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Botswana National Ecosystem Assessment Technical Report

Summary for Policy Makers

March 2026

Disclaimer

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List of Acronyms

BIOFIN	Biodiversity Finance Initiative
BW-NEA	Botswana National Ecosystems Assessment
CBNRM	Community Based Natural Resources Management
DEA	Department of Environmental Affairs
EIA	Environmental Impact Assessment
ESIA	Environmental and Social Impact Assessment
HEC	Human–elephant conflict
IAS	Invasive Alien Species
KMGBF	Kunming-Montreal Global Biodiversity Framework
MoA	Ministry of Agriculture
NBSAP	National Biodiversity Strategy and Action Plan
PES	Payments for Ecosystem Services
REDD+	Reducing Emissions from Deforestation and forest degradation
SNSs	Sacred Natural Sites
SPM	Summary for Policy Makers
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
WMA	Wildlife Management Areas

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Background

The Botswana National Ecosystem Assessment (BW-NEA) provides the first comprehensive, evidence-based evaluation of the condition, trends and future trajectories of Botswana's ecosystems, and the contributions they make to the wellbeing and livelihoods of local communities. The assessment strengthens the interface between science and policy by generating policy relevant knowledge to support national and global commitments to sustainable development, including Botswana Vision 2036, the Kunming-Montreal Global Biodiversity Framework (KMGBF) and the 2030 Agenda for Sustainable Development. Applying established Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) assessment methodologies, the BW-NEA combines ecological and socio-economic evidence, scenario modelling and spatial analyses to evaluate drivers of change and potential pathways for sustainable futures. The assessment weaves Traditional Knowledge systems with scientific knowledge through participatory community dialogues, ensuring that multiple knowledge systems inform decision making for the stewardship of biodiversity and ecosystem services. Six ecosystems were prioritised (Figure SPM1).

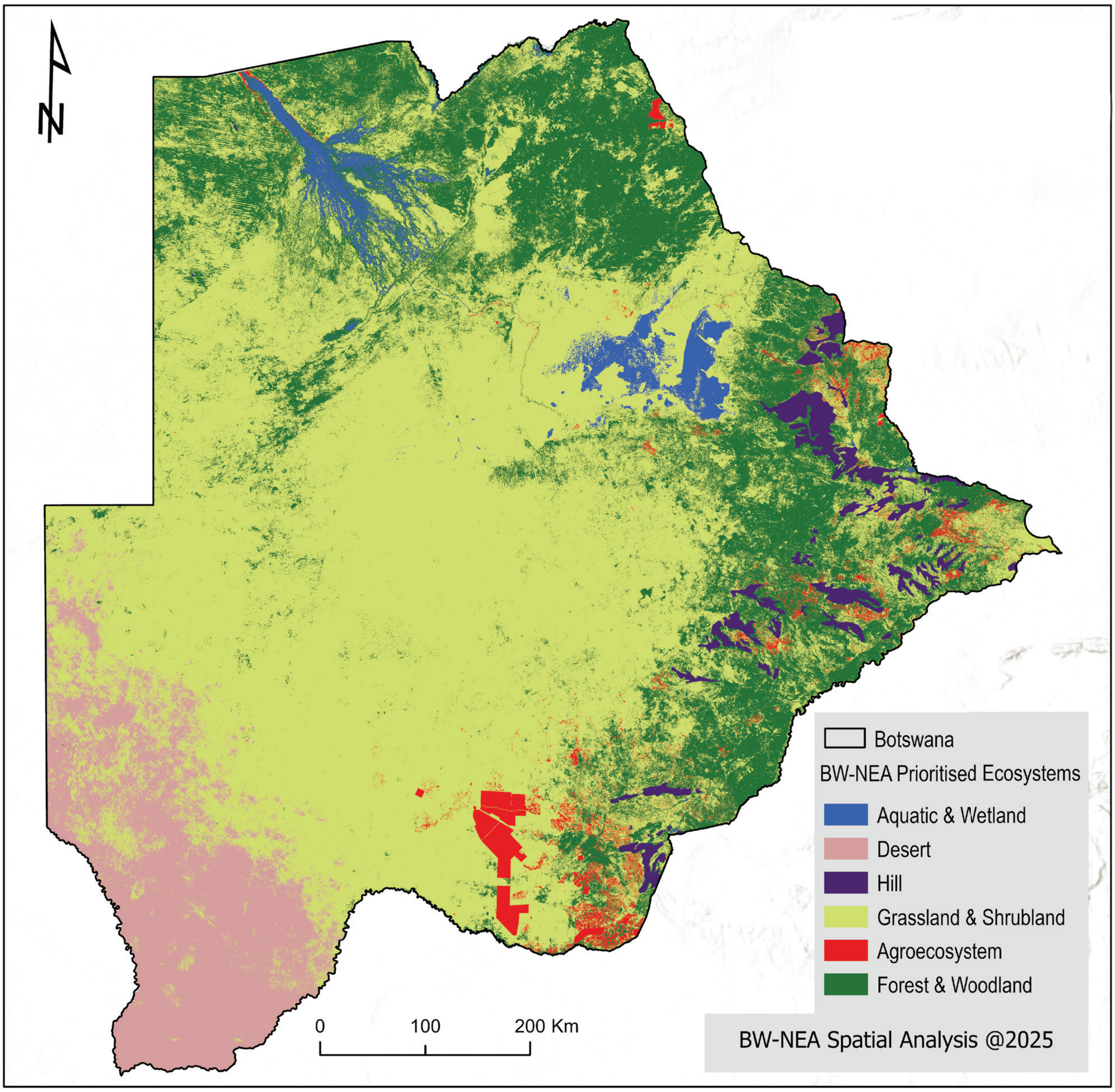


Figure SPM1: Spatial distribution of six prioritised ecosystems for the Botswana National Ecosystem Assessment *(Data source: BW-NEA Spatial Analysis, 2025).*

Key messages

A. Botswana's ecosystems at crossroads: the condition of the prioritised ecosystems and outlook.

A1. Botswana's ecosystems are highly vulnerable to climate change due to erratic rainfall and exposure to extreme events such as droughts and floods *(Well established).* These climatic pressures in combination with land degradation, biodiversity loss, and anthropogenic demands significantly threaten the integrity, productivity and resilience of critical ecosystems. Table SPM1summarises the status of Botswana's prioritised ecosystems **{3.2.1}.**

Table SPM1: The status of BW-NEA prioritised ecosystems

Ecosystem	Status
Aquatic and Wetland Ecosystem	Erratic rainfall and increased temperatures have resulted in seasonal and interannual variability in flood extent, drying of peripheral wetlands, and reduced groundwater recharge (Murray-Hudson et al., 2006)
Forest and Woodland Ecosystem	Rising temperatures, declining rainfall, increased drought and floods have led to dieback of drought-sensitive species; loss of ecosystem integrity; declining groundwater recharge and surface water availability; higher fire susceptibility (Kirilenko & Sedjo, 2007)
Grassland and Shrubland Ecosystem	Due to climate variability and drought, there is lower primary productivity, changes in species composition and plant biomass, expansion of drought-tolerant woody species.
Agroecosystem	Increasing drought frequency, erratic rainfall, heat stress has led to declining surface water levels in seasonal pans and borehole-dependent systems
Desert Ecosystem	Climate variability and change resulted in lower productivity, changes in species composition and dominance of intolerant species
Hill Ecosystem	Prolonged droughts, erratic rainfall has caused drying of freshwater springs; reduced availability of provisioning services (e.g., fodder, water, wild fruits)

A2. Current adaptation and resilience mechanisms for both livelihoods and ecosystems are short-term, leaving little room for transformational adaptation *(Established but Incomplete).* In climate-impacted ecosystems, communities often adopt alternative livelihoods that may degrade ecosystems. Ecosystem-based resilience approaches remain limited and largely pilot-scale. In Botswana, the Community-Based Natural Resources Management program supports livelihoods, income, and employment, buffering households against droughts, river desiccation, livestock disease, and resource declines (Silo & Serome, 2018). Unequal benefit sharing, weak governance, and low revenue constrain resilience (Mbaiwa, 2004), while responses must be context-specific to account for differing vulnerability and adaptive capacity (Cassidy & Barnes, 2012) **{3.2.2}.**

A3. The dearth of knowledge data and information on the waste assimilative capacity of nature in Botswana and this poses a threat to ecosystems as natural ecological sinks *(Established but Incomplete).* Few studies quantify pollution-driven biodiversity loss in Botswana. The Aquatic and Wetland Ecosystem is contaminated with chemical pollutants, including detectable DDT residues across water, plants, invertebrates, and fish in the Okavango Delta (Mbongwe et al., 2003; Selwe, Head, et al., 2024). Wastewater discharge increases soil salinity, nutrient loading, and heavy metal accumulation, though some sites remain within international thresholds (Kebonye et al., 2017; Selwe et al., 2024). In the Agroecosystem, vultures remain vulnerable to agrochemical poisoning. Limited evidence linking pollutants to biodiversity declines constrains monitoring and timely action to protect ecosystem services **{3.5.1}.**

A4. Rapid urbanisation and physical development, intensify land use posing a risk of biodiversity loss through ecological degradation *(Well Established but Incomplete).* Land use and spatial planning drive biodiversity loss through agriculture, mining, urbanisation, and infrastructure expansion, exacerbating pollution, resource depletion, climate impacts, and human–wildlife conflict (Cabernard et al., 2024; Hald-Mortensen, 2023). Integrating environmental, social, and cultural dimensions in spatial planning is critical for sustainable development, ecosystem protection, and coexistence between nature and communities **{3.6.1}.**

A5. The spatial extent of the Aquatic and Wetland Ecosystem has been declining post-2010 *(Established but Incomplete).* The Ecosystem exhibits high temporal variability and a net long-term contraction (−25%). An initial expansion during the 1990s was followed by progressive decline after 2000, with a sharp reduction post-2010 (BW-NEA Spatial Analysis, 2025). This pattern (Table SPM2) reflects a potential ecological threshold or regime shift, consistent with major hydrological stress, upstream water diversions, land conversion, or climate-induced desiccation. The trend emphasizes that past resilience does not guarantee future persistence, reinforcing the need for proactive wetland monitoring, hydrological restoration, and policy enforcement **{4.2.2}.**

Table SPM2 Change of area extent of the Aquatic and Wetland Ecosystem in Botswana between 1990 and 2020 *(Data Source: BW-NEA Spatial Analysis, 2025)*

Period	Area Start (km²)	Area End (km²)	Absolute Change (km²)	% Change
1990 - 2000	16,970.38	19,134.91	+2,164.53	+12.8%
2000 - 2010	19,134.91	18,551.73	−583.17	−3.0%
2010 - 2020	18,551.73	12,703.57	−5,848.16	−31.5%
Net (1990–2020)	–	–	**−4,266.81**	**−25.1%**

A6. The diversity of waterbirds in the Aquatic and Wetland Ecosystem is increasing and sustaining this positive trend is essential for biodiversity conservation *(Established but incomplete).* The Ecosystem supports over 460 bird species acting as a key biodiversity hotspot and a bioindicator of wetland health. Long term trends from 1995 to projected estimates for 2025 shows increasing species richness in the Okavango Delta, Chobe River and Makgadikgadi Pans, underscoring the conservation importance of this ecosystem (Figure SPM2) **{4.2.1}.**

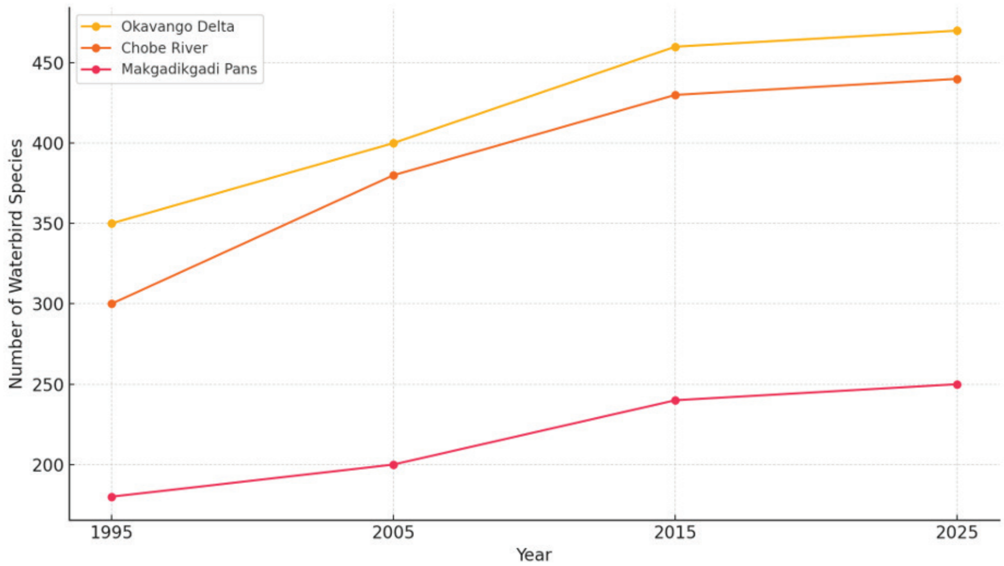


Figure SPM2: Trends of waterbird diversity between 1995 – 2025 in the Aquatic and Wetland Ecosystem, Botswana *(Data source: McCulloch et al., 2009).*

A7. Fish species in the Aquatic and Wetland Ecosystem are associated with distinct risk zones ranging from low to high concern based on their invasiveness and ecological impact *(Established but Incomplete)*. Risk profiling identifies species of greatest concern in southern Botswana dams, with Cyprinus carpio and Micropterus salmoides showing both high invasiveness and high ecological impact. The spiral risk plot categorises species across invasiveness–impact gradients, highlighting clear risk zones from low to high concern (Figure SPM3). This approach supports managers and policymakers in prioritising monitoring and control measures based on empirical risk positions, ensuring targeted and effective biodiversity protection **{4.2.2, Box 4.2}.**

