-established expertise of sectoral agencies and counties and the key role of municipalities in promoting a coherent and comprehensive vision for the city. Indeed, the lack of vision and policy coherence hinders strategic alignment with resilience goals. Inconsistent collaboration results in poorly integrated urban planning. A myopic approach to planning, devoid of a unified vision and value-driven principles, leads to inconsistent results, with plans often failing to outline actionable implementation steps.

Municipalities must enhance their technical and financial capacity to play a key role in the harmonious and resilient development of their territories. Despite devolution, municipalities face limited practical autonomy and struggle with technical and financial dominance from counties in defining and implementing urban plans, with insufficient in-house expertise and few direct funding sources. As a result, municipalities rely on county staff or external consultants to deliver projects. Strengthening local teams, both in number and capacity, is essential, which could be achieved through the gradual transfer of skills from other institutions or external consultants during technical assistance.

To protect existing ecosystems and enable the development or rehabilitation of new NbS, municipalities also need to enhance their ability to enforce development controls and project oversight. Municipalities are working to define land use plans but struggle to implement them, relying on national services or county authorities. While many planners are trained in, Geographic Information System (GIS) most municipalities lack the infrastructure to use such tools effectively, relying instead on outdated, paper-based maps. Additionally, delays in Environmental Impact Assessments (EIAs) may affect project implementation, with some projects progressing before approval.

The development of NbS would benefit from evidence-based planning, but current data on baseline conditions and needs are fragmented and difficult to access. Few municipalities have data on the climate risks their territories may face, and bureaucratic delays in obtaining critical information, such as meteorological reports, hinder timely decision-making (AECOM, 2023). Short-termism and weak monitoring further impede effective plan execution, as insufficient timeframes, limited monitoring capacity, and political interference often derail plans. This encourages business-as-usual practices rather than fostering the adoption of greener, more sustainable alternatives. This underscores the importance of long-term strategies, supported by strong institutions, consistent leadership, and adaptive methods tailored to local contexts.

Professional bodies in Kenya hold a pivotal role in promoting green infrastructure as a viable alternative to traditional grey infrastructure investments. Across the different professions of the urban fabric, these organizations (e.g., Architect Association of Kenya (AIK), Environment Institute of Kenya (EIK), Institution of Engineers of Kenya (IEK), and Kenya Institute of Planners (KIP)) have a strategic position to standardize practices for NbS. However, they face significant limitations, as they lack the capacity to address all aspects of the built environment, particularly in urban areas where informality dominates, and much of urbanization occurs without professional design, oversight, or certified advice.

Acknowledging the role of informality and identifying ways to integrate NbS through community-led initiatives and quick-win projects is essential to reach the most vulnerable population. This approach allows for the implementation of NbS and awareness campaigns targeting residents and stakeholders, even as planning, development control, and standardization efforts continue to mature in this area.

The financing framework shaping NbS development

GLOBAL CENTER ON ADAPTATION

NbS development in Kenya benefit from various sources of external funding, with the coordination and support of state level or local level stakeholders. Some of the NbS Compendium cases illustrate the variety of these sources of support in terms of organizations, as well as projects:

- MDBs and Development Banks: World Bank Kenya Urban Support Program (KUSP1) project funded different NbS projects, such as **Kenyatta Avenue Green Corridor (Case #11)** in Nakuru. City Climate Finance Gap Fund is another window that is today considered by some municipalities such as Kisumu;
- UN Agencies, such as UN-Habitat which develops in partnership with Association of Architect of Kenya (AAK) the Safari Green Building Index;
- NGOs such as The Nature Conservancy initiating the **Upper Tana-Nairobi Water Trust Fund (Case #8)**;
- Bilateral national cooperation framework and development programs, such as in the case of **Saint John's Community School (Case #7)** that benefited from the support of SwedBio a Stockholm based program working in governance of biodiversity knowledge and policy.

This support can also stem from the various guidelines made available by these organizations, such as the Guidelines on Mangrove Ecosystem Restoration for Western Indian Ocean that were used for engaging Mangrove restoration in **Bangladesh Mangrove Restoration project (case #5)**.

However rich this ecosystem of partners and support is, there is still a risk of multiple compliance systems and technical requirements for county level actors that would seek these various financing windows. Some professional bodies, such as the Environment Institute of Kenya, seem to be in a good position to reference and support a pooling of experts trained and aware of these various investment frameworks available for developing NbS projects.

Urban sector development projects supported by Kenya Government and international donors remain a key and impactful source of funding for NbS investment and NbS-informed project. Counties in Kenya receive funding from two primary sources: equitable share transfers from the national government and conditional grants from both the National Government and development partners (KIPPRA, 2019). Conditional grants are linked to the implementation of specific projects such as major urban development programs. They are mainly provided as loans or grants from international agencies like the World Bank or the National Government, disbursed through the National Treasury or relevant ministries. Conditional grants are restricted in use, cannot be diverted to other budget items, and are subject to a county or city meeting some specific requirements. These projects' framework (i.e., strategy and objective, subprojects conditions, assessment criteria and final indicators) and more precisely their investment eligibility criteria thus can play a crucial role in either encouraging or limiting the potential for local NbS development.

Among major urban development programs, KUSP1 and KUSP2 rely on Program for Result (PforR) funding, a results-oriented instrument designed to link the disbursement of funds to the achievement of specific targets, which can influence NbS development in Kenyan cities. KUSP1 was the first part of a PforR to address Kenya's urban development challenge: this program was central in advancing Kenya's urban infrastructure and service delivery. Although KUSP1 has well performed, the 2019 census revealed that rapid urbanization remains a significant challenge for the managers of devolved units. This underscores the urgent need to allocate resources strategically toward urban development. Therefore, phase 2 of the program, KUSP2, has been launched to continue supporting the implementation of the Second Kenya Urban Program 2022–2027 (Kenya Urban Program (KenUP2)).

As a matter of fact, a shift in the perspective of KUSP2 is opening an opportunity for change towards more resilient an inclusive urban areas with a greater potential for municipalities to choose NbS projects. The program is designed to build on previous programs to allow for urban resilient, inclusive and competitive development in Kenya's secondary cities.

Review of NbS integration in KUSP I & II frameworks

	Features conducive to NbS in KUSP1	Features impeding NbS in KUSP1	Opportunity for change in KUSP2
Strategy		**NbS is not a core objective of KUSP1 nor an engineering design alternative streamlined in each category of eligible investment** – no mention of biodiversity or nature or ecosystem in the Program Appraisal Document (PAD).	**Emphasis on planning and delivery for resilient, inclusive and competitive infrastructure and services** – climate resilience-related criteria at least mentioned once in each disbursement-linked indicator (DLI).
Process	**Some flexibility on investment threshold to allow sub-projects of various scales** - a minimum amount of investment (US$ 500,000) however multiple investment could be combined into one, provided they belong to the same geographical area.	**Lack of local awareness of NbS as potential investment projects among institutional stakeholders and citizens limits emergence of green infrastructure proposals** despite consultation processes held with urban boards and citizen fora to suggest sub-projects.	**Climate change mitigation measures are mandatory at most stages of the program to qualify for grants** - each disbursement-linked indicator across all result areas incorporates climate considerations into its minimum conditions or performances standards.
Eligible investment criteria	**Eligible investment specifically targeting NbS** – urban social and economic infrastructure targets green areas and parks.	**Even if all eligible expenditures could potentially include NbS, *de facto* exclusion of measures for existing NbS not identified in planning** - This excludes proposal of NbS that have not been priorly identified in planning. Eligible investment do not include environmental protective or restoration measures and exclusion criteria list, namely (b) and (d) can deter from considering NbS engineering.	**Explicit mention of NbS in potential investments** - explicitly included as a component of greenery and public open spaces investments. **Better understanding of climate risks and vulnerabilities as a pre-condition for investment** - municipalities are mandated to conduct risk assessment and gather data relevant to their geography and climate-related hazards and vulnerabilities.
Assessment criteria and indicators	**Prioritization process of investments consider climate change and disaster adaptation** – one of the four criteria (along with social inclusion requirements) of the investment prioritization.	**Lack of streamlining NbS in investment optioneering and assessment** – even if investment that contribute to climate change adaptation are prioritized, indicative CBA and figures for infrastructure do not promote NbS as a co-benefit for achieving the intended infrastructure. Results indicators for KUSP1 don't include climate change adaptation or ecosystem services promotion.	**Streamlining of climate change adaptation and DRM into assessment and evaluation criteria for a systematic integration in all KUSP2 components** – climate resilience is an explicit core element of results indicators, particularly within planning (national plans, standard guidelines, county-level planning documents) and infrastructure and service delivery components. Only in terms of private sector engagement (Results Area 4) are environmental and climate related considerations not yet mandatory.

NbS Compendium

Guide

The NbS Compendium seeks to enhance understanding and guide the scalability and replicability of Nature-based Solutions (NbS) in Kenyan secondary cities, using existing inspirational NbS projects as a foundation.

Eleven NbS projects, representing ten distinct NbS families, were selected for running a gap analysis. The projects are assessed through eight strategic components:

- response to climate change;
- environmental benefits, with a focus on local biodiversity;
- implementation processes and technical features;
- operations and maintenance implications;
- financial schemes and sustainability;
- monitoring and evaluation systems;
- legal, regulatory, and policy frameworks;
- and stakeholder engagement, including social inclusion processes.

This assessment, based on data from field missions, key informant interviews (KIIs), expert elicitation, and desktop research, identifies inspiring features of the projects as well as critical features to improve scalability for each NbS family. While the methodological framework is consistent across cases, the situational nature of each NbS family's efficiency and applicability means that the cases cannot be directly compared.

Targeted audience of the NbS Compendium section

The NbS Compendium is designed for decision-makers involved in the KUSP2 project as well as those at the county and municipality levels in Kenya, with the aim of identifying potential NbS projects for development. Within the KUSP2 framework, the gap analysis, conditions for uptake, and lessons learned from projects funded by KUSP1 provide key insights to guide the planning of future NbS initiatives. For municipalities, the city assessment section cross-references NbS cases with specific urban challenges and ongoing policies in Kenyan cities, enabling a more targeted analysis of relevant NbS solutions based on the local urban context.

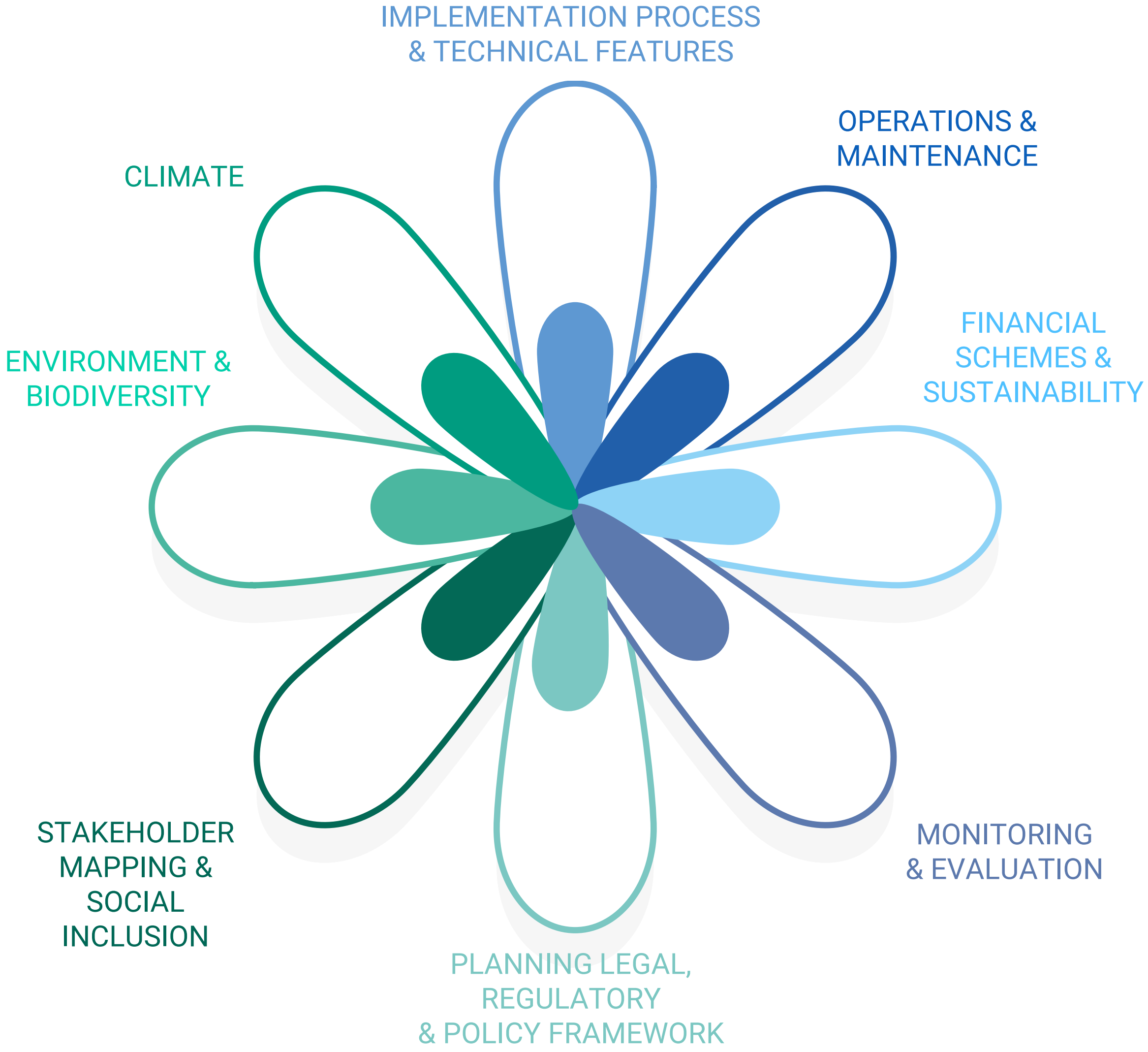


Figure 28 - The eight strategic components for NbS case gap analysis
(Source: SUEZ Consulting, 2024)

GUIDE | How to read the gap analysis result

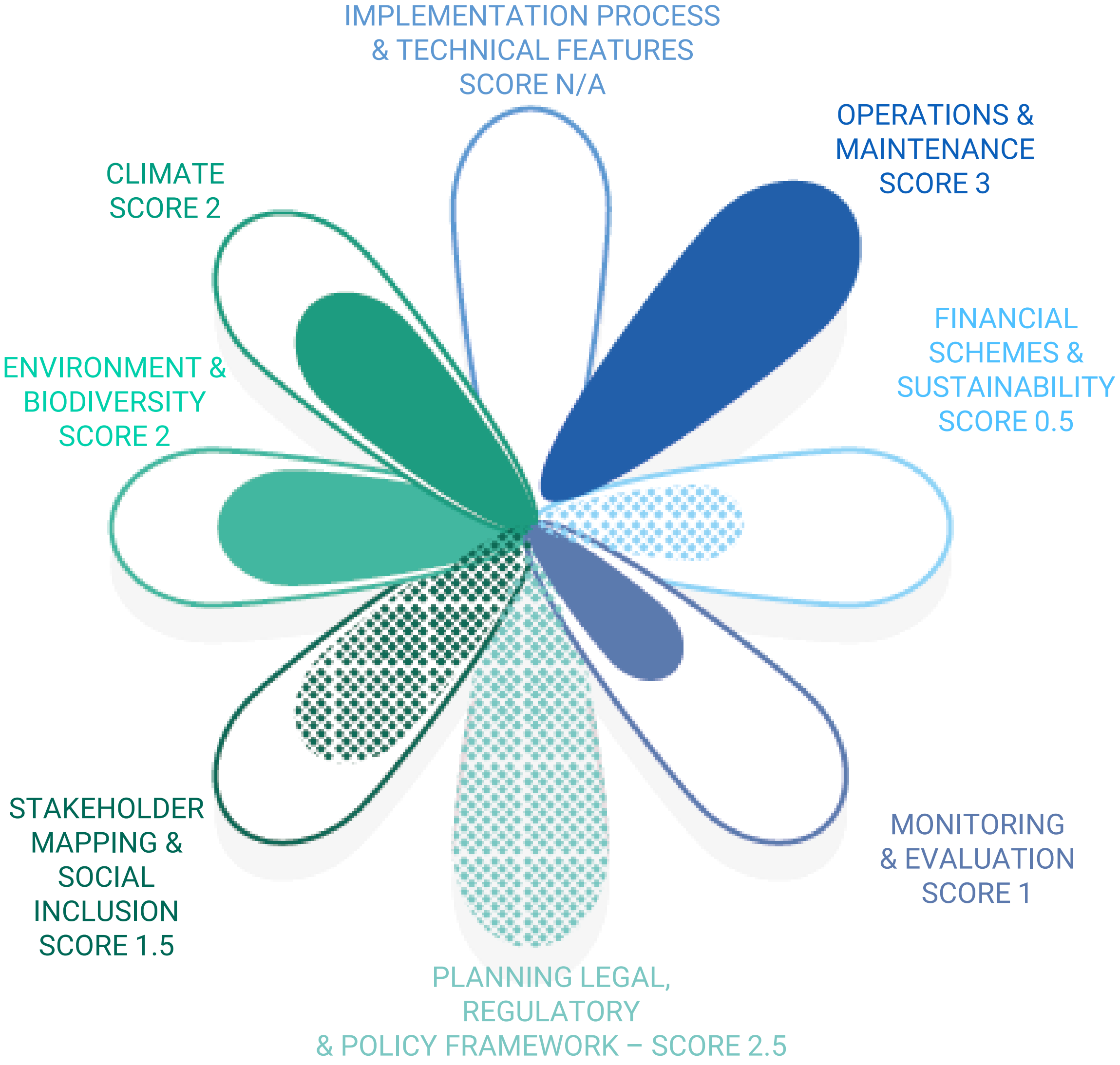
The project analysis consists of 8 components, represented in an evaluation flower to assess the NbS project's maturity and potential for replication in Kenya. Each component includes two equally weighted criteria, with scores ranging from 0 to 3 to assess process mastery and benefits. Score definitions: 0 = insufficient data, 1 = ad hoc elements, 2 = preliminary study, 3 = comprehensive study. For Kaya Tembo Forest, some assessments are marked as N/A (not applicable). Intermediate scores (0.5, 1.5, 2.5) are indicated by dotted petals, as are components with a score of 0 for any criterion as shown in the example below.

Project response to climate risks - score
Project adaptation to local climate conditions and hazards (present and future) - score

Project response to environmental risks (e.g., pollution, biodiversity) - score
Environment and urban biodiversity benefits - score

Stakeholder engagement & consultation strategy - score
Socio-economic benefits and inclusion of vulnerable group - score

Planning and development strategy - score
Regulatory and land tenure strategy - score



Design and implementation process - score
Key features of the technical design - score

Roles and responsibilities - score
Operation & Maintenance plan - score

Project costs, revenue generation and funding - score
Integrated financial plan and project sustainability - score

Key existing indicators - score
M&E system and knowledge dissemination - score

Presentation of the inspiring cases

Case 1 – Open Green Space: Eldoret Arboretum

Open green spaces — including parks, unpaved areas, and biologically active zones — are essential components of sustainable urban development. They assist cities in adapting to climate change by providing cooling effects, enhancing air quality, offering shade, and mitigating the urban heat island effect (Gehrels et al. 2016). Unpaved areas contribute to urban flood risk management by absorbing stormwater, reducing runoff velocity, and alleviating pressure on sewerage systems-in cases of combined sewer/stormwater systems. Designing these spaces with clear performance objectives and fostering community engagement encourages collective ownership and stewardship (World Bank, 2021). Open green spaces significantly improve quality of life by promoting social and physical activities (Wendel et al. 2012), enhancing mental and physical health, and strengthening social cohesion (Yilmaz and Mumcu 2016). They also serve as vital habitats for biodiversity within urban contexts (De la Barrerra et al. 2016). Moreover, these spaces stimulate local economies through increased property values, tourism, and job creation, and contribute to carbon storage and sequestration, aiding in climate change mitigation (Linden et al. 2020).

ELDORET ARBORETUM
The Eldoret Arboretum case is used as an exemplar NbS type under the Open Green Spaces family. The subsequent case analysis illustrates the potential and challenges of open green spaces design, implementation and maintenance in Kenyan cities.

Key inspirational features: *multi-stakeholder collaboration, benefiting both nature and residents.*

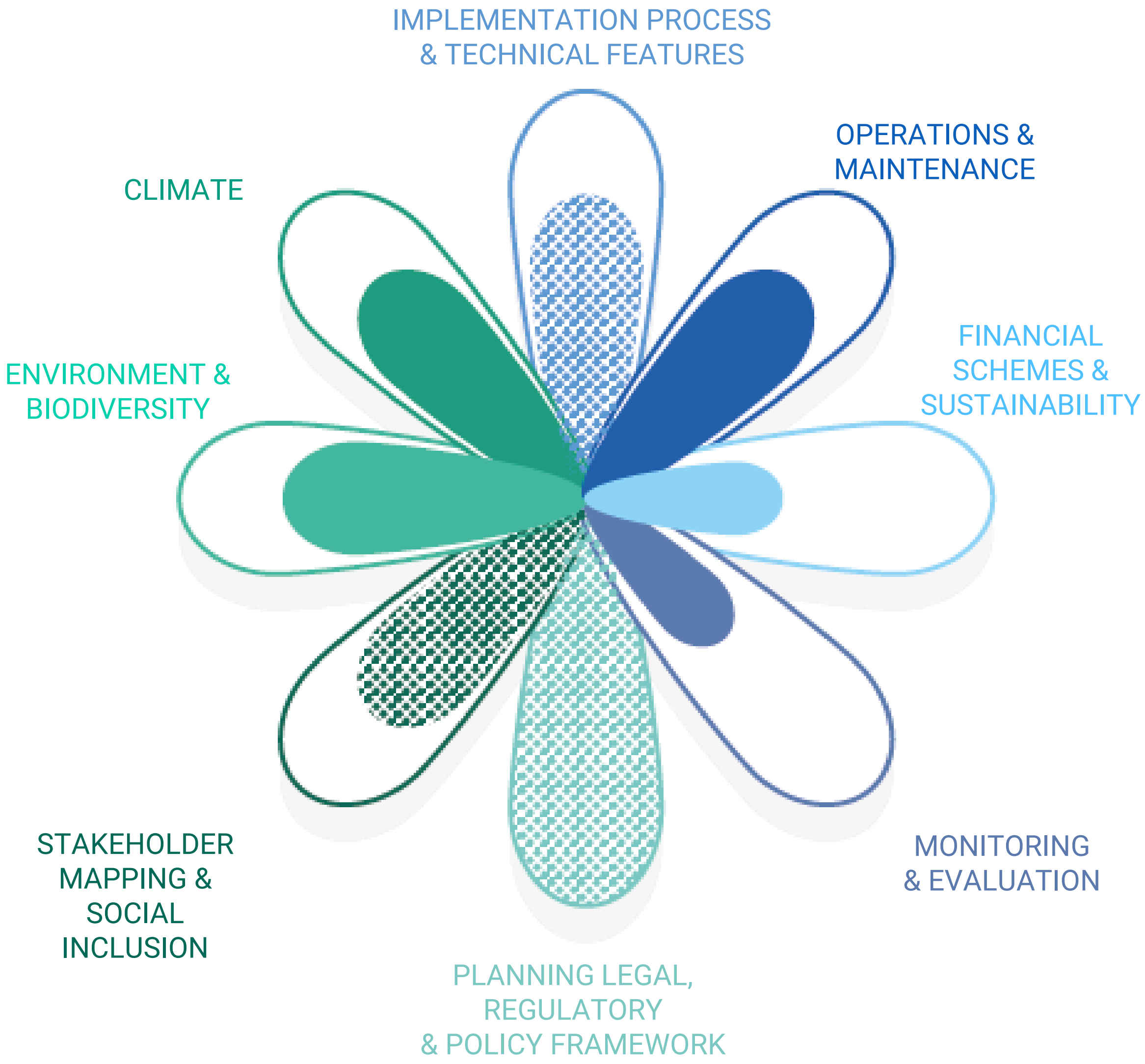


Figure 29 – Gap analysis result for Eldoret Arboretum
(Source: SUEZ Consulting, 2024)

PROJECT PRESENTATION

The Eldoret Arboretum is an urban park case located in Eldoret, Uasin Gishu County. It was developed as part of the World Bank-funded KUSP1. Covering **16.3 ha** and situated approximately 1 km from the Central Business District, the park was intentionally designed to address the escalating impacts of climate change and the scarcity of green spaces within the city. Its construction in 2019-2020 aligned with wider efforts to create resilient urban environments in Kenya. The case's long-term objective is to improve urban resilience, mental and physical health, and social cohesion while promoting climate change adaptation and mitigation.

The Arboretum is an open green space incorporating additional elements such as constructed wetlands for water management and biodiversity enhancement. According to the local stakeholders, the Arboretum aims to mitigate environmental challenges, particularly flooding, biodiversity loss, and urban heat island effects, while providing a space for recreation, education, and social cohesion. Its development involved multiple stakeholders in a public-private partnership. With the Arboretum, Eldoret's residents benefit from enhanced amenity, cultural and recreational opportunities, increased biodiversity and flood risk reduction. However, challenges include lack of funding for operation and maintenance and well as limited public awareness of the benefits of open green spaces.

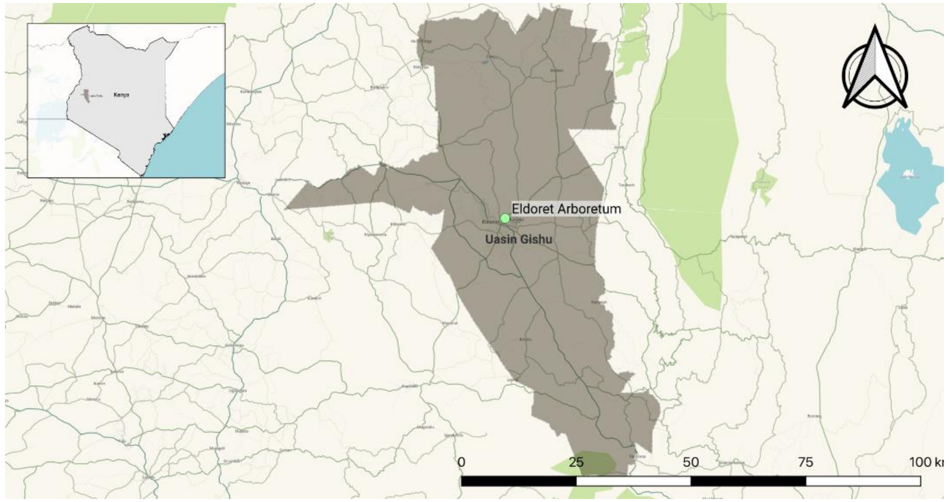


Figure 30 – Location of Eldoret Arboretum, Uasin Gishu, Kenya
(Source: SUEZ Consulting, 2024)

Figure 31 – A view of Eldoret Arboretum
(Source: SUEZ Consulting, 2024)

Figure 32 – Eldoret Arboretum
(Source: SUEZ Consulting, 2024)

Figure 33 – Eldoret Arboretum
(Source: SUEZ Consulting, 2024)

CLIMATE

SCORE 2

- **Project response to climate risks – Score 2**

The Eldoret Arboretum serves as a multifunctional urban space that mitigates the urban heat island effect, manages stormwater, and promotes carbon sequestration.

Uasin Gishu County is considered the breadbasket of Kenya. It has relatively cool climate and receives relatively high rainfall that is evenly distributed throughout the year including in the dry season (MoALF, 2017). The main climate risk in the county is flooding which has occurred annually since 2013 (ibid), affecting different parts of the county including Eldoret's Central Business District (CBD) (KII, 2024). Analysis of temperature trends in the county between 1980 to 2005, show a moderate increase (Fig.19). Although, average seasonal rainfall between 1980-2015 did not change significantly, there has been an increase in number of days with high rainfall intensity. Climate change has disrupted rainfall and weather patterns resulting in unpredictability in timing and intensity of rainfall and dry spells. These changes have led to increased flood, erosion and drought risks (MoALF, 2017).

The city of Eldoret is investing in urban parks to provide recreational and cultural open green space for local citizens. Furthermore, as an open green space that incorporates additional elements such as constructed wetlands, Eldoret Arboretum was developed to mitigate the urban heat island effect by providing shade and cooling the air through evapotranspiration. The pervious areas and constructed wetlands help manage stormwater runoff from the CBD during heavy rains.

Additionally, the trees and plants planted around in the Arboretum and the CBD, as well as the constructed wetland in the Arboretum help to sequester carbon dioxide.

- **Project adaptation to local climate conditions (present and future) – Score 2**

Features such as wetlands, pervious areas, and the use of native flora addresses climate risks like flooding and rising temperatures.

Located 1km from the CBD, Eldoret Arboretum is exposed to flooding, soil erosion and moderately rising temperatures. The Arboretum is well adapted to projected climate risks of flooding through the presence of a wetland and large aggregate pervious areas. The Arboretum's adaptation to climate risk could be further enhanced by linking its (green) water features and ponds with (grey) drainage infrastructure for improved flood risk reduction as well as providing permeable paving in the parking lot to improve infiltration (See Technical Features analysis on the next pages). The use of native flora in the Arboretum enhances its resilience to climate variability (e.g., by lowering the need for watering the vegetation). With rising temperature and change in rainfall, the adaptation to the selection of species to future climate is also to consider.

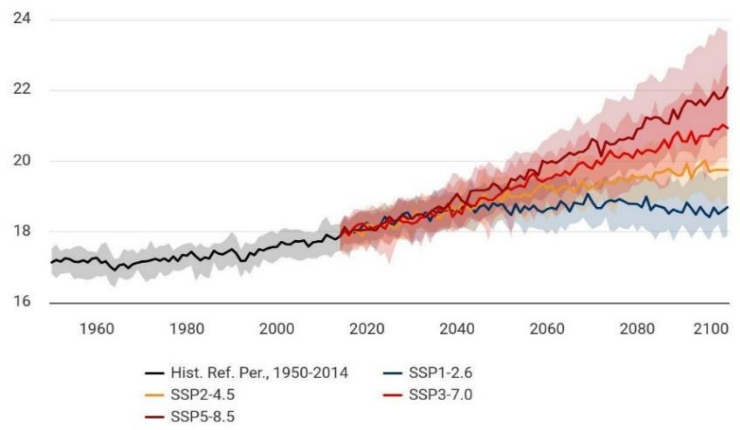


Figure 34 – Projected Average Mean Surface Air Temperature Anomaly for 2020-2039 (Annual) Uasin Gishu, Kenya; (Ref. Period: 1995-2014), SSP3-7.0, Multi-Model Ensemble.
(Source: WB Climate Knowledge Portal – Kenya)

ENVIRONMENT AND BIODIVERSITY

SCORE 2

- **Project response to environmental risks – Score 2**

The Eldoret Arboretum plays a crucial role in mitigating soil erosion, improving air quality, and preserving the environment through its vegetation, ponds, and wetlands.

As a growing city, Eldoret is facing a nexus of well-documented environmental challenges including water, air, soil and noise pollution along with biodiversity loss.

The Sosiani River is highly polluted as result of illegal dumping and discharge of effluent into the river presents a growing environmental problem, also worsening flood risks. The city is affected by poor air quality due to emissions from vehicles and heavy industries. To monitor air quality, sensors have been installed within the city (at the CBD and Lobo Village) with support from Stockholm Institute. Noise pollution emanating from events, vehicles and entertainment lounges presents another challenge as there is a lack of enforcement of noise regulations.

Soil pollution in Eldoret mainly arises from agriculture and industry, through the use and improper disposal of agrochemicals (acidic fertilizers) and oil spills. Solid waste management is a major environmental issue, as the city lacks a designated sanitary landfill and relies on the Kipkenyo dumping site. The convergence of water, soil, and noise pollution, along with rapid urban development, worsens biodiversity loss. Chemicals in drainage channels kill organisms. Encroachment into riparian reserves, especially Chepkoilel, has led to a decline in crane populations. Wetlands in areas like Subaru, Eldoret West, Baharini, Maili Nne, and Chepkanga are also affected. No information is available on the soil used in the Eldoret Arboretum.

The trees and flora planted in Eldoret Arboretum along with the ponds and wetlands help mitigate soil erosion and preserve the natural environment. The vegetation in the Arboretum contributes to the reduction of air pollution by absorbing air pollutants and providing a healthy soundscape respectively (Rey-Gozalo et al., 2023).

- **Environment and urban biodiversity benefits – Score 2**

The Eldoret Arboretum enhances biodiversity, mitigates flood risks, and supports ecosystem services through its native vegetation and wetland features.

Vegetation within the Arboretum primarily consists of young, native trees planted to enhance biodiversity, carbon sequestration, and air quality. This aligns strongly with the ecological objectives of the NbS by contributing to critical ecosystem services such as temperature regulation, habitat creation, and pollution mitigation through indigenous vegetation. However, as the Arboretum matures, additional plantings and the careful selection of species with high ecosystem service potential could further amplify these benefits. Furthermore, the wetland and water features contribute to enhancing urban biodiversity and flood risk mitigation. In alignment with the Eldoret LPLUDP (2022-2032) including a strategy for green spaces development, the integration of the Arboretum within a broader ecological and biodiversity landscape is key to realize the full potential of such project.

Figure 35 – Air quality sensor installed The Lobo Village in Eldoret
(Source: IQAir, https://www.iqair.com/kenya/uasin-gishu/eldoret/the-lobo-village)

GLOBAL CENTER ON ADAPTATION

STAKEHOLDER MAPPING & SOCIAL INCLUSION

SCORE 1.5

- **Stakeholder engagement & consultation strategy – Score 1**

The Eldoret Arboretum project reflects early-stage institutional collaboration between key agencies and the county government, but has not yet developed a structured, data-driven, participatory stakeholder engagement strategy.

The Arboretum is currently co-managed the Kenya Forest Service (KFS) and the Department of Environment of the county but is in the process of being transferred to the City of Eldoret – already in charge of maintenance. It was led by a master plan initially developed by KFS in partnership with the Kenyan Water Towers Agency (KWTA) and Kenya Wildlife Service (KWS). The property is still owned by the KFS, Uasin Gishu County Government and NEMA.

Eldoret City was, and still is, actively involved in the implementation process. The project implementation team coordinated the identification, prioritization and screening of the project and provided quality control of the construction work, which was delegated to a private contractor, Swift Move Logistics. Environment Officers ensured adherence to environmental safeguards during project implementation and operation.

Co-financed by the World Bank and the Government of Kenya under the KUSP1, the identification and prioritization of the Eldoret Arboretum project also involved the private sector and the community, especially through quarterly citizen fora. However, there is no available data on further community involvement and participation during project design and implementation. For future improvements, local stakeholders wish to deepen the collaboration with private stakeholders and institutions. Specifically, they wish to engage further with the University of Eldoret for education and to continue to identify adequate tree species to plant. The City is also open to develop public-private partnerships to enhance park maintenance. However, no data was found on specifics of these projects.

- **Socio-economic benefits and inclusion of vulnerable group – Score 2**

The Eldoret Arboretum project provides significant recreational, social cohesion and cultural benefits for the city's residents, but should further include vulnerable groups in design, implementation and execution processes.

The Eldoret Arboretum Project provides recreational benefits, as it features a watchtower, nature trails, and event areas, enhancing community well-being. Cultural elements displayed within the Arboretum also aim to add significant value by promoting local heritage and community engagement. The wall of legends promotes cultural pride and social inclusion, while the gazebos provide shaded rest areas and serve as information centers, fostering education and recreation. Events like the Eldoret Food Festival and tree planting initiatives, in collaboration with the City Marathon, further engage the community in environmental conservation.

However, there is no available data on the inclusion of vulnerable groups (e.g., women, elderly people, people with disabilities) in the project's design, implementation, or execution. The design of public spaces can significantly impact their accessibility and usage by different groups. For instance, the arrangement and selection of benches can either encourage or deter the presence of families and elderly. To improve accessibility, especially for people with disabilities, future projects should prioritize barrier-free pathways with smooth, paved walkways to accommodate individuals using wheelchairs, crutches, or strollers. Strategically placed shaded seating areas would provide essential rest zones, particularly for elderly visitors. Clear, inclusive signage incorporating Braille and pictograms can enhance navigation for visually impaired individuals.

Additionally, while the project plans to generate revenue through park fees to support maintenance, this could create challenges for low-income individuals with a limited access. Lastly, part of the land within the Arboretum is currently occupied and plans to remove these structures may negatively affect the vulnerable groups living there.

PLANNING LEGAL, REGULATORY & POLICY FRAMEWORK

SCORE 2.5

- **Planning and development strategy – Score 2**

The Eldoret Arboretum was developed within the framework of the WB-funded KUSP1 and aligned with national strategies, demonstrating its integration into broader urban planning and policies.

The development of the Eldoret Arboretum was supported by the WB-funded KUSP1 to contribute to the sustainable urban development of the city. According to Uasin Gishu CIUDP (2017-2022), the Eldoret Arboretum will contribute to both increased protection of the environment and beautification and recreational services. This is also consistent with Kenya's Vision 2030 goals, which emphasize sustainable urban development and climate resilience. This alignment demonstrates how the project was integrated into a broader national and global urban planning framework focused on enhancing urban resilience and sustainability. As a sub-investment under KUSP1, its design and implementation process also adhered to regulations, such as the Environmental Management and Coordination Act, 1999 (amended in 2015), ensuring compliance with environmental management requirements.

However, there is no indication that the project was explicitly mandated by new local or national policies, suggesting it leveraged existing frameworks rather than driving policy innovation.

The regulatory environment could better support similar projects by introducing policies that systematically integrate green infrastructure into urban planning, especially to secure green spaces in the urban sprawl. In 2022, Eldoret included a map of the “distribution of existing and proposed green open spaces in the CBD” in the LDLUDP (2022-2032), including the Eldoret Arboretum, and showing their willingness to elaborate a more strategic approach to green spaces development around the City.

- **Regulatory and land tenure strategy – Score 3**

The Eldoret Arboretum highlights the importance of strategic zoning policies to protect and expand urban green spaces.

The project was implemented on government forest land, within a 1.16 km land reserve with a width of 24 meters. This designated public land provided a secure foundation for implementation without tenure conflicts as it originally belonged to KFS. The Arboretum is one of the first collaboration between the municipality, KFS and the Ministry of Environment to improve the forests around Eldoret and its green spaces.

The Arboretum’s integration into urban zoning reflects thoughtful planning, but expanding such initiatives could benefit from strategic zoning policies that prioritize green corridors and biodiversity hotspots within cities. Part of the land was already occupied, highlighting the need for enforcement tools and clear policies to protect green spaces from encroachments and to value them as public spaces, especially in rapidly urbanizing areas.

IMPLEMENTATION PROCESS AND TECHNICAL FEATURES

SCORE 1.5

- **Implementation process – Score 2**

The Eldoret Arboretum was developed to enhance urban resilience and address climate challenges, following key design steps that align with established urban park design principles.

The design process of the Eldoret Arboretum took into account its alignment with community needs and existing urban structure. For site selection, the location was evaluated based on its proximity to Eldoret's CBD and existing environmental conditions. Local stakeholders were involved to ensure the park addresses community needs effectively (*see Stakeholders analysis*).

Functional zoning areas were designated for recreation, education, and conservation, as outlined in the local physical and land use development plan (County Government of Uasin Gishu, 2022) (see planning analysis). Key features such as 1.8 km of nature trails/pathways, seating areas, parking, and a "Wall of [Sporting] Legends" were incorporated into the infrastructure design to encourage physical activity and social inclusion.

The design and landscaping of the Eldoret Arboretum also involved key technical considerations to ensure environmental sustainability and functionality. Additional technical considerations included soil suitability (critical for pathway construction and other geotechnical structures), construction materials, green energy integration, and smart lighting solutions. Native vegetation was selected in the landscaping phase to promote biodiversity, mitigate urban heat island effects, and enhance carbon sequestration and air quality through thoughtful species selection.
Finally, strategies were developed for the ongoing operation and upkeep of the park to ensure its long-term viability and sustainability.

Existing Local Documentation for Urban Park Establishment

- Eldoret Town CBD Regeneration Local Physical and Land Use Development Plan (2022-2032) - (County Government of Uasin Gishu, 2022)
- Street Design Manual for Urban Areas in Kenya - (Ministry of Roads and Transport, 2022)
- Urban Planning for City Leaders: A Handbook for Kenya - (UN-Habitat, 2018)
- Transforming Nairobi's City Park: Reframing Urban Spaces through Regenerative Landscapes - (Mwendwa, 2024)

Other relevant guidance for Green park Development

- Arboretum Management - (ArbNet, 2022)
- Urban Park Design Concepts and Key Elements - (Pedicini, 2020)

IMPLEMENTATION PROCESS AND TECHNICAL FEATURES

SCORE 1.5

- **Technical Features – Score 1**

Conventional design of urban parks can be enhanced by integrating landscaped and built features for nature-based benefits (e.g., by connecting water features to the drainage system and using permeable paving to enhance water retention).

- Future urban park design may include paved elements such as pathways constructed using impermeable pavers to provide accessibility and convenience for pedestrians as is the case for Eldoret Arboretum. Making pedestrian pathways permeable and linking them along with their associated drainage channels to adjacent water features in an integrated design could further enhance water retention and infiltration potential, thus supporting urban flood management and enhancing local hydrological cycles. Connecting these drainages to the water feature and utilizing permeable paving materials would better support NbS objectives by mimicking natural water management processes.
- More specifically, water features and ponds within the urban parks are often designed and constructed sorely for aesthetic purposes, representing a missed opportunity to reap the benefits of integrated nature-based design that could support water retention, aquifer recharge, and enhance biodiversity through the provision aquatic habitats. By connecting the water features with (natural/hybrid) drainage infrastructure, urban parks could become pockets of self-sustaining hydrological systems that enhance water availability and biodiversity.
- Lastly, amenities such as paved parking lots, public toilets and other park buildings may also be retrofitted to reduce surface runoff, increase water infiltration while addressing water scarcity in a more circular way. Impervious materials could be replaced with permeable pavers parking, while integrating green infrastructure elements such as bioswales, would further enhance their hydrological functionality. Furthermore, the roofs of public toilets and other park buildings could be retrofitted with rainwater harvesting systems, providing water for second-order uses such as toilet flushing and watering.

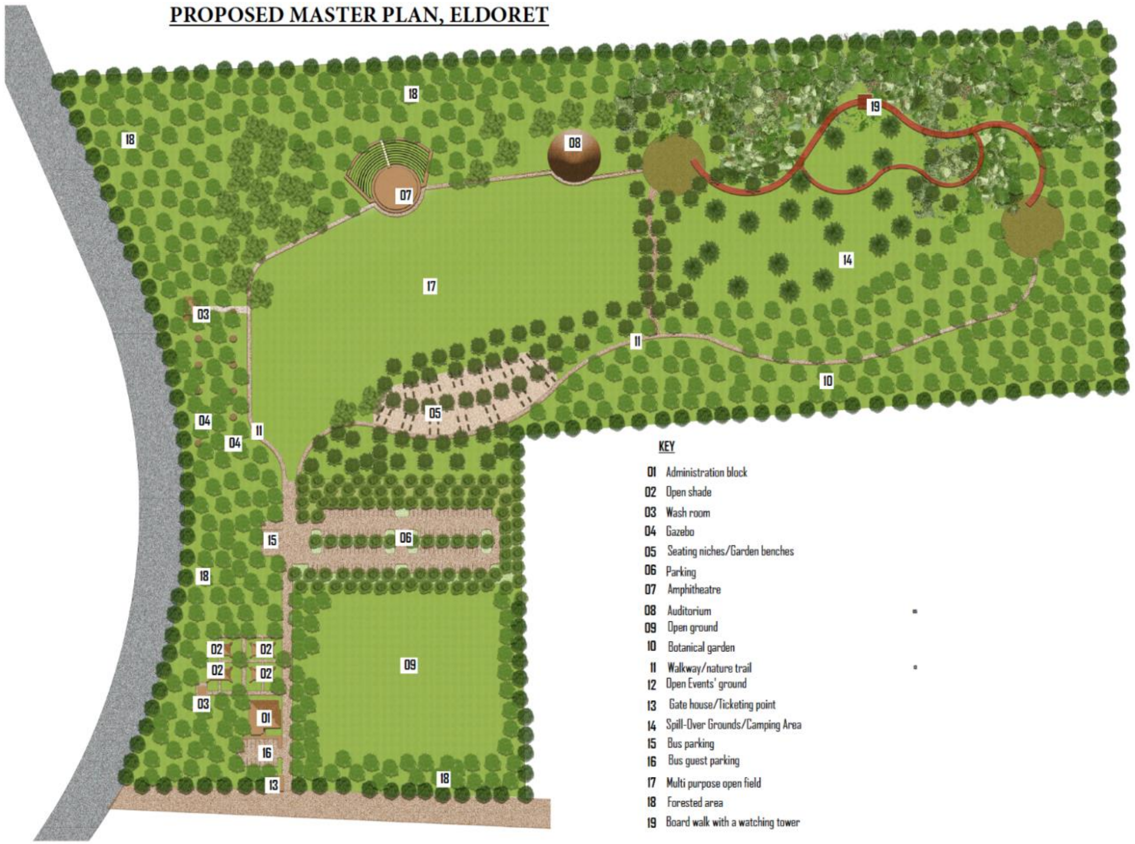


Figure 36 – The Masterplan used in the design and construction of the Eldoret Arboretum (Source: Kenya Forest Services)

IMPLEMENTATION PROCESS AND TECHNICAL FEATURES

SCORE 1.5

Enhancing the design of urban parks by integrating grey infrastructure with blue-green infrastructure. Urban parks provide essential ecosystem services, however most urban parks have been designed without NbS objectives in mind. As such there are opportunities to consider retrofitting urban parks with enhanced NbS-aligned designs in Kenyan cities. There are several NbS-aligned design enhancements applicable to urban parks that could enhance their technical functionality.

Integrating permeable pathways into parks

One approach could be to replace impermeable cabro pavers on pathways with pervious materials, such as resin-bound gravel or modular permeable paving. Permeable pavements support pedestrian and vehicular traffic while allowing rainwater to infiltrate into underlying layers, where it can be stored, infiltrated, or discharged. Permeable pavements manage surface water runoff close to its source, reducing runoff volume and frequency while filtering pollutants through adsorption, biodegradation, and sedimentation processes. Critically, permeable pavements can be retrofitted into existing parks, offering flexibility for upgrading water management systems in urban green spaces. Integrating these pathways with drainage systems, including water features, would enhance water retention, support aquatic habitats, and reduce urban heat island effects, benefiting all parks.

Converting concrete-lined channels into grass swales

Replacing concrete-lined drainage channels with grass swales is a cost-effective and natural alternative for stormwater management. Grass swales slow, filter, and direct runoff, improving water quality through pollutant removal while promoting infiltration. They create habitats for wildlife, enhance biodiversity, and lower surface temperatures, contributing to urban cooling. Additionally, their natural appearance improves the aesthetic appeal of parks and reduces maintenance costs compared to concrete systems. Guidance on the design of both features can be found in texts such as Woods-Ballard et al. (2015).

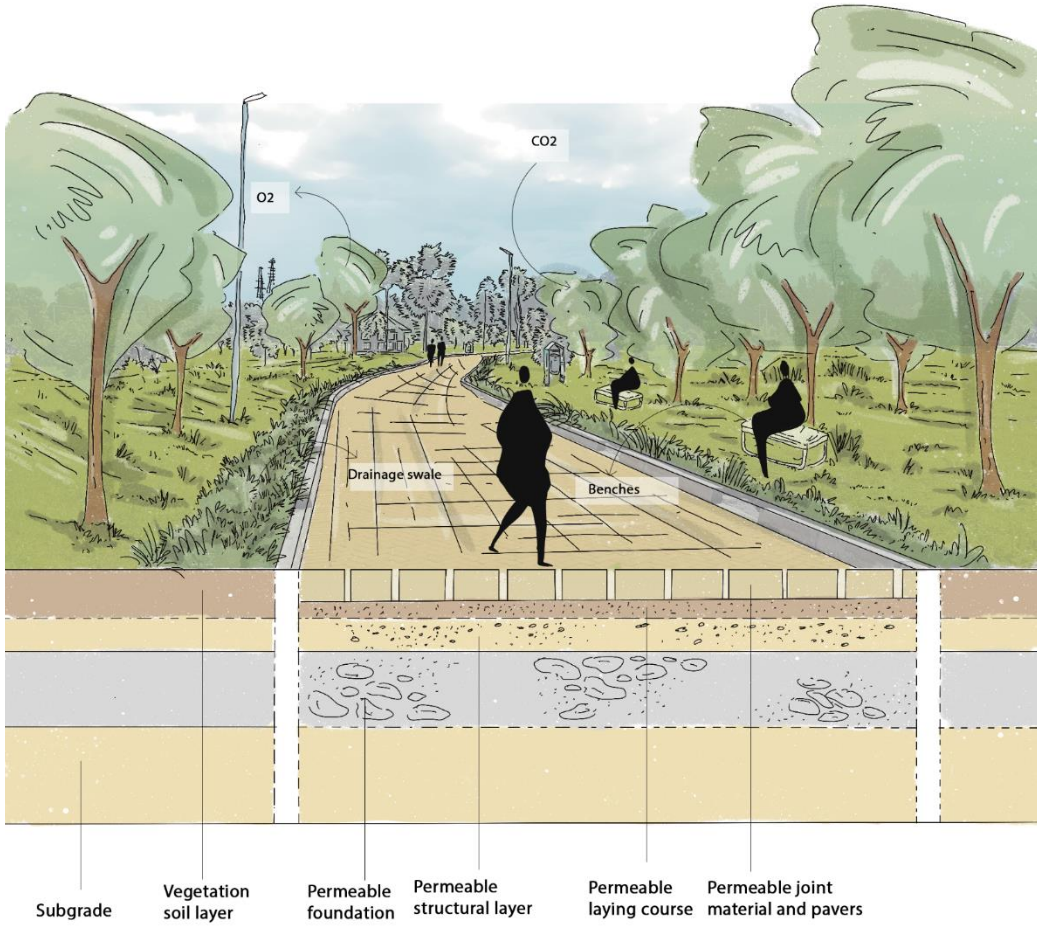


Figure 37 – An overlay showing proposed improvements at Eldoret Arboretum
These include the use of grass swales in place of concrete lined channels to convey stormwater from the park.
(Source: SUEZ Consulting)

Figure 38 – Nairobi Arboretum
(Source: SUEZ Consulting, 2024)

Related NbS Inventory case - the Nairobi Arboretum, Kenya

The Nairobi Arboretum, a 30.4-ha urban forest established in 1907, is one of Nairobi's vital green spaces. Initially a trial plot for exotic tree species for the Kenya-Uganda Railway, it became a gazetted reserve in 1932 and a public resource in 1996. It houses over 350 plant and 100 bird species, offering trails and picnic areas. KFS and a community association manage collaboratively the park, focusing on essential activities such as tree pruning, planting — prioritizing indigenous species — and routine upkeep of nature trails and recreational facilities. The Arboretum generates revenue from entry fees, KFS oversees the financial aspects, including staff salaries and the upkeep of casual workers such as security rangers, records officers, clerks stationed at the gates, the station manager, and cleaners. Additional funding comes from donations, such as those from the Radisson Blue Hotel, for maintenance and rehabilitation efforts.

Figure 39 – Wote green park
(Source: Amboseli National Park, https://www.amboseliparkkenya.com)

Related NbS Inventory case - Wote green Park, Kenya

The Wote Green Park Project, located in Wote, Makueni County, spans 3.46 ha and was developed between 2018 and 2019 with funding from KUSP1. Managed by Wote Municipality, the park employs NbS to address challenges in arid and semi-arid lands (ASAL). Indigenous vegetation enhances biodiversity and cools the microclimate, mitigating rising temperatures and dust pollution. With ICT facilities, cultural spaces, and recreation areas, the park fosters well-being, socio-economic growth, and cultural heritage, exemplifying sustainable urban development through green infrastructure. *Image source: Inside Wote Green Park (2022)*

OPERATIONS & MAINTENANCE

SCORE 2

- **Roles and responsibilities – Score 2**

The management of the Eldoret Arboretum relies on multi-stakeholder collaboration under KFS and County Government supervision, with plans to devolve it to Eldoret City.

The Eldoret Arboretum project is co-managed. Eldoret City Board, in collaboration with stakeholders, is managing the Arboretum project, with plans for eventual devolution of its management to the City.

Eldoret City Board in collaboration with other stakeholders identified, prioritized and screened the project as well as served as the implementing agency. Swift Move Logistics served as the contractor in charge of construction works, while private companies such as Raiply Company donated tree seedlings.

Arboretum management is still currently handled by KFS, NEMA and the County Department of Environment but will eventually be devolved to Eldoret City. The Parks and Gardens Department of Eldoret City already handles the maintenance and management of the Arboretum, with assistance from paid casual workers and prisoners from the neighboring prison.

The property is still owned by the KFS, Uasin Gishu County Government and NEMA.

- **Operation & Maintenance Plan – Score 2**

The Arboretum's maintenance is currently limited due to a lack of dedicated funding, though plans for a more comprehensive maintenance strategy are in development to address various upkeep tasks.

The primary maintenance activity currently involves mowing the grass to maintain the Arboretum's appearance. Although other maintenance activities, such as pruning trees or managing waste, are necessary, these activities are not regularly performed due to the absence of a dedicated budget. Plans are in place to develop a more comprehensive maintenance plan, including regular upkeep activities such as waste management, tree care, and repairs to park facilities like benches and gazebos. The maintenance team works to ensure that the park remains clean, functional, and welcoming for the public, though limited resources have constrained the range of maintenance tasks performed.

Depending on the park elements present, operation and maintenance of the park could include:

- Planting, watering, mowing and reseeding of turf (most frequently at the beginning perhaps weekly, then as required thereafter)
- Seasonal planting/broadcasting of native flora seeds/nursery plants
- Addressing erosion especially in high-traffic areas, repair of eroded areas
- Solid waste removal, Emptying and disinfection of trash bins (weekly)
- Cleaning of public toilet facilities (daily, may be increased in busy seasons)

Restoration of park furniture (e.g., repainting benches, play equipment, as required or annually)

- Weeding, watering, mulching and pruning of trees (monthly)
- Maintenance of wetland (see page *Case 3 – Natural Wetlands)*

FINANCIAL SCHEMES & SUSTAINABILITY — SCORE 1

- **Project costs, revenue generation and funding – Score 1**

Though original funding from the World Bank allowed for implementation, there is no dedicated budget for maintenance yet.

The project was funded by the World Bank and the Government of Kenya through the Kenya Urban Support Program 1. The cost of implementation of the Eldoret Arboretum was US$ 703,600 (KES 90,784,894), for a relative cost of US$ 43,200/ha. Tree seedlings were donated by Raiply Company.

The maintenance team works to ensure that the park remains clean, functional, and welcoming for the public. The absence of a dedicated budget has constrained the range of maintenance tasks performed. Plans are under way to develop a more comprehensive maintenance strategy.

Originally, there were plans to implement revenue sharing, but discussions have not been concluded. Eldoret City mentions plans to fence the park and charge a fee for entrance.

- **Integrated financial plan and project sustainability – Score 1**

The infrastructure implementation and maintenance suffer from insufficient funding.

Planned infrastructure projects were not fully completed due to a lack of funding. Funding constraints and delays in developing a comprehensive operation and maintenance budget have limited the upkeep and possible expansion of the Arboretum.

Insufficient financial planning in the design phase affects the viability of the Eldoret Arboretum. Developing a financial plan would have helped identify potential funding gaps and adapt technical design and O&M planning accordingly. This anticipation benefits both the financial and technical sustainability of the project.

MONITORING & EVALUATION SYSTEM — SCORE 1

- **Key existing indicators – Score 1**

No information is available on existing indicators for project evaluation.

Eldoret City officers report benefits on physical and mental health, stormwater management, heat, social interaction, recreation, job creation, education, and culture without providing concrete indicators to measure these benefits.

Biodiversity has reportedly increased although no inventories of flora and fauna exist. Some undocumented reports of invasive species were also mentioned.

- **M&E system and knowledge dissemination – Score 1**

Eldoret City does not seem to have developed a concrete M&E system nor a detailed communication strategy.

Impact is reportedly monitored through community engagement fora, beneficiary assessments, and interviews. Officials report limited public awareness of the benefits of open green spaces.

The public engagement strategy should aim to improve the ecological literacy of citizens to facilitate public awareness of the benefits of open green spaces.

Open Green Space

CONDITIONS FOR UPTAKE

The Eldoret Arboretum is a practical example of how urban parks can serve as NbS to address critical urban challenges, including biodiversity loss and urban heat. Developed as part of Kenya's urban resilience initiatives, it demonstrates the potential of integrating ecological and social objectives into green space development. Conditions for uptake have been identified based on the lessons learned from the case to ensure replicability and enhance the design of solutions in similar contexts. While its technical features can be improved to foster a greater resilience, the Arboretum showcases valuable elements that can inspire enhancements in similar projects in Kenya.

Key inspirational features for associated NbS families

- **Incorporating native vegetation for biodiversity and climate action:** the Arboretum employs native tree species to enhance local ecosystems and provides valuable insights for urban reforestation and carbon sequestration initiatives contexts.
- **Cultural and recreational integration**: elements like nature-trails and the "Wall of Legends" demonstrate how urban parks can harmonize ecological objectives with cultural and recreational facilities, promoting community pride and participation.
- **Mutually-beneficial cooperation** between the Parks and Gardens Department of Eldoret City and the neighboring prison providing maintenance workers could be strengthened further providing prisoners with opportunities for a Nature-based social prescribing rehabilitation program (de Bell et al., 2024).

Key improvement area for NbS replicability across Kenya

- **Strengthening integration into urban and ecological landscape:** Integrating arboretums and green parks into urban development policies and plans, complemented by a dedicated urban green planning framework, will help maximize their potential environmental and biodiversity benefits. Municipalities and county governments should be empowered with clear mandates, technical expertise, and adequate resources to effectively implement and manage projects.
- **Enhancing community engagement and education:** Engaging communities – in particular vulnerable groups – in the design and management of parks will ensure that green spaces align with local needs and priorities. Expanding and strengthening forestry education through the Kenya Forest Service for schools and the general public will foster a culture of environmental stewardship..
- **Developing sustainable funding mechanisms:** Establishing diverse and innovative funding options, such as green bonds, public-private partnerships, and eco-tourism revenues, is crucial for ensuring the financial sustainability of urban parks and their ongoing maintenance and development. Revenue generation should also be part of stakeholder consultations to link socio-economic benefits for the communities and global financial sustainability of the NbS.
- **O&M and financial planning:** Anticipating O&M needs and associated costs in the design phase is vital to ensure project design is aligned with available funding, and thereby sustainable.
- **Public awareness:** Improving ecological literacy of citizens through appropriate communication strategies would foster the understanding of green spaces' benefits and public acceptance.

Case 2 – Terraces and slopes: Living Smiles (Earth Bunds)

Terraces and slopes are a crucial NbS used worldwide to stabilize steep land, reduce erosion, restore degraded land and protect against natural hazards such as floods, landslides, and droughts. These systems are designed to conserve water and soil while improving water quality by capturing and filtering stormwater. In addition, modern technologies such as geogrids, bioengineered materials, and electronic monitoring tools have enhanced the functionality of traditional terracing practices, improving slope stability and promoting vegetation growth (Berčič & Ažman-Momirski, 2020). Terracing also mitigates the impacts of extreme weather events and promotes water infiltration, helping to recharge groundwater and improve resilience to climate change.

Terracing has key benefits, including increased crop yields by up to 2.5 times, reduced runoff by over 80%, and enhanced biodiversity by providing habitats for various species (Díaz et al., 2019). These systems support food security and sustainable land management while protecting infrastructure from erosion and sedimentation. Possible disadvantages of terracing include the alteration of dynamic balance of water resources (Deng et al., 2021) potentially reducing infiltration in downhill areas and altering groundwater recharge patterns, while poorly designed terraces may lead to increased rill and gully erosions (*ibid*).

LIVING SMILES, KUKU RANCH

The following slides analyze the Living Smiles case to better illustrate the potential and challenges of terrace and slope design and implementation in Kenya.

Key inspirational features: *community-led bund construction for water retention, enhanced soil moisture, resilience to drought, and rehabilitating degraded land.*

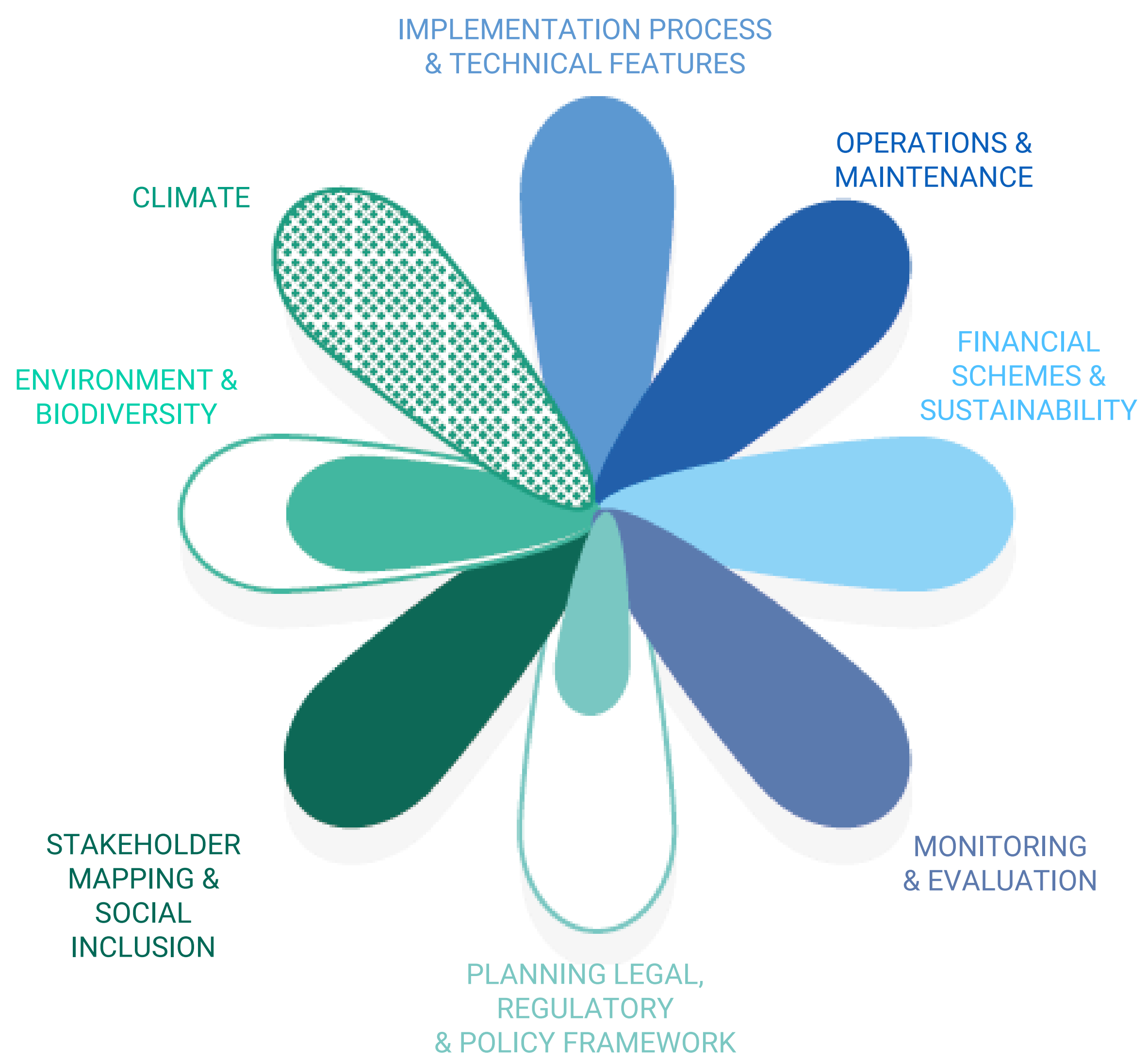


Figure 40 – Gap analysis result for Living Smiles (Source: SUEZ Consulting, 2024)

PROJECT PRESENTATION

Land degradation in the Chyulu Hills, exacerbated by overgrazing and poor land management, creates a cycle of declining vegetation and worsening soil conditions. To address this, the NGO Justdiggit, operating in five areas in Kenya and two in Tanzania, is constructing over 369,000 earth bunds (which they term Living Smiles) across 3830 ha in the Chyulu Hills. In 2021, about 5.42 km2 of land in the Kuku area of Chyulu Hills was rehabilitated using bunds. These semi-circular earth bunds capture rainwater, reduce runoff, and enhance soil infiltration, fostering vegetation regrowth and reversing land degradation.

The projects are community-led, ensuring local engagement and ownership. The bunds' design, which balances water capture with labor efficiency, makes the approach sustainable and cost-effective. Community members are directly involved in the digging process, which provides immediate financial benefits and strengthens their connection to the land. As vegetation regrows within and around the bunds, the initiative not only restores degraded lands but also enhances biodiversity, cools the environment, and improves livelihoods across the region. While not an urban case, it provides an NbS option that is transferable to urban areas with degraded land, particularly on slopes.

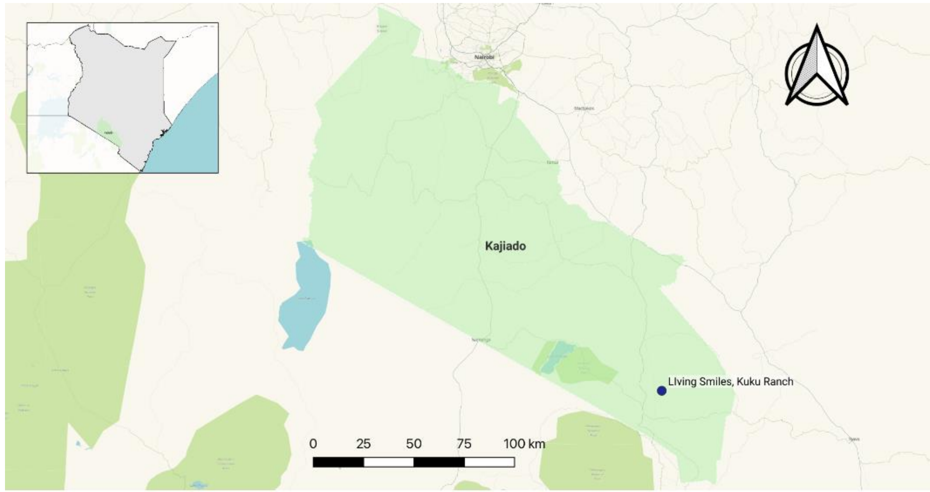


Figure 41 – Location map (above) and A view of Living Smiles, Kuku Ranch (below) (Source: Justdiggit, https://ourworld.Justdiggit.org/en/chapter/water-bunds)

Figure 42 – Earth bunds, Kuku Ranch (Source: https://www.wechoosenature.org/projects/kenya-kuku)

Figure 43 – Earth bunds, Kuku Ranch (Source: https://www.wechoosenature.org/projects/kenya-kuku)

GLOBAL CENTER ON ADAPTATION

CLIMATE

SCORE 2.5

- **Project response to climate risks – Score 3**

Earth bunds, mitigate drought, land degradation, and flooding, while enhancing soil moisture, reducing flood risks, stabilizing temperatures, and supporting biodiversity and carbon sequestration.

The Living Smiles project is located in Kajiado County. As a predominantly semi-arid region, the county is facing significant climate risks such as increased frequency and intensity of droughts, erratic rainfall patterns, rising temperatures and heatwaves, land degradation, water scarcity and flooding (MoALF, 2017; CoGK, 2023). The county has experienced a negative trend in average yearly rainfall, while there has been an increasing trend in temperatures, with the mean annual temperature over the last seven years reaching 38.2°C. These climate risks have implications including water scarcity affecting the availability of water for both human consumption and agriculture. They are also impacting biodiversity (e.g., significant reduction in the Ngong Forest cover), as well as negatively affecting the livelihoods of pastoralist communities (CoGK, 2023).

The Living Smiles project was developed to address the impact of drought and land degradation and flooding in the Chyulu Hills. These were exacerbated by overgrazing and poor land management, creating cycles of declining vegetation and worsening soil conditions. The earth bunds of the Living Smiles project address climate risks in Chyulu in multifunctional ways. The regreening of the landscapes with earth bunds has created 'bundscapes' that mitigate rising temperatures by increasing soil moisture and enhancing evapotranspiration. More importantly, the bunds also capture and infiltrate runoff, thereby mitigating the increased flood risk associated with intense precipitation. The restored vegetation also acts as a carbon sink, contributing to climate stabilization and biodiversity.

- **Project adaptation to local climate conditions (present and future) – Score 2**

Earth bunds are a multifunctional NbS that is particularly suitable for areas prone to both drought and flooding.

Earth bunds are particularly suitable for drought-prone areas such as Chyulu Hills. When constructed with indigenous long-root grasses, earth bunds are well adapted to drought conditions by allowing soil moisture retention and preventing erosion. Beyond addressing drought risk, the earth bunds are inherently multifunctional as their semi-circular vegetated design mitigates flood risk by acting as micro-catchments that slow down, harvest and infiltrate runoff (Challis et al., 2024; SSWM, undated).

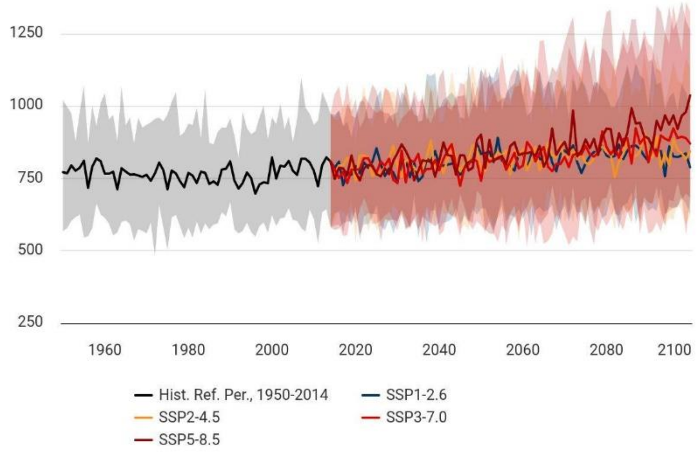


Figure 44 – Projected Precipitation Anomaly for 2020-2039 (Annual) Kajiado, Kenya Ref. Period: 1995-2014), SSP3-7.0, Multi-Model Ensemble. (Source: WB Climate Knowledge Portal – Kenya)

ENVIRONMENT AND BIODIVERSITY — SCORE 2

- **Project response to environmental risks - Score 2**

Earth bunds address soil erosion, boost soil health. Creating these green 'bundscapes' improves general environmental conditions.

The Living Smiles project has helped address the impact of drought and land degradation which had created a cycle of declining vegetation and worsening soil conditions. The semicircular shape of earth bunds helps reduce soil erosion by slowing down and infiltrating runoff across the landscape (Demissie et al., 2022). Earth bunds also contribute to the regeneration of degraded land by improving water retention and soil quality (Justdiggit, 2021). By enhancing water availability and soil health, earth bunds boost crop yields and support sustainable farming practices in drought-prone areas.

- **Environment and urban biodiversity benefits – Score 2**

By regreening the landscape and enhancing soil health and moisture retention, Living Smiles promotes habitat creation and restoration, thus improving biodiversity.

The semicircular shape of living smiles helps reduce soil erosion by slowing down runoff across the landscape. Living Smiles planted with native vegetation also contribute to the regeneration of degraded land by improving water retention and soil quality thereby enhancing biodiversity. By enhancing water availability and soil health, living smiles boost crop yields and support sustainable farming practices in drought-prone areas (Justdiggit, 2021). By regreening the landscape and improving soil health and moisture retention, living smiles enhance biodiversity by (re)creating habitats for diverse plant and fauna and improving connectivity of habitats (Challis et al., 2024).

PLANNING LEGAL, REGULATORY & POLICY FRAMEWORK — SCORE 1

- **Planning and development strategy – Score 1**

The Living Smiles project addresses local needs but remains isolated from broader policy framework, limiting its potential for wider impact.

The project was led by Justdiggit, a community/NGO-led initiative and their local partner and the Maasai local community to enroot it in the local area. Nonetheless, there is no available information indicating the project's integration into a broader policy context. While not explicitly tied to a national policy or international framework, the project aligns with local needs, particularly addressing desertification, which highlights its relevance to the community. Although it contributes to enhancing climate resilience in the community, special attention should be given to ensuring alignment with larger policies to prevent territorial discrepancies.

- **Regulatory and land tenure strategy – Score 1**

The Living Smiles project relies on local land arrangements. Integrating this NbS into zoning regulations and formal planning would enhance replicability in urban areas.

The Living Smiles project does not explicitly indicate that it is located in a legally designated reserved area. Its focus on community-based reforestation and rainwater harvesting bunds suggests reliance on local and communal land arrangements.

To improve the replicability of such projects into constrained urban areas, incorporating zoning regulations that prioritize NbS, such as designated green zones or reforestation areas, would be beneficial. Living Smiles was implemented in rural community area. The integration into formal planning would ensure better integration of NbS into urban planning in constrained and fast evolving environment such as in urban areas and strengthen the project's long-term viability.

STAKEHOLDER MAPPING & SOCIAL INCLUSION

SCORE 3

- **Stakeholder engagement & consultation strategy – Score 3**

The Living Smiles project is a successful example of a community-led conservation project.

This project is structured around collaboration between local Maasai communities, the international NGO Justdiggit, and the Maasai Wilderness Conservation Trust (MWCT). Justdiggit is the project's primary funder, providing the financial resources needed to support land restoration efforts. The organization works closely with MWCT, the local implementation partner, on the technical aspects of the project.

Local community members play an active role in decision-making, implementation, and monitoring of the project. In the Kuku Group Ranch, community leaders and members approved of the project in 2016. Women and youth manage the grass seed banks and are directly involved in land restoration activities, including digging bunds. Each grass seed bank is monitored by a group of 10 women, covering a 10 ha plots, fostering local engagement and ownership. The grazing management plan was defined through stakeholder consultations, between Justdiggit, local partners and "grazing committees", consisting of 130 Maasai pastoralists.

The successful implementation inspired other communities to pick up on this initiatives, such as the Rombo Group Ranch.

- **Socio-economic benefits and inclusion of vulnerable group – Score 3**

The project actively engages Masaai women and youth in its implementation, securing livelihoods and fostering a culture of conservation in the area.

The Living Smiles Project has delivered significant socio-economic benefits to the Maasai communities. First, the establishment of grass seed banks managed by five women groups provides them a steady source of income so they can support their families, send their children to school, and meet essential needs such as food and shelter. The creation of direct financial opportunities through community participation in land restoration activities, like digging bunds, helped address immediate economic challenges, especially during times of drought.

A special effort was made to provide economic opportunities to vulnerable groups, particularly women and youth. According to the testimony of women participating in the project, they have gained increased economic independence and social respect. The project has also empowered youth by equipping them with new skills in conservation and land management, fostering leadership and the ability to educate others in their community.

The project is having a ripple effect, fostering local knowledge sharing and a culture of conservation. It has inspired additional land restoration initiatives beyond the initial sites. For instance, a local tomato farmer in Kuku Group Ranch independently converted his land into a restoration site, and other neighboring communities have also started their own efforts. This reflects a broader impact on the community's engagement towards land restoration efforts.

IMPLEMENTATION PROCESS AND TECHNICAL FEATURES | SCORE 3

Implementation process – Score 3

The implementation process successfully combines the engagement of local communities with appropriate baseline and clear technical steps to follow.

The implementation process begins with engaging local communities to ensure active participation and ownership. Community members are trained in surveying and bund construction techniques to build local capacity and support sustainable land management. Baseline assessments are conducted to analyze soil conditions, vegetation health, and erosion patterns, forming the foundation for intervention planning. Site surveying follows, using tools like spirit levels, A-frames, or water-filled hoses to map contour lines accurately. These contours guide the placement of semi-circular bunds, ensuring optimal water retention and minimizing soil erosion. Feasibility studies assess environmental conditions and resource availability, refining bund designs to suit site-specific needs. This includes adjusting bund size and spacing based on rainfall and topography.

Once designs are finalized, materials are sourced, and construction begins. Workers excavate bunds layer by layer, adhering to specified dimensions. Bunds are arranged in cascading patterns to channel excess runoff into lower structures, increasing water retention efficiency. Stones are used to reinforce bund edges, and diversion ditches are installed to manage runoff and protect the upper bunds. Drought-resistant grass seeds are planted within the bunds to stabilize the soil and promote vegetation regrowth. The grasses help prevent erosion and improve biodiversity. Regular monitoring and maintenance ensure the intervention's long-term effectiveness, addressing any erosion or structural issues and enhancing ecosystem services.

Detailed implementation process can be found here:
https://Justdiggit.org/the-story-of-a-digger/

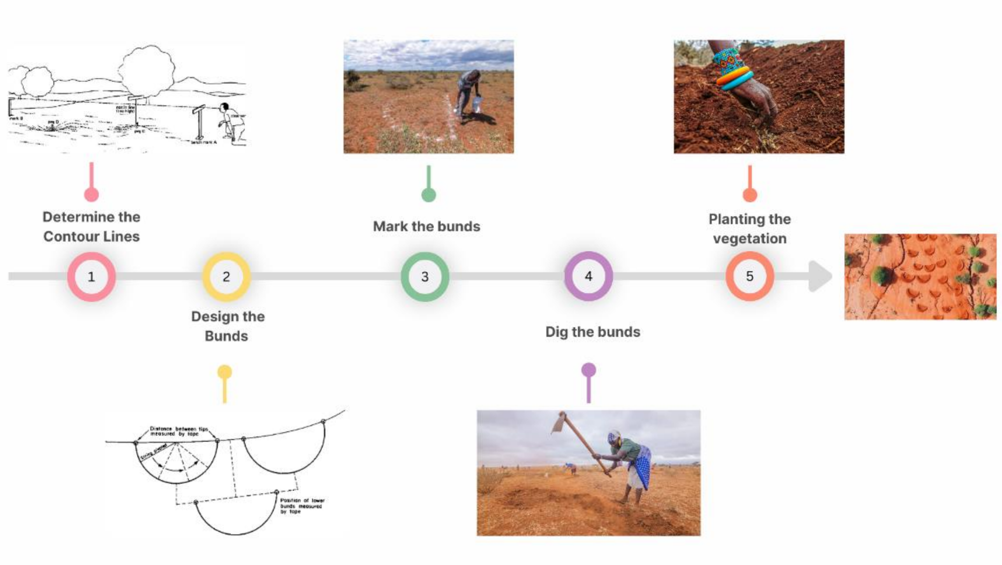


Figure 45– Implementation process for Water Bunds
(Source: Adapted from Amsha Africa Foundation, 2023)

Figure 46 – Community member standing in an installed bund
(Source: Justdiggit, 2021)

IMPLEMENTATION PROCESS AND TECHNICAL FEATURES

SCORE 3

Technical features – Score 3

The technical features provides clear guidance on technical criteria namely slope and soil classification.

