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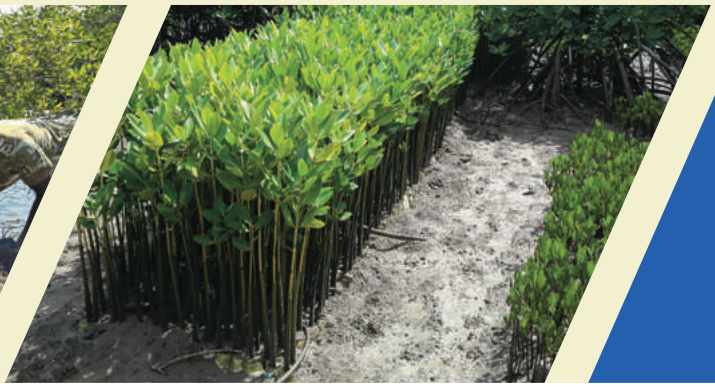
CURRENT NATURE-BASED SOLUTIONS AT MOUNT KENYA-LEWA AND MALINDI-WATAMU-ARABUKO SOKOKE BIOSPHERE RESERVES, KENYA







Kenya VISION 2030

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CURRENT NATURE-BASED SOLUTIONS AT MOUNT KENYA-LEWA AND MALINDI-WATAMU-ARABUKO SOKOKE BIOSPHERE RESERVES, KENYA

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Foreword

UNESCO's Man and the Biosphere (MAB) Programme plays a vital role in harmonizing conservation and sustainable development. Through the designation of Biosphere Reserves (BRs), it promotes biodiversity conservation, economic growth, and cultural preservation using inclusive, participatory approaches. BRs serve as living laboratories for testing nature-based solutions (NbS) that address climate change, biodiversity loss, and social challenges—delivering co-benefits to both people and the planet.

This report highlights the role of NbS in the sustainable management of Kenya's Biosphere Reserves, focusing on Mount Kenya-Lewa and Malindi-Watamu-Arabuko Sokoke. It documents scalable NbS, evaluates their effectiveness, and emphasizes the critical contributions of women and youth. Their innovation, local knowledge, and active participation enhance the impact and inclusivity of conservation efforts.

Kenya's six BRs are rich in biodiversity and ecosystem services. Their integrative management frameworks make them ideal for scaling NbS. These efforts align with national priorities such as Vision 2030 and the Bottom-Up Economic Transformation Agenda (BETA), regional frameworks like EAC Vision 2050 and AU Agenda 2063, and global commitments including the 2030 Agenda and Multilateral Environmental Agreements.

The study confirms that Kenya's BRs offer fertile ground for inclusive, cost-effective, and transformative NbS that support ecological sustainability and climate resilience. Realizing their full potential requires raising the profile of BRs as models for conservation, development, research, and education. They also present opportunities for gender-sensitive capacity building, community empowerment, access to finance, and cross-sectoral collaboration.

I believe the study's recommendations will guide targeted interventions—scaling successful practices and addressing local challenges to build resilient ecosystems

and sustainable futures. I thank UNESCO for funding this study, and our partners, including the Kenya Wildlife Service, the Kenya Forest Service, wildlife conservancies, community-based and civil society organizations. I also appreciate the support from the private sector and development partners and commend the communities whose daily commitment to NbS continues to shape a sustainable future.

I call on all stakeholders to join us in implementing these recommendations. Together, through collaboration and shared purpose, we can achieve lasting impact.

Dr. James Njogu, *HSC*
Ag. Secretary General / CEO
Kenya National Commission for UNESCO

Acknowledgement

This survey was made possible with financial support from UNESCO through the Participation Programme (Request No. 3240115213 PPE – 2024-2025). The Commission expresses gratitude to Dr. Agatha Nthenge, the consultant who conducted this survey and compilation of the report, Biosphere Reserve Managers and their staff at Malindi-Watamu-Arabuko Sokoke and Mount Kenya-Lewa Biosphere Reserves for community mobilizations, local community who served as respondents during the survey, and the participants who were involved in the validation process drawn from local communities from the two respective biosphere Reserves. Finally, we wish to take this opportunity to thank the Kenya National Commission for UNESCO Staff who supported in one way or another during the desktop review, planning data collection and review of this report.

Executive Summary

Nature-based solutions (NbS) are innovative approaches that harness the power of nature to address societal challenges while providing co-benefits for both people and the environment. These solutions leverage natural processes, biodiversity, and ecosystem services to achieve sustainable development goals across various sectors. The crucial role played by nature-based solutions in sustainable development has been confirmed by science. Nature-based solutions (NbS) demonstrate how communities can sustainably manage natural ecosystems while enhancing resilience to climate change, supporting biodiversity, and generating socio-economic benefits. Studies on nature-based solutions bridge scientific understanding and local action by documenting the effectiveness of interventions in improving both ecological integrity and human well-being. Importantly, they highlight the role of inclusive participation, particularly among women, youth, and indigenous groups in ensuring that Nature-based Solutions (NbS) are contextually relevant, socially just, and scalable. By examining local practices and outcomes, NbS studies also inform policy frameworks, funding mechanisms, and adaptive strategies essential for addressing complex environmental and development challenges in biosphere reserves and beyond.

Biosphere Reserves are a classical model to reconcile the conservation of biodiversity and ecosystems with sustainable human development. They serve as living laboratories where innovative approaches to conservation and sustainable development can be tested and refined. The study aimed at generating empirical data that would guide the design, implementation, and scaling of Nature-based solutions within Kenya's biosphere reserves by documenting insights on community participation, biodiversity conservation outcomes, and socio-economic benefits. By capturing locally grounded evidence on how communities engage with NbS through livelihood activities, conservation practices, and decision-making roles, the study sought to generate information to inform policy formulation and decision-making, institutional strategies, and inclusive funding models. Moreover, it aimed to uncover the women and youth participation in NbS, thereby supporting the creation of more equitable and context responsive NbS frameworks that contribute to climate resilience, poverty reduction, and biodiversity conservation at the landscape level.

The data was collected through administering structured questionnaires and in-depth interviews to a cross-section of stakeholders, including local communities, biosphere reserve managers, key informants such as representatives of government agencies, representatives of community-based organisations and civil society organisations. Desktop review and secondary data complemented the fieldwork, drawing on existing reports, MAB-related documentation, and policy frameworks relevant to Kenya's biosphere reserves and environmental conservation and management context.

Key NbS activities documented across the reserves include forest and mangrove restoration, native tree planting, assisted natural regeneration, agroforestry, climate-smart agriculture, agroforestry, composting (including insect-based composting with black soldier flies), wildlife conservation and the development of nature-based enterprises such as ecotourism and sustainable crafts. These interventions are contextually adapted to the reserves' ecological zones and deliver co-benefits across conservation, production, and research functions.

Environmental outcomes include improved biodiversity, restoration of soil and hydrological functions, enhanced carbon sequestration, and rehabilitation of degraded ecosystems, especially within forested slopes and coastal wetlands. Equally important are the socio-economic impacts: NbS initiatives have contributed to livelihood diversification, strengthened local food systems, and enhanced household well-being and resilience, particularly in ecologically fragile and economically marginalised areas.

A notable finding is the central role played by women and youth in spearheading community-led NbS interventions and innovations. From insect-based composting using Black Soldier Fly (BSF) insects to mangrove restoration/replanting and agroforestry activities in both BRs, where they have actively shaped and sustained NbS efforts. Their participation has translated into skill development, income generation, and increased visibility in environmental governance, highlighting the potential of NbS to serve as a vehicle for gender inclusivity and empowerment. Moreover, the study underscores broad-based community engagement in planning, implementation and monitoring of NbS, reflecting a shift toward locally owned and socially embedded ecological restoration. This is consistent with the UN Decade on Ecosystem Restoration (2021-2030) initiatives.

Despite these positive developments, several challenges persist. Resource stock (e.g. fuel wood) and wildlife populations continue to decline due to increased harvesting, habitat fragmentation and human-wildlife conflict. Further, Coastal areas face intensifying water stress driven by climate variability, saline intrusion,

and inadequate infrastructure. The spread of invasive species (e.g. Prosopis juliflora, and Lantana camara) is disrupting native ecosystems and complicating restoration efforts as well as other nature-based solutions. Institutional weaknesses such as limited awareness of BR-related model, poor benefit-sharing mechanisms, high taxation of eco-enterprises, and insufficient compensation for community stewards further inhibit the scalability and institutionalization of NbS within BR landscapes.

Nonetheless, significant expansion opportunities exist. Community-driven NbS innovations demonstrate high adaptability and can be effectively scaled across Kenya's diverse ecological and socio-economic settings. Kenya's carbon market landscape, supported by the Climate Change (Carbon Markets) Regulations 2024, offers a promising avenue to mobilise climate finance for afforestation and sustainable forest management. Integrating NbS into Environmental and Social Impact Assessments (ESIA), County Integrated Development Plans (CIDPs), and voluntary carbon market mechanisms could further unlock policy support and financial investment. Other opportunities include expansion of afforestation initiatives and restoration activities, tree nursery establishment, NbS enterprises and value addition (e.g., herbal soap production, bee keeping and honey production) and insect-based composting. Collectively, these opportunities and innovations present viable, grounded pathways for scaling NbS across Kenya's biosphere reserve network; strengthening ecological functionality, enhancing community resilience, and aligning with national goals on restoration, climate action, sustainable nature-based enterprises and inclusive development including gender and youth mainstreaming.

Ultimately, this study affirms that Kenya's biosphere reserves are fertile grounds for scaling NbS as inclusive, cost-effective, and transformative tools for ecological sustainability and climate resilience. Realizing their full potential will require institutional support, gender-sensitive capacity building, community empowerment, access to credit facilities and funding mechanisms for communities, and sustained cross-sectoral collaborations – advancing progress toward the Sustainable Development Goals (SDGs), including SDG 1 (No poverty), SDG 2 (Zero hunger), SDG 3 (Good health and well-being), SDG 5 (Gender Equality), SDG7 (Affordable and Clean energy), SDG 11 (Sustainable Cities and Communities), SDG 12 (Responsible consumption and production), SDG 13 (Climate Action), SDG14 (Life below water), SDG 15 (Life on Land), and SDG 17 (Partnerships for the Goals).

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Abbreviations and Acronyms

BETA	Bottom Up Economic Transformation Agenda
BR	Biosphere Reserve
BSF	Black Soldier Fly
CBEMR	Community-Based Ecological Mangrove Restoration
CFAs	Community Forest Associations
CIDPs	County Integrated Development Plans
CIF	Climate Investment Fund
ESIA	Environmental and Social Impact Assessment
FAO	Food and Agriculture Organisation
FOLU	Food and Land Use Coalition
GOK	Government of Kenya
IBA	Important Bird Area
ICRAF	International Centre for Research in Agroforestry
IUCN	International Union for Conservation of Nature
KFS	Kenya Forest Service
KMFRI	Kenya Marine and Fisheries Research Institute
KNATCOM	Kenya National Commission for UNESCO
KWS	Kenya Wildlife Service
MAB	Man and the Biosphere
MRV	Monitoring, Reporting, and Verification
MWASBR	Malindi-Watamu-Arabuko Sokoke Biosphere Reserve

NbS	Nature-Based Solutions
NBSAP	National Biodiversity Strategy and Action Plan
NDCs	Nationally Determined Contributions
NGEK	National Gender and Equality Commission
NGOs	Non-Governmental Organisations
PAs	Protected Areas
PELIS	Plantation Establishment and Livelihood Improvement Scheme
PFM	Participatory Forest Management
PPPs	Public-Private Partnerships
SARICODO	Sabaki River Conservation and Development Organization
SDGs	Sustainable Development Goals
TELIS	Trees Establishment Livelihood Improvement Scheme
tCO_2e	Tonnes of Carbon dioxide equivalent
UNEP	United Nations Environmental Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
VCMs	Voluntary Carbon Markets
WRUAs	Water Resource Users Associations

Definition of terms

1. **Biodiversity** – The variety and abundance of living organisms within a given area including plants, animals and microorganisms.
2. **Biosphere Reserve (BR)** – A classical model to reconcile the conservation of biodiversity and ecosystem with sustainable human development.
3. **Carbon Sequestration** – The process by which ecosystems such as forests, wetlands and mangroves capture and store carbon, helping mitigate climate change.
4. **Climate Resilience** – The ability of ecosystems and communities supported by nature based solutions to anticipate, withstand and recover from climate impacts.
5. **Conservation** – The sustainable use and protection of natural resources and ecosystems.
6. **Cultural Diversity** – The richness of human traditions, knowledge and practices that strengthen the design and acceptance of nature based solutions.
7. **Ecological Connectivity** – The linkages that allow species and ecological processes to move across landscapes.
8. **Ecological Sustainability** – The long term maintenance of ecosystem functions and services.
9. **Ecosystem** – A community of living organisms interacting with their physical environment.
10. **Ecosystem Integrity** – The wholeness and functioning of an ecosystem, maintaining its processes and biodiversity.
11. **Ecosystem Services** – Benefits people gain from ecosystems, such as food, water, climate regulation, and recreation.
12. **Genetic Diversity** – Variation within species populations that enable adaptation and survival.
13. **Habitat Fragmentation** – Breaking up of continuous habitats into smaller, isolated patches often due to human activities.
14. **Multilateral Environmental Agreements (MEAs)** – International treaties addressing global challenges such as biodiversity loss and climate change.
15. **Nature-based Solutions (NbS)** – Innovative approaches that harness the power of nature to address societal challenges while providing co-benefits for both people and environment.
16. **Protected Area** – Legally designated areas for conserving biodiversity and cultural values.
17. **Resilience** – The ability of ecosystems and societies to absorb disturbances and recover.
18. **Sustainable Development** – Development that meets the needs of the present without compromising the ability of future generations to meet their own needs incorporating environmental, social and economic considerations.
19. **Transboundary Cooperation** – Joint management of ecosystems and resources across jurisdictions.
20. **Zonation (in Biosphere Reserves)** – Division of a biosphere reserve into zones (core, buffer, transition)to guide where conservation, sustainable use and human activities take place.

CHAPTER ONE:

INTRODUCTION

1.1 Background

Biosphere Reserves (BRs) are internationally designated areas under the UNESCO Man and the Biosphere (MAB) Programme, launched in 1971 to promote a balanced relationship between people and nature. They serve as model regions for fostering interdisciplinary research, biodiversity conservation, and sustainable development through inclusive, ecosystem-based governance (UNESCO, 2017). Globally, BRs function as "living laboratories," enabling communities, scientists, and institutions to collaboratively test and demonstrate innovative approaches to managing ecosystems, improving livelihoods, and strengthening resilience to growing environmental pressures, including climate change (Jones et al., 2021).

Structured around a zonation model comprising core, buffer, and transition zones, BRs enable spatially differentiated interventions that integrate conservation, community development, education, research and monitoring. This framework provides fertile ground for implementing nature-based solutions (NbS), which have emerged as a transformative paradigm to address interconnected societal challenges such as climate change, biodiversity loss, water insecurity, and land degradation. Defined by the International Union for Conservation of Nature (IUCN), NbS encompass actions that protect, sustainably manage, and restore ecosystems to deliver co-benefits for both people and nature, including carbon sequestration, disaster risk reduction, and food and water security (Cohen-Shacham et al., 2016; IUCN, 2020; World Bank, 2022).

Biosphere Reserves are especially well-suited for scaling NbS due to their integrative management frameworks and emphasis on transdisciplinary knowledge production and community involvement. These NbS efforts contribute directly to global priorities, including the Sustainable Development Goals (SDGs), notably SDG 1 (No poverty), SDG 2 (Zero hunger), SDG 3 (Good health and well-

being), SDG 5 (Gender Equality), SDG 6 (Clean water and sanitation), SDG7 (Affordable and Clean energy), SDG 11 (Sustainable Cities and Communities), SDG 12 (Responsible consumption and production), SDG 13 (Climate Action), SDG14 (Life below water), SDG 15 (Life on Land), and SDG 17 (Partnerships for the Goals) as well as the UN Decade on Ecosystem Restoration and the Post-2020 Global Biodiversity Framework (UNEP, 2024; CBD, 2022).

To guide effective implementation, the IUCN Global Standard for NbS provides a rigorous framework comprising eight criteria and 28 indicators that emphasize inclusivity, adaptive management, and measurable impacts across ecological and social dimensions (IUCN, 2020). However, while this framework exists, most of the implementers of nature-based solutions are not only aware of these guidelines but operate in an ad hoc manner driven by the need to achieve sustainable livelihoods and sustainable land management. Despite the growing policy traction, however, there remains a disconnect between NbS frameworks and biosphere reserve management in practice. Scholars argue that BRs hold untapped potential as platforms for transdisciplinary sustainability science, yet they often suffer from weak policy integration, fragmented financing, and a lack of robust monitoring systems (Dabard et al., 2024).

A systematic review of over 3,000 publications on BRs revealed that most research has focused on natural sciences, with limited attention to governance, stakeholder participation, and transformative NbS outcomes (Staffa et al., 2024). Transdisciplinary approaches involving local communities, scientists, and policymakers are still underutilised, despite their potential to enhance legitimacy and scalability.

Moreover, while NbS are increasingly referenced in global biodiversity and climate frameworks (e.g., CBD Targets 8 and 11, SDG 13 and 15), their operationalisation within BRs remains fragmented. For instance, impact assessment frameworks often lack guidance on indirect effects, trade-offs, and long-term ecological baselines (Jiménez-Aceituno et al., 2021). This limits the ability of BR managers to evaluate NbS effectiveness and adaptively manage interventions.

Recent studies underscore the growing relevance of NbS in BRs, yet also reveals persistent gaps in implementation, scalability, and monitoring. Emerging typologies ranging from ecosystem restoration and agroecology to green infrastructure demonstrate the versatility of NbS, but also highlight the need for context-specific adaptation and inclusive governance (Leguia-Cruz et al., 2024). BRs are increasingly recognized as ideal platforms for NbS experimentation, offering opportunities to integrate ecological restoration with community-led development.

