

Piloting Kenya's Nature-based Solutions (NbS) Monitoring and Evaluation Framework for Kenya: Lessons from the Chyulu Hills

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Contributors & Acknowledgments

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List of Abbreviations

AET	Amboseli Ecosystem Trust
AFOLU	Agriculture, Forestry and Other Land Use
ASAL	Arid and Semi-Arid Lands
CIAT	International Center for Tropical Agriculture
CSA	Climate-Smart Agriculture
FGD	Focus Group Discussion
FMNR	Farmer-Managed Natural Regeneration
GHG	Greenhouse Gas
GPS	Global Positioning System
ICAT	Initiative for Climate Action Transparency
IRB	Institutional Review Board
IUCN	International Union for Conservation of Nature
KALRO	Kenya Agricultural and Livestock Research Organization
KEFRI	Kenya Forestry Research Institute
KFS	Kenya Forest Service
KII	Key Informant Interview
KWS	Kenya Wildlife Service
LDN	Land Degradation Neutrality
MWCT	Maasai Wilderness Conservation Trust
NBE	Nature Based Enterprises
NbS	Nature-based Solutions
NBSAP	National Biodiversity Strategy and Action Plan
NCCAP	National Climate Change Action Plan
NEMA	National Environment Management Authority
NGHGI	National Green House Gas Inventory
NGO	Non-Governmental Organization
REDD+	Reducing Emissions from Deforestation and Forest Degradation
SMS	Short Message Service
UNEP	United Nations Environment Programme
UNEP-CCC	United Nations Environment Programme- Copenhagen Climate Centre
UNFCCC	United Nations Framework Convention on Climate Change
WWF	Worldwide Fund for Nature

Executive Summary

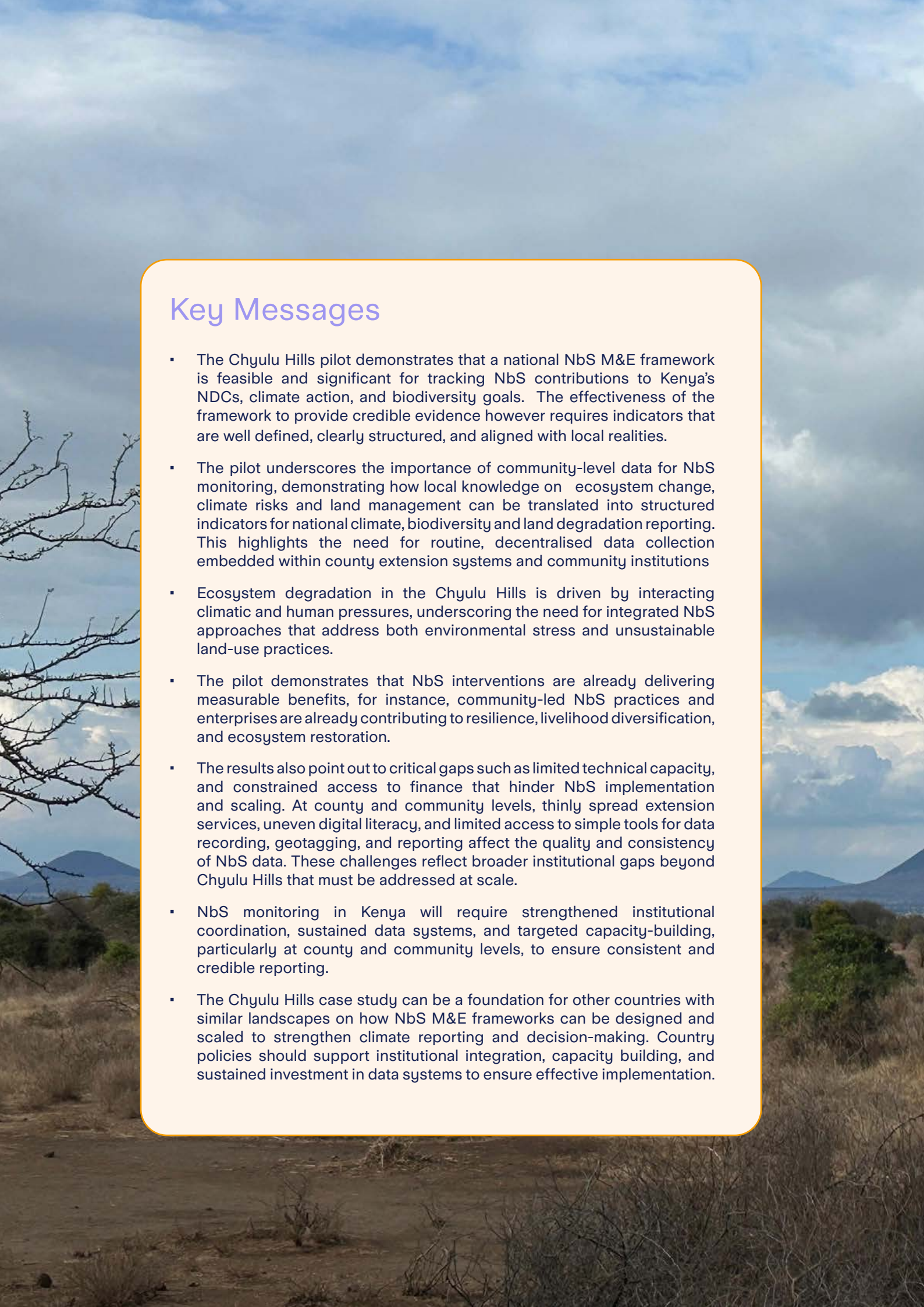
Kenya has increasingly recognised Nature-based Solutions (NbS) as a critical pathway for addressing climate change, biodiversity loss, and land degradation while strengthening livelihoods and food security, particularly in dryland and multi-use landscapes. However, responsibilities for environment, forestry, water, agriculture, land use, and biodiversity are distributed across multiple national and county-level institutions, often resulting in fragmented mandates, overlapping roles, and limited coherence in planning and financing. Effective NbS implementation therefore depends on stronger cross-sectoral collaboration, clear governance arrangements, community participation, and enhanced technical and financial support. Scaling NbS further requires coordinated policy, institutional, and implementation efforts, supported by a robust and harmonised monitoring and evaluation framework that provides credible, standardised evidence to inform national planning, track implementation, and support international climate reporting. In response, the Initiative for Climate Action Transparency (ICAT), in collaboration with the Ministry of Agriculture and Livestock Development (MoALD) Climate Change Unit, and with technical support from UNEP–CCC and Alliance of Bioversity and CIAT, supported the development and piloting of a national NbS Monitoring and Evaluation (M&E) Framework for Kenya.

The developed NbS M&E framework provides a structured approach for assessing the outcomes of NbS interventions and the drivers of ecosystem degradation across Kenya. The framework integrates ecological, socio-economic, environmental, economic, and governance indicators, enabling consistent measurement of NbS performance across landscapes and sectors. It is aligned with the existing Climate Smart Agriculture (CSA) M&E framework, ensuring coherence with Kenya's broader climate transparency and reporting architecture.

The framework was piloted in the Chyulu Hills, a nationally significant dryland landscape characterized by high biodiversity, climate vulnerability, and strong dependence of local communities on natural resources. The pilot confirmed the feasibility of the framework, demonstrating that its indicators are measurable and can generate reliable community-level data that complement institutional datasets. This provides a practical foundation for refining the framework and scaling its application across different agroecological zones in Kenya and beyond.

Findings from the Chyulu Hills highlight the close interlinkages between livelihoods and ecosystem health. Households depend largely on rain-fed, subsistence-oriented agriculture and livestock systems that are highly sensitive to climate variability and natural resource availability. The study identified multiple, interacting drivers of ecosystem degradation, including recurrent droughts, erratic rainfall, rising temperatures, overgrazing, land use change, unsustainable farming practices, and invasive species. These pressures underscore the need for NbS interventions that enhance resilience, stabilize production systems, and restore ecosystem functionality.

The pilot further demonstrates that community led NbS initiatives such as pasture management, tree nurseries, apiculture, and sustainable grazing offer viable pathways for strengthening livelihoods while reducing environmental degradation. Women and youth play a key role in implementing these activities, though their limited participation in decision making highlights an important governance gap. By strengthening evidence on ecological outcomes, livelihood impacts, and governance processes, the framework supports improved planning, accountability, and scaling of NbS across dryland and agricultural landscapes. Its modular structure, use of mixed methods, and alignment with national monitoring systems make it transferable and scalable across Kenya and beyond, while contributing to national climate and development priorities and international reporting obligations.



Key Messages

- The Chyulu Hills pilot demonstrates that a national NbS M&E framework is feasible and significant for tracking NbS contributions to Kenya's NDCs, climate action, and biodiversity goals. The effectiveness of the framework to provide credible evidence however requires indicators that are well defined, clearly structured, and aligned with local realities.
- The pilot underscores the importance of community-level data for NbS monitoring, demonstrating how local knowledge on ecosystem change, climate risks and land management can be translated into structured indicators for national climate, biodiversity and land degradation reporting. This highlights the need for routine, decentralised data collection embedded within county extension systems and community institutions
- Ecosystem degradation in the Chyulu Hills is driven by interacting climatic and human pressures, underscoring the need for integrated NbS approaches that address both environmental stress and unsustainable land-use practices.
- The pilot demonstrates that NbS interventions are already delivering measurable benefits, for instance, community-led NbS practices and enterprises are already contributing to resilience, livelihood diversification, and ecosystem restoration.
- The results also point out to critical gaps such as limited technical capacity, and constrained access to finance that hinder NbS implementation and scaling. At county and community levels, thinly spread extension services, uneven digital literacy, and limited access to simple tools for data recording, geotagging, and reporting affect the quality and consistency of NbS data. These challenges reflect broader institutional gaps beyond Chyulu Hills that must be addressed at scale.
- NbS monitoring in Kenya will require strengthened institutional coordination, sustained data systems, and targeted capacity-building, particularly at county and community levels, to ensure consistent and credible reporting.
- The Chyulu Hills case study can be a foundation for other countries with similar landscapes on how NbS M&E frameworks can be designed and scaled to strengthen climate reporting and decision-making. Country policies should support institutional integration, capacity building, and sustained investment in data systems to ensure effective implementation.

1.0 Introduction

1.1 Background and Context

Nature-based Solutions (NbS) refer to actions that protect, conserve, restore, and sustainably manage natural and modified ecosystems to address societal challenges while enhancing biodiversity and human well-being (UNEA, 2022; UNEP, 2022). According to (IUCN, 2016), NbS include interventions such as forest and landscape restoration, agroforestry, soil and water conservation, rangeland rehabilitation, watershed protection, wetland restoration, and urban green infrastructure. These approaches harness natural ecosystem functions to deliver essential ecosystem services—including provisioning services like food and water, regulating services such as climate regulation, erosion control, and flood mitigation, supporting services like soil formation and nutrient cycling, and cultural services related to heritage and recreation. These ecosystem services are vital for smallholder farmers, who rely on reliable rainfall, fertile soils, and pollination for agricultural productivity and livelihood stability. International commitments, including the Kunming–Montreal Global Biodiversity Framework and the Paris Agreement , further underscore the role of NbS in responding to climate change, biodiversity loss, and ecosystem degradation, with over two-thirds of NDCs mentioning ecosystem-based approaches (UNFCCC, 2021).

In Kenya, the relevance of NbS is heightened by the country's vulnerability to climate variability, land degradation, biodiversity decline, and increasing water scarcity. National policies have integrated NbS as a central component of climate and development planning. Kenya's Second Nationally Determined Contribution (2031-2035) commits to an economy-wide emissions reduction target of 32% by 2030 although sector specific targets are not explicitly defined. Within this context, the AFOLU sector, contributing approximately 73% of national emissions, is expected to deliver a substantial share of mitigation outcomes. NbS actions in this sector, including reforestation and afforestation, restoration of degraded landscapes, protection of water towers, sustainable rangeland management, and conservation agriculture, are therefore prioritized as key mitigation and adaptation pathways. These efforts are further aligned with Kenya's broader national commitment to restore approximately 5.1 million hectares of degraded land under initiatives such as the African Forest Landscape Restoration Initiative (AFR100) and the Bonn Challenge. Beyond mitigation, the NDC also underscores the role of NbS in advancing adaptation and addressing loss and damage through ecosystem restoration, conservation of terrestrial and aquatic systems, and the integration of indigenous, traditional, and local knowledge. In addition, the promotion of nature-based enterprises, including seaweed farming, bamboo value addition, and mangrove eco-tourism, highlights the role of NbS in supporting resilient livelihoods alongside environmental sustainability.

Similarly, the National Biodiversity Strategy and Action Plan (NBSAP) 2019–2030 emphasises ecosystem restoration, biodiversity conservation, and sustainable use of biological resources as foundations for national resilience. These national contributions not only strengthen ecosystem restoration but also support local livelihoods, particularly those of smallholder farmers who depend directly on healthy ecosystems for production and market stability.

Translating Kenya's strong policy commitments on Nature based Solutions (NbS) into effective implementation requires improved institutional coordination and systematic monitoring. Responsibilities for environment, forestry, water, agriculture, land use, and biodiversity are distributed across multiple national and county level institutions, often resulting in fragmented mandates, overlapping roles, and limited coherence in planning and financing. Effective NbS implementation therefore depends on stronger cross sectoral collaboration, clear governance arrangements, community participation, and enhanced technical and financial support.