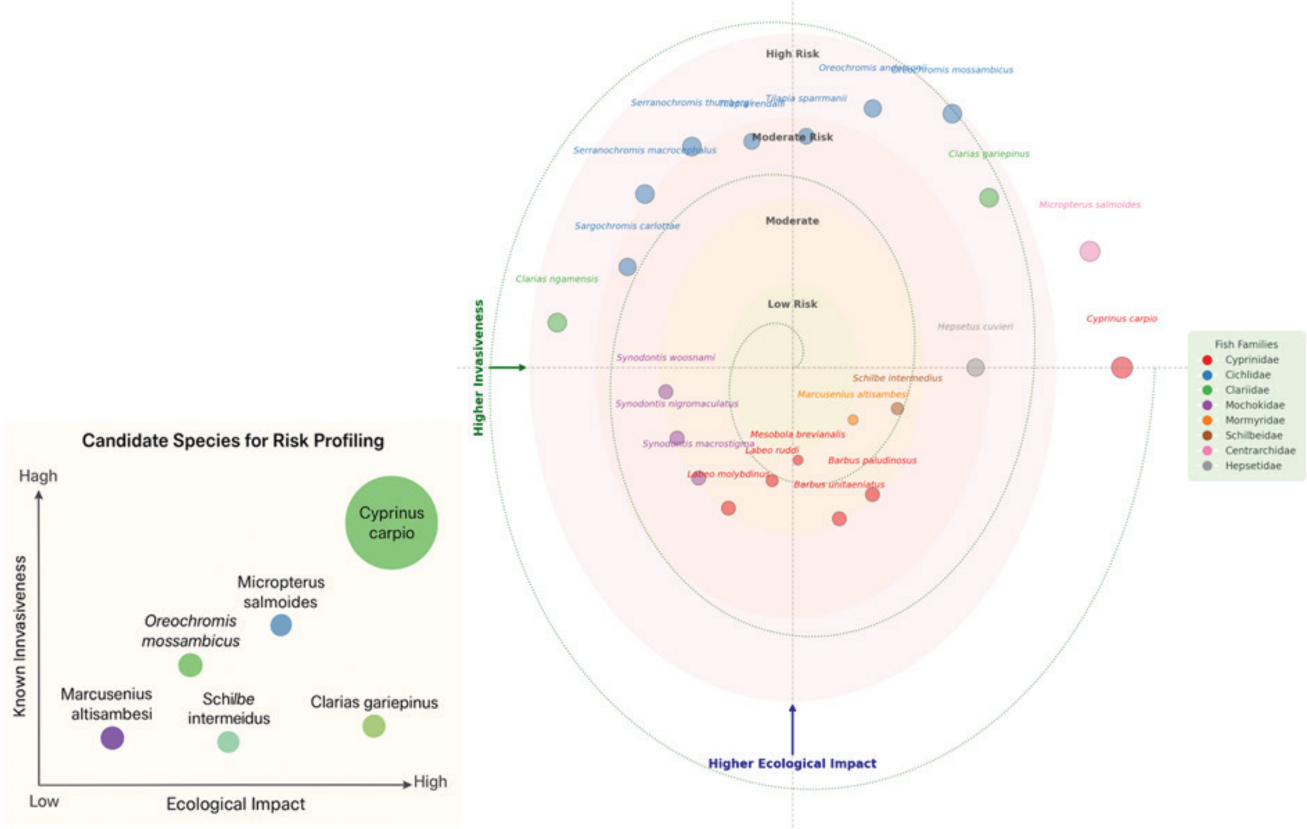


Figure SPM3: Invasiveness and Ecological Impact Risk Profiling of Fish Species in Southern Botswana Dams. *(Data Sources: Skelton, 2016; Tweddle et al., 2003)*

A8. The expansion of invasive species, collapse of functional groups, hybridisation pressure and predator loss in the man-made dams in the Aquatic and Wetland Ecosystem undermines aquatic biodiversity, destabilizes food webs and compromise the delivery of key ecosystem services *(Inconclusive)*. Future trajectories of fish assemblages in southern Botswana dams vary with species' ecological traits, invasive dynamics and functional roles. Invasive species such as Cyprinus carpio and Micropterus salmoides will dominate under unmanaged conditions, displacing native taxa and reducing food web complexity, while omnivore dominance could homogenise functional groups and weaken ecological resilience (Table SPM3).

Table SPM3: Projected fish-related scenarios, ecological responses, and ecosystem service implications for dams in southern Botswana				
Scenario	**Driver/Mechanism**	**Ecological Response**	**Ecosystem Services Impacted**	**Management Implications**
Invasive Dominance	Proliferation of Cyprinus carpio, Micropterus salmoides	Decline of native species, habitat degradation, food web disruption	Provisioning Regulating Supporting	Biosecurity enforcement, early detection, and rapid response
Functional Group Collapse	Over-dominance of omnivores (e.g., Clariidae)	Loss of trophic specialization; food web homogenization	Supporting Provisioning	Maintain functional diversity; habitat complexity enhancement
Hybridization & Genetic Erosion	Hybridization pressure from Oreochromis mossambicus	Genetic homogenization, loss of native Tilapia diversity	Supporting, Cultural	Genetic conservation programs; protection of isolated populations
Declining Predators	Loss of native piscivores (e.g., Hepsetus cuvieri)	Prey species overpopulation; trophic imbalance	Regulating, Supporting	Predator conservation; ecosystem restoration
Ecosystem Service Enhancement	Promotion of specialized low-risk natives (Marcusenius altisambesi, others)	Biodiversity stabilization; maintenance of trophic integrity	Provisioning, Supporting, Cultural	Eco-friendly fisheries management; habitat restoration

Hybridisation involving Oreochromis mossambicus risks genetic erosion, and loss of native piscivores threatens trophic imbalance. Proactive management that promotes specialised native species, such as Marcusenius altisambesi, will stabilise ecosystem processes, sustain fisheries and support cultural services. These scenarios highlight the need for ecosystem-based fisheries management, strengthened biosecurity, and restoration of functional diversity to secure key provisioning, regulating, supporting and cultural services **{4.2.2, Box 4.2}.**

A9. Botswana's Forest and Woodland Ecosystem are a cornerstone of biodiversity, climate regulation, and livelihoods, covering 22.61% of the national territory *(Well Established)*. Forests and woodlands provide essential provisioning services such as firewood, timber, indigenous foods, and medicinal plants, regulating services including carbon sequestration and water regulation, and cultural values that underpin spiritual and heritage practices. The Forest and Woodland Ecosystem in Botswana has experienced the most substantial long-term decline (−33%), with accelerated loss after 2000 (Table SPM4). This trajectory is indicative of systematic woodland degradation, driven by fuelwood extraction, fire regimes, grazing pressure, and land-use encroachment (Feurer et al., 2025). These interlinked impacts underscore the urgency of integrated landscape management that couples ecological restoration with equitable, sustainable resource use.

Table SPM4: Temporal trends in the extent of the Forest and Woodland Ecosystem in Botswana between 1990 and 2020, based on decadal land cover data *(Source: BW-NEA Spatial Analysis, 2024)*				
Period	**Area Start (km²)**	**Area End (km²)**	**Absolute Change (km²)**	**% Change**
1990 - 2000	198,155.95	227,639.59	+29,483.63	+14.9%
2000 - 2010	227,639.59	182,267.48	−45,372.11	−19.9%
2010 - 2020	182,267.48	132,705.14	−49,562.34	−27.2%
Net (1990–2020)	–	–	**−65,450.81**	**−33.0%**

A10. Combined pressures from land clearing for agriculture and settlements, recurrent veld fires, elephant herbivory, invasive alien plants, and climate variability are driving fragmentation, biodiversity loss, and declining carbon storage in the Forest and Woodland Ecosystem *(Well established)*. Settlement expansion, and economic development (e.g., agriculture, mining, infrastructure have led to a decline in biodiversity and ecosystem services (Malagnoux et al., 2008; Safriel et al., 2005); reduced availability of non-timber forest products (fuelwood, poles); loss of cultural services and tourism potential; soil erosion and fertility loss. Fire–rainfall dynamics as a key process: wet years lead to fuel build-up and subsequent high-burn seasons, while extreme drought years heighten combustibility. Burned area analysis shows high variability, with a statistically detectable ecological shift around 2012 - 2013 (Figure SPM4).

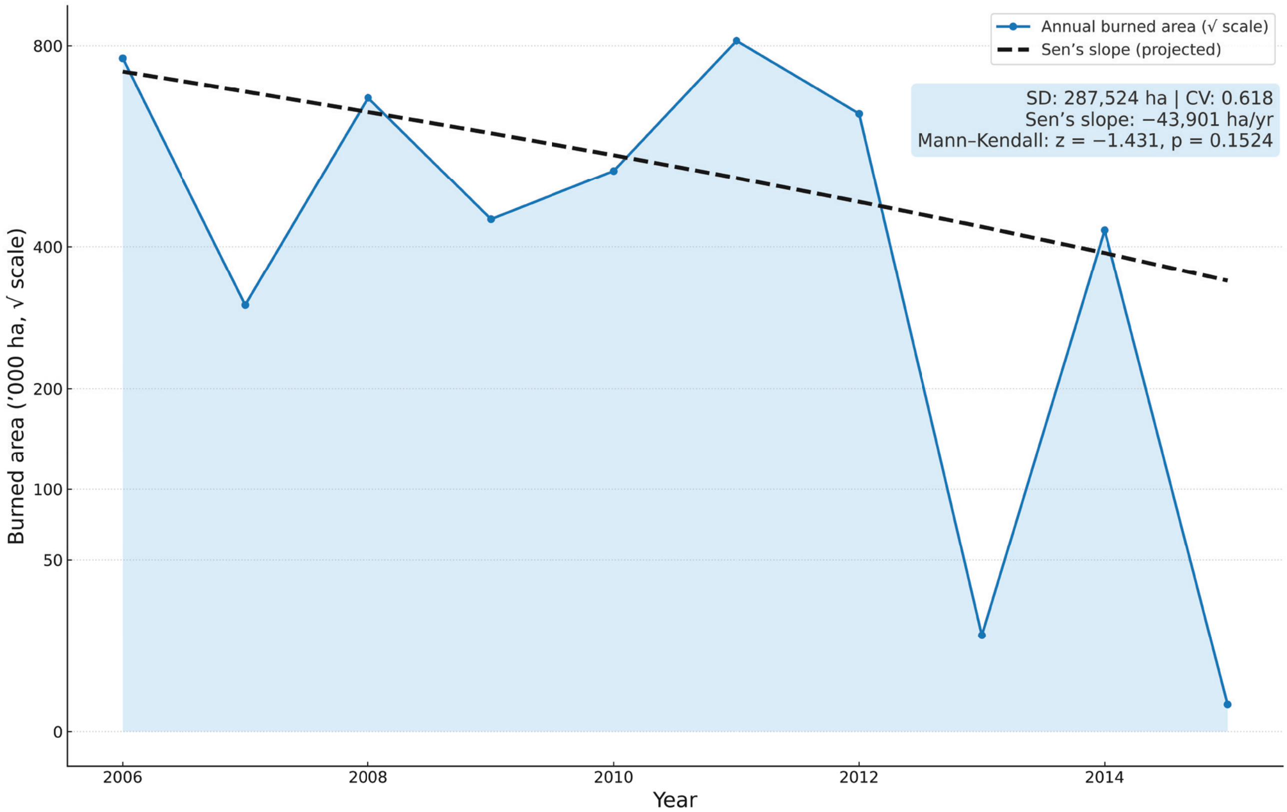


Figure SPM4: Annual burned area in the Forest and Woodland Ecosystem with Sen's Slope and Mann-Kendall trend analysis (2006–2015) *(Data source: Sianga et al., 2025).*

Herbivory, particularly by elephants and large herbivores, reduces forest structure, converts woodlands to shrublands, and eliminates preferred tree species, while invasive woody plants such as Neltuma juliflora and Eucalyptus spp. suppress native flora, lower water tables, and simplify ecosystems (Owen-Smith & Chafota, 2012; Mafokate et al., 2013; Mosweu et al., 2013). Combined with climate change impacts including higher temperatures, lower rainfall, and more frequent droughts and floods, these pressures drive biodiversity loss, reduce ecosystem productivity and carbon sequestration, threaten water resources, and increase management costs. Without reforms in land-use incentives, fire management, and invasive species control, woodland resilience and their function as carbon sinks will continue to decline **{5.3.1}.**

A11. Forest and Woodland Ecosystem futures span from systemic degradation under business-as- usual to resilient recovery under sustainability- driven pathways emphasizing restoration, carbon finance, and nature-based solutions *(Established but Incomplete).* Scenario analysis demonstrates that strategies such as REDD+, Payments for Ecosystem Services (PES), eco-tourism, and afforestation with native species can restore woodland integrity, capture carbon, and diversify rural incomes (Table SPM5). However, without urgent action to halt deforestation and degradation, Botswana risks losing access to carbon markets and climate finance, undermining both biodiversity and socio-economic resilience (Table 5.8). **{5.2.2}**

Table SPM5: Possible future scenarios for Forest and Woodland Ecosystem, Botswana

Scenario	Description	Key drivers	Expected Outcomes	Policy Implications
Business as usual	Continuation of current land-use trends and weak enforcement of environmental regulations.	Population growth, agricultural expansion, overharvesting, and limited enforcement.	Further deforestation, habitat loss, biodiversity decline, and reduced ecosystem services.	Strengthen institutional capacity and improve enforcement to avoid ecosystem collapse.
Sustainability Path	Active investment in conservation, restoration, and community-based forest management	Strong governance, climate-smart policies, reforestation programs, CBNRM, REDD+.	Stabilised forest cover, improved biodiversity, enhanced rural livelihoods, and ecosystem service recovery.	Implement incentive-based programs (e.g., REDD+), integrate local communities in forest governance.
Climate-Driven Decline	Lack of adaptation measures leads to ecosystem degradation, accelerated by climate change (e.g., drought, temperature rise, erratic rainfall).	Climate change, poor adaptation, and continued land degradation.	Shrinking forest cover, increased desertification, and reduced productivity of woodland areas.	Urgently mainstream climate adaptation into forest and land-use policies and prioritise drought-resilient species.
Eco-Tourism Boost	Forest and Woodland Ecosystem is increasingly protected and monetised through nature-based tourism and biodiversity conservation initiatives.	Policy support for eco-tourism, investment in protected areas, and international funding mechanisms.	Conservation of biodiversity hotspots, increased tourism revenue, and community empowerment.	Enhance eco-tourism infrastructure and legal frameworks to support sustainable forest use and benefit-sharing.

A12. Grassland and Shrubland Ecosystem underpin Botswana's pastoral economy and wildlife-based tourism, yet their spatial extent has fluctuated significantly over the past three decades indicating ecological instability *(Established but Incomplete)*. Following a decline in the 1990s, the ecosystem expanded substantially after 2000, resulting in a net increase by 2020; however, the scale and reversals of change signal underlying ecological instability (Table SPM6).