For instance, The Shouf Biosphere Reserve in Lebanon offers a compelling example of landscape-scale NbS through adaptive forest restoration, implemented under the Mediterranean Mosaics Project (Hani et al., 2017). The interventions focused on planting native woodland islets, restoring riparian corridors, and engaging Syrian refugees in land rehabilitation efforts (Hani et al., 2017). These NbS significantly improved biodiversity, curbed wildfire risks, and enhanced water regulation services. Notably, participatory planning created strong community ownership and facilitated inclusive governance, an aspect highlighted as essential in the IUCN Global Standard for NbS (Cohen-Shacham et al., 2016). However, the project exposed challenges in long-term sustainability, particularly around consistent funding and ecological monitoring. As Dabard et al., (2024) argue, many BRs lack robust impact tracking systems that integrate ecological, social, and institutional metrics. The Shouf case demonstrates that while NbS can regenerate ecosystems and benefit vulnerable populations, their longevity depends on institutional commitment and continuous ecological evaluation

In South Africa's Magaliesberg BR, NbS took the form of indigenous vegetation restoration for erosion control and carbon sequestration. The Van Wyksdorp community in partnership with local authorities, planted Spekboom (Portulacaria afra), a succulent known for its high carbon absorption and soil-binding properties. These interventions provided employment opportunities and restored ecological functionality in degraded areas (UNESCO, 2023). While the project demonstrated success in ecosystem regeneration and job creation, its scalability was constrained by limited budget allocations and policy fragmentation. Dabard et al., (2024) emphasize that BR-based NbS must be nested within coherent institutional frameworks and linked to climate adaptation and green economy agendas. Magaliesberg BR shows that community-led restoration can yield rapid environmental conservation outcomes and socioeconomic benefits if supported by long-term funding and policy integration.

Pemba Island BR, in Tanzania advanced NbS through sustainable aquaculture, focusing on women-led seaweed farming and small-scale fisheries. These practices reduced pressure on overharvested marine systems while improving household incomes and food security. Meyer and Hessenberger (2022) report that seaweed cultivation using low-impact techniques not only conserved biodiversity but also fostered gender equity, in line with SDG 5. Nonetheless, challenges such as climate variability particularly rising sea temperatures and fluctuations in international seaweed prices exposed the economic fragility of the intervention. This is consistent with observations by Miralles-Wilhelm and Iseman (2021) that NbS must be designed with climate-informed planning and financial resilience in mind. The Pemba experience suggests that empowering women and leveraging traditional

knowledge enhances NbS effectiveness, but success hinges on diversified markets and climate-adaptive management.

In Peru, the Huascarán BR in Peru demonstrates how NbS can enhance watershed functionality and disaster risk reduction in glacial mountain ecosystems. Restoration measures included planting native species, rehabilitating high-altitude wetlands (bofedales) and constructing infiltration systems to stabilise meltwater flows (IIED, 2021). These interventions addressed water security challenges for both agriculture and hydropower, aligning with SDG 6 on clean water access. However, the rapid retreat of glaciers due to climate change complicated long-term planning. Additionally, governance fragmentation across sectors (water, energy, agriculture) hindered integrated NbS implementation. Li et al., (2023) suggest that mountainous BRs require scenario-based NbS planning and predictive modelling to cope with dynamic ecological baselines. The Huascarán example highlights the critical need for cross-sectoral coordination and climate risk assessment in NbS deployment.

Plate 1: Community - led Mangrove restoration at River Sabaki Estuary ©Gibran Maghanga

These interventions enhanced ecosystem and community resilience, restored key breeding grounds for fish, increased water supply and diversified local livelihoods, aligning with principles outlined in the IUCN Global Standard for NbS (IUCN, 2020). However, project outcomes also revealed critical gaps. Integration of NbS into county-level development planning remained weak, and monitoring systems lacked adaptive indicators tied to long-term ecosystem performance. As emphasized by Dabard et al., (2024), biosphere reserves must align transdisciplinary NbS projects with formal policy structures to ensure scalability

and sustained impact. These cases underscore the need for strong institutional support to complement community-led innovation.

Collectively, these case studies demonstrate that NbS within BRs can deliver wide-ranging and multiple co-benefits including biodiversity conservation, climate mitigation and adaptation, and livelihood enhancement. Yet common gaps emerge around monitoring, financing, climate adaptation, and institutional coherence.

The implementation of nature-based solutions (NbS) across biosphere reserves presents a constellation of benefits and scalable opportunities spanning ecological, social, and economic domains, as evidenced throughout many case studies. Ecologically, restoration interventions such as woodland rehabilitation in Lebanon's Shouf BR have enhanced habitat structure, promoted species richness, and improved landscape connectivity which are critical components for maintaining ecosystem resilience under climate stress (Hani et al., 2017; Cohen-Shacham et al., 2016).

Socially, these projects demonstrated that community engagement, especially when incorporating indigenous knowledge systems and recognising women and youth as key stakeholders, led to more inclusive decision-making and long-term stewardship, consistent with principles outlined in the IUCN Global Standard for NbS (IUCN, 2020; Meyer & Hessenberger, 2022). Additionally, economically, NbS initiatives like seaweed farming in Zanzibar not only diversified rural livelihoods but also catalysed green job creation and expanded local value chains (UNESCO, 2023; Meyer & Hessenberger, 2022).

Plate 2: Shelling of Coconuts
©Azani Ngumbao

Therefore, in Kenya's biosphere reserves, these global examples affirm the poential to replicate and adapt NbS innovations that bolster conservation, climate adaptation, and socioeconomic resilience. Unlocking these opportunities requires policy integration, targeted financing, and sustained capacity building to transition from isolated pilot projects to systemic, landscape-wide transformation.

Despite the wide-ranging opportunities presented by NbS within Biosphere Reserves (BRs), their implementation and scaling continue to face persistent challenges and systemic barriers. Funding and policy limitations remain among the most cited constraints, with many BRs lacking dedicated budget lines or long-term financing mechanisms to support NbS beyond pilot phases (FOLU, 2022). Additionally, institutional fragmentation and weak policy integration often result in misalignment between NbS objectives and local development goals, leading to stakeholder conflicts or diluted impact (Nelson et al., 2020). Technical capacity gaps, particularly in ecological design, participatory monitoring, and adaptive management, further hinder the effectiveness of NbS, especially in resource-constrained settings (IUCN, 2020).

Monitoring and evaluation frameworks for NbS in BRs are frequently underdeveloped, with limited use of standardized indicators to assess ecological, social, and economic outcomes. As Reilly-Moman et al., (2023) note, the absence of robust impact assessment tools impedes learning and accountability, making it difficult to compare effectiveness across sites or inform adaptive strategies. Knowledge gaps also persist around the long-term impacts of NbS, especially in dynamic ecosystems such as coastal zones and mountain watersheds.

Moreover, the integration of local indigenous knowledge systems, while increasingly recognized as essential, is still inconsistently applied in NbS design and governance (UNESCO, 2024; Dabard et al., 2024). Cross-site comparative studies between BRs remain rare, limiting the transferability of lessons, success stories and innovations. The NetworkNature knowledge gap database identifies over 600 gaps in NbS research, including the need for interdisciplinary methodologies, better socio-ecological modelling, and improved understanding of trade-offs and synergies across scales (NetworkNature, 2024). Addressing these gaps will require coordinated research approaches, inclusive governance frameworks, and strategic investment in capacity building to ensure that NbS fulfil their promise as transformative tools for sustainability within biosphere reserves.

1.2 Purpose

This study explored the application of nature-based solutions within Kenya's biosphere reserves with a focus on how these interventions support sustainable

development, biodiversity conservation, sustainable livelihoods and climate adaptation. Grounded in the principles of UNESCO's Man and the Biosphere (MAB) Programme, the report emphasizes the multifunctionality of BRs as socio-ecological systems and highlights the strategic role of NbS in enhancing their zonation model. In core zones, NbS such as ecological restoration, assisted natural regeneration, and habitat connectivity contribute to long-term biodiversity protection and climate mitigation, while enabling research and ecological monitoring. Buffer zones benefit from forest rehabilitation, agroforestry, and watershed management, which reduce edge effects and improve ecosystem services for surrounding communities. Transition zones offer fertile ground for climate-smart agriculture, ecotourism, and nature-based enterprises that promote inclusive livelihoods and sustainable resource use.

The scope of this survey includes an assessment of how NbS are being implemented across Kenya's BRs particularly Mount Kenya–Lewa and Malindi–Watamu–Arabuko Sokoke and how they contribute to ecosystem restoration, livelihood diversification, and resilience-building. It also identifies key barriers to scaling NbS, including governance gaps, financing constraints, and limited technical capacity, while showcasing innovative practices such as mangrove rehabilitation, insect-based composting and afforestation/reforestation activities that demonstrate the adaptability of NbS across diverse ecological and social contexts.

By integrating scientific evidence, community insights, and policy frameworks, this report aims to inform decision-makers, practitioners, and stakeholders on how NbS can be scaled and institutionalized to deliver co-benefits for nature, people, and climate – contributing directly to Sustainable Development Goals (SDGs) notably; SDG 1 (No poverty), SDG 2 (Zero hunger), SDG 3 (Good health and well-being), SDG 5 (Gender Equality), SDG 6 (Clean water and sanitation), SDG7 (Affordable and Clean energy), SDG 11 (Sustainable Cities and Communities), SDG 12 (Responsible consumption and production), SDG 13 (Climate Action), SDG14 (Life below water), SDG 15 (Life on Land), and SDG 17 (Partnerships for the Goals) (United Nations, 2015)

1.3 Role of KNATCOM and the MAB Programme

This work was commissioned by the Kenya National Commission for UNESCO (KNATCOM) to provide a situational analysis of nature-based solutions (NbS) and stakeholder capacity needs within selected Kenyan biosphere reserves. Guided by the objectives of the UNESCO Man and the Biosphere (MAB) Programme, the assignment sought to assess the status of NbS implementation, map key actors, and identify opportunities for strengthening inclusive, ecosystem-based sustainable development across biosphere reserve landscapes.

The Kenya National Commission for UNESCO (KNATCOM) serves as a key liaison between the Government of Kenya and UNESCO, coordinating national efforts across education, science, culture, and sustainable development. Within the MAB framework, KNATCOM plays a strategic role as a Secretariat of the National MAB Committee, coordinates the MAB Programme in Kenya through undertaking research, documenting best practices, mapping and coordinating the nominating of potential sites as BRs, undertaking periodic reviews for BRs, regular monitoring and reporting, mobilizing stakeholders, advancing policy dialogue, mainstreaming gender and youth, and promoting interdisciplinary collaboration around biosphere reserves including local indigenous knowledge systems.

The UNESCO Man and the Biosphere (MAB) Programme, established in 1971, provides an international framework for fostering sustainable relationships between people and their environments through the designation and management of biosphere reserves (UNESCO, 2020). These reserves act as experimental grounds where conservation, research, education, and sustainable development converge – enabling both ecological preservation and community wellbeing. The programme's strategic framework is aligned with national and regional priorities (Vision 2030; GoK, 2016; GoK, 2013; GoK, 2016; Environmental Management and Coordination Act, 1999; Climate Change Act, 2016) and global priorities such as the 2030 Agenda for Sustainable Development, the Convention on Biological Diversity, and the United Nations Framework Convention on Climate Change (UNFCCC), reflecting its central role in advancing integrated, inclusive, and ecosystem-based solutions.

Additionally, KNATCOM facilitates cross-sectoral collaboration, builds institutional capacity, supports environmental education, and mobilizes policy dialogue that anchors biosphere reserve activities within national development plans (KNATCOM, 2021). By acting as a convener, facilitator, and knowledge broker, KNATCOM ensures that biosphere reserves in Kenya serve not only as biodiversity conservation landscapes but also as platforms for climate adaptation, participatory resource governance, and community-driven innovation. This is particularly critical in the context of Kenya's commitments under the National Climate Change Action Plan (2018–2022), various environment and biodiversity laws and policies framework and the post-2020 global biodiversity framework (Government of Kenya, 2018; CBD, 2020) and Sustainable Development Goals.

1.4 Rationale and Problem Statement

Biosphere reserves play a pivotal role in integrating biodiversity conservation with sustainable development and research. However, their effectiveness depends on how well communities and institutions manage ecosystem services, respond

to local threats, and apply adaptive practices such as nature-based solutions (NbS) interventions that harness natural processes to address environmental and societal challenges (IUCN, 2016; UNEP, 2021). Despite growing recognition of NbS globally, there is limited empirical understanding of how they are being implemented, institutionalized, and monitored within Kenya's biosphere reserves.

Currently, there exists a lack of structured documentation on the types, scope, and effectiveness of NbS activities across Kenya's designated biosphere reserves. While several community-led or NGO-supported projects have emerged such as tree planting, wetland restoration, agroforestry, and water catchment protection, these initiatives are often fragmented, underreported, or disconnected from broader ecological and development planning frameworks. Without a clear mapping of what NbS exists and where, policymakers, researchers, and donors face challenges in aligning national and global conservation goals with grassroots realities.

Additionally, stakeholder coordination across the biosphere reserve landscape remains inconsistent, with overlapping mandates, limited communication platforms, and uneven technical capacities among actors such as community groups, county governments, NGOs, and reserve management teams. In some areas, traditional knowledge systems remain underutilized, while in others, external interventions are poorly localized leading to low community ownership and sustainability risks (KNATCOM, 2021).

Compounding these issues is a shortage of comprehensive capacity assessments. There is inadequate understanding of the institutional gaps, skills deficits, and resource constraints that prevent stakeholders from fully participating in the design and implementation of NbS or the governance of biosphere reserves. Moreover, data on stakeholder perceptions, values, and adaptive capacities in the face of environmental degradation and climate change remains limited.

Against this backdrop, the current consultancy sought to address the following:

i) Map and document existing nature-based solutions within selected biosphere reserves in Kenya, highlighting good practices, gaps, and potential for scaling

ii) Evaluate the effectiveness, scalability, and sustainability of identified NbS in addressing conservation challenges and promoting sustainable development

iii) Assess the capacity needs of stakeholders, including local communities, reserve managers, policy agencies, and technical institutions

iv) Investigate the current involvement of women and youth, their roles, innovative approaches, good practices, success stories, challenges, and barriers in conservation activities and NbS implementation within the selected Biosphere Reserves.

v) Generate strategic insights and recommendations to support KNATCOM's efforts in enhancing the visibility, functionality, and sustainability of biosphere reserves as models for integrated development

By filling critical knowledge and coordination gaps, this consultancy supports Kenya's broader efforts to meet its commitments under the UNESCO MAB Programme, Kenya's Vision 2030, and the Post-2020 Global Biodiversity Framework, while promoting inclusive conservation and resilience-building at community and landscape levels.

The insights generated will inform KNATCOM's strategy on strengthening the implementation of the UNESCO Man and the Biosphere (MAB) Programme in Kenya and promoting cross-sectoral collaboration at national and county levels. Ultimately, the findings and recommendations will guide stakeholders in:

i. enhancing biodiversity conservation through context-specific NbS;

ii. addressing institutional fragmentation and strengthening governance;

iii. supporting community-led innovation and ecological stewardship; and

iv. aligning reserve-level activities with national and global environmental commitments, including the Post-2020 Global Biodiversity Framework, UN Decade on Ecosystem Restoration, and Kenya Vision 2030.

1.5 Objectives of the Consultancy

The general objective of this consultancy was to assess and strengthen the role of biosphere reserves in Kenya as living laboratories for sustainability by mapping nature-based solutions (NbS), identifying stakeholder capacity needs, and providing strategic recommendations for policy and programmatic action.

Specific Objectives

To achieve the general objective, the consultancy focused on the following specific goals:

i) to identify and document existing nature-based solutions (NbS) being implemented within selected biosphere reserves in Kenya, including their types, scales, community participation levels, and ecological impacts

ii) investigate the current involvement of women and youth, their roles, innovative approaches, good practices, success stories, challenges, and barriers in conservation activities and NbS implementation within the selected Biosphere Reserves;

iii) to evaluate the challenges, opportunities, and enabling conditions for scaling up NbS in line with Kenya's national development goals and global environmental commitments, including the UNESCO MAB Programme and the Post-2020 Global Biodiversity Framework; and

iv) to provide practical, context-specific recommendations for KNATCOM and its partners on enhancing coordination, capacity development, and knowledge sharing across biosphere reserves to support inclusive conservation and climate resilience.

CHAPTER TWO:

RESEARCH METHODOLOGY

2.1 Description of the Study Sites

2.1.1 Geographic Location of the Mt. Kenya–Lewa Biosphere Reserve

The Mt. Kenya–Lewa Biosphere Reserve is situated in central Kenya, straddling the equator approximately 180 km north of Nairobi. It encompasses the Mount Kenya National Park and Forest Reserve, extending northward to include the Lewa Wildlife Conservancy and the Ngare Ndare Forest Reserve. The reserve lies within the latitudinal range of approximately 0.15°S to 0.15°N and longitude 37.31°E, covering a total terrestrial area of 568,533 hectares. Mount Kenya is a volcanic massif and the second-highest peak in Africa, rising to 5,199 meters above sea level (UNESCO World Heritage Centre, n.d.). The biosphere reserve includes a wide altitudinal gradient, from Afromontane forests and bamboo zones to moorlands and alpine grasslands, transitioning into semi-arid savannahs and woodlands in the Lewa extension.

Mount Kenya National Park was established in 1949 and designated a UNESCO Biosphere Reserve in 1978. In 1997, it was inscribed as a UNESCO World Heritage Site. In 2013, the Lewa Wildlife Conservancy and Ngare Ndare Forest Reserve were officially incorporated as an extension of the Mount Kenya World Heritage Site, and also in 2019, the Biosphere Reserve was extended to include Lewa Conservancy forming the current biosphere reserve configuration. This designation reflects the area's ecological significance, including its role as a major water catchment, a biodiversity hotspot, and a migration corridor for species such as elephants and Grevy's zebras. It includes diverse zones ranging from glacier-fed rivers and highland forests to community-managed grazing lands.