1.2 The Initiative for Climate Action Transparency

Hosted by UNOPS, the Initiative for Climate Action Transparency (ICAT), provides countries with tailored support and practical tools and methodologies to build robust transparency frameworks needed for effective climate action, in line with national development. ICAT's work is highly relevant in the Kenyan context where climate commitments and sectoral strategies increasingly emphasise Nature-based Solutions (NbS) as a means of addressing climate change, biodiversity loss, and livelihood vulnerability. Despite this growing policy focus, Kenya has historically lacked a standardised and systematic approach for measuring and reporting the

climate, biodiversity, and socio-economic impacts of NbS interventions. This gap has constrained the generation of comparable, evidence-based data to inform decision-making and track progress over time.

In response to this national need, ICAT has supported the development of a dedicated NbS Monitoring and Evaluation (M&E) Framework for Kenya. The framework introduces a coherent set of science-based indicators and methodological guidance for assessing NbS outcomes, while also enabling analysis of underlying drivers of ecosystem degradation and change. The framework supports the tracking of ecological outcomes, climate benefits, livelihood impacts, and governance performance, thereby informing decision-making and guiding future investments (GoK, 2021). Establishing this framework is essential to ensure that NbS interventions are not only well-designed but also measurable, scalable, and capable of delivering long-term sustainable development benefits. Importantly, it is designed to be applicable across sectors such as agriculture, forestry, water resources and scales, and to align with Kenya's national and international reporting requirements, including climate adaptation and mitigation reporting.

Within this broader context, ICAT has worked closely with the Ministry of Agriculture and Livestock Development's Climate Change Unit (MOALD-CCU) to strengthen national capacity for monitoring and reporting climate-related interventions, particularly within the agriculture sector and the larger AFOLU. This collaboration, supported by the United Nations Environment Programme–Copenhagen Climate Centre (UNEP-CCC) and complemented by CIAT's in-field implementation, has generated several key outputs that are directly relevant to Kenya's evolving climate and development agenda, including the integration of NbS.

Notable outputs include national policy analysis and decision-support tools such as the Kenya Climate-Smart Agriculture (CSA) Monitoring and Reporting Framework (2021) which provides guidance for the consistent assessment of adaptation and mitigation outcomes in agricultural systems. In addition, ICAT has supported the development of crop activity data collection tools that enable Tier 2 greenhouse gas emissions reporting for the crop subsector (Mwangi et al., 2024; Nyawira et al., 2024; Ndetu & Nyawira, 2024; Mwangi & Nyawira, 2025).

Collectively, these tools have substantially strengthened Kenya's capacity to quantify agricultural emissions, improve transparency, and track progress toward its Nationally Determined Contribution (NDC) and National Adaptation Plan (NAP) commitments under the UNFCCC, providing a strong foundation for the development and piloting of a dedicated NbS M&E framework.

1.3 Methodology

The development of Kenya's NbS M&E Framework (MoALD & Alliance Bioversity CIAT , 2026) is anchored in three strategic objectives that guide its overall design. First, the framework aims to support international and national climate reporting by generating robust data on NbS interventions within agricultural and adjacent ecosystems, particularly for Biennial Transparency Reports (BTRs). Second, it is intended to enable evidence-based policy design, equipping national and county governments with integrated information to improve agricultural production, food security, and ecosystem resilience, and support the implementation of Kenya's Nationally Determined Contributions (NDCs) under the Agriculture, Forestry and Other Land Use (AFOLU) sector. Third, it seeks to standardize and integrate NbS metrics by identifying and operationalizing coherent indicators that can be systematically aligned with Kenya's existing CSA M&E Framework and the National Agriculture Greenhouse Gas Inventory (NGHGI) Tool, ensuring data consistency and long-term usability.

The framework's development (Figure 1) followed a rigorous, iterative process grounded in a comprehensive literature review of global and regional NbS methodologies and indicator systems. This included assessment of the (IUCN Global Standard for Nature-based Solutions, 2020), (Nature-Positive Agriculture Adaptation Case Studies/ Evidence, 2024) and (UNEP,2021). This evidence base guided the initial identification of climatic and ecosystem risks (e.g., land degradation), key NbS interventions (e.g., land restoration, sustainable grazing, agroecology, community livelihoods), outcome areas, and draft indicators.

Further the findings help define the major outcomes, indicators, and metrics for the framework, which then informed the mapping of all stakeholders essential for subsequent engagement related to data gathering and existing institutional arrangements for data collection.



Figure 1: *The NbS M&E Framework development Process*

The subsequent co-creation phase involved iterative consultation with national and county technical teams, validating indicator relevance, feasibility, and alignment with existing monitoring systems. Following this, structured stakeholder validation workshops ensured methodological clarity, data practicality, and policy compatibility. The final methodological step was the pilot in the Chyulu Hills landscape, where selected indicators and tools were applied to assess usability, data quality, and community-based monitoring capacity, generating practical lessons that informed the final framework.

The NbS (M&E) framework is structured around two core components: drivers of ecosystem degradation, and interventions/solutions. The indicators are designed to capture ecological, socio-economic, environmental, and political/governance dimensions of NbS performance.

At the drivers' level, indicators capture key pressures contributing to ecosystem degradation, including unsustainable agricultural practices, climate change impacts, and encroachment on protected ecosystems. The interventions/solutions component includes indicators at both output and outcome levels to assess progress and effectiveness. Outcome-level indicators capture medium- to long-term changes resulting from interventions. Output-level indicators capture the immediate results of interventions.

- **Outcome 1** Focuses on the adoption of sustainable agricultural practices. This will be achieved by diversifying farming systems through the integration of mixed cropping, crop rotation, intercropping, and agroforestry. To support this transition, the initiative will promote an increased cultivation of indigenous crop varieties alongside the rearing of locally adapted livestock breeds. Furthermore, these efforts will improve overall environmental health by reducing the reliance on synthetic chemicals and driving the widespread adoption of integrated soil fertility management and conservation strategies.
- **Outcome 2** Focuses on enhancing the resilience of communities to climatic shocks. This will be achieved by integrating climate-resilient land and water management and conservation practices across the region. To further empower these communities, climate information services will be significantly strengthened, which will in turn drive the widespread adoption of proactive climate risk reduction practices.
- **Outcome 3** Focuses on the restoration and sustained management of protected ecosystems. This will be achieved by bringing protected areas under sustainable forest and biodiversity management, which will result in improved forest cover, enhanced carbon stocks, greater native species diversity, and the effective control of invasive species. This effort is further supported by actively rehabilitating degraded lands and restoring illegal mining sites to foster broader ecosystem recovery.
- **Outcome 4** Focuses on the enabling environment for implementing and scaling NbS interventions. This looks at strengthening community capacity and raising awareness regarding sustainable ecosystem and land management practices, policy and regulatory frameworks and plans supported by active enforcement mechanisms, finance and investments on NbS, and institutional capacity to coordinate NbS interventions.

2.0 Chyulu Hills Context and Pilot Design

2.1 Why the Chyulu Hills

The Chyulu Hills landscape, recognized for its ecological importance and long-standing conservation initiatives, was selected as the pilot site for the NbS Monitoring and Evaluation Framework. The Chyulu Hills functions as a Socio-Ecological Production Landscape where biodiversity conservation, ecosystem service provision, and local livelihoods are tightly interconnected (UNU-IAS, 2014). As one of Kenya's most important dryland water catchments, the landscape spans Makueni, Kajiado, and Taita Taveta counties, feeding key springs and supplying more than 30 percent of Mombasa's water (Coast Water Works Development Agency, 2019). Its ecological relevance is underscored by the presence of Chyulu Hills National Park, Amboseli National Park, and Tsavo National Park, as well as surrounding community-managed group ranches (Amboseli Ecosystem Trust, 2020). Together, these areas support significant wildlife populations—including elephants and black rhinos (KWS, 2019)—and sustain agro-pastoralist communities whose livelihoods depend on grazing, water resources, and forest products.

However, the Chyulu Hills face increasing environmental pressures. Widespread land degradation, forest loss, soil erosion, invasive species encroachment, agricultural expansion, and illegal logging and charcoal production have been documented in recent assessments (NEMA, 2021; Ogutu et al., 2016). These pressures threaten core ecosystem services such as water regulation, carbon storage, and habitat integrity—services essential to both biodiversity and community wellbeing. This combination of high ecological value and mounting degradation makes the Chyulu Hills a highly relevant setting for piloting NbS designed to restore landscapes and improve climate resilience.

The area surrounding the hills hosts several active NbS- and conservation-related programmes, including the Chyulu Hills Reducing Emissions from Deforestation and Forest Degradation (REDD+) Project, and the TWENDE climate adaptation project among others. These ongoing initiatives—run by government agencies, community institutions, and conservation partners—provide a strong foundation for testing the practicality, relevance, and adaptability of the framework's indicators across different ecological and socio-economic contexts. In this context, the Chyulu Hills provide a strong foundation for piloting an NbS Monitoring and Evaluation Framework. Existing conservation programmes, community institutions, and co-management arrangements offer practical entry points for testing ecological, socio-economic, governance, and perception-based indicators. Lessons from the pilot will help refine the framework and contribute to developing a scalable model suitable for application in similar dryland and multi-use landscapes across Kenya and the region.

2.2 Overview of the Study Area

The Chyulu Hills, located in south-eastern Kenya between Amboseli and Tsavo West National Parks, span Makueni, Kajiado, and Taita Taveta counties. The protected core, Chyulu Hills national park covers approximately 741 km², while the broader socio-ecological landscape extends along a 100 km volcanic belt that includes community-managed areas, grazing lands, and agricultural zones connected to the park. Positioned between Nairobi and Mombasa, the Chyulu Hills form a key ecological corridor within the larger Tsavo–Amboseli system (Figure 2).

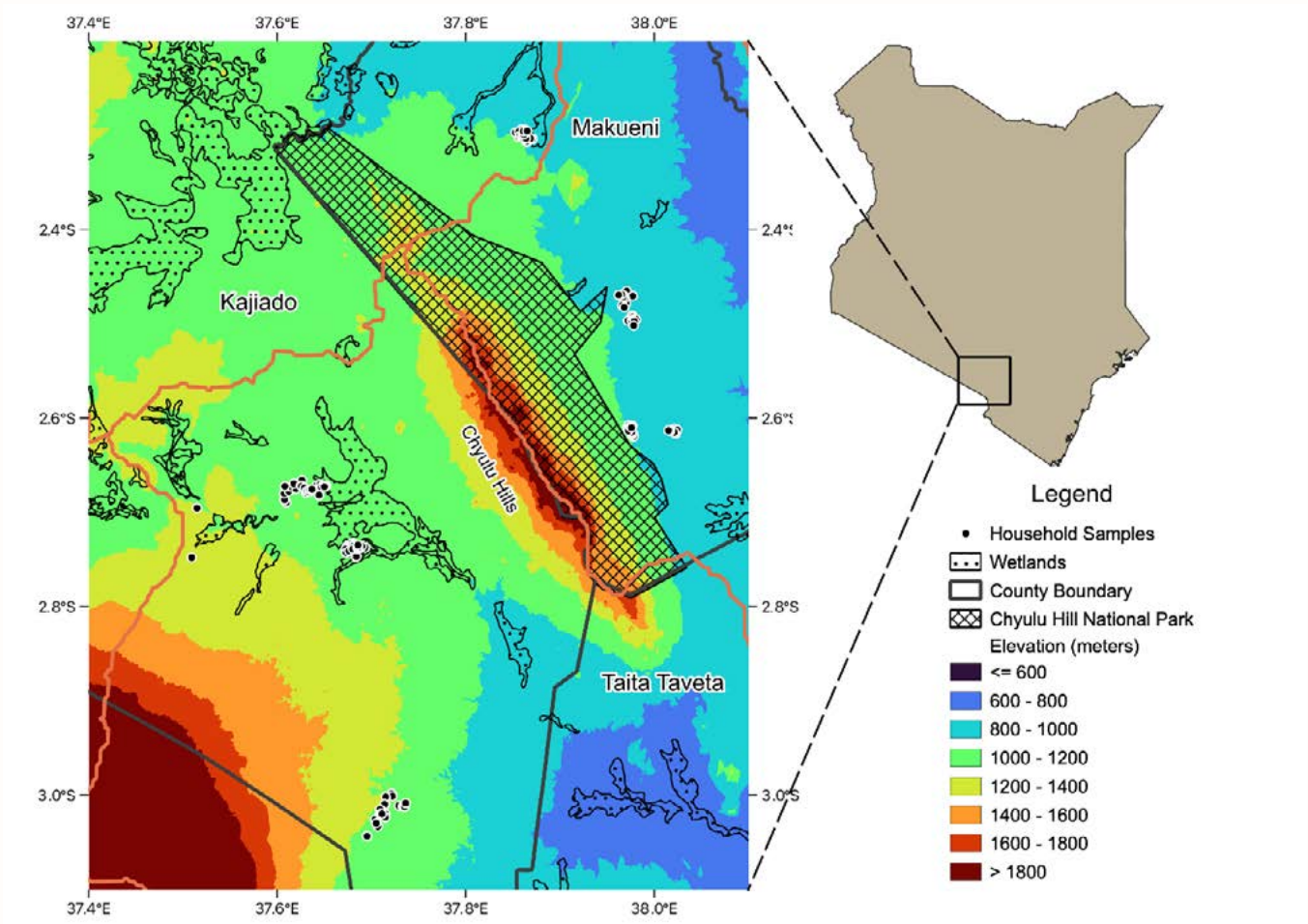


***Figure 2**: A Map showing the Chyulu hills study are and the location of the respondents. The black dots show the location of the households that were interviewed in the pilot phase.*

The landscape contains a diverse mosaic of land uses, including gazetted protected areas, community group ranches that support agro-pastoral systems, and smallholder farming zones at lower elevations. Several rangeland and forest-margin areas show signs of degradation from overgrazing, invasive species, charcoal production, and agricultural expansion. The region's volcanic geology enhances groundwater recharge through permeable lava formations, feeding major springs such as Nolturesh, Umani, and Kiboko, which collectively supply over 30 percent of Mombasa's water. Vegetation ranges from montane forests to savannahs and shrublands, supporting elephants, black rhinos, large carnivores, and a diverse assemblage of herbivores and birds.