Table SPM6: Change of area extent of the Grassland & Shrubland Ecosystem in Botswana between 1990 and 2020 *(Data Source: BW-NEA Spatial Analysis)*				
Period	**Area Start (km²)**	**Area End (km²)**	**Absolute Change (km²)**	**% Change**
1990 - 2000	277,742.91	245,775.31	−31,967.60	−11.5%
2000 - 2010	245,775.31	335,981.20	+90,205.89	+36.7%
2010 - 2020	335,981.20	358,694.74	+22,713.54	+6.8%
Net (1990–2020)	–	–	**+80,951.82**	**+29.2%**

These dynamics are driven by climatic variability, bush encroachment, fire regimes, and land-use shifts, with consequences for forage reliability, biodiversity connectivity, and carbon storage. Strengthening long-term monitoring, integrating ecosystem thresholds into land-use planning, and incentivising adaptive rangeland restoration will be essential to stabilise ecosystem services and reduce vulnerability of pastoral livelihoods **{6.2.2}.**

A13. Grassland and Shrubland Ecosystem is in long-term decline due to unsustainable grazing, invasive woody species, and fragmented tenure systems, resulting in reduced ecosystem services and heightened rural vulnerability *(Well Established)*. Overgrazing, exclusion of fire, and invasive encroachers (Dichrostachys cinerea, Senegalia mellifera, Terminalia sericea) have suppressed palatable grasses and degraded rangeland productivity. Weak enforcement of grazing controls and fragmented land tenure systems further exacerbate degradation. Natural drivers impacting the grasslands include extreme temperatures, shortened and unreliable rainy seasons, drought (King-Okumu et al., 2021) invasive species (Makhabu et al., 2021) and bush encroachment (Kgosikoma et al. 2012; Lori et al. 2019). The aggregation of pressures is degrading the ecological integrity and physical significance of the ecosystem. While anthropogenic drivers can be mitigated, natural drivers amplify negative changes, complicating conservation and sustainable management. Declining ecosystem condition has reduced livestock carrying capacity, biodiversity habitat and soil fertility. Coordinated bush control, adaptive grazing systems and tenure reforms are critical for restoring ecosystem function and sustaining grassland-based livelihoods. **{6.1.5; 6.2.2; 6.3.1}.**

A14. The spatial extent of the Agroecosystem in Botswana has remained spatially stable due to semi-arid conditions and restrictive land-use policies, with agricultural growth driven by sustainable intensification rather than expansion *(Established but Incomplete)*. Agroecosystem extent remains remarkably stable (~2% of national area) across three decades, indicating limited cropland expansion (Table SMP7). This suggests that agricultural pressures are primarily driven by intensification and productivity stress rather than land conversion, with implications for soil, water, and biodiversity condition within existing agricultural landscapes.

Table SPM7: Temporal changes in the spatial extent of Agroecosystem (1990 - 2020) *(Source: BW-NEA Spatial Analysis, 2025)*				
Period	**Area Start (km²)**	**Area End (km²)**	**Absolute Change (km²)**	**% Change**
1990 - 2000	11,497.79	11,386.23	−111.57	−1.0%
2000 - 2010	11,386.23	11,202.72	−183.51	−1.6%
2010 - 2020	11,202.72	11,622.88	+420.15	+3.8%
Net (1990–2020)	–	–	**+125.08**	**+1.1%**

National biodiversity policies limit ecosystem conversion, while intensification strategies such as conservation agriculture, agroforestry, and integrated crop-livestock systems enhance Agroecosystem productivity and maintain essential functions. These approaches prevent land degradation, sustain soil health and functional diversity, and integrating soil health indicators into Agriculture, Forestry, and Other Land Use (AFOLU) monitoring is critical for assessing resilience and unlocking long-term carbon sequestration potential **{7.2.2}.**

A15. Despite the long-term spatial stability of the Agroecosystem in Botswana, crop production trends from 1979 to 2019 show increases in total hectarage under cultivation, rather than sustained improvements in yield, have been the primary driver of output gains, raising concerns about long-term sustainability *(Well Established).* Trends and correlation analyses indicate that for most major crops (maize, sorghum, pulses), expansion in the number of hectares cultivated has contributed more to production growth than gains in productivity per unit area Figure SPM5.

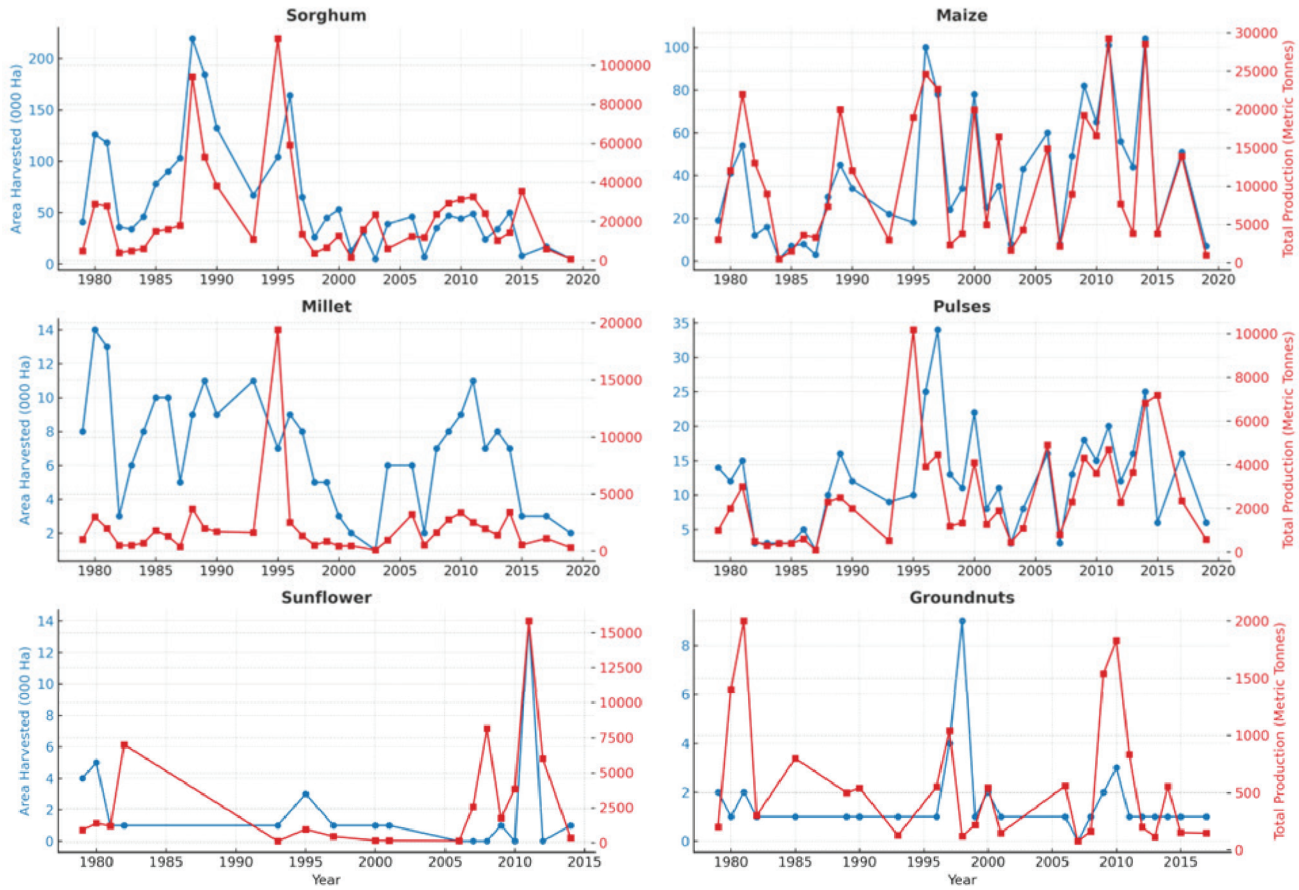


Figure SPM5: Trend in area harvested and total production for major crops in Botswana *(1979 -2019) (Data Source: Statistics Botswana, 2020)*

While some crops, like pulses, show yield growth with stable area, while others stagnate or decline due to rainfall variability, soil health, and limited inputs. Climate-smart and agroecological intensification increase yields and ecosystem resilience, while unsustainable practices, particularly increased agrochemical use, undermine pollination, soil biodiversity, and long-term productivity **{7.2.2; Box 7.2}.**

A16. Livestock production in Botswana's Agroecosystem has undergone significant transitions over the past four decades, with declining cattle populations and rising small ruminant numbers reflecting a shift driven by climate shocks, land degradation, and changing socio-economic conditions *(Well Established).* Time-series modelling reveals a persistent post-2000 collapse in cattle numbers linked to multi-year droughts, rangeland degradation, and weakened grazing policy implementation, reducing the carrying capacity of the ecosystem. The spline model explained 82% of the variance (R² = 0.82), while the piecewise model captured 72% (Figure SPM6).

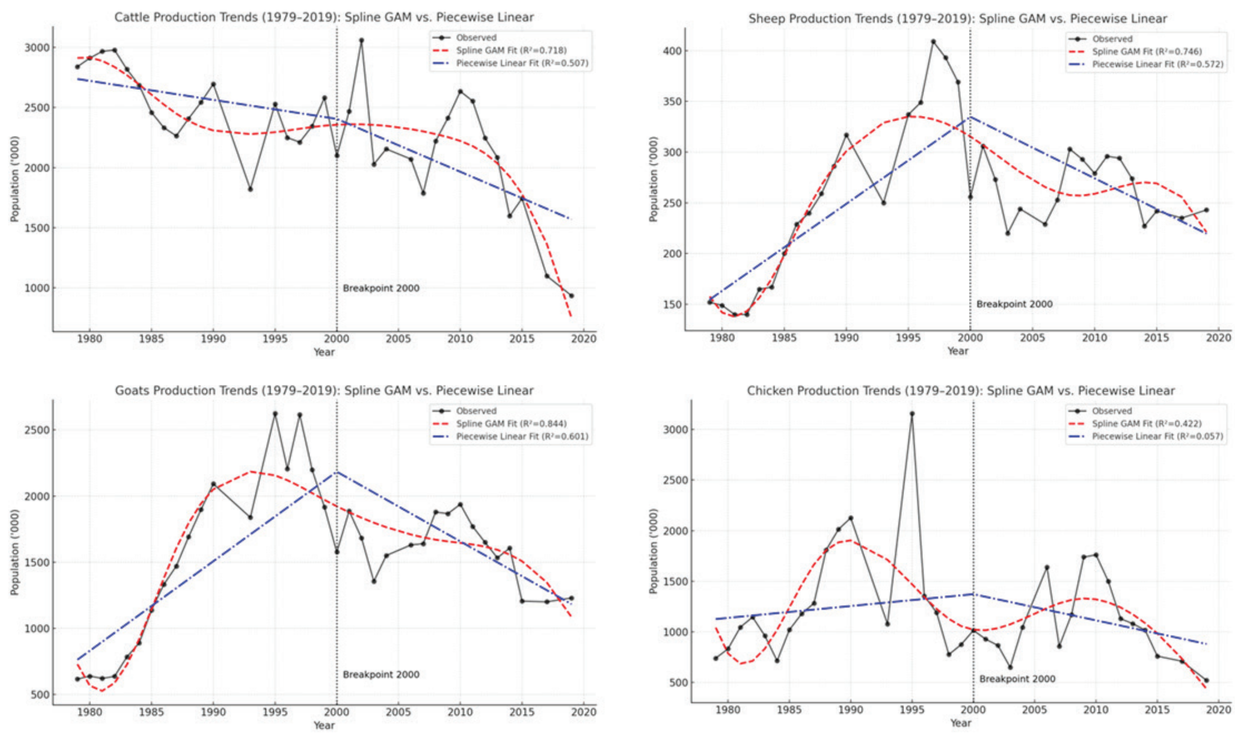


Figure SPM6: Trends in livestock production in Botswana (1979 – 2019) *(Data source: Statistics Botswana, 2020).*

Multi-year droughts (2002–2005, 2013–2015, 2017–2019), overstocking, and bush encroachment have reduced Agroecosystem carrying capacity, lowering cattle productivity (Kgosikoma et al., 2012; Nellis et al., 1997; Tsheboeng et al., 2025). Goats and sheep show resilient growth due to adaptability, supporting food security and livelihoods, particularly for smallholders and female-headed households. Traditional systems dominate livestock numbers but face high mortality from disease, drought, and limited veterinary access, while commercial systems lead in productivity. Strengthening animal health, small ruminant value chains, and climate-smart practices, alongside a One Health approach, is essential for sustainable production, ecosystem resilience, and human–wildlife coexistence. Sheep production trends showed a modest but consistent increase, with Spline GAM R² = 0.75, reflecting their expanding role in mixed production systems of the Agroecosystem, particularly in Barolong, Kgatleng, and Southern Districts (Figure SPM7).