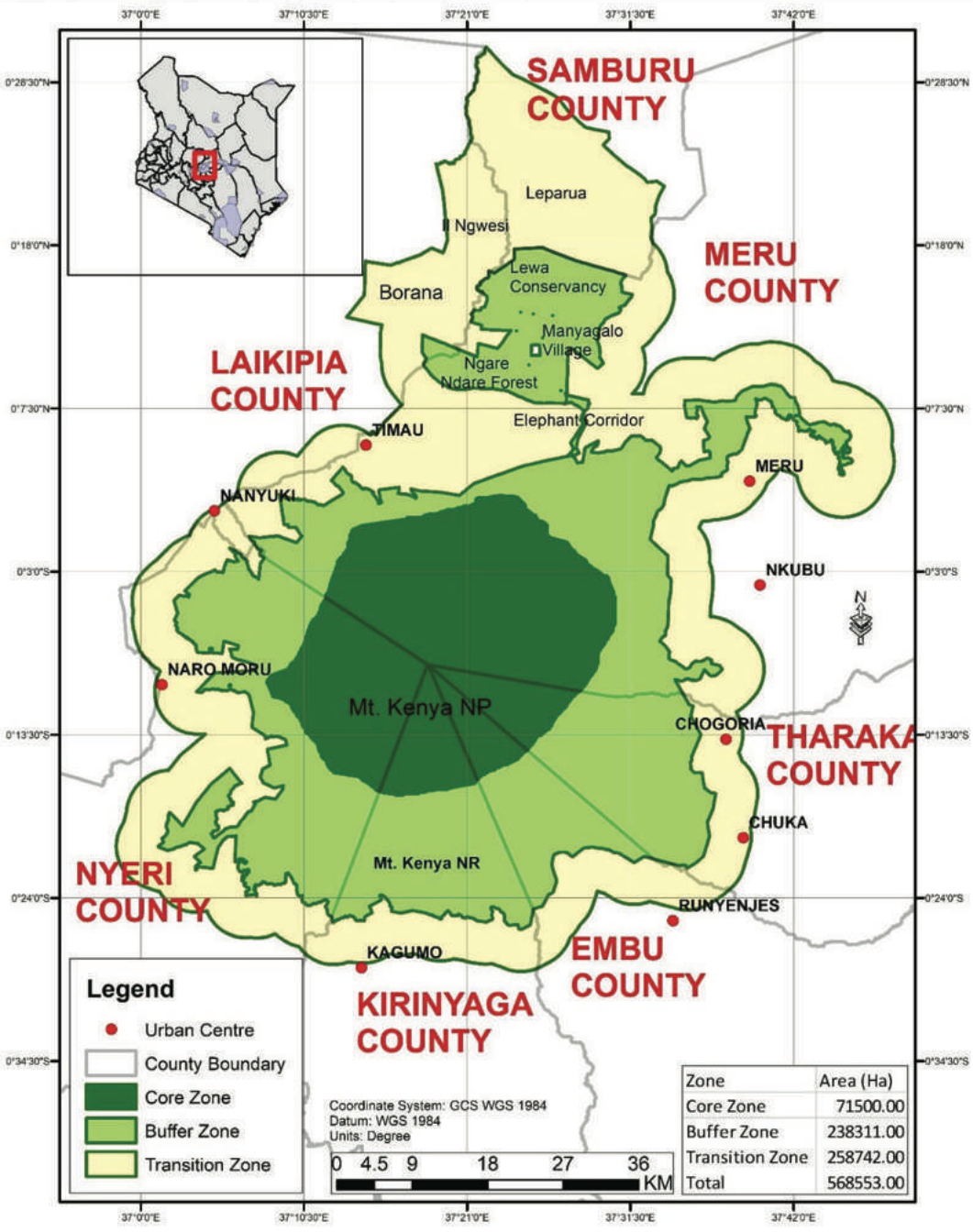

Figure 1: Map of Mount Kenya-Lewa Biosphere Reserve

2.1.2 Climatic Conditions, Vegetation and Soils at Mt. Kenya - Lewa BR

The Mt. Kenya–Lewa Biosphere Reserve experiences diverse climatic conditions due to its pronounced altitudinal range, stretching from semi-arid lowlands to cool alpine zones. The region follows a bimodal rainfall pattern, receiving long rains between March and May and short rains from October to December. Rainfall varies from approximately 1,200–2,500 mm annually in the high-altitude Mount Kenya slopes to just 400–900 mm in the drier lowlands near Lewa (UNESCO, 2023). Daytime temperatures in the Lewa Conservancy range between 24°C and 27°C, dropping to about 12°C at night, while higher zones are considerably cooler, with frost occasionally recorded above 3,000 meters (Muchena & Gachene, 1988).

Vegetation within the reserve is shaped by elevation and rainfall, producing a richly layered ecological mosaic. Moist Afromontane forests dominated by *Juniperus procera*, *Cassipourea malosana*, and *Podocarpus milanjianus* cover the lower zones (1,800–2,500 m). Bamboo belts and tree heathers such as *Arundinaria alpina* and *Erica arborea* prevail at mid-altitudes, while afro-alpine moorlands emerge above 3,200 meters, featuring species like *Hagenia abyssinica, Hypericum revolutum*, and endemic flora such as giant lobelias (UNESCO, 2023). In contrast, the Lewa and Laikipia Plateau zones support semi-arid grasslands, acacia woodlands, and bush thickets adapted to low rainfall, offering critical habitat for elephants and Grevy's zebras (Giesen et al., 2007; Green et al., 2018). The northern extension into Lewa and the Laikipia Plateau contains open woodlands, savannah grasslands, and dryland shrub vegetation, supporting species adapted to arid conditions, such as *Acacia spp*. and *Commiphora spp.*

The region's soils are primarily volcanic in origin, exhibiting both fertility and fragility across the landscape. Highland areas are dominated by deep, red nitisols – clay-rich, fertile, and ideal for agriculture and agroforestry. Mid-slopes feature porous andosols, high in organic matter but susceptible to erosion, especially when deforested (Muchena & Gachene, 1988). In the lowland areas around Lewa, vertisols and cambisols are common – shallow, stony, and with moderate fertility—supporting savannah vegetation and wildlife grazing (Nyaligu & Weeks, 2013). Given increasing pressure from land use and climate variability, sustainable soil management is essential to support both restoration and livelihoods.

2.1.3 Demographic Characteristics of the Mt. Kenya – Lewa BR

The Mt. Kenya–Lewa Biosphere Reserve is home to a diverse and dynamic population, reflecting the ecological and cultural richness of the region. According to UNESCO designation data, the reserve supports a population of approximately

1,001,561 people, distributed across highland, midland, and lowland zones surrounding Mount Kenya and extending into the Lewa Wildlife Conservancy and Ngare Ndare Forest corridor (UNESCO, 2023).

The demographic composition includes a mix of agricultural and pastoral communities, with the Kikuyu, Meru and Embu communities predominantly occupying the fertile highland and midland areas, where they engage in intensive farming, dairy production and horticulture. In contrast, the Maasai, Samburu and Borana pastoralist groups inhabit the drier northern and lowland zones, practicing livestock herding and increasingly participating in community-based conservation and ecotourism initiatives (UNESCO, 2023).

The region also hosts a growing number of settlers and conservation stakeholders, including European landowners and conservancy managers, particularly in the Lewa and Laikipia Plateau areas. These groups often collaborate with local communities through conservancy models that integrate wildlife protection with education, health, and livelihood programmes.

Population growth, land-use change, and resource competition have introduced demographic pressures, especially in buffer zones. However, the biosphere reserve's zoning framework, comprising core, buffer, and transition areas has helped manage human activity while promoting sustainable development and ecological integrity.

2.1.4 Geographic Location of the Malindi-Watamu-Arabuko Sokoke BR

The MWASBR is located along the northern coast of Kenya, within Kilifi County, approximately 110 km north of Mombasa. It spans the coastal towns of Malindi and Watamu, extending inland to include the Arabuko Sokoke Forest, the largest remaining fragment of East African coastal dry forest. The reserve lies between latitude 3°15′S and 3°30′S and longitude 39°45′E and 40°00′E, encompassing a total area of approximately 487,278 hectares following its expansion in 2019 (UNESCO, 2024). This biosphere reserve integrates a mosaic of ecosystems, including two marine national parks including Malindi and Watamu as well as mangrove forests, coral reefs, seagrass beds, coastal wetlands, and terrestrial forest habitats.

MWASBR holds protected status under UNESCO's Man and the Biosphere (MAB) Programme, having been officially designated in 1979 and later expanded to its current configuration. The reserve includes core conservation zones, buffer areas, and transition zones where sustainable human activities are permitted. Key protected areas (PAs) within the reserve include the Arabuko–Sokoke Forest

Reserve, Watamu Marine National Park, and Malindi Marine National Park, all managed in collaboration with the Kenya Forest Service (KFS) and Kenya Wildlife Service (KWS). This designation reflects the region's ecological significance as a biodiversity hotspot and its cultural importance to Indigenous communities such as the Mijikenda, Swahili, and Bajun, who contribute to the stewardship of the landscape through traditional knowledge and conservation practices (UNESCO, 2024).

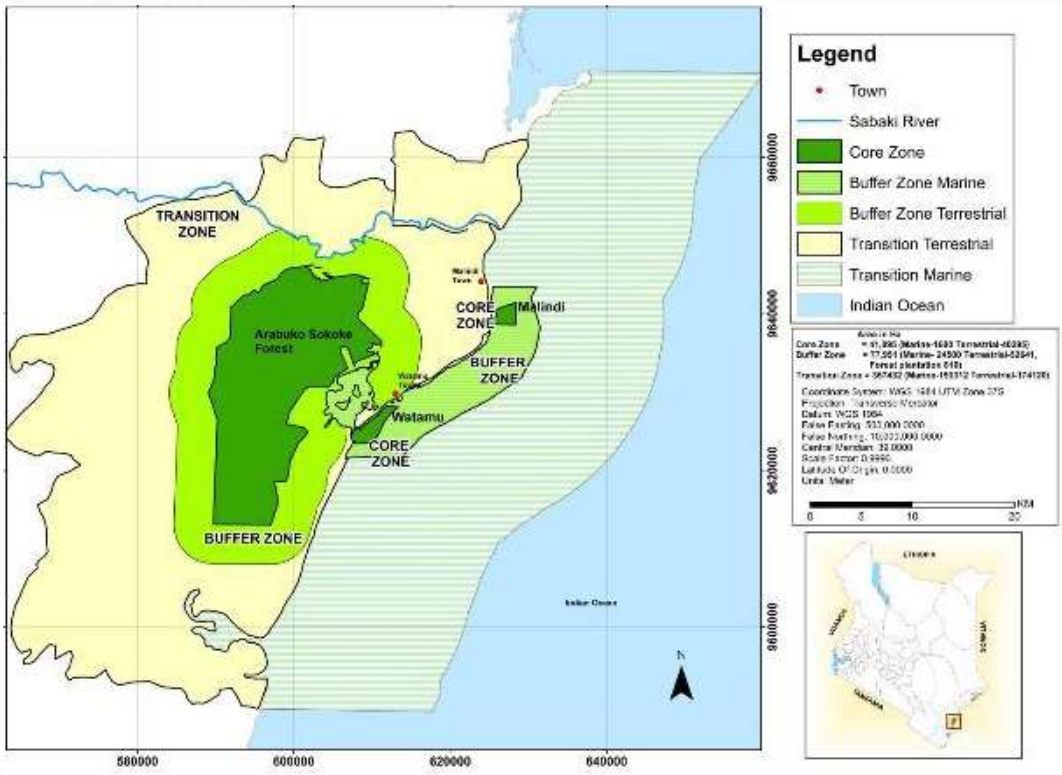

Figure 2: Map of Malindi-Watamu-Arabuko Sokoke Biosphere Reserve

The Malindi–Watamu–Arabuko Sokoke Biosphere Reserve experiences a hot and humid tropical coastal climate, moderated by strong oceanic breezes. Temperatures remain warm throughout the year, with average daytime highs ranging from 27°C to 31°C, and nighttime lows between 20°C and 24°C. The region follows a bimodal rainfall pattern, with the long rains occurring from April to May and the short rains from October to November. Annual rainfall varies between 800 mm and 1,200 mm, with the wettest months being April and May, and relatively drier conditions from December to March and June to September (Tarus et al., 2018).

Vegetation within the reserve is ecologically diverse, reflecting its mosaic of marine, coastal, and terrestrial ecosystems. The Arabuko Sokoke Forest, the largest

remaining fragment of East African coastal dry forest, is composed of three main vegetation types: *Brachystegia* woodland, *Cynometra* thicket, and mixed forest. These support a high diversity of endemic and threatened species, including the golden-rumped elephant shrew and Sokoke scops owl (Wekesa et.a., 2017). Along the Coast, mangrove forests dominate estuarine zones such as Mida Creek, with species like *Rhizophora mucronata, Avicennia marina,* and *Sonneratia alba*. The marine areas feature coral reefs, seagrass beds, and mudflats, which are critical for fish breeding, migratory birds, and shoreline protection (Nature Kenya, 2025).

Soils in the biosphere reserve vary with topography and proximity to the coast. The coastal plain is characterized by coral rag soils-light, sandy, and calcareous-derived from ancient coral reef deposits. Inland, the Magarini sands dominate the forested ridge zones, consisting of deep, red, well-drained sandy soils of Pliocene origin. These soils support the dry forest vegetation but are vulnerable to erosion and nutrient leaching if disturbed. In low-lying areas near Mida Creek and the marine parks, saline and alluvial soils occur, supporting mangrove ecosystems and seasonal wetlands (GoK, 2017)

2.1.5 Demographic Characteristics of the Malindi-Watamu-Arabuko Sokoke BR

The MWASBR is home to a culturally diverse and densely populated coastal population, with an estimated over 300,000 residents living within or adjacent to the reserve's transition and buffer zones (UNESCO, 2024). The area encompasses both urban and rural settlements, including the towns of Malindi, Watamu, and several inland villages bordering the Arabuko Sokoke Forest. The dominant ethnic groups include the Mijikenda (notably the Giriama and Chonyi subgroups), Swahili, and Bajun communities, who have historically relied on the region's marine and forest ecosystems for fishing, farming, mangrove harvesting and artisanal crafts (UNESCO, 2024; Nature Kenya, 2025).

Livelihoods are closely tied to natural resources, with many households engaged in small-scale fishing, subsistence agriculture, ecotourism, and nature-based enterprises such as butterfly farming and mangrove seedling sales. The population is characterized by high youth density, with a growing number of young people participating in conservation, guiding, and environmental education initiatives. However, the region also faces socio-economic challenges, including high poverty rates, limited access to formal employment and seasonal migration, particularly among youth seeking work in coastal tourism hubs (UNESCO, 2024).

The demographic profile of MWASBR reflects a dynamic interface between traditional ecological knowledge and modern conservation practices, making

community engagement a critical pillar of sustainable resource management. The presence of historical and cultural landmarks such as the Gede Ruins and Malindi Old Town further enriches the region's identity and underscores the importance of integrating cultural heritage into biosphere reserve planning and governance (UNESCO, 2024).

2.2 Data Collection Methods

To gather comprehensive, context-specific insights on nature-based solutions (NbS) in the biosphere reserves, this study employed a mixed-methods approach, combining both quantitative and qualitative techniques to triangulate findings and enhance validity.

2.2.1 Structured Questionnaire

A structured questionnaire was designed and administered to a broad sample of community members residing in and around the Mt. Kenya–Lewa and Malindi–Watamu–Arabuko Sokoke Biosphere Reserves, respectively. The questionnaire consisted of both closed and limited open-ended questions organised around key thematic areas, including demographic and socio-economic characteristics of respondents; types and levels of participation in NbS activities; perceived ecological changes and biodiversity outcomes; livelihood benefits derived from NbS involvement; roles of women and youth in implementation and leadership; barriers and opportunities to participation in NbS practices. Additionally, a semi-structured questionnaire was administered to key stakeholders implementing nature-based solution activities.

The instrument was pre-tested to ensure clarity, consistency, and cultural appropriateness, and subsequently refined for field deployment. Data collection was conducted face-to-face by six trained research assistants, thereby enhancing trust and response accuracy. In total, over 150 respondents were interviewed using this tool across the two biosphere reserves.

2.2.2 In-Depth Interviews with Community Members and Key Stakeholders

To complement the structured data and delve deeper into underlying dynamics, in-depth interviews were conducted with selected community members and key stakeholders identified through purposive sampling. These included local leaders, women and youth representatives, ecotourism actors, members of Community Forest Associations (CFAs), and individuals directly involved in NbS projects such as seedling nurseries, mangrove restoration, ecotourism ventures or wildlife conservation. This dual-method approach allowed the study to capture

both quantifiable patterns and lived experiences, offering a holistic view of how key stakeholders and communities perceive, engage with, and benefit from NbS initiatives.

Plate 3: Community Members filling questionnaires at MWASBR
©Gibran Maghanga

2.2.3 Desktop Review

An extensive literature review was conducted at the onset of the study to frame the research questions and guide the development of data collection tools. Peer-reviewed articles, policy documents, technical reports, and baseline assessments related to NbS, biosphere reserves, community participation, and socio-ecological resilience in Kenya and similar contexts were systematically reviewed. This process helped identify key variables and contextualise field-based findings and enrich the report within the broader regional and global evidence.

CHAPTER THREE:

RESULTS AND DISCUSSION

3.1 Communities' Livelihood Activities

3.1.1 Livelihood Activities in the Mt. Kenya–Lewa Biosphere Reserve

Livelihood patterns in the Mt. Kenya–Lewa Biosphere Reserve reflected the socio-economic reliance of local communities on land-based activities, particularly smallholder agriculture, with secondary involvement in conservation-related practices such as tree planting, tree nursery/woodlot establishment. The data collected through surveys and in-depth interviews provide valuable insights into the spectrum of local economic and environmental activities, revealing prevailing livelihood patterns while highlighting potential avenues for sustainable income generation and future resilience strategies.