The semi-circular bunds are constructed to capture rainwater, reduce runoff, and restore degraded land. Earth bunds are effective in areas with rainfall as low as 150 mm per annum. Soils must be at least 1.5 m deep, preferably 2 m, to support root development and water storage. They are suitable for slopes ranging from 0% to 15%, and the topography need not be even. Critchely & Siegert (1991) provide a flowchart of technical selection criteria, including bund height based on slope, to refine site-specific designs. The process begins with site assessment, including slope measurement and soil classification using methods such as the USCS Field Method (Craze 1990). The data collected determines the type and size of bunds to be implemented. Contour surveying with tools like spirit levels and A-frames ensures alignment with natural topography. Bund dimensions (typically 5 m wide, 2.5 m long, 0.5 m deep) are adjusted to conditions, with more extensive bunds for drier areas. Bunds are arranged in cascading patterns to efficiently direct water flow into lower structures (refer to the figure on the right). Diversion ditches (1–1.5 m wide, 0.5 m deep, with a 0.25% gradient) manage runoff, while compacted trenches reinforced with stones enhance durability and prevent erosion.

The design of bunds can be enhanced by constructing bunds in a "V" shape with open ends to maximize water retention. These designs promote vegetation regrowth with drought-resistant grasses, stabilize soil, and restore biodiversity. Improved infiltration supports soil moisture while the established vegetation provides key ecosystem services such as carbon sequestration.

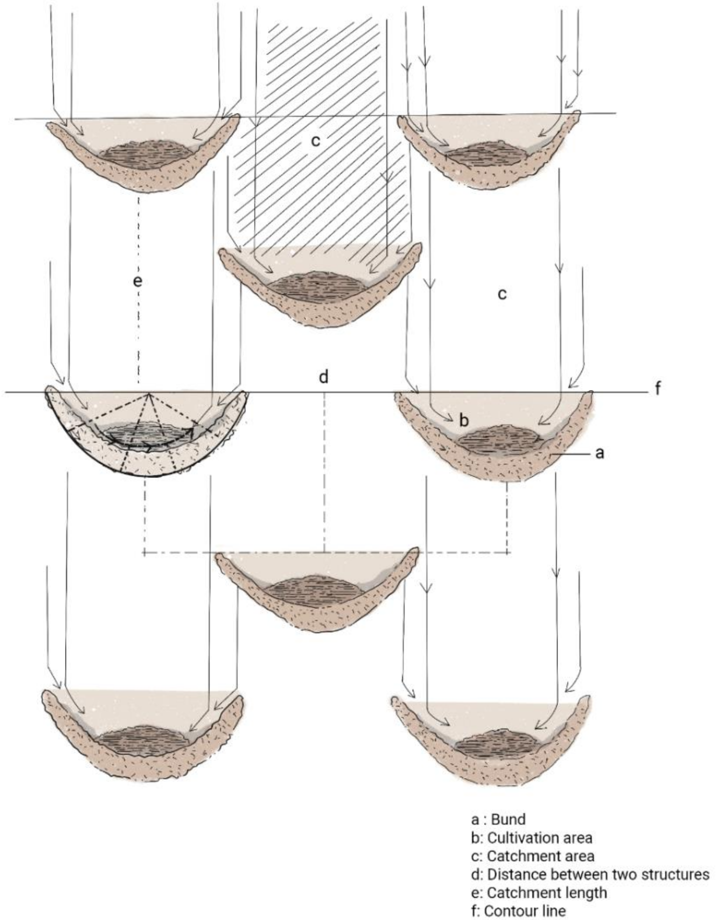


Figure 47 – Sketch of typical layout of bund and the various components involved dimensions vary based on area of site
(Source: SUEZ Consulting, 2024)

Detailed design and construction process can be found here:
https://www.greener.land/index.php/product/demi-lunes-semi-circular-bunds/

Figure 48 – Mauritian project for land resilience (Source: En Haut ! for Grdr, 2020)

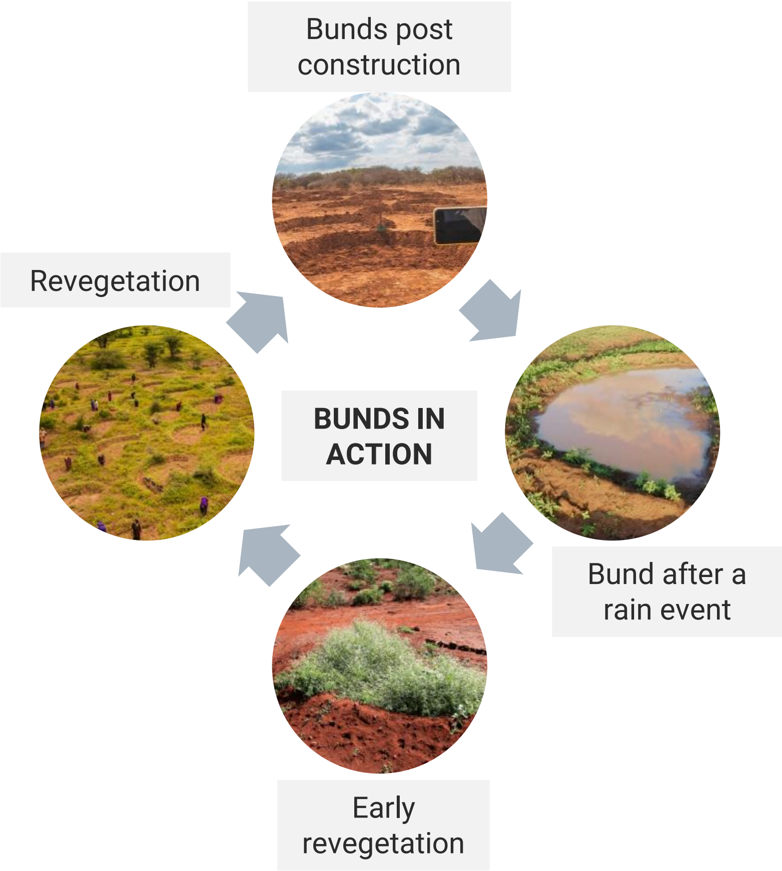


Figure 49 – Earth bunds project (Source: Justdiggit)

Bougherba, Mauritania

The community successfully restored 51 ha of land using a combination of dikes, earth bunds, and half-moon techniques. These methods significantly improved water infiltration, which enhanced millet and fodder production. Additionally, cash support provided at the end of the project enabled beneficiaries to purchase quality inputs like improved seeds and fertilizers, fostering long-term agricultural productivity (World Food Programme, 2021). This showcases initiatives outside the Justdiggit NGO, though scale of implementation is a 10th of Kuku project.

Monduli District, Tanzania

To illustrate with another example from the same NGO which developed Kuku project, Justdiggit undertook the Regreening Arusha Program, transforming degraded landscapes in six villages through a community-driven approach. By 2021, they had built 22,000 earth bunds across communal grazing lands, with the HUSISHA program adding 905 more bunds in 2022. There was collaboration with partners such as the LEAD Foundation and the Pastoral Women's Council, which provided training for farmers. These inspired residents to apply bund-building techniques on private lands (Justdiggit, 2022).

GLOBAL CENTER ON ADAPTATION

OPERATIONS & MAINTENANCE

SCORE 3

- **Roles and responsibilities – Score 3**

Operations and maintenance are primarily the responsibility of local community groups, with oversight and management shared between Justdiggit and the Maasai Wilderness Conservation Trust.

Justdiggit provided the funding and some aspects of project management, while the Maasai Wilderness Conservation Trust implemented and now manages the project. The grass seed banks are managed and maintained by Maasai women groups.

The Kuku Group Ranch Communities is the CBO involved in the construction and monitoring of the bunds. The local community were hired as bund diggers, and some were trained and hired as 'fundis' (i.e., local supervisors of bund construction ensuring the quality of each bund).

Conservation rangers assist with maintenance by preventing livestock overgrazing of the bund's capes.

- **Operation & Maintenance Plan – Score 3**

Robust construction, regular inspections and repairs, vegetation protection for stability, and grazing management to prevent degradation, are key to ensure the bunds' long-term effectiveness.

Maintenance is critical for earth bunds, particularly during the first season when the structures are still consolidating. Regular inspections after runoff events are essential to identify and repair any breaches or damage. Earthen bunds need to be rebuilt to their original height after each rainy season (SSWM, undated).

To keep maintenance to a minimum, it is important that the (1) primary construction is done carefully and solidly, and (2) monitoring and swift repair is performed during the first season as the bunds consolidate. Grass growing on bunds can further enhance stability as its roots fix the soil. It should therefore not be removed (SSWM, undated).

Maintenance principles:

- The key to bund maintenance is protection of the vegetation and the integrity of the bund-structure.
- Regularly inspect the bunds for signs of erosion, damage, or sediment buildup. Repair any issues promptly.
- Keep an eye on the planted vegetation, providing necessary care such as replanting (Amsha Africa Foundation, 2023)
- Grazing management is key to preventing repeated degradation of the landscape (i.e., temporarily designating certain areas as 'grazing reserves' to protect them from overgrazing before vegetation is well-established. (Justdiggit, 2022)). *(The grazing management plan was defined through stakeholder consultations with Maasai pastoralists – see case's stakeholder analysis).*

FINANCIAL SCHEMES & SUSTAINABILITY

SCORE 3

- **Project costs, revenue generation and funding – Score 3**

The project started with Justdiggit funding. Maintenance is now locally led. While still in early stages, revenue generation and potential long-term livelihood benefits could emerge as restoration progress.

The project was fully funded by Justdiggit, which, according to the financial statements published on its website, is about 90% funded by donations from non-profit organizations, companies, and individuals. The Living Smiles project implementation in Kuku Ranch costs US$ 130,000, for a relative cost of US$ 150/ha.

Maintenance is critical in the early years of the project and is led by the communities. Associated costs are not clearly identified.

Revenue generation is not clearly demonstrated yet. For now, communities who participate in bunds construction and maintenance receive compensation for their work through the project fund. Since restoration benefits on livelihoods have not arisen yet, it is difficult to evaluate the impact on the local economy.

However, other Justdiggit restoration projects in Kenya and Tanzania show that beneficiaries already perceive some benefits (*see M&E System analysis*) which represent opportunities for additional income. The neighboring South Rift project in Kenya showed that water retention enhancement through landscape restoration improved grazing management. This will yield significant livelihood benefits for pastoralists in the long term, when livestock have access to grass. In the meantime, the small income they receive from digging the bunds and trenches supports their livelihoods in difficult times of drought.

- **Integrated financial plan and project sustainability – Score 3**

The financial details for this restoration project are limited, but the approach relies on low-cost natural regeneration processes and community-led efforts.

The emphasis on community engagement and local ownership reduces the project's reliance on external funding and the need for a detailed financial plan. In the initial stages, community involvement is essential for maintenance and financial compensation supports these activities. As the ecosystem recovers, it provides livelihood benefits such as improved grazing, better water availability, and resource production. These benefits motivate community members to continue their stewardship.

Over time, the natural regrowth of vegetation helps stabilize the landscape, reducing the need for intensive maintenance, thus allowing communities to dedicate more time and resources to expanding restoration efforts in new areas.

Justdiggit's capacity-building initiatives at the inception of the project equip communities with skills such as sustainable land management, water conservation, and bund construction. These skills enable communities to manage the project independently, replicate restoration efforts elsewhere, and share knowledge locally, reducing the need for ongoing external support.

MONITORING & EVALUATION SYSTEM

SCORE 3

- **Key existing indicators – Score 3**

The organization Justdiggit evaluates the impact of its different renaturation projects in Kenya and Tanzania through indicators addressing landscape restoration and livelihoods benefits.

On Kuku Ranch, the impact on communities' livelihood is currently measured through the number of workers who participate in and get paid for bunds digging. The project being fairly new, restoration impacts on livelihoods should arise in the long run. Vegetation cover is assessed with satellite data, by comparing Kuku bund plots with surrounding areas.

In the same region of Kenya, Justdiggit developed women-led grass seed banks that undergo the same greening monitoring process. Livelihood benefits are measured through the area and number of women per grass seed bank.

Across the many Justdiggit project sites in Kenya and Tanzania, other performance indicators are monitored, such as landscape transformation, tree counts, surface temperature, soil moisture, and perceived benefits in households (figure 48).

Success stories are also a source of inspiration for additional indicators. For instance, this tomato farmer's successful conversion of his land into a restoration site paves the way for indicators on crop yields improvements.

- **M&E system and knowledge dissemination – Score 3**

Justdiggit uses a combination of grassroots methods and new technologies for both its M&E system and communication strategy.

The M&E system is fitted to the specific needs of each project site and associated indicators. Field surveys, ranging from stakeholder consultations to sensors and manual measurements, inform the evaluation of restoration and livelihood benefits.

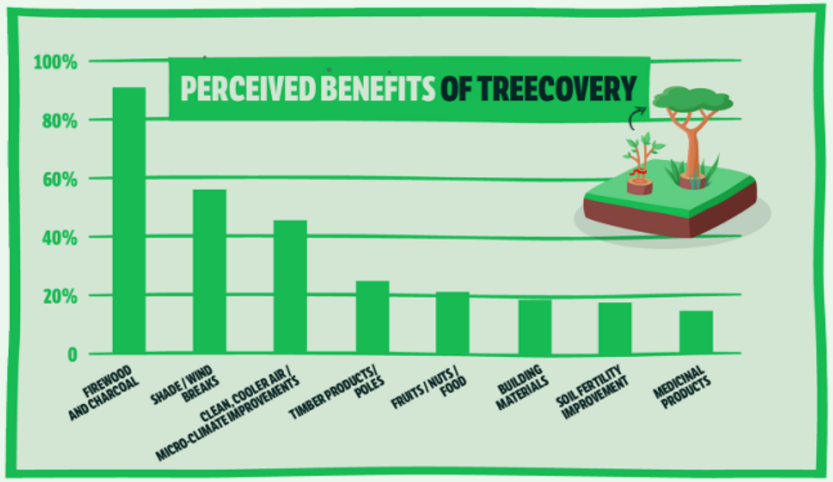


Figure 50 – Proportion of farmers that mentioned each of the benefits : Central Tanzania project (Source: Justdiggit, 2022)

Standardized booklets help data collection and exchange between surveyors and monitoring experts. In parallel, desktop analyses through imagery comparison, satellite data processing, and machine learning provide insights on restoration benefits over larger extents.

Project's knowledge is disseminated internationally via many outlets such as yearly impact reports, a website, social media, and global awareness campaigns. This international communication strategy is crucial to gather organizations, companies and individuals' donations that extensively support Justdiggit.

In the implementation countries, grassroots communication is done through movie roadshows, radio programs, murals and SMS services.

More details on the M&E system and communication strategy can be found here: https://Justdiggit.org/what-we-do/impact/

Terraces and Slopes

CONDITIONS FOR UPTAKE

The Living Smiles project in Kuku is an inspirational case of using earth bunds as a low-cost, adaptable approach to addressing land degradation that is applicable in diverse spatial contexts - urban, peri-urban, and rural contexts. The project aligns with the "Terraces and Slopes" NbS family, showcasing earth bunds as an effective tool for arresting desertification, stabilizing land, reducing erosion and enhancing water retention. These features make it a practical and accessible solution for restoring degraded landscapes. Through Justdiggit's initiatives, its proven effectiveness globally, regionally, and in Kenya highlights the scalability and impact of earth bunds. Conditions for uptake have been identified based on the lessons learned from the case to ensure replicability and enhance the design of solutions in similar contexts.

Key inspirational features for associated NbS families

- **Low-cost and low-tech implementation:** use of local materials, tools and low-tech features ensures affordability and replicability. They can be easily taken in hand and led by communities.
- **Community engagement:** active involvement of communities fosters ownership and sustainability.
- **Versatility:** suitable for diverse terrains and climates, including low-rainfall areas.
- **Ecosystem restoration and adaptation to arid and semi-arid climates:** drought-resistant grasses stabilize soil, improve biodiversity, and enhance water cycles.
- **Performant M&E system:** a combination of grassroots methods and new technologies provides valuable insights on landscape and livelihoods benefits, fostering replicability.
- **Scalability:** simple design integrates seamlessly into regional restoration initiatives.

Key improvement area for NbS replicability across Kenya

- **Topographic requirements:** Areas with annual rainfall of at least 150 mm and soils at least 1.5 m deep, preferably 2 m, are critical for successful replication. Bunds perform well on slopes of up to 5%, making them adaptable to various terrains.
- **Engaging local communities ensures project ownership and sustainability:** Training programs should cover surveying, construction, and maintenance techniques to equip communities with necessary skills. Awareness campaigns emphasizing the benefits of bunds can further foster community participation.
- **Affordable tools for surveying (e.g., A-frames, spirit levels) and locally available materials** such as stones and seeds are essential. Planning for adequate labor resources for excavation and maintenance ensures cost-effectiveness.
- **Alignment with local and national restoration policies** is crucial. Partnerships with organizations like Justdiggit provide technical expertise and monitoring frameworks, supporting effective implementation and scalability (see Justdiggit, 2021)
- **A consistent monitoring framework to track bund performance and vegetation regrowth** is necessary. Regular maintenance, such as repairing bunds, reseeding grasses, and mitigating erosion, ensures the long-term success of the intervention.

Case 3 – Natural Inland Wetland: Ondiri Wetland Rehabilitation

Natural inland wetlands are highly biodiverse and productive ecosystems that serve as critical interfaces between land and water (Ferreira et al., 2023). Historically misunderstood and often degraded, their value is increasingly recognized for their ability to protect urban areas from floods and contribute to climate change adaptation (World Bank, 2021). Acting as natural sponges, wetlands mitigate pluvial and riverine flood risks by capturing and storing stormwater, reducing peak flow velocities, and preventing untreated water from entering water bodies. They also improve water quality through anaerobic processes that facilitate denitrification and the removal of sediments and pollutants (Hatvani et al., 2022). Wetlands are among the most productive habitats globally, supporting a vast array of wildlife (Masto et al., 2023). They are significant carbon sinks, particularly peatlands, aiding in climate change mitigation by storing vast amounts of carbon. Additionally, they offer recreational opportunities such as fishing, and birdwatching, stimulating local economies and job creation (World Bank, 2021). Sustainable harvesting of wetland resources provides food and building materials, necessitating careful management to balance ecological functions with resource use (Hambäck et al., 2023).

ONDIRI WETLAND

The following section examine the case of Ondiri Wetland to showcase the opportunities and challenges associated with conserving and sustainably managing wetlands in Kenya

Key inspirational features: *community-driven wetland restoration, multi-stakeholder integrated management plan, biodiversity enhancement.*

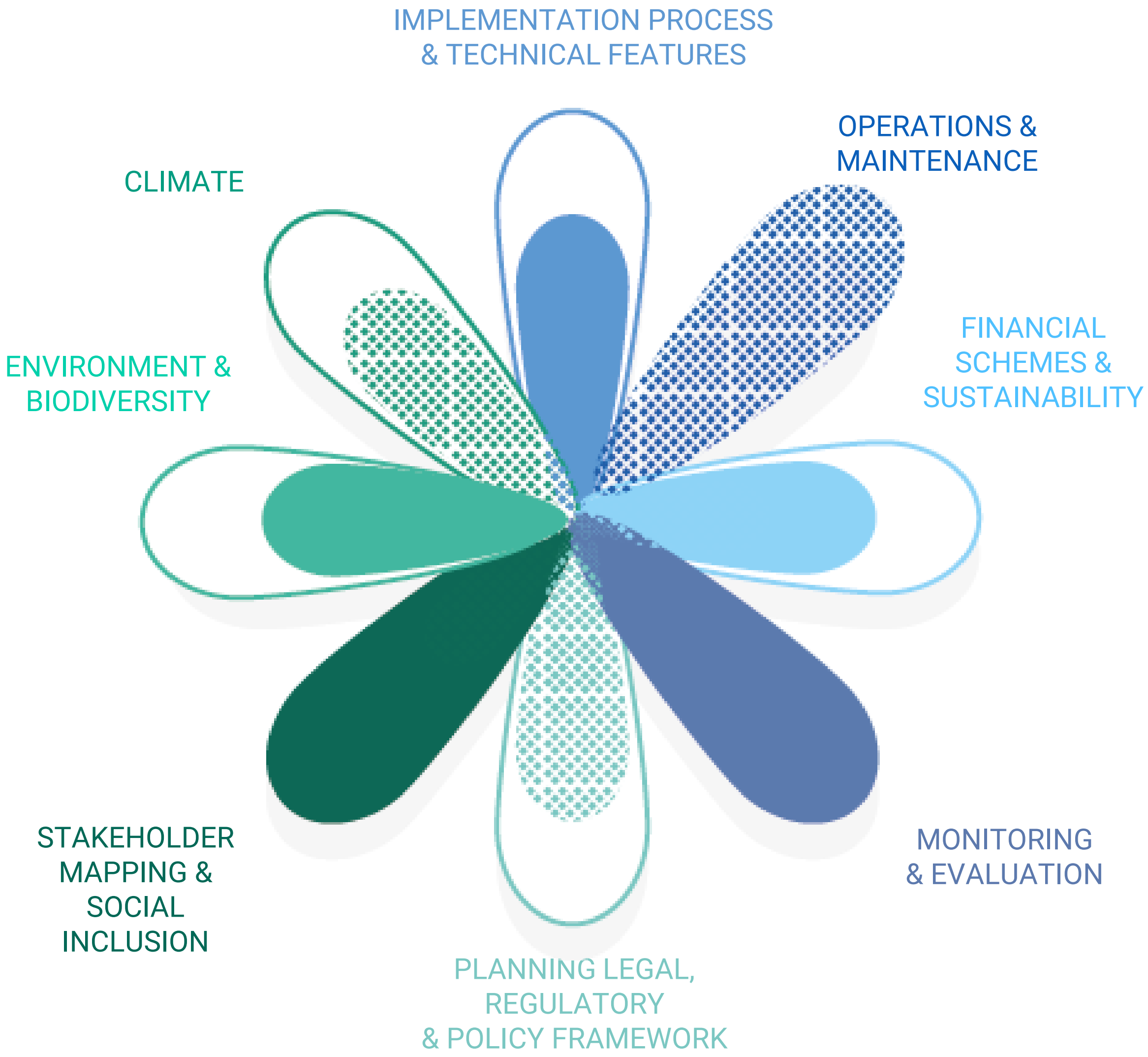


Figure 51 – Gap analysis result for Ondiri Wetland Rehabilitation (Source: SUEZ Consulting, 2024)

PROJECT PRESENTATION

The Ondiri Wetland, located in Kikuyu Municipality, Kiambu County, is Africa's second deepest quaking bog, spanning 34.5 ha (0.345 km^2). This wetland provides crucial ecosystem services, including acting as a water source and sanctuary for diverse flora and fauna. Positioned 2,000 meters above sea level, it supplies water to the Nairobi River, which flows through informal settlements and eventually connects to the Athi River.

This project is driven by Friends of Ondiri Wetland Kenya (FOWK), which is supported by community partnerships, NGOs, and the Youth4Nature initiative. Established in 2016, FOWK champions the rehabilitation of the wetland and addresses environmental degradation caused by poor solid waste disposal and sewer leaks.

The core objective of this NbS project is to restore the ecological integrity of the wetland, improve biodiversity, and provide co-benefits for the local community, including economic and recreational opportunities. Through various conservation activities, the case seeks to harmonize human-environment interactions, ensuring sustainable ecosystem management and resilience against climate change impacts. The initiative also emphasizes capacity building, community engagement, and public awareness to drive regional conservation efforts. Project successes include establishment of the Ondiri Botanical Garden featuring over 70 different plant species, reforestation and management of trees around the Wetland as well as building community awareness through a youth conservation tournament and a conservation marathon.

The National Environmental Management Authority (NEMA), the County Government of Kiambu (CGK) and other civil society stakeholders have formulated the five-year Ondiri Wetland Management Plan (2022-2027) to rehabilitate the wetland.

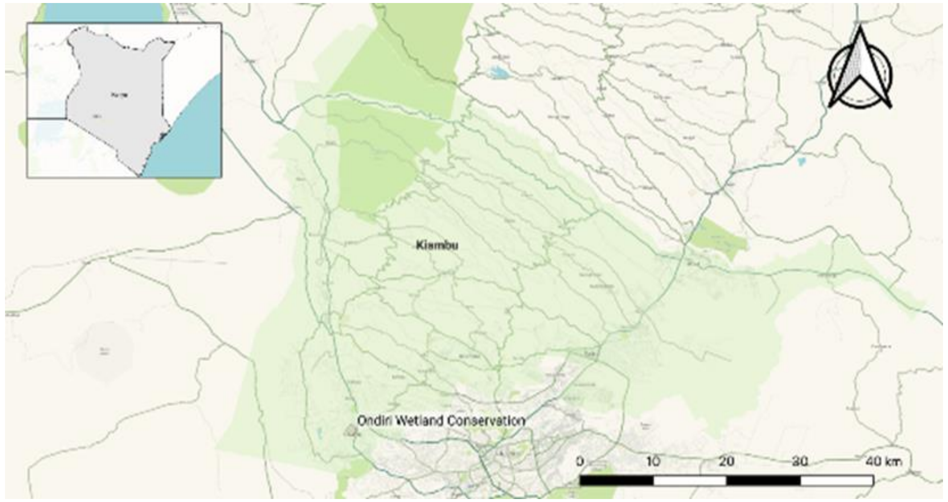


Figure 52 – Location of Ondiri Wetland, Kiambu County, Kenya
(Source: SUEZ Consulting, 2024)

Figure 53 – A view of Ondiri Wetland
(Source: SUEZ Consulting, 2024)

Figure 54 –Ondiri Wetland
(Source: SUEZ Consulting, 2024)

Figure 55 –Ondiri Wetland
(Source: SUEZ Consulting, 2024)

CLIMATE

SCORE 1.5

- **Project response to climate risks – Score 2**

By fostering through integrated management and a catchment model, the project improves water quality, regulates groundwater levels and soil moisture, and enhances flood management.

In Kiambu County, the main climate risks are droughts, flooding, extreme temperatures, and soil erosion. Climate change has disrupted rainfall patterns resulting in unpredictability in timing and intensity of rainfall and dry spells. These risks combined with poor landscape management practices around Ondiri Wetland has affected key economic activities such as agricultural production (MoALFC, 2021; NEMA, undated).

As a Natural Inland Wetland, the rehabilitation of Ondiri Wetland could enhance the wetland's provision of various multi-faceted benefits including climate resilience through water quality improvement, groundwater level and soil moisture regulation and flood regulation (Thorslund et al., 2017; Ma et al., 2024; NEMA, undated)

To maximize the potential for Ondiri Wetland to contribute to climate change adaptation, the development of a catchment model to understand how natural inland wetland systems like Ondiri interact with their surroundings at various scales will be key (Thorslund et al., 2017). It will also help to foster multistakeholder implementation of, and adherence to, to the integrated management approach defined in the current Ondiri Management Plan (2022-2027) for restoring native species and hydrological dynamics while controlling the impact of agriculture, overharvesting of vegetation, urban development, soil erosion and other activities on the wetland.

- **Project adaptation to local climate conditions (present and future) – Score 1**

The Ondiri Wetland rehabilitation restores native species, enhancing water retention, and addressing soil structure changes and carbon release. Integrating a vulnerability assessment in its management plan could further enhance adaptation.

Wetlands are particularly vulnerable to climate change, that may affect their conditions and lead to changes in soil structure, increased frequency of drying or flooding, and alterations in plant or animal communities (Moomaw et al, 2018).

In particular, although wetlands and especially peatlands are among the most carbon rich sinks contributing to mitigating climate change, the disturbances related to changing climate conditions have high consequences on wetlands carbon storage capacity (Moomaw et al, 2018). Changes in soil structure may affect carbon cycling and microbial process and can release stored carbon, contributing to CO_2 emissions. Warmer temperatures and changes in precipitation may further exacerbate carbon loss.

No information on Ondiri wetland vulnerability to climate change is provided in the existing Ondiri Wetland Integrated Management Plan. To play its full role in climate change adaptation and mitigation, the vulnerability of the wetland should be assessed and taken into account in the operation and maintenance plan.

ENVIRONMENT AND BIODIVERSITY

SCORE 2

- **Project response to environmental risks – Score 1**

Though the rehabilitation of the Ondiri Wetland contributes to tackling diverse challenges from pollution and hydrological changes to encroachments, an integrated management approach across catchments would further enhance its impact.

Ondiri Wetland is facing multifaceted challenges such as increased pollutant loads, invasive species, changes in hydrology, unregulated water abstraction, siltation due to construction of the Southern Bypass, encroachment by agriculture and urban development, accumulation of solid waste and deforestation (NEMA, undated). Efforts to rehabilitate Ondiri Wetland thus include reforestation, the delineation and fencing-off of the wetland as well as encouraging adjacent farmers to practice regenerative agriculture.

To maximize the environmental and biodiversity contribution, an integrated, multi-scalar approach the wetland's rehabilitation is important. It should help in managing the coupled hydrological catchments that are connected to and through the Ondiri Wetland (Thorslund et al., 2017) helping to address challenges such as increased pollutant loads, invasive species, changes in hydrology, sandmining, encroachment by development (Irvine et al., 2022). Furthermore, infrastructure upgrade projects, like a sewer treatment plant in Kikuyu Municipality, will help combat wastewater contamination in the Wetland.

- **Environment and urban biodiversity benefits – Score 3**

The rehabilitation of the Ondiri Wetland contributes to ecosystem services restoration and improvement of biodiversity beyond the local scale.

The Ondiri Swamp forms the headwaters for the Nairobi River which part of the Athi drainage system (NEMA, undated). As such it is a vital part of the blue-green infrastructure with catchment-scale impacts beyond the immediate environs. Additionally, the wetland acts as a natural filter, purifying water and improving local water quality security. The integration of Ondiri Swamp with a catchment-level water management strategy could help mobilize downstream users to protect key ecosystem services to provide water to urban areas.
The wetland also acts as a natural barrier against wind erosion for surrounding areas, and it captures silt that would otherwise flow downstream, preventing sedimentation and preserving water quality.

As Kenya's only 'floating bog', the wetland is a unique ecosystem that serves as a habitat for a wide variety of plants and animals, including the endangered Grey Crowned Crane (NEMA, undated). The preservation of the inland wetland supports biodiversity and fosters eco-tourism opportunities that benefit local economies. The plan includes biodiversity surveys, habitat rehabilitation through indigenous tree planting, and invasive species removal. Effective governance, law enforcement, and community engagement will be key to ensure collaboration among stakeholders.

As a peatland, the Ondiri wetland functions also as a crucial carbon sink, capturing more carbon per unit area than any other land ecosystem, and is essential for climate change mitigation (IUCN, 2021).

STAKEHOLDER MAPPING & SOCIAL INCLUSION

SCORE 3

- **Stakeholder engagement & consultation strategy – Score 3**

Combining early grassroots efforts with the organized direction of the Integrated Management Plan offers a thorough method for restoring Ondiri Wetland.

Several CBOs have longed supported conservation efforts, establishing a basis for restoration. Friends of Ondiri Wetland Kenya (FOWK), focused on advocacy and restoration has led many initial efforts, such as reforesting areas surrounding the wetland and installing fencing to deter encroachment. Other organizations include the ONKARU Water Resources Users Association, which developed a Sub-Catchment Management Plan, and Ondiri Riparian Landowners, promoting better land management and ecotourism.

With involvement from various governmental and private stakeholders, the Ondiri Wetland Management Plan (2022-2027) now aims to address coordination gaps. Key government agencies include NEMA (monitoring, advisory, enforcement), WRA (water management), KFS (forest management), KWTA (water tower management), and KEFRI (tree species guidance). The Kiambu County government oversees local governance and plan implementation. Water private entities also play a role, like Kikuyu Water Company, which manages the sewerage project. NGOs are involved at various levels. For instance, Youth4Nature is a key donor, and Nature Kenya regularly monitor biodiversity in the area.

Participatory processes have been included in the project early on. Regular cleanup campaigns are organized with local authorities and volunteers, which have effectively improved the wetland's ecological health (Zhu, 2019), and events like the Ondiri Wetland Conservation Run raised funds and awareness (Abisa, 2024). Other measures include reforestation and soil conservation, along with the establishment of an information center and eco-toilet showing early efforts to integrate education and eco-tourism into conservation strategies. These initiatives have laid a strong foundation for the more structured activities outlined in the management plan.

- **Socio-economic benefits and inclusion of vulnerable groups – Score 3**

Ondiri Wetland conservation enhanced water, food and land security, provided local employment, and emphasized education and youth engagement.

The project supports agriculture and livelihoods by enhancing water, food and land security. Local riparian farmers have been trained in sustainable and organic practices to reduce erosion, enhance soil fertility, and boost crop yields, ensuring long-term food security. The project also supports land ownership security by helping the community acquire freehold title deeds and establish clear wetland boundaries. Plus, indigenous vegetables grown in the wetland botanical garden are sold locally, generating income for community members and supporting local markets. Casual laborers are also employed in the agroforestry project. Finally, wetland conservation improves water availability, benefiting local agriculture and providing better irrigation and water access for Kikuyu residents.

Additionally, the project aims for educational benefits. It offers education on sustainable wetland management, through workshops, village meetings, and awareness campaigns, fostering local stewardship. The Ondiri Wetland Botanical Garden also supports 44 nearby schools providing mentorship and hands-on conservation learning. Four youths are actively engaged in the conservation project. Additionally, volunteers and casual laborers gain practical training and employment, enhancing their socio-economic mobility.

Community engagement efforts are robust but could be expanded to include urban planners, policymakers, and private sector stakeholders. Connecting the wetland to urban livelihood initiatives like eco-tourism or water management could improve sustainability and foster community benefits. The project's impact could be further strengthened by incorporating specific socio-economic objectives for vulnerable groups integrated in the monitoring and evaluation process.

PLANNING LEGAL, REGULATORY & POLICY FRAMEWORK

SCORE 1.5

- **Planning and development strategy – Score 2**

While aligned with national and international frameworks, the project would benefit from actionable, localized integration into urban policies and improved institutional coordination.

The Kiambu County Water and Sanitation Services Act (2015) has dedicated sections related to the conservation and protection of water sources and catchment areas, as well as on the collaboration with other entities for soil conservation and sustainable management of wetlands, among which the Ondiri Swamp.

Such biodiversity areas are also protected by international frameworks, such as the Kunming-Montreal Global Biodiversity Framework and the Ramsar Convention. For instance, Kenya is part of the Ramsar Convention adopted in 1975, dedicated to the protection and sustainable use of wetlands, recognized for their ecological importance. Two of the commitments are related to integration of wetland conservation into land use planning and specific status (e.g., Ramsar List) to reinforce their protection. However, these high-level frameworks lack actionable localization within the initiative. Ondiri Wetland restoration initiative aligns with national climate and sustainability goals but still lacks integration into urban development plans or urban adaptation strategies. Translating these into tailored policies for the wetland would strengthen their relevance and implementation.

Local wetland management remains hindered by overlapping mandates, diluting accountability. A recent Ondiri Wetland Management Plan has been defined for 2022-2027 to set a specific development strategy and aims to foster institutional coordination for wetland governance.

- **Regulatory and land tenure strategy – Score 1**

The project secured Ondiri Wetland's conservation by clarifying its legal status, but enforcement and compliance could be further strengthened.

The wetland's unclear legal status poses risks of encroachment and reduced accountability. The production of a boundary plan and the erecting of a fence with access points are among the key management objectives set by the Ondiri Wetland Management Plan (2022-2027) to reinforce the protection of the natural area. Indeed, clarifying its legal standing and designating it as a protected area under national or county laws would help provide essential safeguards. Ongoing efforts include the advanced stages of gazetting the wetland as a protected area, which would formalize its conservation status and secure additional resources for its preservation status (Kenya News Agency, 2023).

The wetland has also gained national and international recognition through events such as World Wetlands Day celebrations, which have drawn attention to the importance of wetlands in combating climate change and safeguarding biodiversity.

Weak enforcement of environmental regulations undermines the wetland's conservation efforts. Addressing persistent issues like pollution and waste disposal requires stronger partnerships between local governments and NGOs to ensure regulatory compliance.

IMPLEMENTATION PROCESS AND TECHNICAL FEATURES

SCORE 2

Implementation process – Score 2

Ondiri Wetland restoration and rehabilitation strategy and long-term sustainability are enshrined into a five-year Integrated Management Plan (2022-2027).

The restoration and rehabilitation of Ondiri Wetland involve strategic planning, community collaboration, and government support to combat ecological degradation and encourage sustainable development. The Ondiri Wetland Integrated Management Plan (2022-2027) is the primary framework directing these initiatives, which seek to confront years of ecological decline while promoting sustainable development (NEMA, 2022). The management plan emphasizes water management to improve quality and quantity by regulating abstraction, reducing pollution, and creating protective buffer zones.

Existing local documentation on Wetland Rehabilitation

- National Wetlands Restoration Strategy 2023-2032 of Kenya (NEMA, 2023)
- Ondiri Wetland Integrated Management Plan (2022-2027) (NEMA, 2022)
- The Impact of Human Activities on Wetlands: A Case Study of Ondiri Wetland in Kiambu County, Kenya (Muchiri, 2012)
- Assessment of Effectiveness of Community Participation in the Management of Ondiri Swamp, Kiambu County (Miriti, 2016)
- Economic Valuation of Wetland Ecosystems: A Case Study of Ondiri Swamp in Kiambu, Kenya (Muhati, 2005)

Other relevant documentation for Wetland Rehabilitation

- Wetland Restoration Manual (Eades, 2005)

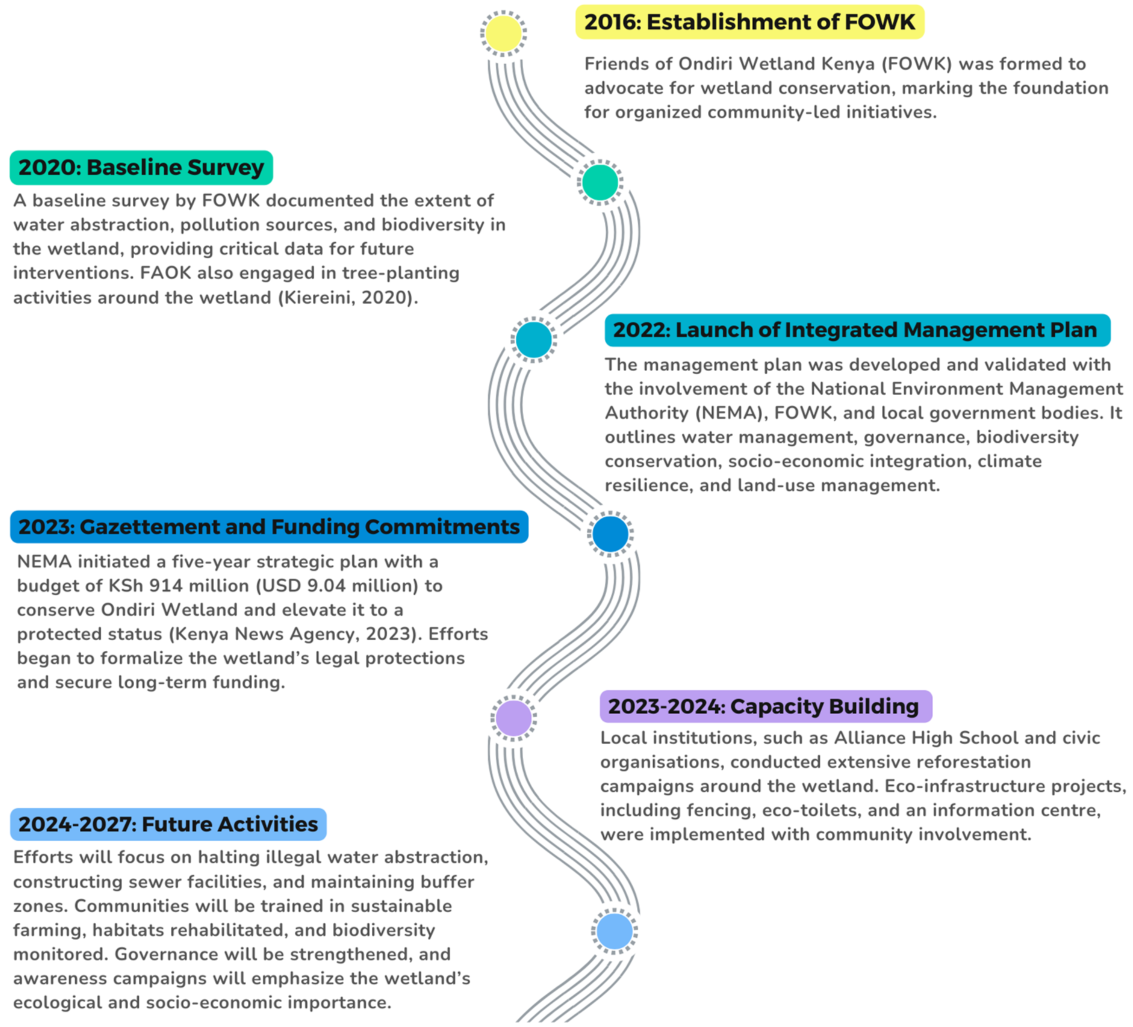


Figure 56 – Timeline of rehabilitation process
(Source: Friends of Ondiri Wetland Kenya - FOWK)

IMPLEMENTATION PROCESS AND TECHNICAL FEATURES

SCORE 2

Technical Features - Score 2

Designing public accessibility infrastructure such as pathways, benches, local signage increase the social value of wetlands.

For future similar project, it can be interesting to build low-flow bridges or boardwalks in place of temporary log walkways. This change aims to improve accessibility, maintain the wetland's integrity, and support eco-tourism. Furthermore, the inclusion of benches and better access will promote eco-tourism and boost visitor involvement.

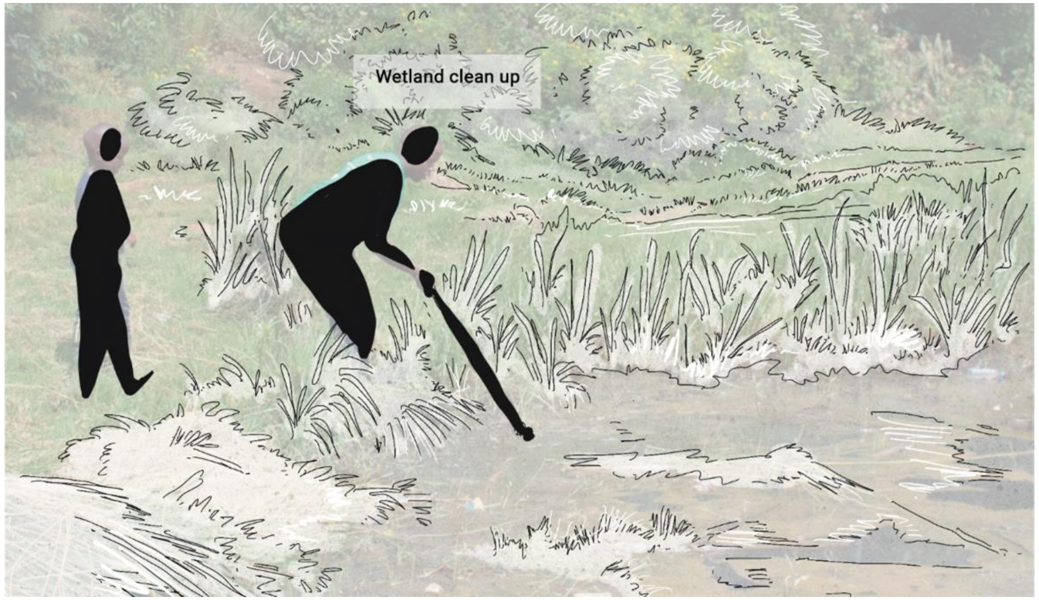


Figure 57 – Overlay sketch of an adult and child cleaning Ondiri Wetland, showcasing community efforts to remove trash and inspire the next generation to protect and sustain this vital ecosystem for the future.
(Source: SUEZ Consulting, 2024)

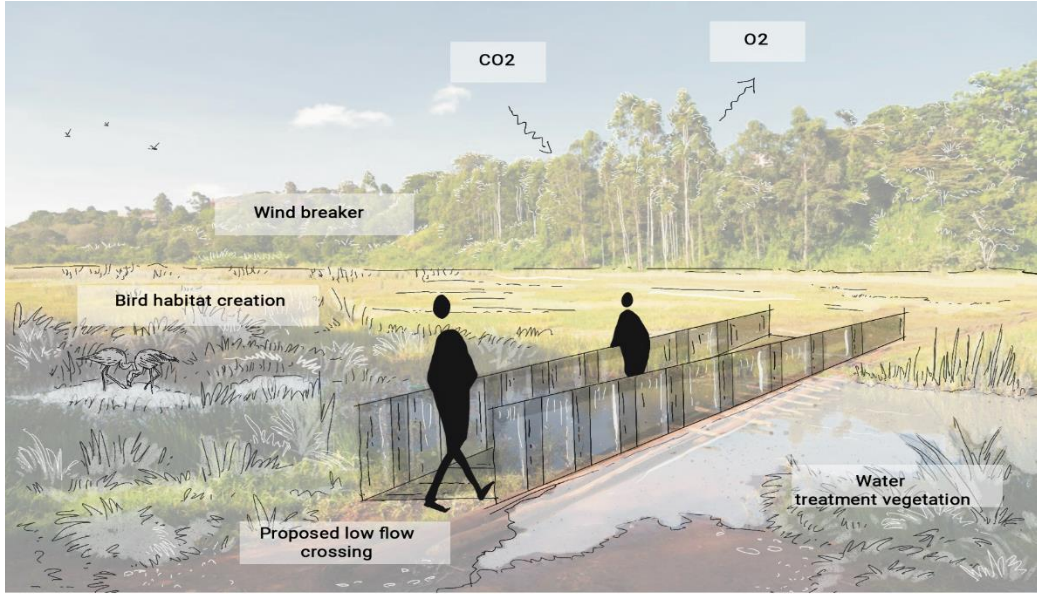


Figure 58 – A conceptual overlay of Ondiri Wetland
showcasing ecological benefits and proposed low-flow bridge
(Source: SUEZ Consulting, 2024)

Figure 59 – Manguo Swamp
(Source: SUEZ Consulting, 2024)

Related NbS Inventory case - Manguo Swamp Catchment Protection, Kenya

Manguo Swamp, a 50 ha seasonal wetland in Limuru, Kiambu County, plays a vital role in climate adaptation through biodiversity conservation, carbon capture, and water flow regulation. It supports eco-tourism and local agriculture while facing anthropogenic threats which, *inter alia*, degrade runoff quality. Contrary to Ondiri Wetland, Manguo Swamp was gazetted in 2021 which led to conservation and rehabilitation measures such as banning cultivation and construction, removing invasive species, and restoring native riparian flora. The swamp's demarcation and fencing ensure its protection, while water resource monitoring is reinforced via a gauging station on Tigoni River. These efforts aim to preserve its ecosystem functions and enhance its resilience to future pressures, yet it this gazetting involves also less local engagement of the stakeholders than what has been observed in Ondiri.

Figure 60 – Wetland at the mouth of the Malewa River.
(Source: SUEZ Consulting, 2024)

Marula Estates Wetland Restoration, Kenya

Marula Estates, a private estate in Naivasha, Kenya, initiated a wetland restoration project in 2009 to rehabilitate approximately 10% of the original 1350 ha wetland at the mouth of the Malewa River. This pilot project focused on creating roosting areas for migratory birds and re-establishing the native papyrus ecosystem, restoring 140 ha and enhancing local biodiversity. The restored wetland functions as a natural water treatment system, capturing sediments and nutrients before they enter Lake Naivasha, thereby improving water quality and supporting fish populations. However, expanding the restoration of the wetland to its original scale requires a financing plan involving landowners, government entities, and various stakeholders, highlighting the question of aligning natural boundaries with strategic project delimitation, to support Integrated Management Plan such as the one of Ondiri Wetland. UNEP has explored private and public financial solutions to support this expansion (UNEP, 2021).

OPERATIONS & MAINTENANCE

SCORE 2.5

- **Roles and responsibilities – Score 2**

The rehabilitation of Ondiri Wetland involves multiple governmental and non-governmental stakeholders. Overlapping mandates and unclear coordination highlight the need for a streamlined county-level management framework.

Multiple stakeholders are involved in the ongoing rehabilitation of Ondiri Wetland. The NEMA, Kiambu County and Friends of Ondiri Wetland Kenya (FOWK) are key among these stakeholders from across the institutional, civil society and community-based organizations stakeholders' spectrum.

Youth4Nature through INUKA AFRIKA are an NGO that has been the project financier and co-coordinator of the Ondiri Wetland rehabilitation project including the setting up of the Ondiri Botanical Garden. FOWK, already involved in Ondiri's Wetland's management through advocacy and conservation since 2016, served as the project lead and oversees the Wetland's maintenance. Brackenhurst Botanic Garden was part of the partnership providing inspiration and technical support.

KEFRI provided support through the provision of tree seedlings. NEMA is mandated with monitoring and providing advising on the sustainable management of the Ondiri Wetland, it also engages in some coordination of stakeholders involved in the Wetland's management. For the project, NEMA provided further support by constructing an eco-toilet for public use. The County Government of Kiambu (CGK), including its Environment Department, provided technical support for the project. The CGK implements the Wetland Management Plan and engages in raising public awareness by sensitizing the community on environmental conservation activities.

Institutional coordination for wetland governance is hindered by overlapping mandates, diluting accountability. Developing an integrated governance framework led by Kiambu County would streamline regulatory efforts and empower local actors.

- **Operation & Maintenance Plan – Score 3**

Maintenance activities are outlined in a five-year integrated management plan implemented by a small team of youth beneficiaries and volunteers, flexible based on needs.

The operation and maintenance plan is defined in the Ondiri Wetland Integrated Management Plan (2022-2027).

Maintenance of the project is usually done by 4 key youth beneficiaries employed by the project as well as 3 volunteers. However, the number of workers involved may vary depending on the technical and seasonal demands of the project. Due to fluctuating rainfall patterns in Kikuyu, FOWK performs monitoring and evaluation twice a week.

Regular and occasional maintenance (as currently performed and/or advisable) includes:
- Clearing solid waste and debris in the wetland
- Inventory and monitor all 44 water abstraction wells (Only 22 were metered, NEMA undated)
- Regular weed management and invasive plant control, removing before seeding, using aquatic-approved herbicides. Replacement of aquatic vegetation
- Repair of erosion in adjacent areas and wetland verges promptly
- Inspect water body for signs of poor water quality (e.g., eutrophication. Aeration when signs of eutrophication are detected).
- Remove 25% of bank vegetation from water's edge to a minimum of 1 m above water level (Annually)
- De-silting of sediment from the wetland every 5 years.
- Place removed sediments upstream of the basin for de-watering, then reuse appropriately.

FINANCIAL SCHEMES & SUSTAINABILITY

SCORE 2

- **Project costs, revenue generation and funding – Score 2**

The Ondiri Wetland rehabilitation project, funded by FOWK, is expected to provide livelihood benefits. However, it lacks detailed implementation costs information, and its Management Plan does not include a revenue generation scheme.

Implementation costs among rehabilitation initiatives on Ondiri wetland are generally provided but lack detailed breakdowns. The implementation of Ondiri botanical garden over nine months cost FOWK nearly US$ 9,000. This includes the garden's installation, community awareness and capacity development, logistics, administration and salaries, and wages for the project implementers and casual laborers.

Maintenance involves 7 people (4 youth beneficiaries and 3 volunteers) who intervene twice a week, but no information on financial compensation is reported. Little to no information is available on O&M costs.

A scale-up project to implement 20 botanical gardens in public schools is ongoing, with a cost of US$ 4,500 per school. They are also kickstarting Ondiri Wetland Story Telling Competitions, aimed at raising awareness, costing US$ 1,000 per event.

The Ondiri Wetland Management Plan lacks a detailed revenue generation scheme but emphasizes expected livelihood benefits through initiatives like ecotourism, sustainable agriculture, and alternative income sources, which aim to enhance community resilience and economic opportunities. Farming inside Ondiri wetland generated revenue for FOWK. They sold their production to a hotel owner in the region and to members of the community.

Across projects, funding generally comes from NGOs, and individual donations.

- **Integrated financial plan and project sustainability – Score 2**

Financial plans across initiatives are inconsistently detailed. Gaps represent a threat to the sustainability and funding of the projects.

FOWK's botanic gardens scale-up project presents a detailed budget, with a complete breakdown of activities, including operational costs. The Ondiri Wetland Management Plan (2022-2027) shows also implementation costs per program and activity but no further financial analysis. Additional information about sub-activities, actors, and 5-year timeframe is provided, but no further breakdown of costs.

Operation and maintenance costs are not consistently highlighted across all proposed programs.

This level of detail can be acceptable at the Management Plan level provided further analyses are promoted for each activity. Failure to provide justified cost estimates can hinder project funding. A cost-benefit analysis can also inform the financial sustainability of the proposed plan and allow technical adaptations if needed. Developing a comprehensive financial plan helps identify potential funding gaps and adapt technical design and O&M planning accordingly. This anticipation benefits both the financial and technical sustainability of the project.

More details on the implementation plan of Ondiri Wetland MP can be found here:
https://www.nema.go.ke/images/Docs/Management_Plans/Ondiri%20Wetland%20IMP%202022-2027-min.pdf

MONITORING & EVALUATION SYSTEM

SCORE 3

- **Key existing indicators – Score 3**

The Management Plan includes a list of performance indicators encompassing environmental and socio-economic conditions to reflect the achievement of the expected outputs and outcomes as well as consequential effects and impacts.

Performance indicators are many and inform all the different objectives targeted by the different management programs of the plan. To name a few:

- Water: inventory of all abstraction plans, improved water quality, river gauging, etc.
- Government and coordination: annual management work plan, participation of stakeholders, enforcement team in place, etc.
- Biodiversity: biodiversity reports, initiatives towards sustainability such as nature walks, security arrangements, citizen participation, etc.
- Socio-economic and cultural: alternative livelihood implementation, income diversification, livelihood awareness programs, benefit sharing, etc.
- Climate change: mitigation and adaptation measures, local advocacy groups, etc.
- Land use: wetland gazetting process, ecologically friendly activities, controlled water abstraction, restoration activities, etc.

Each performance indicator is associated with a measuring method.

In parallel, some grassroots initiatives, such as FOWK's botanical garden scale-up project were also associated with their own set of performance indicators.

- **M&E system and knowledge dissemination – Score 3**

A detailed M&E framework is defined as part of the Ondiri Wetland Management Plan, although no actual feedback on its effective implementation was collected.

As stated in the management plan, the M&E framework will assist to identify attributes of the resources, threats, mitigation measures, as well as identify the baseline conditions and emerging issues. The effectiveness and sustainability of this M&E plan is dependent on the following conditions:

- Participatory approach in the planning and implementation of the management plan involving and including all stakeholders.
- Evidence a strong reliance among partners in implementing and monitoring field activities.
- Timely reporting of feedback to all stakeholders that aid in decision making and adaptive management.
- Thorough analysis of performance as required for decision making and development of lessons learnt so as to skew up performance.

The knowledge dissemination strategy emphasizes stakeholder engagement, public awareness, and collaboration. It involves:

- Stakeholder engagement,
- Public awareness: Media campaigns and educational initiatives,
- Training: capacity building for local organizations and schools,
- Partnerships: collaborating with governments, civil society, private sectors, and development partners,
- Data sharing,
- Community insights through validation meetings and consultations

More details on the M&E system and performance indicators can be found here:
https://www.nema.go.ke/images/Docs/Management_Plans/Ondiri%20Wetland%20IMP%202022-2027-min.pdf

Natural Inland Wetlands

GLOBAL CENTER ON ADAPTATION

CONDITIONS FOR UPTAKE

The Ondiri Wetland stands for Kenyan natural inland wetlands, which have been identified by NEMA and IUCN as vital NbS playing a key role in water purification, providing habitats, encouraging biodiversity, and sequestering carbon. Documenting such wetlands and emphasizing their benefits, alongside strategies for protection and rehabilitation, ensures their sustainable management. Conditions for uptake have been identified based on the lessons learned from the case to ensure replicability and enhance the design of solutions in similar contexts.

Key inspirational features for associated NbS families

- **The diversity and integration of effective practices**, including efforts such as reforestation, erosion control, and sustainable farming in Ondiri's catchment, are needed to ensure the wetland's health.
- **The development of a structured management plan**, such as the Ondiri Wetland Integrated Management Plan, provides a replicable framework for the restoration and conservation of natural inland wetlands. This approach ensures coordinated efforts, clear objectives, and long-term sustainability.
- **Monitoring and evaluation exercises or tools** used in Ondiri are crucial for tracking the progress of interventions, assessing ecological health, and refining strategies.
- **The involvement of local communities**, including groups like Friends of Ondiri Wetland Kenya (FOWK), highlights the critical role of grassroots participation. Expanding community-driven conservation strengthens efforts to restore degraded wetlands and foster long-term stewardship.

Key improvement area for NbS replicability across Kenya

- **Addressing vulnerability**: Wetlands have a key role in climate change mitigation and adaptation strategy at different scale, but their own vulnerability to changing climate conditions should be assessed locally to define the adapted maintenance plan and maximize its potential.
- **Standardizing management plans**: county governments must develop clear, evidence-based plans for wetland restoration and sustainable use, drawing on successful models such as the Ondiri Wetland Integrated Management Plan.
- **Engaging communities**: local communities should be empowered through education, training, and incentives to ensure long-term stewardship. The sense of ownership is also key for such commons, and the provision of strategic recreational features (limited, integrated to the natural landscape, and with adapted rules) for the local communities can also indirectly contribute to the long-term protection of the wetlands.
- **Strengthening policies**: wetland laws must be enforced, the gazettement of critical wetlands prioritized, and accountability mechanisms implemented to prevent degradation.
- **Enhancing monitoring and research**: programs to track wetland health and adopt innovative, data-driven restoration strategies should be implemented to guide effective management.
- **Securing sustainable financing**: resources should be mobilized through partnerships and market-based instruments such as carbon credits, biodiversity offsets, and payments for ecosystem services (PES).

Case 4 – Sandy Shores: Malindi Waterfront Park

Sandy shores, forming the interface between land and ocean, serve as a crucial defense for coastal cities, protecting them from wave action, storm surges, and wind. These shorelines include diverse features like beaches, dunes, biogenic reefs, and seagrass meadows. Beaches are made up of loose, non-cohesive sediment influenced by coastal conditions, while dunes are sand deposits formed by wind and stabilized by vegetation, offering protection from flooding and erosion during storms. Coral and shellfish reefs break wave energy offshore, shaping the shoreline by influencing currents and sediment transport. Seagrasses help retain sediment and contribute to erosion control and carbon sequestration. Together, these elements create rich ecosystems that provide essential ecosystem services such as fisheries, cultural practices, and tourism. Sandy shores are also vital for urban development, providing space for infrastructure and businesses. However, urbanization and sand mining often harm these environments, leading to erosion, flooding, and reduced coastal protection. The conflict between development and preservation threatens the natural processes that sustain these coastal defenses. Special techniques for sandy shores include sediment management measures, such as beach nourishment or sand fencing, and protecting or restoring coastal and aquatic ecosystems that serve as natural lines of defense (World Bank, 2021).

MALINDI WATERFRONT PUBLIC PARK

The following section examines the Malindi Waterfront Public Park case ***as a missed opportunity for sandy shore NbS****. It showcase the opportunities and challenges of revitalizing urban coastal areas through sustainable public space development in Kenya.*

Key inspirational features: *restored open spaces, revitalized tourism, multi-purpose facilities, coastal sustainable land-use.*

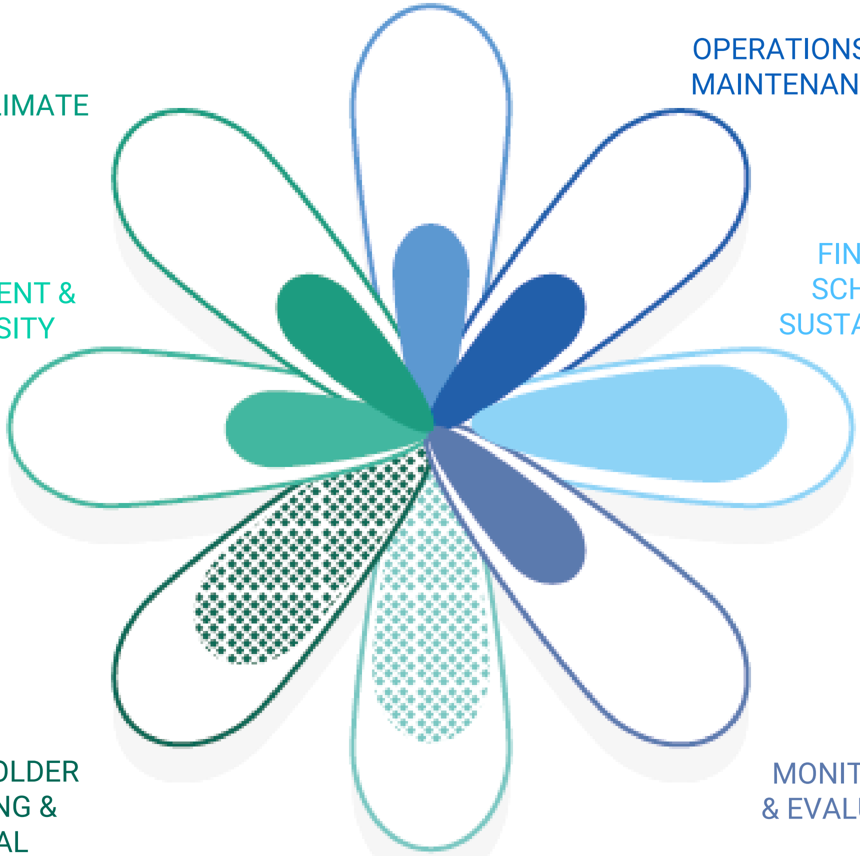


Figure 61 – Gap analysis result for Malindi Waterfront Park (Source: SUEZ Consulting, 2024)

PROJECT PRESENTATION

In the last ten years, Malindi has undergone swift urban growth, expanding into areas that were once undeveloped. This development, however, has led to a decrease in open recreational spaces. To combat this issue, Malindi Waterfront Park was established as a component of the Malindi Waterfront Revitalisation Project, aimed at enhancing open spaces and addressing challenges specific to the coastline. Currently, this case, funded through the Kenya Urban Support Program 1 (KUSP-1), spans about 300 meters and will ultimately stretch 9 kilometers from the Vasco da Gama Pillar to the Sabaki Bridge upon completion.

The project is led by the Government of Kenya, with financial backing from KUSP-1, facilitated by the World Bank as a funding agency. The County Government of Kilifi has been instrumental in policy-making, budgeting, and ensuring the initiative aligns with urban development objectives. Meanwhile, private organizations are tasked with maintaining the park, managing operations, and organizing events, while the local community plays an active role in governance through various committee associations.

The waterfront addressed urban decay that diminished community engagement and tourism. It offers Malindi residents and visitors recreational activities while highlighting natural coastal features that bolster the blue economy. This initiative encourages the sustainable use of open areas, protecting delicate sandy shorelines from encroachment. The park includes designated sports pitches, stalls, management offices, streetlights, cabro paving, waste collection and transfer stations, and public restrooms, among other amenities components.

Addressing specific coastal challenges could further strengthen its effectiveness and turn this project into an effective sandy shores example.

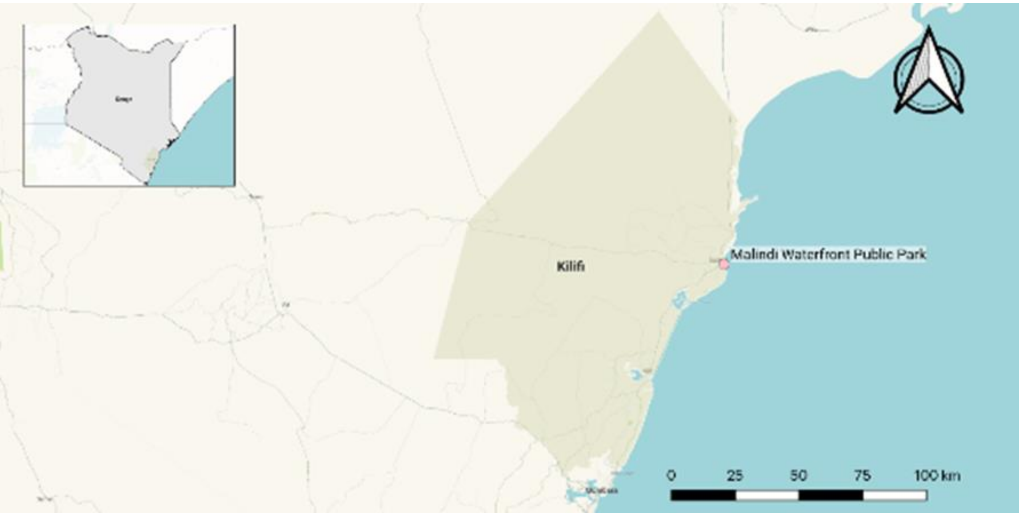


Figure 62 – Location of Malindi Waterfront Park, Kilifi County, Kenya
(Source: SUEZ Consulting, 2024)


Figure 63 – A view of Malindi Waterfront park
(Source: SUEZ Consulting, 2024)

Figure 64 –Malindi Waterfront Park
(Source: Skyscraper city website, https://www.skyscrapercity.com/threads/malindi-waterfront-project.2299315/)

Figure 65 –Malindi Waterfront Park
(Source: Skyscraper city website, https://www.skyscrapercity.com/threads/malindi-waterfront-project.2299315/)

CLIMATE

SCORE 1

- **Project response to climate risks – Score 1**

Key climate risks include drought, rising temperatures, flash floods, storm surges, coral loss, and coastal erosion. The Malindi waterfront parks mainly address rising temperatures.

Climate change impacts in Kilifi Municipality are significant, with the area located near a cliff and an ocean estuary, making it particularly vulnerable to coastal erosion and flooding. Rainfall patterns have become increasingly erratic, with late onset and early cessation of both long and short rains leading to rising water scarcity (CoGKIL, 2023; Cheruiyot et al., 2022). Coastal areas of Kilifi, such as Malindi, are also vulnerable to sea-level rise and storm surges, which can cause damage to infrastructure and livelihoods (CoGKIL, 2023). Coral loss is also a concern, as it exacerbates shoreline erosion, making coastlines more susceptible to storms and waves, and threatening marine life. The decline of coral reefs affects fish populations by reducing breeding grounds and habitat availability, impacting fisheries and the livelihoods that depend on them. Coastal erosion affects the recreational use of beaches and the tourism sector and can cause damage to coastal infrastructure. While it may not directly disrupt fisheries, its broader impacts on marine ecosystems can indirectly affect fishing communities. Kilifi County also experiences frequent and prolonged periods of drought, particularly in semi-arid areas such as Ganze. Additionally, the county has seen an increase in air temperatures by 2-3°C since the early 1960s, with projections suggesting temperatures may rise by up to 3°C on average by the 2040s (CoGKIL, 2023).

Malindi Waterfront Park's vegetated areas aim to cool temperatures through shading and evapotranspiration. However, the project did not fully address key climate risks such as shoreline erosion and storm surges by integrating additional nature-based solutions in its planning and design.

- **Project adaptation to local climate conditions (present and future) – Score 1**

As a missed opportunity to address key climate risks, the park's design has limited resilience to current and projected climate change impacts.

The Malindi Waterfront Park project does provide some resilience to projected temperature increases and drought risks through its vegetated features, such as sports pitches, play areas, and trees planted for beautification.

However, the park does not fully address climate risks like shoreline erosion and storm surges. By not integrating other nature-based solutions, such as dune stabilization, vegetated berms, or green infrastructure designed to withstand coastal conditions, the park's adaptation to sea-level rise and storm surges remains limited. This is evident in frequent flooding events and the impact of saltwater on public infrastructure.

ENVIRONMENT AND BIODIVERSITY

SCORE 1

- **Project response to environmental risks – Score 1**

Deficits in sanitation infrastructure, habitat degradation, and shoreline erosion are key environmental challenges in Malindi

Malindi faces several significant environmental risks, chief among which are poor wastewater management, leading to poor water quality that threatens both human and ecosystem health, as well as tourism (www.skoll.org). Untreated sewage often ends up in local rivers and the sea, polluting beaches and harming marine life ecosystems.

Siltation from the Sabaki River has caused beach front loss, impacting tourism. The Sabaki Estuary, where the future project will extend, faces habitat degradation, while nearby beaches suffer erosion and siltation. This erosion threatens historical sites like the Vasco Da Gama Pillar and Mambrui Mosque ruins. These risks are worsened by poor sanitation infrastructure and unplanned urban development, threatening biodiversity in sensitive areas.

These challenges underscore the missed opportunities for addressing coastline risks in Malindi, mainly through NbS. The Malindi Waterfront Park site was rehabilitated, and waste was repurposed for beach nourishment, which can be regarded as a positive development. However, while advantageous, the emphasis on beach nourishment could have been broadened to address other environmental risks, especially those pertaining to shoreline erosion and storm surges. The park's current design mainly addresses waste management and recreational needs but overlooks a broader opportunity to incorporate NbS that confront the full range of coastal threats. Initiatives such as coral restoration could have been considered part of a broader coastal resilience strategy. Nevertheless, coral restoration is an expensive and intricate process that necessitates tackling underlying issues like water pollution and ensuring appropriate environmental conditions, such as water quality and temperature.

- **Environment and urban biodiversity benefits – Score 1**

Malindi waterfront park has mainly brought social value and limited environmental and ecosystem services benefits beyond keeping the area clean.

The Malindi Waterfront Park focuses on using renewable energy by installing solar lighting, thus decreasing energy consumption.

The grasses and trees planted for the sports pitch, playpark support beautification purpose but have limited effect on erosion or flood erosion control.

STAKEHOLDER MAPPING & SOCIAL INCLUSION

SCORE 1.5

- **Stakeholder engagement & consultation strategy – Score 2**

Early engagement with CBOs facilitated grievance handling in the construction process, but stronger cross-departmental cooperation could have enhanced the design, including greater climate resilience and biodiversity benefits.

Key stakeholders in the project included various government bodies and technical staff, private companies and The World Bank. The World Bank was the primary funding source with the County Government. The Kilifi County and Malindi Municipality technical engineering teams oversaw design execution, with implementation entrusted to a contracted company using the design-build model. KFS and KEFRI offered guidance on suitable tree species for greening efforts. NEMA approved the Environmental and Social Impact Assessment (ESIA), incorporating community input on social issues. A management company is now in charge of the park's management, with support from the municipality.

The local community was actively involved in project prioritization and implementation and in grievance handling. The project was prioritized through a citizen fora and local committees were formed to support its implementation. Plus, the Kenya National Chamber of Commerce represented displaced businesses, with local traders assisting in grievance handling. The Beach Boys Association, directly impacted by the project, participated to address concerns related to tourism activities. Most importantly, village elders, as influential leaders, facilitated site identification and mediated local resistance throughout implementation.

Greater transversality between county and municipality stakeholders could have elevated the Malindi Waterfront Park to a Sandy Shore NbS model, with greater benefits for coast preservation, biodiversity, and benefits for ecosystem services key beneficiaries such as fishermen. These aspects were overlooked, partly because beach management falls under county, not municipal, authority, *de facto* excluding it from the project's foundation.

- **Socio-economic benefits and inclusion of vulnerable group – Score 1**

The project created temporary job and stimulated business opportunities but lacked a comprehensive social inclusion strategy and a monitoring and evaluation framework to ensure long-term socio-economic benefits.

Municipal stakeholders observed a range of socio-economic benefits to the local community, particularly through job creation, business opportunities, and improved infrastructure. Local workers were employed during the construction phase with temporary jobs. Following the completion of the park, the rise in tourism has stimulated local businesses, such as food vendors and small enterprises supporting the park, ensuring a sustained flow of income. Furthermore, opening a new road to the beach has improved access to the area, benefiting the broader neighborhood.

Efforts have been made to engage vulnerable groups and promote social inclusion, but challenges remain in ensuring they fully benefit from the project. As part of these efforts, former drug addicts have been involved in activities related to the project, aiding their social reintegration.

However, other people were impacted: boat makers and traders were relocated, but some local informal businesses were not allowed to remain in the area. To enhance inclusion, alternative spaces could be provided for these displaced groups, and job opportunities could be prioritized for them.

The systematic collection of data to quantify the socio-economic impact could have been integrated into the project from the outset. While the municipality reports notable improvements in the community's socio-economic conditions, no concrete data has been gathered to fully measure the impact. Additionally, engagement in the park's management beyond completion was not highlighted by local stakeholders, though it could have been prioritized to monitor the long-term impacts on the local community and ensure the park's sustainability.

PLANNING LEGAL, REGULATORY & POLICY FRAMEWORK

SCORE 1.5

- **Planning and development strategy – Score 1**

Malindi Waterfront Public Park is consistent with the objectives of KUSP1 investment project. However, it stands as a missed opportunity to develop a climate coastal adaptation measure.

The Malindi Waterfront Public Park aligns well with broader urban renewal and development goals as part of the KUSP1, financed by the World Bank. Its focus on revitalizing community life, promoting tourism, and addressing urban light ties directly to key urban planning objectives of enhancing public spaces and stimulating economic growth.

The implementation of this project underscores the potential for further institutionalization of community-engaged urban renewal approaches. The Malindi Waterfront Park project includes specific features (e.g., football playground) based on community's proposal. The engagement from the beginning of the local community help design the project and manage the implementation to reduce potential grievances and adverse impacts on the inhabitants.

Nonetheless, potential benefits from the project were missed due to limited integration with a broader urban planning framework that explicitly connects the public space to long-term spatial development strategies or blue economy policies. Indeed, despite its location on the waterfront facing coastal erosion challenges, the project focused on a green park development, as beach management and regeneration are considered as missions of the County Government. Active coordination among local institutional stakeholders and guidelines for coastal areas (above the administrative boundaries as potential localized actions could have adverse or positive effects along the coast) could help foster resilient waterfront development along Kenyan coastline.

- **Regulatory and land tenure strategy – Score 2**

Malindi Waterfront Public Park complied with legal framework. However, zoning for beach coastal area remain underdeveloped, impeding a clear definition of appropriate land-use.

The Malindi Waterfront Public Park transformed a former dumpsite into a vibrant public space, demonstrating adaptive land reuse. However, zoning strategies for beach management and public space allocation remain underdeveloped, relying on ad-hoc municipal oversight for long-term sustainability.

Land security was managed through community-mediated agreements with village elders, though reliance on informal tenure could hinder replicability in areas with weaker social structures. While the project complied with legal frameworks, challenges arose around stakeholder management. Resistance from local stakeholders, such as traders and boat makers, highlighted gaps in addressing relocation and compensation.

IMPLEMENTATION PROCESS AND TECHNICAL FEATURES

SCORE 1

- **Implementation process – Score 1**

The design - build procurement of Malindi Park allowed for a cohesive and efficient execution; but also restrained the range of technical expertise that was mobilized at the design phase.

The specific design and implementation details for the Malindi Waterfront Park are unavailable, however the development of the park followed documented practices in similar urban renewal and waterfront revitalization projects.

These include:
- Conducting Environmental Impact Assessments (EIAs) which are essential to evaluate potential ecological impacts and ensure regulatory compliance,
- Socioeconomic feasibility studies to assess the project's expected benefits, such as increased tourism and enhanced community well-being, helping decision-makers understand its broader viability
- A thorough site analysis and spatial planning process is critical to optimize the use of available land, ensuring the integration of recreational, conservation, and infrastructural elements.

For projects like Malindi Waterfront Park, the design process can either involve creating a detailed design prior to appointing a contractor or employ a design-build approach, as was the case in Malindi. This model allows contractors to align the design and construction phases, ensuring cohesive and efficient execution. Features such as sports pitches, play areas, food courts, washrooms, and walkways are tailored to meet the diverse needs of the community.

Construction typically follows a phased approach, allowing essential components to be prioritized while leaving room for future expansions. This ensures that the park can begin serving its purpose early while remaining adaptable to evolving needs.

Existing local documentation for Malindi Waterfront Park

- Malindi Urban Economic Plan - (Tetra Tech International Development Europe, 2021)

Other relevant guidance for Waterfront Park

- Waterfront urban space: Designing for Blue-Green Places - (Babalis, 2017)
- The Complexity of Urban Waterfront Redevelopment - (Hersh, 2012)
- Urban Waterfront Manifesto - (The Waterfront Center, 1999)
- Green Infrastructure Installation, Operation, and Maintenance - (US EPA, 2024)
- Design, implementation and cost elements of Green Infrastructure projects - (Naumann et al., 2011)
- Regenerating Urban Land: A Practitioner's Guide to Leveraging Private Investment - (Amirtahmasebi et al., 2016)
- Coastal Design: The New Waterfront Parks Making Waves - (Baldwin, 2021)
- The Waterfront Edge Design Guidelines - (Lewis et al., 2017)
- Urban Park Design Concepts and Key Elements - (Pedicini, 2020)

*These documents can be supplemented by design guidelines for NbS such as Woods-Ballard et al. (2015)

IMPLEMENTATION PROCESS AND TECHNICAL FEATURES | SCORE 1

Technical Features – Score 1

Although maintaining open green area along the shore, Malindi Waterfront Park, stands as a missed opportunity for showcasing NbS Sandy shores family: dune stabilization or vegetated berms would provide natural barriers to storm surges and erosion, while more natural, permeable features could amplify its environmental impact.

The Malindi Waterfront Park integrates features like sports pitches, children's play areas, food courts, parking lot, walkways, and public amenities to create a multifunctional urban space. These strategically placed recreational and public facilities encourage community interaction, promoting physical well-being and tourism development.

Pathways constructed with cabro paving ensure durability and accommodate heavy foot traffic. For future similar projects, permeable paving could have improved stormwater infiltration and reduced runoff. Similarly, incorporating a boardwalk made from sustainable materials could minimized reliance on impervious surfaces, enhancing ecological sensitivity.

For future similar investments, waterfront parks could incorporate flood and coastal protection measures to ensure resilience against environmental challenges. These measures may include hard engineering solutions, such as seawalls, breakwaters, and groynes, though these can have detrimental effects on beach nourishment and may facilitate erosion. Softer, nature-based elements like dune restoration, mangrove planting, and living shorelines also play a key role. From that aspect, the future similar investments will address coastal resilience through well-drained pathways and vegetated areas designed to control runoff and mitigate erosion. Landscaping with palm trees supports biodiversity and adds aesthetic value, though the greater use of native coastal vegetation would further strengthened ecosystem health and climate resilience.