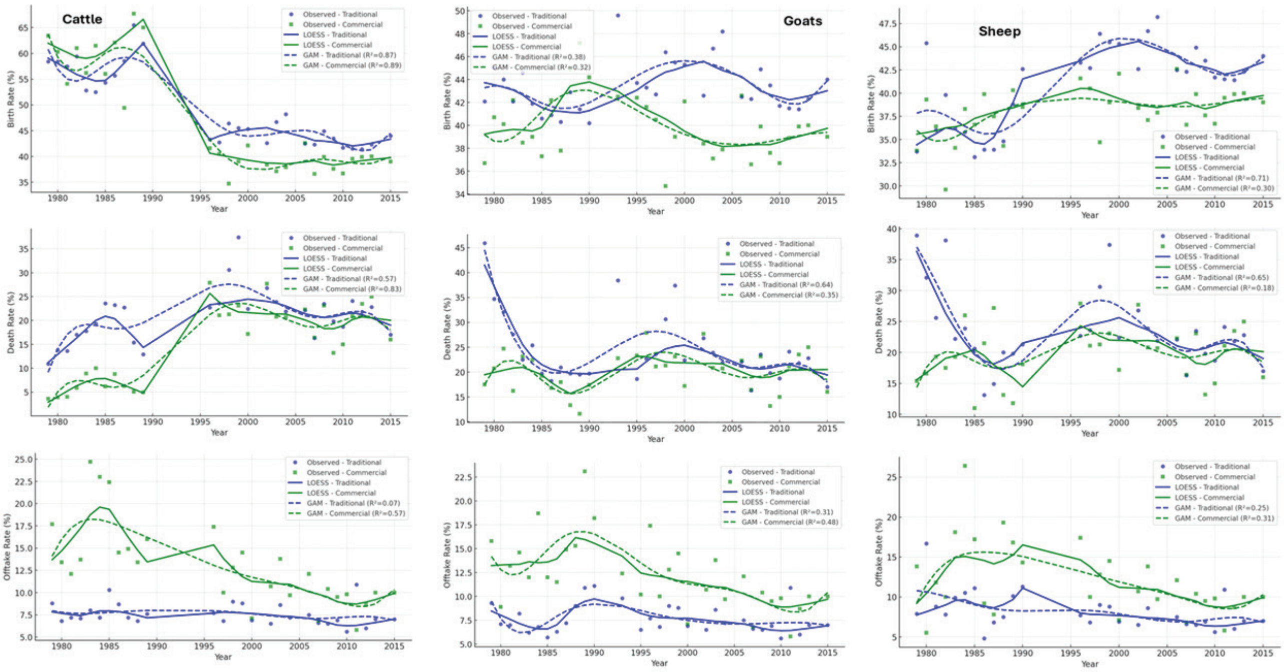


Figure SPM7: Trends in livestock production indicators for the period 1979 – 2019 *(Data source: Statistics Botswana, 2020)*

Their growth may be attributed to increased demand for mutton and the ability of emerging farmers to incorporate sheep into semi-intensive production systems near urban markets (Kgathi et al., 2012). However, growth is constrained by poor lambing rates, disease outbreaks such as enterotoxaemia, and the lack of high-quality rams and breeding services in many communal areas **{7.2.2; Figure 7.4 and 7.5}.**

A17. Botswana's Agroecosystem is undergoing increasing pressure from interlinked socio-economic and environmental drivers, such as population growth, land-use change, climate variability, and global market demands, which are degrading natural resources and reducing the system's ecological and productive integrity *(Established but Incomplete)*. Analysis using the DPSIR (Drivers – Pressures– State – Impact – Response) analysis indicates that interacting drivers intensify overgrazing, invasive species spread, land fragmentation, and unsustainable farming, leading to rangeland degradation, soil fertility decline, biodiversity loss, and water stress. These trends reduce agricultural productivity and food security, increase human–wildlife conflict, and heighten climate vulnerability. Sustaining agroecosystem performance requires regenerative and climate-smart practices, invasive species control, integrated land-use planning, use of Traditional Knowledge, and stronger institutional coordination, enforcement, participatory governance, and monitoring **{7.3}.**

A18. The Desert Ecosystem in Botswana, a globally significant semi-arid landscape, faces accelerating degradation driven by synergistic anthropogenic and natural forces. *(Established but Incomplete)*. Botswana's Desert Ecosystem, characterised by semi-arid landscapes and high biodiversity value, faces increasing pressure from poaching, invasive species, disrupted migration corridors, and climate variability (UNDP, 2023). Immediate, integrated action, anchored in local stewardship, transformative policy reforms, and ecosystem-based adaptation, is imperative to avert biodiversity collapse and to secure the resilience of this critical ecosystem **{8.3.1; Table 8.7}.**

A19. The Wildlife Management Areas (WMAs) in the Desert Ecosystem, are increasingly pressured by interconnected socio-economic and environmental drivers, including settlement expansion and land-use change *(Established but Incomplete)*. Biodiversity in the Desert Ecosystem is supported by a network of protected areas surrounded by WMAs, which function as buffer zones, wildlife corridors and key livelihood areas under CBNRM. In the Kgalagadi and Hukuntsi Districts, these include KD15, KD12, KD1, KD2 and KD6

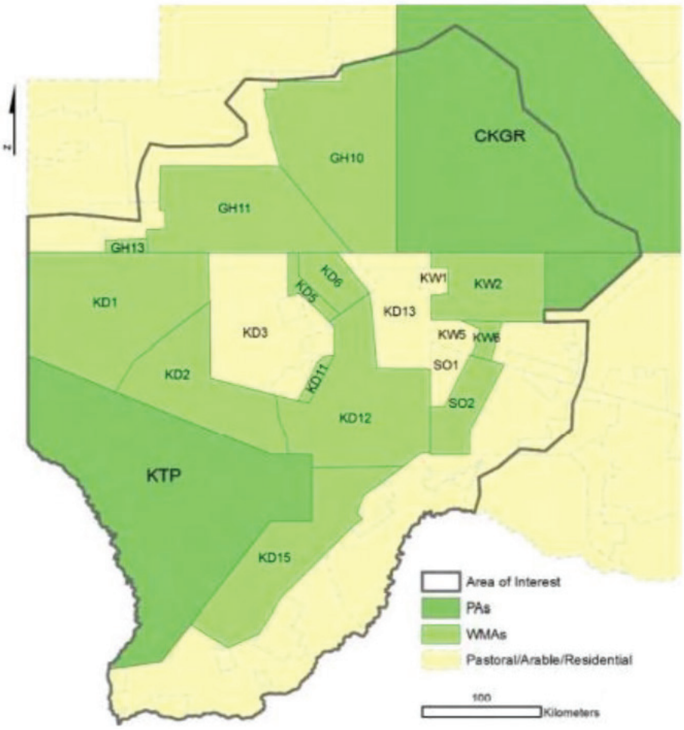


Figure SPM8: Wildlife Management Areas adjacent to Central Kalahari Game Reserve and Kgalagadi Transfrontier Park, Botswana *(Source: GoB, 2022).*

Despite their establishment in the early 1980s, none of the WMAs in this ecosystem have been gazetted, limiting effective management. Restricted forage in neighbouring communal lands results in livestock moving into WMAs in search of better grazing, increasing human–lion conflict. Gazetting these WMAs is critical for improving management effectiveness and reducing socio ecological conflict **{8.1.3}.**

A20. The Hill Ecosystem in Botswana, while occupying a small geographical footprint, is an ecologically irreplaceable and culturally foundational landscape that offer disproportionately high ecosystem services value, especially in water provision, biodiversity conservation, and spiritual-cultural identity *(Well established)*. Despite covering less than 1% of national land area, systems such as the Tsodilo and Tswapong Hills contribute significantly to freshwater availability via springs and aquifers, serve as biodiversity refugia for endemic and threatened species, and preserve centuries-old sacred and spiritual practices. These multifunctional services are crucial to rural livelihoods, particularly in water-stressed zones where people depend on wild foods, medicinal plants, and cultural resources for survival and identity. Yet these systems remain unrecognized in Botswana's major land-use, conservation, and development frameworks. The Hill Ecosystem faces mounting pressure from mining, agriculture, overgrazing, and urban expansion. Unregulated extraction of granite, dolomite, and sand degrades habitats, destabilizes slopes, and reduces vegetation cover (Atlhopheng, 2004). Additionally, expanding agriculture and livestock grazing intensify erosion and threaten the ecological stability and integrity of these systems (Table SPM8).

Table SPM8: Land use and dependency matrix for Hill Ecosystem in Botswana *(BW-NEA Community Dialogues)*			
Land Use Category	**Human Dependency**	**Selected Examples**	**Ecological Impact**
Mining & Quarrying	Extraction of building materials (granite, stone, limestone)	• Kgale Hills: Granite quarrying for urban construction • Tswapong Hills: Small-scale limestone and dolomite extraction	Habitat loss, species displacement, landscape alteration, erosion
Agriculture & Grazing	Subsistence cropping and livestock grazing on hill fringes and valleys	• Koanaka Hills: Seasonal crop farming in valleys • Tswapong Hills: Grazing pressure and seasonal cultivation	Vegetation loss, soil erosion, trampling of sensitive flora, edge encroachment
Tourism & Recreation	Cultural tourism, ecotourism, birdwatching, hiking, and heritage trail development	• Tsodilo Hills: UNESCO site for rock art tourism • Mannyelanong Hills: Birdwatching (Cape vultures) Otse Hills: Pilgrimage	Habitat disturbance, littering, informal trail formation, visual intrusion
Urban & Infrastructure Expansion	Residential development, road networks, and infrastructure on or near hill slopes	• Kgale Hills: Urban encroachment from Gaborone - Molepolole Hill, Peri-urban settlement growth	Habitat fragmentation, waste pollution, edge effects on fauna and flora
Wild Resource Harvesting	Collection of medicinal plants, wild foods, fuelwood, and reeds	• Tswapong & Koanaka Hills: Harvesting of Tylosema esculentum, Harpagophytum procumbens, Elegia tectorum	Overharvesting, species population decline, loss of ecological functions
Spiritual & Cultural Use	Ancestral rituals, spiritual gatherings, local ceremonies	• Baratani Hill (Otse): Known for ancestral rituals • Tsodilo Hills: Sacred landscape for San and Hambukushu communities	Vegetation trampling, informal fire use, unregulated access

Some cultural and tourism activities, along with infrastructure development and reliance on firewood and medicinal plants, threaten habitat integrity. Urgent, community-led conservation is needed to safeguard these biodiversity-rich, culturally significant landscapes, which remain underrepresented in national spatial planning and environmental accounting **{9.1.4; 9.2.2}**

A21: The ecological integrity and cultural significance of the Hill Ecosystem are increasingly threatened by quarrying, agricultural encroachment, unregulated tourism, overharvesting, and climate variability, compounded by fragmented institutional mandates, weak enforcement, and the erosion of traditional protection systems *(Established but Incomplete)*. DPSIR analysis shows accelerating land degradation, aquifer stress, vegetation loss and cultural disruption, with disproportionate impacts on women, youth and poor rural households. Pressures from overgrazing, climate change, rural poverty, governance misalignment, youth disengagement, urbanisation, religious overuse of springs and unregulated resource extraction drive ecological decline. Sacred springs face pollution and reduced flow, while weakened customary governance undermines stewardship of sacred hills and spiritual sites. These ecological shifts coincide with loss of cultural values, reduced water availability, declining carbon storage and diminishing intergenerational knowledge. Governance fragmentation among land, conservation and heritage authorities further limits coherent protection, reducing community access to wild fruits, thatch grass and medicinal plants. Strategic integration of traditional and statutory institutions, and recognition of the Hill Ecosystem within national conservation and climate adaptation frameworks, are essential to halt ongoing degradation **{9.3.1; 9.5.2}.**

B. Unlocking the green and blue economy potential for national transformation

B1: Utilisation and accessibility of ecosystems and their services by different social groups is influenced by broad social, economic and political factors *(Well Established).* The utilisation of ecosystem services is gendered. Women's ability to access, utilise and benefit from ecosystem services is significantly constrained by household commitments, unequal access to land, finance, markets and decision making. These are rooted in structural gender inequalities, customary norms and policy gaps that limit their economic participation and voice in biodiversity and ecosystem governance. Majority of regulations and policies favour men and exclude the interests of women despite their rich ecological knowledge. For instance, basket fishers have intimate knowledge of flood variability, fish migration and habitat and use this knowledge to make decisions about when and where to harvest what type of fish species (Ngwenya et al., 2012a). Incorporating gender into ecosystem assessments is crucial because it informs policy decisions on ecosystem management and conservation (Mugari et al., 2019; Yang et al., 2019). Understanding the gendered dimensions of ecosystem services and their impacts is crucial for developing sustainable and equitable policies and interventions that address both environmental and social needs) **{3.2.1(iii)}**

B2. The value of Traditional Knowledge is a powerful driver for conservation if Traditional Knowledge holders are equal partners in the value-addition process *(Established but incomplete).* Traditional Knowledge plays an important part in the conservation of ecosystems at individual level and collectively through the application of taboos and totems as well as different methods to conserve ecosystem services they utilise (Table SPM9; Table SPM10).

Table SPM9: Examples of Traditional Knowledge and Conservation Awareness)

Actors	Description of practice	Location (Source)
Traditional healers	Harvesting only one part of a medicinal plant to ensure regeneration.	Kweneng, Ngamiland, North-East, Gantsi, Central (Andrae-Marobela, Ngwenya, et al., 2012)
Traditional healers	Harvesting only on demand when consulted by a patient	Kweneng, Ngamiland, North-East, Gantsi, Central (Andrae-Marobela, Ngwenya, et al., 2012)
Traditional Knowledge holders in communities	The primary tubers of the plant, such as 'Sengaparile; and 'Khadi', are never harvested as they are for restoration	Kgalagadi – South, Kweneng, (Velempini & Perkins, 2008) (Community members of Mmankgodi, personal communication to Kristine Andrae-Marobela (KAM), 8 December 2010).
Traditional healers	The root of a medicinal plant is cut from one side, usually from the eastern side, and the other part of the root is left intact for regeneration.	Mmankgodi, Kweneng (Community members of Mmankgodi, personal communication to KAM, 8 December 2010).
Community members	Fruit trees are not cut for firewood. Only dead plants and trees are cut during field cleaning and are used for firewood. Refraining from cutting down trees during the raining season to enable growth. Shade trees are left in fields.	Bobirwa and Kgalagadi (Kayombo et al., 2014)
Community members	Grasses were cut by sickles and seeds dusted off to allow for regeneration.	Bobirwa and Kgalagadi (Kayombo et al., 2014)
Community members	Carving material was restricted to dead trees in winter	Bobirwa and Kgalagadi (Kayombo et al., 2014)
Community members	Only fully grown Mopane worms (Imbrasia belina) were collected, while leaving caterpillars in the highest parts of the trees and pupae untouched for regeneration.	Bobirwa and Kgalagadi (Kayombo et al., 2014)

Table SPM10: Taboos in conservation	
Taboo	**Intended outcome**
Soil needs to be replaced after harvesting of roots and tubers.	Remaining plant parts allow for regeneration and prevent exposure to the sun (Kayombo et al., 2014)
Hunting of calving animals is prohibited.	Allow for reproduction.
Confinement of new mothers, widows, miscarrying women and girls in puberty.	Measures to maintain resource stock for periods of time in communities.
Plants should not be cut without a purpose.	Prevent unnecessary depletion (Velempini & Perkins, 2008).
It is not allowed to eat meat from a community's totem animal	Maintain the population of specific species populations - Mmankgodi, Kweneng (Community members of Mmankgodi, personal communication to KAM, 8 December 2010).