Socio-economically, the Chyulu Hills are inhabited by a combined regional population of approximately 2.4 million people. Based on 2019 KNBS census data, this includes Maasai pastoralists in Kajiado (1,117, 580) and Taita Taveta (340,623) and Kamba smallholder farmers in Makueni (987,550), who depend on livestock, rainfed crop production, forest resources, and emerging nature-based enterprises. These communities face recurrent droughts, livestock losses, water scarcity, and fluctuating food security, making them highly vulnerable to climate variability. Governance is shared among Kenya Wildlife Service (KWS), county governments, group ranch committees, conservancies, and Non-Governmental Organizations (NGOs), creating a complex institutional landscape that shapes natural resource management, land-use decisions, and the implementation of Nature-based Solutions.

2.3 Approach and Methodology

2.3.1 Design of data collection tools/ instruments

A core methodological step in the pilot was the systematic translation of framework indicators into measurable, context-appropriate questions for each data collection instrument. This process ensured that the framework's indicators categories, particularly those designed to assess drivers of ecosystem degradation and responses through NbS could be operationalised in the field and generate evidence that was grounded in local realities.

The mapping process began with a detailed review of the NbS M&E framework to identify priority indicators across ecological, socio-economic, governance, and capacity dimensions. Each indicator was unpacked into its underlying constructs, including drivers of degradation (such as land-use change, unsustainable resource extraction, and climate stressors), adoption of NbS practices, governance effectiveness, and livelihood outcomes.

Key Informant Interviews (KIIs) questions were designed to capture institutional and landscape level dynamics, drawing on the expertise of government officials, conservancy managers, NGO practitioners, and researchers. Indicators related to ecosystem pressures, policy and governance arrangements, enforcement mechanisms, and observed ecological and livelihood outcomes were translated into semi-structured questions that allowed for probing, contextual explanation, and triangulation across respondents. Focus Group Discussion (FGD) guides were aligned with indicators requiring collective perspectives and social differentiation, including community participation, gender and youth inclusion, perceived benefits and trade-offs of NbS, and shared constraints to adoption. This ensured that FGDs generated qualitative evidence explicitly linked to framework domains, while still allowing communities to prioritise locally salient issues.

Household survey instruments were mapped to indicators requiring quantitative measurement at the household level, including adoption of NbS practices (such as agroforestry, water harvesting, and restoration activities), access to resources and services, livelihood outcomes, and exposure to climate risks. Where feasible, indicators were translated into closed or semi-closed questions to support aggregation and comparison across sites, while maintaining consistency with qualitative findings from KIIs and FGDs.

The pilot followed a structured, phased approach. Initial stakeholder engagement with county extension officers supported validation of the tools, facilitated community entry, and enabled mobilisation. Data collection was then undertaken using the aligned instruments, ensuring coherence between the framework's indicator architecture and the empirical evidence generated. This indicator-to-question mapping process was critical in demonstrating the usability of the framework, enhancing comparability and triangulation across data sources, and validating that national-level NbS indicators can be realistically measured using standard field tools in complex socio-ecological landscapes such as the Chyulu Hills.

2.3.2 Sampling Design

The pilot for the NbS Monitoring and Evaluation (M&E) Framework was conducted in October 2025 within the Chyulu Hills landscape. The primary purpose aimed at testing the framework's capacity to generate credible, context-relevant evidence on agricultural practices, climate-shock resilience, and restoration outcomes. Further, the overarching objective was to determine whether the framework could produce reliable data to both inform policy development by the Ministry of Agriculture and guide NbS implementers in selecting indicators aligned with national priorities including Kenya's Nationally Determined Contributions (NDCs) and National Climate Change Action Plan (NCCAP) III 2023-2027 as well as global commitments under the Paris Agreement.

A purposive sampling strategy was employed to ensure respondents were both information-rich and representative of the smallholder farming population adjacent to the Chyulu Hills. A total of 158 smallholder farmers were surveyed across Kajiado and Makueni counties. In Kajiado, three group ranches were selected based on their proximity to the landscape and active land-use dynamics; each contributed at least 25 households. In Makueni, three administrative wards with similar agro-ecological and land-use pressures were selected, each also providing a minimum of 25 households. To complement the survey, KIIs and FGDs were held with community leaders, technical officers, conservancy representatives, and other institutional actors. These participants were identified through a stakeholder mapping process conducted during the framework's development, ensuring perspectives were captured across the governance spectrum from county governments and group ranch committees to conservancies, NGOs, and extension services.

2.3.3. Data collection

A mixed-methods approach was used to generate evidence at household, community, and institutional levels to validate and refine indicators in the NbS M&E Framework. Quantitative data from household surveys were complemented by qualitative insights from FGDs and Key informant interviews (KIIs), enabling a comprehensive assessment of NbS-relevant practices, perceptions, and governance dynamics in the Chyulu Hills landscape.

KIIs were conducted using a standardized guide targeting institutions with expertise in ecosystem management and Nature-based Solutions. Respondents included research institutions such as Kenya Forestry Research Institute (KEFRI)

and Kenya Agricultural and Livestock Research Organization (KALRO), government agencies such as Kenya Forest Service (KFS) and KWS, NGOs and conservancies such as Maasai Wilderness Conservation Trust (MWCT),IUCN, Worldwide Fund for Nature (WWF), Big Life Foundation, community-based organizations such as Pioneer Environment Smart, and county government departments. The KIIs captured information on drivers of degradation, resource-use patterns, restoration practices, community engagement, governance arrangements, institutional partnerships, and existing monitoring systems, providing essential context on ongoing initiatives and the enabling or constraining factors affecting NbS implementation in the Chyulu Hills.

At the community and household levels, FGDs and structured surveys were used in a complementary way. Four FGDs were conducted in each county, with at least 10 participants per group representing women, men, youth, and elders. Discussions explored local land and water management practices, awareness and uptake of NbS, climate-related risks, and community governance mechanisms, with translation support provided where language barriers arose. The household survey generated quantitative data across a wide range of thematic areas, including demographic characteristics, livelihood activities, crop and livestock production, soil and water conservation practices, participation in NbS-related initiatives, access to water and pasture resources, climate risks and their effects, and involvement in community-based natural resource management. Additional modules captured perceptions of ecosystem degradation, use of nearby protected areas, and access to climate and weather information. Together, these instruments provided a detailed and comparable picture of how households and communities interact with the Chyulu Hills landscape and engage in NbS activities.

Data collection followed ethical research standards and procedures. It received prior Institutional Review Board (IRB) approval from the Alliance of Bioversity International and CIAT. Consent was secured at three levels: county authorities, community leaders, and individual participants. All participants were informed of the study's purpose, their right to voluntary participation, and measures to ensure confidentiality. Photographs or audio recordings were taken only with explicit, additional permission.

2.3.4 Data management and quality

Data quality during the piloting exercise was ensured through robust digital controls, trained enumerators, and continuous supervisory oversight. Household questionnaires were administered using SurveyCTO on the ONA platform, which supported built-in checks such as skip logic, field constraints, and relevance settings. All tools were pre-tested to confirm clarity and reliability, and enumerators were required to upload completed forms daily for real-time review and error detection. The data collection team consisted of 10 locally recruited enumerators selected in collaboration with county governments. Their familiarity with community settings and fluency in local languages improved field logistics and helped translate technical agricultural and climate concepts into locally understandable terms. A structured one-day training that included mock interviews and device handling ensured standardization in administering digital tools.

Beyond field procedures, data quality was strengthened through systematic metadata and Global Positioning System (GPS) verification. Metadata checks assessed interview duration, start and end times, enumerator IDs, and consent documentation to detect inconsistencies, while GPS coordinates were reviewed to confirm interviews occurred within the targeted sampling areas and followed logical movement patterns. For qualitative components, FGDs were documented through detailed note-taking, and virtual KIIs were recorded, with consent to support accurate transcription. Together, these digital controls, supervisory reviews, rigorous training, and metadata verification processes ensured the integrity, reliability, and robustness of the dataset generated during the piloting exercise.

3.0 Results from the Chyulu Hills Case Study

This chapter presents the key findings from the pilot of the NbS M&E Framework in the Chyulu Hills landscape. The section is structured to closely reflect the logic of the framework, with each section presenting results that correspond to specific levels of the framework. Sections 3.1 to 3.4 provide the socio-economic and production system context, including household characteristics, nature-based enterprises, crop production, and livestock systems. These sections generate baseline and intermediate evidence that links to both driver indicators such as livelihood pressures, land-use practices, and resource dependence, and to early output and outcome indicators, including adoption of sustainable practices, diversification of livelihoods, and participation in NbS-related activities.

Section 3.5 also presents results aligned with the framework's driver indicators, detailing the key climatic and natural resource management pressures contributing to ecosystem degradation, including drought, overgrazing, land-use change, unsustainable agriculture, and resource extraction. This provides a clear diagnosis of the underlying drivers that NbS interventions aim to address. Section 3.6 focuses on outcome-level results, structured around the four core outcome areas of the NbS framework on; sustainable agricultural practices, enhanced climate resilience, restored and sustained ecosystems, and strengthened community governance and capacity. These sections demonstrate changes resulting from interventions, and supported by evidence on land management practices, adaptive capacity, restoration efforts, and institutional strengthening.

3.1 Socio-Economic Characteristics of the Interviewed Households

The demographic characteristics of respondents showed notable differences between Kajiado and Makueni counties (Table 1). Adults aged 36–60 years formed the largest proportion in both areas, although Kajiado had a slightly higher share of younger adults aged 18–35, while Makueni had markedly higher proportion of respondents aged above 60 years. Gender distribution also varied, with Kajiado's sample being male dominated and Makueni's largely female. Marital status was similar across counties, with more than three-quarters of respondents in both locations reporting that they were married.

Education levels differed markedly between the two respondent groups. In Kajiado, many respondents reported having no education, whereas in Makueni most respondents had completed primary or secondary schooling. Only a small proportion in either county reported technical and university education. These contrasts reflect different educational profiles among households participating in the survey.

Table 1: Summary of the demographic characteristics of respondents in Kajiado and Makueni

Characteristic	Category	Kajiado (n=83)	Makueni (n=75)
Age Group	18 - 35 years	27%	20%
	36 - 60 years	63%	55%
	Above 60 years	11%	25%
Gender	Male	60%	36%
	Female	34%	64%
Marital Status	Married	78%	75%
	Single	7%	7%
	Widowed	13%	16%
	Separated	1%	1%
	Divorced	0%	1%
Education Level	In formal	0%	1%
	No-education	66%	4%
	Primary	17%	56%
	Secondary	10%	27%
	Technical	2%	11%
	University	5%	1%

Household income sources showed both similarities and differences between the two counties (Figure 3). Crop sales were a major income source across both groups, reflecting the importance of agricultural production. Livestock-related income was also significant in both counties, though it featured more prominently in Kajiado due to its agro-pastoral systems. Respondents in Makueni reported higher engagement in casual labour and family assistance, while smaller income streams varied, including activities such as animal product sales, charcoal production, and asset renting. Participation in value-added or processed rural enterprises was low in both counties.

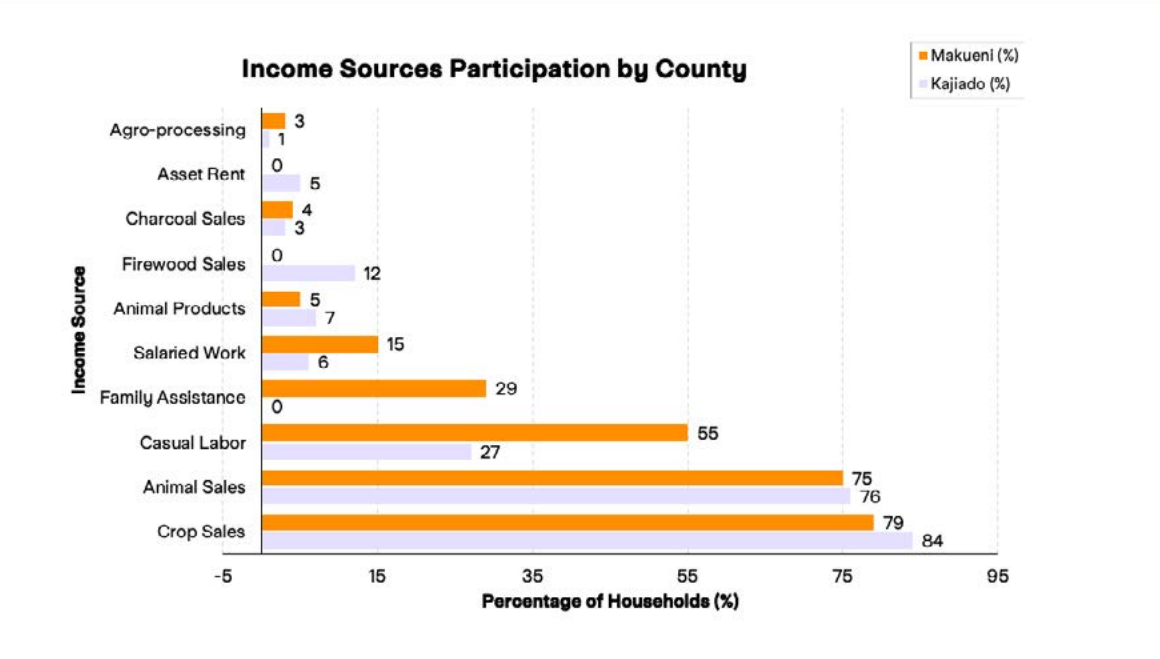


Figure 3: *Income sources of respondents in Kajiado (n=83) and Makueni (n=75)*

Income diversification patterns reinforced these distinctions (Figure 4). In Kajiado, nearly half of surveyed households relied on only two income sources, with participation declining steeply as the number of income streams increased. In contrast, Makueni respondents reported a more diversified livelihood structure, with a majority earning income from three sources.