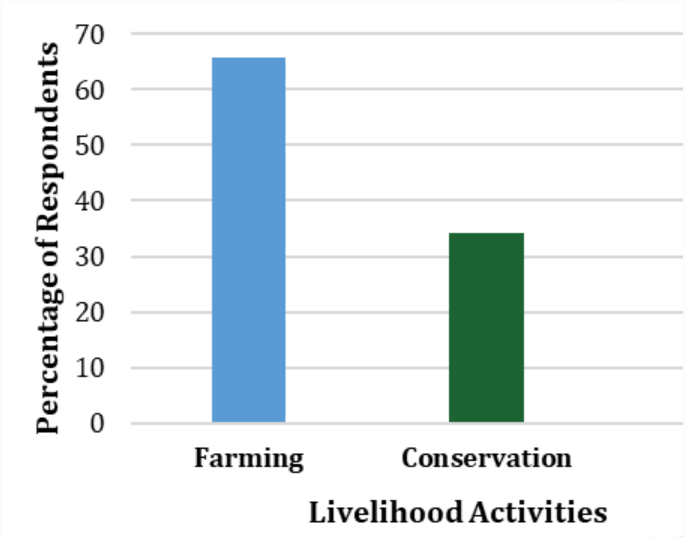

Fig. 3: Livelihood activities carried in the Mt. Kenya-Lewa Biosphere Reserve

The majority of the respondents, 66% (n = 29) reported active involvement in farming activities. This reflects the reserve's agro-ecological potential, with fertile montane soils, highland rainfall, and long-standing land use practices that support subsistence crop production (e.g., maize, potatoes, beans) and limited horticulture. The region's suitability for agriculture is well documented, with over 3,600 smallholder farmers currently supported by Lewa Wildlife Conservancy through sustainable agriculture programmes that promote organic farming, water harvesting, and climate-smart techniques (Lewa Wildlife Conservancy, 2024).

Most farmers operate on small land parcels using traditional techniques. Interviews carried out indicate that most of the respondents engage in agroforestry, integrating indigenous trees for shade, windbreaks, or soil fertility enhancement, practices that align with nature-based solutions (NbS). However, several challenges were reported by community members, including soil erosion, declining soil fertility, unpredictable rainfall patterns, lack of irrigation infrastructure, and inadequate agricultural extension services. Unpredictable rainfall patterns, as reported by the respondents in the Mt. Kenya–Lewa BR reflect broader climate change trends affecting Kenya's highland and semi-arid regions. Nying'uro et al., (2024) documents that the country is experiencing increased climate variability, with erratic rainfall, prolonged dry spells, and shifting seasons disrupting traditional farming calendars and reducing crop productivity. These changes are particularly acute in rain-fed agricultural systems, which dominate rural livelihoods in areas like Mt. Kenya–Lewa.

Plate 4: Data collection in Mt. Kenya-Lewa Biosphere Reserve

© Gibran Maghanga

A study by Nying'uro et al., (2024) highlights that climate change is undermining food security and ecosystem services across Kenya's diverse landscapes, including the central highlands. Similarly, a study by Kogo et al. (2021) found that climate variability is altering cropping patterns, reducing yields, and exacerbating vulnerability among smallholder farmers who lack access to irrigation, insurance, or adaptive technologies. These findings closely reflect the concerns raised by respondents, who identified delayed rainfall patterns, shortened growing seasons, and increased pest incidences as major challenges affecting agricultural productivity. The alignment between empirical data and lived community experiences reinforces the urgency of integrating climate adaptation strategies, particularly nature-based solutions, into biosphere reserve management and rural development planning. Without such measures, these climate-related constraints are likely to continue thus undermining communities' farming resilience and long-term sustainability.

Moreover, 34 % of the respondents (n = 15) indicated participation in conservation-related initiatives. These included tree planting, tree nursery establishment and management, soil erosion control, agro-forestry and involvement in local environmental committees such as Community Forest Associations (CFAs), Water Resource Users Associations (WRUAs) and partnerships with NGOs like Mt. Kenya Trust. Many of these efforts are supported by government agencies such as the Kenya Forest Service and Kenya Wildlife Service, and conservation organisations operating in the buffer and transition zones of the biosphere reserve. Conservation participation often overlapped with farming, with households practising sustainable land-use. Respondents expressed both a sense of ecological responsibility and recognition of Mt. Kenya's role as a critical water catchment, and a key contributor to climate change mitigation, particularly through carbon sequestration and microclimate regulation, thus underscoring its significance as a critical resource in supporting their livelihood activities

While most local respondents interviewed were not directly engaged in tourism-related activities, they acknowledged the presence of several small-scale tourism operators operating within the region. One key stakeholder, the Mount Kenya Guides and Porters Club, a community-based organisation emphasized the vast untapped potential of the Mount Kenya–Lewa Biosphere Reserve in expanding ecotourism offerings. The organisation currently provides a range of tourism services, including mountain climbing and guiding, porter services, and home-stay accommodations, all of which contribute significantly to local employment generation and community empowerment. By leveraging cultural heritage and ecological diversity, such initiatives not only stimulate green job creation but also enhance the social capital and economic resilience of surrounding communities.

These findings echo broader scholarship recognising biosphere reserves as viable platforms for sustainable tourism and livelihood diversification. According to Reed (2018), BRs provide an enabling environment for community-driven enterprises that reconcile conservation with socioeconomic development. Ecotourism, when strategically embedded in BR management, has been shown to reduce reliance on extractive activities and foster environmental stewardship (Mayer et al., 2019). Additionally, aligning tourism with nature-based solutions contributes to climate adaptation by promoting low-carbon pathways, preserving biodiversity, and supporting SDG targets, particularly SDG 8 (Decent Work and Economic Growth), SDG 13 (Climate Action), and SDG 15 (Life on Land). Unlocking this latent potential will require targeted investment, capacity building, and integrated governance frameworks that place local communities at the heart of biosphere reserve tourism planning and benefit-sharing mechanisms.

3.1.2 Livelihood Activities in the Malindi-Watamu-Arabuko Sokoke BR

The MWASBR presents a diverse coastal socio-ecological system where communities engage in a blend of marine, forest-based, and land-based livelihoods. Based on responses from 117 local community members, the most commonly reported livelihood activities included farming with 28% of respondents (n = 49), tourism, ~28% (n = 48), conservation work, 22% (n = 38), and fishing, 22% (n = 38). Importantly, many respondents indicated participation in multiple sectors simultaneously, underscoring the region's dynamic and diversified socio-economic landscape. This multifunctionality reflects the complexity of rural livelihoods and aligns with documented patterns of diversified engagement within biosphere reserves globally (Reed, 2018). The diversity of activities is closely linked to the biosphere reserve's ecological richness, spanning coral reefs, mangrove forests and the Arabuko Sokoke Forest, and its proximity to the Indian Ocean, which sustains both marine-based livelihoods and ecotourism enterprises.

Plate 5: Local community displaying souvenirs made from local materials
© Belinda Anyango

Farming and Fishing: Dual Pillars of Coastal Livelihoods

Farming remains a key livelihood, with 28% of respondents (n = 49) engaged in small-scale agriculture. Crops grown include cassava, maize and coconuts, often grown in sandy or saline-prone soils. However, productivity is constrained by land degradation, saltwater intrusion, and erratic rainfall, challenges exacerbated by climate change and coastal development pressures (UNESCO, 2024). Fishing, practised by 22% of respondents (n = 38) is central to household income and food security. Communities rely on nearshore fisheries, mangrove estuaries, and reef ecosystems. However, overfishing, coral bleaching, and gear conflicts have reduced fish stocks and increased vulnerability (Nature Kenya, 2025; UNESCO, 2024).

Plate 6: Mangrove honey From Mida Creek
© Brian Waswala

Tourism and Conservation

Tourism is practised by 28% of the respondents (n = 48), reflecting the reserve's role as a hub for ecotourism, marine excursions, and cultural heritage. Local initiatives such as butterfly farming, mangrove boardwalks, and community-run eco-lodges offer alternative income streams while promoting conservation awareness (UNESCO, 2024).

Plate 7: Camp Gedeng in MWASBR Kilifi County and Mida Creek boardwalk
© Gibran Maghanga / George Eshiamwata

Conservation-related activities, reported by 22% of the respondents (n =38), include mangrove planting, beach clean-ups, turtle monitoring and participation in community-based organisations like the Mida Creek Conservation and Awareness Group, Sabaki River Conservation and Development Organisation (SARICODO) and Friends of Arabuko Sokoke Forest. These efforts are often supported by NGOs and government agencies such as KWS and KFS, but face funding and coordination challenges (NatureKenya, 2025).

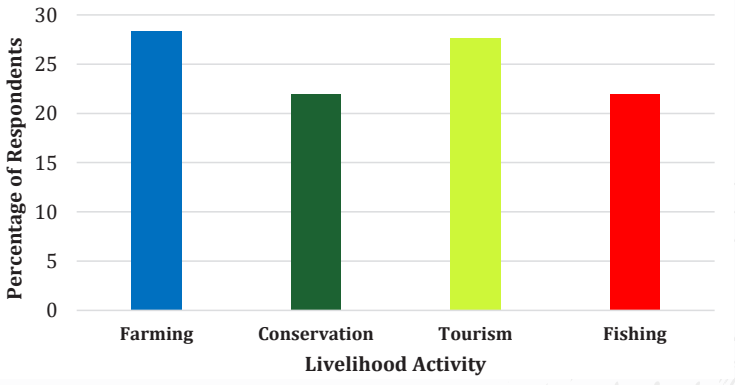

Fig. 4: Livelihood activities carried out in Malindi-Watamu-Arabuko Sokoke Biosphere Reserve

3.1.3 Comparative Analysis: Mt. Kenya-Lewa vs. Malindi-Watamu-Arabuko Sokoke BRs

Key Insights:

Farming is dominant in transition zones of both reserves but more prevalent in Mt. Kenya–Lewa, where it is the primary livelihood due to fertile highland soils and rain-fed agriculture

Tourism and fishing are absent in Mt. Kenya–Lewa but highly significant in MWASBR, reflecting the coastal ecosystem's marine and ecotourism potential, and demonstrating the need for scaling up efforts for increased involvement of Mount Kenya-Lewa communities in investing in tourism ventures and enterprises.

Conservation participation is comparable across both sites, though the nature of engagement differs, forest and water catchment protection in Mt. Kenya–Lewa versus mangrove and marine conservation in MWASBR.

Plate 8: NbS promote co-existence between people and nature
© Jacqueliene Kariithi

Conclusion

The comparison reveals how ecological context shapes livelihood strategies: Mt. Kenya–Lewa communities rely heavily on land-based farming, while MWASBR communities diversify across marine, agriculture, tourism and conservation-linked activities. These insights underscore the need for site-specific nature-based

solutions and livelihood support programmes that reflect local ecosystems and economic realities.

3.2 Nature-based Solutions (NbS)

3.2.1 Terrestrial Restoration

Nearly all respondents from Mt. Kenya–Lewa Biosphere Reserve, 96% (n = 45) reported participation in reforestation as a form of nature-based solution, indicating that the communities in the Biosphere Reserve are strongly engaged in restoring degraded forest ecosystems. These efforts align with national priorities under Kenya's Forest Restoration Strategy, which promotes participatory forest management (PFM) through Community Forest Associations (CFAs) and tree nursery projects to reverse biodiversity loss and enhance carbon sequestration (Ministry of Environment & Forestry, 2020). Furthermore, 83% of respondents (n=39) reported active engagement in tree nursery establishment and management, focusing on the production of indigenous and agroforestry seedlings. These nurseries play a dual role; ecological and economic function, thus supporting localized reforestation and afforestation initiatives while serving as a source of income through the commercial sale of seedlings. These efforts are aligned to Kenya's President Directive and National Tree Growing Restoration Campaign to plant 15 billion trees by 2032 and the role of communities in achieving this target. In addition, these efforts are also consistent with the UN Decade for Ecosystem Restoration (2021-2030). Within the IUCN typology of nature-based Solutions, such practices fall under ecosystem restoration and sustainable land management, particularly agroforestry and assisted natural regeneration (IUCN, 2020). Agroforestry, in particular, is recognised as a multifunctional NbS that enhances biodiversity, improves soil health, and increases climate resilience while supporting rural livelihoods (Mosquera-Losada et al., 2019; UNEP, 2019).

In the African context, agroforestry-based nurseries have been identified as critical for climate adaptation and livelihood diversification. For example, Wekesa (2020) documents how commercial tree nurseries in Kenya's drylands not only supply millions of seedlings annually but also promote community-based adaptation through organic composting (e.g., use of compost-based potting media), water harvesting, and farmer training. These nurseries exemplify NbS that are locally tailored, socially inclusive, and ecologically restorative, aligning with the IUCN Global Standard's emphasis on co-benefits and adaptive governance (IUCN, 2020; GCA, 2023). As such, community-led nursery enterprises represent a scalable NbS typology that bridges ecological restoration with green economy transitions.

Plate 9: Rehabilitating mangrove Forest ©Willys Osore

These findings reflect the significance of land-based restoration in Mt. Kenya–Lewa Biosphere Reserve, where forest degradation and soil erosion remain persistent environmental concerns. The prominence of agroforestry in Mt. Kenya–Lewa aligns with widespread adoption of agroforestry where farmers integrate trees such as Grevillea robusta, Calliandra sp, and fruit trees into their farms to improve soil health, provide fodder, diversify income and enhance climate resilience. This practice aligns with initiatives such as the Trees Establishment Livelihood Improvement Scheme (TELIS), which encourages farmers to incorporate species like Grevillea robusta, Calliandra sp and various fruit trees into their farming landscapes to restore degraded forest margins while supporting livelihoods (Mount Kenya Trust, 2024). This is also consistent with the Plantation Establishment and Livelihood Improvement Scheme (PELIS), a participatory forest management initiative implemented by the Kenya Forest Service (KFS) since 2007 and which integrates tree planting with short-term crop cultivation to enhance both forest regeneration and community livelihoods. By coupling indigenous tree planting with food crop production, TELIS promotes rehabilitation of degraded forest margins while simultaneously improving fodder availability, diversifying household incomes, and strengthening local food security (Mount Kenya Trust, 2024). As a locally grounded Nature-based Solution (NbS), TELIS exemplifies

how tree-based farming systems contribute to ecosystem restoration, economic resilience, and sustainable development within biosphere reserve contexts.

Plate 10: Community udertaking Mangrove restoration at one of the sites ©Willys Osore

In Malindi–Watamu–Arabuko Sokoke Biosphere Reserve, reforestation engagement, 67% (n = 41) and tree nursery establishment, 64% (n = 39) is also widespread, showing that terrestrial NbS are important even in coastal zones. However, agroforestry appears significantly more practiced in Mt. Kenya–Lewa (53%) compared to Malindi–Watamu–Arabuko Sokoke (13%), likely due to differences in soil profiles, rainfall, and agricultural land tenure. Agroforestry is especially critical in upland areas where it supports food production while stabilising soil and enhancing ecosystem resilience (FAO, 2021).

3.2.2 Marine and Coastal Restoration

Marine and coastal NbS are a defining feature of the Malindi–Watamu–Arabuko Sokoke Biosphere Reserve, with over half of respondents, 51% (n = 31) engaged in mangrove restoration. Community-based mangrove restoration has been widely adopted in Mida Creek and Gazi Bay, supported by NGOs and government agencies like the Kenya Forest Service (KFS) and Kenya Marine and Fisheries Research Institute (KMFRI). According to a study by Eshiamwata et al., (2025), there are various objectives and motivations driving communities to engage in mangrove restoration along the Kenya Coast. According to this study, these include environmental protection, community development, climate change mitigation, legislative compliance, corporate social responsibility, income generation, among other factors. Mangrove forests in Mida Creek and Arabuko Sokoke provide crucial services including shoreline stabilisation, nursery habitats for fish, carbon sequestration, fuelwood resources and cultural value to coastal communities. These ecosystems act as natural buffers against coastal erosion and storm surges,

especially during high tides and extreme weather events. They also support rich biodiversity providing breeding grounds for crustaceans, fish and migratory birds while filtering pollutants and improving water quality.

For local residents, mangroves offer sources of income through sustainable harvesting of firewood, honey production and the sale of seedlings. Additionally, mangroves hold cultural and spiritual significance for the Mijikenda community, reinforcing their value beyond ecological metrics (Nature Kenya 2021). Further, their restoration has been shown to improve fishery yields and reduce coastal vulnerability to climate change (Kiprono, 2021).

Plate 11: A thriving commmunity-led mangrove restoration plot
© George Eshiamwata

Furthermore, community participation in mangrove restoration within the Malindi–Watamu–Arabuko Sokoke Biosphere Reserve aligns with the Community-Based Ecological Mangrove Restoration (CBEMR) model, which emphasizes natural regeneration, hydrological restoration, and local stewardship (Wetlands International, 2022). As a recognized typology of nature-based Solutions (NbS), CBEMR contributes to climate change adaptation by enhancing coastal resilience, reducing erosion and sequestering carbon as mangroves store up to five times more carbon than other forest ecosystems (MAP & Wetlands International, 2024).

The approach also supports sustainable development by integrating ecological

restoration with livelihood opportunities, such as ecotourism, sustainable fisheries and mangrove-based enterprises. Critically, CBEMR restoration fosters community resilience by empowering local actors, especially women and youth, to lead restoration efforts, apply indigenous knowledge, and co-manage natural resources. This participatory model reflects the IUCN Global Standard for NbS, which calls for inclusive governance, long-term sustainability and measurable co-benefits for both people and nature (IUCN, 2020). In Kenya, CBEMR has been successfully piloted in Lamu and Tana River counties, demonstrating its scalability and relevance to biosphere reserve management and SDG targets, particularly SDG 13 (Climate Action), SDG 14 (Life Below Water), and SDG 15 (Life on Land)

Plate 12: NbS provide seedlings to be used for restoration purposes but earn income for communities
© George Eshiamwata

In contrast, Mt. Kenya–Lewa respondents reported no engagement in these activities, reflecting their inland context. This stark contrast underscores the site-specific relevance of NbS and the importance of tailoring community support to ecosystem type.

Though less frequently reported, some respondents are involved in wildlife/ biodiversity conservation and in maintaining wildlife corridors that connect Mt. Kenya Biosphere Reserve to Lewa and other neighbouring conservancies. These corridors reduce human-wildlife conflict and support species like elephants and Grevy's zebra to move and maximise the use of the landscape during seasonal variations in weather and other ecological processes (e.g. breeding, altitudinal migration). Wildlife conservation and corridor protection is increasingly embedded in land-use planning through conservancies and partnerships with KWS and Lewa Trust (KWS, 2017).

In Malindi–Watamu–Arabuko Sokoke site, initiatives such as bird monitoring and wildlife conservation were reported by a few respondents. These initiatives are supported by Important Bird Area (IBA) campaigns and community-based tourism projects. For instance, the Arabuko Sokoke Forest is Kenya's largest coastal forest and one of the most globally significant IBA bird habitats, home to endangered species like Clarke's weaver and Sokoke scops owl (BirdLife International, 2023).