However, it must be noted that Traditional Knowledge is vulnerable to socio-economic pressures. For example, traditional healers and community members often express concerns about overexploitation by some members of the community to sell to herb sellers and other bio traders (Andrae-Marobela, Ngwenya, et al., 2012). In situation where there is unsustainable utilization of an ecosystem service, Traditional Knowledge holders and community members adopt the use of alternative resources to achieve the same objective. For instance, in basket weaving women (Box SPM1) reported that they recycle and re-use older material, or at times replace some palm fibres with plastic or use rusting cans and carbon paper for dying their products **{3.4.1 ii}.**

Box SPM1: The Ngamiland Basket Weavers - The dynamics of Traditional Knowledge and Conservation

The value attached to the baskets enables women, particularly from Ngamiland and Chobe Districts in Botswana, to embark on basket weaving as an important livelihood (Mochankana et al., 2024; Velempini & Garekae, 2022).

Figure SPM B1: Baskets from a women cooperative in Shakawe, Ngamiland, Botswana *(Photo credit: K. Andrae-Marobela)*

Basket weaving relies on natural resources including strips of Hyphaene petersiana (Mokola) palm leaves and dyes from trees such as Euclea divinorum (Motlhakola) and Berchemia discolor (Motsentsila) (Mochankana et al., 2024).

The commercialization of the baskets has led in the past to concerns about the potentially unsustainable use of these natural resources (Velempini & Garekae, 2022). Several elements of Traditional Knowledge, however, contribute to the fact that the basket weavers do use their resources in line with conservation concepts. Firstly, the basket weaving skill, as well as the associated Traditional Knowledge of harvesting and dyeing, is traditionally passed from woman to woman throughout generations, and as such it limits the number of knowledge holders utilizing the specific resources. Secondly, with regards to the availability of natural resources, perceptions differ. Interviewing women basket weavers from six villages in Ngamiland, established that women felt that they have no major difficulties in obtaining the material they need (De Motts, 2017), somewhat contrary to past reports from the same area. The study outlined, that Traditional Knowledge holders have developed mechanisms to access the resources they need. Women reported that they monitor available resources in different areas and may access the palm tree in one area where it is plentiful, whereby they might collect the dyeing tree material in another one and pool resources through informal networks. Another recent study documented complains about dwindling palm trees in Etsha 6, though the depletion was attributed to expansion of the village (Mochankana et al., 2024) and not unsustainable harvesting practices.

Thirdly, the value attached to the basket has led to an increased conscience that the natural resources utilized for basket weaving need to be managed. Sustainable harvesting practices informed by Traditional Knowledge but also modified over time are applied individually and collectively and are taught amongst the women themselves. This includes, for example, harvesting with limits, specific cutting techniques or seasonal harvesting patterns. Monitoring resources has also led to efforts by the Ngamiland Basket Weaver's Trust with support from the Department of Forestry to set up and operate a tree nursery for palms, as well as dye products and other trees (De Motts, 2017). Some basket weavers stated that they recycle and re-use older material, or at times they replace some palm fibres with plastic or use rusting cans and carbon paper for dying (Velempini & Garekae, 2022). These practices impair the authenticity of the baskets, but it nevertheless shows the increased awareness of basket weavers on conservation matters. Though the commercialisation of Botswana baskets can create pressure on natural resources, it has also promoted user-led conservation measures applying elements of Traditional Knowledge together with acquired knowledge to relieve pressure on resources.

This case illustrates how Traditional Knowledge contributes to value addition and promotes conservation awareness, even outside formal government or CBNRM structures. Effective conservation therefore requires inclusive approaches that engage informal networks, gendered livelihood systems and Traditional Knowledge holders who may operate outside conventional policy frameworks.

B3. There is need to promote intergenerational transfer of Traditional Knowledge to ensure its sustainability in the future generations *(Well established).* Currently, Traditional Knowledge is transmitted orally from one generation to the other. This results in some aspects of Traditional Knowledge getting lost. There is need to document and incorporate Traditional Knowledge in the school curriculum for its continuity and sustainability. Box SPM2 outlines some ways to achieve intergenerational knowledge transfer as suggested by various communities **{3.4.5}.**

Box SPM2: Ways to Promote intergenerational knowledge transfer – views from Communities *(Source: BW-NEA Community Dialogues Reports)*

The following views were presented during Community dialogues on how to promote intergenerational knowledge transfer:

- Folklore tales or storytelling (Mainane) by the old people during dinner times or by the fireplace
- Documentation of Traditional Knowledge while observing the principle of free, prior and informed consent
- Traditional Knowledge is to be infused into cultural tourism activities.
- Use boot camp organizations to help transfer Traditional Knowledge to the youth
- Promotion of traditional attire to raise awareness among the youth
- Use of drama and traditional dance groups to teach Traditional Knowledge among the youth.
- Participate in hands-on activities, particularly during important periods like post-harvest and basket weaving which makes the information more concrete and remembered.
- Establish Cultural Days at Kgotla and Schools
- Teachers and elderly working together to provide resources and activities that promote the culture and history of the community.
- Initiation ceremonies (Male and female initiations called Bogwera and Bojale respectively) where the rites of passage mark transitions from childhood to adulthood.
- Establishment of community groups of elders who would focus on cultural education to ensure knowledge continuity from the older generations to the younger generations

B4. The circular economy model for waste management offers great potential ecological and socioeconomic benefits *(Well Established but Incomplete).* Reducing waste generation by promoting the continuous use of resources facilitates a circular economy, a transformative waste management approach compared to the conventional linear model which promotes a 'take-make-dispose' approach. This requires waste recovery for use. However, the scale at which the circular economy has been adopted in relation to the amount of waste generated and recovered is still insignificant despite the benefits it holds for the conservation of biodiversity and ecosystems services (see Statistics Botswana, 2021). Much of Botswana's circular economy in waste management is private sector driven (Botswana Climate Change Network, 2023). The companies derive value out of waste through its value chain (Box SPM3).

Box SPM3: Companies that have embraced the circular economy model for waste management *(Botswana Climate Change Network, 2023)*

- Enviro Recovery Botswana processes collected plastics into pellets which are further manufactured into recycled materials such as plastic chairs.
- Eco Zebra Pencils uses recycled paper to produce graphic pencils.
- Green Loop collects plastics, paper, glass and metals and supplies them to industries that use them as raw materials for manufacturing new products.
- Ngwao Glass uses recycled glass to produce glassware.
- Bokomo Botswana, uses recycled packaging for its manufactured food stuffs.
- Botswana Ash mines soda ash in a closed loop system.
- PlastiCycle transforms plastic waste into reusable material.
- EcoFibre uses recycled material to produce eco-friendly bags.

Transitioning to circular systems can significantly reduce environmental pressures, enhance resource efficiency, and create inclusive economic opportunities **{3.5.4}**

B5. The diversity of fish in the man-made dams in the Aquatic and Wetland Ecosystem reflects ecological diversity and promote opportunities for community livelihoods *(Well Established)*. The presence of both native and introduced species of fish in the man-made dams highlights the importance of key ecosystem dynamics, with implications for fisheries productivity, ecological balance and biodiversity conservation. A network–based and ecosystem service-oriented assessment helps to reveal the economic importance of this ecosystem. Building community resilience includes promotion of value-added fisheries products, and development of sustainable aquaculture enterprises. Educational and vocational training in aquaculture will empower youth, fostering a new generation of environmental leaders and entrepreneurs who drives adaptive strategies in response to environmental challenges (Botswana Ministry of Youth Empowerment, Sport, and Culture Development, 2023). The Thuo Letlotlo programme has packages on game farming and aquaculture, but the guidelines thereof have no special considerations for marginalised groups, more especially women and youth (MOA, 2024) **{4.2.2; 4.5.3}.**

B6. The Forest and Woodland Ecosystem sustain the economy of Botswana through their direct and indirect support to agriculture, mining, energy, and tourism, yet these same sectors exert significant pressures on ecosystem integrity *(Well Established)*. Agriculture and infrastructure expansion have been key drivers of deforestation and fragmentation, while mining and settlement growth exacerbate habitat loss. Tourism relies on intact woodlands and scenic landscapes but is increasingly threatened by degradation. The duality of sustaining and degrading relationships highlights the importance of cross-sectoral policy coherence and integrated planning to secure long-term viability of both ecosystems and dependent sectors (Table SPM11) **{5.1.4}.**

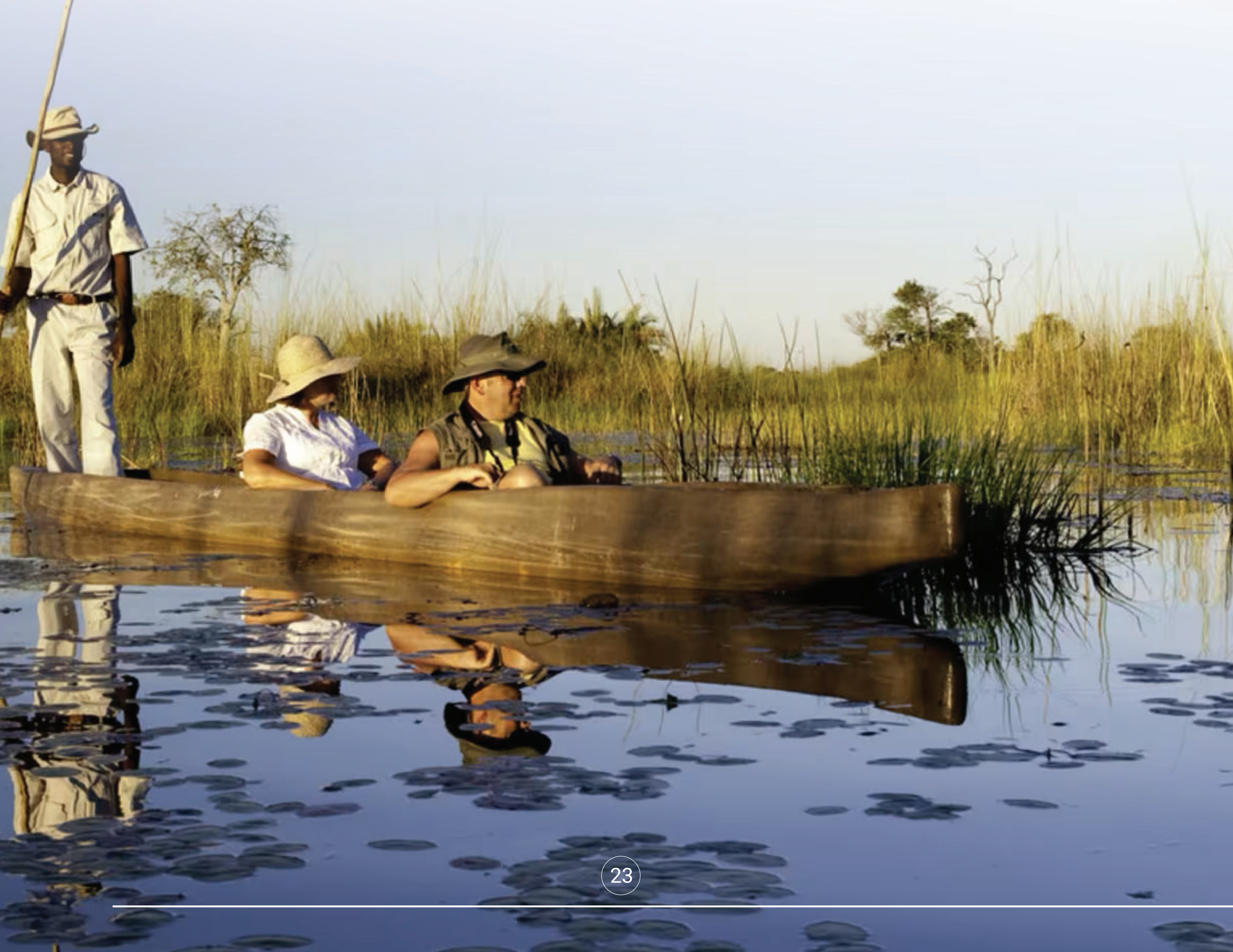


Table SPM11: Key land uses, sectoral dependencies and implications for the Forest and Woodland Ecosystem *(Atlhopheng and Mulale, 2009; Mosigi, 2000; Seleka et al., 2023)*		
Sector	**Nature of dependency on Forest and Woodland**	**Implications**
Agriculture	• Provides grazing land for livestock, particularly small stock (goats, sheep) and cattle. • Supports collection of non-timber forest products (NTFPs) such as wild fruits (e.g., Grewia, Sclerocarya birrea), medicinal plants, and honey. • Shifting cultivation and small-scale cropping at woodland margins.	Pressure from overgrazing and land clearing for cropping may lead to degradation, reduced woodland regeneration, and biodiversity loss.
Mining and Extractive Industries	• Forested areas intersect with mining concessions (e.g., coal, diamonds, base metals). • Woodlands cleared for mining infrastructure, roads, and settlements. • The mining sector may indirectly impact hydrological flows, affecting riparian woodland zones.	Deforestation and fragmentation, pollution risks (dust, chemicals), loss of ecosystem integrity.
Tourism (Eco- and Wildlife-based)	• Supports wildlife-based tourism, particularly in areas where woodlands overlap with national parks, game reserves, or community conservancies. • Scenic landscapes and biodiversity (elephants, antelopes, birds) attract both international and domestic tourists. • Woodland-based cultural tourism (traditional medicine walks, wild food experiences).	Dependency on healthy ecosystems for continued tourism revenue, local employment, and cultural preservation. Degradation could reduce visitor appeal.
Fuelwood and Charcoal Production	• Woodlands are a primary source of fuelwood for rural households. • Charcoal production (though not widespread) occurs informally in some areas.	Overharvesting can lead to localized woodland depletion, reducing availability for other uses.
Construction Materials	• Provides timber and poles for construction (e.g., fencing, kraal building, traditional housing).	Unsustainable harvesting may undermine woodland structure and regeneration.
Cultural and Spiritual Practices	• Certain woodland patches and tree species hold spiritual significance (e.g., sacred groves, ancestor worship sites). • Sites for traditional healing and ceremonies.	Dependency on intact woodlands for cultural identity and heritage continuity.
Water Regulation and Climate Buffering	• Forest and Woodland Ecosystem contribute to microclimate regulation, soil stabilization, and water retention (important for agriculture and settlements).	Loss of woodlands reduces ecosystem resilience against climate variability and droughts.