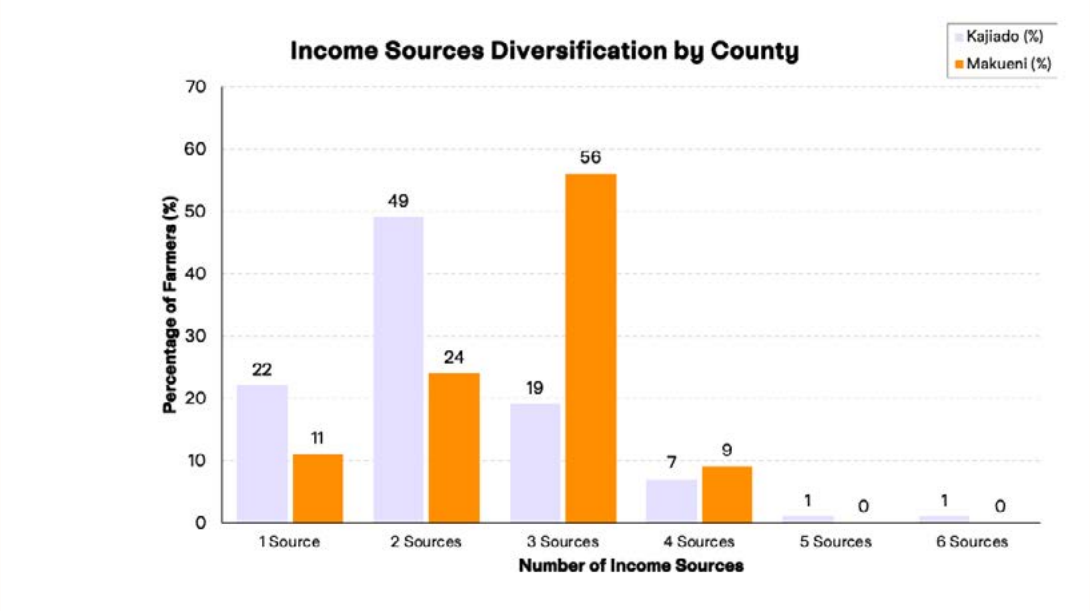


Figure 4: *Percentage of farmers by number of income sources by county [Kajiado (n=83); Makueni (n=75)]*

3.2 Nature Based Enterprises

Nature-based Enterprises (NBEs) are ventures that support biodiversity utilization, conservation, and equitable benefit sharing from derived natural resources, qualifying them as businesses with dual potential for conservation and income generation for local communities (Chiteva et al., 2016). The assessment revealed distinct NBE profiles in Kajiado and Makueni, due to their differing ecological systems. In Makueni, pasture production was the dominant enterprise (52%), significantly surpassing

Kajiado's participation rate of 25%. This substantial engagement reflects Makueni's strong commitment to pasture establishment and management practices through community-based organization (Figure 5). Some of the promoted grass species include *Chloris gayana* (Ex-Tozi Rhodes), *Chloris roxburghiana* (Horse-tail grass), and *Cenchrus ciliaris* (African foxtail grass). Honey harvesting also showed notable participation at 21%, though lower than Kajiado's 33 %, indicating favourable agro-ecological conditions for beekeeping in both counties. Makueni's lower honey-producing capacity relative to Kajiado is likely driven by factors found by (Mutua et al., 2023) which include prolonged dry conditions combined with institutional and market constraints, including limited community sensitization, high beehive costs, weak apiculture husbandry practices, and low-price negotiating power for individual producers. Tree nurseries demonstrated substantial engagement at 20%, more than double Kajiado's rate of 10%, suggesting stronger community involvement in reforestation and agroforestry initiatives. Smaller-scale NBEs included medicinal herbs (9%), which showed modest participation, and ornamental crafts (4%). Ecotourism remained minimal at just 1%, reflecting limited tourism assets compared to Kajiado.

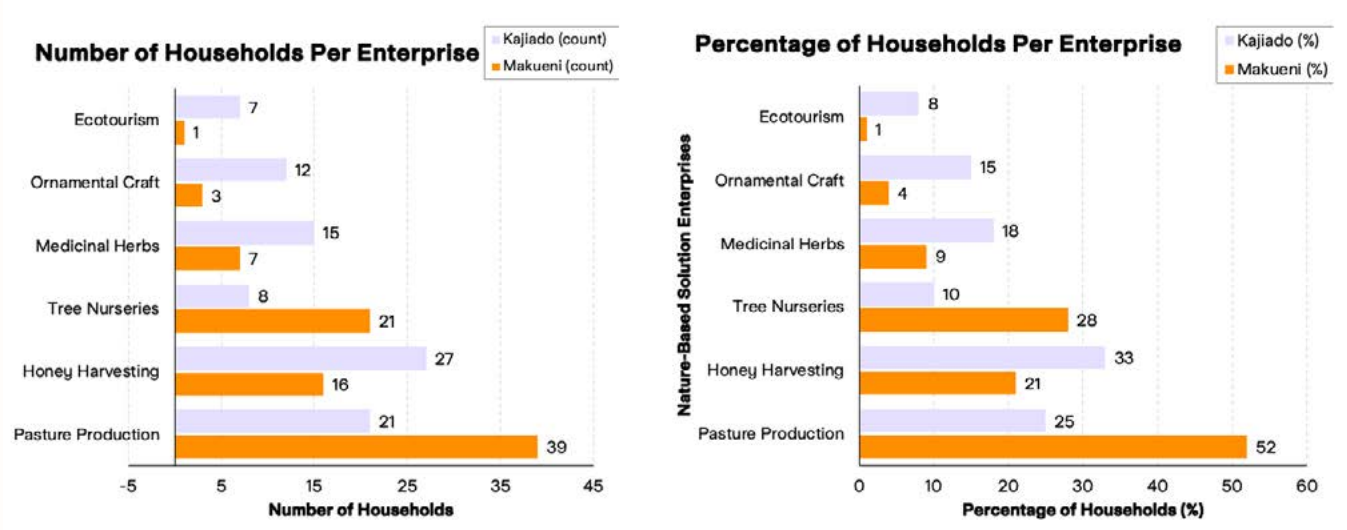


Figure 5: *Number and share of households participating in NbS enterprises in Makueni (n=75) and Kajiado (n=83)*

Patterns of enterprise diversification further distinguished the two counties. Makueni households tended to engage in multiple small-scale NBEs, with 21% participating in two enterprises and additional households engaged in one or three activities (Figure 6). This mix points to moderate diversification and a strategy of spreading livelihood risk across several small ventures. In contrast, diversification in Kajiado was more limited, an estimated 42% of households participated in only one NBE, and engagement sharply declined with additional enterprises. This narrow focus, largely centered on livestock and related activities, may heighten vulnerability to climate and market shocks.

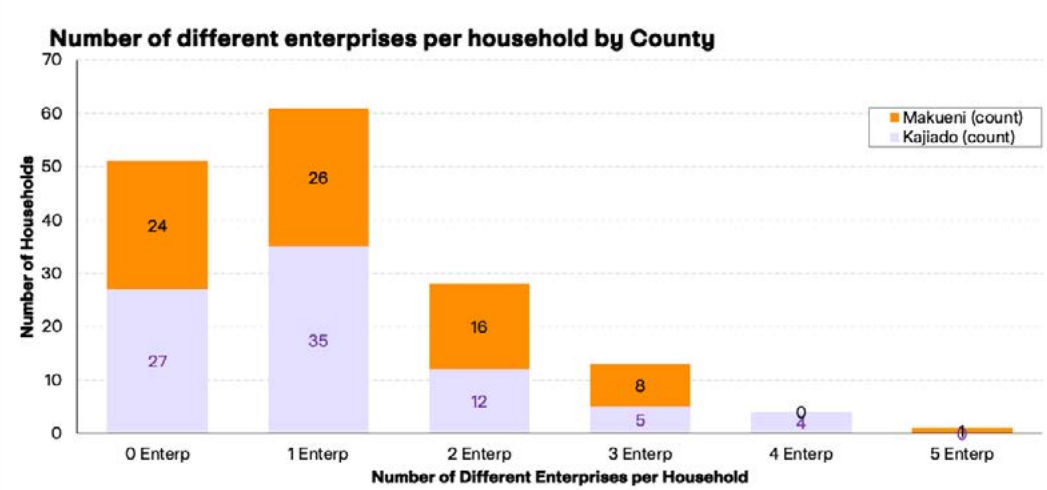


Figure 6: *Number of different NbEs per household in Makueni (n=75) and Kajiado (n=83) Counties*

Out of the interviewed households, 64% had access to finance to support their NBEs. This relatively high level of access to finance particularly through informal and digital channels, may be attributed to the growing penetration of mobile financial services in rural Kenya and the presence of county-level enterprise support programs. The reliance on mobile loans (37%) and limited use of formal banking reflects persistent gaps in institutional credit access, consistent with (Agarwal et al.,2023) on rural financial inclusion where digital platforms fill voids left by traditional banks.

Access to finance for NBEs showed common trends across the counties. Mobile loans were the most widely used financing source (37%) (Figure 7), underscoring the importance of digital credit in rural enterprise development where formal banking services remain limited. Further, County Government programs contributed 20% of support, while microfinance institutions accounted for 20%. NGOs and cooperatives supported 9% and 14% of enterprises respectively. In general, NBE financing was anchored in mobile-based financial services, complemented by public institutions, microfinance actors, and community-based systems that together form a diversified but still limited rural financing landscape.

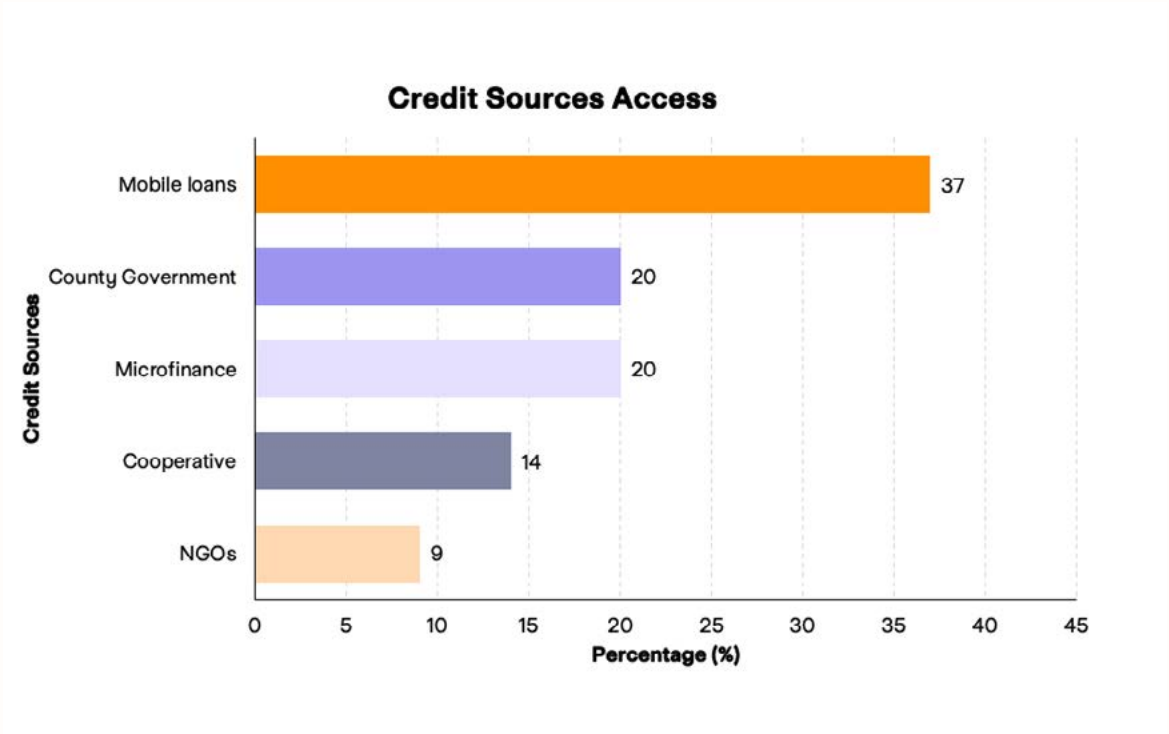


Figure 7: *Sources of Financial Support for NbEs in (Makueni n = 75 and Kajiado n= 83) counties*

3.3 Crop Production and Land Management Practices

3.3.1 Crop Production and Seed Systems

Crop production among surveyed households reflects a predominantly subsistence-oriented system shaped by low and variable rainfall, land degradation pressures, and mixed agro-pastoral livelihoods. Across both Kajiado and Makueni counties, most households cultivated maize, cowpeas, and pigeon peas primarily for household food consumption (Table 2). Market-oriented production was more limited and crop-specific: green grams were the most commercially driven crop, while pigeon peas served dual roles for both food and income. These patterns highlight the continued dependence of households on staple dryland crops for food security, a key consideration for identifying NbS interventions that stabilize yields and build climate resilience.

Seed systems were characterized by a blend of local/indigenous and improved varieties, reflecting adaptation to ecological conditions and variable access to formal input markets. Indigenous seed use dominated for legumes, particularly beans and cowpeas, while maize and green grams showed

higher uptake of improved varieties sourced primarily from agro dealers (Table 2). Informal seed systems remain equally important: nearly half of the respondents relied on saved seed, and others sourced seed from neighbours, supporting local genetic diversity and ecosystem resilience. These findings underscore the need for NbS approaches such as climate-resilient seed systems, community seed banks, and agroecological seed multiplication initiatives that build on both formal and informal seed networks.