A few respondents reported no engagement in any NbS (Malindi-Watamu-Arabuko Sokoke, 30%; n = 18 respondents; Mt. Kenya-Lewa, 21%; n = 10 respondents). These figures highlight barriers to entry for some community members such as lack of awareness, limited training or exclusion from formal programmes with high illiteracy levels or challenges associated with land ownership. This calls for more inclusive NbS strategies, with targeted outreach for women, youth and marginalized groups who might be underrepresented in decision-making structures (UNEP, 2022).

Further, nature-based Solutions have evolved into dynamic livelihood strategies that blend conservation with enterprise. Malindi-Watamu-Arabuko Sokoke and Mt. Kenya–Lewa biosphere reserves showcases other community-led initiatives such as apiculture, crab farming, butterfly farming and water sports, which not only generate income but also incentivize the protection of mangrove ecosystems and forest enclaves (UNESCO, 2024). Similarly, Mt. Kenya–Lewa has embraced NbS through trout farming, apiculture, and ecotourism activities like water sports, all of which depend on healthy forested catchments and sustained hydrological systems (Alando, 2022). These interventions reflect a growing recognition that biodiversity conservation and climate resilience can be achieved through locally adapted, economically viable practices that reinforce community stewardship and ecological integrity (Cohen-Shacham et al., 2016).

In conclusion, the findings for nature-based solutions practiced shows clear thematic and ecological distinctions in that, Mt. Kenya–Lewa is anchored in land-based restoration, showcasing momentum in agroforestry and highland

reforestation efforts. On the other hand, Malindi–Watamu–Arabuko Sokoke Biosphere Reserve thrives through marine and coastal NbS, with strong community participation in mangrove restoration and integrated coastal management. Both sites contribute to Kenya's Nationally Determined Contributions (NDCs) under the Paris Climate Agreement, 2015, which prioritises ecosystem restoration and community participation in climate action. The findings also reflect the broader trend across developing countries of scaling NbS as a cost-effective, inclusive development pathway (Seddon et al., 2021).

3.4 Community Participation in Nature-based Solutions

Local communities are actively engaged in NbS activities in both biosphere reserves, although there is a slight variation between the two sites in regard to the level of participation (Fig 11). At Mt. Kenya–Lewa Biosphere Reserve, community participation is exceptionally high, with all respondents, 100%, (n = 44), indicating "high" level of participation in NbS. Respondents indicated regular involvement in NbS activities, often weekly, depending on the nature of the intervention. For instance, tree nursery establishment and reforestation are practised year-round, with intensified efforts occurring almost weekly during the long and short rainy seasons. Further, agroforestry is deeply embedded into daily farming routines, as farmers maintain woodlots, hedgerows and intercropped trees to enhance soil fertility, provide fodder and support overall farm resilience.

Plate 13: MAB Youth at Malindi-Watamu-Arabuko have a platform to participate in NbS initiatives
©Azani Ngumbao

The high level of participation and uniformity shows a well-integrated approach to NbS, likely underpinned by strong institutional frameworks, significant presence of NGOs and conservation organisations (e.g., Lewa Wildlife Conservancy, Mt. Kenya Trust, Kenya Forest Service, Kenya Wildlife Service) operating in the region, and long-standing conservation partnerships coupled with reserve dependence

and tangible livelihood benefits tied to environmental stewardship. The NGOs, government agencies and other actors often run community empowerment programs, support sustainable livelihoods, and involve local stakeholders in planning and implementation, thereby fostering trust, shared ownership, and long-term commitment to NbS interventions.

Organized community groups such as CBOs, MAB Youth Forum, faith-based groups, women groups and schools have the potential to fully engage, contribute and scale up succesful NbS implementation within Bioshere Reserves and other landscapes.

Studies consistently show that community participation is a cornerstone of successful NbS implementation. According to Cárdenas et al., (2021), over 75% of participants in a global study reported increased motivation and environmental awareness after engaging in NbS activities, especially when citizen science was involved. This aligns with the high participation seen in both sites, particularly Mt. Kenya – Lewa Biosphere Reserve.

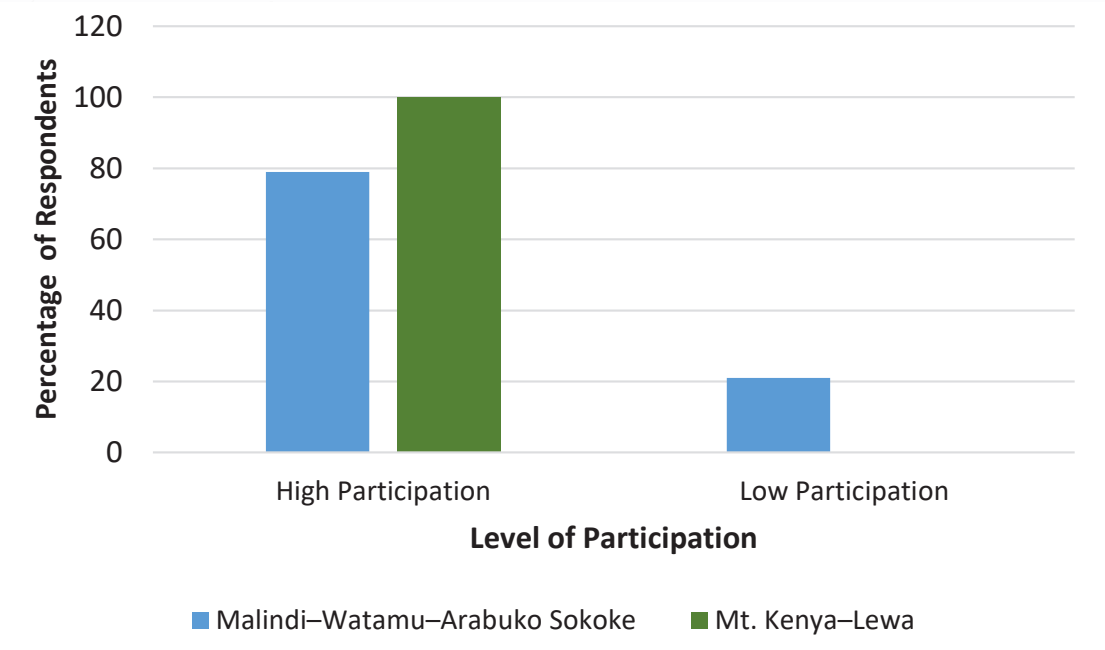

Fig. 5: Communities Levels of Participation in the Two Biosphere Reserves

In Malindi–Watamu–Arabuko Sokoke Reserve, the site exhibits more varied levels of engagement. Approximately 79% of the respondents (n = 48) reported "high" participation in NbS, while 21% (n = 13) indicated "low" participation (Fig 11). While the majority demonstrates robust involvement in NbS activities, the presence

of a notable minority expressing low participation suggests underlying disparities. These may stem from socio-economic differences or diversity, where coastal communities may have competing livelihood priorities (e.g., fishing, tourism) that affect their involvement, and perceived trade-offs between conservation efforts and resource-based livelihoods such as fishing or tourism. Additionally, the fact that this Biosphere Reserve is in an urbanized and cosmopolitan landscape may partly explain the observed trends.

Further, insufficient access to participatory platforms, culture, environmental factors, decision-making and low awareness of the NbS could contribute to this variation in participation. According to Puskás et al. (2021), some NbS projects operate at the level of consultation or partnership, with few achieving delegated power or citizen control and thus, such disparities are common in NbS projects where participation is restricted to consultation rather than shared decision-making. The variation in responses points to a need for more targeted engagement strategies that consider the diverse needs and perceptions of community members, ensuring equitable participation across all stakeholder groups.

3.4.1. NbS Biodiversity Indicators and Changes

Mt. Kenya–Lewa Biosphere Reserve exhibited consistently strong ecological outcomes. The most prominent change was reforestation and tree cover increase (25%), which aligned with 100% community participation in tree planting, agroforestry and nursery tree establishment and management. This was closely followed by improvements in habitat, environmental protection and ecosystem function (23%), outcomes influenced by integrated landscape restoration efforts supported by government institutions, NGOs and other local actors such as the Lewa Wildlife Conservancy, Mount Kenya Trust among others.

Figure 6 shows community-reported ecological changes across the two biosphere reserves, showing both shared outcomes and site-specific patterns of impact resulting from nature-based solutions.

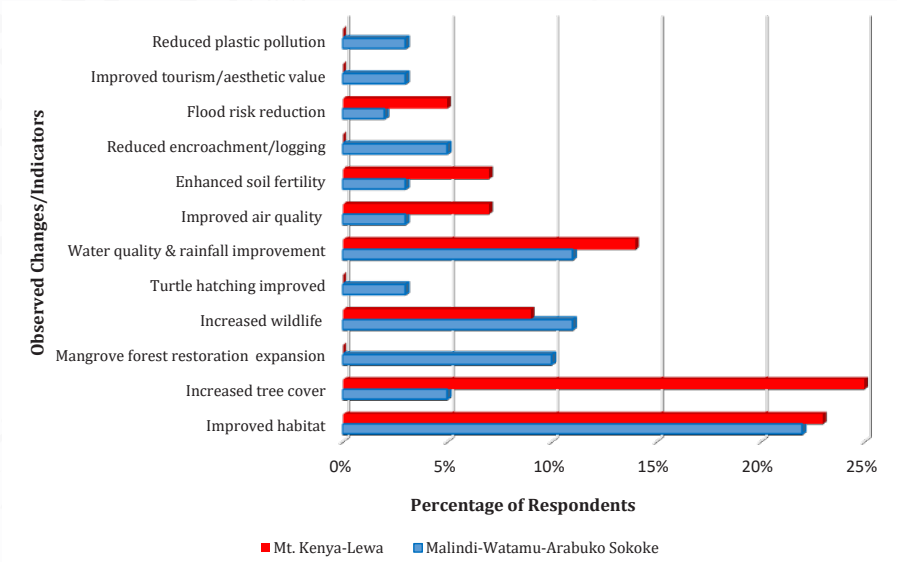

Fig. 6: Ecological Changes Linked to NbS Implementation as observed by local communities

The ecological outcomes reported in the Malindi–Watamu–Arabuko Sokoke Biosphere Reserve, despite slightly lower community participation (79%) compared to Mt. Kenya–Lewa BR, reflects the transformative potential of nature-based solutions (NbS) in coastal and marine landscapes. Gains such as reduced plastic pollution, improved habitat quality, biodiversity recovery and mangrove restoration align closely with NbS typologies focused on ecosystem restoration, pollution control and climate resilience (IUCN, 2020). These outcomes are particularly evident in community-led initiatives within MWASBR, where local groups such as the Mida Creek Conservation and Awareness Group and Friends of Arabuko Sokoke Forest have spearheaded mangrove planting, beach clean-ups and biodiversity monitoring.

Plate 14: NbS provide breeding habitats for species
© George Eshiamwata

Such interventions contribute directly to climate change adaptation by enhancing carbon sequestration, buffering against coastal erosion, and restoring critical habitats for migratory birds and marine life (MAP & Wetlands International, 2024). Moreover, these NbS interventions support sustainable development by generating green jobs, promoting ecotourism and improving fisheries productivity which are vital livelihood pillars for Coastal communities. These efforts also reinforce community resilience by integrating indigenous knowledge, fostering environmental stewardship and diversifying income sources, consistent with SDG targets such as SDG 13 (Climate Action), SDG 14 (Life Below Water) and SDG 15 (Life on Land) (UNEP, 2024). In essence, the MWASBR case illustrates how locally driven NbS can yield multidimensional benefits: ecological, economic and social, when embedded within inclusive governance and supported by long-term restoration strategies.

Plate 15: Plastic bottle collection point in MWASBR
© Belinda Anyango

Respondents in both reserves reported improved water quality and rainfall patterns (11% in MWASBR and 14% in Mt. Kenya-Lewa), indicating that the observed/experienced ecological improvements across both the Malindi–Watamu–Arabuko Sokoke and Mt. Kenya–Lewa Biosphere Reserve (BR) underscore the effectiveness of landscape-scale nature-based solutions (NbS) in enhancing hydrological resilience and ecosystem functionality. The NbS interventions such as reforestation, agroforestry and mangrove restoration are positively influencing local hydrological cycles, an outcome consistent with NbS literature that highlights improved infiltration, reduced runoff, and enhanced groundwater recharge as key benefits of ecosystem-based water management (Granata & Di Nunno, 2025; UNEP-DHI, 2018).

The Mt. Kenya–Lewa BR's higher perceived improvements in air quality and soil fertility (7% each) can be attributed to increased tree cover and agroforestry practices, which align with NbS typologies focused on sustainable land management and climate mitigation. These interventions not only sequester carbon and filter airborne pollutants but also enrich soil organic matter, reduce erosion and support crop productivity, contributing to both climate adaptation and sustainable development goals (IUCN, 2020; UNEP, 2024).

Notably, MWASBR's site-specific ecological changes such as turtle nesting success (3%), aesthetic enhancements (3%) and plastic pollution reduction (3%) reflect the unique role of coastal and marine NbS in supporting biodiversity and ecotourism. Community-led beach clean-ups, mangrove restoration and marine habitat protection in MWASBR have been shown to improve nesting conditions for endangered species, enhance scenic value, and reduce marine debris, thereby strengthening both livelihoods and conservation outcomes (Wetlands International, 2022; Ocean & Climate Platform, 2021). These efforts contribute to community resilience by fostering environmental stewardship, generating green jobs, and diversifying income through nature-based tourism.

These findings strongly reinforce the correlation between high levels of community participation in nature-based solutions (NbS) and the breadth and depth of perceived ecological benefits. In both the Mt. Kenya–Lewa and Malindi–Watamu–Arabuko Sokoke Biosphere Reserves (BRs), communities that were actively engaged in NbS activities reported more frequent and diverse improvements, including enhanced biodiversity, better water and air quality, and restored habitats, thus underscoring the pivotal role of local stewardship in driving environmental regeneration. This aligns with the core function of biosphere reserves as platforms for participatory conservation and sustainable development, research, education and monitoring where community-led initiatives are not only encouraged but essential for long-term success (UNESCO, 2017; Reed, 2018).

The observed outcomes also reflect the broader potential of NbS to address climate change and support resilient livelihoods. By integrating indigenous knowledge, promoting inclusive governance and fostering co-benefits such as green jobs and food security, community-driven NbS contribute directly to SDG targets including SDG 13 (Climate Action), SDG 15 (Life on Land), and SDG 6 (Clean Water and Sanitation). As highlighted by Puskás et al., (2021), a review of over 100 NbS projects revealed that deeper levels of community involvement, particularly those reaching "citizen control" were rare but consistently associated with stronger ecological and social outcomes. These projects demonstrated enhanced biodiversity, improved ecosystem services and greater social cohesion, suggesting that empowerment and co-ownership are critical for transformative change.

In the context of Kenya's biosphere reserves, these insights affirm that scaling NbS requires not only technical interventions but also robust community engagement frameworks. Empowering local actors to co-design, implement and monitor NbS ensures that solutions are contextually grounded, socially accepted and ecologically effective, which are hallmarks of resilient and sustainable landscapes.

3.5 Social-Economic Benefits from Nature-based Solutions

3.5.1. Source of Employment and Income

Community participation in nature-based solutions (NbS) across the biosphere reserves has emerged as a notable driver of employment and income diversification. A substantial number of respondents, approximately 60% identified their involvement in NbS initiatives ranging from reforestation and seedling production to mangrove restoration and ecotourism, as a vital source of livelihood. In many cases, respondents reported gaining paid opportunities as tour guides, scouts or conservation casuals (e.g. tree planting, nursery establishment etc.) particularly in areas where forest and marine resources draw domestic and international visitors.

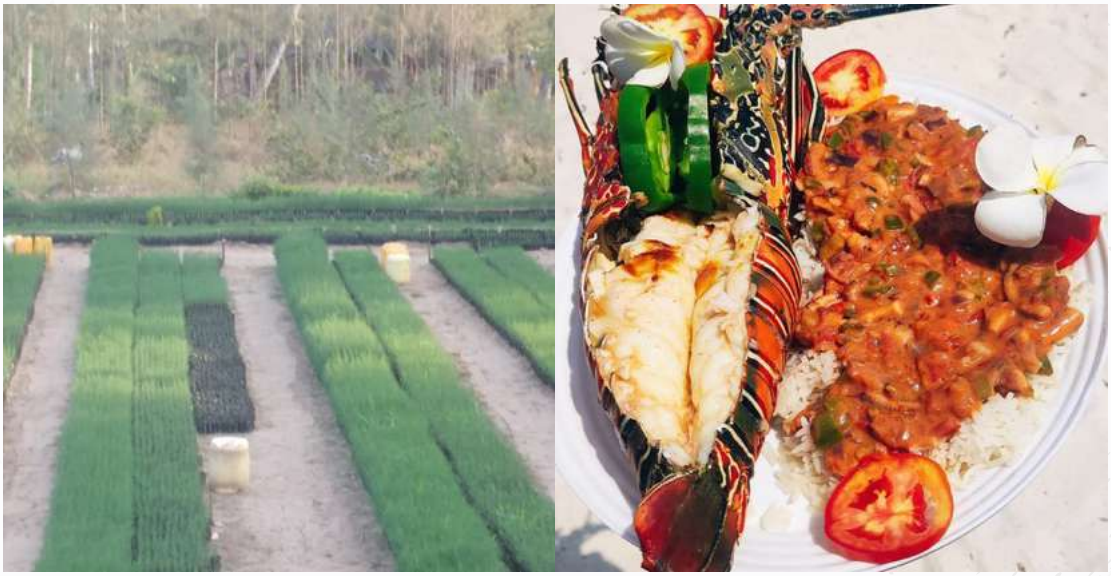

Plate 16: (a) Tree nurseries and (b) sea food platter
© George Eshiamwata / Azani Ngumbao

Ecotourism activities such as guiding nature walks, hosting cultural exchange experiences and offering home-stay accommodations emerged as some of the most consistent income-generating pathways directly linked to nature-based Solutions particularly in coastal communities. These initiatives not only promote

environmental awareness but also create green jobs that support conservation and community well-being. In the Mt. Kenya–Lewa landscape, small-scale tourism operators similarly contribute to local employment and livelihoods, with residents employed as porters, guides and food suppliers (e.g., fresh vegetables, fruits, milk, etc) and service providers, roles that reinforce the biosphere reserve's function as a platform for sustainable development and inclusive economic growth.