B7. Grassland and Shrubland Ecosystem are foundational to Botswana's livestock-based economy, sustaining grazing systems, beef production, and rural livelihoods *(Well Established).* Grassland and Shrubland Ecosystem sustain national beef exports and provide essential ecosystem services including forage and regulating functions that underpin household welfare and food security. Much of this ecosystem supports livelihoods and socio-economic activities by providing pastures for smallholder and commercial livestock production (Kayombo et al., 2006; Chanda & Magole, 2001) as well as for game ranching (Kgosikoma et al., 2012). The continued contribution of these ecosystems depends on maintaining their ecological condition. Declining forage quality, bush encroachment, veld product overharvesting and fragmentation of wildlife corridors reduce rangeland productivity and threaten the long-term competitiveness of the livestock sector. Strengthening climate smart rangeland management, integrating ecosystem service valuation into agricultural policy and adopting incentive-based mechanisms such as payments for ecosystem services can enhance resilience. Diversified land use models including integrated livestock–wildlife systems and agrotourism offer additional opportunities to broaden rural income streams while maintaining rangeland integrity **{6.2.1; 6.3.1; 6.4}.**

B8. The proliferation of Prosopis spp. in the Desert Ecosystem presents complex trade-offs, simultaneously threatening native biodiversity and ecosystem function while offering potential livelihood and economic opportunities for local communities *(Well Established).* The Prosopis spp and other invasive species threaten the existence of biodiversity and human livelihoods in the Desert Ecosystem. Originally introduced for dune stabilization and fodder production, Prosopis spp now pose a significant threat to native biodiversity and forage systems (Schachtschneider & February 2013). The impacts thereof are exacerbated by climate change. Botswana has initiated several policy and management actions, including the promotion of ecosystem-based adaptation (EbA), integrated dryland landscape planning, and invasive species control through community engagement models such as the BORAVAST Trust initiative (DEA, 2015; UNDP, 2023). National responses, including the development of a Prosopis Management Plan and community-based eradication initiatives, are underway but remain constrained by limited financial and technical resources. These efforts require strengthening through coordinated multi-stakeholder approaches, enhanced monitoring systems, and adaptive management frameworks to mitigate biodiversity loss effectively. However, despite the challenge brought by Prosopis's spp, positive opportunities include its utilization as fodder, charcoal, and manure for crop production (DEA, 2015) **{8.3}.**

B9. The Hill Ecosystem offers substantial but underutilised opportunities for climate-resilient and culturally grounded livelihoods through nature-based and bio-cultural enterprise development, including community-led ecotourism, Traditional Knowledge-based products, and bioeconomic value chains. However, these opportunities remain largely under-leveraged due to systemic barriers in policy support, investment flows, market access, and institutional coordination *(Established but Incomplete)*. The Hill Ecosystem supports human well-being through social, cultural, economic, and environmental benefits that strengthen household resilience and collective stewardship. Secret and sacred sites underpin cultural identity and spiritual continuity (Dichaba, 2010), while wild foods, medicinal plants, and natural materials provide livelihoods (Keitumetse & Nthoi, 2009). High-value species such as Marula (Sclerocarya birrea), Mongongo (Schinziophyton rautanenii), and Devil's Claw (Harpagophytum procumbens) hold commercial potential, demonstrated by initiatives like the women-led Kgetsi ya Tsie Community Trust (Tswapong). Limited processing, infrastructure, market access, investment, and protection of intellectual property and Traditional Knowledge constrain enterprise growth. Realising these opportunities requires coherent bioprospecting regulations, access and benefit-sharing frameworks aligned with the Nagoya Protocol, and targeted support for community enterprise development, certification, and market integration **{9.4.2}.**

B10: Valuation of natural resources has not been explored to the extent of inclusion in the System of National Accounts (SNA) and development planning *(Well established)*. Although Botswana has demonstrated commitment to biodiversity and ecosystem service valuation, through landmark assessments of the Okavango Delta, Makgadikgadi Pans, and related institutional studies, the resulting evidence has not been systematically integrated into national development planning, public investment decisions, or the System of National Accounts (SNA). Indirect non-use values such as carbon sequestration, wildlife refuge, groundwater recharge and water purification demonstrate forgone benefits or lost opportunities for Botswana as they are not appropriately captured in the System of National Accounts (SNA). As such, they are not considered in the determination of the country's Gross Domestic Product (GDP). These values are also not considered in the development planning processes of the country. This gap limits the country's ability to align economic development with ecological sustainability and to leverage natural capital as a strategic asset for long-term resilience and prosperity. Nature based finance, however, is currently contributing significantly to most economies around the globe. This has prompted the Botswana Government through the Ministry of Environment and Tourism in partnership with the United Nations Development Programme (UNDP) to implement the Biodiversity Finance (BIOFIN) project as part of the global Biodiversity Finance Initiative **{10.3.2}.**

C. Scenario pathways for sustainable socio-ecological futures

C1: Botswana's future ecosystem integrity will depend largely on the effectiveness of governance and the design and implementation of land-use policies, which shape resource allocation, development patterns, and the capacity of ecosystems to provide essential services, rather than on biophysical limits alone *(Established but incomplete)*. Integrated scenario results demonstrate systematic divergence in habitat condition, biodiversity intactness, and ecosystem integrity under alternative development pathways. Sustainability-oriented pathways consistently buffer integrity loss across ecosystems, while weak spatial planning, enforcement, and coordination lead to accelerated degradation, fragmentation, and loss of ecological capital at national scale. Ecosystem Integrity Index trajectories confirm that governance and land-use decisions amplify or constrain cumulative pressures, making Botswana's ecological future policy-elastic rather than environmentally predetermined. These findings demonstrate that biodiversity-inclusive spatial planning and systematic integration of ecosystem integrity indicators into land allocation, environmental and social impact assessment (ESIA), and development planning are decisive levers for halting biodiversity loss and aligning national development with global biodiversity goals, while failure to do so locks landscapes into high-degradation trajectories {11.5.4; **11.5.5; 11.6.4; 11.6.5; 11.7}.**

C2: Grassland, Shrubland, and Forest & Woodland ecosystems are high-risk yet high-leverage systems, where degradation can disproportionately undermine national ecosystem integrity, while effective management and restoration can secure key ecosystem services and long-term ecological stability *(Established but incomplete)*. InVEST Habitat Quality results (1990 - 2020) show strong structural differentiation across Botswana's ecosystems. Scenario analysis identifies Grassland, Shrubland, and Forest & Woodland as the most responsive to changes in governance and land-use pressure (Figure SPM9).

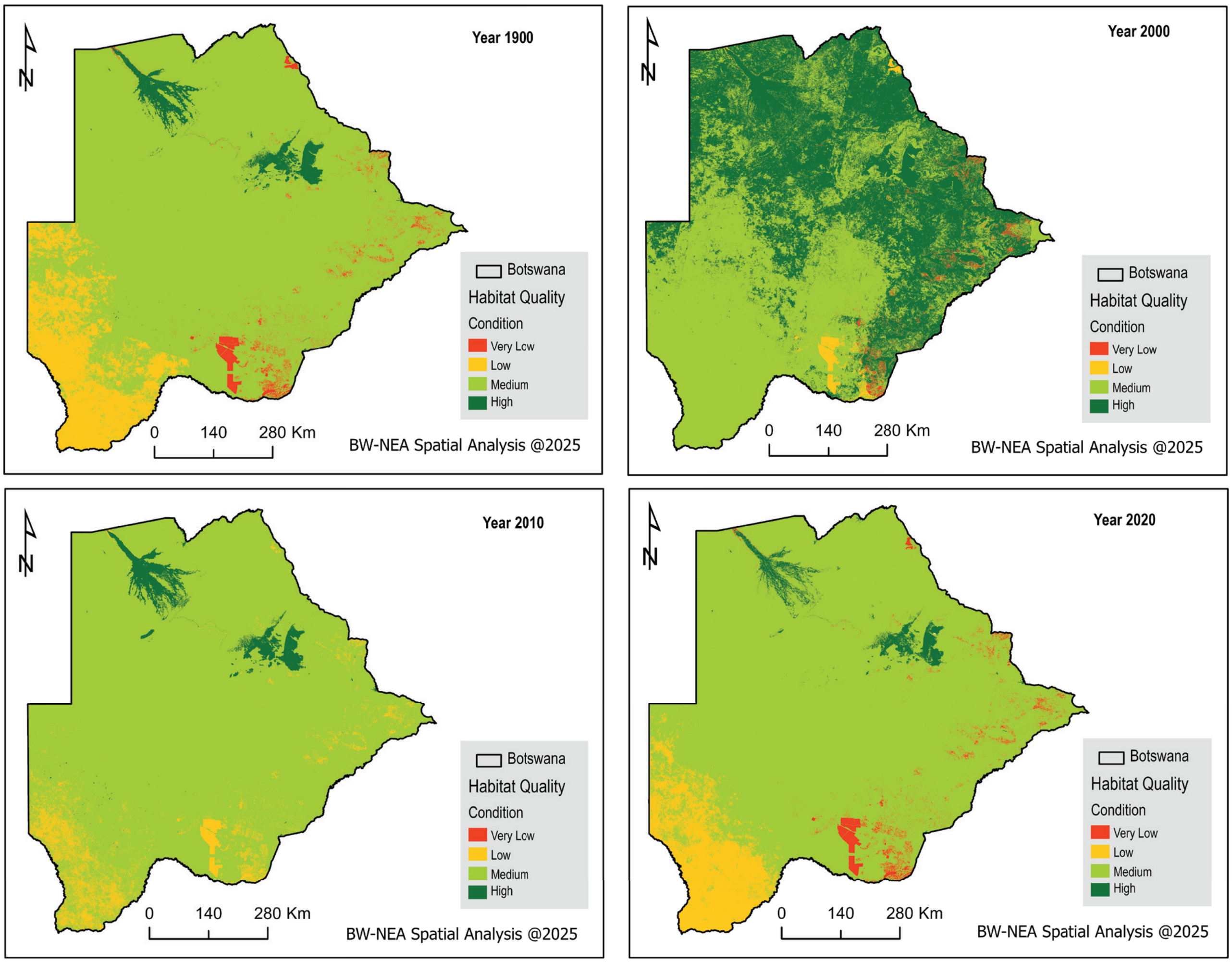


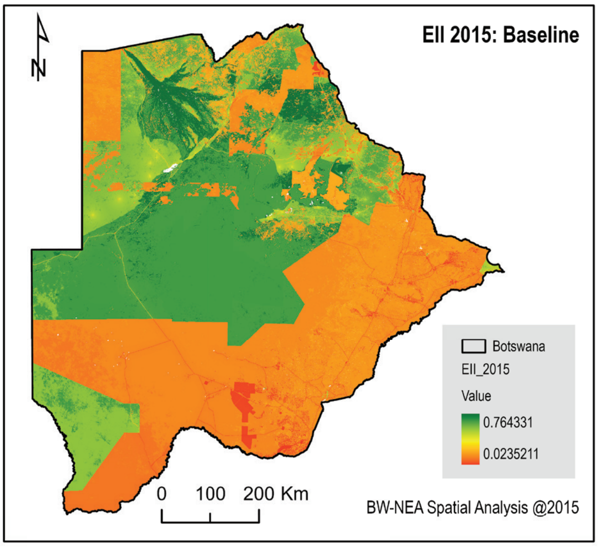
Figure SPM9: Spatial patterns of InVEST Habitat Quality (HQ) in Botswana, 1990 – 2020 *(Source: BW-NEA Spatial Analysis)*

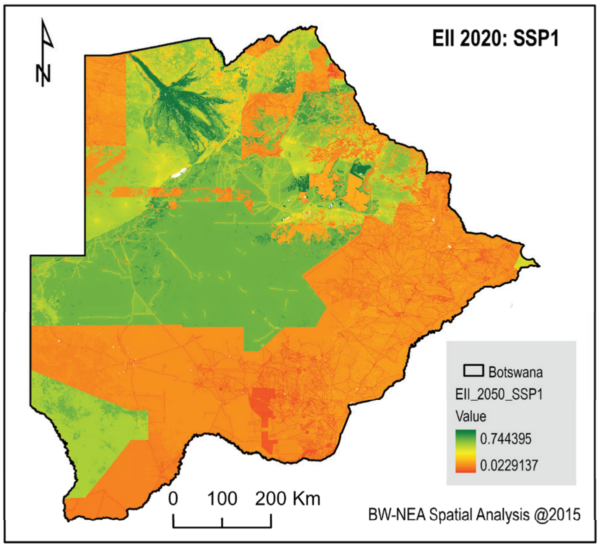
They absorb the largest integrity losses under high-pressure pathways due to grazing intensity, fire regimes, fuelwood extraction, and fragmentation, yet also show the strongest buffering under sustainability-oriented management. Their extensive spatial footprint across Botswana's production landscape positions them as priority intervention zones where targeted reforms can yield disproportionate national integrity gains, even though net recovery is not achieved by mid-century. Prioritising restoration and sustainable management in these ecosystems are essential to achieving meaningful progress toward large-scale ecosystem restoration commitments, as improvements here yield the greatest national returns for biodiversity, ecosystem services, and climate resilience relative to investment effort. Grassland and Shrubland are highly degraded (HD ≈ 0.63) due to grazing pressure, borehole-centred use, and bush encroachment (Dougill et al., 2002; Ringrose et al., 2003). Forest and Woodland show moderate-to-high degradation (HD ≈ 0.56) from fuelwood extraction, land clearing, logging, and fire (Tsheboeng et al., 2025; Lekoko et al., 2025; Sianga et al., 2025). Degradation aligns with land-use intensity and hydrological context, guiding ecosystem management and restoration priorities (Table SPM 12) **{11.5.2; 11.5.3; 11.6.3; 11.6.6; 11.7.2}.**