Table 2: Key Crops, Uses, and Seed Systems in Kajiado and Makueni Counties

Total No of farmers doing crop prod n=148		Key crops (%)		Crop use	Types of seed used	Sources of Seed		
		For Food (%)	Income (%)	Indigenous	Improved	Own seed	Agro-dealers	Other farmers
Kajiado (n=74)	Beans (88%	58%	42%	59%	41%	22%	45%	6%
	Maize (86%)	81%	19%	10%	91%	3%	89%	5%
Makueni (n=74)	Maize (97%)	94%	8%	75%	25%	49%	26%	11%
	Cowpea (58%)	88%	16%	70%	30%	47%	23%	14%
	Pigeon peas (55%)	85%	22%	56%	44%	56%	22%	17%
	Beans (35%)	65%	35%	58%	42%	42%	31%	15%
	Green gram (35%)	31%	77%	31%	69%	8%	58%	8%
	Sorghum (7%)	40%	60%	60%	40%	80%	20%	0%

3.4 Livestock Systems and Pasture Management

3.4.1 Livestock Production

Livestock keeping was widespread across the surveyed households, with 92% owning at least one livestock species. Goats were the most common livestock type, followed by poultry, sheep, and cattle (Table 3). Ownership patterns reflected the differing production systems in the two counties. In Kajiado, households maintained a diversified mix of ruminants—including sheep (81%), goats (81%), dairy cows (43%), and beef cattle (27%), consistent with the county's agro-pastoral livelihood structure and access to extensive rangelands. In Makueni, households relied more heavily on poultry (74%) and small stock, with additional engagement in apiculture and ownership of bulls and heifers. Indigenous breeds dominated across both counties due to their resilience to drought, heat, and disease stress, while improved or crossbred animals remained limited but were more common in Kajiado. The higher numbers of cattle, goats, and sheep in Kajiado compared to Makueni can be explained by Kajiado's predominantly pastoral and agro-pastoral livelihood system, which is well adapted to extensive rangelands, mobility, and grazing-based livestock production, as highlighted by (Arnold et al. 2024). These patterns reflect livestock systems strongly intertwined with ecosystem health, making them central to how Nature-based Solutions perform in the landscape.

Table 3: Distribution of Livestock Ownership and Livestock Breeds by County

Livestock	Livestock Ownership (%)		Livestock breeds			
	Kajiado N=81	Makueni N=75	Makueni (Indigenous %)	Makueni (Improved %)	Kajiado: (Indigenous (%)	Kajiado: (Improved %)
Milking Cows	43	26	20	4	24	16
Bulls	7	26	19	5	4	3
Sheep	81	17	15	1	47	27
Goats	81	84	76	3	52	22
Helfers	4	10	5	4	3	1
Calves (cattle)	31	11	11	-	22	6
Beef cows	27	-	-	-	17	7
Poultry	38	74	64	5	28	6
Donkey	18	6	5	-	12	4
Apiculture	-	6	5	-	-	-
Livestock Count (mean (SD))	3(2)	2 (1)				

Across the 158 households surveyed, respondents reported a range of livestock production constraints closely linked to ecological pressures and climate variability (Table 4). The most frequently cited challenges across both counties were lack of pasture (84%) and livestock disease (84%), followed by shortage of water for livestock (63%), human–wildlife conflict (42%), and heat-stress-related livestock deaths (10%). County-level contrasts were notable. In Kajiado, 93% of households reported pasture shortages and 76% reported water scarcity, indicating acute grazing pressure and limited dry-season water access. Wildlife conflict was also substantially higher in Kajiado (58%), reflecting proximity to Amboseli and Tsavo ecosystems. Relatedly from the FGDs, communities in Kajiado reported frequent human–wildlife conflict, particularly during the dry season, with African elephants, spotted hyena (*Crocuta crocuta)*, and monkeys causing damage to crop, livestock, and occasionally posing risks to human safety (Mukeka et al., 2018; Mukeka et al., 2020). In contrast, Makueni communities—especially in well-fenced areas—reported significantly fewer wildlife incursions, attributing this to effective boundary management, although rare incidents involving monkeys, birds, and predators were noted.

In Makueni, livestock disease was the dominant constraint, reported by 93% of respondents, while 74% reported pasture shortages and 49% cited water scarcity. Conflict over grazing land (25%) and heat-stress impacts (10%) were reported in both counties (Table 4). These findings underscore the extent to which livestock dependent households rely on ecosystem services, including pasture provision, water regulation, grazing corridors, and disease buffering ecological functions, within a conserved landscape (Nyongesa et al., 2023). They also highlight key entry points for NbS interventions. Rangeland restoration, grass reseeding, invasive-species control, rotational grazing systems, and protection of water catchments directly address the biophysical drivers of pasture and water scarcity. Similarly, improved coexistence measures, rehabilitated buffer zones, and community conservation structures can reduce wildlife conflict (Tsavo Trust, 2025). As such, these results form a critical baseline for designing and monitoring NbS interventions aimed at improving rangeland health, livestock resilience, and ecological sustainability in the Chyulu Hills.

3.4.2 Grazing patterns and pasture management

Grazing patterns further highlighted ecosystem stress within the Chyulu Hills landscape. Nearly half of all respondents (47%) reported grazing their livestock inside protected areas, with this practice far more common in Kajiado (70%) than in Makueni (21%). For those who grazed in protected zones, grazing pressure was reported to be particularly high during the dry season due to limited grazing options in community rangelands. These pressures reflect the dependence of households on the ecological functions of conserved areas, especially the remaining grass cover, dry-season forage, and water access points.

Participation in pasture management initiatives was widespread but varied by county (Table 4). In both counties, over half of households engaged in community pasture management committees. This aligns with research showing that participatory, locally led management systems are critical for addressing degradation and enhancing resilience in community-dependent rangeland settings (Nyongesa et al., 2023). In Kajiado, households showed stronger participation in communal grazing agreements, reflecting more formalized traditional rangeland governance. In contrast, Makueni households demonstrated greater adoption of technical and conservation-oriented measures, including controlled grazing, pasture reseeding, feed conservation, and training in sustainable grazing. These community driven practices represent core Nature-based Solutions that promote rangeland restoration, strengthen fodder availability, and enhance ecological stability under increasing climatic stress. (Nyongesa et al., 2023).

Taken together, water access challenges, grazing pressures, and pasture management strategies reveal the central role of ecosystem health in sustaining livestock livelihoods within the Chyulu Hills. They also demonstrate where NbS interventions, such as watershed protection, restored grazing reserves, improved rangeland governance, and drought resilient pasture systems, can yield tangible benefits for both communities and the conserved landscape.

Table 4: Grazing practices, participation in Pasture Management and Livestock related Challenges by County

	Kajiado (n=81)	**Makueni (n=75)**
Grazing in protected areas	70%	21%
Grazing frequency		
Always (almost every grazing trip / throughout the dry season)	39%	60%
Frequently (at least once a week during the season)	8%	20%
Rarely (only once or twice in the season)	15%	-
Sometimes (a few times in the season, but not regularly)	39%	20%
Participation in Pasture Management Initiatives		
Controlled grazing practices (paddocking, deferred grazing)	17%	33%
Development of communal grazing agreements	60%	21%
Community pasture management	58%	57%
Training in Sustainable pasture management	32%	54%
Reseeding of pasture	6%	42%
Feed conservation	-	21%
Livestock related challenges		
Lack of water for livestock	76%	49%
Lack of pasture	93%	74%
Conflict of grazing land	27%	23%
Livestock disease	76%	93%
Conflict with Wildlife	58%	26%
Death caused by heat stress	12%	9%

3.5 Drivers to Ecosystem Degradation in Chyulu Hills Area

3.5.1 Climate Related Drivers

The Chyulu Hills landscape is exposed to a combination of climatic hazards that are a significant contributor to ecosystem degradation. Household and institutional respondents consistently identified recurrent droughts, erratic and late rains, heat stress, flash floods, pest and disease outbreaks, and persistent dry-season water scarcity as the most severe climatic risks Makueni MoALF, 2016; Kajiado MoALF, 2018) (Figure 8). These shocks result in immediate impacts, including rapid pasture depletion, livestock body weight loss, crop failure or replanting, longer treks to water sources, and intensified competition over shared resources.

Insights from FGDs and KIIs emphasised that these pressures interact rather than occur in isolation: degradation stems from the combined effects of climate variability, resource-dependent livelihoods, and gaps in natural resource governance. During prolonged dry seasons, both livestock and wildlife concentrate along forest margins, riparian areas, and protected zones, increasing pressure on biodiversity-rich ecosystems. KWS further noted altered hydrological regimes, including episodic flooding in downstream areas linked to glacial melt from Mt. Kilimanjaro.

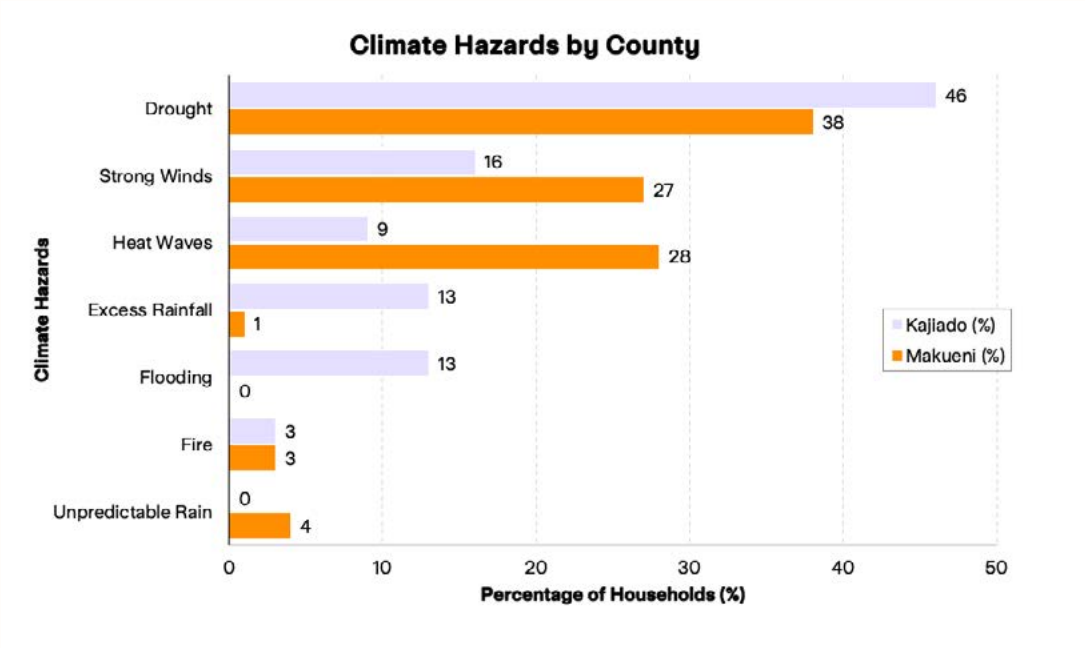


Figure 8: *Climatic Hazards in both Makueni and Kajiado Counties*

3.5.2 Natural Resource Management (NRM) Related Drivers of Ecosystem Degradation

Besides climatic drivers, human-related pressures were identified as major contributors to ecological degradation.

3.5.2.1 Overgrazing and Grazing Management

Overgrazing driven by high livestock densities and weak grazing management, continues to reduce vegetation cover, compact soils, and lower infiltration capacity. During droughts, pasture shortages and water scarcity concentrate livestock and wildlife near water sources, increasing vegetation loss and soil erosion. While some communities use rotational grazing, communal agreements, and pasture reseeding, adoption is uneven. Strengthening community-based grazing management and restoring rangelands can help sustain vegetation and the ecosystem services that support livelihoods.

3.5.2.2 Land Use Change and Agricultural Expansion

Land use change and agricultural expansion are accelerating due to population growth and rising food demand. Informants reported the expansion of commercial agriculture, increased monocropping, and cultivation in ecologically sensitive areas such as wetlands and riparian zones. Together, these trends contribute to habitat fragmentation, biodiversity loss, and the disruption of wildlife corridors.

3.5.2.3 Unsustainable Agricultural Practices

Stakeholders also raised concerns about unsustainable agricultural practices and chemical use. These included inappropriate tillage on steep slopes, burning of crop residues, and the misuse of synthetic pesticides and fertilizers. Such practices contribute to soil degradation, pollution of water bodies, eutrophication, and harm to non-target species such as pollinators.

3.5.2.4 Fire- Related Drivers of Degradation

Fire is a recurrent degradation driver: controlled burns intended for pasture rejuvenation frequently become uncontrolled wildfires, facilitating the spread of invasive species. Some fires on the other hand originate from agricultural residue burning and spread rapidly across dry landscapes while others are as result of honey harvesting by the communities in the protected areas. In Makueni, insights from KIIs indicate that fire incidents can be particularly acute in late dry-season periods (often cited around September), with knock-on effects including vegetation loss and the drying of springs.

3.5.2.5 Illegal Resource Extraction and Encroachment

Illegal resource extraction and encroachment remain a concern despite existing enforcement measures. Although enforcement measures such as fencing, ranger patrols, and community forest associations have reduced incidents in some locations, illegal activities persist. These include charcoal production and fuelwood collection, unauthorized logging of indigenous species, harvesting of forest products and bushmeat, and poaching, which is reported to be declining but still present. These activities are typically carried out covertly and are primarily driven by poverty, resource scarcity, and limited livelihood alternatives. Additional pressures such as sand harvesting, small-scale mining, and land-tenure uncertainty add further complexity to resource governance and undermine ecosystem stability, particularly where enforcement is inconsistent or contested by factors such as corruption.