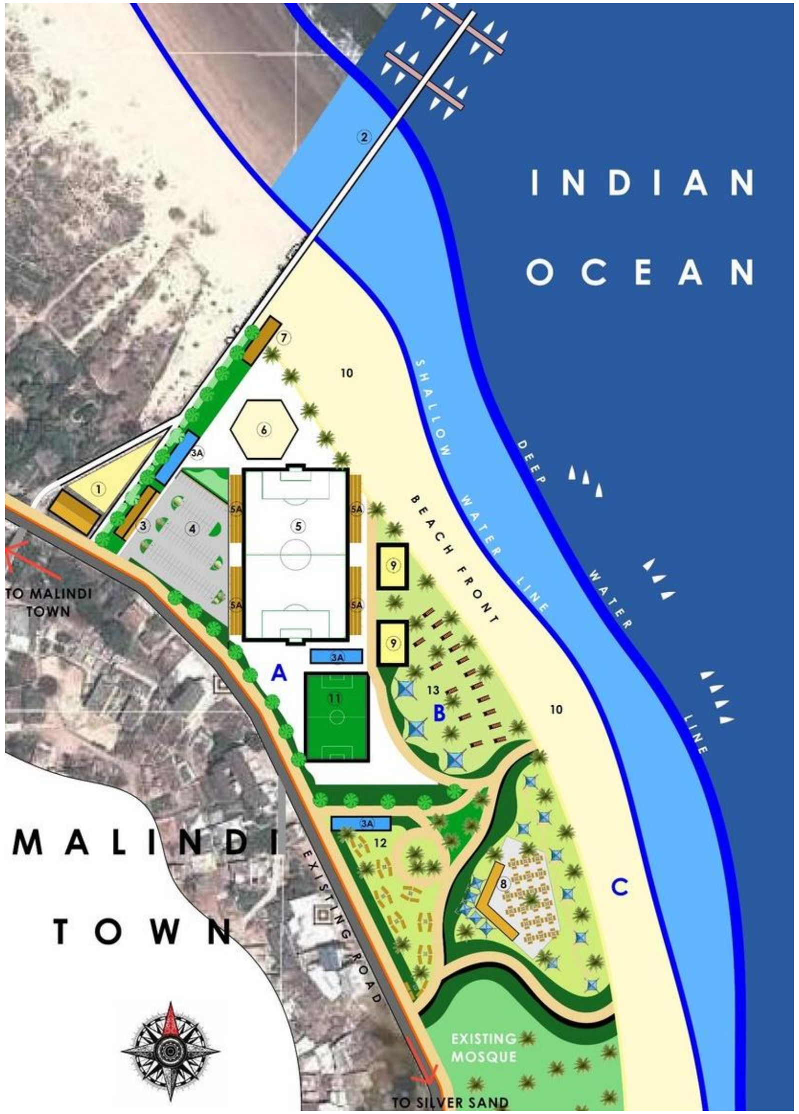


Figure 66 – Layout of Malindi waterfront Park (Source: Kilifi County Government, https://pbs.twimg.com/media/EFfCPnEXkAIDW1w.jpg)

IMPLEMENTATION PROCESS AND TECHNICAL FEATURES

SCORE 1

Proposed technical improvements for future similar projects

One of the key features proposed for the technical design is the stabilization of dunes using native coastal vegetation combined with the construction of vegetated berms. This approach creates a natural buffer against storm surges and mitigates coastal erosion while enhancing the visual appeal of the park. Native grasses and shrubs, are used to anchor the sand dunes, preventing wind and water erosion. Vegetated berms, designed as raised areas planted with hardy vegetation, offer additional protection by reducing wave energy and providing a secondary defense layer against flooding (Fernández-Montblanc et al., 2020; Figlus, 2022).

This feature provides multiple advantages. Dune stabilization is cost-effective compared to hard engineering solutions and requires minimal maintenance after establishment. The use of native vegetation supports local biodiversity, creating habitats for small fauna and pollinators (World Bank, 2021). Additionally, vegetated berms enhance the aesthetic value of the park while contributing to its environmental resilience (D'Alessandro et al., 2022). The combined dune and berm system is designed to blend seamlessly with recreational areas, allowing visitors to enjoy the natural beauty while benefiting from increased coastal protection. In the case of the Malindi Waterfront Park, this approach aligns with the objectives the park to create a sustainable, multi-functional public space that supports tourism, recreation, and environmental health.

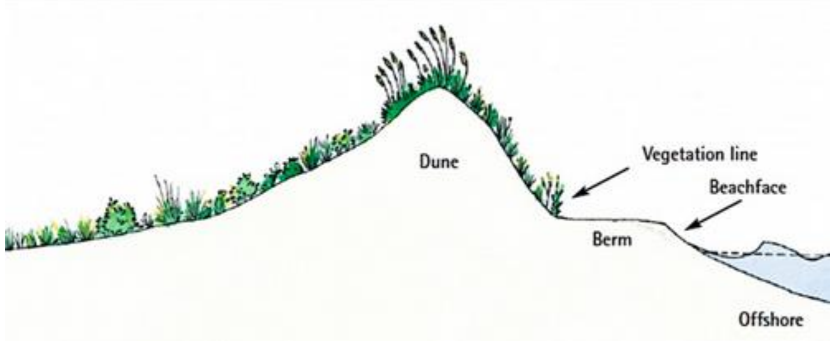


Figure 67 – Schematic cross-section of a typical beach–dune profile (source : D'Alessandro et al., 2022)

Figure 68 – An overlay illustrating proposed enhancements to the food court area, incorporating shaded spaces with indigenous trees, windbreaks created by strategic tree placement, vegetation for dune stabilization, and the inclusion of permeable paving for improved water management
(Source: SUEZ Consulting, 2024)

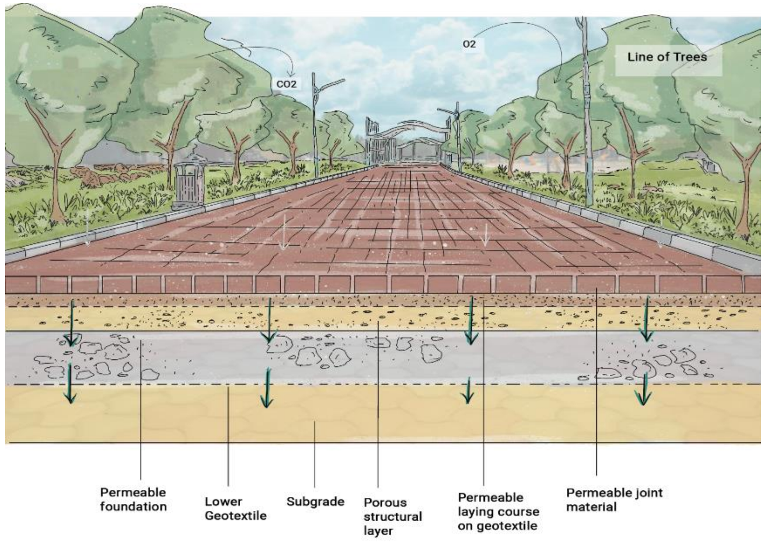


Figure 69 – An overlay of the Malindi Waterfront walkway showcasing its conversion to permeable pavement, increased tree density with a focus on indigenous species to reduce heat, serve as windbreakers, and promote grass growth to mitigate dust
(Source: SUEZ Consulting, 2024)

OPERATIONS & MAINTENANCE

SCORE 1

- **Roles and responsibilities – Score 1**

Siloed approach to responsibilities between county and municipality led to some loophole in beach management and regeneration.

Beach management and regeneration are considered to be County Government mandates. As such, the Kilifi County's technical team managed the design stage of the project with input from the municipality and other stakeholders. Environmental and Social Impact Assessments (EIAs) were done by NEMA in collaboration with the community while KFS & KEFFRI provided advice on the greening aspects and suitable tree species for planting. As there was some initial public resistance to the project, community elders and the local chapter of the Kenyan National Chamber of Commerce were instrumental in the project gaining public and local business support.

Routine operation and maintenance is partly provided a facilities management company that follows a management plan designed for marine public facilities (e.g., facilities affected by salty water, sand and wind). There is support from the County Government through the municipality, especially for street lighting.

- **Operation & Maintenance Plan – Score 1**

Malindi Waterfront Public Park lacks clear O&M plan.

Routine operation and maintenance is partly provided a facilities management company that follows a management plan designed for marine public facilities (e.g., facilities affected by salty water, sand and wind). There is support from the County Government through the municipality, especially for street lighting.

Effective maintenance and management are critical to Malindi Waterfront Park's long-term success. Multiple stakeholders are likely involved in the operation and maintenance of the park. Local government entities, such as Malindi's Municipality, often take responsibility for routine maintenance activities such as landscaping, waste management, irrigation, and pest control.

However, regular monitoring with formal guidelines and clear roles and responsibilities would ensure that expected standards are maintained on each key aspect such as environment, landscape, mixed uses.

To address funding challenges, strategies such as public-private partnerships or user-based fees can supplement municipal budgets, ensuring the park remains functional and attractive.

FINANCIAL SCHEMES & SUSTAINABILITY — SCORE 2

- **Project costs, revenue generation and funding – Score 2**

This KUSP1-funded project cost US$ 690,000 in implementation, and maintenance budget needs are unknown.

The project was funded by the World Bank under the KUSP 1, although the County Government of Kilifi also contributed with counterpart funding. Originally, US$ 500,000 were allocated but contract variations during the implementation phase increased the cost to US$ 690,000. The implementation lasted between early 2019 and early 2022.

Seedlings were provided by the Kenya Forest Service.

The municipality allocates a budget for a private company to ensure regular maintenance of the park. The amount of this budget is unknown.

Revenue generation is not clearly assessed but the municipality reports new businesses that cropped up inside and outside the park, as well as increases in business income for local traders.

- **Integrated financial plan and project sustainability – Score 0**

No information on the project's financial plan is available, and the municipality reports sustainability threats due to high salinity water.

Degradations caused by saltwater would require additional maintenance efforts that do not appear to have been anticipated. The project's sustainability is threatened since no sufficient funding is available to face this issue.

Developing a comprehensive financial plan helps identify potential funding gaps and adapt technical design and O&M planning accordingly. This anticipation benefits both the financial and technical sustainability of the project.

MONITORING & EVALUATION SYSTEM — SCORE 1

- **Key existing indicators – Score 1**

No performance indicators exist on Malindi Park.

In 2023, a socio-economic and beneficiary assessment for the project was conducted as part of the KUSP 1. No further information is available.

The municipality reports a wide array of benefits, such as job creation, tourism, social cohesion, biodiversity, and environmental awareness.

This list of benefits could be associated with indicators, and measurement methods to consolidate the evaluation of the NbS impacts.

- **M&E system and knowledge dissemination – Score 1**

There is no specific M&E framework for Malindi park, which benefits are assessed on a community-feedback basis.

The Malindi Municipality highlights the need for formal evaluations to track impacts. As of now, benefits reported mostly come from community feedback and municipality qualitative observations on business development and social improvements.

A comprehensive M&E framework would greatly help understanding the park's performance in addressing urban and coastal challenges. It would thereby assist in identifying improvement areas to focus on, and steer O&M budget accordingly.
Knowledge dissemination was mostly done through public participation (citizen fora) in the identification, prioritization, construction and use of the project. No further communication strategies were reported.

It its worth noting that locals sought to be given priority when it came to generated jobs although they did not meet the qualifications or lacked the technical skills.

Sandy Shores

CONDITIONS FOR UPTAKE

The Malindi Waterfront Park is included in this NbS compendium as an example of how urban renewal and NbS can transform coastal areas into multifunctional public spaces. The project illustrates how ecological restoration, recreational infrastructure, and community engagement can converge to create a vibrant, resilient, and sustainable park. This case highlights the potential of green infrastructure in addressing urban and environmental challenges while fostering social and economic development. As a missed opportunity for Sandy Shore NbS family both in design and implementation, it offers valuable lessons for enhancing future projects. Conditions for uptake have been identified based on the lessons learned from the case to ensure replicability and enhance the design of solutions in similar contexts.

Key inspirational features for associated NbS families

- **Green infrastructure integration**: The use of vegetation for aesthetic, ecological, and climate-resilient purposes is a transferable model for sustainable urban parks;
- **Community-centric design**: recreational facilities and accessible pathways make the park as a driver for social cohesion;
- **Tourism-driven revitalization**: recreational infrastructure demonstrates the ability to boost tourism and economic growth in harmony with environmental objectives.

Key improvement area for NbS replicability across Kenya

- **Blending green and grey infrastructure** is essential for resilient coastal systems. Hybrid approaches, such as vegetated berms, permeable pathways, and natural drainage, mitigate flooding and erosion while enhancing ecological benefits.
- **Focusing on climate adaptation measure and engaging local ecosystem resilience**: coastal challenges such as erosion, tidal impacts, and salinization necessitate NbS strategies that emphasize resilience. Waterfront parks can serve as natural buffers, mitigating storm surges and reducing the vulnerability of nearby infrastructure. NbS elements like dune stabilization, soft coastal barriers, and vegetated buffers align with Kenya's broader climate adaptation goals. Coral restoration activities could also expand these beach restoration initiatives by mitigating shoreline erosion.
- **Conducting a clear mapping of ecosystem services beneficiaries** and link the objectives of the project to the continuity of these ecosystem services.
- **Clarifying roles and responsibilities**:
  - **Separate design and construction responsibilities** is critical. Civil engineering contractors often prioritize grey infrastructure, limiting NbS integration. Design leadership should be entrusted to landscape architects and environmentalist supported by civil and coastal engineers to ensure a multidisciplinary perspective. Alternatively, civil and coastal engineers with training in NbS can lead, blending technical expertise with ecological principles.
  - **Maintenance needs relating to the coastal location of this project** have to be anticipated and roles and responsibilities between county level and municipal level regarding identified tasks should be clarified.

Case 5 – Mangrove Forests: Bangladesh Mangrove Restoration

Mangroves, called the "blue forest," are unique coastal ecosystems with approximately 80 species of salt-tolerant trees and shrubs inhabiting intertidal zones in tropical and subtropical regions (WB, 2021). Thriving in dynamic coastal environments like deltas, mangroves act as critical buffers against coastal hazards, reducing erosion from storm surges, currents, waves, and tides. Their flood protection benefits are substantial, estimated at over US$65 billion annually, safeguarding around 15 million people annually (Ihinegbu et al., 2023; Menéndez et al., 2020). Beyond flood mitigation, mangroves offer significant economic and social advantages (Beck et al., 2018). They enhance water quality by filtering nutrients and sediments and provide habitats for fish, birds, and crustaceans, supporting the livelihoods of more than four million artisanal fishers globally. Mangroves are among the most carbon-rich forests, which play a vital role in carbon storage and sequestration, aiding in climate change (Donato et al., 2011). Despite their importance, mangroves have been declining due to deforestation and unsustainable coastal development. Restoration efforts, including planting seedlings and restoring hydrological flows, are essential (WB, 2021).

BANGLADESH MANGROVE
This section highlights the opportunities and challenges of rehabilitating degraded mangrove ecosystems in Kenya, using the Bangladesh Mangrove Restoration Project as a model.

Key inspirational features: *community-driven mangrove restoration, and livelihood enhancement to reduce dependence on ecosystem degradation.*

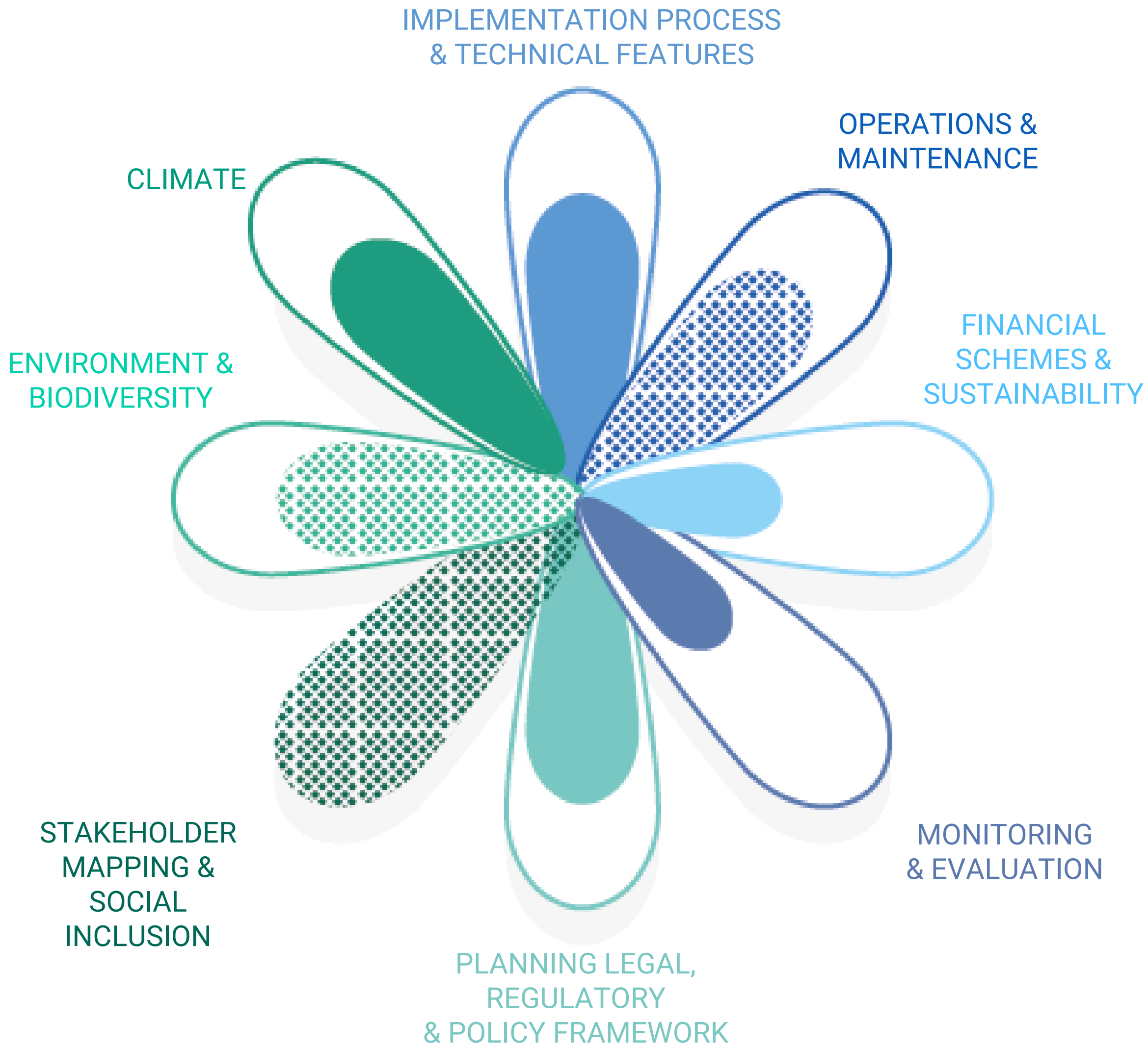


Figure 70 – Gap analysis result for Bangladesh Mangrove Restoration
(Source: SUEZ Consulting, 2024)

PROJECT PRESENTATION

The Bangladesh Mangrove Restoration Project in Tudor Creek, Mombasa, Kenya, began in 2011 to counteract degradation caused by siltation and shoreline encroachment. Historically, this region experienced significant loss of mangrove cover due to urban expansion and resource overexploitation. The consequences included destabilized shorelines, increased erosion, and diminished resilience to storm surges.

Therefore, the Bangladesh Mangrove Restoration Project aims at rehabilitating a degraded mangrove ecosystem affected by siltation from shoreline encroachment; So far, more than 200 ha have been restored, with aspirations to rehabilitate over 1,400 ha in the future phases (Aga Khan Foundation, 2023).

Supervised by the Kenya Forest Service (KFS) and implemented by Community Forest Associations (CFAs) like Big Ship Organization, Cobweb, and Tuliza Sayari, the project works to restore the mangrove forest to stabilize shorelines, prevent erosion, and protect against storm surges and coastal flooding.

The Bangladesh Mangrove Restoration Project employs community-led restoration strategies, engaging local residents in planting and nurturing mangrove seedlings. In addition to ecological benefits, the project provides local communities with jobs and income from activities like seedling planting and management, promoting both climate resilience and socio-economic well-being in the region.

Figure 71 – Location of Bangladesh Mangrove Restoration project, Mombasa County, Kenya (Source: SUEZ Consulting, 2024)

Figure 72 – Community members planting seedlings at the Bangladesh mangrove forest (Source: SUEZ Consulting, 2024)

Figure 73 – Bangladesh Mangrove Forest
(Source: SUEZ Consulting, 2024)

Figure 74 – Bangladesh Mangrove Forest
(Source: SUEZ Consulting, 2024)

CLIMATE

SCORE 2

- **Project response to climate risks – Score 3**

Mangrove restoration mitigates coastal erosion and flood risk. A comprehensive catchment management strategy would help tackle upstream pressures.

Mombasa City experiences frequent flooding from increasingly erratic rainfall, causing damage to infrastructure and loss of life. This risk is exacerbated by Mombasa's unique geography, with much of its infrastructure and poorer neighborhoods located in low-lying areas, additionally making it vulnerable to sea-level rise. It is projected that a sea-level rise of 0.3 meters would submerge about 17% of Mombasa, or 4,600 ha of land (CoGM, 2020:7).

Mombasa's coastline is at high risk of coastal erosion, which threatens the tourism sector and shoreline infrastructure. Related to sea-level rise, saltwater intrusion into freshwater aquifers, poses a challenge, affecting water quality and availability. Climate change and increasing mean temperatures are expected worsen the spread of diseases such as malaria, cholera, and typhoid, especially during flood events. Lastly, climate change and rapid urbanization are resulting in ecosystems degradation. (CoGM, 2020).

The Bangladesh Mangroves Restoration project was primarily developed to address coastal erosion, siltation as well as shoreline encroachment. Mangroves serve as natural barriers, dissipating wave energy and mitigating storm surges. Their intricate root systems stabilize sediments, curb coastal erosion, and slow the flow of incoming water, which significantly reduces the risk of flooding. They can decrease wave heights by as much as 66%. However, persistent issues like siltation and encroachment would benefit from a more comprehensive catchment management strategy to address upstream pressures and ensure long-term success. By restoring mangrove, the project also addresses flood risk and supports carbon sequestration as mangroves are highly effective carbon sinks, capable of sequestering up to five times the carbon per ha compared to terrestrial forests.

- **Project adaptation to local climate conditions (present and future) – Score 1**

To maintain the mangrove's sustainability and health, restoration efforts should account for the specific environmental tolerances of each local mangrove forest.

Mangrove forests are fragile ecosystems that can be substantially impacted by climate change (Ward et al, 2016). For instance, rising mean temperatures are making the Mombasa County vulnerable to extreme heat, residents report increasingly extreme temperatures and high humidity, making daily activities uncomfortable, and the mangrove plant productivity can be affected by increased atmospheric CO_2 concentration and increasing mean temperatures.

In addition, sea level rise, change in ocean currents and altered precipitations regime can also undermine the sediment supply, salinity and coastal line on which mangrove forests are relying (Ward et al, 2016). The tolerance to environmental factors is specific to each local mangrove forest but should be kept in mind in developing mangrove restoration projects to ensure their sustainability and health.

ENVIRONMENT AND BIODIVERSITY

SCORE 1.5

- **Project response to environmental risks – Score 1**

The project addresses ecological degradation by employing community-led restoration strategies. The integration of mangrove restoration in urban planning and environmental management could largely enhance impact of such initiatives.

Ecological degradation is a key cross-cutting environmental risk in Mombasa. Mombasa County has rich coastal, inshore and deep-sea ecosystems. Solid waste is a global challenge, with plastic pollution from the city affecting drainage infrastructure, marine ecosystems and public health. Furthermore, air pollution from sources such as the burning of waste represents a growing problem.

As a result of Mombasa's unique urban geography, ecological degradation illustrating by the declining health of mangroves poses a threat to biodiversity and the blue economy (Stuart et al., 2021). These environmental risks are compounded by rapid urbanization, inadequate waste management, and the city's unique geography, with much of its infrastructure and poorer neighborhoods located in low-lying areas (CoGM, 2020). The Bangladesh Mangrove Restoration Project employs community-led restoration strategies, to engage residents in the protection of this fragile ecosystem and potentially raise awareness on the environmental risks affecting mangrove health. The integration of mangrove restoration projects into City urban planning and environmental management would be key to help ensure the sustainability and long-term health of such ecosystems.

- **Environment and urban biodiversity benefits – Score 2**

The Bangladesh Mangrove Restoration project enhances Mombasa's coastal and urban biodiversity by restoring mangrove ecosystems that provide critical habitat for marine and terrestrial species and maintaining the ecosystem balance.

The Bangladesh Mangrove Restoration project contributes to the rehabilitation and preservation of Mombasa's unique coastal ecosystem.

Mangrove are highly productive coastal systems (Afonso et al., 2021) that contribute to the provision of a habitat for a wide variety of species. The intricate root systems of mangroves create a complex ecosystem that supports a diverse array of organisms. Mangroves can also serve as nesting, breeding, and nursing grounds for numerous marine and terrestrial animals, including fish, crabs, shellfish, sea turtles, and birds. Mangroves act as nurseries, offering food and protection before they move to deeper water or coral reef. This nursery function is vital for maintaining healthy fish populations and supporting global fisheries. This supports complex food webs and sustains local fisheries.

The intricate root systems of mangroves not only provide shelter but also trap nutrients and organic material, enriching the surrounding environment. With coastal erosion and sea level rise, saltwater intrusion in estuaries and freshwater aquifers is a growing concern, affecting water quality and availability (CoGM, 2020). Mangroves can act as biofilters for nutrients in upland runoff, such as nitrogen and phosphorus, helping to maintain coastal water quality. Mangroves may support sediment regulation as they need a steady supply of sediment flows from rivers to survive and thrive. They help maintain sediment balance in deltas and estuaries, protecting them from shrinking and sinking (Ellison et al., 2020).

STAKEHOLDER MAPPING & SOCIAL INCLUSION

SCORE 2.5

- **Stakeholder engagement & consultation strategy – Score 2**

Local communities can rely on compensation mechanisms and government collaboration to support restoration efforts.

The community-led Bangladesh Mangrove Restoration project is implemented by local Community Forest Associations (CFAs) and benefits from support from government agencies. Local CFAs include Big Ship, Cobweb, and Tuliza Sayari, which are responsible for developing, planting, and managing mangrove seedlings in designated restoration areas. The Kenya Forest Service (KFS) is the institution that registers and authorizes CFAs and is in charge of enforcement and supervision of restoration activities. Seedlings are sold to development agencies that are required by the KFS to compensate for the destruction of mangroves caused by their projects (e.g., Kenya National Highways Authority (KeNHA), Kenya Urban Roads Authority (KURA)). The price of the seedlings is double the usual cost to ensure a fair compensation of CFA members for their planting and maintaining labor for a minimum of three years. These national agencies also provide training, monitoring and evaluation.

KFS employs a co-management approach with local communities, allowing them to implement sub-projects like beekeeping in the mangroves. This collaboration includes shared responsibilities, such as mangrove restoration activities. By involving communities in the restoration process, KFS fosters local ownership and long-term sustainability.

Potential improvements include better communication between KFS and CFAs, and collaboration with the County Government of Mombasa for development control and enforcement. Addressing issues such as unclear engagement policies, over-exploitation of mangroves, and encroachment would strengthen restoration efforts. The CIDP also provides an opportunity to further collaborate, as it clearly highlights a goal to rely on multi-stakeholder collaboration for forest cover and mangrove restoration.

- **Socio-economic benefits and inclusion of vulnerable group – Score 3**

The mangrove restoration project delivers a wide array of direct and indirect socio-economic, environmental, and cultural benefits to local communities.

The mangrove restoration project brings a wide range of economic and financial benefits to local communities. By offering alternative livelihoods such as eco-tourism, sustainable aquaculture, and the sale of value-added mangrove products, the project reduces the reliance on mangroves for fuel and timber, helping to protect these vital ecosystems. CFAs are central to the project, as they manage the restoration efforts while also providing job opportunities. Local communities earn income through activities such as planting, managing, and selling mangrove seedlings, which not only support environmental conservation but also improve household incomes and overall socio-economic conditions. Mangrove forests also serve as crucial breeding grounds for marine species like fish and crabs, benefiting local fisheries.

CFA members benefit from access to financial services through table banking, which helps improve financial stability.

Beyond economic benefits, the project holds social, cultural and recreational value. Social cohesion is promoted within CFAs, enhancing community interaction and providing training and knowledge on mangrove management. The restoration of mangroves also helps preserve local cultural heritage, as coastal communities have long relied on these ecosystems. Mangrove forests provide recreational opportunities, enhance the aesthetic value of coastal areas.

PLANNING LEGAL, REGULATORY & POLICY FRAMEWORK

SCORE 2

- **Planning and development strategy – Score 2**

The Bangladesh Mangrove Restoration Project aligns with national and regional environmental policies but lacks integration into local urban planning, a cohesive monitoring system and a long-term management scheme.

The Bangladesh Mangrove Restoration Project aligns with national and regional environmental policies but lacks integration into regional urban planning, limiting its ability to address local socio-economic pressures driving mangrove degradation. While guided by the National Mangrove Ecosystem Management Plan (2017–2027) and UNEP's guidelines (Guidelines on Mangrove Ecosystem Restoration for the Western Indian Ocean), the project still faces encroachment pressures from settlement and farming. Restoration efforts span vast degraded areas but lack clear spatial delineation, making it challenging to target high-risk or high-value zones effectively. This absence of specificity reduces the potential for prioritizing critical restoration sites.

The Mombasa CIDP includes an objective to increase of 2% the mangrove forest cover (existing baseline: 19%) but also highlights the need for a land use management plan, monitoring system and county environment and natural resources long term management master plan to improve the protection of mangrove forests (CIDP 2023-2027).

- **Regulatory and land tenure strategy – Score 2**

Though forests are protected areas, enforcement remains weak, thus, establishing clear land-use zoning and participatory governance frameworks could enhance conservation efforts.

Mangroves are legally designated as public land under Kenyan law and gazetted as “mangrove forests”, but weak enforcement undermines protection efforts and exposes areas to encroachment and unsustainable resource use. Establishing clear land-use zoning and formalizing co-management agreements with communities could strengthen tenure security and encourage local stewardship.

While national and regional guidelines support mangrove conservation, the lack of specific policies addressing community engagement in long-term care hinders the institutional support available to CFAs. Codifying participatory governance frameworks with clearly defined roles and benefits for local communities would enhance sustainability and scale restoration efforts.

IMPLEMENTATION PROCESS AND TECHNICAL FEATURES

SCORE 2

Implementation process – Score 2

The Mangrove Restoration Project uses an inclusive method based on local and international mangrove guidelines that combines ecological restoration with socio-economic benefits for the local community.

The following steps have been followed:

- Initial Site Assessments (2011 (?)–2013) - The project had site evaluations aimed at pinpointing degraded mangrove regions and establishing restoration priorities in line with the *Mangrove Ecosystem Conservation Manual*. These assessments examined hydrological conditions, soil quality, and the best mangrove species for planting. By relying on data-driven decision-making, they ensured that the most damaged areas were prioritized for immediate intervention, setting the stage for successful restoration efforts.
- Community Mobilization and Capacity Building (2012–2015) - Community involvement was key and relied on local residents engagement, supported by the "Adopt a Site" initiative.
- Planting and Nursery Management (2015–Present) - CFAs manage nurseries that supply seedlings, which are sold to cover costs and support ongoing maintenance. The CFAs are responsible for care, such as controlling erosion, and safeguarding against pests and human interference.
- Livelihood Integration (2013–Present) - The project incorporates income-generating activities.
- Monitoring, Evaluation, and Policy Support (Ongoing) - Regular monitoring assesses trees' survival rates alongside the ecosystem's recovery. Collaborations with the Insurance Regulatory Authority (IRA) since 2019 have provided resources and facilitated the planting of more than 47,000 mangrove seedlings, resulting in a survival rate surpassing 90% (Insurance Regulatory Authority, 2024).

Existing local documentation for Bangladesh Mangrove Restoration

1. Kenya National Mangrove Management Plan (2017-2027) (Government of Kenya (GoK), 2017)
2. Mangrove Ecosystem Conservation Manual: A focus on Kenya (Prosperi et al., 2021)
3. Guidelines on Mangrove Ecosystem Restoration for the Western Indian Ocean Region (Kairo et al., 2020)
4. Mangrove Deaths In Kenya: Causes and Recommended Management Interventions (Wekesa et al., 2023)

Other relevant guidance for Mangrove Restoration

1. Best Practice Guidelines for Mangrove Restoration (Beeston et al., 2023)

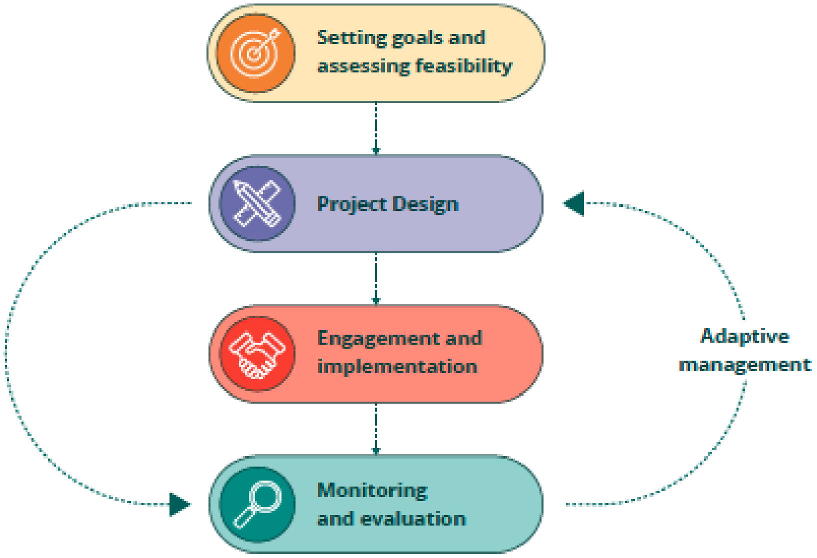


Figure 75 – Mangrove restoration stages shown linearly, though processes often overlap (Source: Beeston et al., 2023)

IMPLEMENTATION PROCESS AND TECHNICAL FEATURES | SCORE 2

Technical features – Score 2

The holistic approach to entrench socio-economic benefits into restoration effort led to the development of a community-led conservation approach with a very low mortality rate. However, scale of impact is still small (1/7th of the total degraded area) and begs the question of the scalability of the approach.

In 2017, the “Adopt a Site" program was launched through a collaboration between the Big Ship Organization and the University of Nairobi, significantly boosting community engagement. This initiative was designed to align with existing restoration guidelines, highlighting the importance of community-led conservation efforts to foster local ownership capacity-building.

Alongside planting initiatives, the project includes socio-economic elements like aquaculture, apiculture, and water quality monitoring. These strategies enhance livelihoods, alleviate strain on mangrove resources, and bolster local resilience against climate change impacts. This holistic approach ensures that ecological restoration yields social advantages, establishing a replicable precedent for similar projects.

The restoration process includes planting mangrove seedlings at a consistent spacing (e.g., 1x1 meter, optimizing growth and reducing competition). CFAs manage nurseries that supply seedlings, which are sold to cover costs and support ongoing maintenance. The CFAs are responsible for care, such as controlling erosion, and safeguarding against pests and human interference.

From 2011 onwards, KFS and CFAs played a crucial role in planting initiatives, helping restore more than 200 ha of mangroves. Despite this progress, over 1400 ha remain degraded, prompting the continuation of the project’s phased restoration approach (Aga Khan Foundation, 2023).

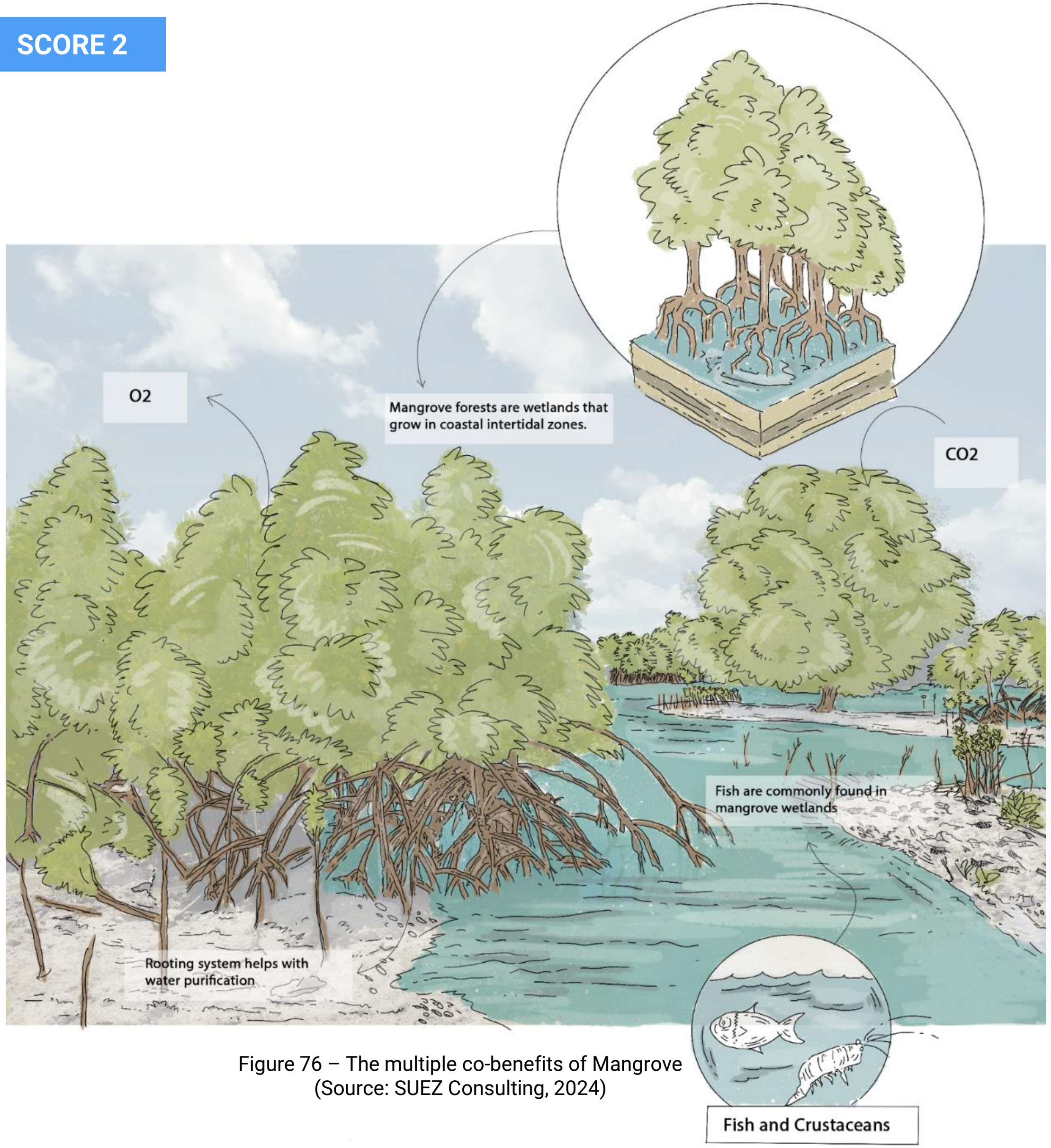


Figure 76 – The multiple co-benefits of Mangrove (Source: SUEZ Consulting, 2024)

IMPLEMENTATION PROCESS AND TECHNICAL FEATURES / OTHER EXAMPLES

Figure 77 – Mangrove
(Source: timothy k / Unsplash, https://theconversation.com/histoire-des-credits-carbone-vie-et-mort-dune-fausse-bonne-idee-212903)

Limpopo river estuary Mangrove Restoration, Mozambique

In 2000, severe flooding devastated Mozambique's Limpopo River Estuary, destroying mangroves and disrupting livelihoods. Community-led restoration began in 2008 to address this, focusing on reopening tidal channels and establishing a nursery producing 168,000 seedlings of six mangrove species. By 2013, 100 ha of mangroves were reforested with a 74% survival rate, illustrating the relative efficiency of the Bangladesh Mangrove Restoration Project (200 ha in roughly the same timespan). These efforts improved flood protection, reduced saltwater intrusion, and enhanced biodiversity, supporting the return of fisheries and wildlife. The project also transitioned local livelihoods from timber harvesting to sustainable practices like crabbing, tilapia farming, and mangrove honey production.

Figure 78 – Mwambani Mangrove, Tanzania
(Source: https://fairtree.org/tanzania-mangroves)

Mwambani Mangrove Restoration, Tanzania

In Mwambani, extensive mangrove deforestation due to wood harvesting and land conversion has increased vulnerability to coastal erosion and storm surges. To tackle this issue, Fairtree.org launched a community-led restoration initiative in 2021, implementing a "pay-to-grow" model that rewards locals for every mangrove planted and cared for over two years. This method has resulted in the restoration of extensive mangrove regions, crucial for coastal protection and functioning as nurseries for marine life, thus benefitting fisheries. Like Bangladesh Mangrove Restoration Project, the project creates sustainable job opportunities, encouraging environmental stewardship within the community.

OPERATIONS & MAINTENANCE

SCORE 1.5

- **Roles and responsibilities – Score 2**

The Bangladesh Mangrove Restoration project involved multiple stakeholders involved at different times, including philanthropic foundations, government bodies, CBOs, business organizations and universities.

As a multi-faceted and multi-phase project that includes socio-economic elements like aquaculture, apiculture, water quality monitoring along with planting mangroves, the Bangladesh Mangrove Restoration project has had multiple stakeholders involved at different times since its inception. Stakeholders include philanthropic foundations, government institutions, community-based organizations, business organizations and universities.

Mangrove management and control is devolved to KFS according to Mombasa CIDP (2023-2027). CFAs manage the nurseries that supply seedlings, which are sold to cover costs and support ongoing maintenance. The CFAs are responsible for controlling erosion, and safeguarding against pests and disturbance

Planting of the seedlings is done by KFS and CFAs such as Tulinde Mikoko SHG.

Collaborations with the Insurance Regulatory Authority (IRA) since 2019 have provided resources and facilitated the planting of more than 47,000 mangrove seedlings.

- **Operation & Maintenance Plan – Score 1**

The Bangladesh Mangrove Restoration project includes regular monitoring but lacks a documented maintenance plan. In mangrove restoration, adaptive management is crucial due to the high risk of failure.

In general, maintaining restored mangroves requires ongoing efforts and attention to ensure their long-term success. Mangrove restoration projects often have high risks of failure thus adaptive management is key, as adjustments to the restoration plan based on monitoring results and changing environmental conditions may be needed (Lovelock et al., 2022; UNEP, 2020; Beeston et al., 2023). A regular monitoring is carried out to assess trees' survival rates alongside the ecosystem's recovery, but no other information is available on maintenance plan.

Key steps for maintaining restored mangroves include:

- Regular monitoring by conducting frequent assessments to evaluate the health and growth of the mangroves, checking for signs of stress or disease
- Hydrological management to ensure proper water flow and tidal inundation patterns are maintained, as mangroves thrive when their roots are wet about 30% of the time and dry for 70% of the time.
- Seedling protection to safeguard young plants from predators and adverse environmental conditions such as storms or excessive saltwater intrusion.
- Invasive species control by remove any invasive plants that may compete with the mangroves for resources.
- Erosion control measures to prevent damage to roots and affect growth.
- Community engagement: Involve local communities in the maintenance process to ensure long-term stewardship of the restored areas.
- Nutrient management: Monitor and maintain appropriate nutrient levels in the soil to support mangrove growth.
- Regular clearing of accumulated debris that may hinder mangrove growth or alter water flow.

FINANCIAL SCHEMES & SUSTAINABILITY — SCORE 1

- **Project costs, revenue generation and funding – Score 1**

This project being essentially community-led, no external funding has been associated, and costs information is scarce.

While KFS is responsible for the supervision and enforcement of restoration activities, seedlings are produced by registered CFAs, who are also in charge of the execution. Since no records of the number of planted trees exist, it is not possible to estimate the overall cost of implementation. Maintenance costs are included in the seedling purchase price. Their cost is doubled to account for planting and seedlings caretaking activities for at least 3 years, bringing the cost per seedling to US$ 4.

Seedlings buyers are development agencies whose projects have destroyed mangrove. They are directed by KFS to compensate their impacts through their involvement in mangrove restoration. Seedlings sale and planting generate revenue for CFA members.

The project includes socio-economic elements like aquaculture and apiculture that enhance livelihoods, but specific figures are not available. Livelihood improvement is crucial to get communities to shift their main energy source away from firewood and charcoal, a practice threatening mangroves.

- **Integrated financial plan and project sustainability – Score 1**

In line with the absence of drawings and designs for this NbS, no financial plan was developed.

The integration of seedlings planting and caretaking in the seedlings purchase price reflects a certain level of O&M planning, although transparency in the allocation of this budget would help ensure sustainability and public buy-in.

MONITORING & EVALUATION SYSTEM — SCORE 1

- **Key existing indicators – Score 1**

Only a short number of indicators is utilized to measure the deployment of the NbS, with no information on the measuring process.

The following indicators are in place:

- Count of participating CFAs,
- Count of planted trees per season,
- Count of surviving trees after a 3-year management period,
- Balance of degraded area (size) → unclear

As of now, the only real performance indicator is the count of surviving trees. Setting up larger scale indicators addressing landscape restoration and livelihood benefits would greatly help the NbS impact evaluation and inform potential changes to make in the O&M strategy.

- **M&E system and knowledge dissemination – Score 1**

There is no M&E framework in place, and the communication strategy is not identified.

The only monitoring elements gathered are the indicators presented above, without clear information about the methods and actors involved.
A detailed M&E framework is crucial to evaluate the NbS success and steer the O&M strategy towards optimized practices. Without, this mangrove degrading compensation initiative could fall short of its objectives, especially taking into account ongoing siltation and informal logging pressures.

Furthermore, a communication strategy promoting knowledge dissemination would improve community awareness and foster sustainable practices. An informed population is also more likely to get involved in supporting activities that increase biodiversity and livelihood benefits.

Mangrove Forests

GLOBAL CENTER ON ADAPTATION

CONDITIONS FOR UPTAKE

The Bangladesh Mangrove Restoration Project at Tudor Creek in Mombasa, Kenya, illustrates the transformative potential of mangrove forests to address climate resilience, ecosystem restoration, and socio-economic issues. This initiative exemplifies how the restoration of damaged mangrove ecosystems can secure coastlines, enhance biodiversity, and protect at-risk communities from climate challenges such as flooding and erosion. Its community-focused strategy highlights the scalability and replicability of these initiatives in Kenya. Conditions for uptake have been identified based on the lessons learned from the case to ensure replicability and enhance the design of solutions in similar contexts.

Key inspirational features for associated NbS families

- **Community-led restoration** that involves CFA in the planting, maintenance, and management of these vital ecosystems. This approach fosters local ownership and promotes long-term sustainability, demonstrating how community engagement can successfully merge environmental restoration with socio-economic growth benefits. The global environment factors that may undermine the mangrove health are mainly human-related, the engagement of local communities into global restoration project will contribute to raise awareness and a sense of ownership of the commons.
- **Incorporating livelihoods through income-generating activities** (aquaculture, apiculture, and eco-tourism) aids in diversifying local economies, reducing reliance on mangrove resources, and enhancing community resilience.

Key improvement area for NbS replicability across Kenya

- **Community engagement and capacity building**: providing legal recognition to CFAs, tools, and training enables local ownership and long-term sustainability. Training programs should develop skills in planting, nursery management, and ecosystem maintenance. Livelihood alternatives (beekeeping, aquaculture, and eco-tourism) reduce dependence on mangrove resources and support economic resilience. Targeting youth and women ensures inclusive participation and benefits.
- **Community awareness and involvement** can play a key role: an appropriate communication strategy can prevent damaging practices such as informal logging.
- **Addressing the underlying drivers of their decline is essential to the effective management of urban ecosystems, including mangroves.** For instance, developing wastewater treatment at the city-level can significantly improve water quality downstream within the mangrove area, and help restoration efforts. Similarly, developing sustainable wood supply chains can alleviate informal logging stress.
- **Funding and financial incentives**: Payment for Ecosystem Services (PES) schemes incentivize conservation by rewarding communities for carbon sequestration and biodiversity efforts. Public-private partnerships (PPPs) can provide shared resources and expertise to scale projects. Climate funds like the Green Climate Fund (GCF) offer financial support for large-scale initiatives.
- **Technical and scientific support towards a global coastal management strategy: a robust M&E system** is key to assess the evolution of the mangrove health and the efficacy of restoration efforts. Its output can help adapt the O&M strategy towards optimized practices. In addition, hydrological assessments can help address challenges like siltation and tidal disruptions, enabling mangrove regeneration. Site-specific interventions, including sediment management and tidal reconnection, optimize restoration outcomes. Innovative techniques such as mixed-species planting and sediment traps improve mangrove survival and resilience. Collaboration with research institutions ensures that restoration practices are science-based. Monitoring frameworks should evaluate carbon storage, flood protection, and biodiversity gains.

Case 6 – Urban Forests: Kaya Tembo Forest

Urban Forests are complex ecosystems within cities or at the rural-urban interface, exhibiting a remarkable capacity for regeneration and resilience (Vogt, 2020). Often remnants of larger regional landscapes or emerging on vacant or abandoned land, these forests adapt to adverse urban conditions such as pollution, compacted soils, and disrupted hydrological cycles (Ordóñez and Duinker, 2012; Vogt, 2020). Despite stresses from pollution, encroachment, and other human activities, urban forests maintain rich biodiversity due to their mix of trees, shrubs, grasses, and complex soil systems (World Bank, 2021). These ecosystems provide significant benefits including mitigating the urban heat island effect and air pollution. Furthermore, they retain stormwater to protect rivers by intercepting rainfall and enhancing infiltration (Ferreira et al., 2022; O'Brien et al., 2022). Urban forests also sequester carbon and regulate water cycles through retention, infiltration, and evapotranspiration (Bherwani et al., 2024; Brack, 2002). They offer critical habitats for various species and contribute positively to urban societies' physical, mental, social, and economic well-being. Preserving and maintaining urban forests present critical opportunities to enhance urban resilience against climate change and improve quality of life.

KAYA TEMBO FOREST

This section presents an analysis of the Kaya Tembo Forest and similar projects, highlighting the challenges and opportunities of preserving sacred indigenous ecosystems in Kenya.

Key inspirational features: *indigenous forest conservation rooted in community practices, biodiversity care, local resources management.*

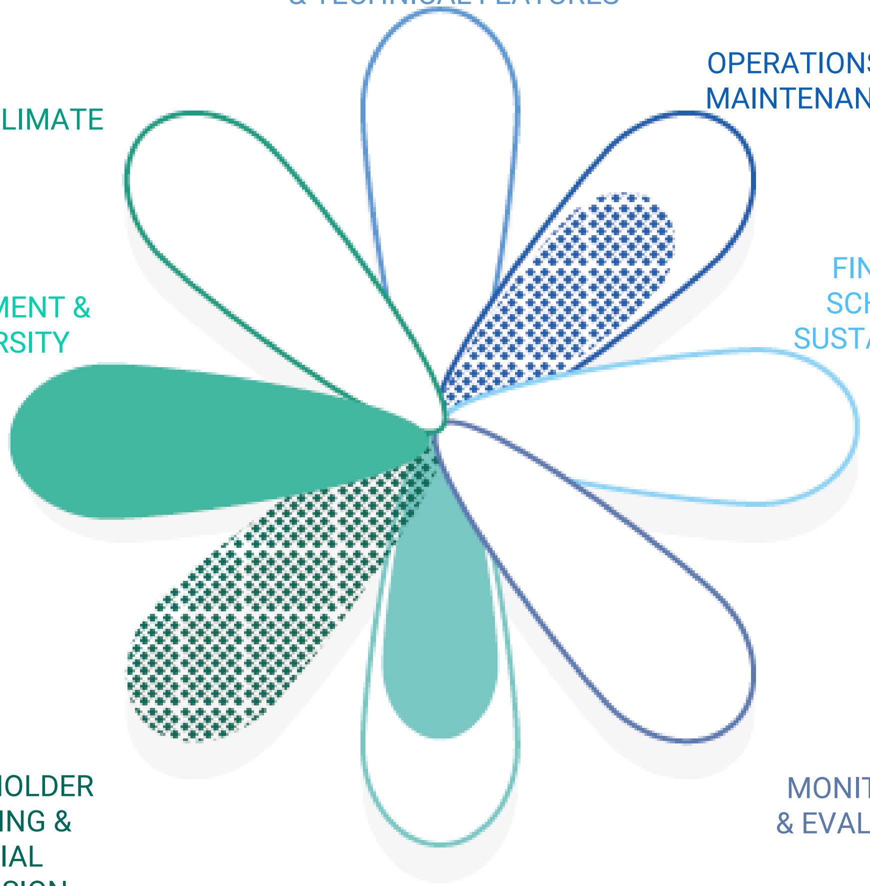


Figure 79 – Gap analysis result for Kaya Tembo Forest (Source: SUEZ Consulting, 2024)

PROJECT PRESENTATION

Kaya Tembo is a sacred indigenous forest located in Dongo Kundu, Likoni sub-County, Mombasa. Historically managed by the Miji Kenda communities, particularly the Digo, it forms part of the Kaya coastal lowland forest, which are legally gazetted and recognized as critical ecosystems. Although not part of the Sacred Mijikenda Kaya Forests UNESCO World Heritage Convention List, Kaya Tembo Forest was declared sacred in the 1940s, and has retained its spiritual and cultural significance, even as urban development has transformed the surrounding area, making it an integral part of the urban landscape and disconnected it from its original forest ecosystem. The focus of the Kaya Tembo case is to demonstrate how existing forests within urban areas can be effectively protected and preserved, rather than creating or designing an urban forest from scratch. By safeguarding its cultural and ecological value, the forest remains a critical asset for biodiversity conservation, soil protection, and climate resilience. It also supplies freshwater from natural springs to over 1,000 households, further enhancing its role as a vital resource for the surrounding community.

Governance is led by the traditional Council of Elders, who uphold unwritten cultural policies to maintain the sacred status of the forest, restrict access, and prohibit resource harvesting. These practices not only preserve the biodiversity of Kaya Tembo but also strengthen the social cohesion and cultural heritage of the Digo community through the revival of traditional practices.

As an urban forest within a rapidly developing area, Kaya Tembo exemplifies the importance of protecting culturally and ecologically significant landscapes amidst urbanization. It highlights how preserving existing forests in urban settings can address contemporary environmental and social challenges while maintaining their spiritual and cultural identities.

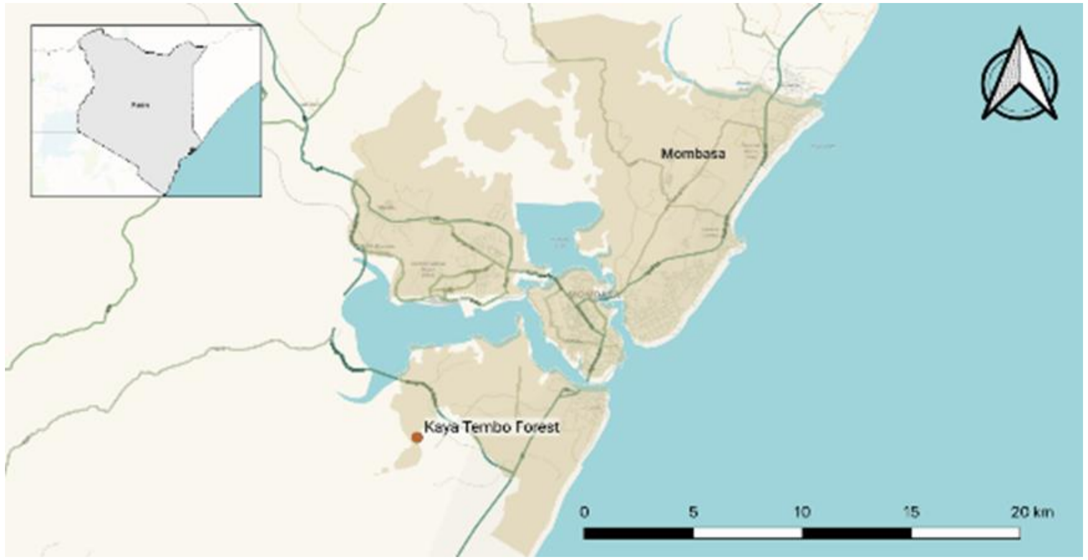


Figure 80 – Location of the Kaya Tembo Forest, Mombasa, Kenya
(Source: SUEZ Consulting, 2024)

Figure 81 – A view of Kaya Tembo Forest
(Source: SUEZ Consulting, 2024)

Figure 82 – Kaya Tembo Forest
(Source: SUEZ Consulting, 2024)

Figure 83 – Kaya Tembo Forest
(Source: SUEZ Consulting, 2024)

CLIMATE

SCORE N/A

• Project response to climate risks – Score N/A

Key climate risks in Mombasa include flooding, sea-level rise and rising temperatures, which urban forest like Kaya Tembo Forest help to mitigate but no documentation is available on this aspect.

Mombasa faces several significant climate risks. Frequent flooding is exacerbated by Mombasa's unique geography, with much of its infrastructure and poorer neighborhoods located in low-lying areas, additionally making it vulnerable to sea-level rise. Rising mean temperatures are making the county is also vulnerable to extreme heat (Omanga, 2024 for CoM SSA). Mombasa's coastline is at high risk of erosion, which threatens the tourism sector and shoreline infrastructure. Related to sea-level rise, saltwater intrusion into freshwater aquifers, poses a challenge, affecting water quality and availability.

Urban Forest such as Kaya Tembo Forest play a key role in helping cities adapt to climate change: they help control the "heat island" effect. Trees and vegetation in urban forests help control runoff from storms and flooding by intercepting rain in their canopies and increasing the infiltration rates thus augmenting groundwater. Urban trees provide carbon sequestration benefits by capturing and storing carbon dioxide while improving overall air quality by filtering pollutants from the air.

However, the lack of documentation regarding the environmental benefits of this urban forest and comparative benefits with created urban forest limit the analysis beyond the associated NbS family.

• Project adaptation to local climate conditions (present and future) – Score N/A

Kaya Tembo urban forest spurs from a natural 200 km coastal forest ecosystem that has been disrupted due to urbanization. This leaves open the question of long-term sustainability of these separated forested sites, that are today preserved without any specific action to ensure their adaptative capacity to climate change.

As an urban forest, Kaya Tembo acts as a natural climate adaptation strategy, reducing heat, preserving groundwater, and fostering sustainable development. The management strategy combines traditional ecological knowledge with contemporary sustainability practices to maintain ecological health and protect cultural heritage practices.

However, Kaya Tembo Forest belong to a coastal forest and cultural ecosystem that is currently threatened by urbanization. This threat and ecological disruption of natural ecosystem is probably affecting the capacity of the forest ecosystem to adapt to climate hazard, even though current protection framework help sustain the natural forest resources.

ENVIRONMENT AND BIODIVERSITY

SCORE 3

- **Project response to environmental risks – Score N/A**

Kaya Tembo Forest addresses water scarcity and has synergies with the sanitation and health agenda, however both the environmental risks and the actual adaptive capacity of the Kaya forest to it is not well documented.

Like other low-lying areas in Mombasa, Likoni is vulnerable to flooding and water logging (Njoroge et al., 2020). The combination of flooding and increased temperatures may elevate the risk of vector-borne diseases in Likoni. During dry periods, Likoni is vulnerable to water scarcity, affecting both residents and local industries (CoGM, 2024). Urban forests like Kaya Tembo play a crucial role in addressing environmental risks in cities (Brandt et al., 2016). The Kaya Tembo Forest is a crucial water supply source for residents and thus has positive synergies with the water, sanitation and public health agenda. Beyond carbon sequestration air quality improvement and groundwater water supply, urban forests regulate nutrient cycling, replenishing essential nutrients like nitrogen and phosphorus, vital for plant growth. Organic matter from decomposing plant material enhances soil fertility and structure, increasing its water-holding capacity and nutrient reservoir.

Urban forest soils can also support phytoremediation by retaining heavy metals and other pollutants due to their organic matter content and pH levels. This reduces the mobility of contaminants, mitigating risks to plants and human health (Gómez et al., 2019). Tree roots in urban forests reduce erosion and soil compaction thus improving aeration, drainage, and root penetration. This supports healthier ecosystems by facilitating better water infiltration and reducing runoff. Urban forests support enhance microbial diversity and activity in soils, which are crucial for processes like nitrogen fixation and organic matter decomposition.

However, the lack of documentation regarding the environmental benefits of this urban forest and comparative benefits with created urban forest limit the analysis beyond the associated NbS family.

- **Environment and urban biodiversity benefits – Score 3**

Indigenous forests are important sites of biocultural diversity and ecosystem support. The ban on importing external plant into Kaya's ecosystem guarantee the environmental integrity of the Kayas.

The Kaya Forests are botanically diverse and have high conservation value both from an ecological and cultural values. More that half of the Kenya's rare plants are found in the coast region, and many in Kaya Forests. A 6-day biodiversity survey conducted in Kaya Kauma in 2018 confirmed the variety of species existing in one of this Forest.

However, given the underlying threats of the rising need for land for urbanization needs, much remain to be done in terms of environmental monitoring of these Kayas ecosystem to follow diversity, conservation status and economic value of Kayas biodiversity.

Moreover, while Kaya Tembo should be protected as a sacred place as such, its ecological and biodiversity value could also contribute to broader planning and climate strategies. For instance, Kaya Tembo Forest could be included within urban biodiversity or green corridor strategy to foster the strategic development of green spaces and buffer zones. This would also help mitigate encroachment and ecological degradation around.

STAKEHOLDER MAPPING & SOCIAL INCLUSION

SCORE 2.5

- **Stakeholder engagement & consultation strategy – Score 2**

The preservation of sacred forests' ecological and cultural values requires strong cooperation between local organizations and national and local government bodies.

The Kaya Tembo Forest is managed by the Council of Elders, who uphold and preserve the cultural practices surrounding the sanctity of the forest. The Council of Elders represent the Digo community. As the custodians of Kaya Tembo, they play a central role in managing access, rituals, and conservation (Protecting the sacred Mijikenda Kaya Forests, 2020). The preservation of oral histories and the spiritual value of the forest involve conducting workshops or storytelling sessions to pass knowledge to younger generations (Habel et al., 2023).

The Council of Elders also ensures collaboration to maintain the ecosystem. They are the link between, the government and the local community for communication and cooperation. They have power to permit or deny entrance permission and provide information to interested individuals about the forest and its significance. Conflict, which has emerged from encroachments with the Special Economic Zone and from influx of non-Digo communities is handled through a structured dialogue between the Council of Elders, the local authorities, and developers.

The KFS plays a key role in gazettement, regulating tree cutting, and mapping Kayas across Kenya. The Council of Elders suggests strengthening collaboration with Mombasa's County Government to establish a clear legal framework for land rehabilitation, create related programs, and explore ways to expand Kaya Tembo's recreational use while enhancing protection against encroachments.

- **Socio-economic benefits and inclusion of vulnerable groups – Score 3**

Kaya Tembo holds significant cultural and spiritual importance for the Digo Community and its conservation provides ecosystem services supporting socio-economic activities.

The Council of Elders from the Digo community enforces informal policies to protect the forest's sanctity, merging traditional wisdom with contemporary conservation techniques (Sowińska-Świerkosz & García, 2022). This governance model fosters social cohesion, protects intangible cultural heritage, and strengthens intergenerational connections through rituals and knowledge transfer, in line with the NbS objectives of cultural enrichment (World Bank, 2021).

Culturally, Kaya Tembo provides a sacred setting for numerous spiritual and social activities for the Digo community. It is a site for initiation ceremonies, burial rites, naming ceremonies, and oath-taking events, all strengthening cultural continuity and spiritual identity. The forest also hosts prayers, weddings, coronations, and mentoring sessions for young people, where elders pass down cultural values, spiritual practices, and ecological stewardship knowledge.

The preservation of Kaya Tembo also supports ecosystem services provision for socio-economic activities stimulation. Its role in protecting the soil helps preserve nearby farmlands from erosion. Indeed, the forest's dense vegetation plays a vital role in soil conservation, preventing erosion caused by strong winds and rainfall. The forest is also home to springs that provide fresh water, supporting over 1,000 households and nourishing the local ecosystem. Women fetching water are welcome in the forest.

PLANNING LEGAL, REGULATORY & POLICY FRAMEWORK — SCORE 2

- **Planning and development strategy – Score 2**

While traditional governance is effective, formal recognition of Kaya Tembo under national conservation or cultural heritage laws would provide an additional layer of protection.

Kaya Tembo is part of the Mijikenda Kaya Forest, which is made up around 30 small patches of forest land that extend between 10 and 400 ha on the coastal plains of Kenya. Declared sacred in the 1940s, 10 sites of the Mijikenda Kaya Forest are now inscribed as UNESCO World Heritage Site since 2008. The protection of the Kaya Tembo Forest is thus included within the holistic and integrated protection initiative for the indigenous Kaya Forest based on both natural and cultural values. However, Kaya Tembo has not yet been inscribed as UNESCO site, and formal recognition of Kaya Tembo under national conservation or cultural heritage laws would provide an additional layer of protection. Collaborating with government agencies like National Museums of Kenya, Kenya Forest Service, county governments and conservation NGOs can support legal designation processes by drawing parallels from other UNESCO-recognized Kaya forests if UNESCO does not recognize the forest, to ensure the forest receives legal protection and potential long-term funding.

The reliance on unwritten cultural policies has been effective locally but poses challenges for collaboration with external stakeholders, and with increasing conflicts with non-Digo populations. Establishing a hybrid governance structure combining traditional practices with formal mechanisms could enhance financial support and alignment with national conservation strategies. Awareness campaigns, community dialogues, and inclusive participation in non-sacred forest activities could foster coexistence and mutual respect, ensuring long-term preservation.

- **Regulatory and land tenure strategy – Score 2**

An adaptative land tenure framework and land-use is required beyond mere protection to ensure long-term sustainable management of forest natural resources.

Kaya Tembo is located in a community land and benefits from legal gazettement under the Kenya Forest Services. The Tembo Forest traditionally managed by local Digo community was declared as Kaya in 1940s. Since then, all Kaya Forests have been delineated and mapped by KFS, gazetted and managed by a traditional team of Council of Elders.

This status hasn't fully prevented land pressure and encroachment on Kayas forest in a context of decline in community adherence to taboos, traditions and beliefs that maintained Kayas forest (Jefwa and al., 2021). This calls for land tenure and land use adaptative framework to account for this evolution to ensure appropriate enforcement, protection and sustainable use of these cultural and ecological heritage.

IMPLEMENTATION PROCESS AND TECHNICAL FEATURES

SCORE N/A

Implementation process - Score N/A

Implementation process for sacred forests incorporates traditional governance and contemporary conservation strategies to safeguard ecological and cultural integrity.

The process of implementing sacred forests like the Kayas integrates traditional governance with contemporary conservation strategies to safeguard their ecological and cultural integrity. Although there is no formal documentation of the Kaya Tembo Sacred Forest's protection, information gathered from interviews with the Digo community's Council of Elders, along with an examination of practices at other sacred forests, has shaped the implementation process detailed below:

- Community engagement and traditional practices: The Council of Elders, as the custodians of Kaya Tembo, plays a central role in managing access, rituals, and conservation (Protecting the sacred Mijikenda Kaya Forests, 2020).
- Boundary demarcation and physical protection: Economic encroachment threatens the sacred forest significantly. Building a chain-link fence, like the one at Kaya Tembo, effectively deters unauthorized access. This physical barrier, complemented by community monitoring systems, strengthens the forest's defense against outside threats and represents the sacred site's significance.
- Traditional access regulation and resource use management: The "invisible gate" idea at Kaya Tembo serves as a vital cultural tool for managing access. Enhancing this system with signage or visible markers at entry points can effectively convey the cultural and ecological importance of the forest to visitors. Compliance with bans on resource extraction, like firewood gathering or tree cutting, should be reinforced through penalties that are upheld by both cultural norms and formal regulations.
- Monitoring and maintenance: Activities such as removing dead trees to reduce fire risks and promote biodiversity maintain the health of the ecosystem.

Existing local documentation for Kaya Tembo Forest

- The Forest Conservation and Management Act - (Government of Kenya, 2017)
- Protection of Traditional Knowledge and Cultural Expressions Act - (Government of Kenya, 2016)
- Traditions and practices associated with the Kayas in the sacred forests of the Mijikenda - (UNESCO World Heritage Centre, 2009)
- Sacred Mijikenda Kaya Forests: A Natural World Heritage Site - (UNESCO World Heritage Centre, 2008)

Other relevant guidance for Forest Conservation :

- Guidelines for Applying Protected Area Management Categories - (Dudley, 2008).

Figure 84 – Spatial analysis of a conservation approach for a botanical garden (Source: Ramodibe, 2023)

IMPLEMENTATION PROCESS AND TECHNICAL FEATURES

SCORE N/A

Technical features - Score N/A

Kaya Tembo Sacred Forest doesn't have any specific technical features associated to its preservation, as its conservation relies on maintaining its conservation boundary and ensuring ecological preservation by embodiment of a cultural heritage.

Its role in maintaining biodiversity through the protection of native plant and animal species directly supports NbS objectives of enhancing ecosystem health. By stabilizing soil, preventing erosion, and regulating microclimates, the forest provides ecosystem services vital for the resilience of the surrounding community.

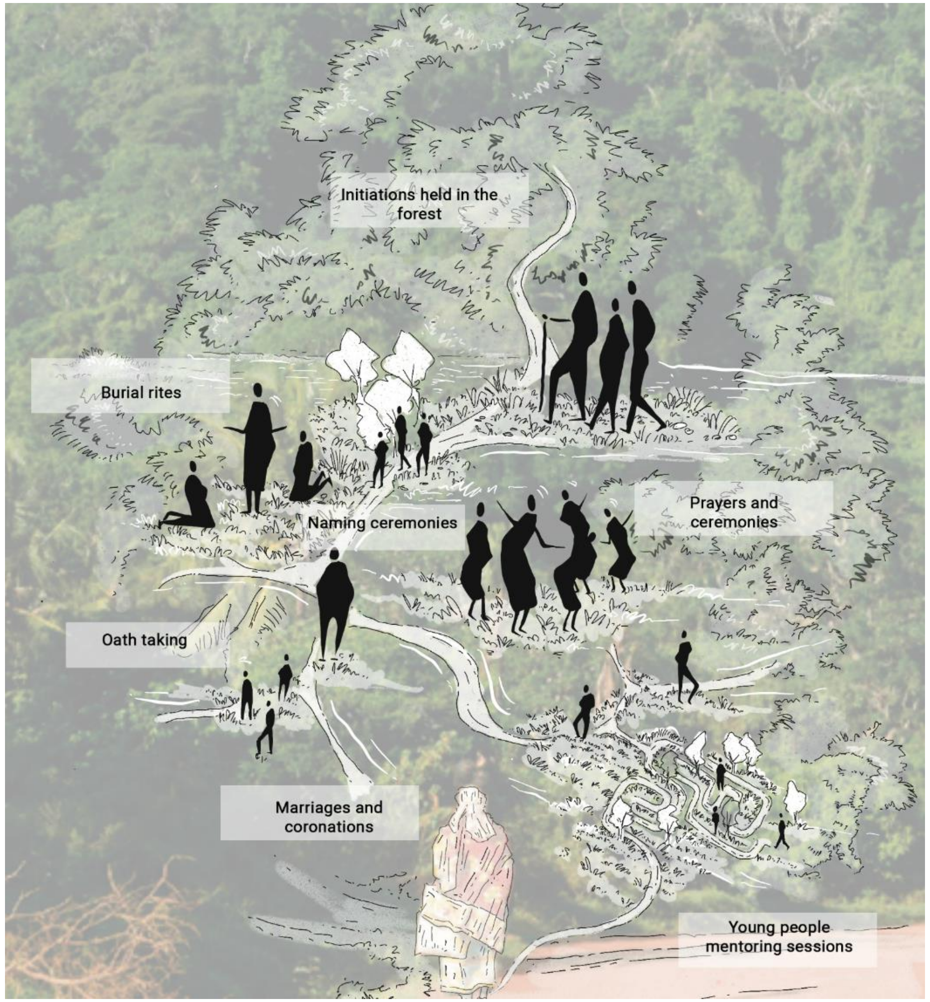


Figure 85 – Overlay of a photograph of Kaya Tembo Sacred Forest with illustrations of its cultural and spiritual activities (Source: SUEZ Consulting, 2024)

Figure 86 – Kenya's Mijikenda people revive sacred homesteads to protect the forest
(Source: Sophie Mbugua, Mongabay, 01/10/2018. https://news.mongabay.com/2018/10/kenyas-mijikenda-people-revive-sacred-homesteads-to-protect-the-forest/)

Mijenka Sacred Kaya, Kenya

Alike Kaya Tembo example, in the Kilifi and Kwale counties of Kenya, the kaya forests, sacred to the Mijikenda people, are endangered by illegal logging, mining, agricultural expansion, and land grabbing, which threaten both their ecological and cultural heritage. In response, the Mijikenda, with support from organizations like the Coastal Forest Conservation Unit of the National Museums of Kenya and WWF Kenya, are revitalizing traditional practices among the youth to safeguard these forests. Elders conduct rituals and educational programs aimed at instilling cultural values and conservation ethics. This community-centric approach has enhanced forest protection, curbed illegal activities, and promoted environmental stewardship (Mbugua, 2018).

Figure 87– Sappi forest
(Source: https://www.sappi.com/managing-for-biodiversity)

Habitat Restoration in Sappi Forests, South Africa

Sappi is an example of private conservation initiative for Forest. It emphasizes biodiversity by overseeing 138,000ha of natural habitats within its forestry plantations. To combat habitat loss, the company safeguards 160 Important Conservation Areas, which include essential ecosystems such as grasslands and wetlands. Their efforts involve collaborating with the South African National Biodiversity Institute and employing integrated weed management strategies to restore native species. These initiatives for habitat protection highlight Sappi's dedication to harmonizing sustainable forestry practices with biodiversity preservation, thereby ensuring resilience and ecological health in their operational landscapes. Though not urban forest per se, it reminds the importance of considering a variety of actors engaged into conservation.

OPERATIONS & MAINTENANCE

SCORE 1.5

- **Roles and responsibilities – Score 2**

Indigenous sacred green infrastructure like Kaya Tembo is best co-managed by traditional leaders leveraging biocultural knowledge and government institutions.

Operation and maintenance of the Kaya Tembo forest is performed by the Kaya Tembo Council of Elders in the Digo community in conjunction with Kenya Forest Services. The Council of Elders provides day-to-day management and maintenance of Kaya Tembo ecosystem. They serve as the link between government entities such as KFS and local community. They permit or deny permission to entrants to the forest. They act as guides and provide information to interested persons. They are the custodians of indigenous cultural practices around the sanctity of the forest and play a role in disseminating these practices to the wider community.

The Council of Elders works in tandem with Kenya Forest Service (KFS) whose mandate is to facilitate the legal gazettment of indigenous forests as well as to delineate and map out all indigenous forests (Kayas). KFS also provide permits for tree-cutting.

- **Operation & Maintenance Plan – Score 1**

Maintenance of Kaya Tembo focuses on maintaining spiritual sanctity and biodiversity, with low engagement on restoration activities.

Ecological and cultural principles guide maintenance activities to protect biodiversity and spiritual significance. A key task in Kaya Tembo is maintaining the perimeter fence to safeguard the forest from unauthorized access and potential damage. Removing dead trees is essential to maintaining forest health, preventing fire risks, and ensuring a balanced ecosystem. Cultural practices are strictly observed, including adherence to community-controlled access rules. An "invisible gate" regulates entry into sacred areas protected from general public access. Tree cutting, firewood collection, and waste disposal are prohibited, ensuring the preservation of the natural environment and its cultural heritage.

Key recommendations for maintenance of urban forests include conducting an inventory to assess the species, age, health, and spatial distribution of trees. Forest thinning, weeding and compost tree waste to recycle nutrients back into the soil are advised. Additionally, replacement of dead plants or trees during rainy seasons is essential to maintain forest density and tree diversity (Tengnäs, 1994; Barnes et al., 2010). Periodic assessment of erosion and performance of remedial erosion control is also recommended.

FINANCIAL SCHEMES & SUSTAINABILITY — SCORE N/A

- **Project costs, revenue generation and funding – Score N/A**

The Kaya Tembo Forest is an indigenous forest that managed by the Digo community and is not subject to project costs, revenue, nor funding like other NbS.

Occasionally, visitors give donations to the council of elders. Individuals interested in the study of Kayas are charged a fee which takes care of the guide, and a fraction goes to a kitty for maintenance.

The average cost of land in Dogo Kundu areas where Kaya Tembo sits is US$ 23,000 per acre, which is the size of the forest.

The cost of putting up a circumference fence using chain-link wire with concrete reinforcement is estimated at US$ 3,500. This cost includes labour costs.

- **Integrated financial plan and project sustainability – Score N/A**

There is no integrated financial plan since the forest is managed by its indigenous community.

MONITORING & EVALUATION SYSTEM — SCORE N/A

- **Key existing indicators – Score N/A**

The Digo community uses its own set of indicators to evaluate the quality of Kaya Tembo forest.

Elders measure the success of the forest by the number of people who present supplications, the respect the people hold the forest with, and the serenity of its environment. Impacts of the Kaya Tembo ecosystem in the lives of the neighborhood are measured by continued availability of clean water, wide variety of floral species, and continued respect of the Digo culture.

- **M&E system and knowledge dissemination – Score N/A**

There is no delineated M&E system nor communication strategy.

Lessons from other sacred forests suggest conducting community-led ecological assessments to ensure interventions remain culturally sensitive while addressing emerging threats.

At Kaya Tembo, the community organizes workshops or storytelling sessions to pass knowledge to younger generations. Promoting the significance of Kaya Tembo through education and awareness campaigns can foster greater appreciation within the Digo community and beyond. Integrating forest conservation into local school curricula and organizing public awareness events highlight the forest's cultural, spiritual, and ecological value while promoting a shared understanding of its importance (*Protecting the sacred Mijikenda Kaya Forests*, 2020). Raising awareness can also garner local and global support, and collaboration with entities like UNESCO can further elevate Kaya Tembo's profile and attract conservation funding.

GLOBAL CENTER ON ADAPTATION

CONDITIONS FOR UPTAKE

Kaya Tembo Sacred Forest is included in this NbS Compendium as an example of integrating traditional governance and ecological preservation within a culturally significant landscape. This case highlights how NbS principles can be effectively applied to protect biodiversity, preserve cultural heritage, and strengthen community resilience. Conditions for uptake have been identified based on the lessons learned from the case to ensure replicability and enhance the design of solution in similar contexts.

Key inspirational features for associated NbS families

- **Preservation of key ecosystem services for local community**: The forest's role as a sacred site for ceremonies, such as initiations, naming rites, and mentoring sessions, emphasizes the value of integrating cultural preservation into NbS projects. Replicating this feature can foster social cohesion and intergenerational continuity in other contexts.
- **Sustainable ecosystem management performed by local community**: Kaya Tembo demonstrates how sacred forests can address ecological challenges such as erosion, biodiversity loss, and water conservation. Its ecological contributions, including stabilizing soils and providing freshwater, can serve as models for linking ecosystem health to community resilience.