Beyond tourism, community members engaged in agroforestry and nursery enterprises reported stable revenue from the sale of indigenous and agroforestry seedlings. These activities exemplify NbS typologies focused on ecosystem restoration and sustainable land management, offering co-benefits such as improved soil health, biodiversity enhancement and diversified income streams (IUCN, 2020; Mosquera-Losada et al., 2019). Biosphere reserves (BRs), by design, facilitate such integrated approaches through their zonation model and participatory governance structures, enabling communities to co-produce knowledge and co-manage resources in ways that strengthen climate resilience and social equity (Reed, 2018; UNESCO, 2023).

Plate 17: (a) Students involved in a tree planting exercise (b) local tour guides providing services to tourists
© Brian Waswala/ Evans Wahome

Collectively, these livelihood pathways demonstrate how NbS within BRs can serve as engines for nature-positive economies, aligning with key Sustainable Development Goals (SDGs) – including SDG 8 (Decent Work and Economic Growth), SDG 13 (Climate Action), and SDG 15 (Life on Land). When supported by inclusive policies and long-term investment, such community-led NbS can transform biosphere reserves into hubs of ecological regeneration and socioeconomic empowerment.

The economic gains reported across both biosphere reserves were not limited to individual beneficiaries but extended meaningfully to household-level improvements. Income generated through nature-based solutions such as ecotourism, agroforestry and nursery enterprises was reinvested in education, housing and livestock acquisition (Table 1), demonstrating ripple effects on broader standards of living and long-term well-being. This pattern reflects the capacity of NbS to serve as engines of inclusive economic development, particularly within Biosphere Reserves (BRs), which are designed to integrate conservation with sustainable livelihoods through participatory governance and spatially differentiated land use. In regions historically marginalised from formal employment markets, such as Coastal and upland communities in Kenya, NbS offer context-sensitive pathways to climate resilience and poverty reduction.

These findings align with global evidence showing that well-designed NbS can deliver high economic multipliers, diversify income sources and stimulate local economies, especially when community involvement is central to their design and implementation (Chausson et al., 2024; Oxford Biodiversity Network, 2024). For example, NbS projects in sub-Saharan Africa have demonstrated how nature-based food production, ecotourism and restoration activities contribute to household resilience by enabling reinvestment in productive assets and human capital (Vicarelli et al., 2025). When embedded within BR frameworks, such initiatives not only enhance ecological integrity but also advance Sustainable Development Goals (SDGs).

Table 1: Livelihood Outcomes from NbS

Livelihood Impact Area	**% of Respondents (approx.)**
School fees payment	60
House building/improvement/renovation	40
Asset and or livestock purchase (e.g. motorcycles, bicycles, land	26
Reported no improvement	8

Note: Many respondents listed more than one role, hence totals exceed 100%

3.5.2 Women and Youth Involvement in Nature-based Solutions

Women and youth play a pivotal role in the implementation and success of nature-based solutions (NbS), contributing innovation, site-based knowledge and local leadership that strengthens community-led environmental action (IUCN, 2020). Across Kenya's biosphere reserves, they serve as frontline stewards of natural resources, spearheading reforestation efforts, managing tree nurseries, restoring mangroves and championing eco-entrepreneurship initiatives. Such contributions have shown to significantly improve ecological outcomes while promoting inclusive governance, livelihood diversification and social equity (UNESCO, 2017; Reed, 2018).

Table 2: Women and Youth Involvement in NbS Activities

Role Category	% Frequency	Examples
Practical implementation	46%	Mangrove restoration, tree nursery establishment & management, seedling selling, site-based restoration efforts, sale of curio-based tourist products
Leadership	38%	Serving as vice-chairs, group leaders, or project coordinators
Advocacy	29%	Campaigns, awareness raising, mobilizing peer groups
Research & innovation	12%	Engagement in environmental data collection, propagation techniques
No role/Not involved	16%	Respondents explicitly stating "none" or "N/A"

Note: Many respondents listed more than one role, hence totals exceed 100%

The findings reveal that hands-on-engagement in nature-based solutions dominates, with women and the youth being primary implementers of restoration activities such as mangrove planting, tree nursery establishment, seedling management and offering ecotourism-related products (Table 2). This participation of women and youth in NbS activities is especially critical in the context of climate change, where they are disproportionately affected by environmental shocks due to limited access to resources, decision-making platforms and formal employment opportunities (Plan International Kenya, 2022; SDG Action, 2021). Yet, their deep reliance on natural ecosystems for daily sustenance positions them as powerful agents of change when empowered through inclusive NbS frameworks. For example, gender-responsive NbS projects in coastal Kenya, such as seaweed farming and mangrove restoration, have demonstrated measurable improvements in women's income,

housing and food security, while simultaneously restoring degraded ecosystems (Wetlands International, 2022; Puskás et al., 2021). As such, in regions where access to formal employment remains limited, particularly for women and youth, NbS offers transformative pathways for livelihood diversification and poverty reduction.

Plate 18: A group of volunteers after participating in a tree growing activity © James Gitahi

Leadership roles, particularly for women serving as vice-chairs, group mobilisers or project coordinators, emerged prominently among respondents, with 38% indicating active involvement of women and youth in NbS-related leadership (Table 2). This reflects growing recognition of their role in environmental governance and aligns with SDG 5 (Gender Equality) and SDG 16 (Peace, Justice and Strong Institutions), which emphasize inclusive decision-making. However, 16% of respondents reported low or no involvement of women and youth in NbS leadership and activities, highlighting persistent barriers such as limited access to training, illiteracy, unequal power dynamics and cultural or traditional constraints (Salcedo-La Viña et al., 2023; Plan International Kenya, 2022).

The most commonly cited barrier was low awareness or understanding of NbS opportunities. Many community members, especially women and youth, lack access to environmental education, technical training and participatory platforms where they can learn about conservation, sustainable livelihoods and decision-making processes. This gap undermines the transformative potential of NbS, which depends on inclusive governance and equitable benefit-sharing nature-based solutions Initiative, 2023). Evidence from global reviews shows that projects with intentional gender integration and leadership development yield stronger ecological and social outcomes (Puskás et al., 2021). Biosphere Reserves, with their

participatory frameworks, offer strategic platforms to overcome these barriers by embedding gender-responsive approaches into NbS design, implementation and monitoring (UNESCO, 2017; IUCN, 2020).

3.6 Site-Specific Environmental Challenges Limiting Biosphere Reserve Success in Delivering NbS Goods and Services

Biosphere Reserves (BRs) are designed to serve as model landscapes for implementing nature-based solutions, yet their success is often shaped by site-specific environmental challenges that vary across ecological zones and socio-economic contexts. Factors such as coastal erosion, forest degradation, water scarcity, pollution and biodiversity loss can constrain the effectiveness of NbS interventions, particularly when compounded by climate variability and anthropogenic pressures (UNESCO, 2023; Vasseur & Siron, 2019). Understanding these localised constraints is essential for tailoring NbS strategies that are ecologically viable, socially inclusive and resilient to environmental stressors – thereby enhancing the transformative potential of BRs in delivering sustainable development outcomes.

3.6.1 Deforestation

Deforestation emerged as the most prevalent environmental challenge within the MWASBR accounting for 30.1% of all recorded issues. Respondents attributed this degradation to a combination of anthropogenic pressures, including illegal logging, charcoal production, firewood collection, wood carving and encroachment for agriculture. According to the Friends of Arabuko Sokoke Forest, over 96% of the Arabuko Sokoke forest was affected by illegal activities in 2019, with widespread tree cutting for building poles and fuelwood posing a serious threat to forest integrity (Friends of Arabuko Sokoke Forest, 2020). These findings are consistent with Habel et al., (2017), who documented significant habitat degradation in Arabuko Sokoke linked to unsustainable resource extraction, resulting in altered species composition, reduced biodiversity and disrupted ecological functions.

Plate 19: Unsustainable exploitation of wood products can undermine implementation of nature-based solutions
© Brian Waswala

The cumulative impact of these activities undermines the forest's capacity to deliver nature-based solutions particularly those related to climate regulation, biodiversity conservation and community livelihoods. Addressing deforestation through participatory forest management and restoration-based NbS is therefore critical to sustaining the biosphere reserve's ecological and socio-economic functions.

In the Mt. Kenya–Lewa Biosphere Reserve, deforestation remains the most prevalent environmental challenge, with approximately 28% of respondents identifying it as a major threat to the integrity of the reserve. This degradation is driven by a combination of illegal logging, charcoal production and agricultural encroachment, activities that fragment forest landscapes and compromise the ecological health of the reserve. Such pressures directly undermine forest-based nature-based solutions including reforestation, agroforestry and assisted natural regeneration, which are essential for delivering ecosystem goods and services that support community well-being (Forest Trends, 2022; Mount Kenya Trust, 2024).

Loss of canopy cover further diminishes the effectiveness of NbS in carbon sequestration, water regulation and habitat connectivity, weakening the reserve's role as a climate buffer and biodiversity corridor. These findings align with Habel et al., (2017), who documented that deforestation in Mt. Kenya's forest zones have severely impacted water catchment functions, increased sedimentation in hydropower dams and contributed to biodiversity loss.

3.6.2 Soil Erosion and Degradation

Soil degradation ranks as the second most prevalent environmental challenge in the MWASBR, with 23.1% of respondents acknowledging its impact in undermining the success of the reserve in delivering nature-based solutions. This degradation is primarily attributed to overgrazing, deforestation and unsustainable farming practices, which accelerate erosion, deplete soil nutrients and compromise ecosystem productivity (Heinrich Böll Stiftung, 2025; Tefera et al., 2024). The Participatory Forest Management (PFM) case study by KEFRI further reveals that forest-adjacent communities historically lacked access to sustainable land use knowledge, resulting in widespread soil erosion and nutrient depletion in buffer zones surrounding Arabuko Sokoke Forest (KEFRI, 2021).

Soil degradation accounts for approximately 16% of reported environmental challenges in the Mt. Kenya–Lewa Biosphere Reserve, posing a significant threat to the effectiveness of nature-based solutions in the region. This degradation is primarily driven by overgrazing, deforestation, poor farming practices and increasing climate variability (Mganga, 2022; Heinrich Böll Stiftung, 2025). The

steep topography of Mt. Kenya's slopes, combined with intensified agriculture and land fragmentation, renders the area highly vulnerable to erosion, compaction and nutrient depletion, factors that undermine soil health and long-term productivity (Mganga, 2022).

Plate 20: Soil degradation poses a major challenge to thriving nature-based solutions © Gibran Maghanga

Addressing these challenges requires integrated NbS approaches – such as agroforestry, conservation agriculture and assisted natural regeneration – that restore soil function while enhancing biodiversity and climate resilience. Biosphere reserves, with their participatory governance frameworks, offer strategic platforms for implementing such solutions in ways that align with SDGs (Leguia-Cruz et al., 2024)

3.6.3 Declining Stock and Biodiversity-Based NbS

Declining biological stock accounted for 19.2% of reported environmental challenges in the MWASBR, reflecting reduced availability of key natural resources essential to community well-being. Respondents cited noticeable declines in fuelwood, fisheries and common wildlife species, particularly those relied upon

for subsistence practices. These reductions were attributed to overharvesting of forest products, unsustainable fishing and illegal poaching linked to the bush meat trade and consumption. Such pressures not only threaten biodiversity but also undermine the reserve's capacity to deliver nature-based solutions that support climate resilience, food security, and sustainable livelihoods (Lindsey et al., 2015; FAO, 2023).

These findings are consistent with assessments by Friends of Arabuko Sokoke Forest (2020), which documented alarming declines in species such as the Ader's duiker (Cephalophus adersi) and bushbuck (Tragelaphus scriptus), with some populations considered locally extinct due to habitat degradation and illegal hunting. The Ader's duiker, once common in Arabuko Sokoke, is now listed as vulnerable on the IUCN Red List, with its population in Kenya restricted to fragmented forest patches and facing imminent risk of extirpation (Wild Planet Trust, 2023; Ngaruiya et al., 2011). Bushbuck sightings have similarly declined, with patrol data indicating near absence since 2018 (FoASF, 2020). These species losses signal broader ecosystem instability and highlight the urgent need for strengthened enforcement, community-based conservation and restoration-focused NbS within biosphere reserve frameworks.

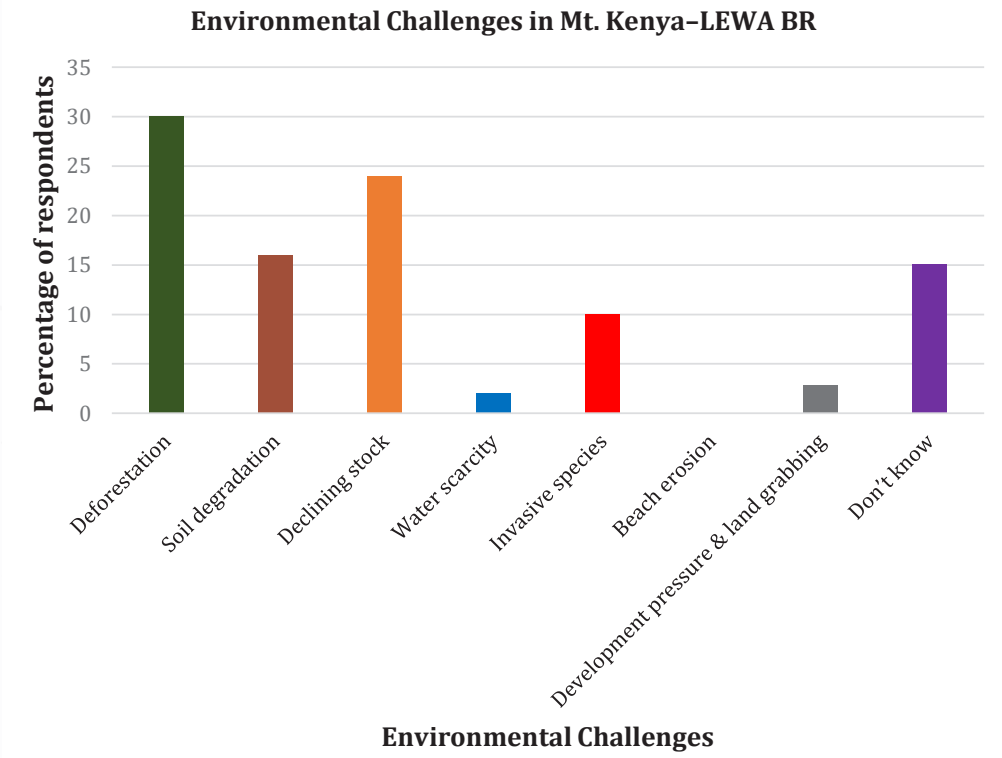

Fig. 7: Environmental challenges affecting the success of NbS in MWASBR

In the Mt. Kenya–Lewa Biosphere Reserve, approximately 24% of respondents identified declining biological stock as a major environmental threat, citing reduced sightings of species such as Grevy's zebra (Equus grevyi) and other key wildlife species. These declines are attributed to habitat loss, poaching and escalating human-wildlife conflict, pressures that undermine the reserve's capacity to deliver nature-based solutions for climate resilience, biodiversity conservation and community livelihoods. Fragmentation and fencing across the landscape have disrupted traditional migration routes, particularly for elephants, leading to isolated populations and increased conflict with adjacent communities (Lewa Wildlife Conservancy, 2024). Addressing these challenges requires integrated land-use planning, strengthened enforcement, and inclusive governance frameworks that align conservation goals with local development priorities.

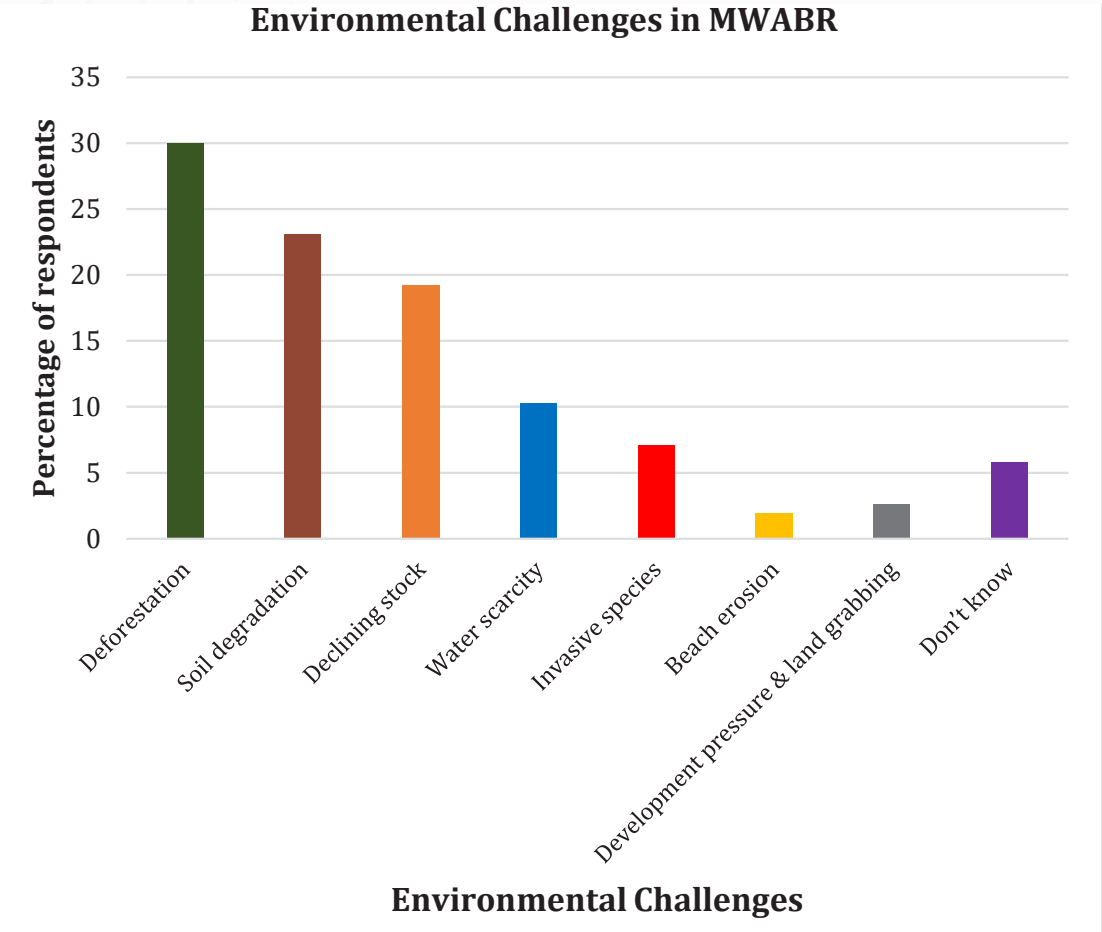

Fig. 8: Environmental challenges affecting the success of NbS in Mt. Kenya-Lewa BR

3.6.4 Water Scarcity

Water scarcity was reported by approximately 10% of respondents as a significant environmental challenge within the MWASBR, with impacts observed across both human and ecological systems, particularly during prolonged dry seasons. Respondents highlighted reduced access to clean water for domestic use, agriculture, and ecosystem functioning, including mangrove health. Kenya's overall per capita water availability remains below 1,000 m^3/year, classifying the country as water-scarce under the Falkenmark Index (Mulwa et al., 2021; UNEP/GRID, 2024).