3.5.2.6 Community Dependence on Protected Area Resources

Findings from FGDs indicate that invasion of protected areas varies between the two counties. In Kajiado, grazing and firewood collection were acknowledged as ongoing, though often covert, coping strategies during periods of resource scarcity. These activities reflect the county's predominantly pastoral livelihood system and continued dependence on natural resources. Conversely, Makueni communities demonstrated higher compliance with conservation restrictions, reporting minimal encroachment due to strict enforcement and fear of penalties. However, participants highlighted that restricted access has reduced availability of grazing areas and firewood, illustrating a trade-off between conservation outcomes and livelihood needs. These findings are consistent with research (Kiumbuku, 2022) showing that communities around the Chyulu Hills National Park remain highly dependent on park resources for their livelihoods, making access restrictions difficult to enforce. This dependence is compounded by limited community involvement in management decisions, perceptions of exclusion and entitlement to local resources, and ongoing human–wildlife conflicts, which together undermine cooperation with authorities and incentivise covert, illegal resource use as a coping strategy.

Patterns of engagement with protected areas offered further insight into community–ecosystem interactions (Table 5). Awareness of protected areas/wildlife corridors was high in both counties (Kajiado: 88%; Makueni: 92%), indicating that differences in engagement are unlikely to be explained by awareness alone. However, among respondents who were aware, patterns of resource-oriented visitation differed markedly between counties. In Kajiado, only 15% reported never visiting protected areas/wildlife corridors to obtain resources, compared with 51% in Makueni, and more frequent visitation (monthly–daily) was higher in Kajiado (36%) than in Makueni (10%). Seasonality also differed: Kajiado, visitation was predominantly reported in the dry season (63%), whereas in Makueni dry-season visitation was lower (22%) and the proportion reporting never visiting remained high (51%). Reported frequency of hearing/seeing illegal activities (e.g., tree cutting, charcoal burning, poaching) in protected areas was broadly similar across counties, with most respondents indicating "never" or "rarely" (Kajiado: 89%; Makueni: 87%), and relatively small proportions reporting monthly-to-daily occurrences (Kajiado: 11%; Makueni: 13%).

Where restrictions are described as strict, insights from KIIs indicate that remaining illegal activities tend to be covert and opportunistic, shaped by livelihood need and enforcement capacity, and in some accounts by corruption risks that may undermine patrol effectiveness. Relatedly, households are the primary resource users, with women commonly responsible for firewood collection, while commercial groups are more associated with logging and charcoal production. Motivations include economic need, lack of alternative energy sources, climate-induced resource scarcity, and, in some cases, weak enforcement or limited awareness of conservation regulations.

Table 5: Awareness and Engagement with Protected Areas/Wildlife Corridors by county

Awareness of protected areas/wildlife corridors **Kajiado** n=83 **Makueni** n=75	**Kajiado: No** =12%; **Yes** = 88% **Makueni: No** = 8%; **Yes** =92%				
How often aware respondents visit protected areas/ wildlife corridors to obtain resources	**Never**	**Rarely**	**Monthly**	**Weekly**	**Daily**
Kajiado	15%	49%	14%	15%	7%
Makueni	51%	39%	4%	6%	0%
Seasons of visits to protected areas/wildlife corridors (among respondents who are aware of these areas).	**Wet**	**Dry**	**Both**	*(Those who never visit protected areas)*	
Kajiado	7%	63%	15%	15%	
Makueni	16%	22%	12%	51%	
Frequency of hearing/seeing illegal activities (e.g., tree cutting, charcoal production) in/around protected areas (among respondents who are aware of these areas).	**Never**	**Rarely**	**Monthly**	**Weekly**	**Daily**
Kajiado	41%	48%	6%	3%	3%
Makueni	46%	41%	9%	4%	0%

3.6 Outcome Level Results from Chyulu Hills Landscape

The pilot further tested the NbS Monitoring and Evaluation framework's ability to generate credible, context specific evidence across its four defined outcome areas: sustainable agricultural production, enhanced resilience to climatic shocks, restored and sustained protected ecosystem, and community governance and capacity. These outcome areas constitute the core results pillars of the framework, designed to capture the integrated socio ecological impacts of Nature based Solutions within the Chyulu Hills landscape.

Through the structured assessment around these pillars, the pilot not only evaluated the framework's operational practicality in a key biodiversity hotspot but also produced actionable insights to inform its refinement and support future scaling across similar landscapes.

3.6.1 Sustainable Agricultural Practices

Land and soil management practices varied notably across Kajiado and Makueni counties, reflecting differences in agroecology, production systems, and household adaptation strategies. Organic amendments were widely used in both counties, demonstrating reliance on low-cost, locally available fertility inputs and alignment with integrated soil fertility management practices emphasized in the NbS M&E framework.

Makueni exhibited stronger adoption of soil and water conservation (SWC) structures, particularly terracing, which was implemented by 67% of households compared to 31% in Kajiado. This reflects a more intensive response to sloping terrain, declining soil moisture, and erosion pressures. Intercropping was also substantially more common in Makueni, highlighting its role as a risk-buffering practice under rainfall variability and contributing to diversified farming systems through mixed cropping.

In contrast, Kajiado displayed a more balanced mix of cropping systems, including monocropping, intercropping, and crop rotation, shaped by agro-pastoral livelihoods and smaller cropping areas. Households in Kajiado also applied a broader range of SWC measures, such as contour ploughing and contour bunds, often linked to rangeland–cropland interfaces. Mixed farming, which integrates crops and livestock, was more prevalent in Kajiado and represents a critical NbS pathway, offering co-benefits for soil health, nutrient cycling, and landscape resilience while supporting the rearing of locally adapted livestock breeds.

Overall, land management across the Chyulu Hills landscape combines traditional practices, targeted conservation measures, and agroecological techniques. Observed practices correspond closely with key indicators in the NbS M&E framework, including diversified farming systems through mixed cropping, crop rotation, intercropping, and agroforestry; increased cultivation of indigenous crop varieties and locally adapted livestock breeds; reduced reliance on synthetic chemicals; and adoption of integrated soil fertility management and conservation practices.

These patterns present strategic entry points for NbS interventions such as agroforestry expansion, regenerative soil management, and landscape-scale erosion control, which can enhance both productivity and ecological resilience (Table 6).

Table 6: Land, Soil and Water Management Practices by county

Category	Practice/System	Kajiado	Makueni
Soil & Water Conservation (SWC)	Contour bunds	17%	3%
	Contour Ploughing	21%	6%
	Grass Strips	17%	12%
	Mulching	8%	3%
	Terracing	31%	67%
	Zai pits	3%	8%

Category	Practice/System	Kajiado	Makueni
Cropping Systems	Alley/Strip cropping	2%	7%
	Intercropping	27%	68%
	Monocropping	29%	16%
	Crop rotation	22%	3%
	Mixed farming	19%	2%
	Multiple cropping	2%	4%
Soil Fertility Management (SFM)	Organic amendments	39%	31%
	Conservation structures	13%	22%
	Cover cropping	1%	5%
	Reduced/minimum tillage	1%	6%
	Agroforestry	1%	6%
	Intercropping	17%	27%
	Mulching	1%	0%
	Crop rotation	28%	3%

3.6.2 Enhanced Climate Resilience to Climatic Shocks

Household adaptive capacity reflects the evolving risk dynamics across the Chyulu Hills landscape. Drought remains the most pervasive shock in both counties, yet coping strategies differ markedly between regions. Kajiado households relied primarily on mobility-based strategies, including temporary migration and herd movement, complemented by livestock vaccination and limited livelihood diversification. In contrast, Makueni households relied more on in situ measures, including livelihood diversification, adoption of early-maturing crop varieties, vaccination, and water-saving practices, with minimal dependence on migration. These approaches illustrate varying degrees of climate risk reduction practices, a key indicator in the NbS M&E framework (Figure 9).

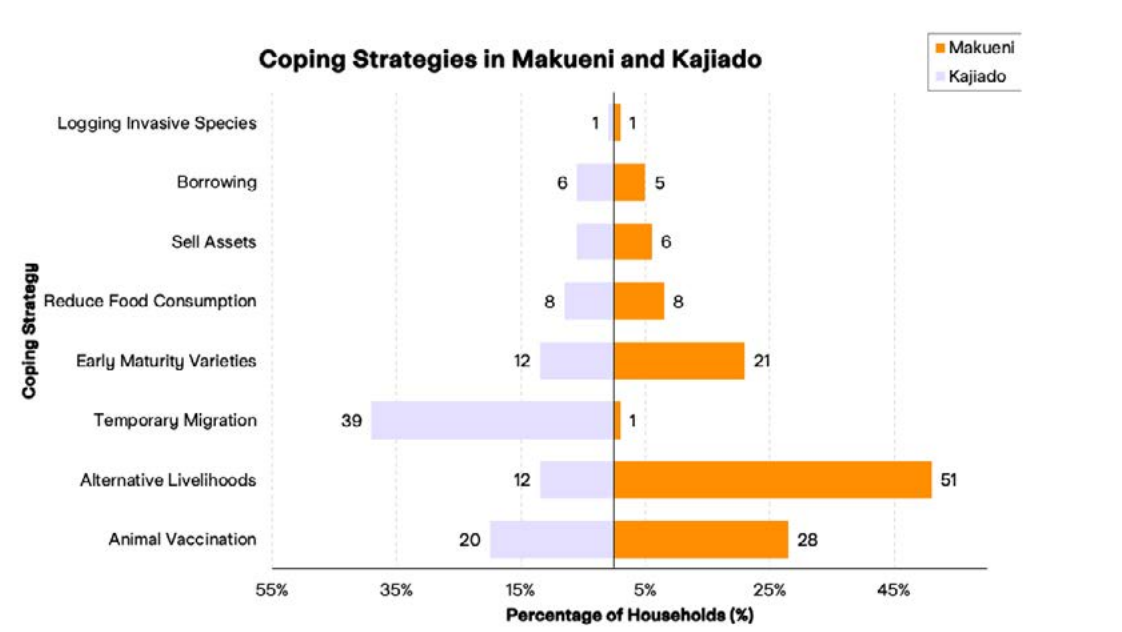


Figure 9: Coping Strategies in Makueni and Kajiado Counties

Access to climate information is high across the landscape, with over 90% of households receiving weather forecasts. However, analyzing the trust indicators highlights a critical vulnerability in the system. While 45% of respondents "somewhat" trust the data, 43% do not trust it at all, and only 12% report full confidence. This mistrust may stem from how the information is delivered: the vast majority receive forecasts via radio (84%) and on a primarily seasonal basis (55%), which may lack the local accuracy and frequency needed for day-to-day decisions. Nevertheless, because households still heavily rely on this data for crop planning (84%) and disaster preparedness (54%), this trust deficit presents a prime opportunity. Co-developing more frequent, localized, and reliable forecasting systems with the community can generate stronger buy-in, ultimately enhancing anticipatory action and integrated land and water management (Table 7).

Table **7**: Climate Information Summary for Makueni and Kajiado Counties

Category		Count	Percentage
Receive	Receive	143	91%
Don't receive	Don't receive info	15	10%
Media sources (*among 143 households receiving weather information*)			
	Radio	120	84%
	Mobile Phone	49	34%
	Community meetings	40	28%
	Television	29	20%
	Extension officer	28	20%
Frequency			
	Seasonal	78	55%
	Monthly	27	19%
	Rarely	23	16%
	Daily	9	6%
	Weekly	6	4%
Trust Levels			
	Somewhat	65	45%
	Not trust	61	43%
	Completely	17	12%
Usage			
	Crop Planning	69	84%
	Disease/Disaster Prep	44	54%
	Livestock management	32	39%
	Water management	27	33%

Water scarcity remains a significant constraint affecting agricultural production, ecosystem management, and restoration outcomes. Household access to water varies depending on the distribution of boreholes, piped systems, surface water, and seasonal water points. Boreholes serve as the primary source of livestock water in both counties, yet challenges such as high pumping costs, mechanical breakdowns, seasonal unreliability, and long travel distances persist. In Makueni, water access is highly seasonal due to variable rainfall, whereas Kajiado households rely more on seasonal rivers that become unreliable during prolonged dry periods. Across both counties, more than 60% of households reported perceived declines in water quality, including changes in colour, taste, and turbidity, reflecting watershed degradation and sedimentation linked to upstream land-use pressures (Table 9).

Table 8: Water Issues Across Makueni and Kajiado County

	Both Counties	Kajiado (n=83)	Makueni (n=75)
Water challenges			
Challenge of water accessibility	21%	22%	20%
Challenge of water cost	39%	36%	42%
Challenge of seasonality	26%	8%	47%
Challenge of water contamination.	33%	30%	36%
Other water challenges	7%	4%	11%
Type of water harvesting Structures			
Rainwater harvesting tanks	71%	91%	66%
Drums	18%	0%	23%
Water pans/ponds	14%	10%	15%
Jerricans	12%	0%	15%
Hours Spent to reach the nearest Source of Livestock water during the last dry season			
1-2 Hours	26%	24%	27%
2-4 Hours	24%	35%	11%
4-6 Hours	9%	18%	0%
Less than 1 hour	41%	23%	60%
More than 6 hours	1%	0%	1%
Sources of domestic water			
Borehole	53 %	65%	40%
Piped water (In the Household)	3 %	0%	5%
Piped water (Water kiosk)	14 %	9%	20%
Rainwater Harvesting	5 %	1%	8%
Surface water river, lake or pond)	13%	25%	0%
Trucked water	8%	0%	16%
Change in water quality from selected sources			
Water quality change (**yes**)	61%	62%	60%
Changes in colour	37%	50 %	22%
Changes in odour	10%	12%	7%
Changes in taste	84%	82%	87%
Increased turbidity	7%	4%	11%
Main Source of Livestock Water			
Boreholes	52%	49%	56%
Piped water in the household	2%	0%	4%
Piped water (water kiosk)	13%	1%	26%
Seasonal river	27%	49%	4 %
Spring	1%	1%	0%
Water pan	2%	0%	4%
Well	3%	0%	6%

In response, communities and institutions have adopted a growing range of water-management practices that also function as Nature-based Solutions. When properly maintained, these systems enhance infiltration, support vegetation regeneration, improve dry-season water availability, and stabilize food and fodder production, with households reporting improvements in livestock productivity, pasture recovery, and domestic water security. Participatory management of water points strengthens trust, collaboration, and mutual support among households, as water is widely regarded as a community resource (Jacob, 2025; Awuora, 2024). Evidence from Kajiado similarly shows that active community engagement improves the relevance and sustainability of water projects, reinforcing social networks and local resilience (Tendwa & Mutundu, 2023). These interventions thus enhance ecosystem services while building social capital and collective wellbeing.