Key improvement area for NbS replicability across Kenya

- **Distinguish forests that have been absorbed by urbanization process to urban forests that are designed and created mostly as climate adaptation and mitigation measures**: Existing natural forests within urban areas need to be recognised as a specific ecosystem. The impact of urbanization on forestry ecosystem need to be documented to design adaptative management framework for these forests.
- **Strengthen policy and institutional support**: Urban forests must be integrated into formal land-use plans and designated as legally protected zones with consistent monitoring and enforcement to prevent encroachment. Strengthening legislation to safeguard indigenous knowledge and culturally significant areas is essential, as these play a key role in conservation. Collaborative governance between local authorities, the KFS, and local communities will ensure coordinated management and accountability. This need for preservation shouldn't impend the necessary adaptative strategy to design to ensure long-term existence of this natural and cultural inheritance especially in the context of weakening traditional social structures.
- **Identify potential funding sources through local-based carbon compensation mechanism**: Financial incentives such as tax rebates and payments for ecosystem services (PES) should be introduced to promote urban forest conservation. Mobilizing funding through public-private partnerships can unlock additional resources and technical expertise. Accessing global climate finance mechanisms, will provide long-term financial support for scaling and protecting urban forests. Tapping into this powerful financial mechanism should always take into account ecosystem services beneficiaries to value forest as a complex social and environmental place.

Case 7 – Bioretention area: St. John's Community School

Bioretention areas are designed to complement traditional grey stormwater and sewerage infrastructure. Typically formed as shallow, vegetated depressions, they intercept, infiltrate, divert, and treat stormwater flow (Técher and Berthier, 2023). The efficiency and treatment capacity of a bioretention area depend on soil type, landform depth, and vegetation selection. Well-designed, installed, and maintained bioretention areas can enhance stormwater management capacity. They are particularly valuable in older cities with combined sewerage systems or limited pervious surfaces. These systems reduce pluvial flood risks by slowing stormwater at its source (Tanyanyiwa, 2023). Bioretention areas also sequester carbon, averaging 12.5 kg carbon per m^2 (World Bank, 2021). They improve real estate values and generate employment opportunities (Oladunjoye et al., 2022). Bioretention areas improve water quality by capturing and treating initial runoff carrying high pollutant loads. Some remove up to 90% of heavy metals, organic pollutants, and nitrogen from stormwater (Hatt et al., 2007; Lucke and Nichols, 2015; Søberg et al., 2020). They also offer educational, recreational and social interaction opportunities (Mclachlan et al., 2023).

ST. JOHN'S COMMUNITY SCHOOL

This section highlights the St. John's Community School Project in Kibera, demonstrating how NbS can address urban flooding challenges in Kenyan settlements.

Key inspirational features: *Community-led initiatives using NbS like rain gardens to manage stormwater, participatory process, flood risks management*

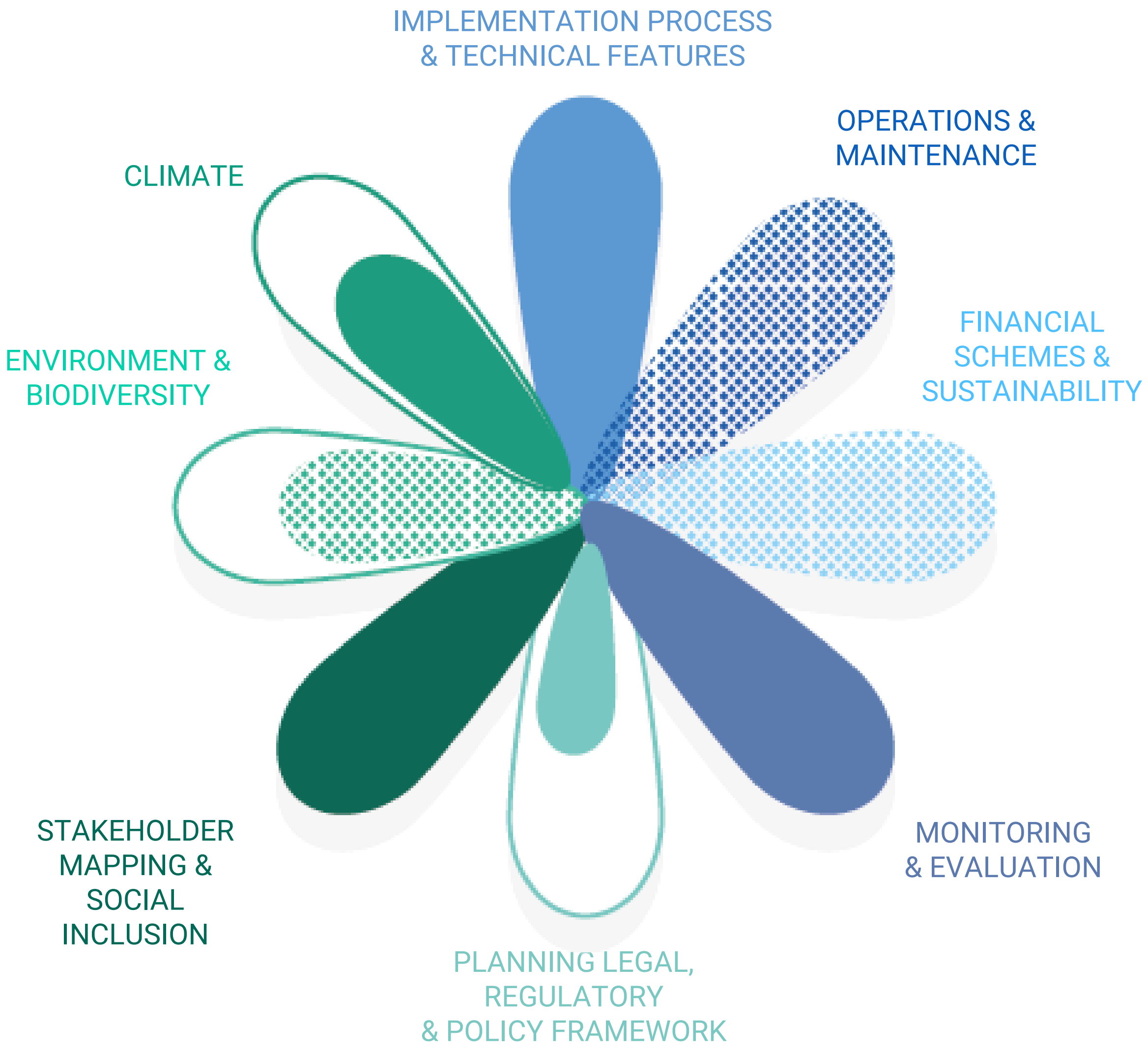


Figure 88 – Gap analysis result for Saint John's Community School (Source: SUEZ Consulting, 2024)

PROJECT PRESENTATION

Nairobi's informal settlements are highly vulnerable to flooding due to in adequate drainage and waste disposal systems. The “NbS to Water Management Challenges in Urban Informal Neighborhoods" program was launched to address this, partnering with local community-based organizations (CBOs). Kounkuey Design Initiative (KDI) led a targeted Request for Proposal process across 3 settlements to identify community partners and specific sites for interventions.

The process involved extensive community engagement and resulted in several proposals, which were evaluated and shortlisted. Selected CBOs then participated in design workshops. These partnerships were formalized through MoUs, outlining mutual commitments in finance, labor, and governance. At St. John’s Community School in Southeast Kibera, interventions such as filter drains, permeable paving and rain gardens were implemented to mitigate flooding and sewage overflow. This case focuses on the rain gardens component. These rain gardens which cover approx. 55 m^2, treat, store, and infiltrate stormwater runoff, also contribute to cooling and enhancing the urban environment. This case illustrates a community-driven approach to managing urban flooding through NbS.

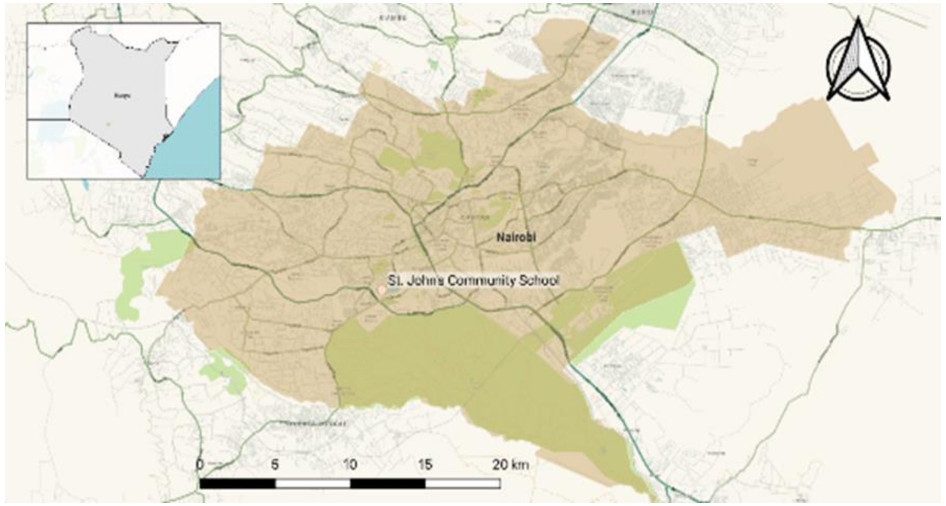


Figure 89 – Location of St John’s Community School project, Nairobi, Kenya.
(Source: SUEZ Consulting, 2024)

Figure 90 – Installation of green landscaping and rain gardens at St. John’s Community School.
(Source: KDI, https://www.kounkuey.org/projects/realising_urban_NbS)

Figure 91 –St John’s Community School
(Source: SUEZ Consulting, 2024)

Figure 92 –St John’s Community School
(Source: SUEZ Consulting, 2024)

CLIMATE

SCORE 2

• **Project response to climate risks - Score 3**

The rain garden and school drainage systems were designed to respond to flood issues, and feedback from local community confirms flood risk mitigation at the school level.

Nairobi County is vulnerable to various climate risks. A key climate risk is flooding as extreme rainfall events are occurring with greater frequency and intensity, leading to severe flooding, particularly in informal settlements (GCA, 2024). The city is also experiencing a rising temperatures, with annual mean temperatures rising by approximately 1.0°C since the 1960s (World Bank, 2021b). Prolonged droughts have become more common since 2000, affecting water availability and agriculture in the county. Warmer and drier conditions can lead to a rise in respiratory illnesses and urban air pollution (ibid). Furthermore, residents in some areas, such as informal settlements, are at risk of landslides due to extreme weather events intersecting with unplanned urbanization.

The School facility being in the low-lying area of Kibera is particularly vulnerable to frequent flooding, and some incidents were reported in the school with children tripping on the school pathways or classroom being flooded. According to the school manager interviewed during the field mission, new design greatly improved both infiltration of water in the raingarden as well as drainage of rainwater throughout the new system put in place.

• **Project adaptation to climate (present and future) - Score 1**

As a bioretention area, the project addresses stormwater management and to some extent outside temperatures but failed to bring a more systemic response to other climate hazards, namely heat.

Flooding as extreme rainfall events are occurring with greater frequency and intensity, leading to severe flooding, particularly in informal settlements (GCA, 2024). The city is also experiencing a rising temperatures, with annual mean temperatures rising by approximately 1.0°C since the 1960s (World Bank, 2021b). Prolonged droughts have become more common since 2000, affecting water availability and agriculture in the county. Warmer and drier conditions can lead to a rise in respiratory illnesses and urban air pollution (ibid). Furthermore, residents in some areas, such as informal settlements, are at risk of landslides.

As a bioretention area, the project addresses stormwater management. Other solutions to take into account ambient temperatures in classrooms and the thermal comfort of pupils could be developed in link with the bioretention project. This could also be improved with the development of green facades as a building-scale NbS to urban heat.

ENVIRONMENT AND BIODIVERSITY

SCORE 1.5

- **Project response to environmental risks – Score 2**

The project focuses mainly on flood hazard and as a co-benefit, on solving waste flowing in into the school as well as boosting the phytoremediation capacity of the rain garden.

Bioretention areas an excellent option for NbS retrofits as they are suited for areas with space constraints such as informal settlements. They address environmental risks while improving aesthetics and establishing a sense of place. Bioretention systems are effective in capturing and infiltrating stormwater, reducing surface runoff, facilitating groundwater recharge and mitigating flood risk. They filter pollutants such as heavy metals, nitrogen, and suspended solids from stormwater through their vegetated soil layer thereby reducing contamination of nearby water bodies and groundwater, which are often critical water sources in informal settings. Choice of plants was made according to their filtering capacity, to boost the capacity of the bioretention solution to remove water pollutants, but no monitoring was done to assess the water quality going out the raingarden.

Health issues were also partly dealt with in the project implementation process: before the project, children were drinking the rainwater believing it was clean, while flood resulted in human waste flow in the school. The community engagement activities and improvement of drainage system help in sensitizing household and children on water-related health issues as well as removing waste.

Other risks were not accounted for in the project. Residents in informal settlements, and especially in these low-lying slope areas where the school is, are at risk of landslides due to extreme weather events and unplanned urbanization. This risk is beyond the NbS project that was proposed which focused on bioretention solution.

- **Environment and urban biodiversity benefits – Score 1**

The project focuses on educational value of tree planting and doesn't include any explicit ecological value.

As a green infrastructure bioretention cells planted with native vegetation can enhance urban biodiversity as microhabitats for diverse species. Their pollutant removal capacities also benefits the health of nearby aquatic ecosystems.

However, in the context of Saint John's Community school, it's the educational value of these rain garden that was stressed with vegetable planting and growing activities performed with the classes.

STAKEHOLDER MAPPING & SOCIAL INCLUSION — SCORE 3

- **Stakeholder engagement & consultation strategy – Score 3**

This case illustrates a community-driven approach to managing urban flooding through NbS in informal areas.

This project was co-led by the Kounkuey Design Initiative (KDI) and St John's Community School and funded by Swedbio.

- Kounkuey Design Initiative (KDI) is an NGO working with government and community stakeholders to develop NbS projects in neighborhoods and cities.
- The St. John's Community School is a Kibera-based Christian CBO since 2005.
- SwedBio is a program for biodiversity and community development at the Stockholm Resilience Centre.

The elaboration process actively engaged the community at all stages:

- Selection: KDI led a targeted Request for Proposal under the "NBS to Water Management Challenges in Urban Informal Neighborhoods" program across three settlements, identifying community partners and intervention sites. Proposals were evaluated and shortlisted.
- Design: Selected CBOs participated in workshops formalized through MoUs, outlining commitments in finance, labor, and governance. At St. John's Community School, workshops focused on flood management, educating the community on necessary actions. The KDI technical team provided engineering designs.
- Implementation: Local school parents, both men and women, contributed as laborers based on self-organized work schedules and were paid KES 500 per day. They also coordinated meetings for material purchases.

As project execution goes on, the school counts with a maintenance committee that monitors the efficacy of the system and handles repairs once a month and counts with KDI for support with technical issues.

- **Socio-economic benefits and inclusion of vulnerable group – Score 3**

The project included vulnerable groups at all stages and provided long-term water security and flooding protection benefits for the community.

The informal settlement community, including women and youth, was actively involved at every stage of the project, generating long-term ownership from the beneficiaries who actively participated in the design and implementation of the rain garden.

The project directly benefits 350-400 children and their families by addressing challenges related to water security. The rain garden, designed as part of the intervention, serves multiple functions: it collects rainwater, purifies it through plants, and removes contaminants before allowing it to flow out, benefiting both the school and the surrounding community. The water is used for external spaces and cooking, notably.

Additionally, the project provided protection against flooding by installing pipes to collect excess water from the school and surrounding area, complemented by a drainage system to prevent future flooding.

Future improvements plan to expand the garden benefits to enhanced food security, by supporting vegetable planting, including tomatoes, which can be grown and transplanted.

The informal settlement community, including women and youth, was actively involved at every stage of the project, generating long-term ownership from the beneficiaries who actively participated in the design and implementation of the rain garden.

GLOBAL CENTER ON ADAPTATION

PLANNING LEGAL, REGULATORY & POLICY FRAMEWORK

SCORE 1

- **Planning and development strategy – Score 1**

The project seeks to address systemic planning gaps especially in the informal settlements by developing and demonstrating tools like the 'Rivers and People Plan,' which provides a local framework for ecosystem regeneration and inclusive planning.

This plan, co-created with community members and stakeholders, is intended to serve as a prototype to improve the integration of informal settlements into urban planning processes. Based on our research, there is no indication that the designers of the St. John's Community School project relied on existing urban planning documents.

The project presents significant opportunities for public authorities to adopt and institutionalize such strategies, potentially amplifying their impact and contributing to more inclusive and resilient urban development frameworks. It proactively advocates for the incorporation of NbS into urban planning through participatory and community-driven methodologies.

A structured collaboration with planning bodies - not mentioned in the project documentation - would help institutionalize and mainstream the tools developed by the project and the lessons learned.

- **Regulatory and land tenure strategy – Score 1**

The St. John's Community School project benefits from leveraging land owned or occupied by the school, providing stability for its implementation.

There is no formal zoning or land-use policy recognizing schools or similar community spaces as priority sites for NbS development or more globally a framework to guide NbS implementation in informal settlements. This lack of explicit zoning frameworks or designated areas for NbS in urban settings - notably in rapidly changing, densely populated, informal neighborhoods - represents a significant regulatory gap that limits the project's replicability in other contexts.

Moreover, the reliance on community governance can both hinder or foster the scalability potential of such solutions in areas where formal land ownership or governance structures may be absent.

IMPLEMENTATION PROCESS AND TECHNICAL FEATURES

SCORE 3

Implementation process – Score 3

The KDI design and implementation process for NbS in communities follows a structured, community-driven approach tailored to informal settlement contexts.

This process ensures that interventions are demand-driven, inclusive, and environmentally sustainable, addressing critical urban challenges such as flooding, water pollution, and inadequate public spaces.

The process begins with context-adjusted community outreach strategies, which form the foundation for ensuring active and equitable participation. These strategies involve public information-sharing forums (Barazas), a Request for Proposals (RfP) process, and a series of participatory community workshops. Outreach is designed to engage a broad spectrum of stakeholders while addressing the specific needs and dynamics of the local community.

The RfP process is a critical step in ensuring the demand-driven nature of the projects. During the initial Barazas, KDI announces the RfP, clearly outlining its scope, objectives, and submission requirements. Community-Based Organizations (CBOs) interested in participating must meet specific eligibility criteria, including demonstrated experience with water-related challenges such as polluted water, sewerage, rainwater, and floodwater; a strong track record as a registered and reputable organization; and ownership or control of public or community spaces suitable for implementing NbS.

The community learns about the Barazas and the RfP process via posters and flyers placed in busy, accessible areas of the settlement. This strategy promotes widespread awareness and accessibility. By choosing projects through an RfP process, KDI ensures the initiatives address community needs, establishing a strong foundation for future success.

Following the selection of a CBO, community engagement workshops are held to gather resident feedback and integrate their insights into practical solutions. Residents identify challenges and propose remedies, ensuring the designs reflect their lived experiences while fostering trust and ownership of the interventions.

The process advances to a site inventory and analysis phase, where insights from workshops are combined with technical assessments, including topographic surveys, infiltration tests, soil analyses, and water quality evaluations. These assessments contextualize the challenges and highlight opportunities for effective solutions.

Based on the findings, the design team develops a matrix of alternative solutions. Engineers and landscape architects evaluate each option for feasibility, addressing limitations and ensuring practicality and effectiveness. Selected interventions are framed within a conceptual framework, with detailed drawings refined iteratively through cost estimation to align with resources.

Once finalized, the project moves to detailed design development and construction planning, outlining technical specifications, schedules, and operational strategies. During implementation, adaptive NbS interventions are constructed, maintaining flexibility to address evolving environmental and social conditions.
Post-construction, a monitoring, evaluation, and learning (MEL) framework assesses the interventions' effectiveness, guides improvements, and documents lessons for future projects.

IMPLEMENTATION PROCESS AND TECHNICAL FEATURES

SCORE 3

Technical Features - Score 3

St. John's Community School's rain gardens proved to be an efficient system for stormwater management yet overflow management was missing.

Rain gardens are specialized bioretention zones that effectively handle stormwater while enhancing ecosystem services. Designed for small catchments of 100 to 4000 m², they can be linked to cover larger spaces (Armitage et al., 2013, 2014; Woods-Ballard, Kellagher & Woods Ballard, 2015; NCDEQ, 2017). They are created to fulfill the key goals of NbS, prioritizing the management of stormwater volume and quality, ecological restoration, community involvement, well-being, and, in the case of St John's Community School, food production (e.g., tomato production).

The technical design of rain gardens starts with a comprehensive checklist to steer the process, involving assessing if an infiltration or filtration design fits soil permeability and other constraints. Designers must also verify that bioretention areas are correctly sized, referring to established guidelines such as Woods Ballard et al. (2015). Furthermore, they ensure that all criteria and technical specifications are fulfilled to enhance functionality. The design caters to specific site requirements, ensuring harmony with environmental and infrastructural factors.

Rain gardens manage stormwater through infiltration, pollutant filtration, and controlled runoff management. In areas where infiltration is unsuitable—due to groundwater contamination, slope instability, or structural risks—the rain gardens are lined and fitted with under-drain networks to ensure functionality and safety. To manage high flow conditions, energy dissipaters (e.g., shallow weirs, check dams, rip-rap mattresses, stilling basins) prevent erosion and protect vegetation while distributing stormwater more evenly across infiltration areas.

Choosing the right plants is crucial in design. Native, drought-resistant species are selected for their resilience against stormwater runoff and extended dry spells. Herbaceous cover helps prevent soil erosion, whereas trees and shrubs boost interception, infiltration, and groundwater recharge.

Rain gardens enhance ecosystem services. They decrease flooding and aid groundwater recharge, and filter pollutants better to water quality downstream. Native plants create habitats, enhancing biodiversity. Shade and evapotranspiration from plants lower runoff temperatures and help regulate urban microclimates.

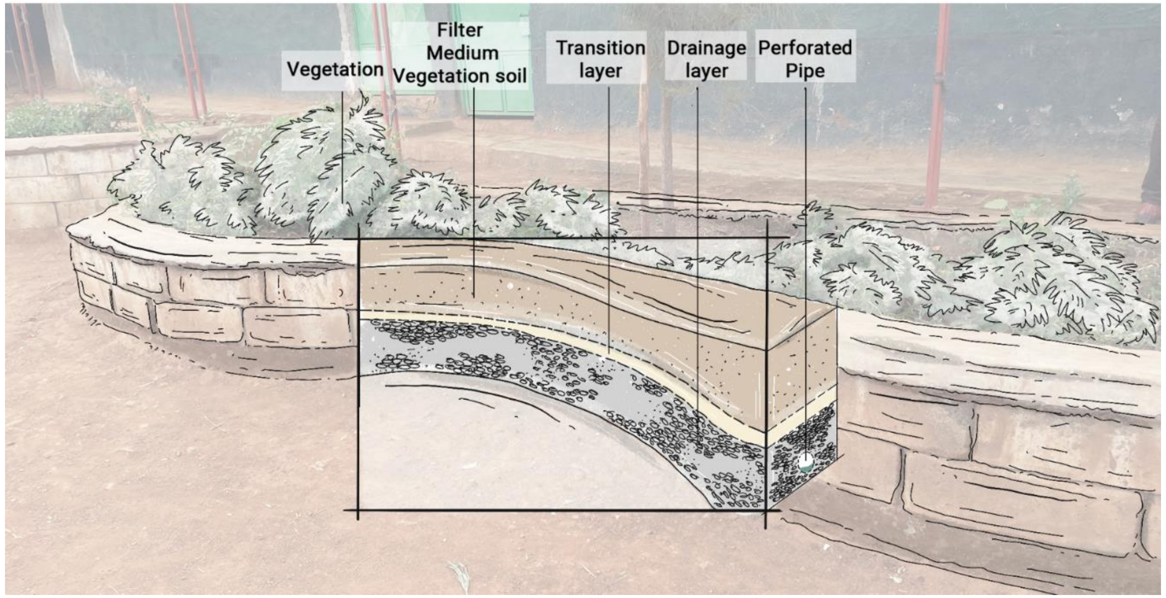


Figure 93 – Overlay of a rain garden at St. John's Community School, illustrating a cross-section of the garden and its various components
(Source: SUEZ Consulting)

IMPLEMENTATION PROCESS AND TECHNICAL FEATURES

SCORE 3

Possible improvements for future similar projects

Vegetating Permeable Pavements and Filter Strips

Future similar projects could be made more comprehensive and multi-functional via the inclusion of native vegetation to the existing permeable pavements and filter strips, which currently lack plant life. This initiative involves introducing native, drought-resistant grasses suited to Kenya’s climate, utilizing their ecological and functional benefits to improve the effectiveness of the rain garden. Vegetation plays a vital role in the structural stability of the pavements and strips, as the root systems help stabilize the surface, reduce erosion, and enhance infiltration efficiency. Furthermore, these grasses act as natural filters, capturing sediment and debris from runoff, thereby reducing sedimentation in the infiltration devices and extending their lifespan. This native vegetation should also be integrated within the rain gardens.

In addition to their functional advantages, greening the pavements offers significant ecosystem services. These include reducing the urban heat island effect by facilitating evapotranspiration, resulting in a more favorable microclimate around the school. Visually, as a place-making device, greenery can also foster a more appealing public space. Nevertheless, incorporating vegetation raises maintenance demands, such as regular trimming and replanting, particularly in the establishment phase. These issues can be addressed by choosing low-maintenance, native, drought-resistant species, ensuring the system's sustainability over time.

Such improvements may further enhance infiltration efficiency, support biodiversity and extend the system’s durability.

Figure 94 – Overlay of a photograph of St. John’s Community School illustrating the proposed vegetation for the filter strips and permeable pavements
(Source: Suez Consulting, 2024)
(Source: Piechowiak, 2021)

Related NbS Inventory case - Kibera Bioretention Area and Community Center, Kenya

Kibera has another example of a public facility that incorporates bioretention area features. The Kibera Bioretention Area and Recreational Space, built between 2017 and 2019 with Swedish Council funding, addresses chronic flooding impacting 40% of households, enhances public sanitation, and offers a safe, multi-purpose recreational area. Developed by KDI, Vijana Usafi na Maendeleo (VUMA), and local stakeholders through community-driven workshops, the project features a bioretention system that mitigates flood risk, improves soil stability, and serves as an emergency refuge.

Managed by VUMA, it generates jobs and revenue through user fees. Routine maintenance supports stormwater management, vegetation health, and sanitation. This NbS strengthens environmental resilience, promotes public health, and improves community well-being in one of Nairobi’s most vulnerable areas.

Figure 95 – Kibera (SUEZ Consulting, 2024)

Figure 96 – Kibera (SUEZ Consulting, 2024)

OPERATIONS & MAINTENANCE

SCORE 2.5

- **Roles and responsibilities – Score 3**

Clear roles and responsibilities are defined between the community represented by the school parents and the design engineering team, both at design, implementation and maintenance stage.

The public information-sharing forums (Barazas), a Request for Proposals (RfP) process, and a series of participatory community workshops were key at design stage to involve community.

The maintenance and management involved active community participation, with both men and women contributing as paid laborers. Safety was ensured during construction through designated individuals who oversaw compliance with safety measures, including COVID-19 protocols.

- **Operation & Maintenance Plan – Score 2**

A maintenance manual supported by a maintenance committee exist to identify key tasks to be performed by the community.

A maintenance manual was developed during workshops to guide long-term stewardship, supported by the formation of a maintenance committee. This committee, trained by intermediaries like KDI, gained skills to manage tasks such as unblocking channels and maintaining gardens. Additionally, the school gardening club looks after the planted areas and monitors the rain garden's impact on the schoolyard.

However, challenges such as financial constraints for materials and gaps in technical knowledge hindered effective maintenance, and reliance on KDI team for some maintenance tasks can also be a long-term constraint.

Suggested maintenance tasks that could be added to the maintenance manual include:

- Monthly litter and debris removal and inlets and outlets in within the cell
- Grass cutting and shrub management monthly
- Sediment management and rehabilitation/repair of structures as required
- Vegetation replacement/Mulching of void areas as required
- Reconditioning of Infiltration surfaces reconditioning by scrapping the surface and first 50 mm of soil every 5 years
- Replacement of the underdrain pipe if needed

FINANCIAL SCHEMES & SUSTAINABILITY — SCORE 2.5

- **Project costs, revenue generation and funding – Score 2**

The implementation cost of the rain gardens at St John's Community School is approximately US$ 85,000. Maintenance budget is guided by a costing manual provided by the implementing agency.

The umbrella project "r u NBS" is funded and overseen by SwedBio, a Sweden based organization that functions as a knowledge interface at Stockholm Resilience Centre. Implementation of projects in Nairobi is under the responsibility of KDI, an international non-profit community development and design organization. Unfortunately, there is no information about the financial scheme behind the project's maintenance. The project being community-led, there is a high probability that maintenance costs are supported by members of the CBO. There is no reports of revenue generation.

- **Integrated financial plan and project sustainability – Score 3**

This NbS was designed through a comprehensive grassroots implementation process involving multiple workshops that fostered financial and technical sustainability.

Technical design underwent iterative refining through cost estimation to align with available resources. Once finalized, a detailed design provided technical specifications, schedules, and operational strategies. These remained flexible during implementation, to ensure the NbS alignment with evolving environmental and social conditions.

A maintenance manual was developed during workshops to guide long-term stewardship, supported by the formation of a maintenance committee within the community. KDI's costing manual helped maintenance budgeting.

MONITORING & EVALUATION SYSTEM — SCORE 3

- **Key existing indicators – Score 3**

KDI developed a mixture of quantitative and qualitative indicators to assess the dynamics affecting the project areas.

These indicators are numerous and cover a wide range of categories: (i) water balance, (ii) environmental quality, (iii) urban transformation, (iv) economic opportunity, (v) cost and effectiveness, (vi) governance, participation, and justice, and (vii) public space, health, and well-being.

They are classified into four groups: Neighborhood Profile indicators (NPI), Project Profile Indicators (PPI), Deep Root Indicators (DRI), and Stories and project artifacts. In total, 81 indicators are evaluated through various data collection methods such as focus group discussions, measurements, online surveys, lab tests, etc.

- **M&E system and knowledge dissemination – Score 3**

A solid M&E system is in place and supported by active public participation.

Post-construction, a monitoring, evaluation, and learning (MEL) framework assesses the interventions' effectiveness, guides improvements, and documents lessons for future projects. It relies on the 81 indicators presented above and on the collection of stories and project artifacts to bridge the knowledge gap on NbS in informal settlements. MEL relies on the efforts of many stakeholders, like residents, CBOs, local authorities and international experts. Communication with beneficiaries is pervasive throughout the project's lifecycle. Outreach strategies, information-sharing forums and participatory workshops are central to the design of the project, which is eventually managed by CBOs. This fosters trust and ownership.

Bioretention Areas

GLOBAL CENTER ON ADAPTATION

CONDITIONS FOR UPTAKE

This case is included in the NbS Compendium as an example of how NbS can address stormwater management challenges in informal urban areas while providing ecological and social benefits. The rain garden design at St. John's Community School also demonstrates how NbS can integrate technical innovation and community collaboration to create sustainable solutions in underserved and resource-limited contexts. Conditions for uptake have been identified based on the lessons learned from the case to ensure replicability and enhance the design of solutions in similar contexts.

Key inspirational features for associated NbS families

- **Public facility and vulnerable population conditions improvement by NbS**: public facility and especially schools are often underserved in terms of external space design and improvement. Indeed, the community's school location, informal context as well as the lack of infrastructure had a strong impact on children health and security. Raingarden and improved drainage system at the school level demonstrated a real improvement in the conditions for accommodating pupils.
- **Community-led design**: active participation of local stakeholders ensures that solutions align with community priorities and foster a sense of ownership. This approach is especially impactful in informal areas, where community involvement is vital for long-term sustainability.
- **Multi-functionality**: beyond stormwater management, the rain garden provides biodiversity benefits, aesthetic improvements, and opportunities for environmental education, empowering communities with knowledge about sustainable practices.
- **Provide economic opportunities for local population through maintenance activities**: training of the community in basic maintenance tasks can pave the way to new skills development for local residents.

Key improvement area for NbS replicability across Kenya

- **Support for niche experiments**: pilot projects, such as the rain garden at St. John's Community School, demonstrate innovative NbS approaches in informal settlements. These projects refine designs, address challenges, and identify scalable solutions. Targeted funding and partnerships with NGOs and academic institutions can accelerate learning and encourage broader adoption.
- **Replicate pilot project**: lessons from pilot projects should guide scalable models adaptable to diverse conditions across Kenya. Knowledge sharing between counties and integration into settlement upgrading programs can ensure widespread adoption and sustainability of these solutions.
- **Integrate policy and urban planning**: integrating bioretention areas into informal settlements requires urban planning policies that prioritize NbS for stormwater management. County and municipal plans should mandate bioretention areas in infrastructure upgrades and promote the use of underutilized public spaces for ecological and community benefits.
- **Design tailored technical features**: bioretention areas must be adapted to local conditions, such as limited space and varying soil types. Modular, low-cost designs enable phased implementation, while indigenous, drought-resistant vegetation minimizes maintenance and supports biodiversity. Solutions like under-drain systems and flow dissipaters address specific challenges, ensuring functionality and sustainability. More specifically, vegetating using native species enhances functionality while boosting biodiversity and extending infrastructure lifespan, particularly relevant in informal settings where resources for replacement are scarce.

Case 8 – Programmatic Approach: Upper Tana Nairobi Water Fund

River and stream renaturation involves restoring natural watercourses in urbanized areas denaturalized through embankments, culverting, and infilling for development purposes. These modifications have led to uniform flows, reduced fauna habitats, decreased vegetation diversity, and increased flood risks due to diminished natural absorption and flow regulation (Brun, 2015). Renaturation techniques include stream daylighting, reestablishment of riparian corridors, removal of concrete barriers, and revegetation of riverbeds and banks (Athavale, 2012). This approach enhances pluvial and riverine flood risk reduction by increasing the capacity of water bodies to hold excessive stormwater, lowering flood heights and velocities, and reducing structural damage to properties and infrastructure (NWRM, 2015). Renaturated rivers offer recreational spaces, improving human health by promoting physical activity and mental well-being (Cai et al., 2022; Gunawardena et al., 2017; Hathway and Sharples, 2012). Biodiversity is enhanced by providing habitats for wildlife and facilitating species movement. Additionally, water quality improves as riparian zones capture sediments and pollutants, reducing erosion and lowering water treatment costs (World Bank, 2021).

UPPER TANA NAIROBI WATER FUND

The following section explores the Upper Tana-Nairobi Water Fund, showcasing how NbS programmatic approach can address water security challenges and promote sustainable watershed management in Kenya.

Key inspirational features: *upstream and downstream collaboration, programmatic approach.*

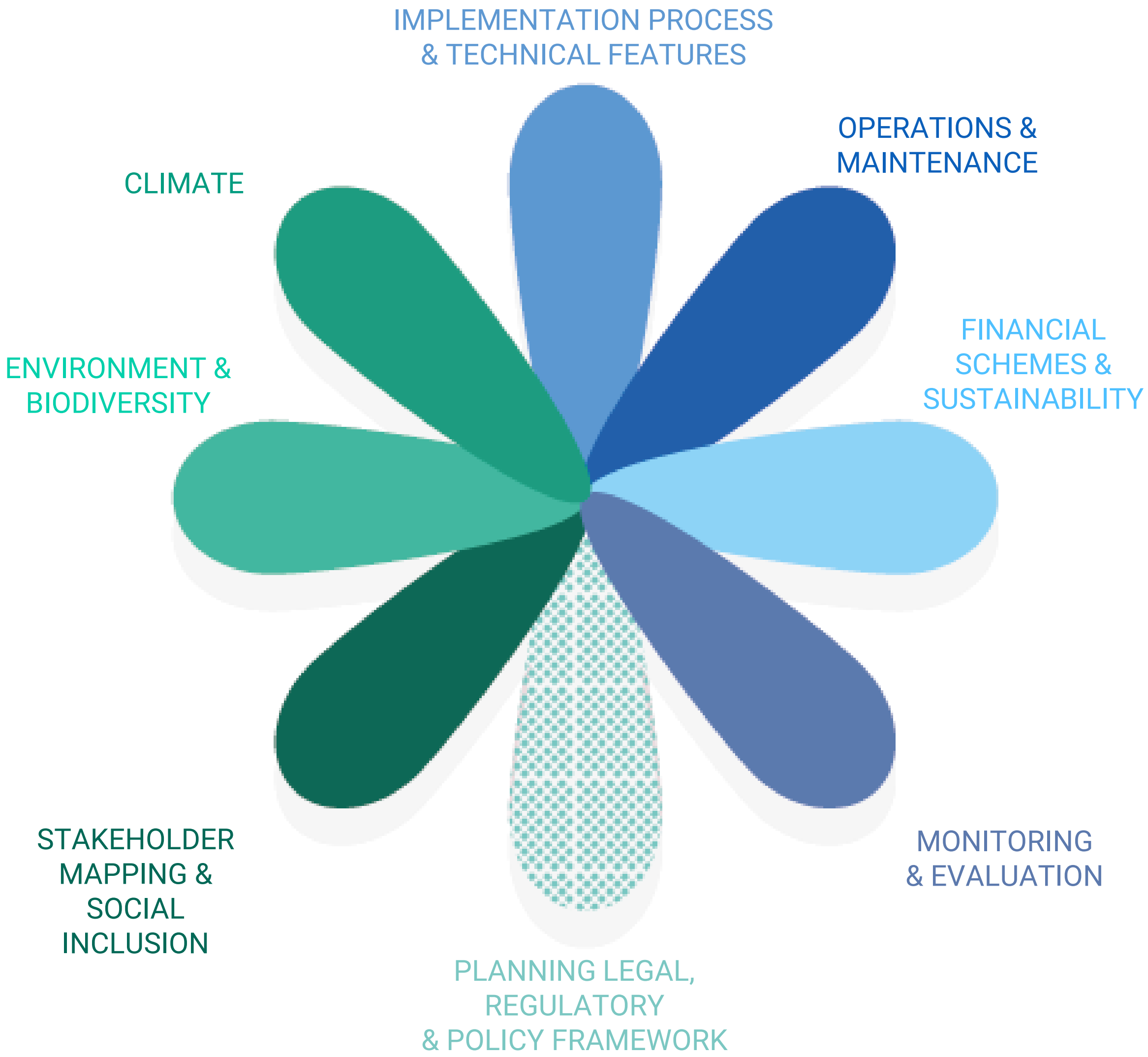


Figure 97 – Gap analysis result for Upper Tana-Nairobi Water Fund (Source: SUEZ Consulting, 2024)

PROJECT PRESENTATION

The Tana River is critical to Kenya's water and energy systems, supplying 95% of Nairobi's water needs, supporting the livelihoods of 5 million people in its watershed, and providing half of Kenya's hydropower output. However, since the 1970s, upstream agricultural expansion has caused increased soil erosion and sedimentation, disrupting water supply, degrading water quality, and reducing electricity generation. To address these challenges, the Upper Tana-Nairobi Water Fund (UTNWF) was established in 2013 as a collaborative effort to strengthen water security through Nature-based Solutions.

The UTNWF connects cities with river basins by engaging stakeholders, including downstream users such as Nairobi residents, businesses, and utilities, alongside upstream agricultural landholders and NGOs. Stakeholders invest in the trust to fund proactive interventions, which are more cost-effective than addressing the impacts of poor water quality or scarcity. Implemented NbS include rainwater harvesting, terracing slopes, restoring riparian buffers and forests, and promoting sustainable land management and agroforestry practices. These actions have improved downstream water quality, enhanced ecosystem health, and supported livelihoods. Future plans involve addressing erosion and expanding riparian buffer zones, further safeguarding water quality and ensuring resilience for this vital resource.

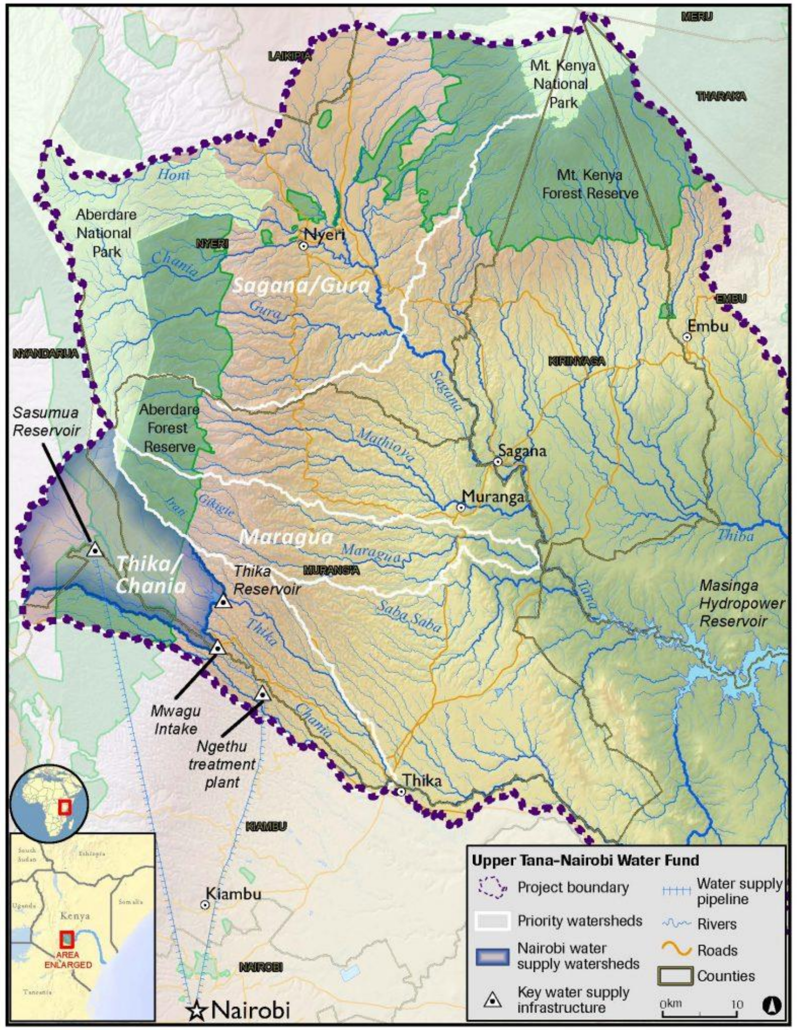


Figure 98 – Areas served by the Upper Tana-Nairobi Water Fund (Source: The Nature Conservancy)

Figure 99 –Chania Falls in Thika near Nairobi in the Upper Tana River Watershed
(Source: © Nick Hall)

Figure 100 – Upper Tana
(Source: UCLA, Institute of the Environment & Sustainability, https://www.ioes.ucla.edu/project/helping-stakeholders-in-kenyas-tana-river-region-manage-water-resources/)

GLOBAL CENTER ON ADAPTATION

CLIMATE — SCORE 3

- **Project response to climate risks – Score 3**

The UNTWF promotes climate-smart agriculture and sustainable water management practices, enhancing resilience at the farm and catchment scales, while integrating climate resilience into policy-making through evidence-based outcomes.

According to the National Adaptation Plan (2015), Kenya faces rising temperatures (up to 3°C by 2100) and shifting precipitation patterns with unpredictable rainfalls, , affecting water availability especially during dry seasons. The Upper Tana basin crosses the counties of Kirinyaga, Murang'a, Nyyeri, Nyandarua, Laikipia, Kiambu, Embu and Machako. It provides 95% of Nairobi water supply, supporting 5 millions citizens, and is key for several economic activities - directly for agriculture and hydropower generation and indirectly downstream.

Climate resilience is part of the UTNWF's vision to provide "a well-conserved Upper Tana River Basin, enhancing ecosystem services and improving human well-being upstream local communities". The project includes two climate-related outcomes:

- Increased ability of people to manage environmental and climate-related risks. The project aims to support climate-smart agriculture practices, including sustainable land and water management practices, upstream to better filter and protect water resources downstream. The project contributes to a better climate resilience at the farm scale and at the catchment scale.
- Better and evidence-based integration of climate resilience into policy making (especially CIDP) supported by the results of the M&A framework.

- **Project adaptation to local climate conditions (present and future) – Score 3**

The project is implemented based on farm-specific needs.

The NbS implemented through the project are defined and conceived with the farmers based on their farm-specific needs (present and future) towards on-farm sustainable soil and water management practices.

ENVIRONMENT AND BIODIVERSITY — SCORE 3

- **Project response to environmental risks – Score 3**

The project collectively improves water availability, enhances ecosystem resilience, and reduces sedimentation, benefiting water supply and land productivity.

Key initiatives of the UTNWF include the installation of over 15,000 rainwater harvesting pans, capturing up to 50,000 l of water each season to reduce water extraction during dry spells and support crop irrigation. Additionally, 596 km of terraces and 988 km of grass strips on steep slopes have been built, significantly reducing soil erosion, stabilizing nutrients, and improving land productivity. Riparian protection measures (e.g., sediment-trapping buffers, planting native vegetation) have helped preserve riverbanks and improve water filtration and reduce sediment runoff that could disrupt downstream water treatment and increase costs by 33%. Over 3.6 million trees, including 1.3 million fruit trees, have been planted, offering shade and boosting soil health. These efforts have brought 100,000 ha under sustainable land management, strengthened ecosystem resilience, and increased Nairobi's water supply by 27,000,000 l daily (Koehorst, 2023). 80 km of riparian vegetation has been restored and sedimentation in the river has decreased by over 15% (IWA, 2018).

- **Environment and urban biodiversity benefits – Score 3**

The UTNWF supports catchment/basin-scale ecosystem services and biodiversity enhancement by promoting sustainable land management and agroforestry.

The UTNWF supports catchment/basin-scale ecosystem services and biodiversity enhancement. By integrating sustainable land management strategies and advancing agroforestry, the UTNWF provides a cost-effective solution through multi-stakeholder collaboration to tackle environmental issues at their source, preserving water and soil biodiversity (Vogl et al., 2017; IWA, 2018). The UTNWF leverages the synergies at the water-food-energy nexus as enhancing the Tana River's water security by extension supports electricity generation through the hydropower plants downstream.

STAKEHOLDER MAPPING & SOCIAL INCLUSION

SCORE 3

- **Stakeholder engagement & consultation strategy – Score 3**

The success of the Upper Tana Nairobi Water Fund hinges on placing behavioral change at its core, supported by a multi-stakeholder governance framework.

The project was launched by The Nature Conservancy in 2015 and relies on collaboration between upstream and downstream communities. Downstream communities incentivize sustainable practices upstream, creating a mutually beneficial relationship that enhances water quality and availability downstream. The project was recognized as a priority by the Government of Kenya in 2016.

In 2021, the governance structure evolved into an independent trust with a multi-stakeholder model involving both the private and public sectors. The Board of Trustees ensures shared leadership and co-investment, and The Board of Management oversees daily operations. Private stakeholders co-invest and are vital partners for the Trust's financial and operational sustainability. They include major water users (i.e., Nairobi City Water & Sewerage Company (NCWSC), KenGen, the National Irrigation Board, Del Monte, flower farms) and corporate stakeholders (i.e., Coca-Cola, East African Breweries, Unilever).

The project counts with the collaboration of concerned county governments along with key regulatory and technical bodies (i.e., Kenya Forest Service, Water Resources Authority and Ministry of Agriculture) providing oversight and expertise to support farmers. A key goal is to maintain active participation from all stakeholders to ensure the project's continuity.

Most importantly, smallholder farmers are at the heart of the project, which focuses on their leadership and ownership. With support from the Trust, they create farm-specific plans, receive training in sustainable practices, and gain the tools and resources to implement new technologies. Their role as agents of change is crucial, as the project's success depends on the adoption of new practices and shifts in their perspectives. Additionally, local beneficiaries and NGOs (e.g., Water Resource Users Associations (WRUAs), Kenya National Farmers Federation (KENAFF)), contribute to monitoring environmental trends through biophysical data.

- **Socio-economic benefits and inclusion of vulnerable group – Score 3**

The UTNWF delivers socio-economic benefits for both upstream and downstream users, while intentionally engaging vulnerable groups through targeted incentives and gender-sensitive frameworks.

The UNTWF offers significant socio-economic benefits for smallholder farmers and local communities. By promoting climate-smart, sustainable land management practices, the project enhances food security, climate resilience, and ecosystem restoration, improving water quality and availability for both upstream and downstream users. In 2022, key benefits included cleaner water for 500,000 people, a US$ 3 million increase in farmer revenue from higher crop yields, and an additional 40 million m³ of water in Masinga Reservoir, reducing power interruptions and generating US$ 600,000 more from hydroelectric energy. Furthermore, the project aims to reduce annual water management costs for the NCWSC.

Other intangible advantages include new employment opportunities, increased educational access due to higher farmer revenues, and the value of improved ecosystem services. The project also leads to carbon sequestration, estimated at 1.6 million tones of CO_2, with potential for carbon payments, adding further economic value. Additionally, the initiative provides local farmers with new skills, training, and resources, improving land productivity and offering long-term socio-economic benefits for the region.

Additionally, the UTNWF actively prioritize the engagement of women and youth. In 2022, over 39% of women and 17% of youth in the watershed were involved in sustainability programs, leading to improved livelihoods and increased incomes. To diminish vulnerability to poverty and food insecurity, the project focuses on reaching them through targeted incentives, such as improved stoves, biogas, and alternative livelihood opportunities, while also enhancing their decision-making roles in local institutions (e.g., WRUAs and catchment committees). To ensure gender-sensitive climate resilience, the project expanded its monitoring tools, including the Women's Empowerment in Agriculture Index (WEAI).

PLANNING LEGAL, REGULATORY & POLICY FRAMEWORK

SCORE 2.5

- **Planning and development strategy – Score 2**

A governance framework was put in place to steer implementation, with a support at the national and global level. This support was essential to create the locally-run NGO that manages the Fund.

In 2015, the Water Fund Board and Charter were officially registered, creating a governance framework to steer implementation. In 2016, the Government of Kenya recognized the Water Fund as a vital initiative, successfully obtaining funding from the Global Environment Facility (GEF) to bolster its efforts activities. In 2017, the Water Fund Trust became a Charitable Trust, initiating its scale-up phase. This phase involved collaboration with county governments, local NGOs, and community organizations to encourage sustainable land management practices among farmers.

The UTNWF benefits from a well-structured project planning framework, combining scientific insights with collaborative governance and diverse financial streams. The fund's establishment was driven by evidence-based business cases but was not initiated as part of a regulatory or policy-driven framework. While Kenya prioritized the model in 2016 and one of the key project outcome targets to support evidence-based integration of climate resilience into policy, its connection to broader urban planning, water management and biodiversity frameworks remains unclear, limiting its integration into policies and local development plans. Deeper integration into national or county-level plans would help ensure financial support (e.g., water tariffs), long-term sustainability and replicability.

- **Regulatory and land tenure strategy – Score 3**

The project relies on voluntary farmer participation for implementing NbS upstream. Formalizing it in Kenya's water management framework would strengthen legal backing, reduce reliance on goodwill, and ensure sustainability and replication.

The project supports and finances the implementation of NbS on farms located upstream in the basin. The project relies on voluntary participation by farmers, who underpin conservation efforts and provision of land. Farmers are often long-established in the area, but potential land-use changes or ownership transitions could undermine the project's sustainability.

Governance supports collaboration but lacks regulatory mandates to integrate NbS into watershed management. Formalizing NbS within Kenya's water management framework would provide legal backing, reduce dependency on goodwill, and bolster institutional support for long-term conservation and replicability across water catchment.

IMPLEMENTATION PROCESS AND TECHNICAL FEATURES

SCORE 3

Implementation process – Score 3

Upper Tana-Nairobi Water Fund showcases the progressive implementation of a governance and management framework to address sedimentation, declining water quality, and water shortages.

The Upper Tana-Nairobi Water Fund was established to safeguard the Tana River watershed, which serves as a crucial water source. The initiative focuses on implementing sustainable land management practices designed to combat sedimentation, soil erosion, and deteriorating water quality. Acknowledging the economic and environmental significance of the Tana River, a 15-member steering committee was formed in 2013 to oversee the initiative's development. By 2015, the Water Fund Board and Charter were officially registered, creating a governance framework to steer implementation.

The implementation was guided by frameworks like the Catchment Management Strategy for the Tana Catchment and incorporated global best practices from The Nature Conservancy's water funds. By 2020, the fund moved towards self-sufficiency, ultimately establishing itself as a locally-run NGO in 2021.

Existing local documentation for Upper Tana-Nairobi Water Fund

- Upper Tana-Nairobi Water Fund (UTNWF) - Detailed design report (IFAD, 2017)
- Upper Tana-Nairobi Water Fund: A Business Case (The Nature Conservancy, 2015)
- Tana Integrated Water Resource Management and Development Plan (Aurecon AMEI Limited, 2020)
- Agroforestry extension manual for Kenya (Tengnäs, 1994)
- The Forest Conservation and Management Act (Government of Kenya, 2017)

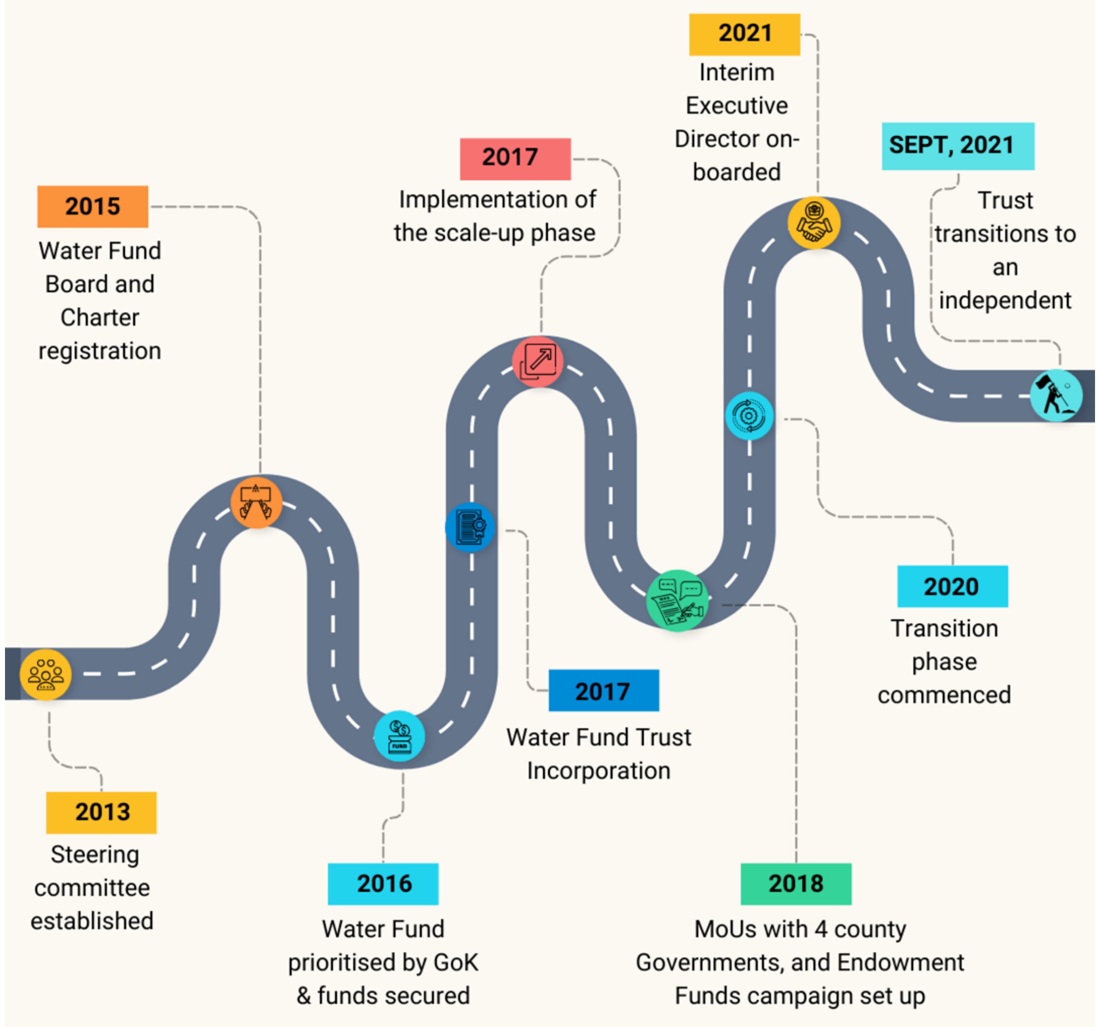


Figure 101 – Timeline for the implementation of the UTNWF
(Source: SUEZ Consulting 2024, based on project documentation)

IMPLEMENTATION PROCESS AND TECHNICAL FEATURES

SCORE 3

Technical Features – Score 3

The UTNWF features a technical framework designed for a farm-scale approach, mobilizing a variety of NbS to address both climate-related challenges and the specific needs of the farmers.

The UNTWF promotes and supports the following interventions, including several NbS:

- Forest protection (indigenous species)
- Replanting forests and restoring natural vegetation in agriculture areas (through agriculture climate-smart and management practices)
- Smart agricultures practices: agroforestry, terraces and slopes, riparian areas restoration, rainwater harvesting
- Restoration of wetlands

Key initiatives include the installation of over 15 000 rainwater harvesting pans, 596 kilometers of terraces and 988 kilometers of grass strips. Other measures concern riparian land protection. Additionally, more than 3.6 million trees, including 1.3 million fruit trees, have been planted.

UNTWF provides technical support (officers of the Ministry of Agriculture and youth trained as 'technology providers') to farmers to define farm-specific plans to improve their practices with regards to their needs, climate change impacts, sustainability, etc, as well as financial incentives to invest in new technology if needed. UNTWF manages also a SMS-platform to share information and data with all the farmers involved.

The technical design for these initiatives follows established guidelines found in the supporting documentation, including standards created by The Nature Conservancy's global water funds available online. These frameworks guarantee consistency and sufficiency in achieving the NbS objectives.

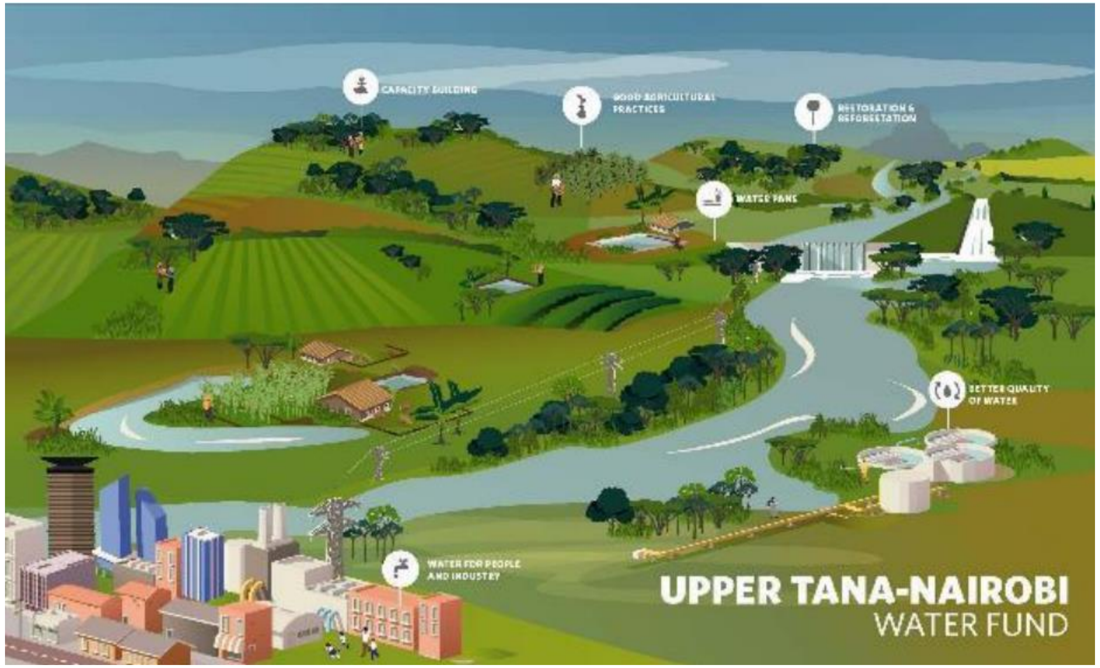


Figure 102 – Upper Tana-Nairobi Water Fund: how does it work?
(Source: UNTWF Strategic Plan, 2021)

The Greater Cape Town Water Fund (GCTWF), South Africa

GCTWF showcases a water fund dedicated to manage one key environmental issue, which is invasive species management to also address multiple benefits, including job creation, as opposed to manage multiple environmental challenges as in the case of Upper Tana. This might also be a way to put in place a phased implementation framework and focus energy and effort into one key action that can also achieve multiple benefits, before moving to other environmental issues.

The GCTWF, established in 2018 by The Nature Conservancy, addresses Cape Town's water scarcity crisis, intensified by invasive alien plants consuming vast water resources in critical catchments. The initiative aims to enhance water security, restore biodiversity, and mitigate wildfire risks by removing water-intensive species like pines, Australian acacias, and eucalyptus from priority catchments feeding the Western Cape Water Supply System.

The GCTWF prioritizes ecological restoration to ensure sustainable water yields. Studies show that invasive species in Cape Town's water catchments diminish water availability by billions of liters each year. By focusing on clearing these invasive species, GCTWF has notably enhanced the flow of water into reservoirs, strengthening the city's water supply resilience, especially during extended drought periods droughts.

A key component of the project is community engagement and job creation. The fund prioritizes hiring workers from local, underserved communities to carry out the labor-intensive clearing process. This provides employment and training, fostering environmental stewardship while supporting livelihoods.

The advantages of the project go far beyond just water security. Enhancing native vegetation boosts ecosystem health, strengthens soil stability, and minimizes wildfire risks. Through collaboration with partners such as SANBI and utilizing public-private partnerships, the GCTWF illustrates the potential of NbS in addressing urgent environmental issues. *Text source: Koehorst (2020).*

Figure 103 – Greater Cape Town Water Fund
(Source: The Nature Conservancy, 2019)

GLOBAL CENTER ON ADAPTATION

OPERATIONS & MAINTENANCE

SCORE 3

- **Roles and responsibilities – Score 3**

The UTNWF's management relies on a basin-wide collaborative framework including a steering committee for guidance, a trustee and management board for daily operations and local partners for on-the-ground activities.

As a basin-wide collaborative initiative bringing together various multi-scale NbS, the UTNWF's management is supported by a collaborative framework involving diverse stakeholders at different scales.

The Nature Conservancy played a key role in initiating the Fund and gathering strategic partners. A steering committee provides guidance on goals, while local implementation partners manage conservation activities in the catchment. Governance is maintained through the UTNWF partners, who ensure alignment with the Fund’s objectives. Additionally, trustee and management boards oversee day-to-day operations, providing steady and consistent oversight. This integrated approach balances high-level strategic direction with effective local implementation, ensuring the Fund’s long-term sustainability and success in achieving its conservation goals.

- **Operation & Maintenance Plan – Score 3**

Because it oversees a number of multi-scale initiatives, the UNTFW does not relies on a single set maintenance plan, which is tailored to each local project.

As a basin-wide collaborative initiative bringing together various multi-scale NbS, the UTNWF does not consist of a single set maintenance plan. Rather the maintenance of each initiative within the UTNWF depend on the objective of the proposed solution’s project as well its social, technical and economic aspects (e.g., terracing of slopes, rainwater harvesting).

FINANCIAL SCHEMES & SUSTAINABILITY

SCORE 3

- **Project costs, revenue generation and funding – Score 3**

UTNWF's budget covers institutional, ecosystem, and knowledge management costs. It relies on downstream user contributions to provide incentives to upstream farmers.

The project cost breakdown in the detailed design phase (2017) was as follow:

- US$ 7.6 million to support the institutionalization of the Water Fund,
- US$ 18.7 million to improve the Upper Tana catchment ecosystems,
- US$ 4.7 million to ensure robust knowledge management, learning systems,
- US$ 2.6 million for direct project management.

Since then, a dedicated endowment fund campaign was launched in 2018 to ensure ongoing financial sustainability. The diagram below displays how funding and revenue streams integrate the UTNWF governance mechanisms, from contributions of downstream users towards financial incentives and technical support to upstream landholders. For instance, as major downstream users, corporate partners like Coca-Cola and Unilever contribute to project funding, reflecting their interest in upstream water security and sustainable supply chains. The UNTWF aims to provide incentives to small farmers (e.g., tree seedlings, materials and support for terracing, payment for ecosystem services) who will also benefit from increasing agricultural yields thanks to terracing.

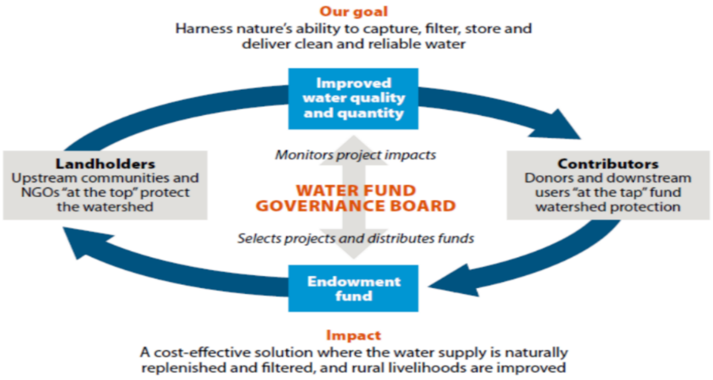


Figure 104 – The Water Fund concept and financial streams
(Source: IFAD, 2017)

- **Integrated financial plan and project sustainability – Score 3**

The UTNWF's evolution towards self-sufficiency is supported by integrated financial and technical planning, while exploring carbon markets for long-term revenue diversification and sustainability.

The fund has experienced many evolutions since its inception and continuously seeks to optimize its revenue streams. By 2020, it moved towards self-sufficiency, ultimately establishing itself as a locally-run NGO in 2021. This is a good opportunity to highlight that integrated financial planning is not only relevant during the design phase but must also undergo frequent updates to maintain alignment with challenges and successes.

Technical planning is also key to ensure financial sustainability, which is proven by UTNWF actions. They started by studying a business case with state-of-the-art planning and watershed modeling tools to estimate expected returns of investments. Then, in planning for the UTNWF, the economic impact of different land conservation interventions were modeled for three key basin stakeholders: small-holder farmers, Nairobi City Water & Sewerage Company (NCWSC), and Kenya Electricity Generating Company (KenGen). Land conservation measures further upstream in collaboration with small-holder farmers were deemed to hold mutual benefits. For implementation, technical design follows established guidelines found in the supporting documentation, including frameworks like the Catchment Management Strategy for Tana Catchment and standards created by The Nature Conservancy's global water funds. These frameworks guarantee consistency and sufficiency in achieving the NbS objectives.

The combination of these practices played a key role in ensuring the UTNWF sustainability. Today, as part of its development strategies, it seeks to secure complementary sustainable revenue streams by exploring carbon markets.

MONITORING & EVALUATION SYSTEM

SCORE 3

- **Key existing indicators – Score 3**

The UTNWF employs a structured set of indicators to measure progress and guide adaptive management across all project objectives.

The UTNWF tracks indicators that measure key project outcomes, such as land degradation, food security, climate resilience, and sustainable agriculture practices. These indicators align with national priorities and international frameworks, ensuring consistency and relevance.

Examples of key indicators include the number of farmers adopting sustainable practices and achieving certifications such as Rainforest Alliance Certification, which has already benefited 8,500 coffee farmers with yield increases of over 40%. Other indicators track ecosystem restoration efforts, such as 80 km of riverine vegetation restored, over one million trees planted, and engagement of 65 schools in conservation activities. Additionally, water quality and quantity are monitored, with notable outcomes such as reduced sedimentation by 15% and improved turbidity levels meeting WHO standards.

Participatory methods are used to select additional quantitative and qualitative indicators, with contributions from stakeholders, partner organizations, and implementation teams. The methodologies for data collection and analysis are collaboratively defined to provide robust and actionable insights. Indicators are tracked through a mix of periodic surveys, geospatial data analysis, and participatory monitoring, ensuring comprehensive assessment. These efforts guide adaptive management, allowing the project to respond to evolving challenges and maximize its impact over time.

- **M&E system and knowledge dissemination – Score 3**

A well-integrated M&E framework supports decision-making, knowledge sharing, and collaboration to achieve the project's goals and amplify its impact.

The M&E system is designed to operate seamlessly at national and county levels, engaging a broad range of stakeholders, including partner organizations and regional teams. It is integrated with national systems and builds on experiences from previous projects to ensure alignment with established guidelines. This approach enhances coherence and allows the system to inform decision-making at multiple levels.

A key function of the M&E system is knowledge dissemination. Regular reporting outputs, such as quarterly operational reports, annual project reviews, and performance assessments, provide critical insights into project progress and outcomes. For instance, the documented availability of millions of additional liters of water for Nairobi each day, achieved through on-farm soil retention and reduced river water extraction, exemplifies how monitoring data translates into measurable benefits.

These reports are complemented by publications, including journal articles and multimedia outputs, designed to share findings with a wider audience and influence policy and practice. The system also supports capacity building by encouraging the participatory development of indicators and methodologies. This strengthens local and regional teams' ability to manage and expand monitoring efforts. Linkages between national and county teams ensure a consistent flow of information, promoting collaboration and enabling timely responses to emerging issues. By integrating monitoring activities with communication and knowledge-sharing efforts, the M&E system amplifies the project's reach and fosters broader adoption of successful practices.

More details on the indicators and M&E framework can be found in: Upper Tana-Nairobi Water Fund (UTNWF) - Detailed design report - (IFAD, 2017)

Programmatic approach / River and stream renaturation

GLOBAL CENTER ON ADAPTATION

CONDITIONS FOR UPTAKE

The UTNWF is an inspiring example of how NbS can effectively address water security, ecosystem degradation, and community resilience at a catchment scale through a pioneering funding model. The fund effectively finances a varied mix of NbS projects, especially focused on restoring rivers and streams, through public-private partnerships. This forward-thinking strategy positions the UTNWF as a prime model for utilizing NbS in sustainable watershed management. Conditions for uptake have been identified based on the lessons learned from the case to ensure replicability and enhance the design of solutions in similar contexts.

Key inspirational features for associated NbS families

- **Portfolio funding across multiple NbS types:** UNTWF provides technical and financial support to implement multiple NbS families based on the local specific needs and climate resilient sustainability strategy, highlighting how combining different NbS methods into a unified strategy can produce synergistic benefits. For instance, the fund supports terracing and soil conservation, restoring riparian zones, harvesting rainwater, and implementing agroforestry to tackle various environmental and socio-economic issues in the watershed.
- **Public-Private Partnerships in NbS financing**: the UTNWF demonstrates how downstream water users, private companies, and donors can work together to invest in upstream conservation, creating shared benefits and promoting financial sustainability.
- **Replication and inspiration for other areas**: Its achievements have already motivated the establishment of a similar fund in Cape Town, South Africa, and it acts as a blueprint for other catchments throughout Kenya and Africa.

Key improvement area for NbS replicability across Kenya

- **The continued update of financial plans along the lifetime of NbS projects ensures their alignment with evolving challenges and successes**. Integrated financial planning is a living component that must adapt to existing opportunities, and potentially transform the project's nature if necessary, as observed with UTNWF's shift to self-sufficiency.
- **Large-scale restoration initiatives must rely on technical guidelines to ensure good practices and desired outcomes** are met across the implementation area. Pilot sites in the inception phase of the project can deliver valuable insights regarding implementation and maintenance requirements, pitfalls to avoid, and expected benefits. They also serve as the ideal communication tool to foster replication and public buy-in thanks to tangible results.
- **Providing initial incentives to small farmers is crucial to engage them in the early years of a restoration project**, before they can rely on the livelihood benefits generated by their work. Tailoring interventions to address local socio-economic realities ensures buy-in and adoption of NbS practices. Incorporating gender-sensitive approaches and equitable benefit-sharing mechanisms ensures inclusivity and long-term community stewardship.
- **Scaling river and stream renaturation requires reliable and diverse funding sources to ensure long-term project sustainability**. Expanding Payment for Ecosystem Services schemes such as water footprint compensation is critical to incentivize private sector investment by linking upstream conservation efforts to downstream benefits for businesses and water users. Additionally, establishing endowment funds and blended finance models combining public resources, donor contributions, and private investments can provide the financial backbone for water fund operations and scaling efforts.

Case 9 – Urban farming: Kansoul Farm

Urban farming involves cultivating plants and animals within and around cities, including producing, processing, and marketing agricultural products (Foeken and Mwangi, 2000; Srinivasan and Yadav, 2023). It is crucial in enhancing food security for urban populations and building resilient food systems. Beyond food production, urban farming supports climate change adaptation and mitigation, promotes biodiversity and ecosystem services, fosters sustainable agriculture, and contributes to urban regeneration and public health (Toku et al., 2024). It encompasses diverse practices such as aquaculture, livestock rearing, vertical gardens, and community gardens (World Bank, 2021). It provides fresh produce, enhancing nutrition and food security, while contributing to carbon sequestration, especially when trees are integrated into the agricultural landscape (Foeken and Mwangi, 2000). It stimulates local economies, offering income opportunities and supporting livelihoods (World Bank, 2021). Additionally, it promotes human health through improved nutrition and psychological benefits, fosters education on environmental stewardship, and enhances social interaction by building stronger (Bradley and Galt 2014).

KANSOUL FARM

The following section presents an analysis of the Kansoul Farm and similar projects,, highlighting the challenges and opportunities in implementing urban farming in Kenya.

***Key inspirational features:** collaborative and youth-driven project, sustainable food resilience program, low income communities.*

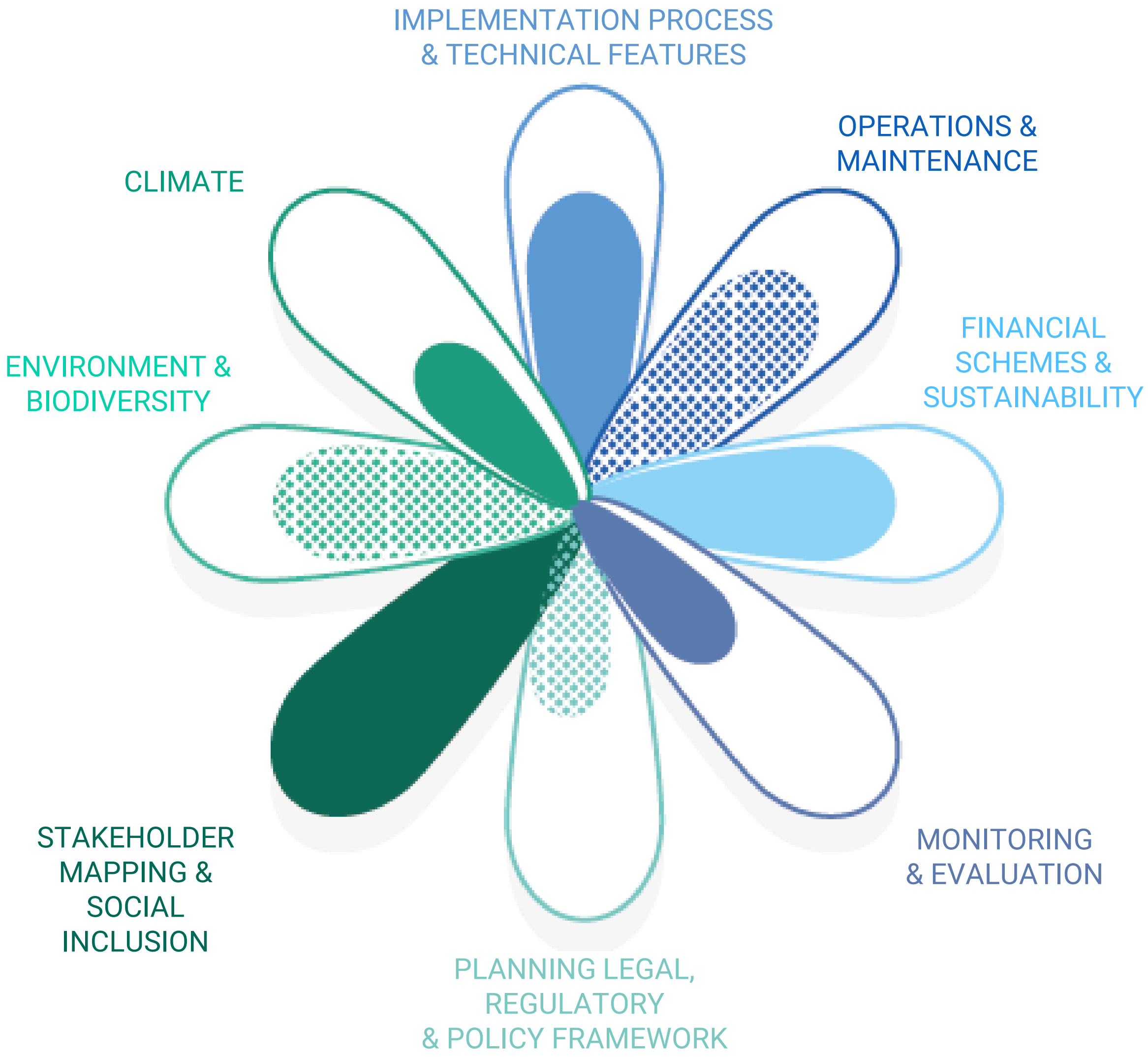


Figure 105 – Gap analysis result for Kansoul Farm (Source: SUEZ Consulting, 2024)

PROJECT PRESENTATION

Nairobi has a rich culture of urban farming. Urban agriculture in the city has transitioned from a legally-ambiguous economic activity to a regulated and supported practice under the Urban Agriculture Promotion Act of 2015. Kansoul Farm is the brainchild of The Viwandani Comprehensive Community Organization (VICCO). VICCO is one of many groups involved in this effort. Initiated in 2019 and based in the Sinai area of Nairobi's Viwandani informal settlement, this youth group has over 40 members. Starting as a small vegetable farm along the banks of the Ngong River, the initiative now supplies Sukuma (Kale), chickens, and more, benefiting their members and the local community through sales and donations.

As a predominantly self-financed organization, VICCO leases land monthly to cultivate various vegetables using different intensive urban farming techniques, including vertical and sack farming, following circularity principles. In addition to enhancing local food security, VICCO provides employment and rehabilitation opportunities for young people in the area. Through its 'Fresh Wednesday' initiative, VICCO supports up to 300 vulnerable households with weekly donations of fresh produce. Additionally, research is central to their approach, as they hire experts and consultants to improve their farming practices and yields.

The organization operates on a duty roster that ensures at least two members are actively working on the farm each day, focusing on various essential tasks. These include mending the fence, purchasing water, cleaning the water tank, planting, and harvesting produce. Additionally, the group holds a monthly general meeting and conducts a clean-up to maintain the farm's overall upkeep and organization.