The Coastal region, encompassing arid and semi-arid counties such as Kilifi, Tana River, Lamu, and Kwale, is especially vulnerable due to erratic rainfall patterns, saline intrusion and inadequate water infrastructure (Winrock, 2021; RCMRD, 2024). In some areas like Watamu and Arabuko Sokoke, seasonal droughts and poor groundwater recharge exacerbate water stress, forcing communities to rely on contaminated sources such as shallow wells, unprotected springs and saline aquifers. This reliance increases exposure to waterborne diseases including cholera, typhoid and schistosomiasis which undermines community resilience, particularly among women, youth and forest-adjacent households (Manetu & Karanja, 202).

Plate 21: Drying river bed in a water scarce area
© Brian Waswala

These conditions also compromise the effectiveness of nature-based solutions such as mangrove restoration and agroforestry, which depend on reliable water flows for seedling survival, carbon sequestration and biodiversity support. Addressing water scarcity in MWASBR requires integrated watershed management, climate-resilient infrastructure and community-led water governance aligned with SDG 6 (Clean Water and Sanitation), SDG 13 (Climate Action), and SDG 15 (Life on Land).

Water scarcity was reported by only a small proportion of respondents in the Mt. Kenya–Lewa BR, indicating that the region currently enjoys relatively stable water availability compared to Kenya's arid and semi-arid landscapes. This can be attributed to the reserve's location within the Mt. Kenya water tower, one of the country's five major catchments, which supports perennial rivers such as the Ewaso Ng'iro, Sirikoi and Ngare Ndare (RCMRD, 2024; Water Resources Authority, 2023). The montane forest cover and high-altitude climate contribute to consistent rainfall and groundwater recharge, buffering the area against acute water stress. Additionally, long-standing investments in community water infrastructure have improved access to clean water for many households (Lewa Wildlife Conservancy, 2024). These proactive measures, combined with hydrological monitoring and capacity building through Water Resource Users Associations (WRUAs), have enhanced local resilience and reduced perceived water scarcity.

3.6.5 Invasive Species

Invasive species represent a growing ecological threat across Kenya's biosphere reserves, accounting for approximately 10.4% of reported environmental challenges in the MWASBR and 12.7% in the Mt. Kenya–Lewa BR. In the Mt. Kenya–Lewa landscape, species such as Prosopis juliflora, and Lantana camara are spreading rapidly, displacing native flora, fragmenting habitats and altering key ecosystem functions. Predictive modelling by Waititu et al., (2022) suggests that Opuntia stricta could expand by up to 223% under RCP8.5 climate scenarios by 2070, posing significant risks to biodiversity, soil integrity and hydrological regulation. These species disrupt nature-based solutions by outcompeting native vegetation, altering fire regimes and reducing the provision of ecosystem services such as carbon sequestration, forage availability and water retention (Ouko et al., 2020; Adionyi et al., 2024). With climate change, the susceptibility of these ecosystems to invasive species will increase and pose a threat to their ecological integrity.

In MWASBR, Prosopis juliflora, locally known as 'mathenge' weed was reported by respondents and has colonized coastal and riparian zones, obstructing access to water sources, degrading grazing lands and exacerbating water stress in arid and semi-arid counties in the Coastal area (SEI Africa, 2022). Its dense thickets

alter soil chemistry through allelopathic effects, reduce native plant recruitment and create ideal breeding grounds for disease vectors such as mosquitoes, thereby compounding public health risks (Cheng, 2024). These impacts undermine NbS interventions such as mangrove restoration, agroforestry and assisted natural regeneration, making ecological restoration more difficult and less cost-effective.

Plate 22: Invasive Prosopis juliflora(Mathenge) colonizing River Sabaki estuary © Gibran Maghanga

To safeguard the integrity of NbS within biosphere reserves, there is an urgent need for integrated invasive species management strategies. These should include early detection systems, mechanical and biological control methods and robust community awareness campaigns. Incorporating indigenous knowledge and landscape-level monitoring, particularly through participatory mapping and citizen science platforms can enhance long-term NbS success and resilience. Such approaches align with SDG 15 (Life on Land), SDG 13 (Climate Action), and Kenya's National Biodiversity Strategy and Action Plan (NBSAP).

3.6.6 Other challenges affecting success of NbS interventions

Limited Policy Support and Awareness

Apart from environmental challenges, other barriers affecting the success of nature-based solutions (NbS) and interventions as identified by both local communities

and key stakeholders include: limited policy support and awareness, insufficient technical expertise and lack of sufficient resources. Despite growing recognition of NbS in enhancing community well-being and advancing global climate and development agendas, their integration into national and local policies remains fragmented. Respondents emphasized that existing policies often lack clarity and coordination across sectors and governance levels.

Landholm et al. (2022) documented similar findings in Kenya, noting that NbS implementation is constrained by fragmented governance and limited institutional capacity to align carbon market mechanisms with restoration goals. Likewise, Nyambo et al. (2024) emphasized that while policy instruments exist to support NbS in rural Sub-Saharan Africa, they are often vague, poorly disseminated, or not operationalised effectively, echoing the findings of this study. Benefits accruing from NbS could be optimal if other funding mechanisms and incentives (e.g. carbon credits through REDD+ and other options) are considered especially for communities living around and within biosphere reserves.

Further, local communities who are expected to collaborate with government agencies such as the Kenya Forest Service (KFS) and Kenya Wildlife Service (KWS) reported having limited or no awareness of the content and implications of Kenya's conservation laws and policies. This disconnect undermines participatory implementation, participation in meaningful decision making and weakens community ownership of NbS interventions, thereby compromising long-term sustainability. Moreover, mainstreaming of NbS into planning and budgeting cycles is notably absent, which impedes systematic implementation and institutional anchoring.

Without dedicated budget lines, measurable targets and performance indicators, NbS remains peripheral to core development priorities. These findings align with broader scholarly concerns. For instance, the World Agroforestry Centre (ICRAF, 2022) highlighted that successful NbS in Kenya's rural counties require deliberate alignment with restoration monitoring frameworks and gender-responsive planning.

The Global Center on Adaptation (2022) similarly stressed the importance of embedding NbS into county integrated development plans (CIDPs) and strengthening coordination between national and county governments to operationalise NbS at the grassroots level. Therefore, for successful NbS outcomes, it is important to mainstream and embed NbS into national development priorities and align them with strategic planning instruments and the Sustainable Development Goals (Gerstetter et al., 2020).

Lack of Sufficient Resources

Although nature-based solutions are widely viewed as cost-effective, their implementation is constrained by insufficient financial resources, staffing gaps and limited institutional support. Respondents emphasized that funding streams are either unavailable or poorly aligned with NbS objectives, hindering the scalability of interventions. Global analyses show that less than 1.5% of climate finance is directed toward NbS for adaptation, despite their triple dividend of environmental, economic and social benefits (World Economic Forum, 2021; UNEP, 2022).

To address these financing gaps, Kenya has proposed mechanisms such as restoration fees embedded in environmental frameworks and the integration of NbS into Environmental and Social Impact Assessment (ESIA) budgets, particularly for land restoration and watershed management (Global Center on Adaptation, 2025; UNEP, 2024). Public-private partnerships (PPPs) and community-led approaches also offer opportunities to mobilize local labour, indigenous knowledge and co-financing (Brears, 2022; World Economic Forum, 2023). Additionally, targeted funding platforms such as the Climate Investment Funds' Nature, People and Climate initiative have earmarked resources to pilot and expand NbS in countries like Kenya, enhancing climate resilience and biodiversity outcomes through dedicated investment windows (CIF, 2022).

Insufficient Knowledge and Technical Expertise

The successful design, implementation, monitoring and communication of NbS require interdisciplinary knowledge and skills spanning ecology, hydrology, climate science and social systems, among other related disciplines. However, respondents highlighted knowledge/skills capacity gaps not only among practitioners and government officers, but also within local communities expected to co-implement and steward these interventions. These gaps often result in poorly designed projects, limited use of monitoring tools and weak communication of outcomes to stakeholders and policymakers.

In Kenya, an IUCN-led capacity-building initiative in Kilifi County revealed that while communities possess valuable indigenous knowledge, they lack access to standardised NbS tools, formal training and institutional support needed to scale their efforts (IUCN, 2024). Similarly, the Forest and Farm Facility (FFF) under Food and Agriculture Organisation (FAO) emphasized that the most resource-intensive aspect of NbS is not infrastructure, but the organisation and technical empowerment of local actors especially in monitoring and reporting (FAO, 2023). Without targeted support, communities struggle to participate meaningfully

in planning, data collection, monitoring and adaptive management, which are essential for long-term NbS success.

Unregulated Infrastructure Development

Infrastructure development and land grabbing, particularly of public land and beach plots emerged as significant threats to the success of NbS in MWASBR, with respondents highlighting unregulated construction at the Coast and privatisation of riparian zones as drivers of ecological degradation and social exclusion. These activities disrupt mangrove ecosystems, accelerate beach erosion, and restrict community access to traditional fishing grounds and tourism-based livelihoods (Kazungu, 2025; Ocean Panel, 2022). The loss of natural buffers such as dunes and mangroves undermine the effectiveness of coastal NbS in mitigating storm surges, saline intrusion, and biodiversity loss. Moreover, the encroachment on public coastal lands violates Kenya's 60-meter shoreline setback regulation, yet enforcement remains weak, allowing developers to build dangerously close to the ocean (Kazungu, 2025).

These dynamics compromise the delivery of key ecosystem services and exacerbate vulnerability among coastal communities, particularly women and youth who rely on marine resources for income and food security. Addressing these challenges requires integrated land-use planning, strengthened environmental governance and the embedding of NbS into coastal infrastructure policies. Such reforms align with SDGs, which call for inclusive, resilient and ecologically sound development pathways.

Legal and Policy Framework Barriers

Respondents identified legal and policy frameworks governing biosphere reserves (BRs) as a significant barrier to the success of nature-based solutions, citing low public awareness, minimal community benefits, inadequate compensation mechanisms and burdensome taxation, particularly in the form of licenses and permits for community-led ecotourism and conservation enterprises. These governance gaps undermine local stewardship and discourage participation in NbS initiatives, especially among marginalised groups. For example, community ecotourism operators in coastal BRs such as MWASBR face high regulatory costs and limited access to incentives, despite their role in promoting conservation and sustainable livelihoods (National Treasury and Economic Planning, 2023; NGEC, 2023). Additionally, weak benefit-sharing frameworks and poor integration of customary land rights further erode trust and reduce uptake of restoration and conservation efforts. To address these challenges, Kenya must strengthen policy

coherence by aligning BR governance with inclusive development goals such as SDG 11 (Sustainable Cities), SDG 13 (Climate Action), and SDG 15 (Life on Land).

Possible solutions include: (i) simplifying licensing procedures for community enterprises; (ii) embedding NbS into county development plans and ESIA frameworks; (iii) establishing compensation schemes for ecosystem services; and (iv) enhancing public awareness through targeted education and participatory policy design. These reforms would not only improve NbS outcomes but also unlock livelihood opportunities and foster equitable conservation across Kenya's biosphere landscapes.

3.7 Unlocking Potential: Innovations, Pathways and Scaling Opportunities to Expand NbS in BR

Kenya's biosphere reserves (BRs) are increasingly recognized as dynamic platforms for scaling nature-based solutions (NbS), with respondents particularly local communities and key informants, highlighting their untapped potential for innovation, replication and cross-sectoral integration. This optimism is grounded in growing policy momentum and empirical evidence positioning NbS as a cornerstone for climate mitigation, biodiversity conservation, and inclusive development (UNESCO, 2025; FOLU, 2022). For instance, FOLU (2022) documents that land-based NbS in Kenya could deliver up to 80 million tCO_2e in annual mitigation potential by 2050, while simultaneously enhancing food security, water regulation, and biodiversity.

Respondents highlighted a diverse set of practical innovations tailored to biosphere reserve (BR) contexts, including expanded restoration initiatives, native tree planting, ecotourism, seaweed farming, organic and climate-smart agriculture, beekeeping, insect-based NbS, and nature-based enterprises such as herbal soap production and sustainable crafts. These locally grounded innovations reflect the growing capacity of communities to co-design and implement nature-based solutions that deliver ecological, economic and social benefits.

In the Mt. Kenya–Lewa BR, agroforestry and assisted natural regeneration are being scaled to restore degraded slopes, enhance soil health and improve water retention, opportunities that merit replication in other montane and semi-arid BRs (Mount Kenya Trust, 2024; GoK, 2021). In the Malindi–Watamu–Arabuko Sokoke BR, mangrove restoration, seaweed farming and youth-led composting initiatives are strengthening coastal resilience, improving fish productivity and diversifying livelihoods, particularly for women and youth (Sirikwa, 2024).

Additionally, insect-based NbS, such as the use of black soldier fly (BSF) in composting, are gaining traction in Kilifi County (Fig. 17), offering low-cost, high-

impact solutions for organic waste management, soil fertility enhancement and sustainable animal feed production. BSF larvae convert organic waste into protein-rich biomass and nutrient-dense frass, which serves as an effective bio-fertilizer, supporting circular economies and climate-resilient agriculture (Mganga, 2022; Farming in Kenya, 2024). These innovations require strategic expansion, technical support and policy integration to scale across Kenya's biosphere reserves and contribute meaningfully to SDGs 2 (Zero Hunger), 12 (Responsible Consumption), 13 (Climate Action), and 15 (Life on Land).

Plate 23: Waste reduction and organic manure production using Black Soldier Fly © Gibran Maghanga

Respondents also identified the carbon market landscape, which presents a promising and underutilised opportunity to scale nature-based solutions (NbS) in Kenya's biosphere reserves and beyond. Kenya's mitigation potential through land-based NbS, including afforestation, reforestation, improved forest management and soil carbon enhancement, is estimated to reach up to 80 million tCO_2e annually by 2050 (FOLU, 2022). However, only a fraction of this potential is currently unlocked due to financing, governance and technical barriers (FOLU, 2022).

Voluntary carbon markets (VCMs) offer a strategic pathway to mobilise climate finance for NbS, particularly in areas where traditional funding is limited. Recent assessments show that Kenya could generate between 16.2–25.1 $MtCO_2e$ annually through VCMs by 2050, representing a significant contribution to its Nationally Determined Contributions (NDCs), which prioritize NbS as a central pillar for achieving a 32% emissions reduction by 2030 (GoK, 2025).

Afforestation and improved forest management projects such as those in Mt. Kenya–Lewa and Arabuko–Sokoke are well-positioned to benefit from carbon credit schemes, especially when coupled with robust Monitoring, Reporting and Verification (MRV) systems and equitable benefit-sharing frameworks. Kenya's recent enactment of the Climate Change (Carbon Markets) Regulations 2024 provides a legal foundation for scaling carbon trading under Article 6 of the Paris Agreement and through voluntary mechanisms.

To fully harness this opportunity, Kenya must address key challenges, including land tenure insecurity, limited technical capacity, and low community awareness. Governance reforms, capacity building, and spatial mapping of NbS potential are essential to attract investment and ensure that carbon revenues support local livelihoods, biodiversity, and restoration goals. Integrating NbS into carbon market portfolios also aligns with SDGs, offering co-benefits for climate resilience, ecosystem services, and inclusive development.

To fully realise these opportunities, stakeholders recommended:

i. expanding NbS pilot programs into adjacent counties and ecological zones;

ii. investing in innovation hubs that incubate community-driven NbS technologies;

iii. strengthening capacity and monitoring frameworks to track scalability, impact, and equity; and

iv. leveraging blended finance models, including carbon credits, restoration fees, and public-private partnerships.

CHAPTER FOUR:

CONCLUSION AND RECOMMENDATIONS

4.1. Conclusions

This study examined the implementation and scaling of nature-based solutions (NbS), ecological outcomes, socio-economic benefits, women and youth participation, challenges, and innovations and opportunities across two distinct biosphere reserves in Kenya – Mt. Kenya–Lewa and Malindi–Watamu–Arabuko Sokoke – highlighting their ecological, socio-economic and governance dimensions. The findings underscore the critical role of biosphere reserves as living laboratories for climate resilience, biodiversity conservation, community livelihoods and inclusive development.

In Mt. Kenya–Lewa BR, NbS efforts are strongly rooted in agroforestry, water conservation and community-led afforestation and reforestation of degraded areas, with high levels of participation from communities who are formally organised into groups such as Community Forest Associations (CFAs). The reserve's upland ecology, structured governance frameworks and presence of active community-led groups and NGOs have enabled relatively high uptake of sustainable practices. However, challenges persist including land-use pressure, high community dependence on the Mt. Kenya Forest for sustenance and limited continuity in funding for long-term NbS initiatives.

In contrast, the Malindi–Watamu–Arabuko Sokoke Biosphere Reserve (MWASBR) landscape demonstrates a more diversified livelihood base – including farming, tourism, conservation and fishing. NbS initiatives in the region are closely tied to coastal ecosystem restoration such as mangrove planting and restoration, organic composting, beach clean-ups and turtle monitoring. The area's urbanised and cosmopolitan nature of the region contributes to dynamic community engagement but also presents challenges in aligning conservation goals with ongoing development pressures. Additional threats include bush meat and trade, which drive illegal poaching and species decline, as well as deforestation, charcoal production and agricultural encroachment.