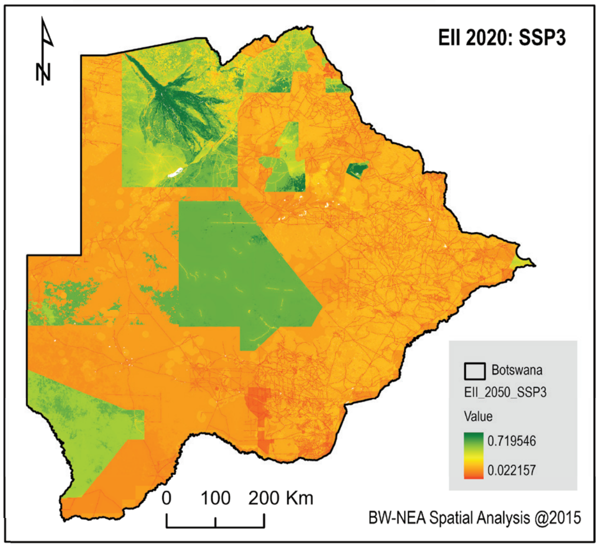
Table SPM 12: InVEST Habitat Degradation (HD) across BW-NEA prioritised ecosystems			
Ecosystem	**Mean HD**	**Degradation Class**	**Spatial Expression and Condition**
Agroecosystem	0.757	Very High (> 0.70)	Eastern and southeastern Botswana, strongly clustered along the Lobatse–Gaborone–Francistown corridor. Severe degradation associated with intensive cultivation, settlement concentration, and overstocking
Grassland & Shrubland	0.634	High (0.55 - 0.70)	Central and eastern communal rangelands, radiating from boreholes and road networks. Widespread degradation driven by chronic grazing pressure and bush encroachment
Forest & Woodland	0.563	High (0.55 - 0.70)	Northern Botswana (Chobe, Ngamiland) and parts of Central District. Biomass loss and structural decline linked to fuelwood extraction, fire, and clearing
Hill Ecosystem	0.475	Moderate (0.35 - 0.55)	Isolated hill complexes across the country. Localised degradation from quarrying, settlements, and infrastructure
Aquatic & Wetland	0.421	Moderate (0.35 - 0.55)	Okavango Delta fringes, Chobe floodplains, Limpopo Basin. Moderate pressure from livestock access and abstraction; some high values reflect seasonal exposure
Desert	0.298	Low (< 0.35)	Kalahari interior and Kgalagadi region. Largely intact systems with emerging connectivity pressures

C3: National ecological connectivity is recoverable under strong spatial governance but erodes rapidly under high-pressure development trajectories *(Established but incomplete)*. Spatial integrity analysis shows that connectivity outcomes diverge sharply between pathways. Ecosystem Integrity Index values decline across all ecosystems between 2015 and 2050, with losses greatest under the regional rivalry pathway (SSP3-7.0) due to intensified land use, fragmentation, and weak governance. Forest and Woodland and Grassland and Shrubland ecosystems show the largest declines, while Aquatic and Wetland systems retain higher integrity but still deteriorate. Agroecosystem and Hill Ecosystem remain persistently degraded under both scenarios, highlighting limited recovery without targeted intervention. Under sustainability-oriented governance, integrity losses remain spatially fragmented and largely confined outside protected and low-use areas, allowing large-scale ecological linkages to persist. Under the sustainability pathway (SSP1-2.6), integrity is highest in Aquatic and Wetland (0.533) and Grassland and Shrubland (0.374), with moderate gains in forests (+0.050) and grasslands (+0.087), small improvements in aquatic (+0.037) and desert systems (+0.013), and negligible change in agroecosystems, demonstrating the responsiveness of semi-natural systems to sustainable land-use strategies (Table SPM 13; Figure SPM10).

Table SPM 13: Ecosystem Integrity Index (EII) across BW-NEA prioritised ecosystems and scenario, and change				
Ecosystem	**EII SSP1-2.6 (2050)**	**EII SSP3-7.0 (2050)**	**ΔEII SSP1-2.6 (2050 - 2015)**	**ΔEII SSP3-7.0 (2050 - 2015)**
Agroecosystem	0.105	0.105	−0.014	−0.014
Aquatic & Wetland	0.533	0.496	−0.028	−0.065
Desert	0.311	0.298	−0.011	−0.024
Forest & Woodland	0.341	0.290	−0.037	−0.088
Grassland & Shrubland	0.374	0.287	−0.028	−0.115
Hill	0.214	0.213	−0.034	−0.034







In contrast, high-pressure trajectories produce contiguous integrity decline along transport corridors, agro-industrial belts, and settlement fronts, undermining species movement, climate adaptation capacity, and tourism resilience. Connectivity outcomes are therefore a governance choice rather than an inevitable consequence of development. Maintaining and restoring connectivity beyond formally protected areas is critical for achieving effective conservation coverage at landscape scale, underscoring the need to recognise ecological corridors, Wildlife management Areas (WMAs), and community-managed landscapes as integral components of national conservation and spatial planning systems **{11.5.4; 11.5.5; 11.6.5; 11.7.2; 11.7.3}.**

C4: Traditional knowledge, socio-cultural systems, veld-product value chains, and gendered livelihoods are foundational drivers of Botswana's socio-ecological resilience, shaping ecosystem futures and the sustainability of ecosystem services *(Well established)*. Veld products in Botswana, including Mopane worm (Gonimbrasia belina), marula (Sclerocarya birrea), wild medlar (Vangueria infausta), thatching grass, and fuelwood, deliver culturally embedded and climate resilient services that support subsistence, women and youth incomes, and seasonal diversification (DFRR & JICA, 2017; Setlhogile et al., 2011). Veld-product scenario analysis demonstrates that household equity, ecological outcomes, and system resilience vary strongly with governance arrangements, stewardship norms, and value-chain structure. Traditional Knowledge guides sustainable management and adaptive responses, strengthening equity, governance, and cultural resilience (UNESCO, 2023). Traditional harvesting practices regulate offtake, support regeneration, and buffer climatic variability, while women's central role in harvesting and processing links biodiversity conservation directly to livelihood equity. In addition, as part of the socialization process in livestock rearing communities, boys engage in small stock herding at a young age which exposes them to the local environment, its biodiversity and conservation practices. Where governance marginalises customary institutions, degradation accelerates despite formal conservation measures, confirming that socio-cultural systems are integral, not ancillary, to sustainability outcomes. Scenario analysis highlights trade-offs between short term income gains and long-term ecological integrity, with Inclusive Growth increasing rural incomes but raising overshoot risks without safeguards, while a Stewardship to Inclusive Growth pathway sustains high ecological capital at approximately 85 on the index alongside phased income expansion (Figure SPM11).

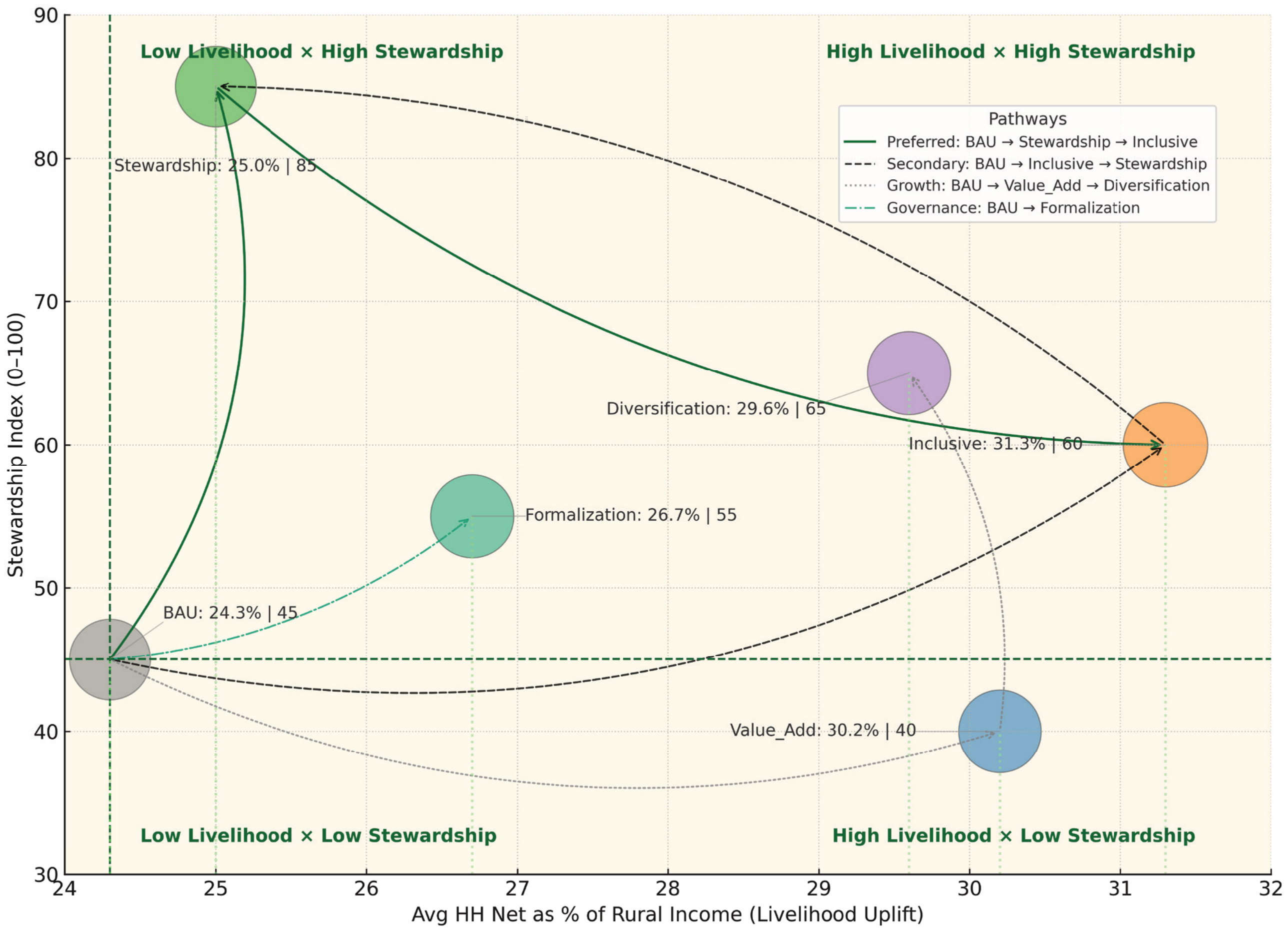


Figure SPM11: Scenario Pathways and trade-offs between local livelihoods with ecological sustainability *(Source: BW-NEA Scenario Analysis (2025).*

Ensuring equitable participation of local communities, particularly women, and recognising the value of Traditional Knowledge systems is therefore not merely a normative imperative but a structural prerequisite for sustaining ecosystem services, regulating resource use, and maintaining long term ecological integrity across development pathways **{11.9.1; 11.9.2}.**

C5: Invasive alien species (IAS) act as a cross-cutting amplifier of ecosystem degradation or recovery across all scenarios *(Established but incomplete)*. Invasive alien species, including Prosopis juliflora, Salvinia molesta, Chromolaena odorata, and Opuntia stricta, pose escalating risks across ecosystems by altering hydrology, degrading water quality, transforming fire regimes, suppressing native biodiversity, and reducing grazing productivity, with high fiscal costs. IAS trajectories consistently intensify ecosystem degradation under weak governance, compounding habitat loss and biodiversity decline in rangelands, wetlands, and riparian systems. Conversely, high-ambition eradication and restoration pathways substantially reduce IAS extent, restore vegetation structure, and generate livelihood co-benefits. Scenario analysis identifies flexible pathways that balance governance, markets, and community action: Shield to Sweep to Sustain targets at least 50 percent reduction through legal harmonization, surveillance, and risk finance; Local First, Scale Later prioritizes community empowerment and phased technology scaling; Market Driven Utilization with Guardrails leverages certified biomass markets; and Data First, Markets Second emphasizes adaptive management (Figure SPM12).

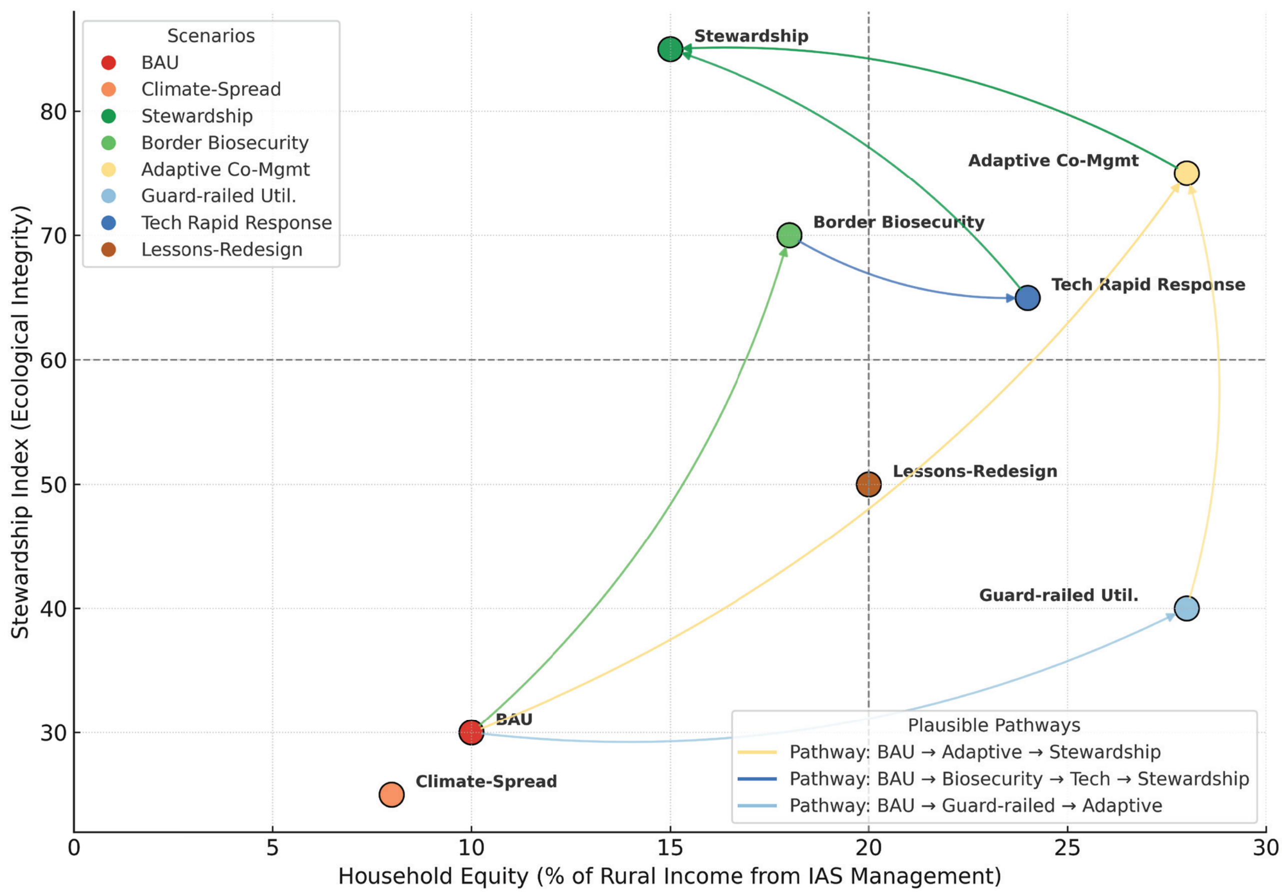


Figure SPM12: Plausible pathways for invasive alien species management in Botswana

These pathways can be sequenced or combined to align with resource availability, policy priorities, and climate driven pressures. Spatial overlap between IAS hotspots and low-integrity zones demonstrates that IAS management is one of the most cost-effective levers for improving ecosystem integrity and reducing long-term restoration costs. Strategic investment in early detection, rapid response, and restoration delivers high biodiversity and livelihood returns per unit cost, making IAS management a priority mechanism for mobilising and directing biodiversity finance toward measurable integrity gains **{11.9.3; 11.9.4}.**

C6: Long-term resilience depends on integrated social–ecological governance that coordinates institutions, policies, and community actions, alongside carefully sequenced development pathways that balance ecosystem health, resource use, and socio-economic needs *(Well established).* The Ecosystem Integrity Index shows that stabilisation or recovery occurs only where habitat condition and biodiversity intactness improve simultaneously, supported by aligned governance, stewardship, and pressure reduction. National ecosystem integrity trends align with ΔEII patterns, with improvements in low-pressure ecosystems and declines in high-pressure production landscapes. Under SSP1-2.6, losses are moderate and fragmented due to improved planning and lower pressure, whereas SSP3-7.0 drives extensive declines through land conversion, infrastructure expansion, and weak governance. Stability is largely confined to protected and remote areas, underscoring the need for stronger spatial planning, enforcement, and cross-sectoral governance to safeguard ecosystem assets (Figure SPM13).