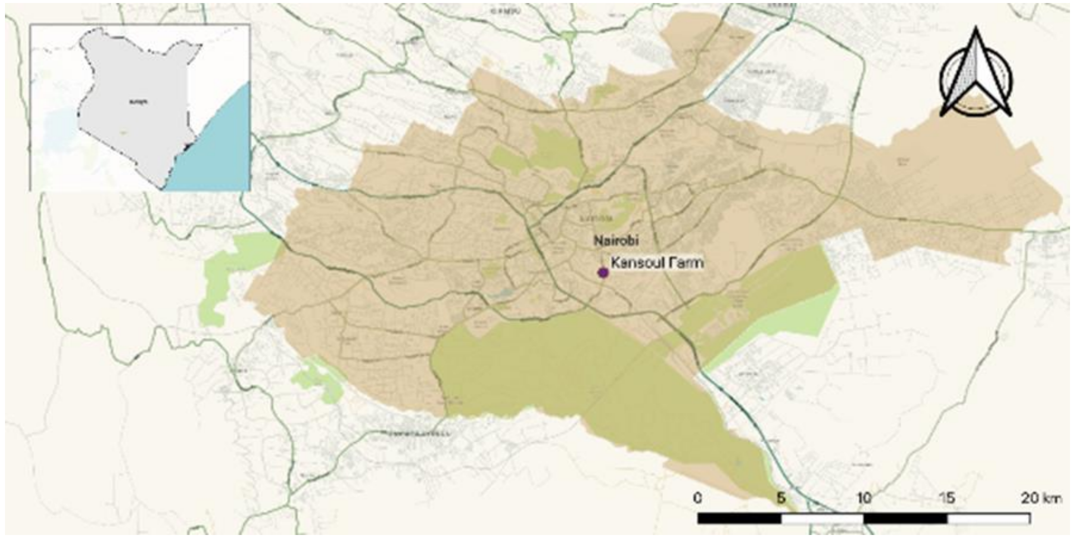


Figure 106 – Location of Kansoul Farm, Nairobi, Kenya (Source: SUEZ Consulting, 2024)

Figure 107 – VICCO's Farm
(Source: A Few Years Later -Transforming Nairobi's Informal Settlements Through Urban Farming – HealthyFoodAfrica)

Figure 108 –VICCO's Farm
(Source: HealthyFoodAfrica, https://healthyfoodafrica.eu/labs/kenya-nairobi/)

Figure 109 –VICCO's Farm
(Source: HealthyFoodAfrica, https://healthyfoodafrica.eu/labs/kenya-nairobi/)

CLIMATE — SCORE 1

- **Project response to climate risks – Score 1**

Although not designed as a response to an identified climate risk, sack-farming method being more water-efficient, can help respond to water scarcity issues.

Nairobi County is vulnerable to various climate risks. A key climate risk is flooding as extreme rainfall events are occurring with greater frequency and intensity, leading to severe flooding, particularly in informal settlements (GCA, 2024). The city is also experiencing a rising temperatures, with annual mean temperatures rising by approximately 1.0°C since the 1960s (World Bank, 2021b). Prolonged droughts have become more common since 2000, affecting water availability and agriculture in the county. The agricultural sector is essential to Kenya's economy and food security and is considered to be one of the most vulnerable to climate risks (World Bank, 2021b). Prolonged droughts will cause water shortages for domestic use, crops, and livestock. Increased temperatures might affect crop yield potential and create favorable conditions for pests and diseases (Aryal et al., 2021). Although not design as a response to any identified climate risks, The VICCO employs the sack-farming method that is highly water-efficient, using significantly less water than conventional farming. The controlled environment of sacks helps minimize water wastage, making it suitable for locales facing water scarcity such as Nairobi's informal settlements.

- **Project adaptation to local climate conditions (present and future) – Score 1**

This urban farming practices are very vulnerable to flood.

Located in riparian areas and very dense environment, this urban farming practices are exposed to climate hazards: floods in May 2024 caused livestock and crop losses, highlighting the project's vulnerability to climate change impacts.

ENVIRONMENT AND BIODIVERSITY — SCORE 1.5

- **Project response to environmental risks – Score 2**

The project aimed to transform a small riparian buffer area into a flourishing farm that cultivates a variety of crops, including kale, spinach, and other traditional vegetables: the use of sacks helps mitigate water scarcity and soil pollution.

Limited farming space and funding constraints have hindered the expansion of operations. The floods in May 2024 caused livestock and crop losses, while the subsequent demolitions by local authorities along the riverbank after the floods, disrupted operations and displacing parts of the community. High pollution levels in the river make its water unsuitable for farming. Potential soil pollution risks due to high pollution levels in the river may require costly soil quality checks and remediation measures that sack-farming allow to avoid.

- **Environment and urban biodiversity benefits – Score 1**

The Kansoul Farm project illustrates that urban agriculture as an NbS integrates well with circular approaches, using recycled materials (e.g., planting in sacks, repurposing clothes, and using animal waste as fertilizer).

Urban farming examples like VICCO can result in additional benefits such as enhanced community cohesion via community food donation initiatives. Vertical agriculture is an exciting alternative to ground-based cultivation, which helps vulnerable communities engage in productive urban farming activities despite space limitations. The soil and compost blend improves soil quality, facilitating nutrient cycling essential for crop growth while decreasing dependence on chemical fertilizers. This enhancement not only boosts local biodiversity but also limits potential runoff pollution, thus safeguarding downstream ecosystems like the nearby Ngong River. Moreover, the vertical configuration conserves land, protecting urban green spaces and accommodating other community activities coexist.

STAKEHOLDER MAPPING & SOCIAL INCLUSION

SCORE 3

- **Stakeholder engagement & consultation strategy – Score 3**

With self-funding and a well-established structure, VICCO stands as a model of a successful community-led urban farming initiative within an informal setting.

The heart of the Kansoul Farm community-led project are Viwandi Comprehensive Community Organization (VICCO) members, over 40 people from the local Viwandani community, who are directly involved in daily farm activities like planting, harvesting, and maintenance. This self-financed CBO is responsible for running the farm, VICCO plays a central role in coordinating all aspects of the project (i.e., leasing land, implementing sustainable farming practices, managing the farm’s operations). The organization operates on a duty roster that ensures at least two members are actively working on the farm each day, focusing on various essential tasks. These include mending the fence, purchasing water, cleaning the water tank, planting, and harvesting produce. Additionally, the group holds a monthly general meeting and conducts a clean-up to maintain the farm's overall upkeep and organization.

The European Union, through its Horizon 2020 funding program, provides financial support to VICCO via the HealthyFoodAfrica Project. The support from the EU also underscores the potential key role of international donors.

- **Socio-economic benefits and inclusion of vulnerable group – Score 3**

The Kansoul Farm project has improved food security in the Viwandani community, fostered social cohesion, and created training opportunities for youth.

One of the most direct socio-economic benefits of the Kansoul farm project is its impact on food security. The project fosters sustainable, circular practices while also generating income. The produce grown at VICCO is sold and shared within the community. Members of the Viwandani community have unlimited access to the farm for inspiration, capacity building and mentoring, as well as free produce. Community members can also sell surplus produce. Additionally, the “Fresh Wednesday” initiative donates fresh produce to up to 300 vulnerable households weekly and encourages them to start their own kitchen gardens for subsistence.

VICCO also provides employment and rehabilitation opportunities for young people in the area. The organization serves as a training hub, equipping youth with agricultural skills that improve their livelihood prospects. They are engaged in planting, harvesting, and maintaining the farm’s infrastructure, gaining hands-on experience and training in a context of scarce job opportunities.

VICCO’s approach strengthens community resilience by promoting collaboration and cohesion. The farm offers a space for community building. By engaging local residents in farming activities, mentoring programs, and educational initiatives, VICCO fosters a sense of unity and shared purpose. The initiative also encourages local networking and partnerships, for instance with local schools. For example, VICCO partners with Ghetto Shiners and other local groups to mentor other residents and schoolchildren through Kenya’s Competency-Based Curriculum (CBC), further spreading knowledge and fostering long-term community engagement.

PLANNING LEGAL, REGULATORY & POLICY FRAMEWORK

SCORE 0.5

- **Planning and development strategy – Score 1**

Project is supported by national-level policy and international network; however, it lacks integration and support in municipal-level planning or resilient development framework.

In 2014, Nairobi County adopted the Urban Agriculture Promotion and Regulation Bill 2014 recognizing urban agriculture as "an activity conducive to food security and well-being of the population, [...] and for the environmental sustainability of the country". While promoting the development of urban farming, the key objectives of the bill are also to transition to a regulated and supported practice, with a better access to land and water resources and a reinforced control of the potential adverse impacts on public health and environment among other things.

The Kansoul Farm is part of the Food Systems Lab, global initiative led by HealthyFoodAfrica in several African countries, and more precisely of Nairobi Food Systems Lab, which includes urban farming initiatives, basic infrastructure for vendors and learning hub in two settlements - Korogocho and Viwandani (where the Kansoul Farm is located). The Food Systems Lab aims to "demonstrate the practicality of food production in limited spaces in informal settlements using innovative modern techniques" (HealthyFoodAfrica website).

However, the project is not explicitly integrated into broader urban planning or resilience frameworks in Nairobi City or in the settlement. Connecting it to disaster preparedness plans or sustainable development strategies could strengthen its positioning and amplify its impact.

- **Regulatory and land tenure strategy – Score 0**

Land tenure to support and secure VICCO land lease is unclear given the informal settlement context of the project.

There is no information available on the land used for the project implementation. The core objective of development a vertical urban farm was to address the constraints of limited land availability in informal settlements and reduce the risks of land tenure and land use conflict with other stakeholders.

Question of land access is critical in informal settlements, and if the Urban Agriculture Promotion Act of 2015 legitimizes urban farming, it lacks provisions tailored to informal settlements.

Introducing explicit provisions for urban farming zones, including innovative methods like vertical or sack farming, would help address space constraints and enhance viability in informal settlements.

IMPLEMENTATION PROCESS AND TECHNICAL FEATURES

SCORE 2

Implementation process – Score 2

The Kansoul Farm vertical farming project, designed and implemented by the Viwandani Comprehensive Community Organization (VICCO), serves as a replicable model for tackling urban food insecurity with innovative, community-focused strategies.

VICCO started by pinpointing key issues in Nairobi's Viwandani informal settlement, such as food shortages, unemployment, and restricted access to cultivable land. Understanding the opportunities presented by urban farming, they utilized the Urban Agriculture Promotion Act of 2015 to align with local regulations.

The planning process focused on choosing vertical and sack farming methods that fit the area's limited space and resources. VICCO's self-funded approach, backed by monthly land leases and support from the community, emphasizes the importance of flexible financing strategies.

Figure 110 – VICCO Group member gathering vegetables from "towers" their urban farm (Source: Muungano wa wanavijiji, 2023, https://www.muungano.net/)

Figure 111 – Example of a vertical farm in South Africa, (Source: Piechowiak, 2021)

Existing local documentation for Kansoul Urban Farm

- The Nairobi City County Urban Agriculture Promotion and Regulation Bill 2014 - (GoK, 2014)
- Urban Agriculture in Kenya - (Memon and Lee-Smith, 2014)
- Strengthening Vegetable Production and Consumption in a Kenyan Informal Settlement: A Feasibility and Preliminary Impact Assessment of a Sack Garden Intervention - (Zivkovic et al., 2022)

Other relevant guidance for Urban Farm

- Making a sack garden - (Shamba Chef, 2024)
- Guide to Step-by-Step Urban Community Gardening - (CoCT, 2016)

IMPLEMENTATION PROCESS AND TECHNICAL FEATURES

SCORE 2

Technical features – Score 2

By implementing sack farming, the project maximizes the use of limited space in the Viwandani informal settlement, allowing for productive agriculture in areas unsuitable for traditional methods.

The Kansoul Farm vertical gardens showcase a creative approach to urban farming, reflecting the goals of NbS to improve food security, harness ecosystem services, and encourage sustainability. The design also features an uncomplicated yet efficient drainage system with rocks and bottomless buckets, promoting effective water management. This design promotes a circular resource use approach, alleviating environmental pressures by mobilizing a soil and compost blend.

Although the technical design encourages ecosystem services, additional integration of ecosystem-based improvements could amplify its effects. For instance, adding pollinator-friendly plants around the vertical gardens may draw in bees and other helpful insects, thereby promoting biodiversity and boosting crop yields. Likewise, implementing organic mulching or companion planting methods could naturally improve soil moisture retention and pest control. On the other hand, depending on manually sourced water might put pressure on local resources in times of drought.

Figure 112 - Technical design steps illustrated
(Source: Zivkovic et al., 2022; https://www.muungano)

Step 1: Setting up the sack
The process begins with preparing the 90 kg sack to facilitate proper drainage and structural integrity. Five drainage holes are made at the bottom of the sack, which is then placed on the ground.
A bottomless bucket is positioned in the center of the sack to act as a framework for filling. A stick or pole is placed in the middle of the bucket to guide the structure, and the bucket's cavity is filled with rocks to create a drainage system. This setup ensures water flows through the sack, preventing waterlogging.

Step 2: Filling the sack
The sack is filled incrementally with a 3:2 mixture of soil and compost, creating a nutrient-rich growing medium. The bucket is moved upward along the guiding stick as the sack fills, and its cavity is consistently refilled with rocks to maintain the drainage channel. This step is repeated until the sack is entirely filled, forming the foundation for planting.

Step 3: Marking the sack and planting
Using a permanent marker, the sack is marked to ensure plants are spaced evenly, typically 15 cm apart. Openings are cut into the sack using scissors or a knife, and a stick is used to create 1.5 cm holes at each marked spot. Seedlings or suckers are then planted in these openings, and additional plants can be added to the top of the sack.

IMPLEMENTATION PROCESS AND TECHNICAL FEATURES

SCORE 2

Proposed improvement for future similar projects

The recommended enhancements to the vertical garden design focus on sustainable water management, preventing contamination, and improving irrigation efficiency.

- A significant aspect is the implementation of rainwater harvesting systems, which offer a clean, renewable water supply while decreasing reliance on greywater. By collecting rainwater through gutters and storage tanks, a consistent source for irrigation is secured, even during dry periods, thus reducing health and environmental hazards linked to untreated greywater.

- In scenarios where greywater usage is necessary, integrating a rapid sand filter with onsite storage provides a safe, effective solution. These filters efficiently eliminate sediments and impurities, enhancing water quality prior to irrigation. Onsite storage ensures that treated water is conveniently accessible for use, minimizing operational delays and enhancing farming efficiency. This approach not only guarantees safer crop production but also safeguards the overall ecosystem from possible contamination.

- To enhance sanitation, raised platforms or plinths elevate the sacks, preventing contact with contaminated ground or flowing greywater. Additionally, the gravel drainage column within the sack, as illustrated in the figure on the right, channels excess water into an infiltration trench. This feature ensures effective water management, prevents waterlogging, and reduces surface water pollution. The design of these proposed features can be found in guidelines such as the Sustainable Urban Drainage Systems (SuDS) Manual by Woods-Ballard et al. (2015), ensuring integration with urban hydrological systems while promoting sustainable, resilient farming. Collectively, these innovations aim to boost sustainability, resilience, and productivity in urban farming environments.

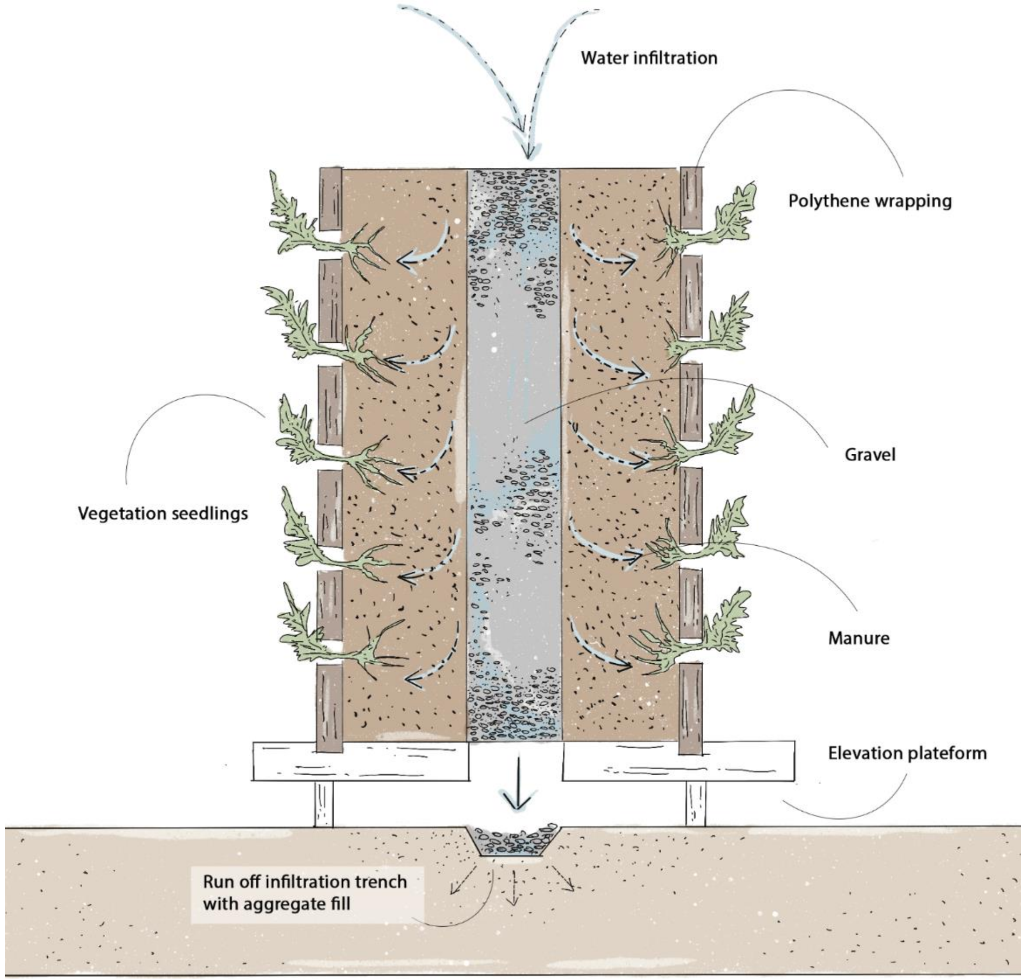


Figure 113 – Sketch of showing the cross section of the proposed improved sack design, inspired by Shamba Chef
(Source: SUEZ Consulting, 2024)

Figure 114 – Karanja Vertical Farms
(Source: SUEZ Consulting, 2024)

Related NbS Inventory case - Karanja Vertical Farms, Kenya

This examples showcases alternative techniques to sack garden. In Karanja, Kibera, one of Africa's largest informal settlements, the Karanja Vertical Farms tackle food insecurity and nutritional issues. Initiated in February 2024 as part of CARE Kenya's Catalyzing Strengthened Policy Action for Healthy Diets and Resilience(CASCADE) program and overseen by Salama CBO, the project operates on a quarter-acre plot adjacent to the Nairobi River, featuring six-story vertical farms. Each tower houses 200 kale seedlings and has a base diameter of 1.5 meters, effectively using limited space. The vertical farming methods are implemented to boost productivity, reduce land requirements and enhance water usage. Local community members are trained in setting up and maintaining the farms, along with sustainable agricultural practices, which contribute to the project's longevity. This NbS bolsters food security, strengthens resilience against economic and climate challenges, and generates income for vulnerable communities.

Figure 115 – Make me Smile, Vertical Farms
(Source: https://makemesmile-kenya.org/en/vertical-gardens/)

Vertical Gardens - Growing Upwards Together, Kenya

Sack garden has also a positive impact in improving local accessibility to nutritious food. In 2019, Make Me Smile Kenya discovered that families with HIV-positive children lacked resources for nutritious food, resulting in malnutrition and poor health. The organization launched a pilot project providing 251 vertical sack gardens to 249 households in Kajulu, Miwani, and Kolwa East. These innovative gardens use sacks filled with nutrient-rich soil and stones for water distribution, maximizing space and minimizing water usage. Families were trained for sustainable setup and maintenance. The initiative improved access to nutritious food for over 1,000 people, enhanced health outcomes, and generated income from surplus produce sales. Beneficiaries save KES 50-100 weekly on food, enabling participation in saving and lending groups.

OPERATIONS & MAINTENANCE

SCORE 1.5

- **Roles and responsibilities – Score 2**

VICCO is implementing and managing the project, while the members are the beneficiaries of the program.

Although the Viwandani Comprehensive Community Organization (VICCO) is mainly a Kibera-based self-funding community organization, it occasionally receives funding from donors such as European Union Horizon 2020-funded Healthy Food Africa Project. The VICCO is the project implementer and manager while members of the Viwandani Community especially the youth and women are the main beneficiaries of the VICCO's urban agriculture program.

- **Operation & Maintenance Plan – Score 1**

Operation and maintenance of the project is dependent on the funds available.

While maintenance of the farm is quite dependent on external source of funding, and also vulnerable to disaster such as the 2024 flood that can cause disruption in the project, the farm mainly serves as a demonstration case where agricultural training of children, youths and women's organisations takes place.

The VICCO group is comprised of eighteen people. It operates a duty roster that ensures at least two members are actively working on the farm each day, focusing on various essential tasks.

Operation and maintenance tasks include (Source: VICCO, 2024):

- Mending the fence
- Purchasing water
- Cleaning the water tank,
- Seedbed preparation, transplanting, planting watering and harvesting produce.
- Looking after livestock including cleaning out pens
- Managing the project accounts
- Additionally, the group holds a monthly general meeting and conducts a clean-up to maintain the farm's overall upkeep and organization.
- Cooking sessions are also conducted with marginalized young adolescent mothers to disseminate food and nutrition knowledge.

FINANCIAL SCHEMES & SUSTAINABILITY | SCORE 2

- **Project costs, revenue generation and funding – Score 2**

Kansoul farm funding followed a different path than VICCO's other farms. Cumulative costs since 2019 currently amount to US$ 14,000.

VICCO generally relies on self funds to manage its farms. Kansoul farm is bit particular as it serves as a demonstration and training project. It was reportedly funded through different organization grants. Management costs vary with readily available funding. For a group of 18 trainees, managed by 2 people, the monthly cost amounts to US$ 116. This includes several activities such as seed bed preparation, transplanting, watering, harvesting, and cooking sessions.
Revenue generation on VICCO's farms comes from produce selling, although, from the information gathered, it does not seem to be the most common practice. The community benefits from the farms through in-kind donations in the spirit of Ubuntu, a set of Bantu African-origin value systems that emphasize the interconnectedness of individuals with their surrounding societal and physical worlds. Viwandani inhabitants have unlimited access to the farm to get free produce and all community groups have reported sharing the food among members, with some sharing with neighboring schools. Some households have received kitchen gardens courtesy of VICCO. These in-kind donations economically alleviate households by minimizing their food expenses.

- **Integrated financial plan and project sustainability – Score 2**

VICCO's self-funded approach is backed by monthly land leases and support from the community, resulting in irregular funding streams.

VICCO has reportedly adopted a flexible financing strategy in response to irregular contributions. Based on weekly reports, the project lead and chairperson develop monthly activities and plans. No further information was gathered.

MONITORING & EVALUATION SYSTEM | SCORE 1

- **Key existing indicators – Score 1**

No specific performance indicators were reported to evaluate the Kansoul farm project.

VICCO reports benefits on food security, education, and mental health.

These benefits could be associated with indicators, and measurement methods to consolidate the evaluation of the NbS impacts.

- **M&E system and knowledge dissemination – Score 1**

Barely any data on the M&E system could be collected, but knowledge dissemination seems to be efficient.

The project lead receives reports from the two farm managers on a weekly basis. The content of these reports, including data collection methods, and involved actors, is unknown.

Knowledge is transferred through Kansoul farm's training. it plays a role in teaching communities to grow their own food in challenging environments. Information about available fresh produce circulates through children's word of mouth at school, and through dedicated training with organized groups. VICCO also shares about its activities on social media.

The Viwandani community's unlimited access to the farm also fosters inspiration, capacity-building, and mentoring.

Urban Farming

GLOBAL CENTER ON ADAPTATION

CONDITIONS FOR UPTAKE

The Kansoul Farm vertical gardening initiative is a vital inclusion in the NbS Compendium as it demonstrates how innovative urban farming techniques can address food insecurity, youth unemployment, and ecosystem restoration in informal settlements, with potential application in formal settlements as well. Conditions for uptake have been identified based on the lessons learned from the case to ensure replicability and enhance the design of solutions in similar contexts.

Key inspirational features for associated NbS families

- **Innovative and space-efficient farming techniques**: the use of sack and vertical farming optimizes limited urban space while incorporating sustainable practices like composting and drainage columns, making it a scalable model for urban food production;
- **Sustainability through circularity**: the project emphasizes circular resource use, incorporating compost, efficient water management, and minimal land use, making it an exemplary model for sustainable urban farming;
- **Community-driven approach and social impact:** engaging local youth through cooperative management fosters resilience, employment, and social cohesion, with initiatives like "Fresh Wednesday" directly benefiting vulnerable households and strengthening community ties;
- **Community livelihood is improved thanks to in-kind donation**: they all have access to the farm to get free produce, and food is generally shared among community members. These donations economically alleviate households by minimizing their food expenses.

Key improvement area for NbS replicability across Kenya

- **Integrate an action plan to adapt and mitigate climate change impacts**: urban farms being often located into informal settlements, on riparian areas, and in very dense contexts, they are very vulnerable to climate change impacts. Specific actions to ensure continuity of these urban farms beyond disaster are keys to allow long-term adaptability of the farming solution;
- **Implement policy support and regulatory frameworks**: strengthening policies like the Urban Agriculture Promotion Act (2015) and implementing zoning regulations for urban agriculture can support scaling efforts. These frameworks ensure access to resources and incentivize urban farming, particularly in informal settlements and underutilized spaces;
- **Engage Capacity building and community-level activities**: training programs on techniques such as sack farming and composting can empower communities. Community-led approaches build ownership, resilience, and local adaptation, while partnerships with stakeholders enhance long-term success;
- **Design market access and value chain development**: connecting farmers to markets through distribution networks and cooperatives enhances economic viability, beyond distribution in the immediate surrounding of the urban farm site;
- **Integrate indigenous practices such as Ubuntu in urban farming can help communities build resilience and social cohesion**. Giving free access to urban farms is also an opportunity to foster public engagement and disseminate knowledge. Residents gain a sense of ownership that can be extended to the whole neighborhood. Thus, urban farms have the capacity to generate a sense of belonging to people living in informal settlements, in particular for internally displaced people and refugees.

Case 10 – River Stream Renaturation: John Michuki Memorial Park

River and stream renaturation involves restoring natural watercourses in urbanized areas denaturalized through embankments, culverting, and infilling for development purposes. These modifications have led to uniform flows, reduced fauna habitats, decreased vegetation diversity, and increased flood risks due to diminished natural absorption and flow regulation (Brun, 2015). Renaturation techniques include stream daylighting, reestablishment of riparian corridors, removal of concrete barriers, and revegetation of riverbeds and banks (Athavale, 2012). This approach enhances pluvial and riverine flood risk reduction by increasing the capacity of water bodies to hold excessive stormwater, lowering flood heights and velocities, and reducing structural damage to properties and infrastructure (NWRM, 2015). Renaturated rivers offer recreational spaces, improving human health by promoting physical activity and mental well-being (Cai et al., 2022; Gunawardena et al., 2017; Hathway and Sharples, 2012). Biodiversity is enhanced by providing habitats for wildlife and facilitating species movement. Additionally, water quality improves as riparian zones capture sediments and pollutants, reducing erosion and lowering water treatment costs (World Bank, 2021).

JOHN N. MICHUKI MEMORIAL PARK

The following section examines the John Michuki Memorial Park, highlighting the opportunities and challenges of designing and implementing urban green spaces and river stream renaturation in Kenya.

Key inspirational features: *integration of NbS to transform a derelict brownfield site, complemented by public engagement campaigns and effective public-private sector collaboration.*

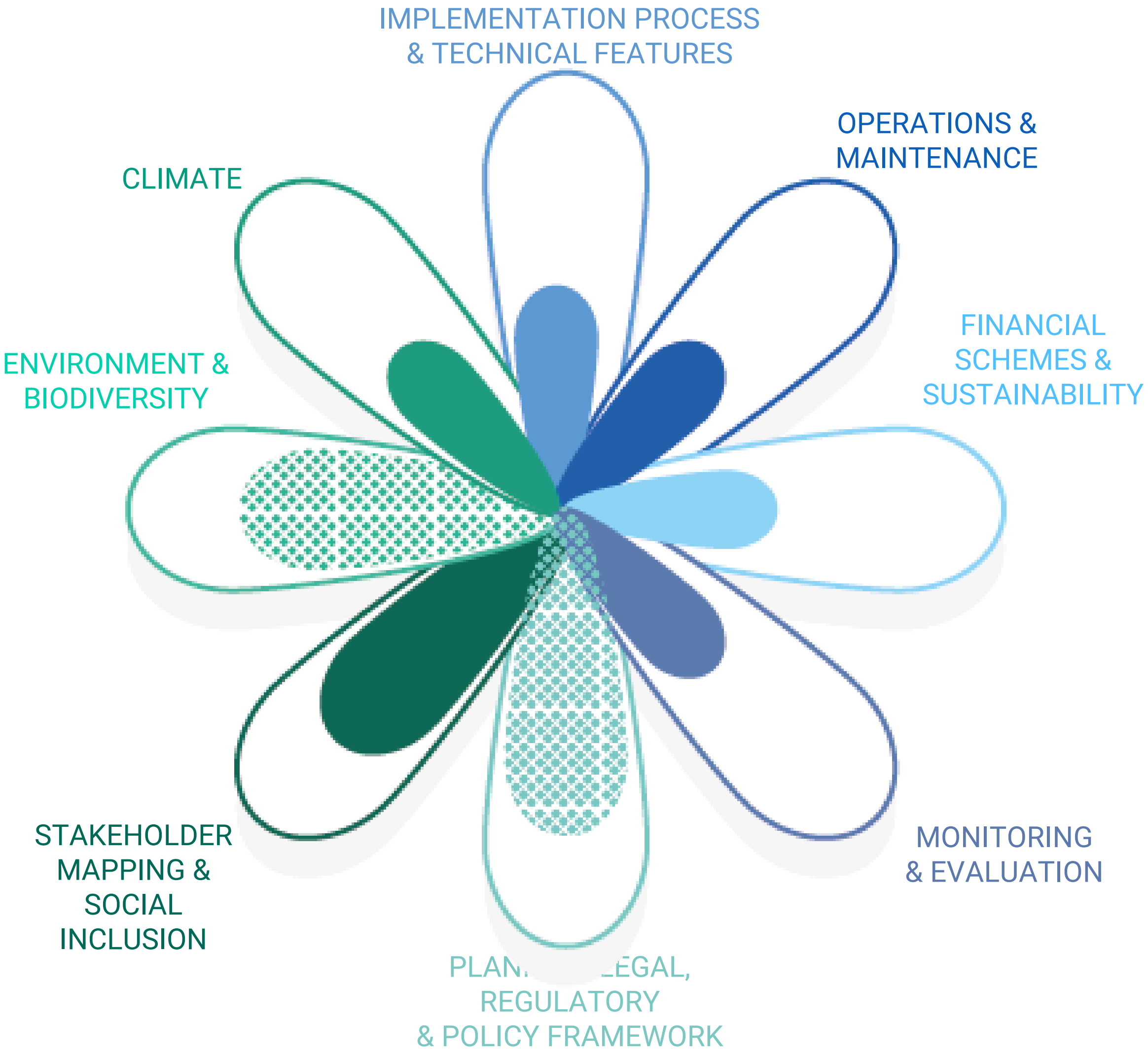


Figure 116 – Gap analysis result for John Michuki Park
(Source: SUEZ Consulting, 2024)

PROJECT PRESENTATION

The Hon. John N. Michuki Memorial Conservation Park, established in 2008 as Mazingira Park, is located along the Nairobi River and spans 12.3 ha. The park was developed through efforts to transform a former illegal dumpsite and criminal hideout into a public recreational area.

However, prior to rehabilitation in 2020, the site still suffered from high levels of insecurity, pollution, and waste accumulation, with sections of the river choking on solid waste and occupied by hawkers and informal garages. As part of the rehabilitation program, 20,000 tons of solid waste were removed, and a major cleanup was conducted across Nairobi. Key activities included clearing illegal structures, leveling the riparian zone, and constructing pathways to define the riparian boundary. Additionally, 6,357 indigenous trees were planted to improve biodiversity and stabilize the soil.

This case aimed to restore the Nairobi River, reduce crime, and create an ecological space for public use. Beneficiaries include Nairobi residents, international tourists, schools using the park for educational purposes, and spiritual groups holding prayer sessions. The John Michuki Memorial Park is located within the same area as the Botanical Garden (including also pharmacal garden and nursery) managed by KEFRI.

According to the stakeholders, the project addressed the risks of water pollution and riverine flooding, while providing heat stress reduction, pluvial flood risk reduction, biodiversity and social interaction as benefits.
The park's management is guided by the Forest and Conservation Act of 2016, which provides a legal framework for forest conservation.

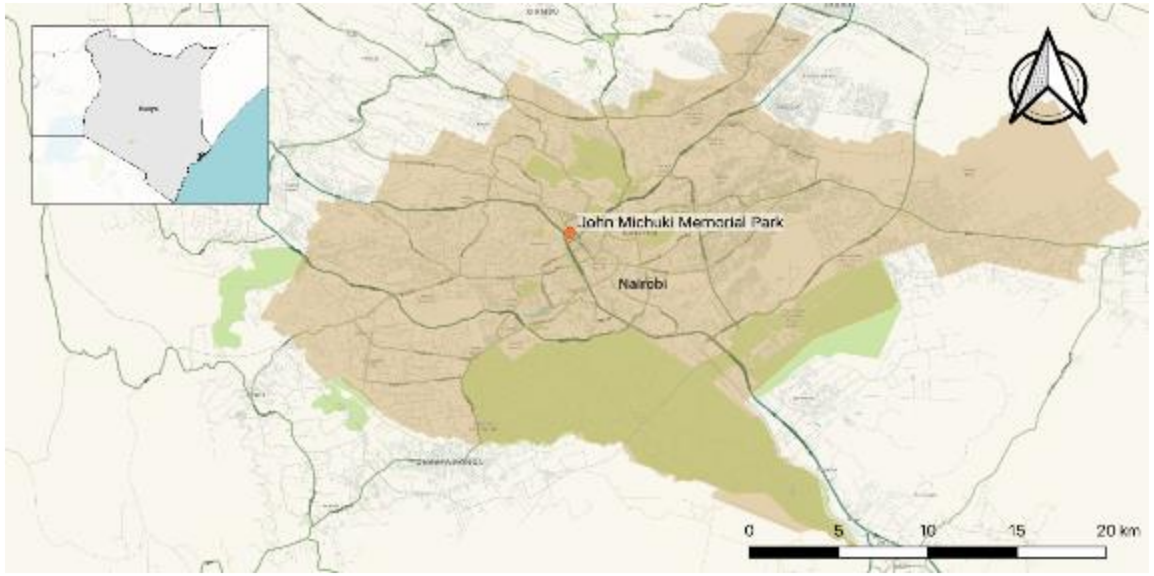


Figure 117 – Location of John Michuki Memorial Park in Nairobi
(Source: SUEZ Consulting, 2024)

14/02/2004

14/02/2024

Figure 118 – Evolution of John Michuki Memorial Park area from 2004 to 2024
(Source: Google Earth)

Figure 119 – John Michuki Park
(Source: SUEZ Consulting, 2024)

Figure 120 – John Michuki Park
(Source: SUEZ Consulting, 2024)

CLIMATE

SCORE 1

- **Project response to climate risks – Score 1**

The Park targets brownfield area restoration and preservation of riparian area, which responds indirectly to climate risk such as heat wave and flood risk.

Nairobi County is vulnerable to various climate risks. A key climate risk is flooding as extreme rainfall events are occurring with greater frequency and intensity, leading to severe flooding, particularly in informal settlements (GCA, 2024). The city is also experiencing a rising temperatures, with annual mean temperatures rising by approximately 1.0°C since the 1960s (World Bank, 2021b). Prolonged droughts have become more common since 2000. Warmer and drier conditions can lead to a rise in respiratory illnesses and urban air pollution (ibid).

As an Open Green Space along the river, including River Stream Renaturation activities, the John Michuki Park could have for instance contribute to address riverine flooding by improvement river design and maintenance as well as pluvial flooding by increasing the permeable surface and infiltrating capacity of the area. In addition, such Open Green Space also usually contributes to reduce heat stress. However, none of these climate risks were identified as a priority objective of the John Michuki Memorial Park restoration.

To maximize their potential to contribute to climate change adaptation, the following steps are key. Firstly, climate risks should be mapped to set climate risks resilience as one of the key objectives of the project *(in the Project Report and ESIA).* Secondly, future climate risks should be integrated to adapt not only to the current climate but not future projections as well. Thirdly, hydraulics studies should be developed to understand the impacts of climate change on river and water flows. Finally, the project design and maintenance plan should be adapted accordingly.

- **Project adaptation to local climate conditions (present and future) – Score 1**

Unavailability of the information regarding the frequency or scale of climate hazards leads to a lack of clear strategy on appropriate ways to incorporate these risks into park design and maintenance.

Located along the river, the park is exposed to heavy rains and stormwater events. Recently, a part of the riverbank, gabions of the riverbed and a section of the pedestrian path collapsed. The park is also exposed to heat waves, that can affect the green environment. In the aftermath of this event, bamboo trees were planted along the riverbank to stabilize it. Pedestrian path will be rebuilt as it was before.

The species selection was led by KFS, taking into account water needs and sustainability. No information was available to confirm choice of species as having both ecological function riverbank stabilization capacity and adequacy to various climate hazards and climate change impact (flash flood, increase of temperature…).

Feasibility studies for park design (including riverbank profile, park infrastructure location and materials) should include hydraulic study to ensure the long-term sustainability. Indeed, the lack of understanding of flood risk led to the destruction of part of the riverbank in a recent event. Frequency of these events is not monitored at the park level.

Therefore, indicators need to be defined and carefully monitored at the Nairobi river scale as they are key to keep improve and adapt to the evolving climate conditions and assess the efficiency and adequacy of the proposed measures. This monitoring framework also needs to be shared with the various stakeholders involved in key sections of Nairobi River, such as the John Michuki Park management team.

ENVIRONMENT AND BIODIVERSITY

SCORE 1.5

- **Project response to environmental risks – Score 2**

The Park mainly aimed at restoring a wasteland area.

As a River Stream Renaturation, the project aims at restoring the local river ecosystem and surroundings, by stabilizing the riverbanks and riverbed and cleaning main water and ground pollution from solid waste. As an Open Green Space, the project also required specific soil and environmental conditions to grow vegetation, that the previous land use may have impacted. John Michuki Park being a former dumping site, the soil had too high contamination risks. Solid waste were removed, and the soil was renewed with soil imported from Kiambu County to cover and leverage the existing. Nairobi Water Company cleaned the water and introduced bacterial chemicals to accelerate organic water pollution remediation. Clean up of the area (park and river) is still daily conducted. In addition, parcel of the park is dedicated to small urban farming. Such activity requires soil quality control (e.g., pollution, nutriments).

About waste pollution, river pollution is a non-point source at river scale hence a difficulty to act on water pollution other than conducting litter picking regularly. A more global strategy to manage water resources with the upstream especially within the urban areas would contribute to reduce solid waste accumulation in John Michuki Park.

To avoid importing natural rich soil from elsewhere for riverbank renaturation project, implementing a local circular economy approach could reuse excavated land for construction work in green areas project, providing it is adequately tested for pollution and appropriately enriched with compost or biochar to be used for planting purposes.

- **Environment and urban biodiversity benefits – Score 1**

Enhancing local biodiversity comes at odd with public uses of the park.

John Michuki Park hosts several species of trees, such as yellow acacia and birds. A couple of Egyptian Gooses nest there along the river. Nature Kenya (from the National Museum) visits regularly especially for inventory of the birds. Monkeys are used to come to the park at night or early morning.

However, public use of the park comes sometimes at odd with enhancing potential ecological value of the park: for instance, the need to preserve a co-visibility on the two banks or provide lightening for safety and security reasons constraint more natural riverbanks.

The integration of John Michuki park within a broader ecological and biodiversity landscape is key to realize the full potential of such project. The role of the John Michuki Park for the wildlife development within the urban area (monkeys or protected birds for instance) could have also been taken into account, to secure good nesting conditions and/or to ease the wildlife mobility through green corridors across Nairobi's green areas. The park is also strategically positioned along the Nairobi River and could have been integrated in larger ecological regenerative initiatives, such as Nairobi River Life, partnership between UN-Habitat and the Kenyan Government, to reclaim and renovate kilometers of the river system.

Finally, to avoid the development of non-endemic species and the risk of proliferation of bamboos planted for riverbank stabilization purpose, a listing of recommended species that are both compatible with biodiversity purposes and bank stabilization should be developed to guide future developments.

STAKEHOLDER MAPPING & SOCIAL INCLUSION

SCORE 2

- **Stakeholder engagement & consultation strategy – Score 2**

Many stakeholders are involved in the park, but it lacks a clear stakeholder engagement strategy.

17 stakeholders were involved in the project. The 5 main stakeholders and their respective roles within the project are KFS, which supervises overall project management – the area management was specifically devolved to KFS by a presidential directive to ensure the security –, KEFRI, in charge of the maintenance of the gardens, NEMA, in charge of the maintenance of the river, the National Museum, and Simlaw Seeds, for management and operations of urban farming. Other stakeholders include the Nairobi Metropolitan Service, in charge of waste management, the National Youth Service, the Community Forest Association (CFA), which gathers different user groups, to work collaboratively with KFS on sustainable management of the resources, and public users

The Participatory Framework Management (2005) foster a co-management approach, especially with surrounding community groups such as CFA. However, information on engagement strategy or PFMP for John Michuki Park isn't publicly available and compliance with this Framework couldn't be checked. Also, implication of stakeholders is being done on a silo basis: they could be aggregated into a structured forum or consultation body that aggregate all stakeholders involved in Nairobi river. Lastly, a Community Forest Association was formed to engage local residents in managing the park, promoting ownership and sustainability. In addition, a Grievance Redress Mechanism (GRM) could also be implemented as a general framework to ensure that concerns from stakeholders and local population can be heard and addressed at all project phase.

- **Socio-economic benefits and inclusion of vulnerable group – Score 2**

The Park is largely used by local communities, however specific activities and spatial layout favoring women and children uses are still lacking.

Asides global urban resilience improvement, the John Michuki Park provides:

- free access recreational area for the neighborhood, mainly for workers and students (around 200pp/day);
- educational materials (e.g., botanical and pharmacal gardens);
- available space for economic activities, mainly the urban farming led by Simlo Seeds. The park also hosts some company gatherings or parties (paid activities);
- jobs for the youth, namely through the "climate week" 10-days program or the former *'Kazi mtaani'* national program.
- Public engagement and awareness-building activities with CBO and schools (e.g., *mazingira day*, clean-up days)

An inspirational feature developed by the John Michuki Park is the important communication campaign for the reopening of the park to market the park as a neighborhood and educational place for the inhabitants, far from the former dumping site and risky area it was.

However, the Park still suffers from negative perceptions and stigma on previous insecurity issues which has hindered its full potential for women and children to utilize the space for recreational activities. Specific engagement activities targeting women and children could be proposed.

PLANNING LEGAL, REGULATORY & POLICY FRAMEWORK

SCORE 1.5

- **Planning and development strategy - Score 1**

The mandate of KFS for managing the Park should be expanded to include NbS development maintenance activities.

The development of the John Michuki Memorial Conservation Park, while guided by the Forest and Conservation Act of 2016, lacked integration into a comprehensive urban resilience or biodiversity strategy. The initial focus on eliminating criminality and rehabilitating the site overshadowed broader objectives such as enhancing biodiversity and connecting the park to other green spaces in Nairobi, limiting its integration into a cohesive urban framework.

The rehabilitation of the park was strongly supported by national-level authorities, including a rehabilitation initiative driven by the Ministry of Environment and a presidential decree. This top-down mandate provided significant momentum, ensuring the allocation of resources and prioritization within governmental agendas. The Kenya Forest Service (KFS), bolstered by annual funding, played a crucial role in implementing the project. This level of governmental commitment underscores the importance of high-level political and institutional backing for impactful urban rehabilitation efforts.

- **Regulatory and land tenure strategy - Score 2**

The Park responds to the need of securing appropriate land-use on Nairobi river riparian areas which are themselves under the management of Nairobi Water Commission.

The riparian areas of the Nairobi river within the park (30 meters both sides of the river along a 27 km corridor) are under the management of Nairobi River Commission and should be preserved from urbanization and pollution. This formal framework need further site-based measures to become effective.

From that perspective, John Michuki Park and devolution of Park management to KFS is a response to this need of securing appropriate land-use in river riparian area.

However, the Park's location on public land managed by KFS needs formal gazetting to secure its legal status and long-term sustainability. The absence of formal gazetting limits its legal protection, leaving the site vulnerable to future encroachments and inadequate long-term enforcement mechanisms should the management responsibility shift to other stakeholders. Securing tenure through formal conservation designations is therefore critical to ensure sustainability beyond management framework.

IMPLEMENTATION PROCESS AND TECHNICAL FEATURES | SCORE 1

Design and implementation process – Score 1

The phased restoration of the John N. Michuki Memorial Park converted the area from a neglected dumpsite into a usable urban green space. However, technical guidance for ensuring the integration of the rehabilitation various components namely, riverbank renaturation, flood adaptation measures, green park development in the riparian area was missing.

At first, the park faced significant environmental issues, such as illegal dumping, encroachments, and a lack of security. In 2008, guided by the late Hon. John Michuki, the rehabilitation commenced with a cleanup initiative that involved 17 ministries and various stakeholders. The initial phase aimed to remove around 20,000 tons of waste, dismantle illegal structures, level the riparian zone, and plant 6,357 indigenous trees to help stabilize the ecosystem. These efforts were part of a larger vision to restore the Nairobi River and establish a secure recreational area.

In 2012, the park was renamed in honor of Hon. Michuki by then-Prime Minister Raila Odinga. Unfortunately, following this initial recognition, the park fell into disrepair due to illegal dumping and encroachments. A revival of the project was initiated in 2020 through a Presidential Directive, which transferred management to the Kenya Forest Service (KFS). Implementation activities involved riverbank stabilization using gabions, additional tree planting, and creating 2.4 kilometers of accessible walkways. The park also saw the addition of modern facilities, including a 500-seat amphitheater, a tree nursery for indigenous seedlings, and public event spaces, all aimed at enhancing the park's appeal utility.

Relevant guidance for River Renaturation

- Guidelines For Rehabilitating Degraded Water Tower Ecosystems In Kenya - (KEFRI, 2017)
- Restoring Rivers And Wetlands At Scale: Results and Lessons From The Cross-Sector Living Danube Partnership - (Ereifej et al., 2021)
- Manual of River Restoration Techniques - (The River Restoration Centre, 2021)
- Becoming# Generationrestoration: Ecosystem restoration for people, nature and climate - (United Nations Environment Programme, 2021)
- Guidelines for designing, implementing and monitoring nature-based solutions for adaptation - (Donatti et al., 2021)

IMPLEMENTATION PROCESS AND TECHNICAL FEATURES

SCORE 1

Technical Features – Score 1

The rehabilitation of the park did not involve formalized technical designs for the renaturation of the Nairobi River. Instead, interventions were guided by existing practices for river rehabilitation and gabion installation.

Key technical measures included the installation of gabions along the riverbanks to control erosion and stabilize the river channel. These hard infrastructure solutions effectively reduced sediment flow into the river and protected the riparian zone from further degradation. Additionally, 6,357 indigenous trees were planted to enhance biodiversity, sequester carbon, and provide shade, aligning with the project's ecological and recreational goals. Walkways were constructed to improve accessibility while marking riparian boundaries, ensuring minimal disruption to ecological processes.

These interventions aimed to restore ecological integrity, stabilizing the riparian zone, and creating a functional green space. Gabions indirectly supported water filtration by stabilizing sediments, while indigenous vegetation contributed to air purification, climate regulation, and habitat provision. The restored riparian zone and tree canopy improved urban biodiversity and created a cooling microclimate, essential for addressing urban heat challenges. Recreational infrastructure provided cultural ecosystem services, promoting public well-being and social interaction.

Although the project relied on immediate practical solutions rather than formal design, it achieved significant ecological and social outcomes. The provided documentation can significantly aid in guiding future interventions. Future phases may benefit from integrating more soft engineering techniques and adaptive management strategies to enhance outcomes sustainability such as addition of vegetation-based stabilization techniques to gabions to foster natural riverine processes. Expanding riparian buffers with native vegetation would also improve filtration, support biodiversity, and strengthen ecological resilience.

Figure 121 – Nairobi river running past John N. Michuki Memorial Park before and after rehabilitation (Source: Ministry of Environment and Forestry, 2020)

IMPLEMENTATION PROCESS AND TECHNICAL FEATURES

SCORE L1

Proposed improvement for future similar projects

Soil and Water Bioengineering Solutions (SWBS) into park's rehabilitation can significantly enhance riverbank stabilization and ecological health. SWBS employs living plant materials in engineered structures to reinforce soil and manage water, offering a sustainable alternative to traditional hard engineering methods. The primary objective of SWBS is to stabilize riverbanks by leveraging the natural properties of vegetation. Plants provide direct protection against erosion, disrupt flow patterns, manage soil moisture, and enhance soil tensile strength through their root systems. Beyond stabilization, SWBS contributes to increased aquatic and terrestrial biodiversity, improved water quality, and enhanced ecological connectivity. Establishing a buffer zone whose width is determined by modelling with a riverbank slope ratio of 3:2 (horizontal to vertical) is recommended to optimize these benefits.

Four main techniques of SWBS are most common:

- ***Brush layers :*** Brush layers use cuttings and plants disposed on layers parallel to the flow. Main advantage: they are deeply inserted into the bank and have better resilience against droughts. They allow multi species compositions.
- ***Brush matt:*** Brush matts use willows branches disposed on the bank covered by 5 cm layer of soil. Main advantage: very dense vegetation start, but less resistant to drought.
- ***Fascine :*** Fascine is an assemblage of willows branches packed together and places in tranches parallel to the river, between stakes. Main advantage: very well adapted to the riverbank toe, can be combined with other techniques, really structures the slope if multiplied.
- ***Cuttings and plants :*** If erosion just started or is to expect on a small width or to complete another SWBS techniques cuttings or riparian plants can be implemented in a dense and wide manner.

Implementing these techniques requires the use of locally sourced, native riparian vegetation to ensure ecological compatibility and sustainability. The installation of SWBS should occur during the dormant season to facilitate plant establishment. A comprehensive management plan is essential to maintain the functionality and effectiveness of these bioengineered structures over time.

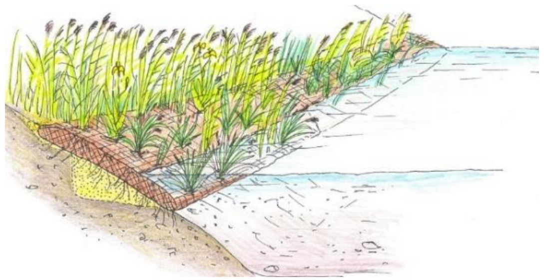


Figure 122 – Use of plants secured by hessian bags to stabilize riverbed
(Source: Naturalea, 2021)

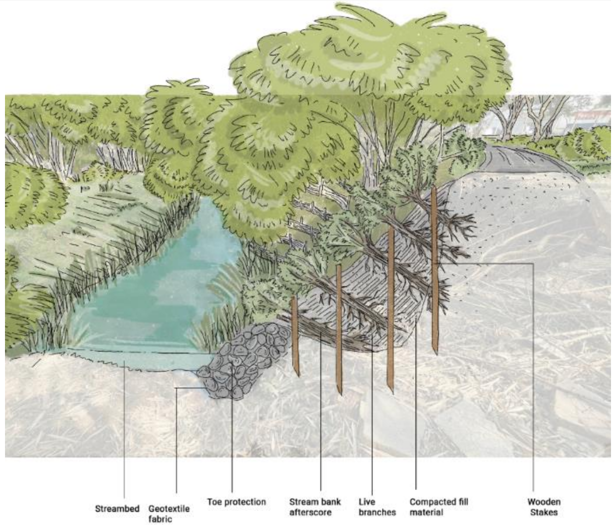


Figure 123 – Overlay of river section showing proposed bioengineering features, including live branches and toe protection to stabilize the riverbed
(Source: Suez Consulting)

The Sekenani River Restoration Project, Kenya / Tanzania

The Sekenani River Renaturation Project follows a similar approach to the John Michuki case. These practices now require the incorporation of more ecological engineering techniques, such as challenging bamboo use for riverbank stabilization and adopting SWBS methods, to mature. Located in the Nashulai Maasai Conservancy, it aims to restore the degraded Sekenani River, an important tributary of the Mara River Basin. Factors such as climate change, overgrazing, illegal logging, sand harvesting, and pollution have led to riverbank erosion, diminished water quality, and jeopardized biodiversity.

Initiated in 2020 with backing from Summa Equity, the project engaged 120 women and 224 youth to lead restoration initiatives. Major activities involve planting 2,000 native trees, distributing 25,000 acacia seedballs, and growing 3,000 bamboo seedlings to stabilize eroded banks, diminish sedimentation, and inhibit further erosion. These initiatives also support Kenya's national pledge to enhance tree cover, aiding in carbon sequestration and climate change mitigation.

Nashulai scouts and volunteers lead patrols that monitor and deter illegal logging and sand harvesting, crucial for maintaining the river's ecological health. Local community members are trained in riverbank maintenance, supporting continuous rehabilitation efforts. The project employs sustainable methods, such as using bamboo to prevent erosion and reintroducing native species to enhance biodiversity. Partnerships with local CBOs and the KFS supply additional seedlings and resources, increasing the project's impact. This river-focused initiative illustrates the transformative potential of Nature-based Solutions in safeguarding essential ecosystems while improving water security and resilience in the Mara River Basin.

Figure 124 – Community members removing waste along a 13 km stretch of the river, with trash heaps displayed after removal
(Source: Nashulai Maasai Conservancy, 2020)

OPERATIONS & MAINTENANCE

SCORE 1

- **Roles and responsibilities – Score 1**

Multiple institutions are involved in park and river maintenance. There are occasional conflicting interests that are not conducive to sustainable and integrated park and river maintenance.

KFS has taken over the overall management of the John Michuki Park, upon presidential directive in 2020, to ensure the security and safety of the Park, with rangers and associates (including one inspector). KFS is a well-established authority in forest conservation and management with paramilitary training to enforce security within its perimeter. However, their management role in urban parks, KFS lacks training on key aspect of park management (ecotourism development, ecological preservation…) and has applied for external training to supplement for this lack of expertise. Capacity building in ecological preservation is key to ensure the environmental and biodiversity benefits provided by the park, and to better manage the river restauration and conservation.

River and park maintenance is conducted respectively by NEMA and by KFS casual workers respectively for the river and the park maintenance. In 2024, a new presidential initiative was announced to recruit young people for cleaning and planting in the riparian area across Kenya, including in John Michuki Park. Communities are also engaged in park maintenance through clean-up days.

Other stakeholders include KEFRI and the Nairobi Water Commission. In parallel, KEFRI manages and maintains the gardens and Simlaw Company, a registered company, oversees the urban farming activities. Along KFS, Nairobi Water Commission is involved in the river rehabilitation and was given the authority by the government to manage the riverbanks.

- **Operation & Maintenance Plan – Score 1**

Lack of existing guidance on park and riverbank management plan impend effort to incorporate a more systemic approach to maintenance activities.

The roles of each stakeholder, especially in the park area, are clearly presented. However, no operation and maintenance plan is publicly available.

An O&M plan would help clearly state the interventions of each and identify potential development (and its conditions) to enhance the area. In the riparian areas, the responsibilities are more blurred, between KFS, NEMA and the Nairobi Water Commission. The Nairobi Water Commission is a newly created authority, overseeing the riparian areas (30 m from the riverbed, 27 km along Nairobi River).

A clear strategy for Nairobi River Management and Restoration will help clarify the roles, responsibilities and budgets allocated for each stakeholder and plan more effectively the required actions.

FINANCIAL SCHEMES & SUSTAINABILITY

SCORE 1

- **Project costs, revenue generation and funding – Score 1**

There is no information on implementation or maintenance costs, neither for the park's creation in 2008, nor for its rehabilitation in 2020.

KFS Nairobi Region receives a quarterly budget allocation from the Ministry of Environment for all its managed urban forests and parks, including John Michuki Memorial Park. However, any unexpected expenses or developmental projects fall outside the scope of this budget.

The maintenance costs for equipment is estimated at KES 250,000 per year. The budget and source of funding for disaster management (e.g., destruction of sections of the riverbank due to stormwater) is not defined. Casual workers are paid between US$ 115 and US$ 195 per month.

The rehabilitation of the John Michuki Memorial Park (formerly known as Mazingira Park) was launched in 2020 at the initiative of the Cabinet Secretary Ministry of Environment and Forestry Hon. Keriako Tobiko. No information being publicly available, the project is supposed to have been funded by the State through the Ministry of Environment and Forestry.

The initial funding for the dump site cleaning and creation of Mazingira Park in 2008 is unknown as well. The park generates limited revenue since entry is free for individuals. Group activities, photography, weddings, and parking are charged. Certain areas of the park can also be rented for events, which adds to revenue streams. Managers report that limited funding constrains the scope of maintenance and expansion efforts.

The Simlaw Company also generates revenues through seedling sells, but the revenue stream is separate from the John Michuki Memorial Park. No information is publicly available on the financial arrangements between John Michuki Park and the Simlaw Company for space use or renting within the park area.

- **Integrated financial plan and project sustainability – Score 1**

No integrated financial plan was defined on the park, a significant gap considering the multiple stakeholders involved in its operation.

An integrated budget for the park including revenue and cost doesn't exist. Multiple institutions, agencies and groups intervene, maintain and use the parks for various purposes. The park's sustainable management would improve with a clear delineation of budget allocations and associated activities.

As part of the O&M plan, the maintenance plan and budget should be assessed during the design phase and adjusted during implementation if needed. The preparation of the O&M plan provides key elements to the project financial plan, essential both during design and execution, to ensure the technical and financial sustainability of the project.

The preparation of a financial plan will identify potential funding gaps and lead planners to either identify other revenue generation streams or funding sources or adapt technical design. This balance can be found through an iterative process.

MONITORING & EVALUATION SYSTEM

SCORE 1

- **Key existing indicators – Score 1**

Monitoring efforts are scarce and fragmented, and no specific performance indicators have been reported.

Several monitoring initiatives have been reported:
- Water quality measurements have been conducted on an *ad hoc* basis by the Nairobi Water Company that installed testing equipment during the rehabilitation phase.
- Nature Kenya from the National Museum comes every month in the park to monitor local fauna (especially birds) but their results are not circulated to KFS.
- The Nairobi Rivers Commission oversees the Nairobi River monitoring. In Michuki Park, instances of riverbank collapse have been reported due to excessive rainfall. This organization is tasked with finding innovative solutions to address such issues and ensure effective oversight of the river and its banks.

There is a missed opportunity for these organizations to come together and identify relevant performance indicators. KFS, as the park manager, is the dedicated actor to organize this type of meeting that fosters stakeholder collaboration and efficient monitoring. As an NbS, the John Michuki Park has the potential to provide a wide range of benefits to surrounding communities, thanks to ecosystem services enhancement and conservation. To ensure its performance and sustainability, it is essential to monitor result-based indicators relating to the ecosystem's health and its benefits on people. Activity-based indicators should also be involved to monitor the efficacy of management activities.

- **M&E system and knowledge dissemination – Score 1**

There is no monitoring and evaluation system at the park level yet, nor any communication strategy.

The existing monitoring initiatives mentioned before are not integrated into a comprehensive M&E system.

The operation of John Michuki Memorial Park involves multiple stakeholders which calls for the designation of an M&E focal point, ideally at KFS. Their role would be the centralization of indicator measurements, their transversal analysis, and the dissemination of key findings to the management board to inform decision-making and the coordination of activities. In particular, this M&E approach would highly benefit the management of riparian areas that represent the interface of KFS, NEMA, and the Nairobi River Commission responsibilities.

The M&E system should be tailored to the targeted benefits of the project, to help in
- Having a clear, long-term vision of the desired project results,
- Collecting, processing, and disseminating data,
- Adapting the project to evolving challenges for implementation and execution
- Clarifying involved actors, and their responsibilities.

The park is mostly visited by casual workers who use it as a resting area between work shifts. The park suffers from its historical reputation, and its small size limits its capacity to become a space for families and diverse groups. Knowledge dissemination could help inform the population about possible activities in the park and ensure its appropriate use to guarantee its sustainability. Signage around the park, or radio broadcasts are examples of applications to communicate about it.

River Stream Renaturation

GLOBAL CENTER ON ADAPTATION

CONDITIONS FOR UPTAKE

The John Michuki Park is one of the River Stream Renaturation showcase examples in Kenya, and is combined with Open Green Space, one of the most common NbS identified within urban context, reflecting the legacy of Garden City principles in African urban planning. Conditions for uptake have been identified based on the lessons learned from the case to ensure replicability and enhance the design of solutions in similar contexts.

Key inspirational features for associated NbS families

- **NbS family combination**: The John Michuki Park associates Open Green Space and River Stream Renaturation approaches, combining the restoration of the river and protection of its riparian areas with the provision of recreational area for the neighborhood, enhanced tree coverage and urban farming / economic activities.
- **Land development control enforcement example**: The 2020 restoration contributes to stop the land-grabbing process, through a combined strategy: (i) giving the area to play a specific and clearly defined role in the neighborhood, providing benefits to the people and to the city and (ii) ensuring security and safety by devolving the overall management to KFS, experienced in control enforcement;
- **Strong communication campaign to change public perception of the Park**: suffering from negative perceptions and stigma on previous insecurity issues and as a dumping site, the park organized a communication campaign for the reopening to market the park as a neighborhood and educational place for the inhabitants, far from the former dumping site and risky area it was.
- **Public-private collaboration to foster economic development and generate revenue**: the private registered company, Simlaw Seeds, was associated since the beginning of the project in 2020 and hosts part of its urban farming activities (especially innovation lab) within the park area. Nonetheless, revenue generation and the global financial plan remain unclear.

Key improvement area for NbS replicability across Kenya

- **Scale up the ecological potential of the Park**: integrating John Michuki Park (and more broadly Open Green Spaces and River Stream Renaturation) within a broader ecological and biodiversity landscape is key to realize the full potential of such project and provide substantial environmental and biodiversity benefits. For instance, the park could be part of a broader strategy associating green park and river restoration along the Nairobi River (*see Nairobi River Life project*).
- **Integrate climate change hazard analysis**: Open Green Spaces and River Stream Renaturation are key to adapt to climate risks, and project planning should always include a climate risks mapping and identification of climate risks resilience as a primary objective to streamline the integration of climate risks into project design, maintenance and evaluation – to avoid, as it has happened recently, riverbank collapse and destruction of public infrastructure in the Park.
- **Set up a shared monitoring and maintenance framework among the stakeholders intervening in this complex project site:** going beyond its first beautification role hence requires technical capacity building of the stakeholders to identify proper solutions to such challenges and adapt their activities accordingly. This includes monitoring and evaluation of the activities to assess the effective benefits of the park, compared to the targeted results. Indicators are key to keep improve and adapt to the evolving climate conditions and assess the efficiency and adequacy of the proposed measures. To support these monitoring activities, a shared structure of governance is necessary to address these very cross-sector issues.
- **Ensure an inclusive design that maximize co-benefits**: the core security focus of the Park maintenance overshadows other potential design benefits, especially on the riverbank management. A co-design approach drawing different expertise would help find the best solution to solve conflicting uses and objectives.

Case 11 – Green Corridors in Nakuru

Green corridors are vegetated strips connect green spaces within a city, forming a green urban infrastructure network that supports biodiversity and ecological connectivity (World Bank, 2021). Examples include riparian corridors along rivers and streams, tree-lined streets and avenues, converted railways into linear parks, urban greenways linking parks and gardens, and vegetated utility corridors beneath power lines (NWRM, 2015; World Bank, 2021). These corridors allow flora and fauna to move and propagate, while enhancing the landscape's capacity to mitigate flood risks. The imbalance between paved surfaces and impervious areas in many cities exacerbates flooding and pollution due to overburdened drainage systems. Establishing green corridors increases water absorption, storage, and recirculation, reducing strain on sewerage systems and protecting urban environments from flooding and polluted discharges. Additionally, green corridors alleviate urban heat stress by providing shade and promoting evapotranspiration (Arshad et al., 2024; Jiang et al., 2021), contribute to carbon sequestration (Tang et al., 2016), improve human health by increasing thermal comfort (Capobianco et al., 2024), and strengthen urban identity and cultural values (Yilmaz and Mumcu, 2016).

ONGINGA ODINGA ST. & KENYATTA AV.
The following section examines two cases of green corridors in Nakuru highlighting the opportunities and challenges of designing and implementing such green infrastructure in urban road design in Kenya.

Key inspirational features: *planters, street tree canopies and swales to combat urban heat, enhancement of air quality, pedestrian-friendly spaces*

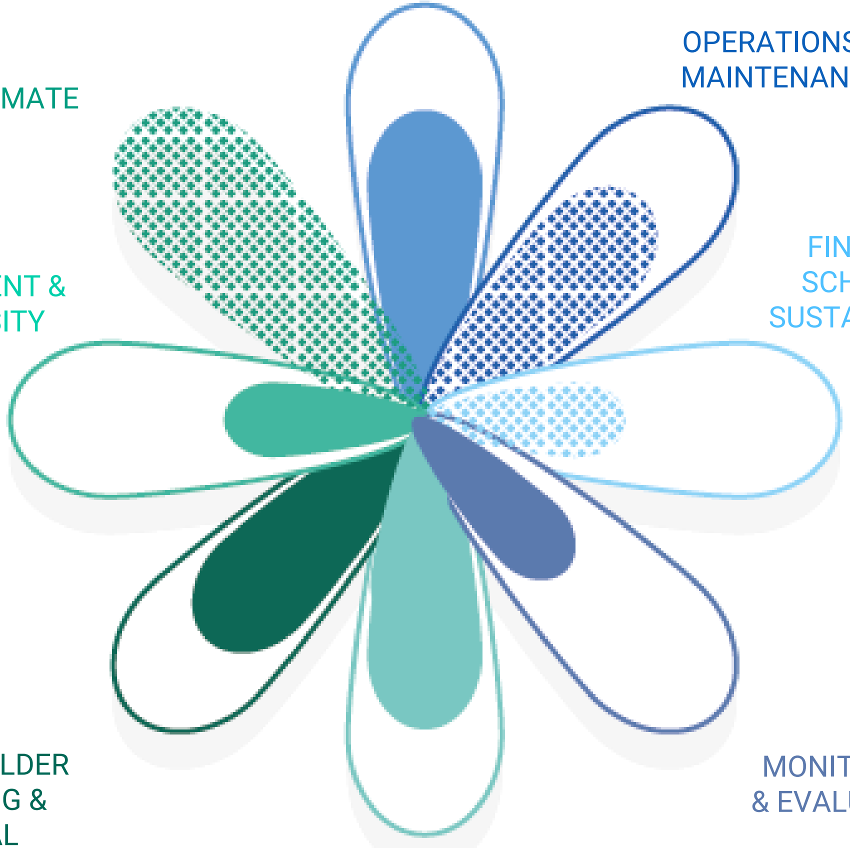


Figure 125 – Gap analysis result for Nakuru Green Corridors
(Source: SUEZ Consulting, 2024)

PROJECT PRESENTATION

Both projects are combined as a single case, as they showcase the same NbS family and illustrate how a municipality can develop a network of similar NbS within different investment contexts.

Kenyatta Ave & Moi Street project

The Nakuru City Board sought to enhance the urban environment along Kenyatta Avenue and Moi Street using NbS, such as bioretention areas and green corridors, to support sustainable development. Funded under KUSP1 and implemented between 2020 and 2021, the initiative focuses on improving aesthetics, promoting walking and cycling, boosting public safety, and encouraging eco-friendly mobility. The project transforms Nakuru's streetscape with pedestrian pathways, cycling lanes, tree-lined corridors, street furniture, bus stops, and vending areas. It emphasizes inclusivity with accessibility features like at-grade crossings for differently-abled persons. It also addresses urban climate challenges like surface water runoff and the heat island effect and reduces carbon emissions.

Oginga Odinga Street project

Funded and implemented by the Kenya Urban Roads Authority (KURA), this project aims to mitigate urban heat island effects, improve street aesthetics, enhance air quality, and support biodiversity in Nakuru City. Spanning 1.16 km with a width of 24 meters, the NbS includes planting street trees and creating swales to manage stormwater runoff. The trees provide shade, improving thermal comfort for pedestrians and cyclists while boosting urban biodiversity. The project enhances Nakuru's green infrastructure, reducing heat, improving air quality, and fostering social cohesion, while promoting active mobility through shaded spaces.

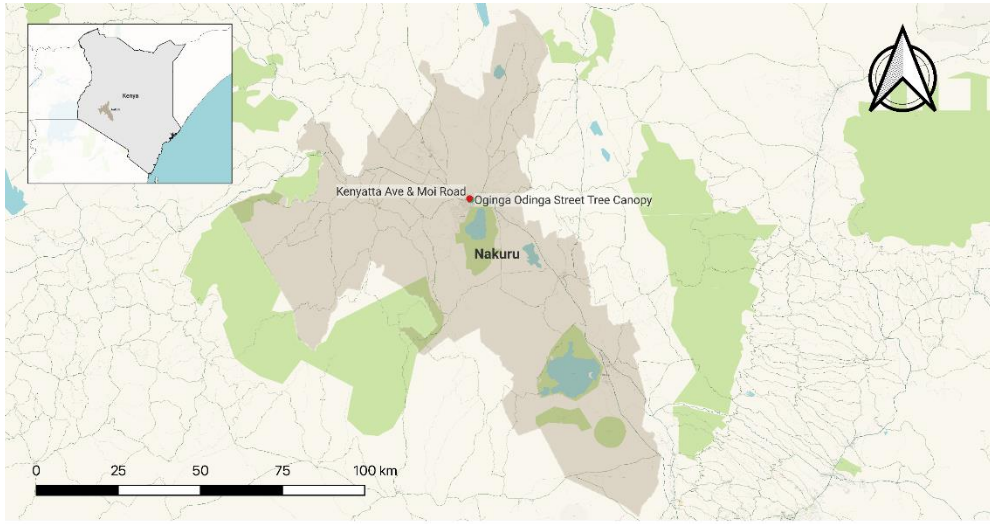


Figure 126 – Location Map of the two Nakuru Green Corridors
(Source: SUEZ Consulting, 2024)

Figure 127 – Junction between Kenyatta Ave & Moi Street
(Source: SUEZ Consulting, 2024)

Figure 128 – Oginga Odinga Avenue
(Source: SUEZ Consulting, 2024)

Figure 129 – Road near Kenyatta Avenue
(Source: SUEZ Consulting, 2024)

CLIMATE

SCORE 2.5

• **Project response to climate risks – Score 3**

The green corridors are explicitly aiming at responding to flood and urban heat.

The main climate risks in Nakuru County include flooding, prolonged droughts, unpredictable rainfall patterns, rising temperatures which all coalesce to increase the risk of waterborne diseases, landslides, fires and general environmental degradation.

The county experiences flooding causing extensive destruction of infrastructure, including roads, water reservoirs, and buildings, particularly in river basins such as Tana and Lake Victoria leading to displacement, property damage, and loss of life. Prolonged droughts have become more frequent, especially affecting communities in the county's semi-arid areas. These droughts contribute to famine and negatively impact agricultural and livestock production. The county experiences significant rainfall variability, with some areas facing prolonged dry spells while others receive higher-than-average rainfall. This variability affects agricultural productivity and water availability. The county has been experiencing rising temperatures leading to extreme heat. Nakuru city recognizes the limits of a grey infrastructure drainage system to respond efficiently to extensive flood, as this system has merely displaced and fueled in the flood hotspot to other more low-lying parts of the city.

The NbS elements (i.e., trees and vegetation) in the two projects were explicitly designed to reduce flood risk to favor infiltration, as well as contribute to carbon sequestration and address urban heat island. On Kenyatta avenue, tree were planted with planting pit wide enough to allow water infiltration. Though not monitored, the decrease in street floods has been visually observed by the municipality staff.

• **Project adaptation to local climate conditions (present and future) - Score 2**

Being disconnected site-based interventions, the adaptative capacity of these two projects to changing climate conditions isn't evident. Elaborating a sponge-city plan would help strengthen this adaptative capacity.

Both projects are well adapted to current and projected climate risks of flooding and, rising temperatures. The swales and green avenues provide cooling along with other benefits, such as green avenues with well watered trees to reduce the air temperature in and around a street by up to 1.6 °C during heat waves (Shashua-Bar et al., 2011; Albers et al., 2015). Swales and filter strips are excellent interventions for mitigating flood risk. They increase permeability of the urban landscape reducing the volume and speed of runoff during heavy rainfall events, while allowing infiltration and groundwater recharge. Roadside swales can manage road runoff onto adjacent land, reducing disruption from flooding and alleviating pressure on urban drainage systems. Trees and vegetation in green avenues, swales and roadside planters also contribute to carbon storage, addressing both climate adaptation and mitigation and improving air quality.

At the time of the design, climate resilient capacity of the plants and trees weren't a key criteria in tree selection. Given that they are quite recent project, mortality rate wasn't raised as an issue when site were visited. However, as they are quite recent project, monitoring should continue to further evaluate the adaptative capacity of these green corridors.

The Nakuru Municipality has the intention of developing a sponge-city network. This would strengthen the connectivity of these isolated project sites and ensure a more systemic response at the city-level to flood risk prevention.

ENVIRONMENT AND BIODIVERSITY

SCORE 1

- **Project response to environmental risks – Score 1**

Nakuru City faces significant environmental challenges, including urban heat, air and water pollution, and inadequate solid waste management. A major threat to its long-term sustainability is the frequent blockage of swales due to waste accumulation.

Nakuru City faces several environmental challenges, including water pollution from untreated sewage and industrial waste discharged into Lake Nakuru and other water bodies, severely impacting ecosystems. The biodiversity of Lake Nakuru is threatened, with flamingo populations declining due to changes in water chemistry. Solid waste management is another major issue, as about 40% of the city's waste remains uncollected, leading to improper disposal and plastic pollution. Air pollution, deforestation. Land degradation from settlement and agriculture in surrounding areas have caused increased soil erosion and siltation of Lake Nakuru. Finally, inadequate water and sanitation infrastructure poses risks to both human and ecosystem health (Muoria et al., 2024).

At the county level, the main environmental risks in Nakuru County include flooding and rising temperatures which all coalesce to increase the risk of waterborne diseases, landslides, fires and general environmental degradation. Landslides, pollution, poor water quality and wildfires are common natural hazards in the region. Coupled with climate risks, they worsen environmental degradation.

While swales, planters and linear green corridors incorporated into the two projects can address these environmental risks, without clear maintenance protocols, solid waste management problems and deficits in sanitation infrastructure may be a threat to the NbS' sustainability. Furthermore, the use of non-native species such as Jacaranda trees on the green avenue may compromise biodiversity in the long run.

- **Environment and urban biodiversity benefits – Score 1**

Green corridor potential ecological benefits are reduced by the design choices that have been made, and by their location along the infrastructure network.

NbS like swales, roadside planters, and green avenues incorporated into the two projects enhance ecosystem services, improve stormwater management, and support groundwater recharge. Tree-lined avenues, swales, and planters help regulate temperatures, reduce the urban heat island effect, and address air pollution, while creating habitats for native flora and fauna. These features also slow runoff, reduce erosion, promote groundwater recharge, and mitigate flood risks. Vegetation in swales and green avenues improves soil fertility by adding organic matter and nutrients, supporting microorganisms and beneficial fungi. This boosts soil health and carbon sequestration. Swales also filter pollutants, improving water quality and reducing turbidity before runoff enters water bodies like Lake Nakuru. Overall, these NbS solutions contribute to restoring Nakuru's ecosystems.

The municipality and local stakeholders have acknowledged these benefits and are moving from cutting down the trees in Odinga Avenue to restoring tree canopy. Biodiversity is not a key objective of these projects: trees have been chosen for height, aspect, root orientation than for biodiversity reason, and multi-layered vegetation plan is missing. By connecting green corridors to mobility infrastructure, the ecological potential of these green corridors is also weakened due to traffic disturbance.

Implementing ecological design and management of these green corridors, locating some of these corridors away from the infrastructure network, would greatly boost their local biodiversity benefits.

STAKEHOLDER MAPPING & SOCIAL INCLUSION

SCORE 2

- **Stakeholder engagement & consultation strategy – Score 2**

Iterative implementation of green corridors as isolated projects provide opportunities to generate public acceptance of a changing urban environment.

Key stakeholders in the design and implementation of green corridors in Nakuru included local and national government bodies, private sector consultants, and contractors. The Kenyatta Avenue and Moi Street project was co-funded by the World Bank and the Government of Kenya under the KUSP1. The Nakuru City Board oversaw design, implementation, monitoring, and evaluation, working alongside consultants (Mwitari Civil & Building Engineers and Sustainable Mobility Concepts Ltd.) and contractors (Statesman Agencies). For the Oginga Odinga Street Tree Canopy, the primary funder was KURA, which also managed the design and implementation process. In both projects, the Nakuru County Department of Environment was responsible for post-construction maintenance, including waste management, vegetation care, inspections, and repairs, employing casual laborers.

Public acceptance was a key focus of the consultation strategy. Nakuru residents provided input through citizen fora. They identified, prioritized and provided feedback on the projects. To build trust and demonstrate benefits, a trial section was first showcased to the community. This pilot effectively eased tensions and fostered a sense of ownership, ultimately gaining local support for full-scale implementation. Local stakeholders have also highlighted the importance of hiring competent consultants and contractors through efficient procurement processes.

Engagement strategies could further encompass the entire project lifecycle, from early planning and design phases to post-construction monitoring and maintenance decision-making, which could ensure sustained ownership.

- **Socio-economic benefits and inclusion of vulnerable group – Score 2**

Green Corridors in Nakuru support local businesses and offer recreational benefits. However, benefits could be further enhanced with a purposeful and well-designed social cohesion strategy that specifically addresses the needs of vulnerable groups.

The Green Corridor projects in Nakuru offer several indirect socio-economic and community benefits. The employment of casual laborers during both the construction and maintenance phases created temporary job opportunities. Improved accessibility for all road users also benefits local businesses by creating cleaner, more attractive environments that increase foot traffic and boost commerce. Additionally, the trees help mitigate urban heat island effects, improve air quality, and provide shade. Green spaces and shaded areas enhance safety, reduce noise pollution, and create a more serene environment, promoting mental well-being.

These features enhance accessibility for vulnerable groups, but further measures are needed to ensure greater intentional inclusion throughout the project's lifecycle. Vulnerable populations could be engaged more directly during the planning phase. Targeted training and job opportunities for green space maintenance, landscaping, and environmental monitoring could create long-term, sustainable economic benefits.

The project also indirectly supported planting initiative by local residents among which some green ambassadors such as Meshack Maina, a boda boda driver, are emerging.

However, being mainly located around the CBD, these green corridors project may entail some neighborhood gentrification dynamics that need to be paid attention to.

PLANNING LEGAL, REGULATORY & POLICY FRAMEWORK

SCORE 2

- **Planning and development strategy – Score 2**

The two green corridors project are part of a broader incremental strategy to elaborate a sponge-city plan.

The Oginga Odinga Street Tree Canopy project was initiated by the Kenya Urban Roads Authority, while the Kenyatta Avenue and Moi Street project was led by the Municipality of Nakuru as part of the WB-funded KUSP1.

Both align with Nakuru's urban planning objectives by contributing to greening the city, reduction of traffic congestion and pedestrian/cyclist comfort. Nakuru Transport Master Plan has been developed by KURA to guide project prioritization across Nakuru for road improvement.