Despite these gains, the effectiveness of water management structures is often constrained by labour demands, limited maintenance capacity, inappropriate siting, restricted technical support, and unpredictable rainfall. These challenges highlight the need for integrated, watershed-based NbS that combine water harvesting with catchment restoration, strengthened governance of water points, and closer alignment between community institutions and county or conservancy led initiatives. Water availability and its management remain central to the success of restoration, agroforestry, and rangeland interventions across the Chyulu Hills, emphasizing water as a foundational entry point for scaling Nature based Solutions and building climate resilience.

3.6.3 Restored and Sustained Protected Ecosystem

Across the Chyulu Hills landscape, communities and institutions have gradually shifted from open-access resource use toward more structured ecosystem management. Discussions from the FGDs revealed that households are increasingly engaging in restoration practices such as protecting springs and wetlands, installing spot fencing, desilting community ponds, undertaking pasture reseeding in designated enclosures, and constructing predator-proof bomas to limit livestock losses during periods of heightened wildlife pressure. Although these interventions contribute to improved ecological health, their sustainability is limited by challenges such as insufficient maintenance funds, labour shortages, limited access to inputs, and inconsistent coordination across water, wildlife, and agricultural actors. With modest and sustained support, however, these measures could remain viable and deliver significant returns to both households and the environment.

Land-use change continues to shape ecosystem dynamics. Participants noted the expansion of cultivation into former rangelands, shorter or absent fallow periods, increased fencing of grazing areas, and rising use of agrochemicals along seasonal streams where small-scale irrigation has grown. Rehabilitation of degraded rangelands—through terracing, soil bunds, and reseeding—has been reintroduced by project-based initiatives, although many of these practices decline once external support ends. While tree planting has expanded through homestead nurseries and watershed initiatives, survival rates remain low due to prolonged droughts, poor aftercare, and pest pressure.

Agroforestry is widely promoted and variably adopted across the Chyulu Hills landscape. Households integrate trees into their farming systems through silvopastoral practices, live fencing, windbreaks, and the establishment of fruit trees for nutrition and supplemental income. Where adopted effectively, these systems improve soil moisture retention, contribute to microclimate regulation, expand fodder availability, and provide diversified livelihood benefits. Additionally, the tree planting expanded through homestead nurseries and watershed initiatives further contributes to forest cover, carbon stocks and native species diversity. However, adoption remains uneven and survival rates remain low, largely constrained by water scarcity, poor aftercare, inadequate extension support, and uncertainty about land rights. Many households plant trees but struggle with maintenance, particularly during extended dry spells when watering is limited and termite infestations increase seedling losses. While restoration and agroforestry programmes have created strong awareness of the potential benefits, the transition to more widespread and sustained adoption requires stronger support systems, including improved access to water, seedlings, technical guidance, and incentives that align short-term needs with long-term ecological gains.

Fire management has become a key restoration strategy across the Chyulu Hills landscape, with community-led actions such as constructing firebreaks, supporting patrols, and participating in seasonal awareness campaigns helping to reduce wildfire risk and protect regenerating vegetation. These efforts are reinforced by invasive species removal and riparian restoration measures, including spring protection, riverbank stabilization, and the construction of gabions and water diversion structures to control erosion and enhance infiltration. With support from conservancies such as Big Life, MWCT, and the Amboseli Ecosystem Trust (AET),

alongside NGOs and research institutions, these interventions are contributing to improved ecosystem integrity and the long-term sustainability of restored and protected areas.

Despite the introduction of newer restoration interventions, many households continue to rely on conventional agro-pastoral practices. Mixed crop–livestock production remains the norm, with maize–bean systems dominating even as drought-tolerant crops become more common. Conventional tillage, manure application, hand weeding, and sporadic pesticide use continue to characterize field operations. Grazing patterns remain largely open-access except in areas where rotational grazing or cut-and-carry systems have been introduced through group ranch initiatives. These trends illustrate a transition phase in which emerging restoration efforts coexist with long-standing livelihood systems, offering a foundation upon which stronger NbS approaches can be built.

3.6.4 Community Governance and Capacity

Insights from KIIs indicate that restoration across the Chyulu Hills has evolved into a coordinated, multi-actor landscape process involving conservancies, community groups, NGOs, county governments, and national research institutions. Forested zones are undergoing active reforestation led by KFS, KEFRI, and county governments, while community nurseries support the supply of indigenous seedlings for homestead planting and watershed rehabilitation. In the rangelands, adoption of Farmer Managed Natural Regeneration (FMNR) has expanded, particularly through selective pruning of Acacia species to enhance grass regrowth and natural tree recovery. Pasture reseeding efforts, especially using species such as *Bushra and Masai love grass*, have shown promising results when timed with early rains, contributing to improved forage availability in previously degraded grazing blocks.

As illustrated above, community involvement in fire management, invasive species control, and riparian restoration, supported by key conservancies, NGOs, and research institutions, signals strengthening local capacity and more coordinated governance for sustainable ecosystem management.

Respondents reported visible improvements linked to these initiatives, including better vegetation cover, increased grass species diversity, improved soil fertility, enhanced water retention in catchments, and reduced wildfire incidence. Many communities have also developed a renewed belief in the possibility of ecological recovery, with improved livestock survival during dry seasons in areas where reseeding and FMNR have been consistently implemented. Nonetheless, barriers remain, including erratic rainfall, labour constraints, limited financial resources, short project cycles, lingering scepticism in some communities, and challenges linked to land tenure. These constraints underscore the need for long-term institutional support and mechanisms that sustain restoration gains.

Focus group discussions further revealed governance-related differences across the landscape that influence restoration outcomes. Communities in Makueni reported structured mechanisms such as grazing committees, environmental oversight bodies, and community by-laws that support natural resource management, with some participants linking these arrangements to improvements in tree cover and food security. In contrast, governance in Kajiado appeared more informal, relying largely on negotiated access arrangements such as reserved grazing areas during drought and exhibiting fewer regulatory structures. Across both counties, compensation for wildlife-related losses was acknowledged but widely described as delayed, a factor that may undermine community tolerance for conservation measures and weaken long-term restoration success.

Community awareness of ecosystem degradation and the role of Nature-based Solutions is high across the Chyulu Hills landscape, as reflected in the FGDs and KIIs. Participants demonstrated a clear understanding of major local challenges—including soil erosion, pasture decline, and water scarcity—and expressed strong support for restoration and conservation efforts. However, practical capacity gaps remain significant. Many communities know what interventions are needed (tree planting, spring protection, rotational grazing), but lack the technical skills required to implement them effectively, such as soil testing and interpretation, pasture condition scoring, integrated pest management, water-point maintenance, and tree aftercare. Training remains inconsistent, often delivered through short-term projects with limited follow-up, leaving communities without continuous extension support needed for sustained NbS adoption.

Capacity-building initiatives in the landscape are extensive and diverse, delivered by conservancies, NGOs, county governments, and research institutions. Training programmes cover FMNR, agroforestry, beekeeping, rangeland restoration, soil and water conservation, gender-responsive restoration, briquetting, and riparian rehabilitation. In conservancy-managed zones, these activities are more regular and structured, supported by ranger-led sessions, demonstration plots, and community-based organisations. In contrast,

Makueni communities rely more on intermittent NGO and county extension services, resulting in uneven distribution of technical knowledge across the landscape. Despite this variability, a growing understanding of NbS principles has emerged, particularly where practical demonstrations and on-site mentorship accompany trainings.

Participation patterns also shape community capacity to adopt NbS. Women and youth play central roles in nursery management, seedling care, record keeping, firefighting, and invasive species removal, yet they remain marginalised in decision-making structures dominated by men, such as grazing committees and resource-user associations. CBOs act as critical mobilisers and custodians of community bylaws, but their influence varies across locations. Enabling factors such as carbon credit revenues, ranger employment, scholarships, and NGO support have strengthened participation in some areas by providing tangible incentives for engagement in restoration. Nonetheless, significant barriers persist, including labour constraints, limited access to climate-smart technologies, weak extension services, low digital literacy, and erratic rainfall that undermines confidence in long-term investments.

Communities also highlighted challenges in accessing and using climate information—despite high overall access, trust levels remain low, and technical advisories are often not available in local languages or simplified formats. This limits the use of climate data for anticipatory ecosystem management. FGDs indicated strong interest in more accessible information channels, such as Short Message Service (SMS) and voice-based advisories, community radio, and visual demonstration plots. Strengthening community capacity therefore requires a more continuous, inclusive, and coordinated approach. Seasonal training schedules aligned with rainfall patterns, community-led monitoring systems, gender-responsive governance reforms, and consistent technical support from conservancies, county governments, and research institutions would deepen community ownership and enhance the long-term effectiveness of NbS across the Chyulu Hills landscape.



4. Lessons and Recommendations for Strengthening Nbs Monitoring in Kenya

4.1 Lessons from the Chyulu Hills Pilot

The Chyulu Hills pilot demonstrates that meaningful monitoring of NbS in Kenya must be anchored at the household and community level, where NbS interventions are implemented and where ecosystem change is first experienced. Evidence from the pilot shows that farmers and pastoralists possess strong awareness of ecosystem degradation, climate risks, and restoration priorities, and are already engaging in NbS-related practices such as pasture reseeding, soil and water conservation, agroforestry, and sustainable grazing. However, these actions are rarely captured through routine, standardised data systems. The pilot confirms that without a structured framework, NbS monitoring remains fragmented, project-specific, and difficult to aggregate for county or national reporting.

Beyond identifying where NbS data resides, the pilot demonstrates the value of the NbS M&E Framework as a decision-support and evaluation tool. By systematically capturing data on ecosystem condition, livelihood practices, and climate risks, the framework enables stakeholders to assess the effectiveness of NbS interventions, identify priority areas for action, and track changes over time. This strengthens evidence-based planning at both county and national levels and supports more targeted and efficient allocation of resources. At the local level, the framework also creates opportunities for communities to benefit from improved monitoring systems. By making visible the outcomes of their practices and strengthening data flows from community to national levels, the framework enhances local participation in decision-making, supports better resource management, and can contribute to improved access to NbS-related investments and programmes over time.

Evidence from the Chyulu Hills pilot shows that local NbS practices such as pasture management, tree nurseries, and sustainable grazing contribute positively to climate adaptation, biodiversity conservation, and sustainable livelihoods, rather than unintentionally exacerbating environmental degradation. This provides clear messages to ministries and policymakers about the effectiveness of locally implemented interventions.

The pilot further demonstrates how the NbS M&E Framework can inform policy and management decisions. By linking data on ecosystem degradation, livelihood practices, and NbS interventions, the framework provides a basis for identifying priority areas for restoration, selecting context-appropriate NbS measures, and tracking progress against national targets such as the NCCAP and NDCs. It also enables comparison across locations and over time, supporting more strategic planning and improved targeting of NbS investments at both county and national levels.



A key lesson is that NbS performance data do not primarily reside within institutions, but rather with land users themselves. Household surveys, FGDs, and KIIs revealed that farmers routinely manage information relevant to NbS such as changes in pasture condition, water availability, crop performance, livestock health, and restoration outcomes—but this information is informal, inconsistently recorded, and seldom linked to formal monitoring systems. The NbS M&E Framework proved effective in translating these lived experiences into structured indicators aligned with Kenya's climate, biodiversity, and land-degradation reporting needs. This reinforces the importance of routine, decentralised data collection mechanisms that can be embedded within county extension systems and community institutions, rather than relying solely on ad hoc project evaluations.

The pilot also highlights the importance of context specificity in NbS monitoring. Distinct livelihood systems in Kajiado and Makueni agro-pastoral versus mixed smallholder systems, shaped how communities adopt NbS practices, respond to climate shocks, and interact with protected areas. A rigid, one-size-fits-all indicator set would fail to capture these differences. The framework's modular structure allowed indicators to be applied flexibly while maintaining comparability across counties, offering an important lesson for national scaling across Kenya's diverse agro-ecological zones, as recognised in the National Climate Change Action Plan (NCCAP III, 2023–2027) and County Climate Risk Profiles developed by the Ministry of Agriculture and Livestock Development (MoALD).

4.2 Key Gaps Identified

Despite the framework's effectiveness, several gaps were identified during the pilot. First, data continuity remains a major challenge. Most NbS-related data are collected through short-term projects, with no institutionalised mechanism for regular follow-up. This limits the ability to track trends in ecosystem recovery, livestock resilience, or livelihood outcomes over time—an issue also noted in Kenya's State of Environment Reports (NEMA, 2021).