Across the biosphere reserve landscapes, women and youth emerge as key implementers of nature-based solutions (NbS), actively engaging in practical activities such as tree planting, nursery establishment, insect-based composting and seedling production for sale. Their involvement reflects a strong grassroots commitment to environmental stewardship. Notably, women and youth are also represented in leadership roles, including positions such as vice chairpersons and advocacy coordinators, thus demonstrating growing inclusivity within governance structures. However, persistent barriers continue to limit their full and equitable representation in decision-making spaces. For women in particular, high illiteracy levels, traditional household gender roles, limited access to land ownership and constrained mobility due to family responsibilities significantly hinder their participation in NbS leadership and strategic planning. For the youth, migration to urban centres in pursuit of formal employment contributes to underrepresentation in local leadership and long-term NbS planning. Addressing these gaps through targeted capacity-building, mentorship, tangible benefits and inclusive policy frameworks will be essential to harness the full potential of women and youth in driving sustainable development.

Despite the promising uptake of nature-based solutions (NbS) across both biosphere reserves, several systemic challenges continue to hinder their scalability and long-term impact. Legal and policy framework barriers, including fragmented mandates, weak enforcement and integration of NbS into county development plans, create uncertainty and restrict community-driven initiatives. Additionally, the lack of sufficient financial and material resources constrains the implementation and maintenance of NbS interventions, particularly in marginalised areas. Insufficient technical expertise and limited access to training further impede innovation and adaptive management. Notably, low awareness of conservation laws and environmental policies among community members reduces compliance and weakens local stewardship. Addressing these challenges will require coordinated policy reforms, increased investment in capacity-building and inclusive awareness campaigns that empower communities to participate meaningfully in environmental governance.

The biosphere reserves present fertile ground for expanding nature-based solutions through innovative and context-responsive approaches. Emerging opportunities such as carbon finance and credit schemes can incentivize reforestation, agroforestry expansion and sustainable land management practices. Community-led tree planting, apiculture and butterfly farming offer dual benefits of biodiversity conservation and livelihood enhancement. Enhancing agroforestry, tree planting and nurseries establishment in the BRs and other potential sites and

promoting mangrove restoration along sea riparian zones can significantly bolster ecosystem resilience while supporting blue carbon strategies. Technical training in coral reef identification, tree species classification and sustainable harvesting techniques can empower communities with the skills needed to steward their environments effectively. Additional pathways include ecotourism linked to biodiversity hotspots, organic farming, aquaculture integrated with wetland conservation and circular economy models that turn waste into bio-fertilisers or energy (e.g. insect-based composting using BSF). Scaling these innovations will require multi-stakeholder collaboration, dedicated funding streams and policy alignment to ensure that NbS become central pillars of sustainable development across Kenya's landscapes.

Across both reserves, the report finds that:

i. community participation is a decisive factor in the success and longevity of NbS interventions;

ii. gender inclusivity, especially women-led initiatives enhance sustainability and social equity;

iii. youth involvement remains uneven and requires targeted strategies to foster meaningful engagement;

iv. sustained funding is essential to maintain momentum and scale impact;

v. opportunities such as ecotourism, regenerative agriculture, afforestation and agroforestry, green entrepreneurship and carbon finance among others exist and require strategic investment, capacity-building and enabling policies; and

vi. policy integration is partial, with gaps in aligning local NbS efforts to national climate and biodiversity frameworks.

These findings affirm that successful NbS implementation hinges not only on ecological design but also on inclusive governance, strategic investment, community empowerment, strong institutions and coherent policy alignment. To unlock the full potential of NbS across Kenya's landscapes, stakeholders must prioritise community-driven approaches, capacity building, embed gender and youth equity into planning and bridge local initiatives with national climate and biodiversity frameworks. Strengthening these pillars will ensure that NbS delivers

lasting environmental, social and economic benefits, thus transforming reserves into resilient models for sustainable development.

4.2 Recommendations

Building on the findings of this study and the NbS activities, challenges and opportunities identified, the following recommendations aim to guide key stakeholders in scaling nature-based solutions within biosphere reserves and beyond. These tailored actions address systemic barriers, unlock innovative pathways and promote inclusive, sustainable environmental governance. By aligning efforts across communities, government agencies, policy makers, development partners and academic institutions, Kenya can accelerate the integration of NbS into its climate resilience and sustainable livelihoods and development agenda.

Communities: Local communities should be empowered to take active roles in environmental conservation by enhancing awareness of relevant laws, policies and the ecological value of nature-based solutions (NbS). Targeted outreach, participatory forums and culturally responsive education can foster deeper understanding and compliance. Additionally, livelihood diversification through apiculture, butterfly farming, mangrove restoration, seedling production, insect-based composting and agroforestry can offer synergistic benefits for both biodiversity and household incomes. Establishing, managing and expanding community-run tree nurseries, engaging in carbon credit schemes and ecosystem service schemes, and participating in hands-on technical training (e.g. coral reef mapping and identification, tree species identification and sustainable harvesting) will strengthen local capacity, ownership and long-term commitment to NbS implementation.

Government Agencies: Government agencies should prioritise the harmonization of legal and policy frameworks to embed Nature-based Solutions (NbS) into county and national development plans, ensuring clarity of mandates and effective enforcement. Dedicated and sustained funding is essential to support NbS implementation, infrastructure development (e.g., seed banks, eco-monitoring systems, training centres), and capacity-building at the community level. Government agencies should also strengthen inter-sectoral coordination across related domains such as environment, agriculture, water and tourism while facilitating' land access and tenure security for communities to enable long-term and sustained investment in restoration and conservation efforts.

Policy Makers: Policy makers are urged to develop inclusive policies that institutionalise community-led NbS and promote gender and youth participation.

Incentives for private sector engagement, such as tax breaks or recognition schemes, can accelerate investment in green jobs and technologies. NbS should be integrated into national climate strategies and biodiversity frameworks, supported by robust monitoring and evaluation systems to guide adaptive policy refinement.

Donors and Development Partners: Development partners should prioritise funding for scalable NbS innovations, including carbon finance, regenerative agriculture and circular economy models. Long-term investment in technical training and institutional strengthening will enhance community resilience. Supporting and expanding pilot projects and multi-stakeholder platforms for knowledge exchange and co-design will foster inclusive governance and replication of successful interventions across diverse landscapes.

Research and Academic Institutions: Academic institutions should generate locally grounded evidence on NbS effectiveness and socio-economic impacts to inform policy and practice. Interdisciplinary curricula that integrate NbS, agroecology, climate resilience and community development are vital for capacity-building. Participatory research with communities will ensure knowledge co-production, while open-access platforms can disseminate best practices and innovations across Kenya and the region. There is also a need to promote agroecology within the buffer and transition zones as well as sustainable nature-based enterprises

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Annexes

Annexe 1: Local Community Questionnaire

Introduction:

I am _____, and I work for the Kenya National Commission for UNESCO, Nairobi. We are conducting a study aimed at gathering information on the current nature-based solutions at Mount Kenya-Lewa and Malindi-Watamu-Arabuko Sokoke Biosphere Reserves. The information gathered in this questionnaire will be used for the purposes of the study only and the data collected will remain confidential.

Your participation will be highly appreciated. For any further information, please contact 0721853227 /0723812990.

Local Communities Draft Questionnaire

7. Respondent Information

Name:

Gender: ☐ Male ☐ Female ☐ Prefer not to say

Age (Optional) ☐ 18-30 ☐ 31-45 ☐ 46-60 ☐ 61+

Occupation:

Name of the Biosphere Reserve:

Specific Location/Constituency:

How long have you lived/worked in this area? ☐ Less than 1 year ☐ 1-5 years ☐6-10 years ☐ 10+ years

Primary Activities: ☐ Farming ☐ Fishing ☐ Conservation ☐ Tourism ☐ Other (Specify)

8. Are you familiar with the concept of NbS? ☐ Yes ☐ No

In your own words, how would you describe NbS?

……

……

9. What NbS initiatives are you currently engaged in this area?

☐ Tree nursery establishment ☐ Reforestation ☐ Agroforestry ☐ Mangrove restoration ☐ Wetland conservation ☐ Conservation agriculture/no till farming ☐ Wildlife corridors ☐ Community forests and gardens ☐ Urban green infrastructure ☐ None ☐ Others (Specify)

10. What driving factors led you to join/be engaged in NbS?

☐Biodiversity conservation ☐ Climate resilience
☐ Community livelihood improvement ☐ Sustainable tourism
☐ Did it sub-consciously ☐ Others (Specify)

11. What NbS are currently implemented within this Biosphere Reserve/landscape?

☐ Reforestation ☐ Agroforestry ☐ Mangrove restoration☐ Wetland conservation ☐ Others (Specify)

12. How big is the area under NbS in acres……

13. Which organisations or institutions support NbS implementation in this area?

……..

……

……..

14. Does the community actively participate in NbS activities in this area?

☐ 1 (low participation) ☐ 2 ☐ 3 ☐ 4 ☐ 5 (High participation)

15. Have you observed changes (positive or negative) in biodiversity due to NbS interventions (e.g. species population, habitat quality, or ecosystem services in this area? ☐ Yes ☐ No ☐ Not sure

Please explain ……
……

16. **What specific biodiversity indicators have improved due to NbS implementation?**

☐ Increased wildlife populations ☐ Improved water quality ☐ Enhanced soil fertility ☐ Improved air quality ☐ Others (Specify)

Can give examples:

……
……

17. **How would you assess the ecological effectiveness of NbS in improving biodiversity in this area?**

☐ 1 (Low effectiveness) ☐ 2 ☐ 3 ☐ 4 ☐ 5 (High effectiveness)

18. **What social-economic benefits have you gained/benefitted from in the NbS programme(s) implemented in this area?**

……
……

19. **Have the NbS initiatives implemented in your area contributed to revenue generation (e.g., ecotourism, carbon credits)?**

☐ Yes ☐ No ☐ Not sure

If yes, elaborate more on what revenue streams have been generated?

……
……

20. **Has the revenue improved your living standards and in what ways?**

☐ House renovation/building ☐ school fees payment ☐ asset purchase (e.g. motorcycle, bicycle, car, cart etc) ☐ livestock purchase ☐ land purchase ☐ Others (Specify)

……
……

21. **Have NbS interventions helped reduce environmental costs (e.g., drought, flood protection, water purification, soil erosion, over-extraction etc)?**

☐ Yes ☐ No ☐ Not sure

22. **What environmental challenges does your community face and affect the success of the Nbs?** (select all that apply) ☐ Deforestation ☐ Soil degradation ☐ Declining stocks (e.g. fish, fuel wood etc) ☐ Water scarcity ☐ Invasive species ☐Others (Specify)

23. **What nature-based approaches could address these challenges identified above? (select all that apply)**

☐ Agroforestry ☐ Reforestation ☐ Marine protection ☐ Organic farming ☐Others (Specify)

24. **On a scale of 1 to 5, how would you rate community involvement in NbS decision-making in this area?**

☐ 1 (Low engagement) ☐ 2 ☐ 3 ☐ 4 ☐ 5 (High engagement)

25. **What factors do you think influence the success of NbS interventions in this area? (select all that apply)**

☐ Funding ☐ Policy support ☐ Technical expertise ☐ Local participation ☐ Others (Specify)

26. **How does your community perceive NbS interventions and do they address local needs and priorities?**

☐ Highly beneficial ☐ Moderately beneficial ☐ Not beneficial ☐ Facing opposition

Please Explain……

27. **What additional measures could improve community acceptance and participation in NbS projects?**

☐ Training ☐ Funding ☐ Scientific research ☐ Community engagement ☐ Other (Specify)

28. How engaged are women and youth in NbS initiatives within this landscape?

☐Low engagement ☐ Moderate engagement ☐ High engagement

29. What roles do women and youth play in NbS implementation? (Select all that apply)

☐ Leadership ☐ Advocacy ☐ Research ☐ Practical implementation
☐ None ☐ Others (Specify)

Please share any success stories/examples of women and youth driving NbS initiatives in this area?

30. What are the main challenges and barriers limiting the participation of women and youth in conservation efforts in this area?

☐ Lack of awareness ☐ Cultural & societal norms/ duties
☐ Low representation in leadership roles ☐ Restricted access to land
☐Limited access to funding ☐ Others

31. Are there indigenous or traditional knowledge practices related to NbS that should be integrated into conservation strategies? ☐ Yes ☐ No. If yes, describe these practices

……
……
……

32. What challenges affect the success of NbS interventions in your area? (select all that apply) ☐ Lack of funding ☐ Limited policy support
☐ Insufficient technical expertise ☐ Low community participation
☐ Lack of resources ☐ Land tenure system ☐ Invasive species
☐ Other (Specify)

Annexe 2: Key Stakeholders Questionnaire

Key Stakeholders Questionnaire

Introduction:

I am _____, and I work for the Kenya National Commission for UNESCO, Nairobi. We are conducting a study aimed at gathering information on the **current nature-based solutions at Mount Kenya-Lewa and Malindi-Watamu-Arabuko Sokoke Biosphere Reserves.** The information gathered in this questionnaire will be used for the purposes of the study only and the data collected will remain confidential.

Your participation will be highly appreciated. For any further information, please contact 0721853227 /0723812990.

Key Stakeholders Draft Questionnaire

1. Organisation/company information

Name of Organisation/Institution:

Position:

Sector or Sub-Sector (select all that apply) ☐ Forestry
☐ Marine Conservation ☐ Agriculture ☐ Policy ☐ Research/Training
☐Policy ☐ Other (Specify)

Location (Specify region within the biosphere reserve):

Role in NbS Implementation: ☐ Research ☐ Funding ☐ Conservation ☐ Community outreach ☐ Policy-making

2. What specific NbS initiatives/solutions does your organization currently implement or support within this area?

3. How big is the area under NbS in aces……

4. What were the main drivers for supporting/adopting NbS in your sector? ……
……

5. **What environmental challenges does this area face?** (select all that apply)

☐ Deforestation ☐ Soil degradation
☐Declining stocks (e.g. fish, fuel wood etc) ☐Water scarcity
☐ Invasive species ☐Others (Specify)

6. **How effective are NbS in addressing environmental challenges in this biosphere reserve?**

☐ 1 (Not effective) ☐ 2 ☐ 3 ☐ 4 ☐ 5 (Highly effective)

7. **How do you assess the ecological effectiveness of your NbS interventions?** (e.g., biodiversity gains, habitat restoration, ecosystem resilience)

☐ 1 (Low effectiveness) ☐ 2 ☐ 3 ☐ 4 ☐ 5 (High effectiveness)

8. **What resources or expertise does your organisation require to improve NbS effectiveness?**.....
.....

9. **What indicators do you use to measure NbS success? (Select all that apply)**

☐ Species richness ☐ Habitat quality ☐ Carbon sequestration
☐ Water purification ☐ Community empowerment & livelihoods
☐ Others (Specify)

10. **Have NbS helped reduce environmental costs in this area (e.g., flood protection, soil conservation, water purification, species population increase)?**

☐ Yes ☐ No Please elaborate

11. **Have NbS interventions contributed to generating revenue streams? (e.g., ecotourism, carbon credits)**

☐ Yes ☐ No. If yes, what revenue sources have been established?

12. **What social-economic benefits have local communities gained from your NbS programmes?**

13. **How do you rate the participation of local communities in the Nbs Programmes?**

☐ Low engagement ☐ Moderate engagement ☐ High engagement

14. **What factors hinder active participation of local communities?**

☐ Lack of awareness ☐ Cultural & societal norms/ duties
☐ Lack of funding ☐ Others

15. **Are women and youth actively participating in NbS programmes?**

☐ Yes ☐ No

16. **What roles do women and youth play in NbS implementation? (Select all that apply)**

☐ Leadership ☐ Advocacy ☐ Research ☐ Practical implementation
☐ None ☐ Others (Specify)

17. **Please share any success stories/examples of women and youth driving NbS initiatives in this area?**

18. **What challenges and barriers limit the participation of women and youth in conservation efforts in this area?**

☐ Lack of awareness ☐ Cultural & societal norms/ duties
☐ Low representation in leadership roles ☐ Restricted access to land
☐ Limited access to funding ☐ Others

19. **What strategies have you used to improve community participation and motivation in NbS initiatives?**

☐ Training ☐ Livelihoods ☐ Financial incentives ☐ Other

20. **What collaborations do you have with other stakeholders?** (e.g., government, private sector, communities)

Please explain……
……

21. Do current policies adequately support NbS implementation?

☐ 1 (Not supportive) ☐ 2 ☐ 3 ☐ 4 ☐ 5 (Highly supportive).
Elaborate……
……

22. Which policy improvement(s) are needed to enhance NbS integration?

……

23. Can NbS interventions in this biosphere reserve be replicated in other locations? ☐ Yes ☐ No

24. What incentives would encourage broader adoption of NbS among different sectors?

……

25. What barriers limit the scaling up of NbS interventions to other regions? (Select all that apply)

☐ Policy gaps ☐ Limited funding ☐ Lack of technical expertise ☐ Institutional challenges ☐ Others (Specify)

26. What opportunities exist for expanding NbS practices beyond this biosphere reserve?

……

Annexe 3: Focused Group Discussions

Focus Group Discussion Guiding Questions

1. How are community members currently involved in environmental decision-making and NbS projects?
2. What mechanisms exist for feedback and accountability in NbS implementation?
3. What factors encourage or discourage meaningful participation from marginalized groups?
4. How can participatory governance be strengthened to ensure long-term stewardship of NbS?
5. What roles do women and youth play in local NbS initiatives?
6. Are there specific challenges that women face in accessing resources or leadership roles in environmental projects?
7. What strategies have worked (or could work) to promote gender equity in NbS planning and implementation?
8. How can gender-sensitive indicators be incorporated into monitoring and evaluation frameworks?
9. How well are current policies aligned with the goals of NbS and inclusive development?
10. What gaps exist in institutional capacity or coordination that affect NbS outcomes?
11. What kind of support (technical, financial, policy) is most needed to scale successful NbS models?
12. What innovative approaches have emerged in your community or sector to enhance NbS?

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