The involvement of the transport sectoral agency and the municipality in these two projects paves the way for more collaboration between these two institutions and showed that national agency has already put in place some NbS design principles in their infrastructure investment framework.

It highlight the potential and the need for high-level collaboration between the municipality and the different sectoral agencies to foster NbS mainstreaming and integrated development in key urban infrastructure and development project.
Lastly, the objective of the municipality to design a sponge-city network would help move from a piecemeal intervention to a more systemic and planned framework.

- **Regulatory and land tenure strategy – Score 2**

Though NbS land tenure is secured, adding NbS into urban dense areas involves a complexity of accommodating multiple uses in a narrow space.

The Oginga Odinga Street Tree Canopy was implemented within a 1.16 km public road reserve. The NMT project is located on 1.2 km of public road reserve, connecting key recreational areas like Lions Garden and Nyayo Garden. This provision of public land for both projects provided a secure foundation for implementation without land tenure conflicts. The location within a road reserve effectively anchored the intervention in public infrastructure, reducing land-use disputes.

The public ownership of the land, by KURA or Nakuru County or Nakuru Municipality, facilitated the integration of green corridors and pedestrian-friendly designs, preventing land tenure conflicts. The use of road reserves to integrate green infrastructure demonstrates the potential for zoning regulations to support NbS. Establishing clear guidelines for allocating and protecting road reserves for green development could serve as a replicable model for other urban areas. Expanding zoning policies to mandate green corridors in urban designs in would also further strengthen the integration of NbS.

Concerning long-term land-use, the municipality indicated the possibility of turning existing swales into covered grey drainage channels to mitigate waste blockage and provide cycle path. Green corridors would then be only focused on tree canopies. This reminds that swales require space to be implemented that is often rare in urban dense areas, and that their compatibility with other uses need also to be taken into account in the design.

IMPLEMENTATION PROCESS AND TECHNICAL FEATURES

SCORE 2

- **Implementation process – Score 2**

Since the two examples followed different investment processes, the commitment and acculturation of county environmental officer and municipal manager to green corridor infrastructure were key for ensuring consistency at the city level.

Project identification and prioritization in Nakuru occur within a broader institutional and legislative framework, notably the CIDP, a five-year plan integrating spatial, environmental, and sectoral objectives. These are further refined in LPLUDPs at the county and local levels, aligning strategic priorities with spatial development and public budgeting (Chanin-Morris et al., 2023). All projects undergo formal public participation, ensuring community input shapes interventions. This participatory process ensures that Nakuru potential nature-based infrastructure projects identified incorporate community feedback, environmental sensitivity checks, World Bank screening tools, and feasibility studies ensuring only projects with medium or low environmental impact are implemented (Muwonge, 2018; Urban Development Department, 2023).

The contrasting funding mechanisms for Nakuru's green corridors reflect these processes. For KURA-funded improvements along Oginga Odinga Street, the authority followed its internal protocols, guided by national standards and environmental safeguards. In contrast, for the NMT interventions along Kenyatta Avenue and Moi Road, municipal authorities first submitted proposals for funding approval. Once confirmed, they initiated an open tender process for contractors and consultants. During design development, the appointed consultant conducted field surveys to ensure evidence-based planning.

Once projects pass through these procedural and participatory stages, implementation proceeds with transparent procurement, adherence to legal and technical standards, and ongoing oversight. For instance, the KURA-funded Oginga Odinga Street corridor followed established Kenyan road and urban design manuals, while the KUSP1-financed improvements on Kenyatta Avenue and Moi Street involved a competitive open tender process and consultant-led field surveys. Additional community engagement took place before construction: a trial section of the NMT project was built and presented to the community (Nakuru City Manager, 2024), which was effective in garnering local support for full-scale implementation.

Existing local documentation for Nakuru Green Corridors

- Proposed Consultancy Services for Design, Documentation, Supervision for Construction of Non-Motorized Transport, Street lighting and Storm Water Drainage Nakuru Central Business District: Design Report (Mwitari Civil & Building Engineers, 2021)
- Road Design Manual for Roads – Part II: Drainage Design (Ministry of Transport and Infrastructure, 2009)
- The Street Design Manual for Urban Areas in Kenya (2019 Draft) (Ministry of Roads and Transport, 2022)
- Kenya Roads Maintenance Manual (Ministry of Roads, 2010)
- Environmental Management and Coordination Act, 1999

Other relevant guidance for Green Corridors

- Green Infrastructure Installation, Operation, and Maintenance (US EPA, 2024)

IMPLEMENTATION PROCESS AND TECHNICAL FEATURES | SCORE 2

Technical Features – Score 2

The technical features of the Nakuru green corridor projects reflects an integrated approach that balances engineering, environmental stewardship, and inclusivity.

Adherence to national guidelines—including the KURA standards, the Street Design Manual for Urban Areas in Kenya (2019 Draft), and the Road Design Manual Part III—ensured the interventions met both infrastructural and ecological requirements. Compliance with the Environmental Management and Coordination Act (EMCA) of 1999 (Revised 2015) and alignment with the World Bank's screening processes further minimized negative environmental impacts (Urban Development Department, 2023).

NbS such as swales, planters, and green corridors were integrated to improve ecosystem services, stormwater management, groundwater recharge, and biodiversity. Tree-lined avenues regulate temperatures, reduce the urban heat island effect, and create habitats for native species. These elements were central to the design, ensuring tangible environmental benefits. Feasibility assessments guided the inclusion of SDGs, addressing gender and climate change mitigation. Infrastructure features like accessible crossings, protected cycling lanes, vending areas, and proper lighting prioritized safety and comfort, particularly for differently-abled individuals.

Drawing on locally generated data from reconnaissance tours, NMT surveys, parking assessments, and guidelines from the Street Design Manual for Urban Areas in Kenya, these technical solutions were tailored to local conditions and user needs Manual (Ministry of Roads and Transport, 2022; Mwitari Civil & Building Engineers, 2021).

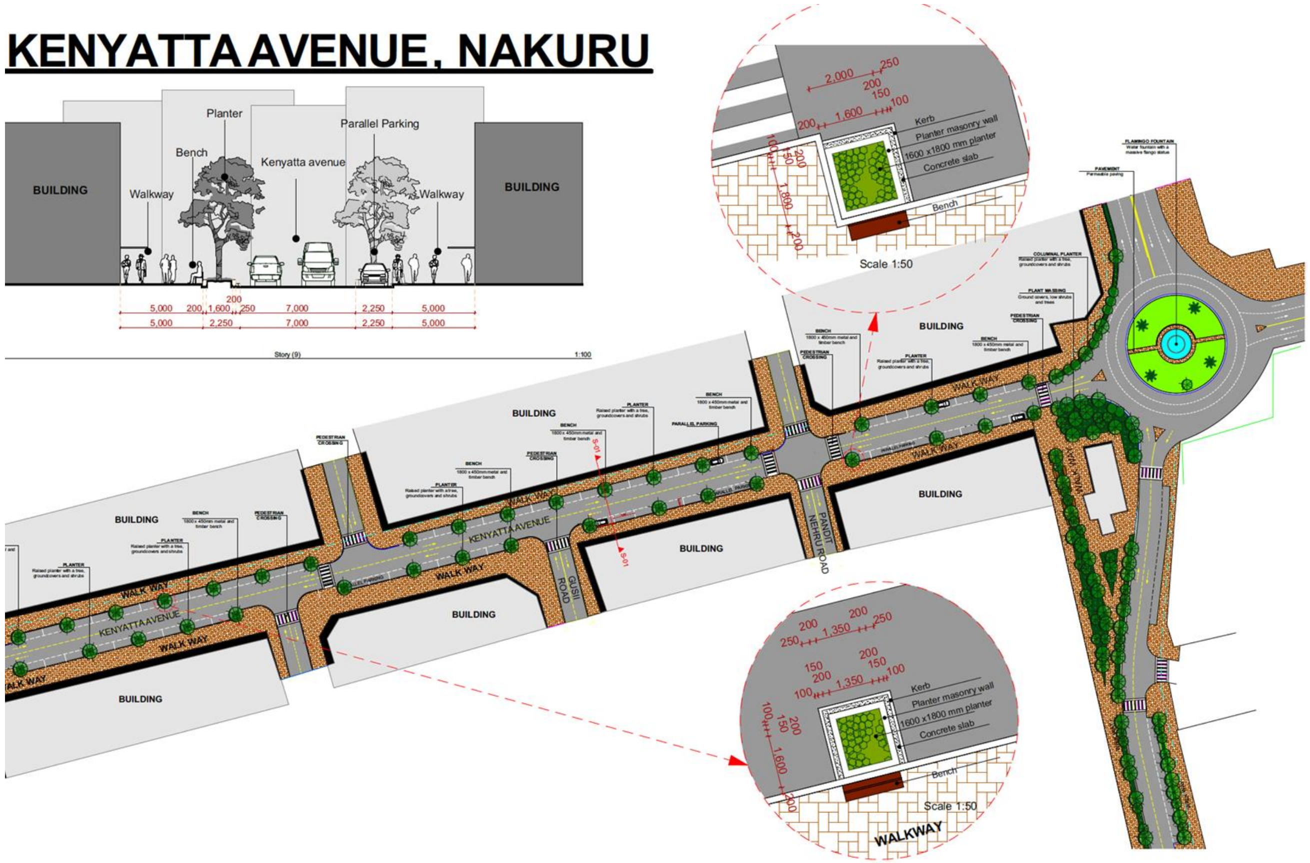


Figure 130 – Layout of the Kenyatta Avenue street tree planters
(Source: County Government of Nakuru)

IMPLEMENTATION PROCESS AND TECHNICAL FEATURES | SCORE 2

MOI ROAD, NAKURU

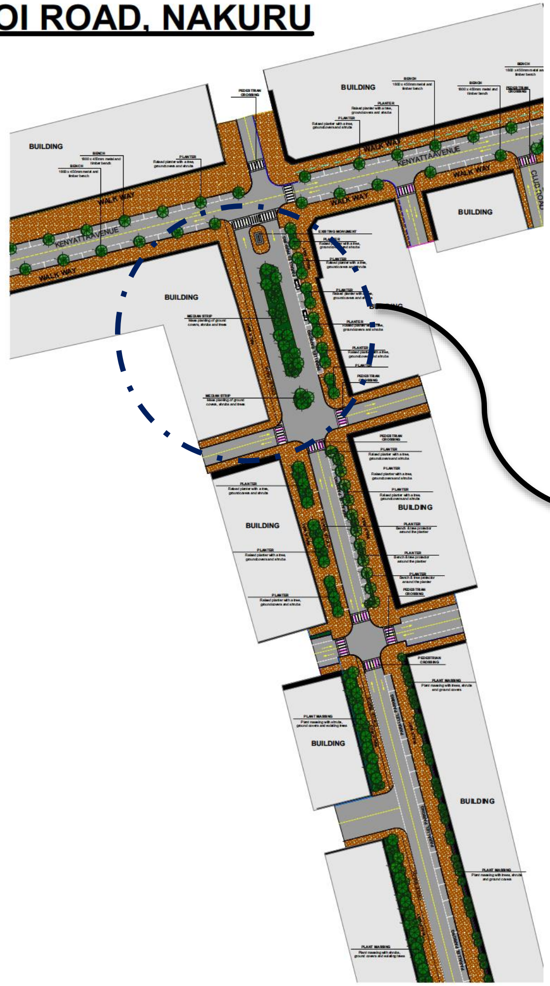


Figure 131 – Plan of the Moi Road street tree planters as per the existing drainage layout
(Source: County Government of Nakuru)

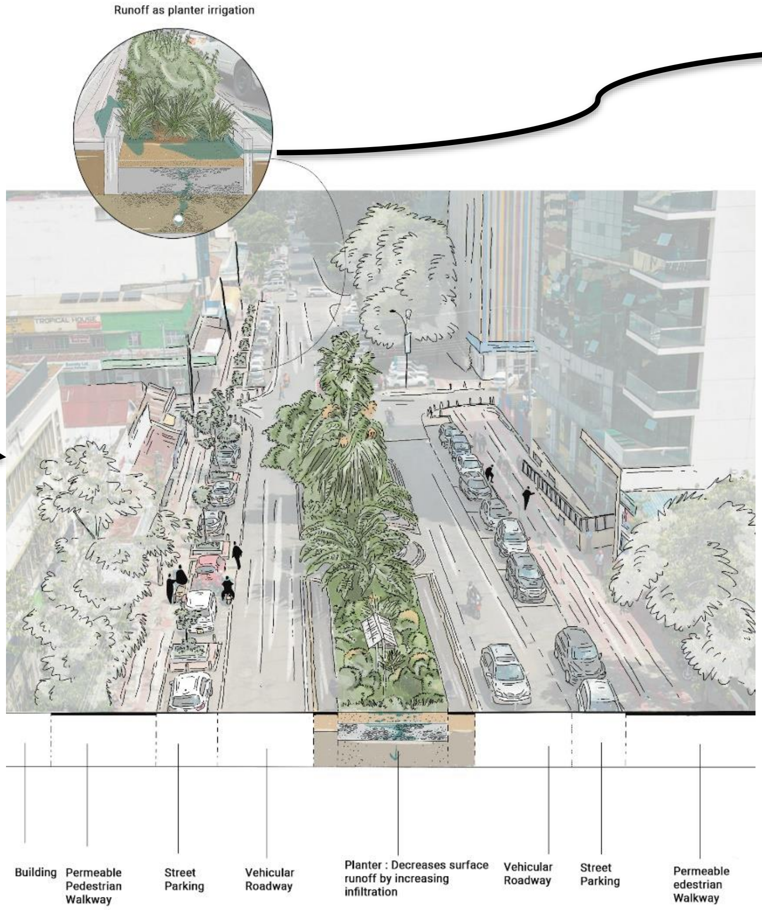
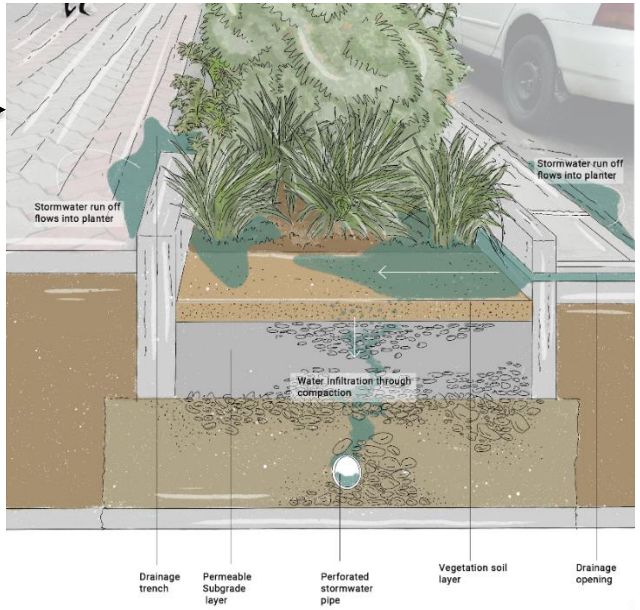


Figure 132 – Overlay illustrating sketches of the proposed improvements to the Moi Road street tree planters, including stormwater integration and permeable pavement design
(Source: Suez Consulting)



Proposed improvements for future similar projects

Future similar projects can focus on integrating street tree planters and planted islands into the existing drainage network. Stormwater can be directed into the planters to enable natural infiltration, reducing reliance on external irrigation and improving soil moisture for healthier tree growth. Excess runoff can be managed through perforated pipes connected to the main drainage line, preventing waterlogging and maintaining efficient drainage. Additionally, the pedestrian walkway can be converted into permeable pavement, which would further enhance water infiltration and reduce surface runoff.

IMPLEMENTATION PROCESS AND TECHNICAL FEATURES

SCORE 2

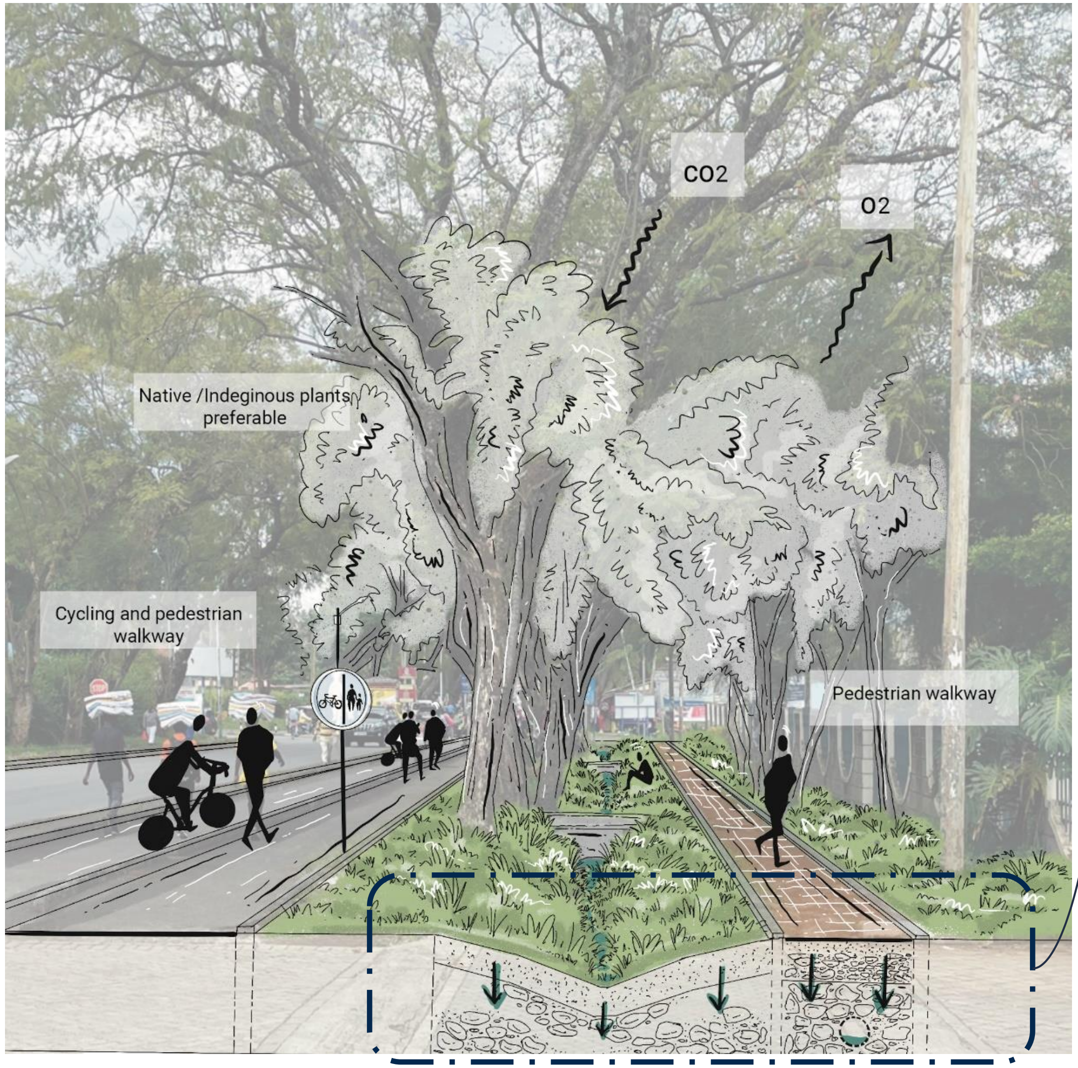
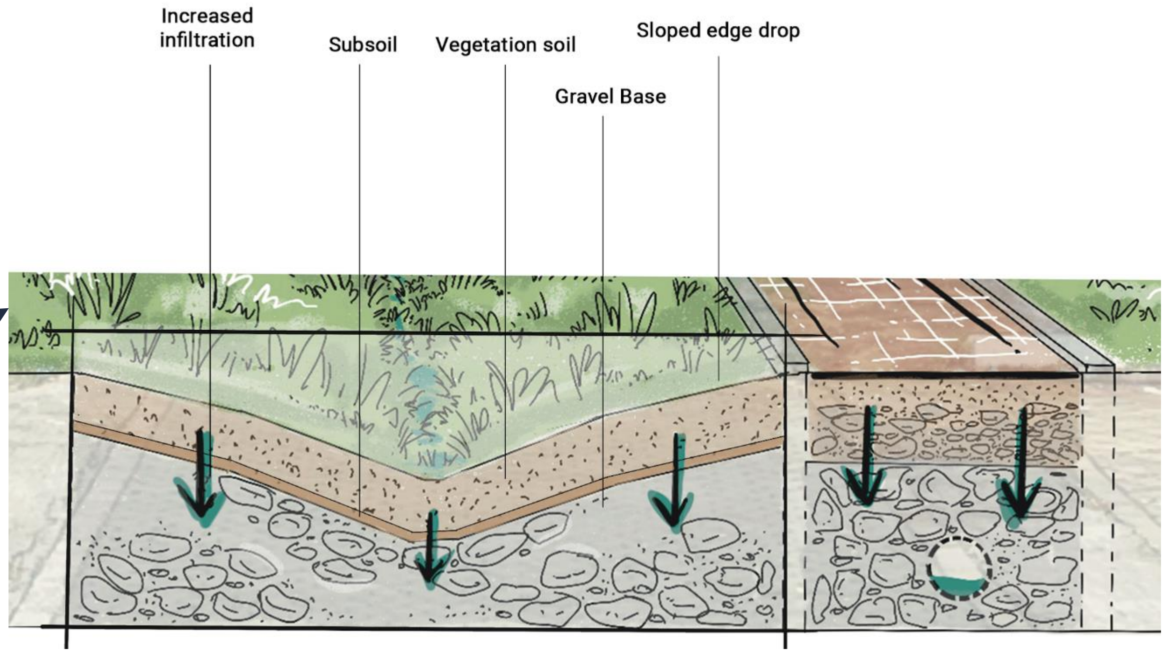


Figure 133 – Overlay of the proposed improvements along Oginga Odinga Street (Source: Suez Consulting)



Proposed improvements for future similar projects

First, clearly defining pedestrian and cycling zones can reduce user conflicts and enhance safety. A potential alternative involves constructing a walkway over the existing drainage channel, using a high-infiltration surface and a perforated pipe with equivalent hydraulic capacity. This approach would accommodate heavy rainfall while infiltrating lower flows, improving groundwater recharge and flood resilience. Additionally, replacing non-native trees with indigenous species will enrich local biodiversity and provide better ecological services.

Kisumu NMT Triangle Project, Kenya

Implemented under the World Bank-financed KUSP1, this initiative aims to improve urban mobility and safety in Kisumu, Kenya's third-largest city. The project reconstructed 1.5 kilometers of walkways along Oginga Odinga Street, Ang'awa Avenue, and Jomo Kenyatta Highway, focusing on promoting NMT and creating safer, more inclusive urban spaces. Key features included wide, raised footpaths, protected cycle lanes, and accessible pedestrian crossings, along with stormwater drainage, utility ducts, solar streetlights, and public toilets. These interventions addressed the need for functional, equitable urban spaces, aligning with strategies in Nakuru's green corridor projects.

The design included features like bollards to prevent vehicular encroachment, permeable paving around conserved trees, and streetlights for enhanced security. Public transport facilities, including bus shelters and universally accessible at-grade crossings, were integrated to improve connectivity and access. Maintenance, supported by increased budget allocations, involved routine inspections and repairs to ensure long-term infrastructure functionality. Like the Nakuru project, Kisumu's use of vegetation and permeable surfaces demonstrates the potential of NMT projects to provide broader ecosystem benefits. However, the project faced challenges such as limited space for a dedicated cycle track, vehicle encroachment, and insufficient enforcement.

This project's approach, also reflected in Nakuru's interventions, illustrate the scalability of NMT-linked NbS, offering a blueprint for sustainable urban development across Kenya.

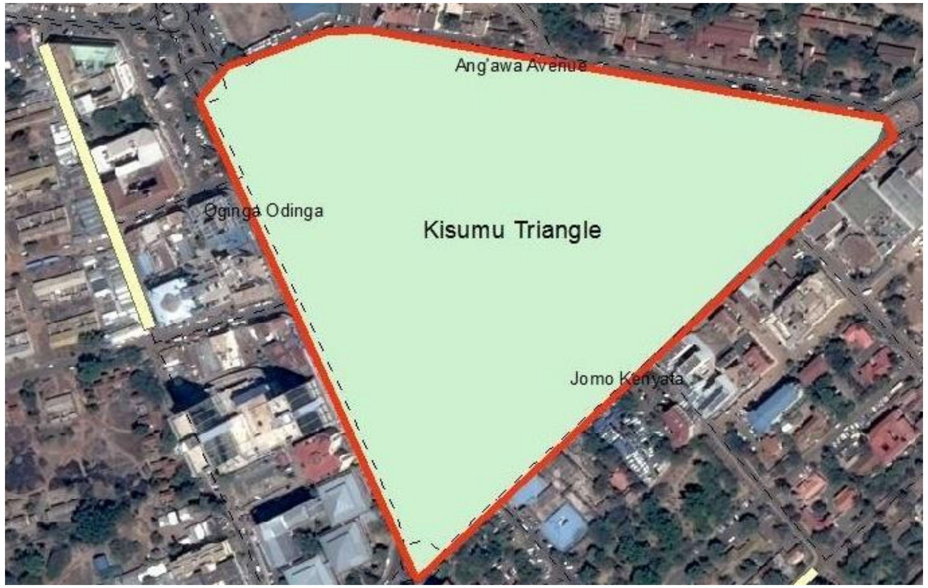


Figure 134 – Location and extent of the Kisumu Triangle project (Source: K'Oyoo, 2023)

Figure 135 – Pedestrians using one of the constructed walkways with integrated planters (Source: Institute for Transportation and Development Policy, 2021)

OPERATIONS & MAINTENANCE

SCORE 1.5

- **Roles and responsibilities – Score 2**

Maintenance involves the collaboration between county-level environment department and the Kenya Urban Roads Authority.

The Nakuru County Department of Environment oversees the maintenance and management activities for Kenyatta Ave and Moi Street. For the maintenance of the Oginga Odinga case, the Nakuru County Department of Environment collaborates with the Kenya Urban Roads Authority (KURA).

For NbS integrated with roads or pavements (e.g., tree pits, planters), maintenance needs to be scheduled in collaboration with institutions which are responsible for underground services (e.g., pipes and cables under pavements). This didn't look to be the case when the project site was visited.

The environmental aspect of NbS beyond aesthetics features is not monitored.

- **Operation & Maintenance Plan – Score 1**

For both projects, the maintenance budget is allocated as a lump sum at county level, thus neither project has a specifically allocated budget for maintenance.

Maintenance of the Oginga Odinga street

While the maintenance budget is allocated as a lump sum for the entire county and not site-specific, casual laborers are employed by the department to perform various tasks. These activities include regular street cleaning and solid waste removal, which helps maintain cleanliness and reduce environmental risks. Vegetation management is also a key focus, involving grass cutting, weeding, thinning of trees, and pruning of overgrown vegetation to ensure a healthy and controlled environment.

Kenyatta Ave and Moi Street

Routine maintenance activities include regular inspections to assess the condition of infrastructure, such as permeable pavements, streetlights, and Closed-Circuit Television (CCTV) installations. Tree care, specifically pruning trees planted along the streets, is a key activity to ensure the health and growth of the urban greenery. Drainage systems are regularly unclogged to prevent flooding, which is particularly important during the rainy season. Additionally, broken pavement blocks are replaced promptly to maintain pedestrian safety and the overall aesthetic of the streets. The department employs casual laborers for these tasks, although the budget allocated for maintenance is a lump sum, covering various cases across the county rather than being site-specific.

FINANCIAL SCHEMES & SUSTAINABILITY — SCORE 0.5

- **Project costs, revenue generation and funding – Score 1**

Both projects were financed through different funding mechanisms, but limited information is available on implementation and operation costs.

Oginga Odinga Street Tree Canopy was funded by KURA, but not information is available on its implementation cost. The maintenance costs tap into a lump sum budget provided by Nakuru County meant to cater for all maintenance activities in the county. The planters are maintained by 10 casual workers at a cost of US$ 4.65 per person per day. On the other hand, the Kenyatta Avenue and Moi Street green corridor was funded by the World Bank under KUSP1. The implementation cost was around US$ 625,850. Maintenance is funded by the same Nakuru County budget, but no information was collected on upkeep costs. Managers report a lack of maintenance budget. There was no mention of revenue generation induced by these NbS.

- **Integrated financial plan and project sustainability – Score 0**

No information was collected on the financial plans behind either projects.

They both followed some existing implementation frameworks through their funding agencies, suggesting some level of financial planning took place. Both NbS projects have contrasting funding mechanisms and associated processes:

- On Oginga Odinga Street, KURA followed its internal protocols, guided by national standards and environmental safeguards,
- On Kenyatta Avenue and Moi Street, municipal authorities followed KUSP1 requirements involving initial proposals to secure funding approval, contractors and consultants' procurement, and evidence-based planning through field surveys.

MONITORING & EVALUATION SYSTEM — SCORE 1

- **Key existing indicators – Score 1**

No performance indicators are clearly in place on either projects.

The benefits are generally measured through observations. Some sensors were installed on Oginga Odinga Street to monitor air quality, but data is unavailable. Benefits evaluation is centered around community's satisfaction on Kenyatta Avenue and Moi street, but no indicators or specific measuring techniques have been reported.

- **M&E system and knowledge dissemination – Score 1**

There is barely any M&E system in Nakuru, nor any communication strategy.

On both sites, monitoring and evaluation are only conducted by site visits with no particularly defined process. On Oginga Odinga Street, potential benefits were identified during the environmental and social impact assessments. This represents a missed opportunity to not have adapted the evaluation tool developed during implementation for the execution phase.

There is no specific knowledge dissemination strategy in place in Nakuru. There was some community involvement during the project identification and project design phases in the form of participation fora. It is difficult to state whether these consultations were more of a tokenistic nature or actually involving beneficiaries.

However, an interesting example of initiative to foster community buy-in is found in Nakuru. To build confidence and demonstrate the potential benefits of the project, a trial section of the NMT was constructed and showcased to the community, building local support for the full-scale implementation.

CONDITIONS FOR UPTAKE

This case is included in this NbS Compendium to demonstrate how green corridors in urban settings can address multiple sustainability challenges. This case highlights the central role of NMT infrastructure in creating multifunctional urban spaces that support biodiversity, manage stormwater, and promote eco-friendly mobility. Conditions for uptake have been identified based on the lessons learned from the case to ensure replicability and enhance design of the solutions in similar contexts. The proposed enhancement illustrates how better integration of tree-lined avenues, planted islands, and pedestrian pathways can deliver NbS that serve environmental and social needs.

Key inspirational features for associated NbS families

- **Optimizing NMT for NbS Benefits**: While NMT infrastructure primarily improves urban mobility, this case underscores its potential to deliver additional NbS benefits. By incorporating features like tree canopies, permeable pavements, and integrated drainage systems, NMT corridors can become tools for stormwater management, microclimate regulation, and biodiversity enhancement.
- **Community engagement in design**: The project's success demonstrates the value of early and consistent community involvement and iterative design process to allow room for progressive social appropriation of a changing urban context. Stakeholder consultations informed design decisions, addressing local needs while building support for interventions like tree planting and infrastructure adjustments.

Key improvement area for NbS replicability across Kenya

- **Enhance Policy Integration:** ensure green corridor projects are integrated into CIDPs LPLUDPs. As envisioned by Nakuru Municipality, this strategy can also be supported by a dedicated sectoral planning such as a sponge-city plan to allow a more consistent city-scale approach as opposed to current piecemeal development strategy;
- **Strengthen NMT Design for NbS benefits**: adapt NMT infrastructure designs in the Street Design Manual for Urban Areas in Kenya to maximize NbS outcomes, such as incorporating permeable pavements, stormwater-linked planters, and indigenous tree canopies to enhance biodiversity, regulate urban temperatures, and manage water resources.
- **Develop a clear planting guidelines**: prioritize the use of indigenous tree species in urban greening initiatives to support local ecosystems, reduce water demand, and align with regional biodiversity goals, integrate a variety of plant layers to the design to foster local biodiversity development and develop corresponding maintenance strategies and guidelines;
- **Beyond securing land tenure, anticipate potential conflict of uses**: to avoid restraining green corridors to tree canopies and removing open air swales, favor a co-design approach to find the most appropriate way to combine various uses in public space
- **Avoid gentrification through NbS development**: integrate underserved urban areas into the NbS development to make more vulnerable portion of the population benefit from the improvement of urban context
- **Implement green corridors outside of mobility infrastructure**: locating some of these corridors away from the infrastructure network would greatly boost their local biodiversity benefits.

NbS potential in Kenyan secondary cities: insight from 6 cities

NbS potential in Kenyan secondary cities

GLOBAL CENTER ON ADAPTATION

The potential for NbS development in various urban and climate contexts is explored for six Kenyan cities.

Each city assessment builds on the results from World Bank's NbS Opportunity Scan (NBSOS) result which provides spatial analysis of climate hazards and a pre-screening of NbS opportunities.
A comprehensive report detailing the full results of the NBSOS application in these areas is available upon request from the authors of this report.
The city assessment complements this evaluation of NbS development potential by reviewing urban planning frameworks, ongoing initiatives, and barriers to NbS implementation. The findings are linked to relevant case studies from the NbS Compendium to offer practical examples, lessons learned, and opportunities for peer-to-peer learning across cities.

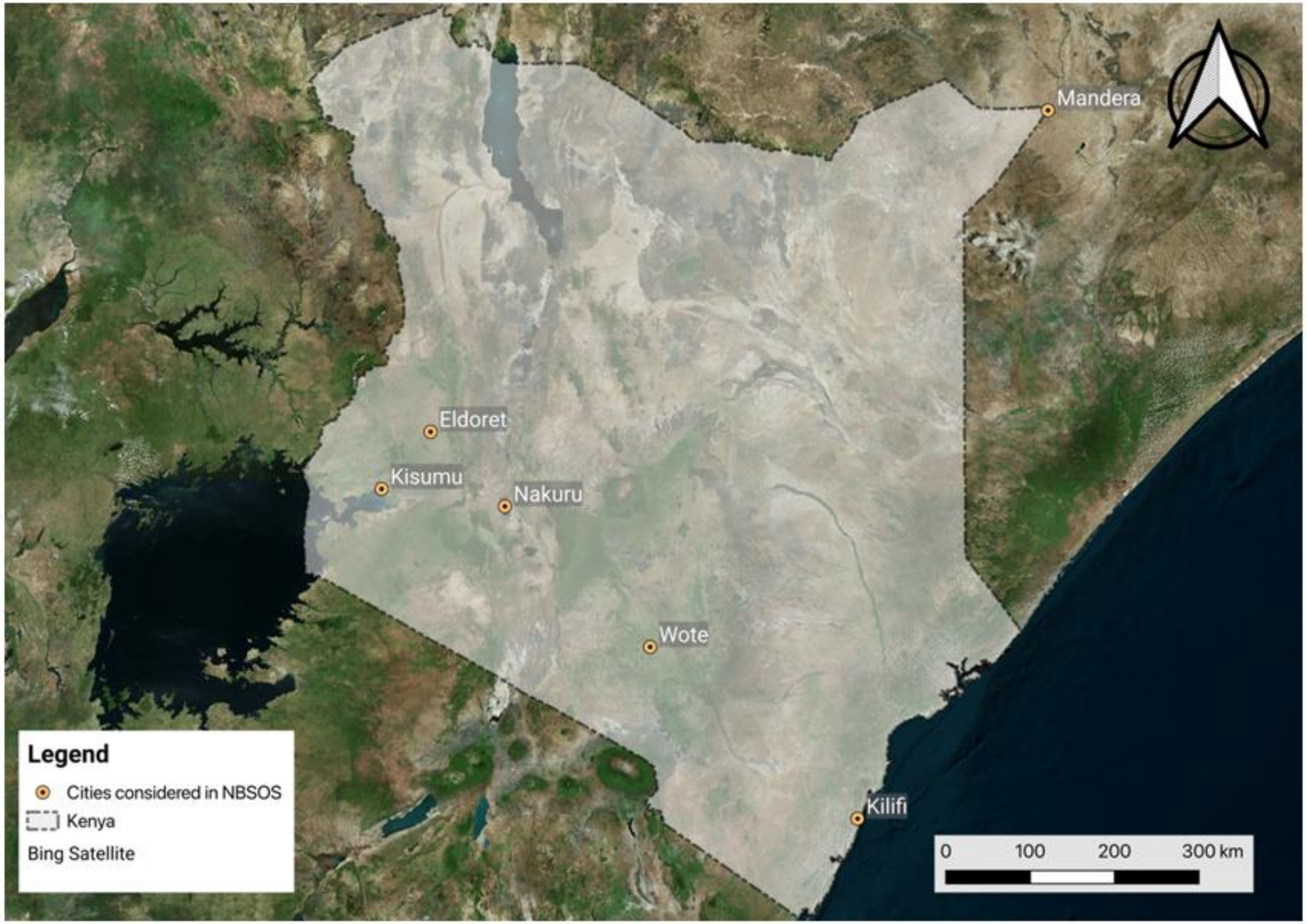


Figure 136 – Map of the six cities
(Source: SUEZ Consulting, 2024)

Table 1 – Examples of NbS development opportunities in 6 Kenyan secondary cities

NbS Development Opportunities											
NbS Family		Terraces and Slopes	Sandy Shores	Mangrove Forests	Natural Inland Wetland	Urban Farming	River and Stream Renaturation	Urban Forests	Open Green Spaces	Bioretention Areas	Green corridors
REF. CASE		2 - Living Smiles	4 – Malindi Waterfront Park	5 – Bangladesh Mangrove Restoration	3 – Ondiri Wetland Rehabilitation	9 – Kansoul Farm	10 – John Michuki Memorial Park	6 – Kaya Tembo Forest	1 – Eldoret Arboretum	7 – St. John's Community School	11 – Green Corridors In Nakuru
Adequacy to local context	Eldoret City	√				√	√	√	√	√	√
		Climate change heightens Eldoret's vulnerability to soil erosion and runoff. Plus, practices such as overgrazing, deforestation, and the overuse of agrochemicals accelerate soil degradation, while jeopardizing the flow of the River Sosiani. Implementing Terraces and Slopes management strategies could help alleviate these risks.	N/A	N/A	N/A	Urban farming was not highlighted as a priority in Eldoret City's key planning documents.	Urbanization has reduced permeable surfaces and blocked River Sosiani's streams, increasing flood risks, alongside deforestation and soil degradation. In the CBD Regeneration plan, the riverfront is to be a conservation area, creating an opportunity for renaturation, though, as noted in the NBSOS, this would be most effective if implemented citywide or at catchment level.	Deforestation leads to increased soil erosion and drought risks. Local stakeholders have expressed a strong desire to protect the existing Urban Forests with the involvement of NGOs. Additionally, the NBSOS identifies substantial opportunities for the creation of Urban Forests throughout the city, with a 1,000 ha providing high heat reduction benefits.	Building on the experience gained from creating the Eldoret Arboretum, development of new green spaces outlined in the CBD Regeneration Plan can be achieved. Notably, this includes improvement of open public spaces and existing hills to active community parks, and the creation of other recreational public parks in various neighborhoods.	Bioretention areas could be incorporated to the implementation of the Drainage Master Plan. The NBSOS recommends their creation in urban zones to help mitigate pluvial flooding. The CBD Regeneration Plan offers related resilience features such as permeable pavements sidewalks and gardens for better stormwater management.	The CBD Regeneration plan includes an integrated green spaces strategy including Green Corridors, which features the transformation of the railway into a green corridor and improved access to the Sosiani River via a linear park. This Green Corridor strategy could also align with the implementation of the Drainage Master Plan.
	Kilifi City	√	√	√		√	√	√	√	√	√
		Kilifi Municipality has predominantly flat coastal terrain. This issue has not been prioritized in local strategies.	Reef conservation, coastal erosion, rising sea levels, and saltwater intrusion threaten farmlands and fisheries in Kilifi. Sandy shores could help mitigate these impacts, and local stakeholders' awareness provides a strong foundation for supporting their implementation.	Mangrove forests are vital ecosystems for biodiversity, supporting fisheries, protecting against the impacts of extreme climate events, and providing recreational value. The local government supports local CBOs in their mangrove restoration efforts in Kilifi Creek, which could be expanded and integrated into planning.	N/A	Much of Kilifi's current land is still designated for agricultural use, but droughts and floods reduce crop yields, heightening food insecurity and impacting small-scale farmers. Though urban farming development is not prioritized in Kilifi Municipality's planning documents, agricultural resilience for small-scale urban cultivation could be further enhanced.	Kilifi Creek is an estuary for the Goshi River, passing through a small part of the municipality. However, its protection and renaturation have not been prioritized in planning or the NBSOS.	The NBSOS highlights extensive protection and creation opportunities of urban forests, especially in the northern plateau, near the urban core, to reduce downstream flooding and prevent urban development while mitigating heat stress, in a context of increasing temperatures leading to diseases and livestock stress. However, this was not prioritized in urban planning documents.	The NBSOS shows creation opportunities for Open Green Spaces in the core urban center and in proximity to the shoreline, which could provide high flood reduction benefits. Key documents emphasize upgrading and maintaining existing parks, but do not prioritize the creation of new open green spaces.	The municipality has plans to improve drainage, which could include Bioretention Areas to mitigate pluvial flooding within urbanized areas.	The ISUDP and IDeP (Integrated Development Plan) plan for greening activities and a Drainage Master Plan, which create a conducive context to the creation of Green Corridors along main roads. NBSOS results highlight the potential to mitigate both heat stress and flooding.

NbS Development Opportunities

NbS Family		Terraces and Slopes	Sandy Shores	Mangrove Forests	Natural Inland Wetland	Urban Farming	River and Stream Renaturation	Urban Forests	Open Green Spaces	Bioretention Areas	Green corridors
REF. CASE		2 - Living Smiles	4 – Malindi Waterfront Park	5 – Bangladesh Mangrove Restoration	3 – Ondiri Wetland Rehabilitation	9 – Kansoul Farm	10 – John Michuki Memorial Park	6 – Kaya Tembo Forest	1 – Eldoret Arboretum	7 – St. John's Community School	11 – Green Corridors In Nakuru
Adequacy to local context	Kisumu City	√			√	√	√	√	√	√	√
Adequacy to local context	Kisumu City	Due to the flat terrain of the city, flooding risks are prevalent, often leading to, landslides which Terraces and Slopes could mitigate. NbS such as Natural Inland Wetland and River and Stream Renaturation could further limit soil erosion issues.	N/A	N/A	Uncontrolled urban sprawl threatens wetlands around the Lake. The LPLUDP and City Zoning Regulations have strong ambitions for the conservation and valorization of natural sites through ecotourism, in order to mitigate flood risks and reduce water pollution. This could include rehabilitation.	Urban farming is not highlighted as a key priority in Kisumu. However, River and Stream Renaturation and Natural Inland Wetland in the eastern part of the city could improve agricultural resilience. In addition, land-use planning emphasizes organic farming practices and strengthening development control.	The LPLUDP emphasizes the protection of riparian zones along the Lake and in the North and East, which are flood-prone, especially in encroached areas. The resilience strategy aims to maintain, protect and recover natural buffers to increase floodwater storage and drainage, providing renaturation opportunities, as recommended in the NBSOS.	The NBSOS identifies opportunities for the creation of Urban Forests in the East.	The Environment Strategy plans green recreational spaces along the Winam Gulf. The Resilience Strategy aims for a city-wide valuation and inventory of natural assets, laying a strong foundation for development. The NBSOS highlights creation opportunities, especially in the East.	The NBSOS emphasizes creation opportunities in the East to prevent pluvial flooding. Though this was not emphasized as a key priority in planning documents, Bioretention Areas could be developed to improve drainage in informal settlements, which have been recognized as flooding hotspots.	The development of Blue Green Infrastructure is supported by a comprehensive Environment Strategy in the LPLUDP. Additionally, the NBSOS prioritizes the development of biodiversity corridors. The city can build on existing efforts, such as green landscaping of the Kisumu Triangle NMT in the CBD in partnership with private stakeholders.
Adequacy to local context	Mandera City	√				√	√	√	√	√	√
Adequacy to local context	Mandera City	Mandera is prone to soil erosion due to local soil conditions and arid climate. Soil erosion is worsened by poor farming practices especially along the river Daua. The existing drainage design report emphasizes soil stabilization for the preservation of natural drainage systems. Developing Terraces and Slopes is an opportunity to further strengthen it.	N/A	N/A	N/A	Many private farms are located along river Daua and pastoralism supported by irrigation represents about 52% of total household income. Though the development of urban farming was not highlighted as a key priority in planning documents, protective measures against drought and flooding could enhance agricultural resilience.	River Daua and Laghas are prone to flash floods, especially in case of heavy rains, causing a threat to riparian farming activities and settlements. Conservation of riparian reserves is included in planning documents, though enforcement issues persist. The NBSOS shows high NbS opportunities along the river.	Deforestation stems from high charcoal production and needs for animal feed. Parts of urban forests are conservation, though enforcement remains a challenge.	Though ongoing greening efforts have proven successful, Mandera counts with limited Open Green Spaces due to its arid environment. The IDeP plans for the construction of two green parks by 2028. 136 ha are identified in the NBSOS, especially in the East, for potential creation.	Mandera is prone to pluvial flooding, disrupting transport and economic activities. NBSOS recommends Bioretention Areas creation to prevent it, especially in the South. This NbS could be included as part of the municipality planned stormwater drainage improvements.	The Greening Project is contributing to Green Corridor development. The municipality picked drought-resistant species to lessen maintenance costs, and the project includes socio-economic benefits for vulnerable groups NBSOS recommends further expansion of Green Corridors for heat stress mitigation and social cohesion.

NbS Development Opportunities											
NbS Family		Terraces and Slopes	Sandy Shores	Mangrove Forests	Natural Inland Wetland	Urban Farming	River and Stream Renaturation	Urban Forests	Open Green Spaces	Bioretention Areas	Green corridors
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Adequacy to local context	Nakuru City	√			√	√	√	√	√	√	√
		Nakuru's sloppy terrain exacerbates water runoff into the lake, which increased in size by 48%, and further alters the fragile ecosystem and wildlife with potential consequences on tourism. Terraces and slopes could help mitigate such risks.	N/A	N/A	Nakuru, with its extensive wetland holds significant tourism and recreational potential but is at risk from climate events and anthropogenic activities such as deforestation and encroachments. The County Government's restoration efforts is an opportunity to maximize this NbS benefits.	The ISUDP focuses on promoting urban agriculture as a strategy to enhance food security and stimulate local economies, creating a fertile ground to the development of urban farming initiatives.	The city is intersected by several rivers, some of which are seasonal due to irregular rainfall and reduced moisture. The NBSOS recommends the protection of existing streams in the East and South, and creation of buffer zones along the Lake. However, the protection of riparian reserves has not been prioritized in key planning documents.	The NBSOS highlights extensive creation opportunities for Urban Forests in the East and West, especially surrounding the urban core for heat stress reduction benefits, which aligns with the municipality's plans to develop an Arboretum.	The municipality could build on the success of Nyano Gardens to continue creating Open Green Spaces, as outlined in the ISUDP, particularly in the CBD. The NBSOS highlights significant potential for developing new Open Green Spaces in the urban core and in the eastern and western parts of the city, offering benefits such as flood reduction and heat mitigation.	Bioretention Areas could be included in the design of the upcoming Drainage Master Plan. NBSOS identifies creation opportunities, especially in the eastern informal settlements, providing high flood reduction benefits.	Nakuru already has a well-developed Green Corridor policy (e.g., Oginga Odinga Street Canopy, Kenyatta Avenue), which could be expanded as part of the upcoming mobility and drainage master planning processes. The ISUDP also includes plans for a Green Corridor strategy, such as linking the CBD to the National Park and the Lake.
	Wote City	√			√	√	√	√	√	√	√
		Wote's sloping land is prone to landslides. The IDeP includes ambitions to improve soil stabilization. Terraces and Slopes could be a part of these future efforts.	N/A	N/A	Wetlands are designated as conservation areas in the municipality Spatial Plan. Their protection is not emphasized as a key priority in the IDeP though Natural Inland Wetland NbS could be included in the future riparian policy.	Close to 84% of Wote's land is still for agriculture us, with small-scale cultivation and rearing of indigenous livestock. Many areas outside of the urban centers are still designated for agriculture in the municipality Spatial Plan. Therefore, urban farming is not highlighted as a key development priority, though there is a will to promote drought-resistant farming practices.	Wote counts with fragile water catchments and riparian zones along the Kaiti River, designated as critical conservation areas in the Spatial Plan. The IDeP outlines the elaboration of a riparian policy and a conservation regulatory framework, which would provide an opportunity for River Stream Renaturation. This was confirmed by the NBSOS.	Deforestation disrupts the water cycle and contributes to frequent droughts. Aligned with county strategies, Wote municipality plans to develop a Participatory Forest and Hill Management Plan. The NBSOS also highlights significant opportunities for creating Urban Forests.	The Wote Green Park is a model of green space promoting social cohesion while incorporating climate-resilient features. The NBSOS highlights the potential for the creation of 1 ha of Open Green Spaces. The IDeP plans for new recreational parks in seven neighborhoods. They could build on existing experience for these projects.	Local stakeholders highlight stormwater drainage improvement plans as a key strategic priority, and manifest interest towards water-related NbS, which could include the development of Bioretention Areas. NBSOS shows 3 ha of creation opportunities, mainly surrounding the core urban center.	Green Corridors were not identified as a key priority neither the local planning documents nor in NBSOS results, though they could be included as part of stormwater drainage improvements.

Eldoret City

Figure 137– View of Eldoret City (Source: Eldoret begins race to become fifth city – Kenya News Agency 2022)

In the North Rift Region, Eldoret City is a trading hub of regional and national significance. With a population of 504,086 people and an area of 147.9 km², Eldoret is today the primary urban center and capital of the Uasin Gishu County and was recently granted the city status. As the headquarters of the North Rift Economic Bloc (NOREB), Eldoret is strategically connected to Kenya and East Africa through the roads to Nakuru and Mombasa, a railway and an international airport.

Indeed, Eldoret is a diversified economic and logistical node, supporting agriculture, trade, and services across the region. Agriculture, forestry, and fishing contribute to half of the region's Gross Domestic Product (GDP). The establishment of the Africa Economic Zone (AZE) and the support to industries (e.g., Rivatex, Kenya Pipeline Corporation), and investments (e.g., Alten Solar Project) highlight Eldoret's potential as an industrial and economic powerhouse. Its infrastructure makes it a regional center for commerce, education, and healthcare. Additionally, it is called the "City of Champions", as a renowned base for international athletes.

However, the city faces increasing pressures due to rapid population growth and urbanization (6.8% per year). The surge of rural-urban migration since the 1970s has been driven by the city's economic dynamism, well-developed infrastructure and attractive image. The demand escalated for residential, commercial, industrial, and institutional spaces, resulting in urban sprawl patterns, straining infrastructure, increasing property prices and rents and adding pressures on the environment.

Climate Risk Profile

With the Sosiani River at its heart, Eldoret experiences a cool climate favorable to agriculture. Culminating at 2,085 m, it welcomes agricultural, industrial and recreational activities. During the two rainy seasons and two dry seasons, mean annual temperatures remains below 25°C and rainfall is moderate and consistent. Annual precipitation range between 1200 mm to 1500 mm, spread evenly across the months. The County is considered "Kenya's breadbasket" for its great maize supply. It also accommodates other crops, livestock farming and dairy production.

However, the region is increasingly exposed to hazards, notably heatwaves, droughts, runoffs and pluvial flooding. Temperature trends from 1979-2023 show an average increase of 1°C. Rainfall remained relatively stable, though intensity increased, and dry spells are longer, leading to higher flood and erosion risks. This tendency is projected to continue.

Floods and droughts threaten food security and disrupt agriculture, trade, and industry in Eldoret, with further aggravation due to uncontrolled urban development. Unsustainable practices such as overgrazing, deforestation, and excessive use of agrochemicals contribute to soil degradation, putting the River Sosiani at further risk of drought. Urbanization has reduced permeable surfaces, and construction in the river's stream obstructs its flow, increasing flood risks. Pollution from dumpsites and poor drainage maintenance worsens flooding, causing losses of lives, damage to property, and infrastructure, and heightened risk of diseases like cholera and malaria.

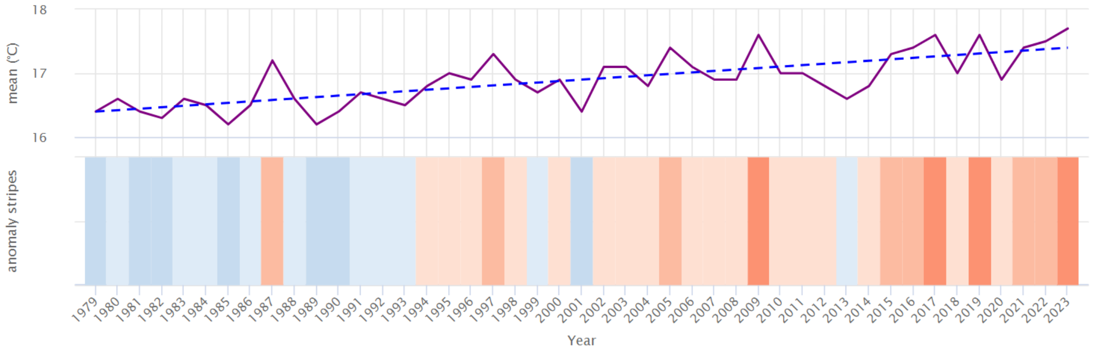


Figure 138 – Mean yearly temperature, trend and anomaly in the larger region of Eldoret (1979-2023)*
(Source: Meteoblue, 2024, Data: ERA5, with a spatial resolution of 30 km, www.meteoblue.com)

(*) Top graph estimates mean annual temperature. Dashed blue line represents linear climate change trend. Lower graph represents warming stripes - blue for colder and red for warmer years.

Eldoret's strategic planning for urban resilience create an enabling environment for NbS by addressing climate risks and promoting blue and green infrastructure. The city's Land Physical Development Plan (LPDP) and the Country Integrated Development Plan (CIDP) emphasize climate-resilient infrastructure, environmental conservation, especially springs, wetlands and riverbanks, green space and forest cover expansion and rainwater harvesting for new buildings. The CBD regeneration plan (2022–2032) includes a strategy for green spaces integration, a green railway corridor, and improved access to the Sosiani River with a linear park. It offers resilience features such as permeable pavements and gardens. Additionally, the Drainage Master Plan, established in 2016 to improve drainage in flood-prone areas and could be enhanced with NbS. These initiatives are supported by the County's 2021 Climate Change Act and 2023–2027 Action Plan. The Eldoret Arboretum is a prime example of NbS in action in the City. A partnership with the Kenya Forest Service (KFS), Kenya Water Towers Agency (KWTA), and Kenya Wildlife Service (KWS) has transformed the area into a multifunctional space that aims to balances ecological preservation and recreational use, with ongoing efforts to enhance its educational value and ensure long-term sustainability.

The city presents opportunities for NbS to tackle environmental and social challenges. First, the NBSOS highlights opportunities to protect green spaces (e.g., greenery and green spaces), for instance in the East to control urban sprawl and maintain ecological balance. In addition, Urban Forests would provide a dual benefit by reducing heat and flood risks while contribute to foster social cohesion. River and Stream renaturation along the Sosiani River is also crucial for preserving natural flood management systems and improving water quality. Other NbS like Bioretention Areas can help further mitigate flood risks and reduce vulnerability downstream. Targeted NbS interventions in densely populated areas will help alleviate heat stress.

Strengthening land ownership policies and regulation enforcement present significant opportunities for the successful implementation of NbS in the city. Expanding land acquisition is crucial to support the Drainage Master Plan and develop new green spaces, addressing the needs of the city's growing population. The ongoing transfer of development control to the City is a promising opportunity to better preserve riparian reserves and optimize urban planning efforts.

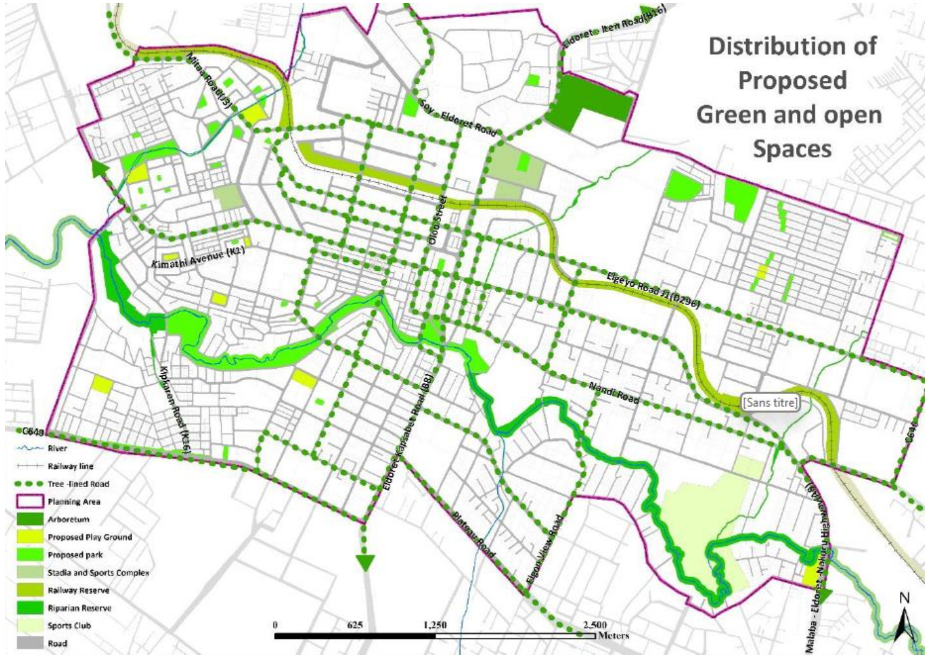
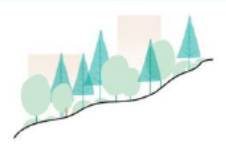


Figure 139 – Distribution of Existing and Proposed Green Open Spaces in the CBD LPLUDP (2022-2032)
(Source: Renaissance Planning Limited, 2022)

NBS Opportunities Examples

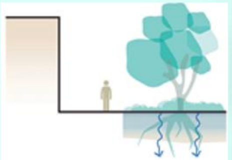


Urban Forests

Explore Case 6 Kaya Tembo Forest

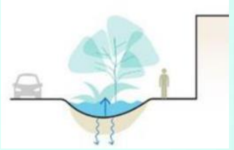
River and Stream Renaturation

Explore Case 8 Upper Tana Nairobi Water Fund



Green Corridors

Explore Case 11 Green Corridors in Nakuru



Bioretention Areas

Explore Case 7 St. John's Community School

NB. Additional information provided in the WB NBSOS Report for the 6 Kenyan cities.

Kilifi Municipality

Figure 140 – Aerial view of Kilifi Creek (Source: www.abirikenya.com)

Kilifi Municipality, located on the Western coast of Kenya, is an ancient coastal town serving as the political capital of Kilifi County. With a population of 157,616 (KNBS, 2019) and an area of 301 km², it is home to the administrative headquarters of Kilifi County. Its municipality status was granted in 2018.

The economy is still predominantly agriculture-based but could further develop through coastal tertiary activities. Key activities include sisal plantations, particularly in Mnarani and Tezo wards, particularly coconut farming and cashew nut willing, a declining activity since 1990. Urban agriculture also holds a great place (i.e., poultry farming, vegetable cultivation). The area also has retail and wholesale traders, and an increasing number of commercial banks. The shoreline and Kilifi Creek supports artisanal fishing and small-scale mariculture. Additionally, Kilifi holds significant potential for blue economy and resort tourism. However, it faces high poverty levels.

The economy distribution between agricultural and urban activities shapes the settlement patterns within the municipality. The central urban area is densely populated, characterized by compact, nuclear settlements. The surrounding, growing peri-urban zones, particularly along major roads, follow a more linear settlement pattern. This area is area is well-served by infrastructure, including piped water and electricity. The semi-arid eastern regions are sparsely populated, while areas with high agricultural potential, such as Chonyi and parts of Tezo, are more populated.

Climate Risk Profile

Kilifi municipality is in a tropical climate zone, with proximity to the Indian Ocean. The area experiences two main rainfall seasons, with the southern coastal belt receiving more rainfall than the hinterlands, while the Nyika plateau and rangeland qualify as arid and semi-arid zones. With average temperatures ranging from 22.5°C and 34°C, Kilifi is characterized by high humidity and evaporation rates all year-round.

Climate hazards, including erratic rainfall, prolonged droughts, flooding in low-lying areas and coastal erosion, threaten livelihoods, infrastructure, and food security. Climate impacts strain infrastructure and local livelihoods notably, small-scale traders and farmers. Droughts and floods reduce crop yields, thus heightening food insecurity. Coastal erosion, rising sea levels, and saltwater intrusion further threaten farmlands and fisheries. Increasing temperatures promote pests, diseases, and livestock stress. Additionally, vulnerable groups are disproportionately affected by water scarcity, induced health risks, and limited resources to adapt.

Climate projections indicate that the municipality will experience significant warming and increased climate variability. Temperatures are expected to rise up to 3°C by the 2040s, leading to more frequent heatwaves and extreme heat days. The region also faces greater risks of droughts (from January to June) and floods (from July to December). Rainfall patterns should get more variable, with uneven distribution and low mean daily precipitation, disrupting agriculture and crop yields.

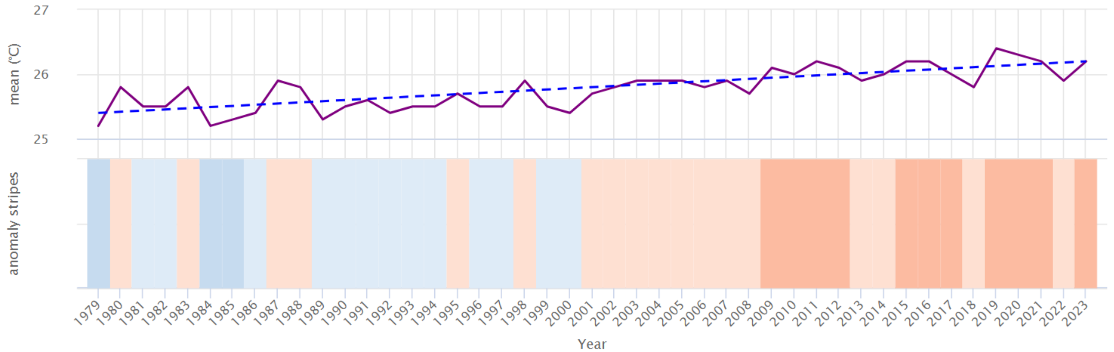


Figure 141 – Mean yearly temperature, trend and anomaly in the larger region of Kilifi (1979-2023)*
(Source: Meteoblue, 2024, Data: ERA5, with a spatial resolution of 30 km, www.meteoblue.com)

(*) Top graph estimates mean annual temperature. Dashed blue line represents linear climate change trend. Lower graph represents warming stripes - blue for colder and red for warmer years.

Recent strategic and regulatory documents create a conducive environment to NbS development in Kilifi municipality. At the county-level, the 2016 Environmental Act and 2019 Forest Conservation and Management Act were first steps for environmental protection. Additionally, a Disaster Management Act, focused on capacity for disaster risk reduction, was adopted in 2016, and the 2021 Climate Change Act and 2023 Climate Change Bill facilitated a comprehensive framework to address climate change impacts within the county. At the municipality-level, planning documents (i.e., the Strategic Plan (2021-2025) and Integrated Development Plan (IDeP) (2020-2024)) incorporate measures for urban resilience such as upgrading and sustaining urban parks, greening the city, establishing a Drainage Master Plan and improving development control, presenting opportunities to integrate NbS in policy elaboration. An example of NbS potential is the mangrove restoration project in Kilifi Creek, implemented by local CBOs and supported by the municipality to enhance fish breeding activities and environmental protection in this strategic area.

Kilifi holds significant potential to develop NbS to mitigate flooding, heat-related risks and coastal erosion. The World Bank NbS Opportunity Scan highlighted an opportunity in the North to control urban expansion, protect natural existing natural areas, and create Urban Forests, thus providing high pluvial floods benefits. Urban Forests, combined with the creation of Open Green Spaces and Green Corridors, could also mitigate heat stress in the recently urbanized area. Additionally, Mangrove Forests and Sandy Shores' protection and restoration, could contribute to enhance reef conservation and mitigate coastal erosion.

Addressing jurisdictional restrictions, funding gaps, and capacity limitations provides valuable opportunities for advancing the implementation of NbS. Addressing these areas can promote the integration of climate change and conservation, particularly for urban forests, into municipal frameworks. Expanding technical training and resources for municipal stakeholders will empower them. Improving data sharing and strengthening the evidence base for resilience measures in municipal planning can lead to more informed, strategic decision-making. Lastly, decentralizing offices to the ward level offers the potential to optimize public participation and deepen community engagement.

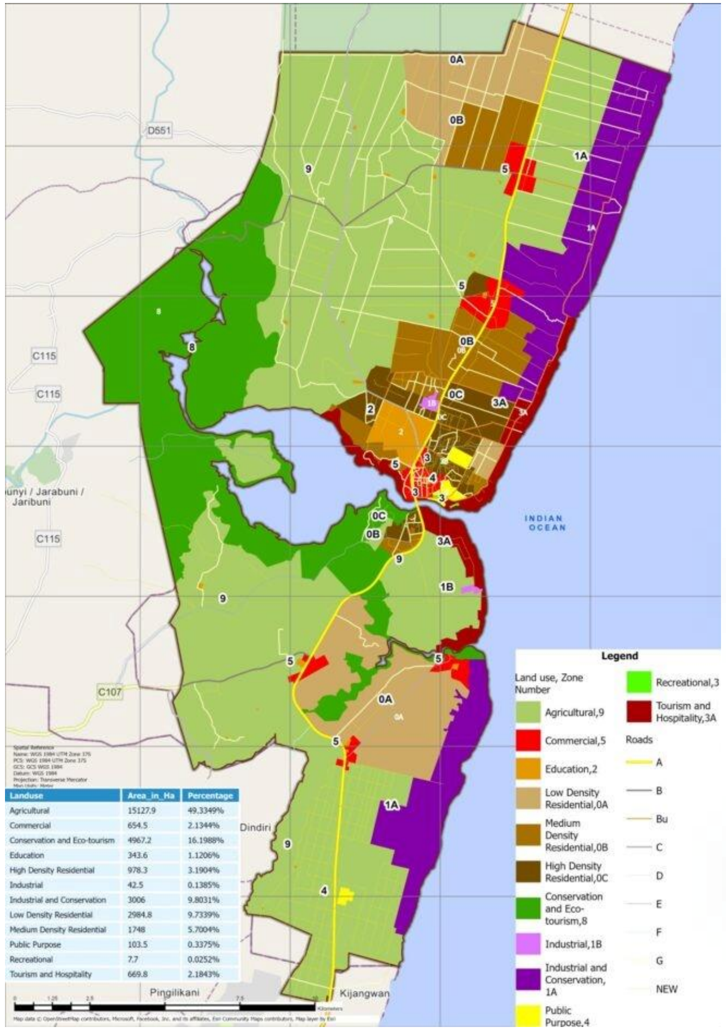
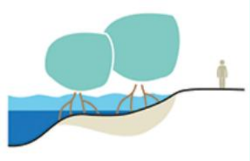


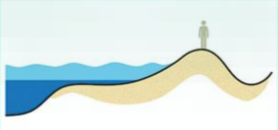
Figure 142 – Land Use in Kilifi municipality
(Source: Geosurveys and Geospatial Information Limited)

NBS Opportunities Examples



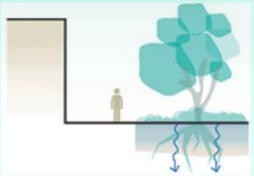
Mangrove Forests

Explore Case 5 Bangladesh Mangrove Restoration



Sandy Shores

Explore Case 4 Malindi Waterfront Park



Green Corridors

Explore Case 11 Green Corridors in Nakuru

Urban Forests

Explore Case 6 Kaya Tembo Forest

NB. Additional information provided in the WB NBSOS Report for the 6 Kenyan cities.

Kisumu City

GLOBAL CENTER ON ADAPTATION

Figure 143 – View of Kisumu City from Ramogi Road, in the city center, towards informal settlements (Source: County Government of Kisumu, 2022)

Located on the western side of Kenya, Kisumu City is a regional hub opened towards eastern Africa, benefiting from its strategic position on Lake Victoria. With an estimated population of 527,416, it covers 417 km², of which 71% of land and 29% of water mass. As the third-largest city in Kenya and an active industrial and commercial center, it serves as the headquarters and capital of Kisumu County. While it was officially designated a city in 2001, it still operates under a municipal charter and is yet to be officially granted a city charter.

While the region is known for its flourishing agriculture and fishery industry, Kisumu's economy has declined in the last few decades. The surrounding geography (i.e., wetlands in the South, tree cover in the North), allows for agriculture in the eastern expansion and a fishery activities nourished by the lake. However, the poverty rate of 58% and an unemployment rate of 15,3% are persistent concerns.

Transport infrastructure development was the original driver of spatial growth, but today, unplanned urban sprawl strains infrastructure. The construction of the Uganda Railway and establishment of a port along the lake in the early 1900s, provided a critical link for trade and transportation. Kisumu became a center for commerce and administration in colonial Kenya and continued to expand in the 1930s and 1940s. Most recently, the urban expansion towards the eastern periphery in the form of unplanned, high-density informal settlements has increased population pressures, further complicating urban service delivery.

Climate Risk Profile

Kisumu City is in a tropical climate zone characterized by warm, humid conditions throughout the year conducive to agriculture and fishery, but it is under increasing pressure from climate change. With two rainy seasons and two dry seasons, temperatures range from 23°C to 33°C, with high humidity levels averaging around 80%. An extensive hydrographic network, including the lake and numerous rivers and streams, fosters horticulture and fishery activities. The city's physiographic features, from the alluvial soils of Kano Plains to the rocky outcrops of Riat Hill, support large-scale agriculture. However, climate patterns are shifting. Temperatures have risen by 1°C since 1973, with projections of further increases. Plus, rainfall is decreasing, with more irregular spatial distribution and shorter seasonal rains. Reciprocally, dry spells are getting longer, and drought frequency has doubled since 2005.

Increased hazard intensity and frequency has worsened water and food security, amplified by uncontrolled urban sprawl. Rising temperatures and prolonged droughts have intensified water scarcity. Lake Victoria, supplying 80% of the city's water, knows fluctuating levels due to unpredictable rainfalls and compromised water quality due to pollution. Droughts and floods threaten food production and escalate ecosystem degradation. The city's flat topography and poor drainage infrastructure, especially in informal settlements (e.g., Nyalenda, Manyatta) make it vulnerable to flash flooding, causing infrastructure, property and business damage, displacements, and waterborne diseases.

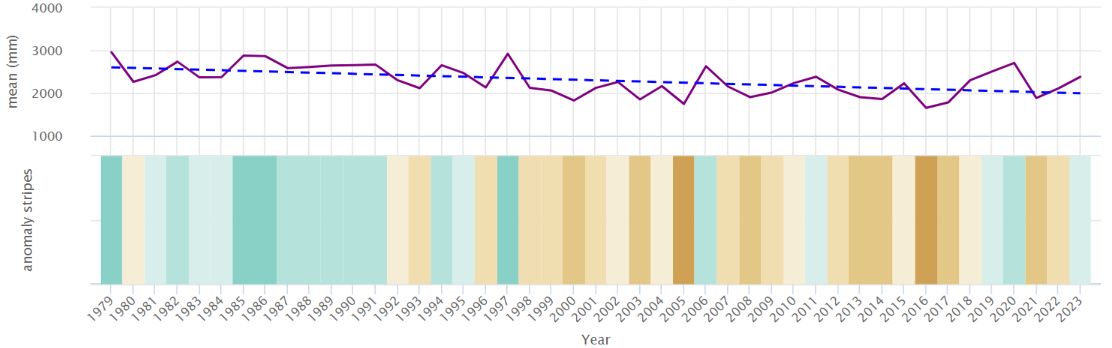


Figure 144– Mean yearly precipitation, trend and anomaly in the larger region of Kisumu (1979-2023)*
(Source: Meteoblue, 2024, Data: ERA5, with a spatial resolution of 30 km, www.meteoblue.com)

(*) Top graph estimates mean annual precipitation. Dashed blue line represents linear climate change trend. Lower graph represents precipitation stripes - green for wetter and brown for drier years.

Kisumu City has established a comprehensive framework to address climate change and protect natural areas for risk mitigation and ecosystem services provision. Municipal policies align with key county-level policies and regulations, including the Climate Change Policy (2019), Climate Change Act (2020), and Climate Fund Regulations (2023), supported by a five-year Climate Change Action Plan (2023-2027) that complements the CIDP (2023-2027). The city's land-use planning documents prioritize blue and green infrastructure. They focus on the conservation of natural sites for ecotourism, flood risk reduction, and water quality preservation. Kisumu has also adopted a Resilience Strategy to enhance critical infrastructure (e.g., stormwater management, drinking water, sanitation, energy) and reduce disaster risk. Kisumu's first NbS steps include green landscaping initiatives (e.g., Kisumu Triangle NMT project, a partnership with street vendors to plant and maintaining green areas) and the rehabilitation of the polluted Kachok dumpsite into an Arboretum.

Consequently, there is a significant opportunity to integrate NbS into future planning and investments. The NBSOS identifies key areas in the North and East for developing Urban Forests, Green Spaces, Green Corridors, and Bioretention Areas, which are crucial for pluvial flood protection and align with the LPLUDP conservation strategy. Creating Urban Forests would provide heat reduction and recreational benefits, particularly in the eastern part of the city. Additionally, restoring Natural Inland Wetlands and renaturing rivers could further reduce lacustrine and riverine flooding. Given Kisumu's floodplain area and recent urbanization trends in high-risk zones, it is recommended to protect floodplains and regulate development in these areas to mitigate future flood risks.

Kisumu City has opportunities to advance NbS by addressing encroachments in wetlands and riparian zones, improving enforcement, and setting clear intervention guidelines. Additional funding for infrastructure and environmental conservation would further support these efforts. Strengthening governance, operational capacity, and data availability would create a more supportive environment for NbS. A comprehensive M&E system would also ensure effective tracking and long-term development success.

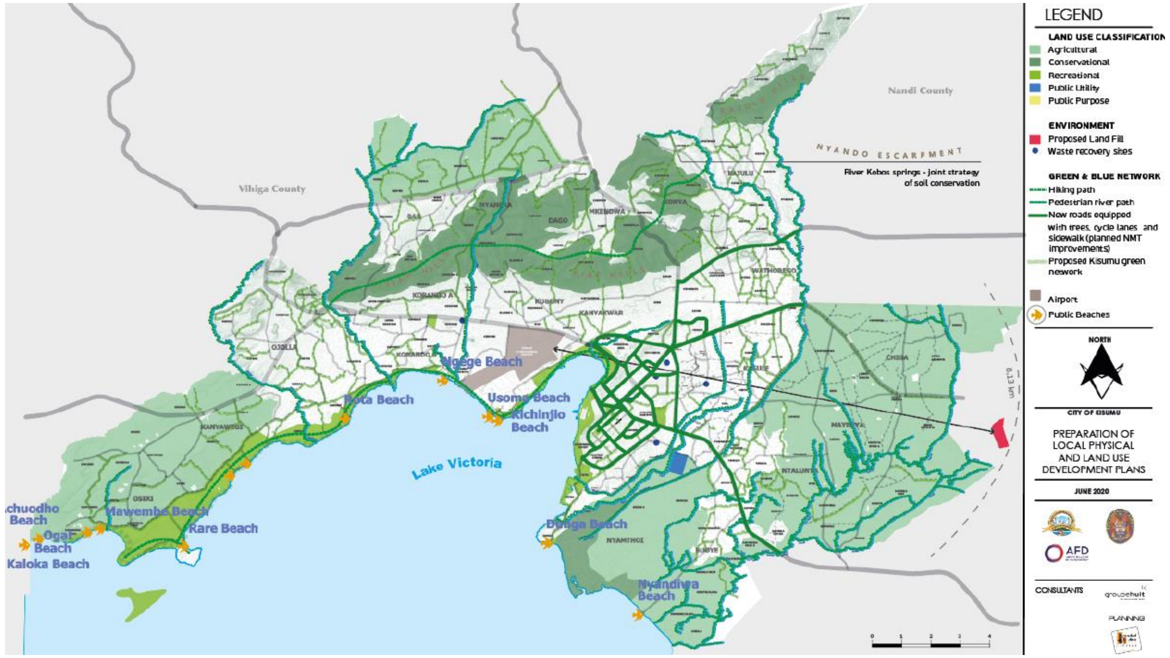
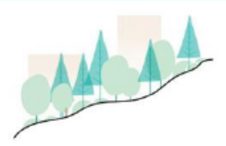


Figure 145 – Environment strategy of Kisumu City as presented in LPLUDP (Source: public-report-LPLUDP1234.pdf, 2022)

NBS Opportunities Examples

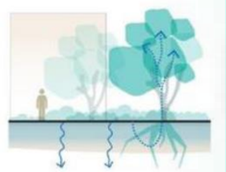


Urban Forests

Explore Case 6 Kaya Tembo Forest

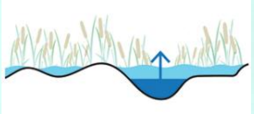
River and Stream Renaturation

Explore Case 10 John Michuki Memorial Park



Open Green Spaces

Explore Case 1 Eldoret Arboretum



Natural Inland Wetland

Explore Case 3 Ondiri Wetland Rehabilitation

NB. Additional information provided in the WB NBSOS Report for the 6 Kenyan cities.

Mandera Municipality

GLOBAL CENTER ON ADAPTATION

Figure 146 – An aerial view of Mandera town where trees have been planted along the road
(Source: Mandera History – County Government of Mandera)

Mandera Municipality is located in Mandera County, in the north-eastern part of Kenya, at the borders of Somalia and Ethiopia. With an area of 599,2 km² and a population of 159,638 persons, 71,9% of which are considered as urban (KPHC, 2019), Mandera was fully established as a municipality in 2018.

The development of Mandera is highly driven by its key position as a marketplace along transport routes and between two international borders. Agriculture is also an important economic activity within the municipality with domestic crop farming, livestock practices, riparian farming along River Daua and traditional pastoral practices. Mandera hosts some mining activities for construction materials such as stones (from the hills) and sand (from the river).

Settlements are wider in the north : (i) along main transport corridors such as Mandera-Khalilo road and trade amenities and (ii) on the Daua riverbanks in the search for pastures, grazing land and water resources for livestock and crop farming (for domestic or professional use). The population density varies across the municipality, from 35 inhabitants per km² in Khalalio ward to 1,264 in township ward. The rapid urbanization towards the West fosters mushrooming informal settlements and a widening basic infrastructure gap highlighted in the list of priorities raised by the residents for 2024-2025 (*Annual Investment Plan).*

Climate Risk Profile

Mandera is described as « one of the driest counties in Kenya with frequent occurrence of droughts, flash floods and heat waves » (CGIAR 2018). Its arid climate is characterized by high average annual temperatures (25°C and above), two specific rainy seasons with extremely low and unpredictable precipitation (below 250mm per year) and long hours of sunshine in a day, causing high evaporation rates.