Second, institutional coordination gaps persist across sectors and governance levels. NbS-relevant data are scattered across agriculture, environment, water, forestry, and wildlife agencies at both national and county levels, reflecting fragmented mandates established under Kenya's devolved governance system. While policies such as the Climate Change Act and the National Climate Change Action Plan emphasise integrated approaches, operational coordination for NbS monitoring remains weak (Government of Kenya, 2016 & 2023).

Third, capacity constraints at county and community levels limit effective implementation. Extension services are thinly spread, digital literacy is uneven, and many community institutions lack simple tools for data recording, geotagging, and reporting. These gaps directly affect the quality and consistency of NbS data, particularly in remote rangeland areas such as those surrounding the Chyulu Hills.

4.3 Recommendations from the Pilot Study

4.3.1 Refinement of the NbS M&E Framework

The pilot highlights the need to revise the NbS M&E framework through a systematic comparison between the intended indicator set and the type, quality, and feasibility of data generated in practice. While the framework is extensive, covering ecological, socio-economic, environmental, and policy and governance dimensions, the findings show that not all indicators are equally measurable at the local level. While household and community data provided rich local insights, the pilot also assessed existing institutional datasets from county and national agencies, national parastatals, and NGO to determine data availability and quality for NbS indicators. This review informed the feasibility of indicators and highlighted areas where the framework could be revised to better align with available data. Indicators grounded in everyday practices, such as land management, water use, grazing patterns, and livelihood activities, were more readily captured through household surveys, FGDs, and KIIs, and provided insights into how communities interact with ecosystems and implement NbS interventions. In contrast, higher-level or technically complex indicators (e.g., ecosystem condition metrics, carbon-related indicators, and biodiversity measures) lacked sufficient baseline data. This gap underscores the need to refine the framework by aligning indicators with existing data availability realities, while maintaining its ability to capture long-term NbS outcomes.

4.3.2 Usability and Scaling of the NbS M&E Framework

The pilot shows strong motivation among communities but persistent gaps in technical know-how such as pasture condition scoring, soil assessment, tree survival monitoring, and water-point management. Strengthening extension services, training community monitors (including youth and women), and deploying simple digital or paper-based tools would significantly enhance data quality and local ownership, aligning with national priorities to strengthen extension systems. Capacity building should therefore prioritise practical, farmer-facing monitoring skills.

To strengthen the framework, indicators should be aligned with data collection capacities across scales. A core set of indicators should focus on those that can be consistently measured using household surveys, FGDs, and KIIs, ensuring regular and comparable data collection. More complex indicators should be retained but repositioned to be supported by remote sensing, institutional datasets, or targeted technical assessments.

The framework should be scaled progressively across diverse ecological and livelihood contexts to test robustness and adaptability. Expanding pilots to other dryland, highland, and coastal landscapes, while maintaining a core indicator set, would support national learning and refinement. Stronger coordination among conservancies, county governments, research institutions (KALRO, KEFRI), and national agencies (KWS, KFS) will be essential to ensure that NbS monitoring supports both ecosystem restoration and livelihood resilience.

4.3.3 Policy Recommendations

The Chyulu Hills pilot provides clear direction for strengthening NbS monitoring in Kenya. First, the NbS M&E Framework should be institutionalised as a routine data-collection tool at household and community levels, rather than treated as a one-off assessment instrument. County governments through agriculture, environment, and climate change units are best positioned to coordinate regular data collection using simplified versions of the framework, aligned with existing extension visits and community engagement processes. For local ownership, community-based monitoring systems should be institutionalised by establishing standardised data collection frameworks, strengthening local capacity, deploying digital platforms.

The framework should be integrated into existing national monitoring and reporting systems, such the Climate-Smart Agriculture (CSA) M&E Framework and the Agriculture GHG Inventory tools supported by ICAT. Integration would reduce duplication, improve data efficiency, and strengthen Kenya's capacity to report NbS outcomes under the UNFCCC Biennial Transparency Reports, the NDC, and the National Biodiversity Strategy and Action Plan (NBSAP 2019–2030). The Agriculture Departments at both national and sub-national will need to anchor NbS M&E within the national MRV system coordinated by the Ministry of Environment and Climate Change by integrating NbS indicators into National Climate Change Registry and BTR reporting templates under the UNFCCC to ensure NbS data becomes a mandatory input for national climate reporting.

The national and county governments should adopt a coordinated approach that simultaneously strengthens technical capacity and expands access to finance by establishing structured capacity development programmes, building pipelines of bankable NbS projects, deploying blended and results-based financing mechanisms, and embedding NbS within extension, planning, and budgeting systems. This integrated approach will promote scalable and investment-ready NbS implementation across Kenya

References

Agarwal, A., & Assenova, V. (2023). *Mobile money as a steppingstone to financial inclusion: How digital multi-sided platforms fill institutional voids*. Forthcoming in *Organization Science*. https://ssrn.com/abstract=4132783

Akinola, M., Oladipo, F., & Adepoju, A. (2016). Nature-based enterprises: Opportunities for biodiversity conservation and community livelihoods. *Energy and Environmental Research, 6*(1), 1–10. https://doi.org/10.13189/eer.2016.040105

Amboseli Ecosystem Trust. (*2020*). *Amboseli Ecosystem Management Plan 2020–2030*. https://amboseliecosystem.org/wp-content/uploads/2021/09/AET-Annual-report-2020-1.pdf

Arnold, J.-C., Onono, J., Ballesteros, C., Aboge, G., & Alarcon, P. (2024). Modeling the economic performance of small ruminant pastoralist flocks and financial impact of changes in reproductive performance and mortalities in Kajiado County, Kenya. *Frontiers in Sustainable Food Systems, 8*. https://doi.org/10.3389/fsufs.2024.1406864

Awuora, M. A. (2024). *Effects of community participation on the sustainability of county government funded water projects: A case of Kaiti Kamunyii Water Project, Makueni County, Kenya*. Daystar University.

Coast Water Works Development Agency. (*2019*). *Annual report and financial statements for the year ended 30 June 2019*. Government of Kenya. https://www.parliament.go.ke/sites/default/files/2022-02/Report%20of%20the%20Auditor-General%20and%20Financial%20Statements%20on%20Coast%20Water%20Works%20Development%20Agency

Government of Kenya. (2016). *Climate Change Act, No. 11 of 2016*. Government Printer. https://new.kenyalaw.org/akn/ke/act/2016/11/eng

Government of Kenya. (2021). *National Climate Change Action Plan: Second implementation status report for FY2019/2020*. Ministry of Environment and Forestry. https://napglobalnetwork.org/wp-content/uploads/2022/01/napgn-en-2022-kenya-NCCAP-2018-2022-Implemantation-Status-Report.pdf

Government of Kenya. (2023). *National Climate Change Action Plan III (NCCAP) 2023–2027.* Ministry of Environment, Climate Change and Forestry. https://www.refworld.org/policy/strategy/natauth/2023/en/150105

International Union for Conservation of Nature (IUCN). (2016*). Annual report* (Vol. 1). https://portals.iucn.org/library/node/46619

IUCN. *2020. Global standard for nature-based solutions: A user-friendly framework for the verification, design and scaling up of NbS* (1st ed.). https://portals.iucn.org/library/sites/library/files/documents/2020-020-En.pdf

Jacob, W. M. (2025). *Public participation and its influence on sustainability of water projects in Makueni County, Kenya*. Kenyatta University.

Kenya Climate Smart Agriculture Monitoring and Evaluation Framework (2021). https://climateactiontransparency.org/wp-content/uploads/2023/06/Kenya-Climate-Smart-Agriculture-Monitoring-and-Evaluation-Framework.pdf

Kenya National Bureau of Statistics (KNBS). *2019. Kenya population and housing census: Volume I – Population by county and sub-county.* https://www.knbs.or.ke/wp-content/uploads/2023/09/2019-Kenya-population-and-Housing-Census-Volume-1-Population-By-County-And-Sub-County.pdf

Kenya Wildlife Service. *(2019). Strategic plan 2019–2024: Rising to the conservation challenge – Together we rise.* https://www.kws.go.ke/sites/default/files/2023-09/KWS%20Strategic%20Plan%202019-2024_0.pdf

Kiumbuku, S. (2022). Challenges of community-based management of protected areas: Contested trade-offs between livelihood and conservation interests in Chyulu Hills National Park, Kenya. *Environment and Natural Resources Research, 12*(2). https://ccsenet.org/journal/index.php/enrr/article/download/0/0/47569/51010

MoALF. (2016). *Climate risk profile for Makueni County*. Kenya County Climate Risk Profile Series. https://hdl.handle.net/10568/80457

MoALF. (2018). *Climate risk profile for Kajiado County*. Kenya County Climate Risk Profile Series. https://hdl.handle.net/10568/96288

Mukeka, J. M., Ogutu, J. O., Kanga, E., & Roskaft, E. (2018). Characteristics of human–wildlife conflicts in Kenya: Examples of Tsavo and Maasai Mara regions. *Environment and Natural Resources Research, 8*(3), 148–165. https://doi.org/10.5539/enrr.v8n3p148

Mukeka, J. M., Ogutu, J. O., Kanga, E., & Roskaft, E. (*2020)*. Spatial and temporal dynamics of human–wildlife conflicts in the Kenya Greater Tsavo Ecosystem. *Human–Wildlife Interactions, 14(*2), 255–272.

Mutua, C., Waswa, F., & Mcharo, M. (2023). Apiculture for sustainable land use and enhanced community livelihoods in dryland ecosystems: The case of Makueni in Kenya. *East African Journal of Environment and Natural Resources, 6*(1), 198–216. https://doi.org/10.37284/eajenr.6.1.1313

Mwangi, O., Kioko, A., Jalango, D., Kinyua, I., & Nyawira, S. (2024). *County capacity building workshop on GHG inventory for Kenya's crop subsector report*. https://hdl.handle.net/10568/174054

Mwangi, O., & Nyawira, S. (2025). *User guide: GHG activity data collection tool.* https://hdl.handle.net/10568/174419

Ndetu, V., & Nyawira, S. S. (2024). *Greenhouse gas reporting in Kenya's crop subsector and roadmap for improvement.* ICAT. https://climateactiontransparency.org/wp-content/uploads/2024/11/Kenya-GHG-inventory-Roadmap-final.pdf

NEMA. (2021). *Kenya State of Environment Report 2019–2021.* Government of Kenya. https://nema.go.ke/wp-content/uploads/2025/03/State-of-Environment-Reports_SoE-2019-2021-SUMMARY-FOR-POLICY-MAKERS.pdf

Nature-Positive Agriculture Adaptation Case Studies / Evidence. (2024). https://wwfint.awsassets.panda.org/downloads/nature-positive-agriculture-adaptation-case-studies_evidence.pdf

Nyawira, S., Mwangi, O., Jalango, D., & Kioko, A. (2024). *Empowering counties: Building capacity for GHG reporting in Kenya's crop production.* CIAT. https://alliancebioversityciat.org/stories/empowering-countiesbuilding-capacity-ghg-reporting-kenya-crop-production

Nyongesa, J. M., Donatti, C. I., & Kiptenai, T. K. (2023). Community-based rangeland restoration for climate resilience and pastoral livelihoods in Chyulu, Kenya. In M. Nishi & S. M. Subramanian (Eds.), *Ecosystem restoration through managing socio-ecological production landscapes and seascapes (SEPLS)*. Springer. https://doi.org/10.1007/978-981-99-1292-6_3

Ogutu, J. O., Piepho, H.-P., Said, M. Y., Ojwang, G. O., Njino, L. W., & Kifugo, S. C. (2016). Extreme wildlife declines and concurrent increase in livestock numbers in Kenya. *PLOS ONE, 11*(9), e0163249. https://doi.org/10.1371/journal.pone.0163249

Tendwa, M., & Mutundu, K. (2023). Collaborative currents: Assessing the role of community involvement in the durability of Kajiado County's water projects. *International Journal of Scientific and Research Publications, 13*(12), 57–68. https://doi.org/10.29322/IJSRP.13.12.2023.p14406

Tsavo Trust. (2025). *Why grasslands matter: Restoring balance in the Chyulu Hills*. https://tsavotrust.org/why-grasslands-matter-restoring-balance-in-the-chyulu-hills/

Ministry of Agriculture and Livestock Development Kenya and Bioversity International and the International Center for Tropical Agriculture. (2026) . The national monitoring and evaluation framework for nature-based solutions in Kenya: An approach for landscapes such as the Chyulu Hills. https://hdl.handle.net/10568/182821

United Nations Environment Assembly. (2022). *Nature-based solutions for supporting sustainable development (UNEP/EA.5/Res.5)*. UNEP. https://wedocs.unep.org/items/2aeda9ba-6bcb-44c7-a60f-a5a89c412f21

United Nations Environment Programme. (2021). *Integrated approaches in action: A companion to the international good practice principles for sustainable infrastructure.* https://www.uncclearn.org/wp-content/uploads/2021/12/Session-1b-UNEP_Integrated-Approaches-in-Action.pdf

United Nations Environment Programme. (2022). *Nature-based solutions: Opportunities and challenges for scaling up.* https://wedocs.unep.org/handle/20.500.11822/40783

United Nations Framework Convention on Climate Change. (2021). *UNFCCC annual report*. https://unfccc.int/sites/default/files/resource/UNFCCC_Annual_Report_2021.pdf

UNU-IAS, Bioversity International, IGES, UNDP, Bergamini, N., Dunbar, W., et al. (2014). *Toolkit for the indicators of resilience in socio-ecological production landscapes and seascapes*. https://hdl.handle.net/10568/104521

Annexes

ICAT NbS field Key Informant Interviews (KIIs).pdf

ICAT NbS field Focus Group Discussion (FGDs).pdf

ICAT NbS Household Survey...pdf

IRB Clearance.pdf



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