Climate change effects further aggravate heat stress and drought risks. For the last 30-35 years, temperatures have kept increasing (+1°C) and rainfall decreasing (around 50mm) with growing unpredictability (very high and very low intensities are more frequent). Projections show likely similar trends, with temperatures increasing from 1°C to 2.5°C (RCP4.5 and RCP8.5 – CIMP5) by 2065, and more common extremes.

Extreme climatic conditions in Mandera Municipality disrupt the environment, put settlements at risk and imperil local livelihoods. Frequent droughts worsen water scarcity, crop and livestock losses, threatening 52% of local incomes and increasing the burden on women to fetch water. This forces many to abandon pastoralism for urban life. Clan tensions and risks of conflict increase. Additionally, altered rainfall undermine the Daua River's role as a key water source and drainage system. Due to the topography and inadequate stormwater drainage, unpredictable heavy rains cause flash floods and river flooding, damaging farming and settlements and disrupting markets, schools, and crop storage.

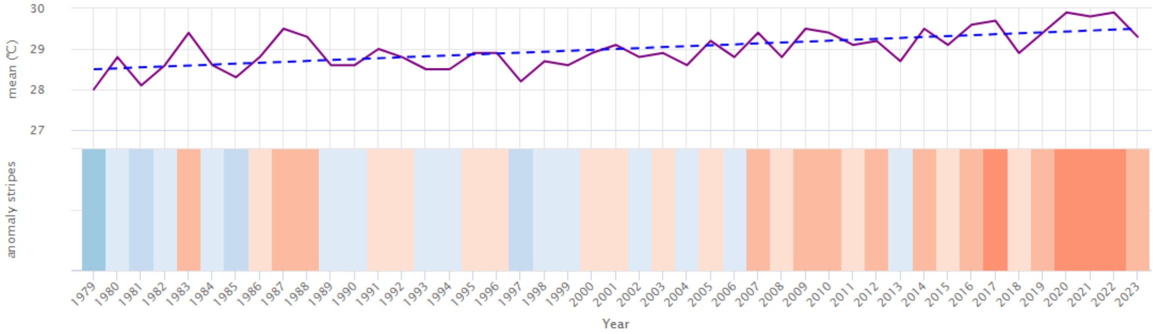


Figure 147 – Mean yearly temperature, trend and anomaly in the larger region of Mandera (1979-2023)*
(Source: Meteoblue, 2024, Data: ERA5, with a spatial resolution of 30 km? www.meteoblue.com)

(*) Top graph estimates mean annual temperature. Dashed blue line represents linear climate change trend. Lower graph represents warming stripes - blue for colder and red for warmer years.

Mandera Municipality's planning documents and county-level strategies integrate climate change mitigation, environmental conservation and sustainable resource management. Strong political will, led by the governor, has generated momentum for climate change adaptation. The Municipality's 2024-2028 IDeP aligns with the County's Climate Change Policy and the 2023-2027 CIDP on this issues. Nine percent of the planning area is designated as riparian reserves and conservation zones. The plan also includes tree planting and green park construction. The municipality aims to elaborate a climate risk assessment for each ward, to enhance disaster risk reduction, and to prevent flooding by improving stormwater drainage. As the IDeP outlines a commitment to adopt "nature-based enterprises", the KUSP1-funded protection works designs already integrates land management NbS for the rehabilitation of natural drainage systems. Additionally, an emphasis on multi-stakeholder collaboration and a gender-inclusive, participatory approach, exemplified by an innovative tree planting project with high women and youth engagement, allows to maximize social and economic NbS benefits for vulnerable groups.

Building on experience, Mandera could precise, systematize and mainstream a NbS lens into its strategic priorities. The WB's NBSOS highlights the need to protect the banks of River Daua in the northern part of the city, to prevent urban sprawl in high-risk areas, protect natural flood management systems and improve water quality, complementing existing stormwater drainage works. Creating River Floodplains and Bioretention Areas in the South could provide flood protection, and Terraces and Slopes could enhance soil stabilization. Residents of recently urbanized eastern zones could benefit from new Open Green Spaces to reduce heat stress and provide recreational areas. Rain barrels and green facades could also be relevant in Mandera to fight water scarcity and heat stress. Lastly, Green Corridors, already in development, could be expanded to mitigate dry spells and sandstorms.

The municipality has several opportunities for strengthen its role in NbS development. As the devolution process advances, transfer of key competencies like development control will further strengthen local governance. Stabilizing budget allocations and minimizing the effects of frequent reallocations for emergency operations will boost the municipality's ability to effectively manage both growth and climate-related challenges, and secure funding for infrastructure development.

NB. Additional information provided in the WB NBSOS Report for the 6 Kenyan cities.

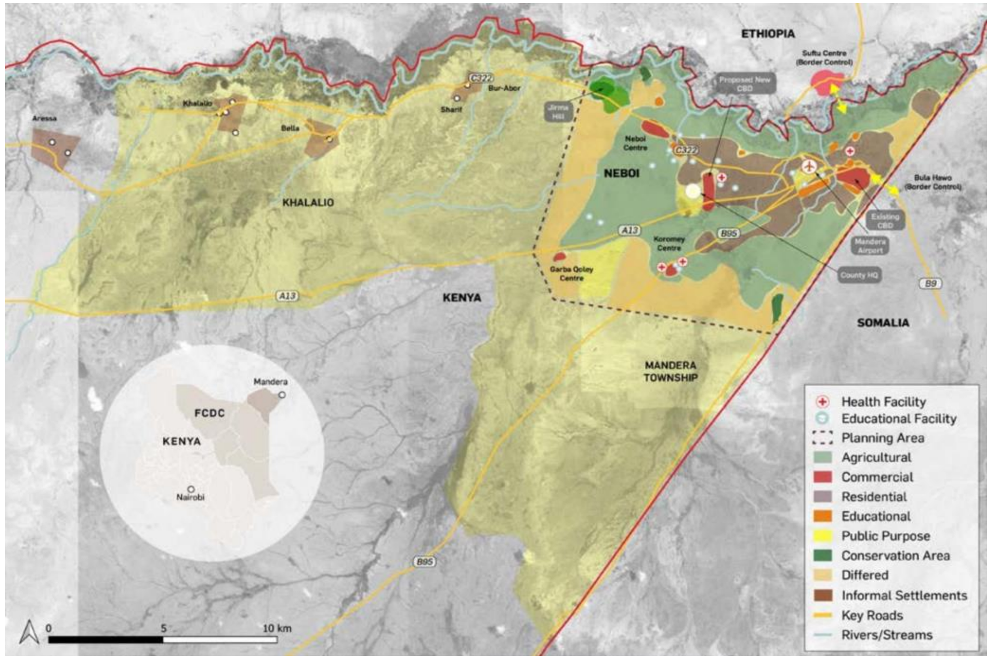
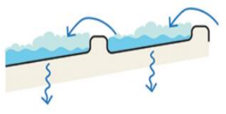


Figure 148 - Existing Land Use in Mandera Municipality (Source: Mandera Urban Economic Plan by Tetra Tech International Development Europe - Issuu, 2021)

NBS Opportunities Examples

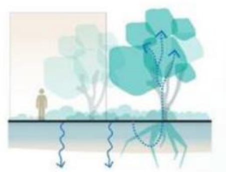


Terraces and Slopes

Explore Case 2 Living Smiles

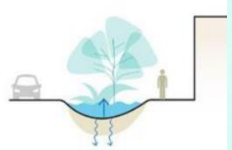
River and Stream Renaturation

Explore Case 10 John Michuki Memorial Park



Open Green Spaces

Explore Case 1 Eldoret Arboretum



Bioretention Areas

Explore Case 7 St. John's Community School

Nakuru City

Figure 149 - Aerial view of Nakuru City (Source: 19677.pdf, 2022)

Nakuru City is the rapidly growing capital of Nakuru County, known for its vibrant cultural scene and significant economic role in the Rift Valley region. Located 160 km Northwest of Nairobi along the Nairobi-Eldoret highway, it is Kenya's fourth-largest urban center with 570,674 inhabitants (KNBS, 2019), and third-largest metropolitan area, covering 302.8 km². It was elevated to city status in 2021.

Nakuru's economy is driven by agribusiness, financial services, geothermal power, and tourism. In the colonial era, it developed around agro-industries and machinery, close to the railway. Today, these activities still concentrate in the west of the CBD. Key sectors also include retail, wholesale, motor vehicle services, and finance. The city holds significant resources for geothermal energy production. With a strong cultural heritage and a unique landscape, tourism thrives, with attractions like Lake Nakuru National Park and Menengai Crater. Its strategic location makes Nakuru a key conference destination and growing innovation and investment center.

Settlement patterns in Nakuru were shaped by a combination of historical, economic, and demographic factors. During the colonial area, the town's grid structure centered around the railway station. Following independence, European farms were informally subdivided into smaller plots, staff-housing schemes were created for industries, and more recently, rural-urban migration increased. This led to a significant urban sprawl towards the East and West, with the surge of informal settlements along the Lake, outpacing infrastructure and services development.

Climate Risk Profile

Nakuru City's climate is characterized by moderate temperatures year-round and distinct wet and dry seasons, influenced by its tropical setting. The city receives over 1250 mm of precipitation annually, with temperatures averaging under 15°C. It follows a bimodal rainfall pattern. Dry spells range from 35 to 80 days in the second season and from 25 to 60 days in the first season.

The city experiences prolonged dry spells, intense precipitation, and rising heat stress, impacting people, infrastructure and economic activities. Some rivers have become seasonal due to unreliable rainfall patterns and strong winds in the dry season further reduce moisture, contributing to water scarcity. Flooding is also a concern, as it displaces communities, damages infrastructure and aggravates water pollution. Plus, the sloppy terrain exacerbates water runoff into the lake, which increased in size by 48%, further altering the fragile ecosystem and wildlife, with consequences on tourism. Lastly, the extreme weather is harmful to manufacturing sectors reliant on raw materials, as well as agro-based industries, since it impacts crop and animal production.

Climate projections for Nakuru City indicate significant changes in temperature, rainfall and moisture patterns over the coming decades. By the early 2040s, temperatures are expected to rise by 0.3°C. Precipitation patterns are less certain, with models showing potential increases and decreases in certain months. By 2065, moisture stress is projected to significantly increase.

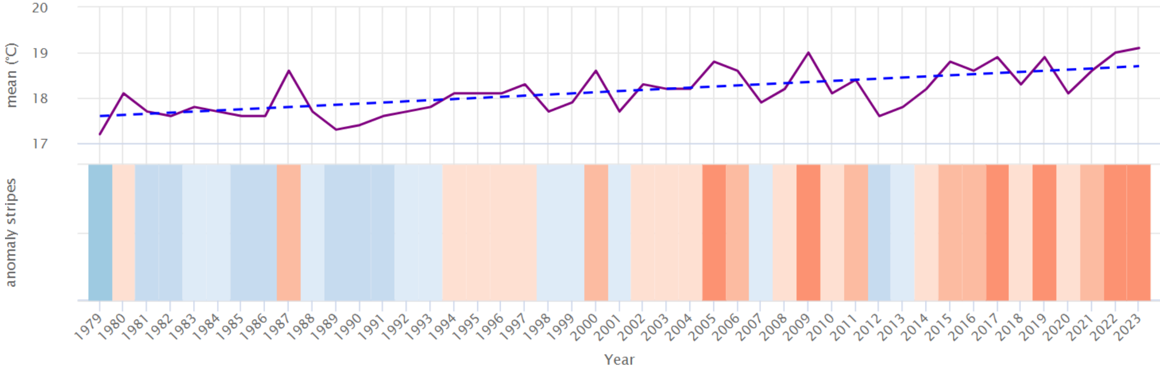


Figure 150 - Mean yearly temperature, trend and anomaly in the larger region of Nakuru (1979-2023)*
(Source: www.meteoblue.com, 2024, Data: ERA5, with a spatial resolution of 30 km)

(*) Top graph estimates mean annual temperature. Dashed blue line represents linear climate change trend. Lower graph represents warming stripes - blue for colder and red for warmer years.

Climate resilience is integrated as a cross-cutting within local policies in Nakuru, allowing for potential NbS development. County-level Climate Change Act, Fund Regulations and Policy (2021) were completed by an Action Plan (2023-2027). At the municipality-level, the ISUDP (2014-2034) elevates the conservation natural systems (i.e., Menengai Crater, Lake Nakuru, National Park) as a foundation for urban development. It also emphasizes social integration and local economies, both potential NbS co-benefits, and focuses on developing urban agriculture. Plus, the City Strategic Plan (2023-2027) mentions greening initiatives, climate-resilient infrastructure and the elaboration of infrastructure master plans. Finally, the city has an integrated Urban Resilience Strategy. Nakuru City has already invested in NbS, including Green Corridors (e.g., Kenyatta Avenue, Oginga Odinga Street canopy), Open Green Spaces (e.g., Nyayo Gardens), and Urban Forests (e.g., reforestation of indigenous ecosystems).

There is a strong potential to expand NbS, offering benefits such as flood mitigation, heat stress reduction, and improved social cohesion. The NBSOS identifies Open Green Spaces in the city's North and East as effective for flood control, aligning with the city's plans for new parks. As urbanization increases in the north, protecting and expanding green spaces would enhance climate resilience. Additional flood mitigation can be achieved through Bioretention areas, Stream Renaturation, and Urban Farming. Runoff into the lake can be reduced with Terraces and Slopes, while Urban Forests and Green Corridors can build on existing efforts. Upcoming mobility and drainage masterplans also offer opportunities to integrate NbS like Green Corridors and Bioretention Areas.

Improved governance, financing, operational capacity, and data availability would help create a more conducive environment for successful NbS projects in Nakuru. Local stakeholders report challenges such as unclear delegated functions, inadequate budget allocations, and delays in fund disbursement. Limited office space, equipment, and staffing also pose obstacles to effective operations. Lastly, improving data availability and reinforcing coordination between government bodies would accelerate the implementation of existing frameworks.

Figure 151 – Nakuru (Source: SUEZ Consulting, 2024)

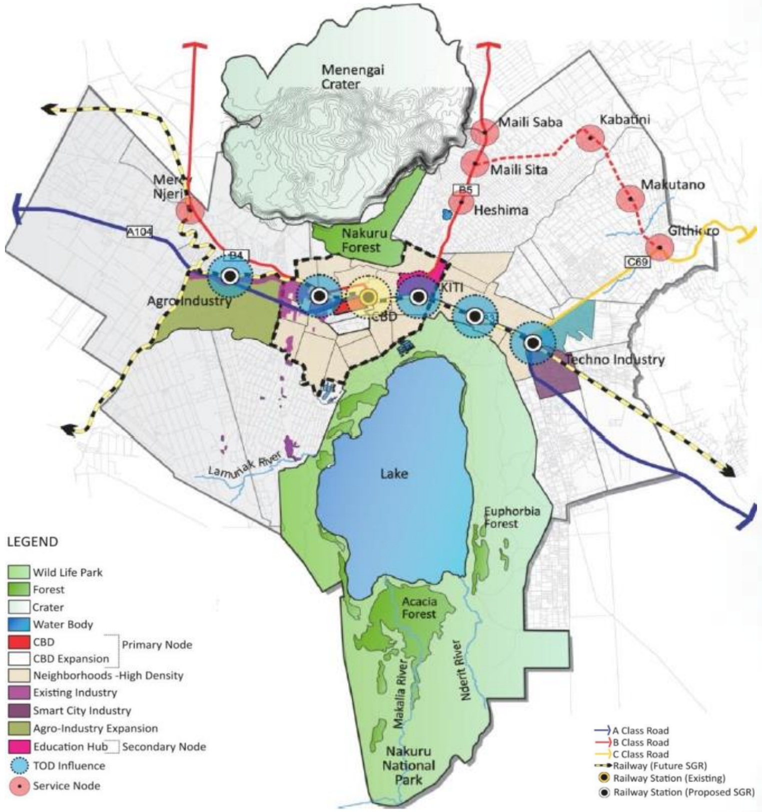
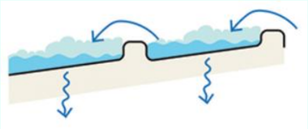


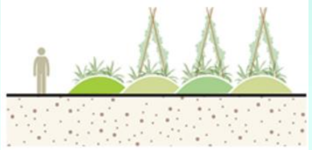
Figure 152 – Tree canopy (top) and Integration of urban and natural systems of Nakuru City, as planned in the ISUDP (Source: County Government of Nakuru, 2021).

NBS Opportunities Examples



Terraces and Slopes

Explore Case 2
Living Smiles

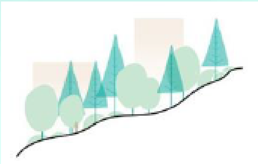


Urban Farming

Explore Case 9
Kansoul Farm

Bioretention Areas

Explore Case 7
St. John's Community School



Urban Forests

Explore Case 6
Kaya Tembo Forest

NB. Additional information provided in the WB NBSOS Report for the 6 Kenyan cities.

Wote Municipality

Figure 153 - Aerial view of Wote Municipality (Source: Moving to Wote, Makueni County | Nellions Moving and Relocations Company, 2020)

In the southeast of Kenya, in Makueni County, Wote is an increasingly urbanized, fast-growing municipality. With a population of 161,996 (KNBS, 2019), it covers six wards across an area of 1092 km². It was granted a municipality charter in 2018. However, the devolution process is still ongoing, and the operationalization of some delegated functions, such as road infrastructure, is yet to be completed.

The municipality is experiencing high-density, informal, haphazard, rapid urban sprawl along major roads, particularly in Kathonzeni, Mukuyuni Market and Wote Township, which has an urban growth rate of 11.8% alone. This unplanned expansion is fueled by the establishment of the Southeastern Kenya University and a will to expand tourism. Nonetheless, the municipality struggles with insufficient infrastructure and services, land tenure issues, urban poverty and unemployment.

Wote's economy is still widely rural, based on farming and agro-based industries, with a growing urban informal sector. 83,93% of total land is for agricultural use, with urban small-scale cultivation and rearing of indigenous livestock. Agro-based industries include a milk processing factory, a fruit processing plant and a ginnery). Due to urban expansion, informal markets have grown. The informal sector thrives on its artisans (e.g., welders, motor mechanics), food traders, and boda boda (motorcycle taxis).

Climate Risk Profile

Wote Municipality has a tropical savanna climate shaped by its varied topography. It experiences two dry seasons and two rainy seasons. The lower regions (Kathonzweni) are semi-arid, while the upper regions (Kaiti and Mbooni Sub-Counties) are sub-humid. Mean temperatures range from 23.9°C to 19.3°C. The area is mostly flat with gently sloping land, hilly zones (Nthangu and Unoa hills), riparian zones along the Kaiti River, and fragile water catchment areas.

In recent years, the region's vulnerability to climate challenges has grown due to erratic rainfall and rising temperatures. Extreme temperatures up to 35°C, are causing heat stress, and the climate has become increasingly dry since the early 2000s. Future temperatures are expected to rise and persist longer. Rainy seasons are shorter, more unpredictable, and more intense, leading to increased flooding and landslides, a trend likely to continue.

Rapid urbanization, population growth, and environmental degradation worsen the effects of floods and droughts. Poor drainage in Kilala Market Centre makes it very vulnerable to flash floods, leading to severe economic impacts. Deforestation disrupts the water cycle and contributes to frequent droughts. Sand harvesting and poor waste management further exacerbate environmental degradation. These factors result in loss of life, property damage, water scarcity, and declines in biodiversity, livestock, and crops, contributing to food insecurity.

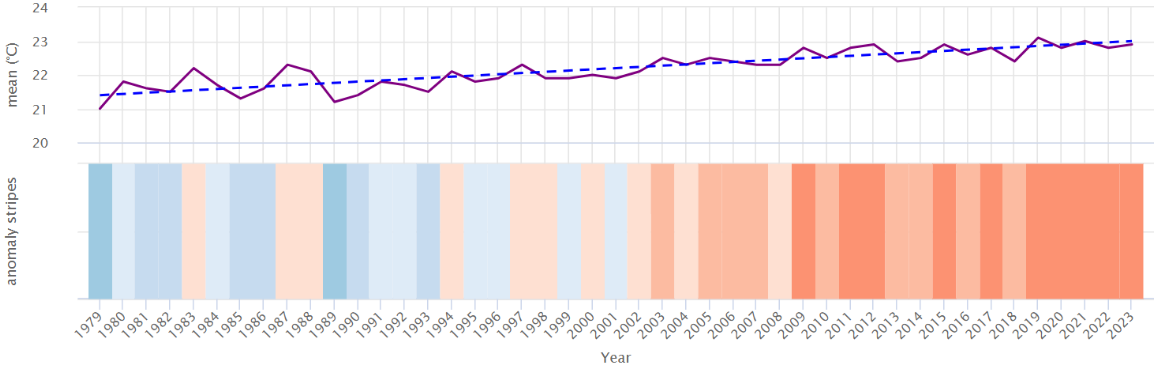


Figure 154 - Mean yearly temperature, trend and anomaly in the larger region of Wote (1979-2023)*
(Source: www.meteoblue.com, 2024, Data: ERA5, with a spatial resolution of 30 km)

(*) Top graph estimates mean annual temperature. Dashed blue line represents linear climate change trend. Lower graph represents warming stripes - blue for colder and red for warmer years.

Wote Municipality has a supportive legal and policy environment for integrating a NbS lens into its processes. The County's 2022 Climate Change Act and 2023 Environmental Management Act and Sustainable Forest Management Bill are reflected in municipal planning documents. Indeed, the municipality Spatial Plan incorporates critical conservation areas such as riparian zones, wetlands, and hills. The IDeP (2021-2025) outlines the development of an Environmental Management Plan and a riparian policy, aligning with Makueni County's Forest and Landscape Restoration Implementation Plan (2023-2030) for the sustainable management of riparian zones, wetlands, and forests. In response to flash floods and droughts, Wote plans to improve stormwater drainage, stabilize soils, and promote drought-resistant farming. Participatory approaches are prioritized (e.g., gender-inclusive framework, development of a Participatory Forest and Hill Management Plan), which is crucial to maximizing NbS benefits for vulnerable groups. The municipality has played a pivotal role in the creation of the KUSP-funded Wote Green Park, a model of NbS providing social cohesion benefits and business growth opportunities while integrating flood and heat mitigation features.

There are significant opportunities to enhance social cohesion and diminish drought- and flood-related risks through NbS. The WB's NBSOS shows extensive creation opportunities for Urban Forests to provide heat mitigation benefits for areas within and surrounding the core urban center. Local stakeholders are putting an emphasis on the improvement on drainage, an opportunity for water-related NbS such as Bioretention Areas. The protection and renaturation of the Kitui River and its floodplain could also help mitigate fluvial flood events, and Terraces and Slopes could limit soil erosion and landslides.

The key opportunities for the Wote Municipality to support NbS implementation include addressing financial resources, improving governance, and enhancing data availability. Structural budget constraints are linked to regional imbalances across the County. Some delegated functions, such as urban forests, which remain with the County Government, could be transferred to the Municipality to further strengthen local governance. Additionally, the Municipality is working to improve data availability by developing informatized land use monitoring systems and establishing a meteorological department to support NbS initiatives.

NB. Additional information provided in the WB NBSOS Report for the 6 Kenyan cities.

Figure 155 - Wote Green Park (Source: County Government of Makueni)

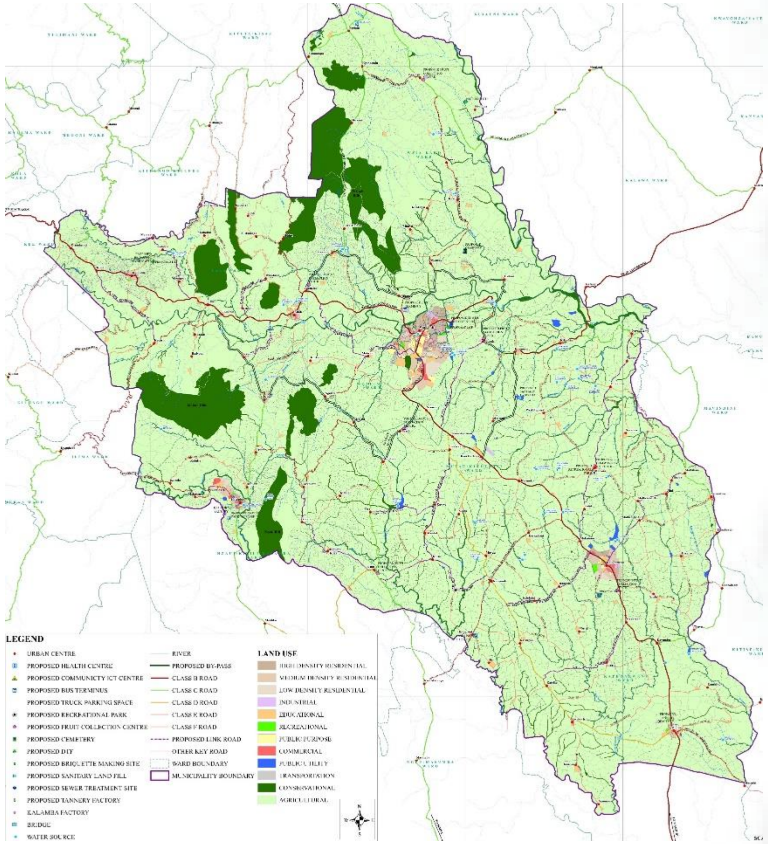
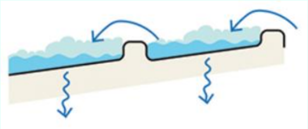


Figure 156 - Wote Municipal Spatial Plan (2021-2030) (Source WOTE MUNICIPALITY SPATIAL PLAN (2021 -2030) - Government of Makueni County, 2021).

NBS Opportunities Examples

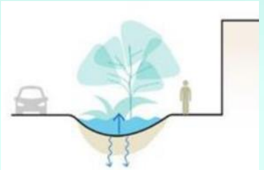


Terraces and Slopes

Explore Case 2
Living Smiles

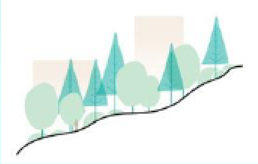
River and Stream Renaturation

Explore Case 10
John Michuki Memorial Park



Bioretention Areas

Explore Case 7
St. John's Community School



Urban Forests

Explore Case 6
Kaya Tembo Forest

Recommendations for implementation

Guide

This section highlights key and focused recommendations for enabling the integration of NbS into upcoming infrastructure projects. It completes gaps in existing guidance, namely AECOM Resilient Infrastructure Guidelines (2023).

The recommendations aim at drawing a general framework to facilitate NbS project at each stage of the project cycle (planning, project identification and design, construction and operation and maintenance, monitoring and evaluation) as well as expanding on four key enabling environment drivers for NbS development. Though drawing from NbS Compendium NbS cases and related NbS family, these recommendations are not specific to any NbS family.

The four enabling environment drivers are:
- identifying knowledge generation and technical requirements,
- fostering the inclusion of stakeholders,
- strengthening institutional capacities and ensuring adequate resources and
- integrating policies and regulations.

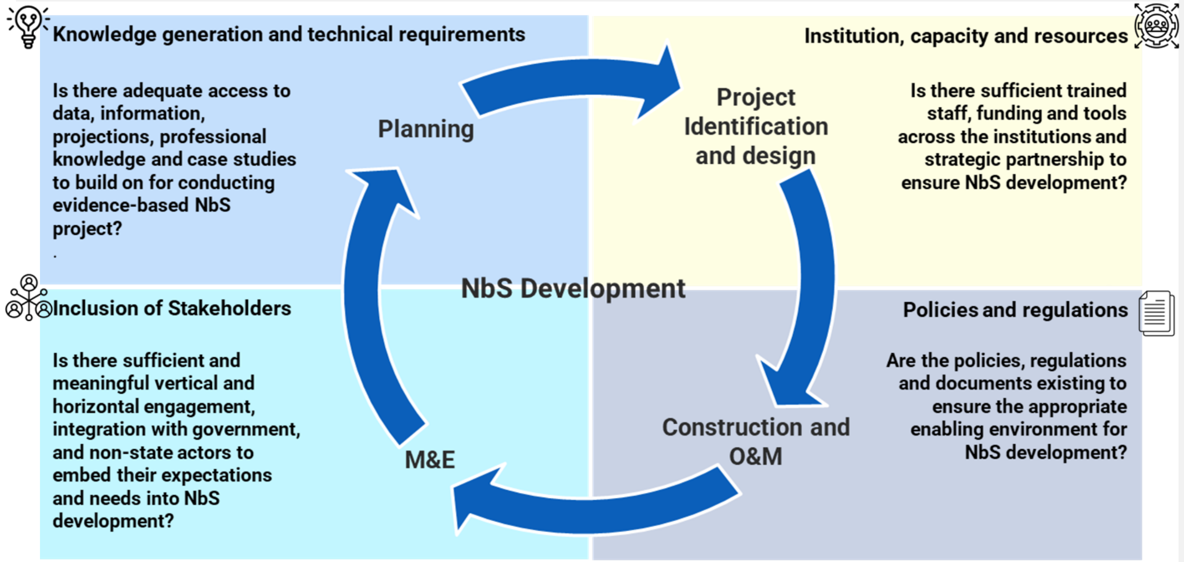


Figure 157 - Project cycle and the four enabling environment drivers (key methodological questions) (Source: SUEZ Consulting, 2024)

Recommendations insist on key features of NbS, in the general landscape of resilient infrastructure which are:
- preserving and restoring existing NbS as a priority,
- anticipating long-term efficiency and sustainability of NbS projects in the context of climate change,
- paying specific attention to the cross-sectoral nature of NbS.

All of these key features need to be factored in to reach a systemic approach to NbS implementation.

Key recommendations reflecting the priorities for Kenyan stakeholders are identified, following discussions during the validation workshop held in February 2025. These recommendations were carefully selected based on their relevance to the local context, their potential to drive sustainable outcomes, and their ability to address pressing challenges. Stakeholders also pinpointed critical actors (see annex). For each recommendation, the principal implementation level (municipal, county, or national) is identified.

Link with the NbS Compendium cases are stressed when appropriate. The reference to NbS Compendium Cases are highlighted **in green** with the name of the Case and NbS Compendium case number.

Targeted audience of the Recommendations for Implementation

The Recommendations for Implementation have a larger targeted audience than the NbS Compendium, namely decision-makers at all level, but also municipal and county engineers (and consulting engineers where design is procured externally), municipal and county planners, Environmental Assessment Experts. Other actors involved in infrastructure development such as National Agencies could also look at these recommendations to feed their own guidance regarding NbS development

GUIDE | How to read the recommendations

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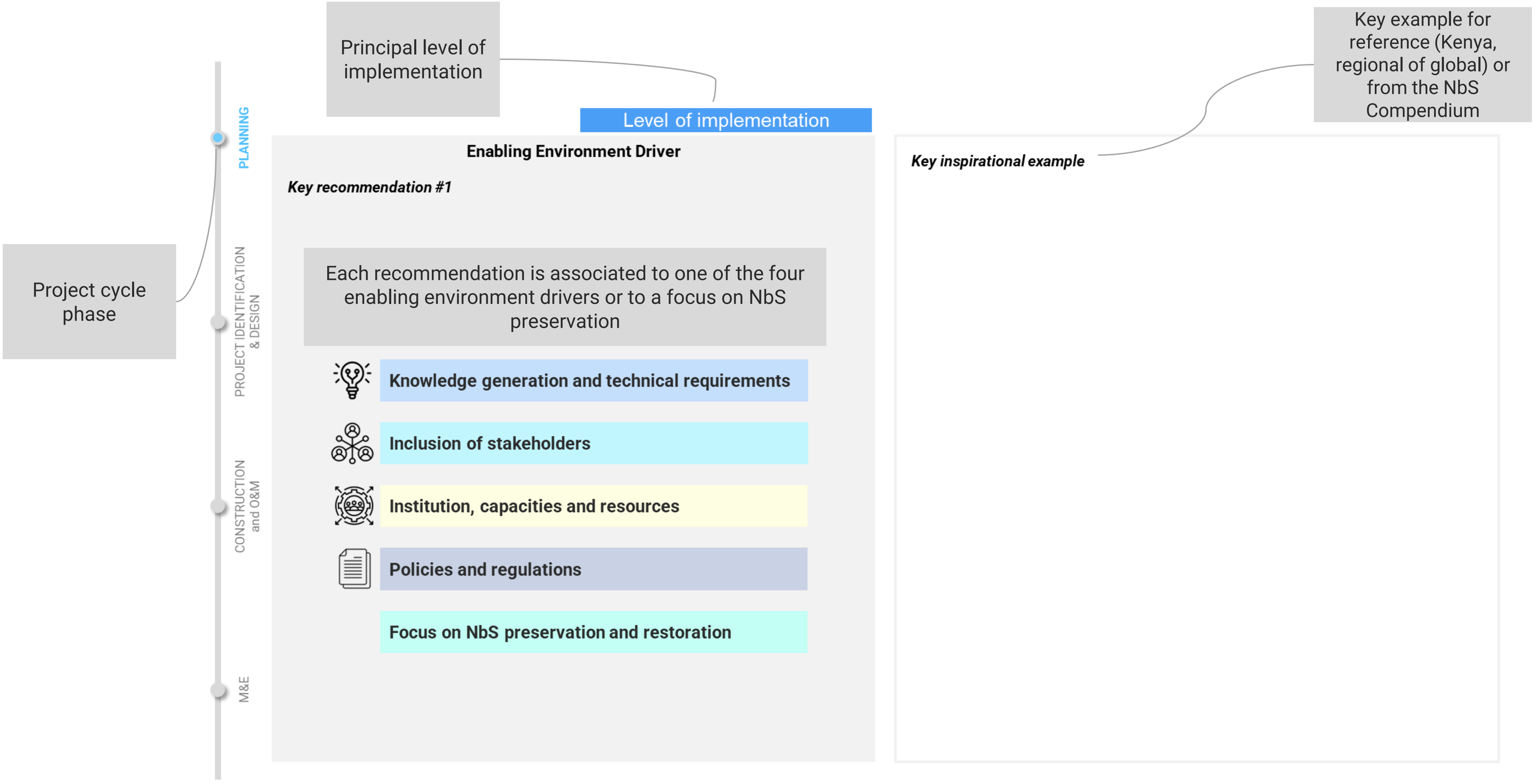

Figure 158– Recommendations template guide
(Source: SUEZ Consulting, 2024)

Recommendations overview by project phase

GLOBAL CENTER ON ADAPTATION

PLANNING | PROJECT IDENTIFICATION & DESIGN | CONSTRUCTION, OPERATION & MAINTENANCE | MONITORING & EVALUATION

Knowledge generation and technical requirements

- #1 Clarify the objectives and contents of environmental baseline for long-term strategic and sectoral planning — Muni. | Cou.
- #2 Develop evidence-based land-use and investment prioritization strategy — Municipality | P

Inclusion of stakeholders

- #1 Develop awareness raising platforms and channels with local stakeholders — Municipality
- #2 Encourage ownership of local stakeholders — Municipality
- #3 Identify and support the development of community-level climate resilience initiatives — Municipality | P

Institution, capacity and resources

- #1 Ensure coordinated actions under climate change umbrella — Muni. | Nat.
- #2 Reinforce collaboration between urban planning county departments and city-level authorities — Muni. | Cou. | P
- #3 Shift urban planning from solution-centric to problem-centric approaches — Muni. | Nat.

Policies and regulation

- #1 Enforce NbS as a national initiative — National | P
- #2 Transition municipal plans from guidance documents to comprehensive urban planning tools — Municipality
- #3 Recognize and formalize community initiatives to enhance urban planning policies — Municipality

Institution: Level of implementation

P: Identified as priority by the stakeholders

PLANNING

PROJECT IDENTIFICATION & DESIGN

CONSTRUCTION, OPERATION & MAINTENANCE

MONITORING & EVALUATION

Knowledge generation and technical requirements

#1 Foster interdisciplinary expertise to advance NbS development Muni. Nat. P
#2 Develop a cost-benefit analysis (CBA) framework to prioritize large-scale NbS development Muni. Nat.
#3 Ensure inclusive design Municipality

Inclusion of stakeholders

#1 Adapt NbS projects to community-level scope and capacity through co-design and multi-functional design following local necessities and interests Municipality

Institution, capacity and resources

#1 Clarify roles and foster collaboration for NbS integration Muni. Nat. P
#2 Enhance municipal capacity to support NbS projects and integration Municipality
#3 Strengthen the role of professional bodies in enhancing technical standards for NbS development address Nat.
#4 Land tenure challenges through public-private partnerships for NbS Development Muni. Nat.

Policies and regulation

#1 Integrate environmental quotas and incentives in development control to foster NbS implementation Muni. Nat.
#2 Strengthen the role of environmental and social impact assessment (ESIA) to drive NbS adoption and resilience-oriented investments National P

Institution Level of implementation P Identified as priority by the stakeholders

PLANNING | PROJECT IDENTIFICATION & DESIGN | **CONSTRUCTION, OPERATION & MAINTENANCE** | MONITORING & EVALUATION

Knowledge generation and technical requirements

#1 Activate local supply chains for NbS construction and long-term management — Muni. | Cou. | P

Inclusion of stakeholders

#1 Preserve and enhance the social value of public spaces through NbS development — Municipality

#2 Encourage the participation of local communities in O&M activities — Municipality

Institution, capacity and resources

#1 Pursue coordinated action initiated at the planning throughout construction and O&M — Municipality | P

#2 Develop O&M plans to ensure O&M planning, responsibilities, financial sustainability, and clear management guidance from the NbS design phase — Municipality | P

#3 Develop O&M capacity building programs — National

Policies and regulation

#1 Enhance NbS inspection and enforcement at the local level — Municipality

Institution: Level of implementation

P: Identified as priority by the stakeholders

PLANNING | PROJECT IDENTIFICATION & DESIGN | CONSTRUCTION, OPERATION & MAINTENANCE | **MONITORING & EVALUATION**

Knowledge generation and technical requirements

#1 Develop a robust monitoring framework to evaluate NbS performance and benefits — Municipality

#2 Implement an adaptive management framework for NbS — Municipality

Inclusion of stakeholders

#1 Tap into citizen sensing data potential — National — P

#2 Foster partnerships with Kenyan research institutions for advanced impact analysis and knowledge dissemination — Muni. — Nat.

Institution, capacity and resources

#1 Design an appropriate framework for monitoring and evaluation — Municipality — P

#2 Harness labelling initiatives for NbS as an adaptation measure to attract funding — National — P

Policies and regulation

#1 Establish a national NbS monitoring framework to track outcomes across sectors — National — P

#2 Implement a resilience scorecard to evaluate NbS integration in municipal plans — Municipality

#3 Develop community-led NbS impact assessment tools — Municipality

Institution — Level of implementation

P — Identified as priority by the stakeholders

Preliminary checklist for municipalities

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This flowchart presents a detailed checklist of the key tasks and actions required for the development of a NbS project at the municipal level in Kenya, structured across the four main phases of the project cycle. Each phase is broken down into specific steps, with priority recommendations highlighted based on stakeholder input. These recommendations are designed to facilitate the smooth execution of tasks and strengthen the enabling conditions necessary for NbS development. By incorporating these insights, the flowchart aims to provide a practical guide for municipalities, ensuring that the necessary actions are taken at each stage of the project cycle to promote successful NbS outcomes.

PLANNING

- ❑ Use a spatial prioritization framework to map NbS that need to be protected, restored and created #2
- ❑ Engage with local communities where NbS opportunities exist to choose sites suitable for NbS implementation within target communities #3
- ❑ Strengthen coordination and clarify roles and responsibilities between county-level and city-level planning mechanisms #2
- ❑ Elaborate comprehensive planning document #2

PROJECT IDENTIFICATION & DESIGN

- ❑ Identify NbS opportunities #2
- ❑ Define project goals and outline the scope for NbS with the support of an adequate technical advisory committee
- ❑ Set up a project team gathering the required expertise #1 #1
- ❑ Collect project related data (climate, environment, local stakeholders…) #2
- ❑ Identify required permits and ensure regulatory compliance before construction #2

CONSTRUCTION, OPERATION & MAINTENANCE

- ❑ Incorporate local socio-economic development criteria #1
- ❑ Engage the community during and after construction #2
- ❑ Evaluate various NbS construction methods (e.g., phased vs. full-scale implementation) #1 #2
- ❑ Integrate both construction and O&M cost in evaluation criteria
- ❑ Elaborate a comprehensive checklist for inspecting NbS based on NbS family guidelines #1

MONITORING & EVALUATION

- ❑ Establish baseline information and monitoring framework #1
- ❑ Identify sources of potential data to build the project indicators, and centralize these data sources #1
- ❑ Implement a management framework that allows room for adaptative measures #2

Recommendations for NbS implementation

Planning Phase

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Knowledge generation and technical requirements

Key recommendation #1 Clarify the objectives and contents of environmental and social baselines for long-term strategic and sectoral planning

Establishing clear and comprehensive environmental and social baselines at municipal and county levels is essential for effectively integrating Nature-based Solutions (NbS) into urban resilience and development strategies. A robust baseline ensures informed decision-making and maximizes the potential and effectiveness of NbS in strengthening urban resilience. These baselines should include key metrics such as environmental quality, land-use patterns, biodiversity status, and climate risk assessments. They provide a foundation for understanding current conditions, monitoring progress, and prioritizing investments.

The baseline should specifically map green and blue areas to help classify protected zones alongside urban land-use analysis and assess development trends and land suitability. It should also highlight underutilized or degraded urban spaces such as "in-between spaces" that could support NbS creation or restoration, as well as areas that hinder ecological connectivity such as parking lots. Vulnerable zones, such as those impacted by air or noise pollution near major infrastructure, should also be highlighted, with strategies like buffer zones proposed to alleviate risks.

In parallel, social aspects must be considered such as identifying relevant stakeholders. These include individuals, communities, marginalized groups, local businesses, NGOs, and institutions affected by or involved in urban resilience planning. Engaging stakeholders ensures that their concerns are integrated, fostering social inclusion and equity in urban planning.

Inspirational example

Offered by the GFDRR, the Nature-Based Solutions Opportunity Scan (NBSOS) is a response to the constraints of lack of data and technical expertise on NbS. It is a geospatial analysis that supports cities and coastal areas worldwide in identifying NbS investment opportunities and understanding the benefits that NbS would bring for communities and the environment. It is a tool particularly suitable for pre-feasibility studies and for sensitizing local decision-makers on how NbS could respond to their urban development challenges.

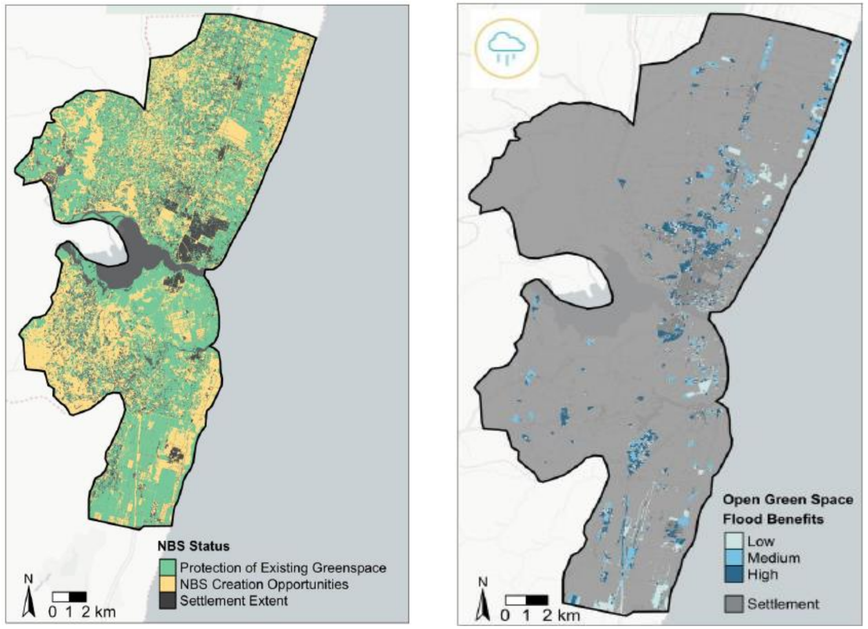

Figure 159 - Urban NbS Suitability for Open Green Spaces in Kilifi (left) and associated benefit for reducing pluvial flooding (right) (source: The Nature-Based Solutions Opportunity Scan – Kenya: 6 cities, World Bank, 2024)

Planning Phase

Municipality

Key recommendation #2 Develop evidence-based land-use and investment prioritization strategy

To guide effective integration of NbS into urban development, it is essential to develop evidence-based land-use and investment prioritization strategies.

Based on the baselines (*Recommendation #1*), evidence-based land use requires clear definitions within zoning frameworks. Land use plan should clearly identify ecosystems to preserve, cataloging local biodiversity with a focus on both iconic and ordinary species, and determining appropriate buffer zones for riparian areas. A typology of green and blue zones should be established, outlining their specific functions and objectives—whether preservation, restoration, or incorporation of green-blue infrastructure into urban development controls.

These zoning frameworks must be cross-referenced with risk maps and climate risk assessments to address present and future climate change impacts (e.g., flooding, heat stress, droughts). Planning should be refined based on existing and emerging data.

Having these data in mind, a Multi-Criteria Analysis (MCA) should guide investment prioritization by evaluating gaps in NbS preservation, restoration, and creation. This analysis should also integrate a systematic approach to hybrid infrastructure solutions, ensuring the balance between gray, green, and hybrid options is clearly understood and strategically applied. This prioritization framework will ensure NbS investments are targeted, effective, and aligned with broader urban resilience objectives.

Inspirational example

The Hotspot Stoplight, co-created by UN-Habitat, the University of Pennsylvania, and One Architecture, is an evidence-based tool that projects the risks of land use change, biodiversity loss, and climate change up to 2050. Using AI and open-source data, it maps these risks at a 30-meter resolution, generating a "stoplight" map. Red areas highlight high-risk zones for development, urging conservation; green areas within urban footprints are suitable for densification; and yellow areas suggest caution in expansion due to lower biodiversity or higher accessibility.

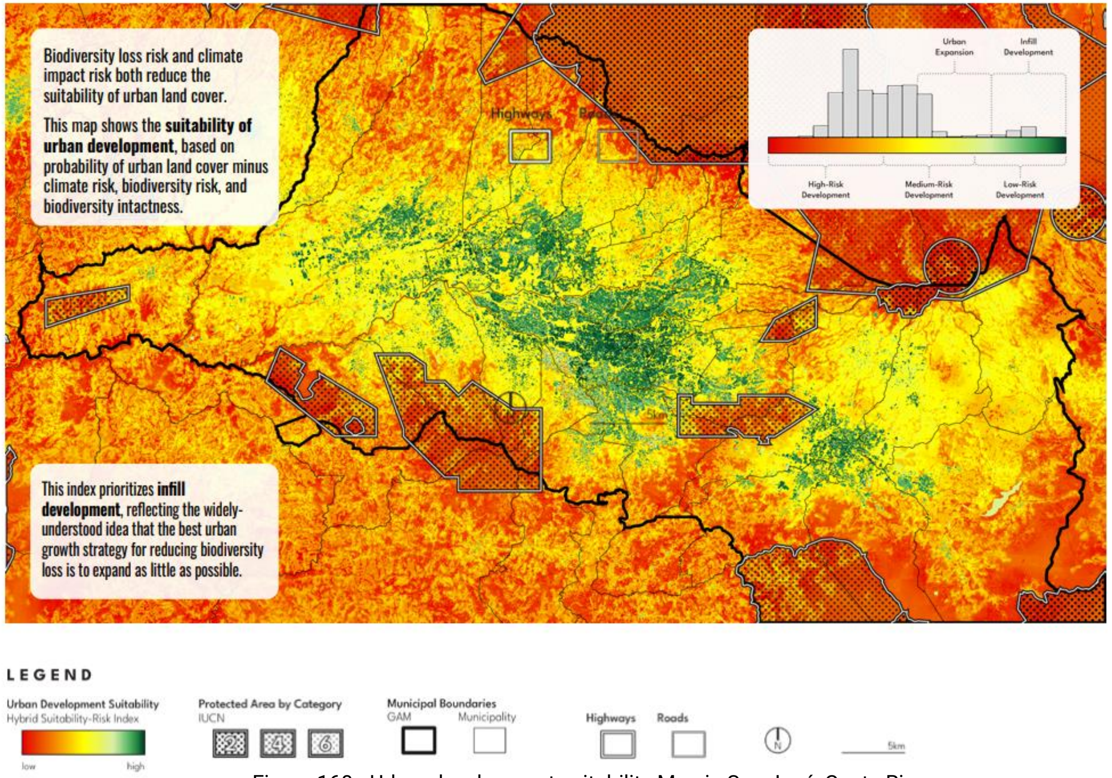

Figure 160 - Urban development suitability Map in San José, Costa Rica
(source: https://unhabitat.org/sites/default/files/2024/11/hotstop_stoplight_brochure_2024.pdf)

Planning Phase

GLOBAL CENTER ON ADAPTATION

Municipality

Inclusion of stakeholders

Key recommendation #1 Develop awareness raising platforms and channels with local stakeholders

Developing awareness-raising platforms for local stakeholders is essential to foster effective participation. While urban resilience projects incorporating NbS are complex and require a range of technical, environmental, and economic knowledge, the participation of civil society in the planning process is key to ensure the full benefits of such solutions to the human communities (a key pillar of NbS definition (IUCN, 2016)). For citizens to contribute meaningfully, they must first understand the issues and concepts behind these projects. Without this knowledge, their input may not significantly impact decision-making processes.

This can be achieved by communicating the benefits of ecosystem services through schools, NGOs, and citizen forums, while complementing these efforts with public events to shift perceptions about urban open spaces. Additionally, identifying and training "green ambassadors" within the community can foster stewardship and serve as reliable points of contact for residents seeking information about flood risks or areas suitable for sustainable living.

An online platform or centralized repository can also be created to consolidate fragmented information on climate risks and ecosystem services, ensuring that the public has easy access to critical data. This resource would empower informed decision-making and enhance participatory planning. Citizen forums must be used to identify local needs, co-develop NbS solutions, and align project site selection with community insights, ensuring that the planning process is both inclusive and tailored to the needs of the local population.

Inspirational example

In Nakuru, Meshack Maina, a boda boda rider, is transforming his community by planting trees to challenge negative stereotypes surrounding his sector. His journey began in 2016 when he planted two trees after one was cut down for road construction. Despite challenges such as limited funds and livestock damaging his plants, Maina persisted, planting over 2,000 trees. His efforts aim not only to enhance the environment but also to reshape the narrative of boda boda riders as environmental stewards, this role being now recognized by the municipality as a local “Green Ambassador”.

Figure 161 - Trees planted by Meshack Maina (right of the picture)
(Source: SUEZ Consulting, 2024)

Planning Phase

Municipality

Key recommendation #2 Encourage ownership of local stakeholders

By equipping municipal staff with a clearer understanding of how NbS complement climate adaptation strategies, they are better able to critically engage with consultants, advocate for locally relevant solutions, and ensure plans align with the community's needs. Municipal or sectoral plans as well as project technical designs are often developed by external consultants, which can limit engagement and ownership by municipal staff. While municipal staff understand the climate change impacts on their communities and their local urban challenges, the challenge lies in linking this knowledge to practical, actionable solutions. This disconnect can undermine their involvement in planning processes.

By demonstrating how NbS can address climate-related challenges like flooding, heat islands, and biodiversity loss, planners can gain confidence in integrating them into municipal strategies. This empowers them to take ownership of the planning process, ensuring that the solutions are sustainable, locally informed, and practical.

Inspirational example

The communities of Casiguran and Dilasag (Philippines) face several disaster risks, but also unsustainable development and tourism. Although natural hazards are quite well understood, the communities are less aware about the potential impacts of development and tourism. The local organization Alay Bayan-Luson, Inc. (ABI) engaged with the community to undertake training and other activities to raise awareness about the risks. A Disaster Preparedness Organization (DPO) was set up and replicated in several villages to conduct community training, and development of early warning systems aimed at reaching the most marginalized groups. This local engagement ensured a change in culture of community members themselves which have developed a culture of helping each other. The presence of DPOs in several villages has contributed to their endorsement as a locally recognized structure.

Municipality

Key recommendation #3 Identify and support the development of community-level climate resilience initiatives

To strengthen municipal climate resilience strategies, it is essential to recognize the principle of subsidiarity, which highlights the effectiveness of addressing specific climate challenges at the local level. NbS community-level initiatives, often grounded in local knowledge and tailored to specific needs, present practical and scalable solutions that are deeply connected to their contexts. Key actions:

- Municipal authorities could prioritize identifying and cataloging existing community-led resilience projects to understand their scope, achievements, and areas for potential support.
- Municipalities could identify a champion to coordinate these activities at the municipality-level and work together with the communities to identify neighborhood-level champions to mobilize and facilitate engagement.
- Municipalities could propose capacity-building programs to enhance the technical, financial and organizational skills of community groups. This will also permit to the municipal staff to better integrate local knowledge into planning.
- Municipalities could propose pathways for collaboration between municipal staff and communities, ensuring the grassroots initiatives are aligned with larger urban resilience objectives. For instance, the municipality could create a platform (e.g., WhatsApp group, Facebook page) for sharing the best practices and fostering dialogue between communities and municipal planners.

Figure 162 - Community training on disaster preparedness
(Source: Cookbook on institutionalizing sustainable CBDRM, GNDR, 2018)

Planning Phase

National Municipality

Institution, capacity and resources

Key recommendation #1 Ensure coordinated actions under climate change umbrella

Leveraging climate change as a central framework offers a strategic entry point for integrating NbS as a core adaptation measure. In Kenya, where climate change is a well-established priority, aligning NbS efforts under this umbrella can streamline policy implementation and funding opportunities while fostering cross-sectoral collaboration.

At the national level, clarifying roles and responsibilities under the existing Climate Change Act is essential to avoid overlap and inefficiencies. Clear delineation of mandates among ministries, departments, and stakeholders will strengthen coordination. At the municipal level, establishing or replicating climate change planning committees, such as those in Kisumu, provides a proven model for managing cross-cutting issues. These committees can integrate NbS into their mandates, ensuring NbS is prioritized and mainstreamed across sectoral policies and urban planning initiatives, creating a comprehensive approach to urban climate resilience.

Inspirational example

The establishment of the Kisumu County Climate Change Council, which facilitates the integration of climate change adaptation and mitigation strategies into local development plans, notably through County Climate Change Fund Mechanism. The council, launched by Kisumu Governor Anyang Nyong'o in June 2023, works in tandem with the County's Climate Change Action Plan and supports the creation of climate change funds to address adverse impacts, with also the support of key development partners, especially the City Climate Gap Fund that supported a biogas project. A stormwater NbS project has also been submitted to Gap Fund.

Figure 163 - Liquid organic fertiliser made from the biogas process helps farmers' crops (Source: https://www.eib.org/en/stories/kenya-biogas-waste-recycling)

Planning Phase

GLOBAL CENTER ON ADAPTATION

County | Municipality

Key recommendation #2 Reinforce collaboration between urban planning county departments and city-level authorities

Strengthening collaboration between county urban planning departments and city-level authorities is essential for integrated and effective urban resilience strategies. Current practices in many counties, as highlighted in Eldoret, show active engagement with county departments like environment, roads, and energy, but a notable gap exists in the involvement of urban planning departments. This disconnect hinders the cohesive integration of urban planning principles into projects addressing climate resilience and NbS at the different scales. To address this, institutional frameworks must explicitly require a greater collaboration between county urban planning departments and city urban planners / technical team, that will ease the alignment of projects and decision-making processes. Mechanisms for structured communication and coordination, such as joint planning committees or inter-departmental task forces, could be established to facilitate regular information sharing, project updates, and collaborative decision-making. Additionally, joint training programs for county and city urban planning units should be implemented, and could serve as an opportunity to clarify their respective roles while enhancing their ability to work together towards common NbS goals.

Improved transmission of information across departments is also critical. Developing a centralized information system or shared digital platform can enable seamless access to data, plans, and progress reports, ensuring that urban planning considerations are embedded in environmental, infrastructure, and energy initiatives. This coordinated approach will ensure that urban planning functions as a cornerstone of climate resilience strategies, fostering synergies across sectors while avoiding fragmented and duplicative efforts.

National | Municipality

Key recommendation #3 Shift urban planning from solution-centric to problem-centric approaches

The effective integration of NbS requires rethinking how urban resilience challenges are addressed. Solutions must stem from a deep understanding of underlying problems, ensuring interventions are targeted, relevant, and impactful. Addressing issues like climate resilience begins with placing the problem at the core of planning and using NbS as tools to address specific needs rather than as one-size-fits-all answers.

Additionally, there is a critical cultural shift needed within the urban planning sector. Historically, nature has been viewed as an obstacle to development; however, it should instead be embraced as a key element of sustainable solutions. To achieve this transformation:

- Integrate local knowledge into planning: for instance, Kaya Tembo is a sacred indigenous forest managed by the Miji Kenda communities and gazetted since 1970s. Since many years, this community is in charge to protect the forest and revive traditional beliefs and practices.)
- Enhance cross-sector collaboration: create platforms for collaborations between urban planners, ecologists, engineers, etc., to address resilience challenges holistically and mainstream the protection and enhancement of existing ecosystems.
- Develop multidisciplinary training programs: equip planners and decision-makers with skills in ecology, community engagement, and NbS design. Training should emphasize interdisciplinary problem-solving to break down traditional silos in urban planning.

Planning Phase

National

Policies and regulations

Key recommendation #1 Enforce NbS as a national initiative and leverage existing successful programs

By formalizing NbS as a national priority, Kenya can create a replicable and scalable framework that advances climate resilience, enhances biodiversity, and improves the quality of life for urban and rural populations alike. To enforce NbS at the national level, it is essential to integrate them into overarching policies and frameworks, such as Kenya's Climate Change Act and Vision 2030. The establishment of clear national targets for NbS, such as a percentage increase in urban green cover or ecosystem restoration by 2030, would provide a unified goal for stakeholders across sectors. Additionally, linking NbS to existing climate action commitments under Kenya's Nationally Determined Contributions (NDCs) would align these efforts with global climate agendas, attracting international funding and partnerships. A thorough review of existing legal and policy frameworks is necessary to ensure alignment with NbS objectives, and efforts should be made to harmonize these frameworks across various sectors.

A key element of this enforcement strategy involves identification of champions and scaling up the Green Initiative’s community engagement model. Positioning NbS as a national initiative in Kenya requires leveraging successful programs like the Green Initiative, which aims to increase tree cover and restore degraded ecosystems. This initiative has demonstrated that coordinated national efforts can mobilize resources, engage diverse stakeholders, and achieve measurable environmental outcomes. Public awareness campaigns, educational programs, and incentives for local communities to participate in NbS projects would foster ownership and long-term sustainability. Furthermore, institutionalizing mechanisms for monitoring and evaluation — using the Green Initiative's tracking framework as a model — can ensure that NbS projects deliver tangible ecological, social, and economic benefits. By building on its success, Kenya can expand the scope of NbS to include a broader range of actions such as wetland restoration, urban greening, and the establishment of ecological corridors.

Municipality

Key recommendation #2 Transition municipal plans from guidance documents to comprehensive urban planning tools

The transformation of municipal plans from project-oriented guidance documents into comprehensive urban planning tools is critical to foster urban resilience. Municipal plans often function as statements of intent or local budgeting instruments, focusing on acceptable land uses or priority projects without a coherent strategy for resilience. For instance, the absence of mapping and zoning in Malindi weakens the potential for systematic land use planning (AECOM, 2023). This places the burden of resilience-building on individual projects, limiting the ability to address systemic challenges like disaster mitigation and climate adaptation. To address these gaps, municipalities should adopt the following measures:

- Policy integration: develop mandatory policies within municipal plans to guide land use, enforce zoning regulations, and ensure disaster risk reduction is a core planning principle. Policies could include the preservation of natural floodplains, mandatory green infrastructure in urban areas, and clear guidelines for infrastructure siting.
- Mapping and zoning: provide comprehensive mapping and land use zoning for all municipal plans. This will operationalize a spatial planning that aligns with local vulnerabilities and development priorities, ensuring projects contribute to broader resilience goals.
- Resilience mainstreaming: shift the focus from standalone resilience projects to embedding resilience into every aspect of urban planning. This includes policies for integrating NbS, reducing urban heat islands, and designing inclusive public spaces that mitigate climate risks.

A key step to implementing these measures is revising existing municipal planning guidelines at the national level to mandate comprehensive planning practices. Capacity-building programs should accompany this revision to equip municipal authorities with the tools and expertise needed to operationalize the new planning standards.

Planning Phase

Municipality

Key recommendation #3 Recognize and formalize community initiatives to enhance urban planning policies

Community-led initiatives offer valuable opportunities to integrate local perspectives into urban planning while advancing NbS. Formalizing these efforts ensures they contribute to resilience-building and sustainable development. For example, the Saint John Community School's participatory planning tool demonstrated how grassroots actions can influence policymakers to adopt NbS.

To replicate such successes, Kenyan cities could:

- Establish recognition: map existing community initiatives and bring them to the attention of policymakers to ensure alignment with urban resilience goals.
- Support capacity building: provide technical and financial resources to scale successful community efforts.
- Adopt participatory tools: institutionalize tools that facilitate dialogue between communities and policymakers, ensuring local needs are reflected in planning.
- Integrate into policy: create mechanisms to incorporate impactful community initiatives into municipal zoning, disaster risk reduction, and green infrastructure strategies.

See also recommendation #3 – inclusion of stakeholders: Identify and support the development of community-level climate resilience initiatives

Planning Phase

NbS Compendium Case #10 – John Michuki Park

John Michuki Park is an example of River and Stream Renaturation, highlighting the challenges of preserving riparian areas and reaching a collective framework for managing rivers and other NbS connected to this, at the appropriate scale. From a planning perspective, the riparian areas of the Nairobi river within the park (30 meters both sides of the river) are formally protected. However, some upstream sections of the river have not been reclaimed by public authority, leading to continued pollution of downstream river. Moreover, the Park as a whole hasn't been gazetted as a protected area, lacking long-term legal enforcement framework.
Lastly, from an institutional perspective, Nairobi River Commission manages the riparian areas of Nairobi river, yet Kenya Forest Service (KFS) is the one identified for maintaining and managing the Park. This leads to institutional overlap and inadequate long-term enforcement mechanisms.

Figure 164 - John Michuki Park Facility
(SUEZ Consulting, 2024)

Focus on NbS preservation and restoration

At the planning level, a city-level "canopy plan" that would identify and prioritize key areas of conservation and restoration is a prerequisite for understanding the role of tree in the city. It helps developing an environmental perspective on tree planting as a necessary complement to aesthetics value and national campaign such as the objective of planting 15 billions trees in 10 years in Kenya.

The main steps of a canopy plan are:
1. Take stock of tree cover (and assess current health of the trees, as well as resilience in the context of climate change)
2. Identify priority neighborhood,
3. Identify potential restoration sites.

A quantitative objective could be taken to formulate a general strategy (such as setting a 3% objective) but still need to take into the following prioritization: Conserve, Compensate (for lost trees) and lastly Increase.

To support this strategy, various tools are needed (phytosanitary baseline, E&S construction regulation to preserve existing tree canopy, simple decision making tool to select the appropriate tree for planting etc.).

Stressing the patrimonial and cultural value of the tree canopy is also key to the success of this strategy, and can be achieved by conducting public awareness campaigns.

Figure 165 - MITI CS Hon. Rebecca Miano and the PSs planted trees
as part of GoK's initiative to plant 15 billion trees by 2032
(Source: https://www.investmentpromotion.go.ke/stepping-towards-goks-initiative-plant-15-billion-trees-2032)

Project Identification & Design

GLOBAL CENTER ON ADAPTATION

Knowledge generation and technical requirements

Key recommendation #1 Foster interdisciplinary expertise to advance NbS development

Developing interdisciplinary expertise is critical for designing and implementing NbS that address climate, ecological, socio-economic, and urban challenges effectively. Within the institution, organizing project teams composed of diverse profiles and facilitating site visits, along with regular meetings or reviews, would help foster a shared vision and common working practices among team members. For instance, expanding the involvement of underrepresented professions, such as landscape architects, is particularly important. Their expertise in public space design, plant selection, and ecological integration is crucial for developing site-specific and context-sensitive NbS. Additionally, embedding ecological expertise in all aspects of NbS development is necessary to ensure that projects align with biodiversity conservation goals, reinforcing their long-term environmental impact of these solutions.

Streamlining NbS into business-as-usual practices, a greater collaboration between professionals and a diversification of their skills will ensure NbS projects are holistic and sustainable. Existing professionals, including engineers, should receive training in ecological principles, climate adaptation, and socio-economic analysis through updated curricula and interdisciplinary programs. Promoting dual-degree programs and encouraging cross-sector collaboration will enhance the standardization of technical practices and facilitate knowledge sharing.

Furthermore, implementing structured knowledge transfer mechanisms between institutions as well as within project procurement processes will ensure capacity building throughout all stages of NbS implementation, bridging gaps between institutions, and between international expertise and local needs.

Inspirational example

The Green Education Hub is a five-year program launched in 2022 under the global umbrella academic program "Climate-U" Network. This Hub brings students, ambassadors on climate change and action and other stakeholders to elaborate and disseminate learning materials on climate change, environmental sustainability and green education. Such academic initiative could further contribute to NbS development by incorporating these learning materials into regular academic curriculum to ensure long-term standardization and streamlining.

Figure 166 - Kenyatta University Green Education Hub
(Source: https://greeneducationhub.ku.ac.ke/)

Project Identification & Design

National | Municipality

GLOBAL CENTER ON ADAPTATION

Key recommendation #2 Develop a cost-benefit analysis (CBA) framework to prioritize large-scale NbS development

By embedding a tailored CBA approach into planning processes, Kenya can maximize ecological, social, and economic returns, enabling sustainable growth and climate resilience. Incorporating nature's benefits such as biodiversity, recreation, hazard mitigation, and water regulation into economic analyses is essential. Failure to account for these impacts result in significant underestimation of their value.

CBA are powerful decision-making tools that are essential for prioritizing large-scale NbS developments. They confront anticipated implementation and maintenance costs of different alternatives with the variety of benefits they will generate along their lifetime. Unlike in traditional CBAs, the monetary valuation of NbS benefits is more complex. Although some benefits can be modeled and monetarized, such as flood risk reduction and food supply, many intangible benefits cannot be fully expressed in monetary terms such as social cohesion and cultural value. CBAs remain possible but can be incomplete.

Slow return on investments can also be a key challenge in implementing NbS, especially for demonstrating benefits to secure financing, presenting benefits alongside costs in a multicriteria analysis is thus recommended to capture the full breadth of benefits and compare alternatives in a standardized way, and could help attract funding including from the private sector. Indicators and their metrics must be assigned to each ecosystem services and can be evaluated in a qualitative or quantitative manner and even involve some monetary terms if possible. A scoring system can be applied to normalize all criteria, offering the option to prioritize, although presenting disaggregated results is helpful to foster discussion.

Additionally, the framework could be embedded in green-gray infrastructure planning *(see recommendation #2 – Planning phase)*, facilitating comparisons and synergies between nature-based and engineered solutions. This integration will enhance resilience while balancing ecological benefits and infrastructural reliability.

To operationalize, local governments and stakeholders could be trained to apply the CBA tools effectively. Aligning the framework with Kenya's Vision 2030 and climate action strategies ensures that NbS planning supports broader development goals.

Inspirational example – CBA for prioritizing mangrove conservation and restoration at the national-level in Indonesia

The mangrove conservation and restoration case study in Indonesia highlights the role of CBA in supporting this target by providing spatially disaggregated estimates of the costs and benefits of mangrove restoration and conservation at a national scale. The analysis has been instrumental in shaping the World Bank's Mangroves for Coastal Resilience Project, a US$ 419 million investment aimed at rehabilitating 75,000 ha and protecting an additional 400,000 ha of mangroves across four key provinces in Indonesia. The government of Indonesia has set an ambitious target to rehabilitate 600,000 ha of mangroves by 2024 — equivalent to the total amount of mangrove loss since 1990. By quantifying both the economic and ecological benefits of mangrove restoration, this initiative provides a powerful example of how evidence-based analysis can drive large-scale investments in nature-based solutions, enhancing coastal resilience and supporting sustainable development goals.

Guidelines on CBAs for NbS projects and other case studies can be found in *Assessing the Benefits and Costs of Nature-Based Solutions for Climate Resilience: A Guideline for Project Developers*, van Zanten *et al.*, 2023.

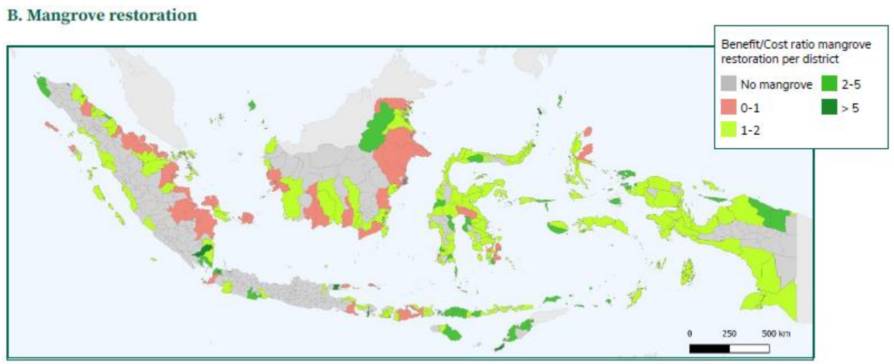

Figure 167- Benefit/Cost ratio of mangrove restoration in Indonesia (Source: The Economics of Large-scale Mangrove Conservation and Restoration in Indonesia, World Bank, 2021)

Project Identification & Design

Municipality

GLOBAL CENTER ON ADAPTATION

Key recommendation #3 Ensure inclusive design

Inclusive design for NbS must prioritize the needs and participation of diverse communities, especially vulnerable groups. NbS aim to enhance human well-being, and collaboration with local communities is crucial for ensuring that designs address local needs through an intersectional lens and incorporate informal contexts such as informal shops or street vendors, which are often overlooked in traditional urban planning. Designing in partnership with vulnerable populations helps reduce inequalities, ensuring that these spaces are inclusive both physically and representatively, while also contributing to social equity. Co-creating designs with these groups prevents further marginalization and empowers those who are typically excluded from urban development decisions. For example, it is vital to ensure that public spaces are accessible to all, including people with physical disabilities and marginalized groups such as women and the elderly. Key areas to strengthen while applying the concept of universal access include improving data access and raising awareness among various stakeholders, as well as enhancing the capacity to enforce UA implementation.

Additionally, NbS designs should be adaptable and responsive to the dynamics of urban life. For example, public spaces can serve different purposes at various times of day, necessitating flexible and context-sensitive approaches to design.

Figure 169 - Public participation across the Homa Bay forty wards on the budget estimates for the fiscal year 2024/2025.
(Source: County Government of Homa Bay Facebook page)

Inspirational example

The NbS Compendium case of **John Michuki Park (NbS Compendium, Case #10)** in Nairobi shows that spontaneous natural development of park and preservation of local biodiversity often comes at odd with the need to ensure safety in public areas, and by such, ensuring a certain degree of visibility and co-visibility at any time of the day, night and season. These kinds of conflicting purposes could be easen in a process of proposing design, exploring existing parks and places and accounting for this safety needs while designing green areas. Safetipin is an app interesting for that co-design objective https://safetipin.com/.

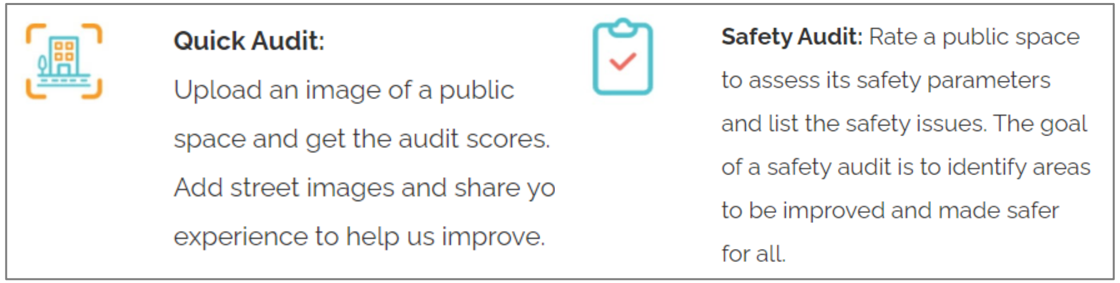

Figure 168 - Quick Audit and Safety Audit
2APP functions to ensure safety is taken into account into green park design
(Source: Safetipin | My Safetipin App))

Inspirational example

Homa Bay residents voice their opinions on the budget development process for fiscal year 2024-2025 at a public meeting at Kabund Social Hall. They stressed the need for a budget that reflects local concerns, particularly in the areas of roads, water and rural electricity. *(see figure on the left)*

Project Identification & Design

Municipality

GLOBAL CENTER ON ADAPTATION

Inclusion of stakeholders

Key recommendation #1 Adapt NbS projects to community-level scope and capacity through co-design and multi-functional design following local necessities and interests

Tailoring NbS to community-level scope allows for incremental resilience-building while fostering public engagement and ownership. Strategic planning can be instrumental in tapping into NbS potential to foster community-level project. Though smaller-scale projects yield less expansive benefits, they provide valuable testing grounds for public participation and NbS-informed designs.

Participatory budgeting mechanisms can fund such projects, with citizen fora institutionalized to prioritize low-cost, short-term solutions.

Digital tools can also enhance participation, ensuring diverse perspectives are included and potential conflict of uses or objectives are solved in a co-design fashion. Partnerships with NGOs and civic groups can strengthen implementation and sustainability.

By aligning NbS with community capacity, Kenya can empower communities, promote local ownership, and lay the foundation for larger-scale resilience efforts.

Inspirational example

“Grow a classroom project” in Kenya, aims at changing the perception of what a school should be: instead of a design focused on room capacity calculation according to number of students, school design should integrate external green playground to address urban heat island and infiltrate rainfall (as in the NbS Compendium case of **Saint John’s community School (NbS Compendium, Case #7)**), and provide also additional space for outside class. The program intends to support the planting of 2,000 trees seedlings in 17 schools across the counties of Nairobi, Machakos, Kiambu and Kajiado.

Figure 170 - Various events as part of the program “Grow a classroom” (Sources: https://globalpeace.org/kenyas-grow-a-classroom-program-sponsors-tree-planting-for-nairobi-area-schools/)

Project Identification & Design

National Municipality

Institution, capacity and resources

Key recommendation #1 Clarify roles and foster collaboration for NbS integration

To effectively integrate NbS into urban and sectoral investments, it is essential for public organizations to develop internal expertise specific to their areas of operation. For example, agencies like the Kenya Urban Roads Authority (KURA) have already begun adopting systemic approaches by integrating green corridors and sustainable drainage systems into road infrastructure projects. Expanding this kind of expertise across all relevant public organizations will ensure that NbS principles are embedded into project planning and execution.

However, institutionalizing a coordinated approach will be key to move beyond individual initiatives. Establishing cross-sectoral committees at the county level, such as climate or sustainability committees, can ensure consistent oversight and collaboration. These committees would align project objectives, set common standards, and prevent conflicts or redundancy, serving as platforms for NbS integration across sectors and scales. This will contribute to foster synergy between departments, minimizes fragmented efforts, and ensures that NbS initiatives are comprehensive and impactful. To do so, policies and frameworks should ensure that NbS principles transition from ad hoc initiatives to a standard practice, leveraging collective expertise to promote resilience and sustainability at all le

Inspirational example

Matching potential investor and investee is key in mobilizing resources for NbS development. In South Africa, following the approval of the national Biodiversity Finance plan and with the support of the UNDP BIOFIN Initiative, the Department of Forestry, Fisheries and the Environment (DFFE) has launched the South African Biodiversity Sector Investment Platform which serves as a catalyst to match Investment Opportunities to the appropriate investors and intermediaries. The collaboration and implementation of the Biodiversity Investment Portal brings together various levels of decision-makers as well as biodiversity program and the financial investment required to create platforms both online and in-person.

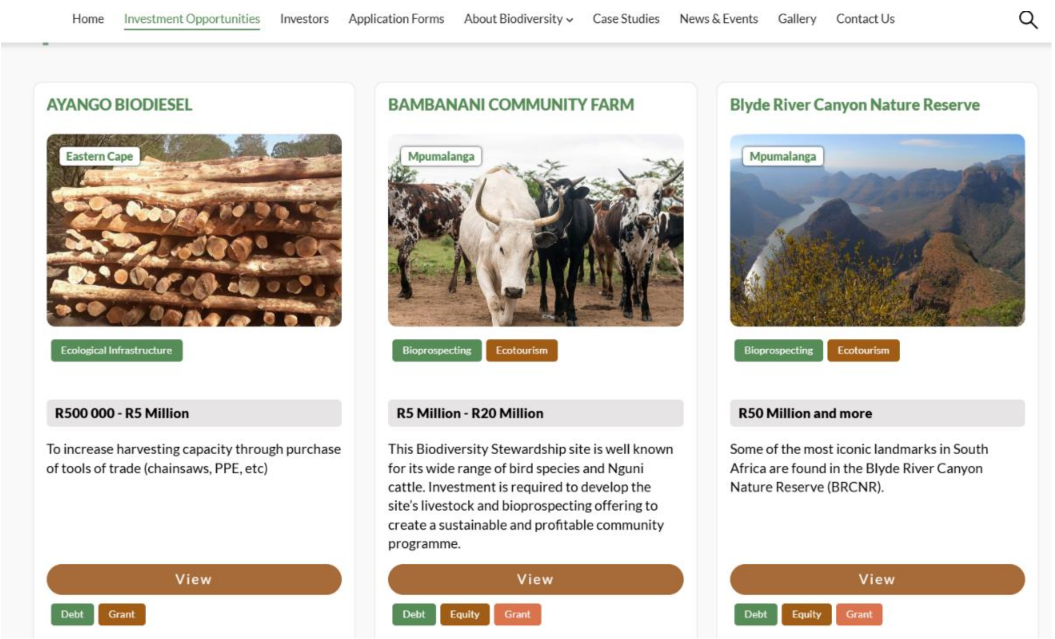

Figure 171 - Some of the investment opportunities showcased on the platform
(Source: https://www.biodiversityinvestment.co.za/)

Project Identification & Design

Municipality

Key recommendation #2 Enhance municipal capacity to support NbS projects and integration

To ensure the effective implementation of NbS and NbS-informed projects, municipalities must build internal capacities to address environmental considerations within their urban planning frameworks. Currently, municipalities often rely heavily on county-level expertise, which can limit their ability to independently develop and enforce NbS-focused initiatives. By equipping municipal staff with the necessary skills and resources, cities can better integrate environmental priorities into their physical planning processes and ensure that procurement specifications for NbS projects align with sustainability goals.

A key enabler for this transformation is the integration of knowledge transfer mechanisms. Partnerships with academic institutions, international organizations, and experienced practitioners can provide structured training, mentorship programs, and access to cutting-edge NbS practices. A dedicated list of essential roles — such as environmental planners, urban ecologists, and landscape architects — should guide hiring and training priorities to address critical capacity gaps.

In parallel, addressing structural challenges in public engineering roles is essential. Competitive compensation, clearer career pathways, and opportunities for professional growth will attract and retain talent within municipal institutions, creating robust teams capable of implementing and sustaining NbS projects. By combining enhanced technical expertise with supportive employment structures, municipalities can transition into key drivers of urban resilience through NbS integration.

National

Key recommendation #3 Strengthen the role of professional bodies in enhancing technical standards for NbS development and funding

While professional bodies like the Engineers Board of Kenya (EBK) and the Environmental Institute of Kenya (EIK) already play significant roles in overseeing technical standards, several gaps need to be addressed to optimize NbS integration into infrastructure projects. For instance, while registered engineers are mandated to sign off on designs, there is often a lack of targeted training on NbS-specific principles, such as ecosystem services valuation or nature-climate-society interconnections. Introducing specialized NbS accreditation within these professional bodies could fill this gap by certifying practitioners with advanced expertise in sustainability and resilience.

Additionally, although environmental officers are linked to professional associations, stronger enforcement mechanisms are needed to align local expertise with global funding standards. For example, requiring evidence of NbS-specific certifications for accessing international funds (e.g., the 3IF or World Bank climate funds) could incentivize compliance with higher standards.

Finally, professional bodies should expand their advocacy to address gaps in multi-sector collaboration. This includes developing interdisciplinary guidelines that integrate engineering, ecological, and social dimensions, fostering a shared language among practitioners, and driving collective ownership of NbS projects.

Project Identification & Design

National Municipality

GLOBAL CENTER ON ADAPTATION

Key recommendation #4 Address land tenure challenges through public-private partnerships for NbS Development

Collaborative land development tools must be established to foster negotiation between public authorities, private developers, and community representatives. Land tenure complexities significantly hinder the development of NbS-informed public spaces. These challenges affect not only public authorities but also communities and private stakeholders attempting to implement NbS initiatives, particularly in reclaiming or repurposing spaces like riparian zones. Additionally, without strategic land-use frameworks, NbS projects risk overlooking the economic and social value they can generate for communities. High-quality NbS projects — such as urban green corridors or restored riparian areas — can enhance property values, attract tourism, and foster community well-being. However, these benefits often remain unrealized due to unclear land tenure arrangements and fragmented planning processes, which limit the ability to align public and private interests effectively. Public-private partnerships or collaboration will ensure that NbS projects deliver both environmental benefits and economic viability, unlocking the potential of underutilized spaces.

For maximum impact, the approach can combine incentives for collaboration with enforceable regulations to ensure accountability and alignment with urban resilience objectives. This balance fosters sustainable urban development while addressing land tenure issues collaboratively. For instance, public-private collaborative tools could include incentives for developers to integrate NbS in their projects, such as tax breaks or expedited permitting for green-certified developments, to align private actions with public goals, as well as more formal agreements to preserve portions of land for public use while promoting co-development.

Inspirational example

Rehabilitation of Sheik Zayed vacant parking lot in Cairo (Egypt) was conducted through a partnership between City Council and private investor to develop public space. City council decided to retain the public land to generate land revenue as opposed to selling it to private developer. They also contracted a marketing consultant to operationalize revenue generation activities as part of this public space. Temporary activities (such as food truck) were favored over commercial venue to allow more flexibility in land development.

Although the proposed design could be improved to integrate more NbS features (permeable pavements, extensive open grounds area), integrating land revenue generation strategy and economic activities in public space is key to build land provision for potential green areas on vacant urban spaces.

Figure 172 - Plot 202 unused parking lot (above) and rehabilitation design (below)
Sheik Zayed neighborhood, Cairo
(Source: Resource efficiency and climate adaptation strategies in new urban neighborhoods – Sheik Zayed, Egypt, HCU, 2018)

Project Identification & Design

National | Municipality

Policies and regulations

Key recommendation #1 Integrate environmental quotas and incentives in development control to foster NbS implementation

By aligning regulations and appraisal tools, Kenya can foster widespread NbS adoption, ensuring that private developments contribute meaningfully to urban resilience and sustainability.

Embedding environmental quotas into development control regulations can ensure that urban projects systematically incorporate NbS, particularly on private land, where a some NbS initiatives are located. These quotas could include specific requirements, such as minimum environmental contributions for walls, roofs, and external spaces, alongside broader plot-wide targets like water infiltration capacity. By offering developers the flexibility to choose context-appropriate NbS solutions, these regulations can enhance environmental integration while accommodating site-specific needs.

To support this shift, development appraisal processes and tools must also be updated to prioritize resilience and sustainability across all projects. These updated appraisals would evaluate NbS not only for technical feasibility but also for their long-term socio-economic benefits, such as community well-being and ecosystem services. Incorporating frameworks like the Safari Green Building Index — a tool for rating building environmental performance — can further incentivize developers and set higher industry standards.

Inspirational example

The Safari Green Building Index is a proposed national rating system for all kinds of building in Kenya. This Index is currently elaborated by the Architectural Association of Kenya (AAK), the University of Nairobi and UN-Habitat. This Index aims at providing locally tailored and comprehensive green building standards and assessment tools in East Africa. 6 performance categories are assessed: Prerequisite requirements (compliance with AAK healthy Homes Guidelines Checklist as well as Integrated & Inclusive Infrastructure Framework – 3IF), Building Landscape, Passive Design Strategies, Energy Efficiency, Resource Efficiency, Noise Control and Acoustics and Innovation. NbS development requirements could be included in the Building Landscape category.

Lastly, as in the case of Porto Alegre sustainability certification, private developer could be incentivized to get their project certified by linking certification to development control provisions (i.e., get a FAR (Floor Area Ratio) density bonus if more open ground is left on the plot).

Figure 173 - Scoring system in 4 different classes of the Safari Green Building Index (Source: https://safarigreenbuilding.org/)

Project Identification & Design

National

Policies and regulations

Key recommendation #2 Strengthen the role of Environmental and Social Impact Assessment (ESIA) to drive NbS adoption and resilience-oriented investments

As a well-established and systematic approval environmental step, ESIA should serve as a strategic tool to mainstream NbS in project design and implementation. ESIA frameworks can enhance both climate change mitigation and adaptation measures by integrating NbS-informed approaches into infrastructure development and broader urban planning.

Key actions to enhance ESIA for NbS implementation:

- Embed climate change and vulnerability assessments as core project objectives: move beyond traditional assessments of infrastructure resilience to include forward-looking adaptation measures addressing future climate impacts, particularly in areas such as urban drainage and heat island mitigation.
- Leverage specialized tools and localized climate data: identify specific assessment tools for NbS and ensure access to locally relevant climate data or robust proxies to inform decision-making processes.
- Adopt integrated approaches to DRM and climate change adaptation: reduce siloed practices by developing comprehensive strategies that address both immediate risks and long-term climate adaptation.
- Incorporate key resilience concepts: integrate frameworks such as urban heat island (UHI) mitigation and flood risk management into ESIA methodologies to ensure holistic project design.

To achieve this, a cross-agency task force could be created, coordinated by NEMA, bringing together experts from various fields to review and facilitate the revision of existing ESIA regulations and requirements. This task force would represent the various stakeholders typically involved in the preparation of ESIAs, which would facilitate the adoption and ownership of the proposed modifications.

Project Identification & Design

NbS Compendium Case #11 – Nakuru Green Corridors

Nakuru green corridors illustrate the variety of processes in identifying and designing NbS: common design guidance principles (connection to drainage system, plant species choice, cyclability and walkability) are key to ensure consistency of approach across various projects. Though identified as part of the County Integrated Development Plan, these projects are supported by two different streams of funding: KUSP1 for Kenyatta Avenue and KURA for Oginga Odinga Street. For the KURA-led Oginga Odinga Street corridor, for example, work was executed by following established Kenyan road and urban design manuals, while the KUSP1-funded improvements on Kenyatta Avenue and Moi Street underwent a competitive open tender process and leveraged consultant-led field surveys.

Figure 174 - Nakuru Green Corridors
(SUEZ Consulting, 2024)

Focus on NbS preservation and restoration

Adaptative green space management framework value management methods that are more respectful of the environment by defining a variety of management actions according to specific green spaces that exist in urban contexts. These adaptative management strategies are necessary to avoid uniformization of environments and decline in biodiversity, deterioration in NbS efficiency and landscape degradation. This approach takes into account the specific features of each site such as grassy strips, lawns around buildings, flowerbeds, in order to apply a management method to each green space that is better adapted to its situation and its purpose whether ecological, aesthetics, reception of the public.
The different management actions to take:

- ✓ Facilitate parts of the green areas to return (and maintain) their natural state
- ✓ Define a mowing plan that favor biodiversity
- ✓ Infrastructure maintenance if any that respects environmental quality
- ✓ Combating invasive species by adopting management measures
- ✓ Eliminate pesticides and synthetic fertilizers

The City of Breda is working on a program establishing a green biodiverse belt connecting ecological corridors and green areas, to bring biodiversity in the city and improve public health. Monotonous vegetation such as lawns are replaced by more natural and biodiverse urban meadows. The program promotes sowing instead of planting and increases exposure to bacteria by making semi-natural green areas experienceable. Priority areas for the greening interventions will be urban areas frequented by many people. As part of the program, residents are encouraged to turn their private gardens more natural.

Figure 175 - City of Breda, Green Belt
(Source: https://urbact.eu/sites/default/files/2022-12/urbact_green_guide_2022_a4_fin_web_0_0.pdf)

Construction and O&M

County | Municipality

GLOBAL CENTER ON ADAPTATION

Knowledge generation and technical requirements

Key recommendation #1 Activate local supply chains for NbS construction and long-term management

NbS are inherently tied to the ecosystems they aim to restore or enhance and establishing robust local supply chains is critical for the long-term viability and scalability of NbS projects. Leveraging local, biobased materials and techniques in the construction and management of NbS not only aligns with their ecological ethos but also ensures sustainability, reduce carbon footprints, and foster local economic growth.

Key actions to activate local supply chains:

- Enhance the knowledge of local materials and biobased techniques: conduct region-specific studies to identify sustainable materials available at the county level. Building on existing research, such as the French Embassy study, this effort should map and plan for the use of locally sourced materials. Standards for testing, certification, and application must be developed to facilitate adoption and ensure quality.
- Engage local green suppliers: identify and collaborate with local nurseries to provide plants for NbS projects. For large-scale initiatives, consider integrating project-specific nursery operations during the planning phase to secure consistent and sustainable plant supply. This approach addresses missed opportunities, like in John Michuki Park (**NbS compendium case #10**), where botanical and nursery potential was underutilized.
- Promote circular soil management systems: adopt sustainable soil management practices to support long-term NbS development, particularly in urban areas. For example, the Nakuru project demonstrated the reuse of green space from urbanized outskirts, which could be further enhanced by exploring technosoil development. Experimental technosoil projects require robust testing and monitoring protocols to ensure effectiveness and scalability.

Inspirational example

Accessing the right climate-resilient plant list is key for NbS creation project. The plant list can be part of a sectoral plan, such as the Agadir Green City Action Plan that includes as one of its action the elaboration of a climate-resilient plant species list, or as a national initiative to elaborate a regional planting guide according to local climate conditions.
Preserving and identifying seed stock, through a robust partnership with local seed nursery such as the one between KEFRI represented by the Kenya Forestry Seed Centre) and registered seed nurseries is essential to ensure seed supply.

Figure 176 - Ecoregional Planting Guides focusing on selecting plants for pollinators (left) and Florida Landscaping Guidance by type of plant considered (right)
(Sources: https://www.pollinator.org/guides https://ffl.ifas.ufl.edu/media/fflifasufledu/docs/FFL-Plant-Guide_v030624_web.pdf | https://araburban.org/en/infohub/projects/?id=7755)

Construction and O&M

GLOBAL CENTER ON ADAPTATION

Municipality

Inclusion of stakeholders

Key recommendation #1 Preserve and enhance the social value of public spaces through NbS development

The development of NbS should uphold and enhance the social value of public spaces by integrating human activities and fostering public engagement. Public spaces serve as vital public goods, providing livelihoods for vulnerable groups and acting as hubs for community interaction and essential activities, particularly for women who perform 75% of care-related activities. By promoting participation, adaptability, and shared responsibility, NbS can seek to transform public spaces into more inclusive and multifunctional environments that connect people to nature while enhancing community ownership, resilience, and economic opportunity.

Key actions to align NbS with the social value of public spaces:

- Foster participatory NbS implementation: expand initiatives like the "Grow a Classroom Project" by involving citizens in hands-on activities such as tree planting. This not only builds awareness of NbS benefits but also strengthens community ownership and pride in public spaces.
- Emphasize participatory, flexible, and low-cost approaches to urban development, focusing on temporary interventions that allow for measurable outcomes with minimal risk: tactical urbanism aims to address immediate needs, maximizing land use opportunism and implementing quick wins with limited costs. By implementing short-term, adaptable solutions, these approaches can help identify and respond to urban challenges effectively, providing an opportunity for iterative improvements.
- Integrate marketing and communication strategies: develop targeted campaigns to highlight the benefits of NbS in public spaces, fostering acceptance and engagement among stakeholders, including institutions and civil society.
- Identify revenue opportunities from NbS management: explore sustainable revenue-generation models linked to NbS maintenance and activities, such as partnerships with local vendors or community-managed services that provide economic benefits to local populations.

Inspirational example

Tactical urbanism can provide alternative and low-cost way of co-design green public areas. Students and teachers from 4 different universities gathered, with the support of DAAD and MASARAT Jordan Foundation, to carry out a participatory project for the redevelopment of a public garden in the Ettaamir city in La Soukra, Tunis, close to a primary school. The workshop allowed the students to co-design the garden with the local population, and especially with 10-year old children. New pedagogical methods were experienced, such as the child's speech describing an ideal day in a public garden and the drawing of his or her own vision for the garden. During the realization phase, the children took part in the work by drawing on the walls and participating in the painting. This participatory approach ensured that the garden was accepted and appropriated by the children and the inhabitants of the neighborhood. As soon as the work was finished, the children took over the site, enjoying the furniture and the new games. The actual site implementation cost was 3000 euros with 7 days of mobilization.

Figure 177 - Students and teachers' participants to participatory project for the redevelopment of a public garden in La Soukra, Tunis
(Source: https://www.daad.tn/en/2023/04/01/portrait-of-the-month-april-2023/)

Construction and O&M

Municipality

Inclusion of stakeholders

Key recommendation #2 Encourage the participation of local communities in O&M activities

To ensure the long-term sustainability of NbS interventions, it is crucial to actively involve local communities in the operation and maintenance (O&M) of these projects. Encouraging their participation enhances local ownership, fosters knowledge transfer, and strengthens the overall resilience of urban infrastructure.

Key action to encourage the participation of local communities:

- Establish community-based stewardship programs, where residents take an active role in maintaining green infrastructure, such as urban wetlands, green corridors, and stormwater management systems. These programs can include training sessions on NbS maintenance techniques, regular community-led monitoring activities, and volunteer maintenance initiatives.
- Incentivize participation is also key. This can be done through employment opportunities for community members in NbS maintenance work, financial incentives such as stipends or tax benefits, or non-monetary rewards like public recognition or skill certification programs.
- Foster collaboration between municipalities, private sector actors, and community organizations to develop co-management agreements where responsibilities are shared between local authorities and community groups can improve the efficiency of O&M efforts. Transparent communication channels, such as regular stakeholder meetings and digital reporting platforms, should also be implemented to facilitate coordination and feedback loops.

Inspirational example

Local private initiative can also bring additional resources and capacity in NbS development. Seedball is a private organization that moved from providing sustainable charcoal production out of local indigenous trees (as opposed to standard cyprus forest), to promote seed-based green cover restoration. It relies on a process of co-production of charcoal and biochar out of the dust produced by charcoal processing. Biochar is used to coat seeds into a protective shell to reduce tree mortality when seeds are being spread. The production chain delivers 500,000 seedballs a day, selling approximately 100 types of indigenous tree seeds. A third product has been recently developed which is biochar for farming purpose. Biochar is an additive to produce bio-pesticides and, by increasing soil infiltration capacity, reduce irrigation needs. Main challenge today is expanding the species choice for green cover restoration and conduct communication campaign about seed planting and growing as well as tree conservation. Seedball sees also a development opportunity in producing biochar out of green areas mowing and harvesting. Lastly, used in **green corridors** along the roads, biochar has good purification efficiency of road runoff pollutants (Romandi, 4/2024).

Figure 178 - Seedball growing
(Source: https://www.seedballskenya.com/)

Construction and O&M

Municipality

Municipality

Institution, capacity and resources

Key recommendation #1 Pursue coordinated action initiated at the planning throughout construction and O&M

To ensure the continuity and success of NbS, the coordination mechanisms established during the planning phase must extend into the construction and O&M stages. By maintaining coordinated action initiated at the planning stage, projects can ensure that NbS are effectively constructed, maintained, and adapted to evolving needs, thereby achieving long-term sustainability and resilience. This requires a seamless transition of roles and responsibilities, supported by mechanisms to sustain collaborative efforts over the project lifecycle.

Considerations include:

- Maintenance responsibility: define these roles early and formalize them through tools such as Memorandums of Understanding (MoUs) to clarify accountability and ensure long-term stewardship. The appointment of a project implementation team, gathering all the resources and capacities required, at the early stage will help ensure continuity and the consideration of all relevant elements throughout every phase of the project *(see recommendation #2).*
- Consistency and knowledge sharing: promote a structured approach for sharing management plans, best practices, and technical standards across various actors to maintain coherence.
- Capacity building: emphasize interdisciplinary collaboration by involving municipal staff, consultants, and community representatives in defining and implementing O&M protocols, while ensuring knowledge transfer from experts to local project owners.
- Institutional alignment: leverage bodies such as climate committees or cross-sectoral oversight groups to maintain alignment of O&M practices with the broader goals of climate adaptation and resilience, reducing fragmentation.

Key recommendation #2 Develop O&M plans and guidelines to ensure O&M planning, financial sustainability, and clear management guidance from the NbS design phase

To ensure the long-term sustainability and effectiveness of NbS, it is essential to develop clear O&M plans and guidelines to elaborate them consistently. These guidelines should provide structured approaches to maintaining, monitoring, and adapting NbS projects over time. Reflecting O&M and financial sustainability considerations into NbS design while providing specific guidance for effective NbS management plans is key to develop resilient, cost-effective, and well-maintained NbS solutions that deliver long-term ecological and social benefits.

Early-stage O&M planning should address key elements, including:

- Roles and responsibilities: clearly define who will manage and oversee O&M, potentially through a multi-stakeholder steering committee *(see recommendation #1 on MoU)*. The objective is to match the technical design features with the available capacities and expertise or provide relevant training in a timely manner.
- Budget allocation: incorporate funding for maintenance tasks to ensure the affordability and thus sustainability of the solution for local actors. Integrated financial planning: the elected O&M strategy should be revised in light of the overall financial scheme and adapted along other components to reach a financially sustainable model. Anticipated financial planning can also foster the implementation of (innovative) revenue-generation models (e.g., sale of green space products like grass or compost as well as urban farming products).
- Technical guidance: outline guidelines and protocols (e.g., for ecological management of vegetation with watering schedules, pest control, seasonal pruning)), emphasize avoiding invasive species unsuitable for the local context.
- Monitoring and evaluation: develop clear targets and metrics to assess the long-term functionality and benefits of NbS interventions. Promote adaptive management strategies for flexibility, climate adaptabilité and responsiveness to unforeseen environmental challenges and evolving conditions.

The guidance should also include mechanisms for fostering community ownership, such as participatory management practices, and align O&M plans with insights from existing resources like the NbS Compendium.

Construction and O&M

GLOBAL CENTER ON ADAPTATION

National

Key recommendation #3 Develop O&M capacity building programs

To ensure the long-term functionality and resilience of NbS, it is essential to develop targeted capacity-building programs focused on O&M. Strengthening the technical expertise of institutions, municipal staff, and local implementing agencies will improve the effectiveness of NbS interventions and ensure their sustainability over time.

Key actions to develop O&M capacity building programs

- Tailor training programs to the needs of key stakeholders involved in the O&M of NbS: these programs should provide technical knowledge on the upkeep of green infrastructure, including vegetation management, water flow regulation, soil stabilization techniques, and biodiversity conservation. Training should also cover adaptive management approaches that allow O&M teams to respond to changing climatic and environmental conditions.
- Integrate NbS-focused O&M training into their existing urban planning and infrastructure development programs: this could be achieved by establishing dedicated NbS training centers, embedding NbS O&M modules within professional certification courses, or partnering with academic institutions and technical training institutes.
- Prioritize hands-on learning opportunities: share and demonstrate field-based workshops, pilot projects, and peer-to-peer learning exchanges between cities and regions implementing NbS. Additionally, digital platforms can be developed to provide remote learning opportunities and continuous professional development resources, including online courses, instructional videos, and best-practice repositories.
- Financial and institutional support: governments, donor agencies, and private sector partners should be encouraged to allocate funding for O&M training programs and establish mechanisms for continuous learning and skills enhancement.

Municipality

Policies and regulations

Key recommendation #1 Enhance NbS inspection and enforcement at the local level

To ensure compliance and sustainability of NbS developed by private actors, it is crucial to integrate NbS-specific inspection measures into the routine monitoring and enforcement activities of municipalities. By embedding NbS considerations into routine inspection frameworks, municipalities can ensure that private developments contribute meaningfully to urban sustainability goals while fostering accountability and long-term impact. Local authorities, given their proximity and contextual understanding of urban projects, are well-positioned to perform regular inspections and enforce compliance effectively.

This expanded scope of inspections should include assessing the maintenance and functionality of open green spaces, verifying the implementation of green building features, and ensuring that ecological components such as vegetative cover, water management systems, and biodiversity support measures meet prescribed standards. Additionally, municipalities should evaluate the ongoing functionality of NbS elements, such as permeable pavements, stormwater management systems, or rooftop gardens, to ensure their continued contribution to urban resilience.

Training municipal inspectors in NbS principles and equipping them with the tools needed for environmental performance assessments will be essential for effective enforcement. Establishing clear penalties and remediation requirements for non-compliance will further incentivize adherence to NbS requirements.

Construction and O&M

NbS Compendium Case #7 – Saint John's Community School

Saint John's Community School is an inspiring example of how community in informal settlement can be involved in constructing and maintaining NbS. The project showcases an efficient middle-ground between community-level project and third-party funding (SwedBio) and technical assistance support. Inspirational features include community-led design to avoid maladaptation, community training and engagement in simple and regular maintenance activities while providing environmental education to both local community and school children. However, the more complex maintenance tasks are left to KDI (through SwedBio funding) which begs the question of long-term sustainability of the project.

This project could be further developed by providing a more systemic response to climate change issues in informal settlement, by including issue of heat along with issue of stormwater drainage.

Figure 179 - Saint John Community School – Raingarden (SUEZ Consulting, 2024)

Focus on NbS preservation and restoration

As part of the Environmental and Social (E&S) framework, specific NbS preservation and rehabilitation measures can be integrated in a Green Worksite Charter to guide worksite in preparation, during and after the work. This could be reflected into the procurement documents to ensure their enforcement by contractors.

Key provisions include:
- Identification of suitable season to conduct the work,
- Protecting existing green cover and trees and implement micro-habitat favorable to local existing biodiversity with illustrative pictures,
- List and pictures of invasive species with management guidelines.

Principales plantes invasives présentes dans le département du Rhône et risques associés

	Présence Rhône	Risque Environnement	Risque Sanitaire	Risque Socio-éco	Intervention optimale
Érable à feuilles de frêne	moyenne	moyen	faible	moyen	Mars-avril
Ailante glanduleux	forte	moyen	moyen	moyen	Avril-juillet
Arbre aux papillons	forte	moyen	faible	moyen	Mai-aout
Balsamine géante	moyenne	fort	faible	moyen	Mai-juillet
Renouées asiatiques	forte	fort	faible	moyen	Avril-juillet
Robinier faux-acacia	forte	moyen	faible	moyen	Mars-mai
Séneçon du Cap	forte	moyen	faible	moyen	Mai-juin
Solidages du Canada	forte	fort	faible	moyen	Mai-aout
Jussies à grandes fleurs	moyenne	fort	faible	fort	Juin-septembre

Figure 180 - Table presenting Invasive species list with environmental, socio-economic, health risk level (from low, medium and high) and season for intervention In Great Lyon Green Worksite Charter (Source: https://developpementdurable.grandlyon.com/app/uploads/2020/09/CAHIER-ESPECES-INVASIVES-bd.pdf)

Monitoring & Evaluation

Municipality

Knowledge generation and technical requirements

Key Recommendation #1 Develop a robust monitoring framework to evaluate NbS performance and benefits

To verify the effectiveness of NbS measures and demonstrate their co-benefits compared to gray infrastructure, it is critical to establish a scalable and targeted monitoring framework. By clearly demonstrating NbS outcomes and their wide-ranging benefits, this framework will help build evidence, inform future projects, and facilitate broader adoption of NbS solutions.

The monitoring framework should:

- Verify performance effectiveness: use a tiered approach, from basic tools to advanced methods, depending on the criticality of the benefit. For example, Urban Heat Island (UHI) assessments may involve simple UHI scores or advanced LCZ (Local Climate Zones) modeling alongside cost-effective mobile sensors.
- Capture co-benefits: incorporate metrics to measure ecological, social, and economic benefits (e.g., biodiversity, water retention, and heat perception surveys), providing a holistic evaluation of NbS services. As for the performance, co-benefits can also be measured through proxy or tiered approach.
- Support replicability: standardize tools, protocols, and data-sharing processes to enable scalability and adaptation across multiple contexts and urban settings.

Municipality

Key Recommendation #2 Implement an adaptive management framework for NbS

NbS requires an adaptive management framework. NbS projects are inherently dynamic, requiring iterative monitoring and management based on feedback, outcomes, and changing conditions. By embracing adaptive management, NbS projects can respond effectively to uncertainties, optimize their benefits, and remain aligned with resilience and sustainability goals.

This approach includes:

- Continuous monitoring and evaluation: regularly assess performance indicators and co-benefits, using flexible metrics that evolve with project objectives and outcomes. *(see recommendation M&E #1)*
- Documenting lessons learned: develop and share case studies that highlight successes, challenges, and replicable best practices to inform future NbS projects.
- Feedback-driven adjustments: use monitoring results to refine design, maintenance practices, and implementation strategies, ensuring NbS remains effective and responsive to urban challenges.
- Stakeholder engagement: involve local authorities, experts, and communities in reviewing and adapting management plans to address emerging needs and knowledge gaps.

Monitoring & Evaluation

National

Inclusion of stakeholders

Key recommendation #1 Tap into citizen sensing data potential

As digital penetration is high in Kenya, citizen sensing offers an innovative and participatory approach to monitoring urban challenges and NbS multiple benefits, empowering communities to contribute valuable data. To harness this potential, target indicators must be clearly defined in collaboration with diverse stakeholders, ensuring they align with project goals and the resources available. Citizen sensing initiatives can include the deployment of low-cost sensors, crowd-sourced data platforms, or mobile applications that allow residents to report environmental conditions. Training and support for citizens involved in data collection are essential to ensure data reliability and engagement. This participatory monitoring approach not only generates actionable insights but also fosters a sense of ownership and awareness among communities, promoting broader support for NbS projects.

Examples of citizen-sensed data include:

- Air quality: use of low-cost sensors or apps to measure PM2.5 and PM10 levels which are key indicators of air pollution. This helps monitor the quality of air in different neighborhoods, providing valuable data for identifying pollution hotspots and the effectiveness of NbS like green spaces in improving air quality.
- Urban heat: temperature recordings through mobile devices or handheld sensors to identify heat hotspots.
- Biodiversity: crowd-sourced data on flora and fauna observations via mobile applications.

As highlighted in the case of **Living Smiles (NbS Compendium, Case #2)**, Justdiggit employs a comprehensive knowledge acquisition strategy to monitor its restoration efforts in Kenya and Tanzania. It combines desktop analyses and field surveys, leveraging advanced satellite products, manual or sensors ground truthing, and stakeholders consultation in parallel.

Inspirational example

In data-scarce environment, the use of social media to tap in citizen sensing data potential is key to monitor evolution of climate change impacts, and potential positive impacts of NbS. The city of Jakarta together with SMART Infrastructure Facility and the University of Wollongong in Australia introduced a crowd-sourced solution, PetaJakarta for collecting sharing of information relating to flood. When someone sees a flood in Jakarta, Tweet #banjir @petajkt (meaning #flood and @MapJKT) will map these flood hotspot on the PetaJakarta.org platform, which then allow citizen to monitor the real-time situation and stay safer. The project, dating back to beginning of 2010, was then the first collaboration between a disaster management agency, a university and Twitter. A more recent example, "Urban Releaf" , a Horizon Europe Innovation Action piloted by the University of Dundee, is currently undergoing to monitor a range of environmental issues to support NbS development.

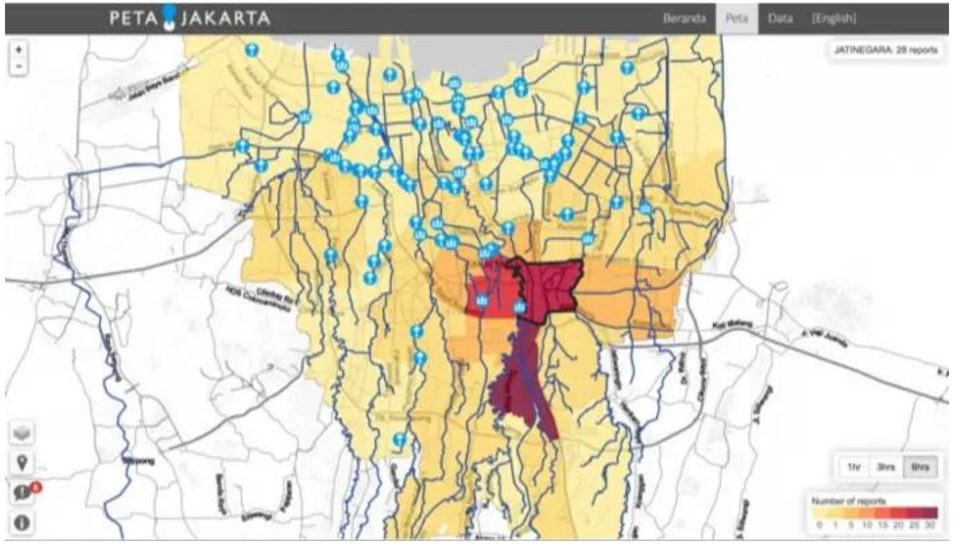

Figure 181 - PetaJakarta.org flood hotspot map
(Source: PetaJakarta.org)

Monitoring & Evaluation

National Municipality

Key recommendation #2: Foster partnerships with Kenyan research institutions for advanced impact analysis and knowledge dissemination

Collaborating with Kenyan research institutions, such as universities and specialized centers, can significantly enhance the monitoring, evaluation, and scaling of NbS projects. These partnerships can generate deeper insights into NbS impacts, exploring ecological, social, and economic outcomes with scientifically robust, context-specific methodologies suited to Kenya's diverse ecosystems. Research institutions bring valuable expertise in innovative tools like remote sensing, environmental modeling, and field experiments. By supporting advanced impact analyses, they can highlight co-benefits and lessons learned, while identifying areas for improvement. These collaborations also offer opportunities for capacity building, equipping municipal staff and communities with advanced monitoring techniques and environmental assessment skills.

Importantly, partnerships can serve as platforms for knowledge dissemination at the national and regional levels, ensuring that success stories, data, and methodologies inform future NbS projects. This feedback loop integrates research findings into policy and practice, improving adaptive management and promoting Kenya as a leader in NbS innovation across East Africa.

Municipality

Institution, capacity and resources

Key recommendation #1 Design an appropriate framework for monitoring and evaluation

To ensure the effectiveness of NbS, a robust framework for M&E should go beyond defining indicators and include clear provisions for staff roles, budgets, and responsibilities. This framework must integrate both activity indicators (tracking implementation progress) and performance indicators (measuring the outcomes and benefits), drawing insights from existing gaps such as those highlighted in the AECOM guidelines. Incorporating indicators that capture the potential benefits of NbS, including co-benefits like biodiversity enhancement or urban cooling, will strengthen the ability to assess and communicate their value. Adaptive management principles should also guide the framework, allowing for iterative adjustments based on emerging data and changing urban conditions. Tools such as "adaptive pathways" can help link planning and monitoring phases, ensuring a feedback loop that improves long-term outcomes.

Ultimately, this comprehensive M&E framework should provide municipalities and other stakeholders with the tools to track progress, evaluate success, and make evidence-based adjustments, thereby maximizing the resilience and sustainability of NbS projects.

See recommendations M&E – Knowledge generation and technical requirements #1 and #2.

Monitoring & Evaluation

GLOBAL CENTER ON ADAPTATION

National

Key recommendation #2 Harness labelling initiatives for NbS as an adaptation measure to attract funding

To address the dual challenge of financing NbS and valuing their broad range of benefits, it is essential to develop mechanisms that highlight their measurable contributions to climate adaptation. By aligning these initiatives with Kenya's climate adaptation goals, a structured labelling system will highlight NbS benefits, attract funding, and enhance their recognition as vital tools for urban resilience. Indeed, while NbS deliver significant co-benefits — such as flood mitigation, urban cooling, and biodiversity enhancement — their localized impacts are often less tangible than mitigation-focused projects like carbon credits. Developing a tailored labelling system that accounts for both carbon credit potential and NbS co-benefits can help bridge this gap. For example, Kenya could explore integrating NbS into a localized carbon credit framework that highlights broader environmental and social impacts, making NbS projects more attractive to investors and funding bodies. The Ministry of Environment's efforts to introduce an environmental restoration fee under EMCA (Environmental Management and Coordination Act) could complement such labelling initiatives. Additionally, the NETFUND – National Environmental Trust Fund, also established under EMCA - could play a pivotal role in supporting these labelling efforts by providing the necessary financial backing for projects that meet the criteria of the new labelling system. Applying the polluter-pays principle while earmarking funds specifically for NbS implementation is critical to ensuring transparency and effectiveness.

Moreover, leveraging existing frameworks like the Safari Green Building Index provides another opportunity to integrate NbS into green building standards. By promoting features such as sustainable urban drainage systems, green roofs, or biodiversity corridors, this approach can incentivize private-sector investments and mainstream NbS adoption in urban development practices.

Inspirational example

Local-based carbon credit system allows to compensate project negative impacts with NbS that are located in the close vicinity of the project. This increases the easiness of monitoring of the impact as well and factoring ecosystem services beneficiaries in the process. However, NbS as an adaptive measure to climate change, often lack the support of a labelling system to certify the impact of its benefits et co-benefits. Moreover, in the urban context the carbon sequestration potential of green areas is relatively low due to space or plant species limitation. French Low Carbon National Label has developed a specific labelling methodology called "leafy city" that certify the benefits brought about by trees in urban context, measuring both carbon sequestration opportunity along with other co-benefits. This existing label support the funding of projects that are currently being developed in French cities local-based Carbon Compensation Funds.

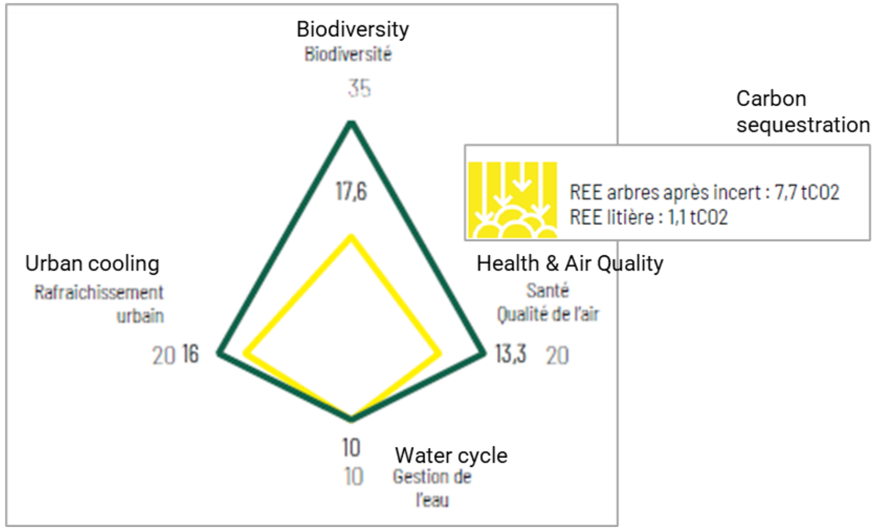

Figure 182 - "Leafy City" Label criteria
(Source: SUEZ Consulting, Société Forestière)

Monitoring & Evaluation

National

Policies and regulations

Key recommendation #1 Establish a national NbS monitoring framework to track outcomes across sectors

Building on the planning phase's emphasis on integrating NbS into national policies and targets, the M&E phase should institutionalize a standardized monitoring framework to track the implementation and benefits of NbS at a more global level than project-based. This framework would:

- Align with Kenya's Climate Change Act and Vision 2030 by incorporating indicators that measure progress toward urban green cover targets, wetland restoration, and ecosystem health.
- Incorporate indicators into local planning and objectives (e.g., IDEP).
- Leverage lessons from the Green Initiative's tracking system, expanding it to monitor broader NbS categories such as urban greening and ecological corridors.
- Introduce reporting requirements for national and sub-national entities to ensure coherence in NbS progress assessments.
- Use adaptive management approaches to refine indicators and methodologies based on lessons learned during implementation, ensuring long-term effectiveness and relevance.

Municipality

Key recommendation #2 Implement a resilience scorecard to evaluate NbS integration in municipal plans

To ensure that municipal plans effectively operationalize resilience goals, an evaluation tool such as a resilience scorecard should be developed. This would:

- Assess the extent to which municipal plans include policies, zoning frameworks, and NbS components for disaster risk reduction and climate adaptation.
- Require municipalities to periodically report on the implementation of resilience-focused policies, with benchmarks for NbS integration.
- Use M&E results to inform national-level reviews of municipal planning practices, identifying gaps and best practices.
- Provide municipalities with access to national technical resources and capacity-building based on scorecard results, ensuring continuous improvement in resilience mainstreaming.

Key recommendation #3 Develop community-led NbS impact assessment tools

To evaluate and support the contributions of community-led initiatives in NbS, an impact assessment framework should be established. This would:

- Include participatory monitoring mechanisms that empower communities to evaluate their own NbS projects, ensuring alignment with urban resilience goals.
- Create a platform for local initiatives to report progress, share lessons learned, and receive recognition for successful contributions.
- Link community monitoring outputs with municipal and national systems, providing a comprehensive picture of NbS outcomes.
- Develop adaptive feedback loops, where insights from community-level assessments inform adjustments to policies and urban planning strategies.

Monitoring & Evaluation

NbS Compendium Case #8 – Upper Tana-Nairobi Water Fund Trust

The UTNWF is a good example of designing and following a structured set of indicators to measure progress and guide adaptive management across all project objectives, but also of disseminating the results of measurable benefits. The UTNWF tracks indicators that measure key project outcomes, such as land degradation, food security, climate resilience, and sustainable agriculture practices. These indicators align with national priorities and international frameworks, ensuring consistency and relevance. Also, participatory methods are used to select additional quantitative and qualitative indicators. A key function of this robust M&E system is knowledge dissemination. Regular reporting outputs, such as quarterly operational reports, annual project reviews, and performance assessments, provide critical insights into project progress and outcomes.

Figure 183 - Farmer involved into erosion control activities and indicators measurement (Source: UNTWF, 2013)

Focus on NbS preservation and restoration

Measuring the biodiversity footprint of NbS is challenging due to the need for localized action, but metrics can help assess the potential of local actions. However important to NbS benefit measurement, determining the biodiversity footprint of any action is difficult, as species conservation requires very localized action. Some metrics are today available to assess the potential of any local actions to contribute to reduce species extinction risk such as STAR methodology developed by IUCN. The acronym refers to the two main actions that are targeted by this metrics: Species Threat Abatment and Restoration. This metric aims at helping any actor (companies, finance industry, gouvernment and civil society) to better plan projects that would bring benefits for threatened species, as well as assess biodiversity risk.

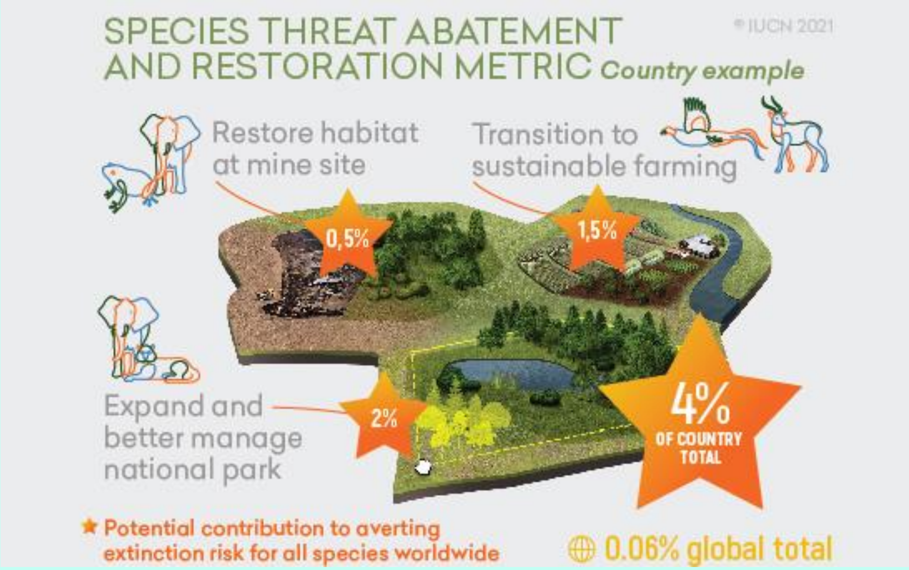

Figure 184 - STAR metric (Source: https://iucn.org/es/node/32099)

Related Documentation

The table below summarizes the related key regulations, policies, guidance and other documents to update or create:

Table 2 – Summary of key regulations, policies, guidance or other documents for NbS development

Name	Type	Status	Comments
National Building Code	Regulation	Existing (2024)	Building code is already being revised to integrate green development control provision: these provisions should also be reviewed to integrate NbS development. Update Physical and Land Use Planning Act (2019) accordingly, especially zoning and development control provisions to allow preservation of riparian areas or plot green areas.
Environment Impact Assessment and audit	Regulation	Existing (2003)	List of sections that could be improved/checked/reinforced to help NbS development: - Materials, Soil analysis - Analysis of alternatives - Environmental impacts including positive impacts - Need to enhance the focus on socio-economic benefits - Tackle ownership, attachment to nature, protection in community plan - Deepen the components and need for management plan - Project cost and maintenance cost and organizational set-up - Green worksite charter focusing on ecological components - Proposed preliminary design - Analysis of social impacts on projects relevant for Nbs development. Update related guidance: Environment impact assessment Guidelines and Administrative Procedures (2022) as well as Strategic Environmental Assessment Guidelines (2020)
Climate Action Plan	Policy	Existing in some municipalities	This plan is necessary to prepare the project identification phase at the design step and ensure that climate change is mainstreamed into NbS selection process and design
County Integrated Development Plan	Policy	Existing	Integrate a Climate change and environmental baseline. Improve the social baseline. Clarify criteria for project selection and investment pipeline towards more climate resilient and NbS informed project in the short term.
County and Urban Spatial Plan	Policy	Existing	Include climate change, environmental baseline and social baseline, elaborate clear criteria for project selection and improvement towards more climate resilient and NbS informed project Update related Planning Guidelines (2018) and Urban Land Use Planning: Monitoring and Oversight Guidelines to reflect these new requirements
Stormwater drainage guidance	Guidance	Existing	Develop NbS alternatives to stormwater drainage, valuing the decision rationale for green, gray and hybrid infrastructure When appropriate, streamline these guidances into other relevant design guidance such as Kenya Road Design Manual for Road and Bridge (2016), Final Practice Manual for Sewerage and Sanitation services (2008), Practice Manual for Water Supply Services in Kenya (2005)
Street design manual for urban areas in Kenya	Guidance	Existing (2022)	Add a NbS focus on street design manuals: species selection, planting and growing guidelines (including various criteria such as climate-resilience, urban context, soil characteristics, etc.), NbS development for stormwater drainage, maintenance guidelines When appropriate, streamline these guidances into other relevant design guidance *such as* Kenya Road.
Wetland Integrated Management Plans	Guidance	At project level	Management Plans are existing for some Wetland Park, such as the **Ondiri Wetland Park (2022-2027) (NbS Compendium, Case #3).** NbS Management plan guidance by specific NbS families could be elaborated as general framework to be reflected in each NbS investment or NbS informed investment such as roads.
Annual State of the Environment	Document	Existing at national level but not updated	Need to be cascaded to local level Guidance need to be provided for environmental baseline

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Annexes

Annex 1 – Methodology

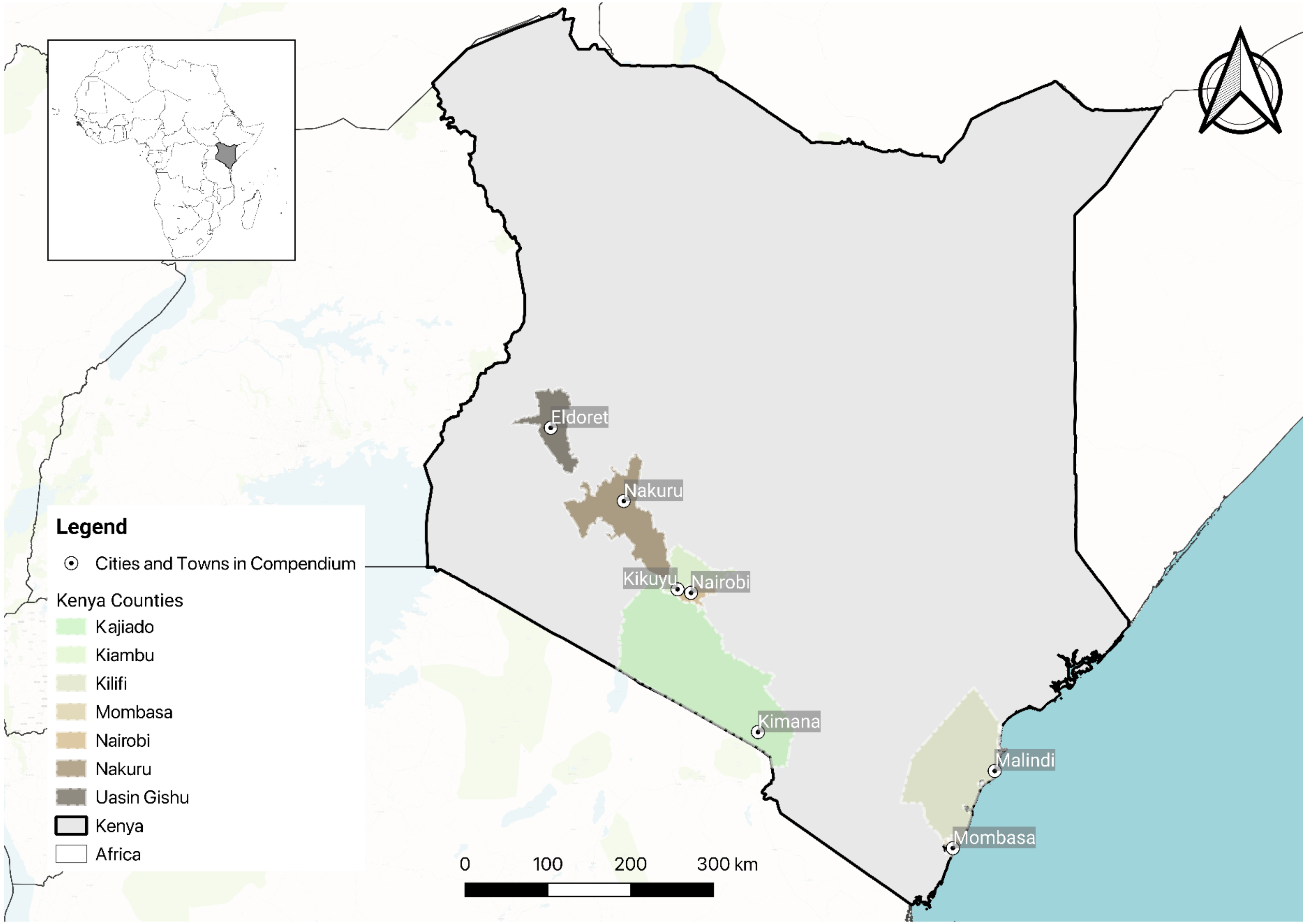

Figure 185 – Overview of counties, cities and towns in NbS Compendium
(Source: SUEZ Consulting, 2024)

During the inventory phase, 60 NbS projects were identified through comprehensive literature reviews, online searches, and expert consultations, encompassing both technical initiatives and policy efforts. From these, 26 sites were selected for detailed analysis, including 14 primary sites visited in the field and 12 additional sites studied through desktop research.

Using the 26 inventory sites, a MCA was conducted to identify at least 10 relevant cases for the Compendium.
This process resulted in 11 cases located in the cities highlighted on the map: Eldoret, Nakuru, Kikuyu, Nairobi, Kimana, Malindi, and Mombasa.

A gap analysis is performed on each of these selected cases, focusing on 8 different project components, which forms the heart of the Compendium. This analysis aims to identify key take-aways and missed opportunities throughout these cases and help the formulation of recommendations for NBS implementation in Kenya. More details on the gap analysis methodology are presented in the introduction of the Compendium section.

Selection methodology for the NbS Compendium

The NbS Compendium seeks to highlight the most inspiring features encountered across existing NbS projects in Kenya. To streamline the analysis and avoid redundancies, a multicriteria analysis (MCA) was performed to select at least 10 relevant cases within the NbS Inventory.

The selection process aimed for the inclusion of:

- All NbS families and scales of implementation identified in the NbS Inventory,
- A large variety of cities and the whole diversity of climate contexts,
- All NbS case categories (green infrastructure, hybrid infrastructure, resource production and protection, and policy/programmatic),
- All urban settings (informal, formal, peri-urban),
- The examples with the most reported benefits.

Other criteria were also added to the MCA to prevent the selection of inappropriate NbS cases:

- Costs, including implementation and maintenance costs,
- Feasibility, including the operational and institutional feasibility, and public acceptability,
- The eligibility to the Kenya Urban Support Program (KUSP2) Urban Development Grant (UDG) was tested against each case, as well the alignment with the World Bank's E&S framework.

It should be noted that although urban farming and policy-related NbS are not funded under KUSP2 UDG grant, corresponding cases were integrated into the NbS Compendium upon agreement with GCA.

Each criteria was scored through expert elicitation on a scale of 0 to 3:

Table 3 – Scoring matrix for NbS selection

Score	Benefits	Costs	Feasibility	Grant eligibility
3	High	Cheap	Easy to implement	Many opportunities
2	Moderate	Moderate	Some challenges	Some opportunities
1	Low	Expensive	Hard to implement	Few opportunities
0	None	No info	No info	Not eligible

It should be noted that criteria are not aggregated since they are not comparable. They all inform the selection process as a group.

The benefits criteria were evaluated as the sum of individual scores for a long list of 20 benefits classified into 3 categories.

Individual scores were estimated based on survey reports, and expert elicitation.

Table 4 –List of potential benefits provided by NbS

Benefits category	Benefits
Climate Resilience	Heat stress reduction
	Coastal flood risk reduction
	Pluvial flood risk reduction
	Riverine flood risk reduction
	Coastal erosion mitigation
	Land subsidence mitigation
	Landslide mitigation
	Soil erosion mitigation
	Drought mitigation
Socio-economic Development	Resources production
	Stimulate local economies and job creation
	Social interaction
	Education
	Cultural
Health and Environmental Quality of Life	Biodiversity
	Air pollution
	Water pollution
	Tourism and recreation
	Carbon storage and sequestration
	Health

Results of the selection

Eventually, the selection process followed these simple steps:

1. For each NbS family, NbS with the most reported benefits are selected,
2. The list is completed so that it covers all scales, settings, case categories, and climate contexts by selecting the ones with the most reported benefits,
3. Other criteria are analyzed in parallel to ensure relevance and adapt the selection if needed.

The table below shows an example of selection for the Bioretention Areas family. Cases are sorted per maximum benefits score, and other criteria are displayed to ensure the NbS case suitability. This table also highlights the significant irregularity of data availability among cases.

Table 5 – Summary of Selected cases based on different criteria

Project Name	Reported benefits	Costs		Feasibility			Grant eligibility	
							KUSP II Urban Development Grant (UDG)	*WB E&S Framework
		Implementation cost	Maintenance cost	Operational feasibility	Institutional feasibility	Public acceptability	UDG eligibility	Number of ESS supported
St. John's Community School	**16**	**3**	**2**	**3**	**3**	**3**	**0**	**3**
The Nairobi Dam Trust Initiative	15	N/A	N/A	N/A	N/A	N/A	3	1
Kibera Bioretention Area/Recreation Center	11	N/A	N/A	3	3	3	N/A	2
The Shelter Program	7	N/A	N/A	N/A	N/A	N/A	N/A	1

Cases with the most collected data generally stood out for any given criteria, which fostered their inclusion in the NbS Compendium and potentially left out more performant cases hiding behind data scarcity.

Although this could be regarded as a limitation in the selection process, this actually serves the NbS Compendium as these cases are also more likely to provide valuable information on the 8 systemic components targeted by the NbS Compendium, such as details on the implementation process, financial schemes, or monitoring system.

The selection process led to the identification of 12 NbS cases to compose the NbS Compendium. The following table summarizes the composition of the NbS Compendium with respect to the NbS Inventory.

Table 6 – Summary of selected NbS categories for the NbS Compendium with respect to the NbS Inventory

Category	Inventory	Compendium
NbS families	10	**10**
Scales	4	**4**
Cities	11	**7**
NbS case categories	4	**4**
Urban settings	5	**5**
Climate contexts	5	**4**

All NbS families presented in the NbS Inventory are represented in the NbS Compendium. Two Green Corridors – Oginga Odinga Street Tree Canopy and Kenyatta Avenue & Moi Street – were merged into a single case (Case #11 – Green Corridors in Nakuru) to combine their respective experience with this NbS family.

Seven cities are represented in the NbS Compendium, and Nairobi hosts 4 of the 12 selected cases. Examples in Kisumu, Limuru, Moyale, and Wote could not integrate the NbS Compendium according to the selection method, but insights of some of them are provided through “other examples”.

The NbS Compendium covers a wide array of urban, climate, and implementation configurations, which reinforces the replicability of its output. All scales, NbS case categories, and urban settings are covered, as well as most climate contexts, the exception being the tropical rainforest climate of a single case in Kisumu.

Table 7 – NbS Compendium selected cases

NO.	Project	City/Town	Urban setting	NbS Family	NbS Type	Scale	NbS Case Category	Climate context
1	Eldoret Arboretum KUSP1	Eldoret	CBD	Open Green Spaces	Urban park	Neighborhood	Green infrastructure	Subtropical highland
2	Living Smiles, Kuku Ranch	Kajiado County	Rural	Terraces and Slopes	Living Smiles	Plot	Green infrastructure	Hot semi-arid
3	Ondiri Wetland KUSP1	Kikuyu	Peri-urban	Natural Inland Wetlands	Wetland restoration and rehabilitation	Catchment	Green infrastructure	Subtropical highland
4	Malindi Waterfront Public Park	Kilifi	Formal	Sandy Shores	Waterfront park	Neighborhood	Hybrid infrastructure	Tropical dry savannah
5	Upper Tana-Nairobi Water Fund (UTNWF)	Nairobi	Peri-urban	River and Stream	Bank and bed renaturation	Catchment	Policy/Programmatic	Subtropical highland
6	Bangladesh Mangrove restoration	Mombasa	Formal	Mangrove Forests	Mangrove restoration and rehabilitation	Catchment	Green infrastructure	Tropical dry savannah
7	St. John's Community School	Nairobi	Informal	Bioretention Areas	Rain gardens	Plot	Hybrid infrastructure	Subtropical highland
8	Kaya Tembo Forest	Mombasa	Peri-urban	Urban forest	Habitat conservation	Plot	Green infrastructure	Tropical dry savannah
9	Kansoul Farm	Nairobi	Informal	Urban Farming	Vertical gardens	Plot	Resource production	Subtropical highland
10	John N. Michuki Memorial	Nairobi	Formal	River and Stream Renaturation	River rehabilitation and clean-up	Plot	Green infrastructure	Subtropical highland
11	Oginga Odinga Street Tree Canopy KUSP1 Kenyatta Avenue & Moi Street	Nakuru	CBD	Green corridors	Street tree canopies	Street	Green infrastructure	Warm-summer Mediterranean

Methodology for the NbS Compendium

The purpose of the NbS Compendium is to enhance the understanding of Nature-based Solutions and the characteristics of scalable NbS families for urban resilience in Kenyan secondary cities. It provides actionable guidance to local stakeholders to identify replicability potential of existing cases, and their conditions for scalability and to maximize their benefits within the Kenyan urban context. The NbS Compendium builds on knowledge dissemination and sharing across Kenyan stakeholders through lessons learned. By improving understanding of these solutions, the NbS Compendium aims to foster NbS mainstreaming and promote informed decision-making in urban planning and development.

In particular, the analysis goes through the lessons learned from existing inspirational projects for eight specific components to facilitate the replicability and scalability of NbS. The NbS Compendium relies on an analysis of 11 selected existing inspirational NbS projects implemented in Kenya, representing 10 NbS families. Based on available data, this involves an in-depth examination of the key features of the project.

This analysis helps identify specific features from projects that could help leverage their development across Kenya or potential room for improvement to improve their scalability potential. This gap analysis looks at eight strategic components of NbS project: project response to climate change; its benefits for environment, biodiversity and soil; implementation process and technical features; implications in terms of operations and maintenance; financial schemes and their sustainability; monitoring and evaluation systems; legal, regulatory and policy framework; and key stakeholders and process for social inclusion. The analysis through these eight strategic components will also contribute to reinforce NbS understanding among stakeholders and provide a basic evaluation framework.

Figure 186 – NbS as hybrid infrastructure in Nakuru – Green Corridor along A104 Highway (Source: Nakuru City)

Methodology for the Recommendations

Following the NbS Compendium, the section regarding Recommendations for implementation aims at enhancing the integration of Nature-based Solutions into upcoming infrastructure projects. Drawing on lessons learned from existing inspirational NbS cases and challenges identified in the enabling environment drivers, these recommendations provide actionable insights for improving the planning, design, and execution of NbS initiatives.

This section spells out the recommendations to align enabling environment drivers to NbS development, as a complement and support to the technical aspects. These drivers cover knowledge generation and technical requirements, fostering the inclusion of stakeholders, strengthening institutional capacities, ensuring adequate resources and integrating policies and regulations, throughout the whole project cycle.

To better integrate such recommendations into actual practices, this report is developed along the AECOM Resilient Infrastructure Guidelines framework. It provides recommendations at each stage of the project cycle, ranging from planning through project identification and implementation to monitoring and evaluation, as defined and known by the stakeholders, to enhance and ease potential NbS development or NbS integration along the process.

This report insists on key features of NbS, in the general landscape of resilient infrastructure. First, the report emphasizes the need to link NbS projects with the environmental ecosystems that support urban development and exploring opportunities to tap into potential ecosystem services. Second, it pays particular attention to the sustainability of NbS and ensure long-term efficiency in the context of climate change. Third, this report acknowledges the importance of preservation and restoration of existing NbS, with relevant strategies incorporated at each stage of the project cycle. Lastly, the complexity of NbS, which involves a variety of approaches and expertise, requires recognition of the blurred boundaries between different disciplines and the need for a holistic approach to its implementation.

Figure 187 – Vegetable gardens and the swamp in the Ondiri Wetland.
(Source: SUEZ Consulting, 2024, https://www.youth4nature.org/blog/ondiri-blog)

Recommendations for implementation have been formulated to foster the incorporation of an NbS lens into guidelines for project prioritization, delivery and operations and maintenance. Based on the barriers and opportunities identified during the development of the NbS Compendium to scale up NbS, the recommendations follows the general phasing of the project cycle as defined by AECOM in the Urban Resilient Infrastructure Guideline (2022) with some adjustment:

- **Planning phase focuses on strategic planning reflected into the analysis of long-term development trends and objectives.** Strategic planning can cover both national (such as Kenya Vision 2030) and local level planning whether spatial planning (Urban Spatial Plan) or sectoral planning in environment, transport or water for instance. This long-term view is essential to factor in environmental ecosystem development, and to anticipate mid- and long-term needs in terms of infrastructure development linked with development patterns.

- **Stemming from strategic planning framework and guidance, project identification and design phase defines investments integrated into the 5-year planning required by the CIDP (County Integrated Development Plan).** This section will include a focus on interdisciplinary technical coordination, Cost-Benefit Analysis (CBA) methodology for NbS projects, and highlight co-design and public-private partnership possibilities to develop them.

- **Construction and Operation and Maintenance (O&M) are merged into one single phase.** Even if they relate to different procurement and costing for CAPEX and OPEX, they are both part of the implementation process and need to be balanced when running the NbS CBA to ensure the long-term sustainability of the project.

- **Monitoring and Evaluation (M&E) is key to identify the global potential of NbS.** Assessing NbS as an adaptive measures to climate is complex given the variety of co-benefits it provides. However, the analysis points out ways to elaborate tailor-made methodology, adequate to the specificities of the project, to conduct ex-ante and ex-post assessment. The link with Environmental & Social Impact Assessment (ESIA) M&E framework will also be strengthened.

Building on AECOM approach for mainstreaming resilience into urban planning, strategic inputs will be analyzed at each stage of the project cycle:

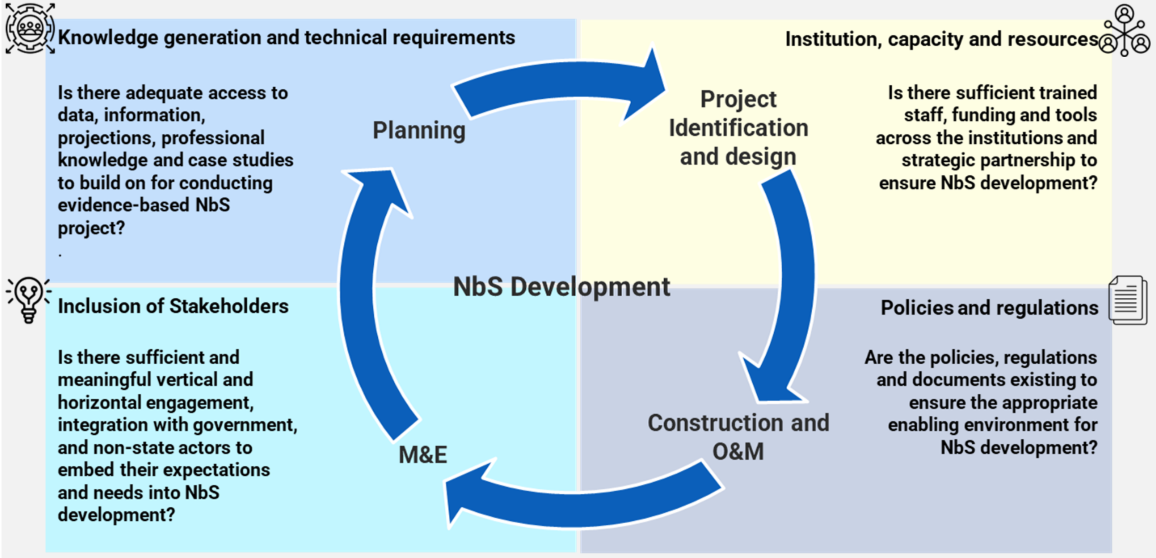

Figure 188 – Project cycle and enabling environment drivers (associated methodological questions) (Source: SUEZ Consulting, 2024)

Key recommendations reflecting the priorities set by Kenyan stakeholders were identified during the validation workshop held in February 2025. These recommendations stem from challenges identified and data collected for the analysis of the NbS Compendium cases and city assessments, as well as through expert elicitation, KII with 6 municipalities specifically targeted for this study, key national experts as well as national agencies, or collective discussions and interactive work during the workshop conducted with a panel of national and local stakeholders in October 2024 (list of KII provided in Annex 1). The final list of recommendations was carefully selected based on their relevance to the local context, their potential to drive sustainable outcomes, and their ability to address pressing challenges. Stakeholders also pinpointed critical actors *(see annex)*. The principal implementation level (municipal, county, or national) is defined for each recommendation.

Methodology for the Six Cities' Assessment

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Following the NbS Compendium, insights from 6 cities are provided to get a first sense of the NbS development potential in Kenyan secondary cities. A city assessment was carried out in 6 cities, selected as examples of various urban and climate contexts, to highlight the underlying conditions contributing to NbS development. The 6 cities are: Kisumu, Mandera, Kilifi, Eldoret, Wote and Nakuru. The city assessment includes:

- **A high-level overview of the city or municipality's urban profile and climate risk exposure**, covering key geographic, demographic, and institutional characteristics, economic drivers, land-use and spatial development patterns, urban challenges, climate zone, climate patterns, current hazards and impacts, and climate projections. This analysis provides a foundational understanding of the key urban challenges and climate vulnerabilities.

- **An assessment of NbS development potential, considering possible alignment with the urban planning framework, ongoing NbS-related efforts and results from the World Bank's NbS Opportunity Scan (NBSOS).** The methodology includes reviewing the incorporation of climate resilience and environmental protection into key planning documents and a brief examination of existing NbS initiatives. The NBSOS provides a spatial analysis of the potential development of specific NbS families. Finally, the assessment highlights the remaining barriers to NbS implementation, such as financial, technical, and regulatory constraints.

- **Linking of the pre-identified NbS development opportunities for each city with relevant NbS Compendium case studies to provide return from experience and triggers further peer-to-peer learning across Kenyan cities.** The NbS Compendium cases offer practical examples of successful NbS implementation in similar urban contexts, lessons learned and conditions for replicability. A summary table is provided. On each City Assessment, the potential NbS development opportunities are indicated, with a selection of 4 NbS families focusing on new NbS families rather than on well-established NbS practices, that are already integrated into local systems.

This assessment is based on several sources. This includes:

- **A literature and policy review:** key planning documents at the county and city/municipality levels were analyzed, with a focus on urban challenges, climate risks, and the integration of NbS features or enabling conditions (e.g., County Climate Change Policies and Action Plans, city/municipality Integrated Development Plans, land-use planning documents, zoning regulations). Additionally, some project-specific documentation was examined to assess the extent of NbS integration into local practices. This was further complemented by data from scientific articles and county- or national-level reports (e.g., participatory county climate risk assessments, national housing census).

- **Key Informant Interviews (KIIs):** KIIs with city/municipality managers or deputy managers, urban planners, and/or environmental officers provided valuable insights into internal structures, strategic priorities, implementation challenges, NbS understanding, and ongoing NbS projects.

- **The NbS Opportunity Scan (NBSOS) developed by The World Bank Group:** results from the NBSOS complement the analysis by providing spatial information and geospatial modeling to identify NbS that could effectively reduce hazard impacts, such as heat and flood, and build resilience. It aims at mapping areas with the highest hazard exposure and determines where NbS will have the greatest impact. The scan focuses on specific NbS families such as Open Green Spaces, Bioretention Areas, Urban Forests, Building Solutions, River Floodplain Restoration, River and Stream Renaturation, and Green Corridors. Results are integrated to the analysis.

Methodology of the NBSOS

The Nature-Based Solutions Opportunity Scan for Climate Resilience (NBSOS) is a tool designed for World Bank operations by the Global Program on Nature-Based Solutions (GPNBS) of the Global Facility for Disaster Reduction and Recovery (GFDRR). NBSOS supports the World Bank, its clients, and development partners in identifying nature-based solutions (NBS) investment opportunities and understanding their benefits for communities and the environment. It supports the integration into investment project financing, addressing the demand from project teams and government decision-makers lacking essential information on NBS typologies, priority areas, costs, and benefits. Primarily used in the investment identification phase, NBSOS provides NBS opportunities and their resilience-building benefits in urban or coastal areas. It also supports strategic diagnostics, such as in Country Climate and Development Reports and climate change adaptation planning, for cross-sectoral investment prioritization.

See more details about the NBSOS tool at:

https://naturebasedsolutions.org/opportunity-scan.

NBSOS is a geospatial analysis and participatory process offered by GFDRR as an on-demand service in World Bank engagements worldwide. NBSOS is applied at the request of and in collaboration with World Bank operations teams and their clients. It is tailored to each case to offer the most pertinent guidance.

In about 6 weeks, NBSOS provides a comprehensive package including geospatial data, hazard maps, NBS opportunities, benefit analyses, prioritization, scenarios, cost-benefit assessments, interpretations, and investment recommendations. As the starting point for an investment plan, NBSOS results help the World Bank engage governments and stakeholders and to inform feasibility studies, design, and implementation.

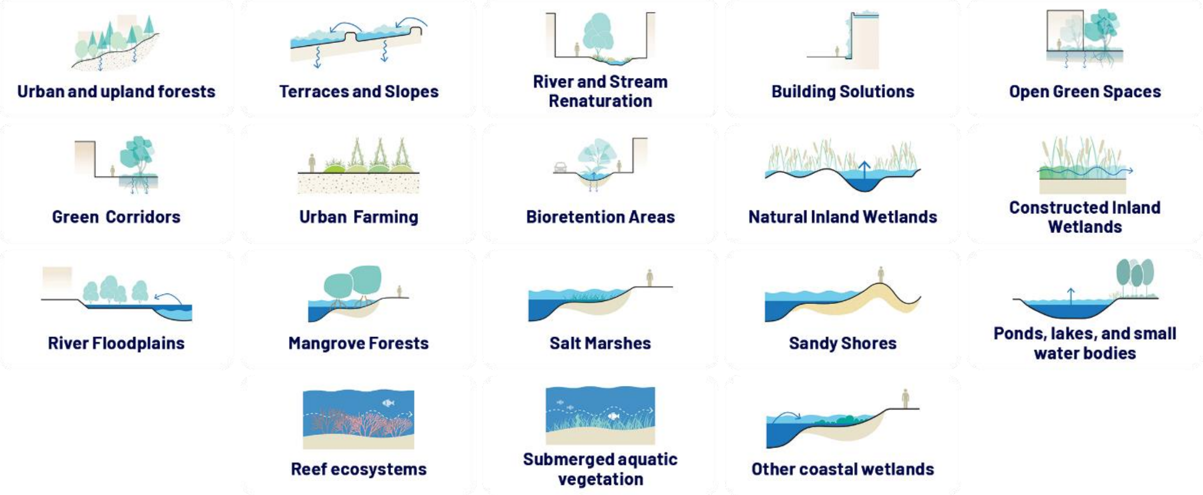

Figure 189 – Types of Nature-Based Solutions in urban and coastal areas
(Source: A Catalogue of Nature-Based Solutions for Urban Resilience, World Bank, 2021)

Annex 2 – List of Key Stakeholder Interviews (KII)

List of Key Stakeholder Interviews (KII)

Table 8 – List of Key Stakeholders Interviews (KII)

No.	Name	Organization	Position/Title	Date	Mode (Virtual/In-Person)	Section
1	Philip Khaulaba	Nairobi Arboretum	Conservator	27/08/2024	In-person	Inventory
2	Ismail Adan	Kenya Forest Service (KFS)	John Michuki Park KFS Manager	27/08/2024	In-person	Inventory
3	Gitau Thabanja	Nakuru Municipality	City Manager	28/08/2024	In-person	Inventory
4	Everlyn Mutua	Wote Municipality	Municipal Manager	28/08/2024	In-person	Inventory
5	Christopher Aboch	VUMA - Makina Village	Vuma CBO Chairman	29/08/2024	In-person	Inventory
6	Daniel Mutinda	St. Johns - Silanga Village	Teacher	29/08/2024	In-person	Inventory
7	Aula Juma Ndago	KAYA TEMBO – Council of elders	Chairman	30/08/2024	In-person	Inventory
8	Peter K Mwangi	KFS – Bangladesh Mangrove Forest	Coast Ecosystem Conservator	30/08/2024	In-person	Inventory
9	Tito Koiyet	Eldoret Municipality	City Manager	30/08/2024	In-person	Inventory
10	Ruth Gituria	FOWK – Ondiri Swamp	Deputy Manager	30/08/2024	In-person	Inventory
11	Gitau Thabanja	Nakuru Municipality	City Manager	11/10/2024	In-person	All sections
12	Arch. George A. Ndege	The Architectural Association of Kenya (AAK)	Architect	14/10/2024	In-person	Recommendations
13	Mr. Ismail Adan John	Kenya Forest Services (KFS)	Park Manager	14/10/2024	In-person	Compendium
14	Dr. Purity Muthoni	Kenyatta University – Department of Spatial & Environmental Planning	Researcher	16/10/2024	In-person	Compendium & Recommendations
15	Sumaya Mohamed	WWF Kenya	Policy and Advocacy Specialist	16/10/2024	In-person	Compendium & Recommendations

List of Key Stakeholder Interviews (KII)

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No.	Name	Organization	Position/Title	Date	Mode (Virtual/In-Person)	Section
16	Mr. Dan Mutinda	St. John's Community School	Teacher	16/10/2024	In-person	Inventory & Compendium
17	Mr. Alex Mugambi	Environment Institute of Kenya (EIK)	Chairperson	17/10/2024	In-person	Recommendations
18	Eng. Elisha Akech	Institution of Engineers of Kenya	Engineer	17/10/2024	In-person	Recommendations
19	Everline Mwikali	Wote Municipality	Municipal Manager	13/11/2024	Virtual	Compendium & 6 cities assessment & Recommendations
20	Said Haji Hassan	Mandera Municipality	Civil Engineer behalf of the City Manager	07/11/2024	Virtual	Compendium & 6 cities assessment & Recommendations
21	Charles Omollo	Kisumu Municipality	Deputy City Manager	08/11/2024	Virtual	Compendium & 6 cities assessment & Recommendations
22	Tito Koiyet, Cyprian Chesire and Gideon Kirwa	Eldoret Municipality	City Manager, Planner and Environment Officer	12/11/2024	Virtual	Compendium & 6 cities assessment & Recommendations
23	Elius Chipa, Kaleli Katana and Tracy Ayieko	Kilifi Municipality	Municipal Manager, Environmental and Environmental Specialist	14/11/2024	Virtual	Compendium & 6 cities assessment & Recommendations
24	Anthony Kariuki	Upper Tana Nairobi Water Fund	Program Manager	14/11/2024	Virtual	Compendium & Recommendations

List of Key Stakeholder Interviews (KII)

No.	Name	Organization	Position/Title	Date	Mode (Virtual/In-Person)	Section
25	Seth Omondi Odero, Lawrence Wachira, Kennedy Wafula	Kenya Urban Roads Authority (KURA)	Deputy Director (E&S Safeguards), Environmentalist, Assistant Director (Environmental Safeguards)	10/01/2024	Virtual	Recommendations
26	Dr. David Gikungu, Aura Beverly, Ezekiel Njoroge, John Mungai, Peter Masika,	Kenya Meteorological Department (KMD)	Director, Project Department, Director Assistant, Customer Services Officer, Principal Assistant, Assistant Director (Strategic Planning and Finance)	14/01/2025	Virtual	Recommendations
27	Benjamin Muindi	Kenya Forest Services (KFS)	Senior Forest Officer	16/01/2025	Virtual	Recommendations
28	Dr. Chrispus Ndinyo, Dr. Eng. Meshack O. Otieno, Elle Rabongo	National Construction Authority (NCA)	Manager training and capacity building, Assistant manager, Research and Development Officer	21/01/2025	Virtual	Recommendations

Annex 3 – Results of the Validation Workshop

Results of the Validation Workshop

Table 9 - Results of the Validation Workshop

Project cycle	Driver	Recommendation	Level of implementation	Priority	Preliminary list of stakeholders to involve As identified by Kenyan stakeholders during the validation workshop (February 2025)
Planning		Develop evidence-based land-use and investment prioritization strategy	Municipality	Priority	**Urban / City Boards** (lead) Ministry of Environment, Climate Change and Forestry Knowledge Institutions Institute of Engineers Kenya ; Kenya Institute of Planners
		Identify and support the development of community-level climate resilience initiatives	Municipality	Priority	**Municipalities** (lead) Community/neighborhood-level champion committees CBOs and local NGOs Ministry of Interior and Coordination
		Reinforce collaboration between urban planning county departments and city-level authorities	County & Municipality	Priority	**County Government Departments** (lead) **Urban / City Boards** (co-lead) Professional Bodies (e.g., Kenya Institute of Planners)
		Enforce NbS as a national initiative and leverage existing successful programs	National	Priority	**Ministry of Environment, Climate Change and Forestry** (overall coordination and policy guidance) State Department for Urban ; State Law Office Council of Governors ; NEMA
Project identification & design		Foster interdisciplinary expertise to advance NbS development	Municipality & National	Priority	**City Managers** (lead) Urban / City Board National Government and Education Institutions
		Clarify roles and foster collaboration for NbS integration	National & Municipality	Priority	**Ministry of Environment, Climate Change and Forestry** (overall coordination and policy guidance) **Urban / City Boards** (lead at project/municipality-level) The State Department for Housing and Urban Development KUSP PSC, PTC, NPCT, CPCT ; Council of Governors Technical Assistants (e.g., environment, social safeguards) Relevant Line Ministries and Agencies

Results of the Validation Workshop

Project cycle	Driver	Recommendation	Level of implementation	Priority	Preliminary list of stakeholders to involve As identified by Kenyan stakeholders during the validation workshop (February 2025)
Project identification & design		Strengthen the role of environmental and social impact assessment (ESIA) to drive NbS adoption and resilience-oriented investments	National	Priority	**NEMA** (lead) **KUSP NPCT** (lead for KUSP2 project) NCA ; Professional Bodies County Governments ; Municipalities Trainings and Inductions Attorney General
Construction, operation & maintenance		Activate local supply chains for NbS construction and long-term management	County & Municipality	Priority	**County Governments & Municipalities** (lead) Private Sector National Government
		Pursue coordinated action initiated at the planning phase throughout construction and O&M	Municipality	Priority	**Urban / City Boards** (lead, overall coordination) Department of Lands and Urban Planning Private Sector
		Develop O&M plans to ensure O&M planning, responsibilities, financial sustainability, and clear management guidance from the NbS design phase	Municipality	Priority	**Municipalities** ; County Governments National Government
Monitoring & evaluation		Tap into citizen sensing data potential	National	Priority	**Kenya Meteorological Department** NEMA Ministry of Environment, Climate Change and Forestry County Departments
		Design an appropriate framework for monitoring and evaluation	Municipality	Priority	**City Boards** Project Teams

Results of the Validation Workshop

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Project cycle	Driver	Recommendation	Level of implementation	Priority	Preliminary list of stakeholders to involve As identified by Kenyan stakeholders during the validation workshop (February 2025)
Monitoring & evaluation		Harness labelling initiatives for NbS as an adaptation measure to attract funding	National	Priority	**Ministry of Environment, Climate Change and Forestry** (lead) NETFUND – Restoration fund NEMA ; KFS County Governments ; Municipalities
		Establish a national NbS monitoring framework to track outcome across sectors	National	Priority	**NEMA** (framework establishment) **Ministry of Environment, Climate Change and Forestry** (overall coordination) County Departments on Climate Change CBOs Private Sector ; Climate Change Fund

Annex 4 – NBSOS Results Summary

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