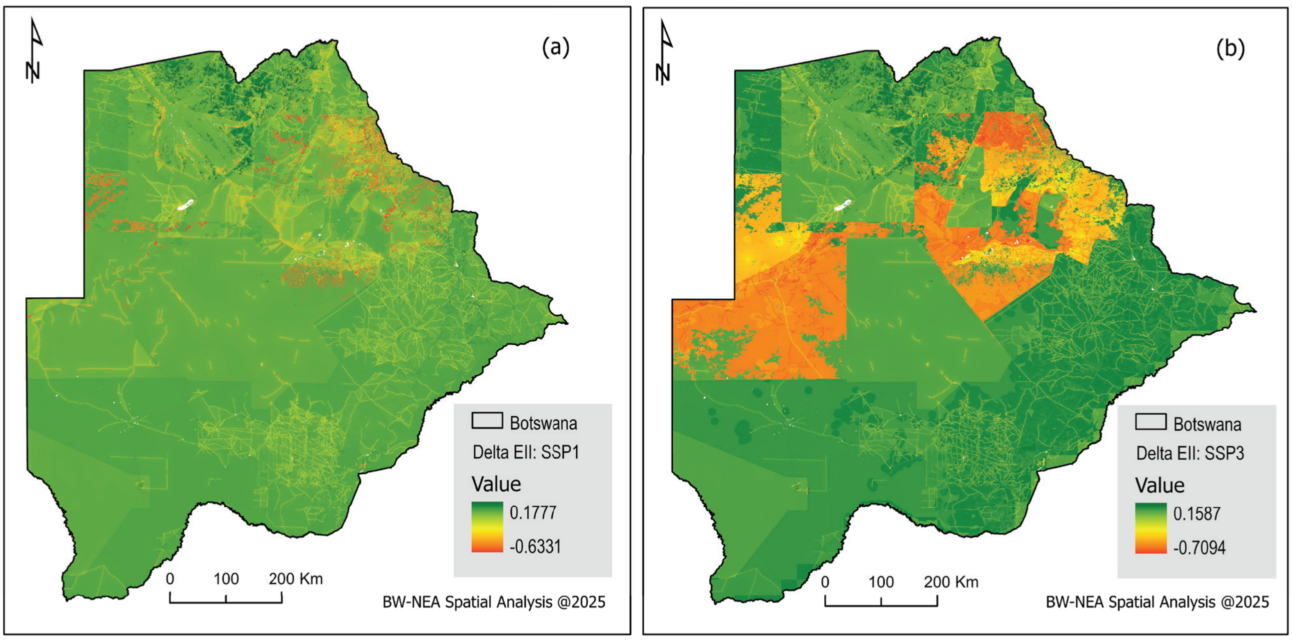


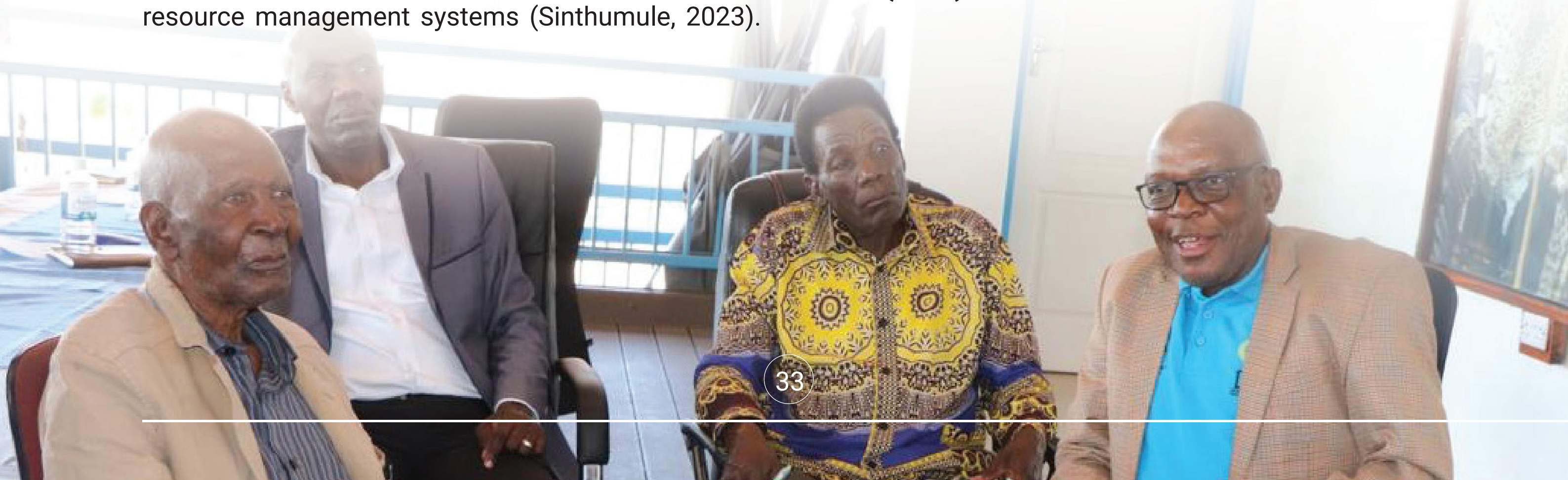
Figure SPM13: Change in Ecosystem Integrity Transitions (ΔEII) under (a) sustainability pathway *(SSP1-2.6, and (b) regional rivalry pathway (SSP3-7.0) by 2050.*

The combined InVEST–GLOBIO assessment shows that ecosystem integrity determines the delivery of nature's contributions to people. Under SSP1, integrity gains in Desert, Hill, and Aquatic and Wetland ecosystems strengthen regulating services and climate resilience, particularly in the Okavango, Boteti, and Makgadikgadi corridors, whereas SSP3-driven declines in the Agroecosystem and Forest and Woodland reduce ecosystem services, carbon storage, and adaptive capacity while increasing fire and hydrological risks. These results highlight the need to embed ecosystem-based adaptation, landscape restoration, and stronger rangeland governance in climate policy, and to formally support protected and community-managed landscapes to maintain integrity, connectivity, livelihoods, and commitments under the KMGBF (Scarano, 2017; Terêncio et al., 2021; Hughes & Grumbine, 2023. Sector-specific interventions fail to arrest decline in high-use landscapes when uncoordinated. Scenario synthesis indicates that pathways prioritising ecological stabilisation before livelihood expansion produce more durable outcomes, whereas growth-first strategies risk irreversible integrity loss. Botswana's resilience therefore depends on coordinated, cross-sectoral governance integrating scientific modelling, traditional knowledge, and adaptive management. Embedding repeatable, spatially explicit integrity indicators into national monitoring, reporting, and investment frameworks is essential for tracking progress, guiding adaptive management, and sustaining long-term alignment between biodiversity conservation, climate adaptation, and inclusive development objectives **{11.7.1; 11.7.2; 11.8}.**

D. Enabling governance conditions for resilient socio-ecological systems

D1. Traditional Knowledge is embedded in diverse traditional governance systems *(Well established)* Traditional Knowledge categories with a role in biodiversity conservation include taboos and totems, customary laws and regulations, metaphors and proverbs, traditional protected areas, local knowledge of plants, animals and landscapes and traditional resource management systems (Sinthumule, 2023). The use of customary laws and regulations play a role in setting standards and conditions for conserving ecosystem services. Local leaders (Kgosi and other Traditional Knowledge leaders) oversee the enforcement of these customs and rituals in celebrations and ceremonies to drive conservation practices **{3.4.1 ii}.**

D2. Sacred natural sites (SNSs) sustain ecosystem integrity and high biodiversity through community stewardship and customary governance systems that regulate access and resource use, functioning as locally embedded conservation mechanisms *(Well established)*. Sacred and natural sites (SNSs) are owned, confined and practiced within specific families or in clearly defined community leadership structures. This type of Traditional Knowledge largely remains secret and is practiced at secret places. Often, these practices are only conducted in times of severe crisis involving communities, families or guarded rites of passage. These Traditional Knowledge systems are closed to third parties, and the secrecy should be respected as such (Centre for Scientific Research, Indigenous Knowledge and Innovation (CesrIKi), 2012). The SNSs are associated with taboos that regulate access to resource use and form part of community identities shaped by a contractual relation with spiritual entities and ritual enactment. SNSs in Botswana mainly are hill tops, hill ecosystems, trees (e.g. Baobabs), aquatic ecosystems (eg. springs, waterfalls), rocks and caves (Government of Botswana, 2006; Nkomazana, 2020). SNSs in Botswana have different statuses ranging from UNESCO World Heritage Sites (e.g. Tsodilo Hills), national monuments (e.g. Moremi Gorge, Gcwihaba Caves) to many formally recognized and informal places of meaning for communities. This has implications for management and development strategies, as SNSs are not static structures, but dynamic entities which develop differently and unevenly due to their varying statuses of recognition, changing interests of communities, opportunities, environmental factors and stakeholder participation /engagement and the evolution of the significance of sacredness over time and space (Tatay & Merino, 2023). The lesser known SNSs of Bobirwa District and how they are governed are illustrated in Box SPM3 **{3.4.3}.**



Box SPM3: The sacred natural sites (SNSs) of Bobirwa (Source: Nkomazana, 2020)

The SNSs consist of six sites, Leribe, Matadela, Mareledi, Leleti, Maiswe and Semabaje. All of them are located on top of a hill within a 12 to 95km radius of Bobirwa, the main village of the Bobirwa Subdistrict. The sacredness of these sites results in being the home of ancestral spirits *('Badimo')* and at the same time being entry points to the spiritual world.

Five of the six SNSs are places where rainmaking rituals are performed under the leadership of the chief *('Kgosi')* and traditional healers *(Dingaka tsa morafe)*. Rainmaking rituals involve giving offerings and sacrifices (Sepheko) to 'Badimo', with requests to reverse and mitigate *(severe)* droughts by providing rain and soil fertility. Offerings are often traditional beer *(Bojalwa)* in a sacred pot to make 'Badimo' happy and the sacrifice of domestic animals, such as goats, sheep or cattle.

There are certain precautions to be taken and taboos to be observed when accessing the sites. These are strictly reinforced. Permission to visit the sites must be sought from 'Kgosi'. When accessing the sites, no shoes, no perfume or perfumed lotions should be worn, as noise and strong smell is intolerable for 'Badimo'. Polluting and littering, as well as destruction (e.g. removal of materials) of the sites are strongly forbidden, as pollution is believed to anger 'Badimo'. At some sites, the number of people accessing the site is controlled by allowing only 'Badimo' related people of Bobirwa to visit for ritual purposes. It is not allowed to take money, communicating that the SNS is not a commercial entity. Consequently, trees, firewood, rock artefacts, sand, water from the site cannot be sold. Visits are only approved for specific purposes at stipulated times.

D3. Recognizing communities as heterogeneous socio-economic spaces, inclusive participatory approaches are critical to balance representative engagement, mitigate power asymmetries, and capture diverse perspectives *(Well established)*. The success of a policy in terms of its acceptance by stakeholders and successful implementation depends largely on how the development process is conducted. Experience has shown that a people-centred approach, which is inclusive of ideas, opinions, attitudes, perceptions and suggestions by various Traditional Knowledge holders, custodians and users is more likely to yield a holistic policy with better chances of successful implementation (Irvin & Stansbury, 2004; Rijal, 2023). The application of diverse participatory methods during community consultations allows for collection of information rich data. People-centred approaches, which are inclusive of ideas, opinions, attitudes, perceptions and suggestions by various Traditional Knowledge holders, custodians and users are more likely to yield a holistic policy with better chances of successful implementation **{3.4.4}.**

D4. Safeguarding environmental flows is essential to sustain Botswana's ecosystems, biodiversity, and livelihoods *(Well Established)*. Across Botswana's major rivers, including the Notwane, Tati, Okavango, and Boteti, altered flow regimes from dams, water abstractions, and urban demand have produced prolonged low flows, shortened flood durations, and declining baseflows. These hydrological changes have degraded ecological integrity, driving riparian vegetation loss, wetland desiccation, and shifts from permanent swamps to seasonal grasslands, while undermining key ecosystem services including fisheries, grazing, flood-recession agriculture, and groundwater recharge. The impacts extend to critical sectors such as tourism, where even modest flood reductions threaten visitor numbers, and urban water security, with deficits in Gaborone projected beyond 2031 despite infrastructure investments. Evidence demonstrates that environmental flows underpin biodiversity and human well-being, and their neglect erodes climate resilience, economic diversification potential, and cultural identity. Long-term sustainability requires adaptive environmental flow management, systematic water quality monitoring, and operations guided by hydrological and ecological thresholds. For instance, Figure SPM8 illustrates the lower Boteti River over 1973 to 2002 transitioning from a perennial system to highly intermittent flows, exemplifying the systemic consequences of upstream regulation and reduced environmental flows. Across all basins, hydrological simplification reduces aquatic habitats, weakens ecological resilience, and threatens livelihoods. Ensuring ecological connectivity through adaptive environmental flows, climate-responsive dam operations, and integrated water-resource planning is critical for sustaining Botswana's riverine ecosystem services and long-term water security (King et a., 2009).

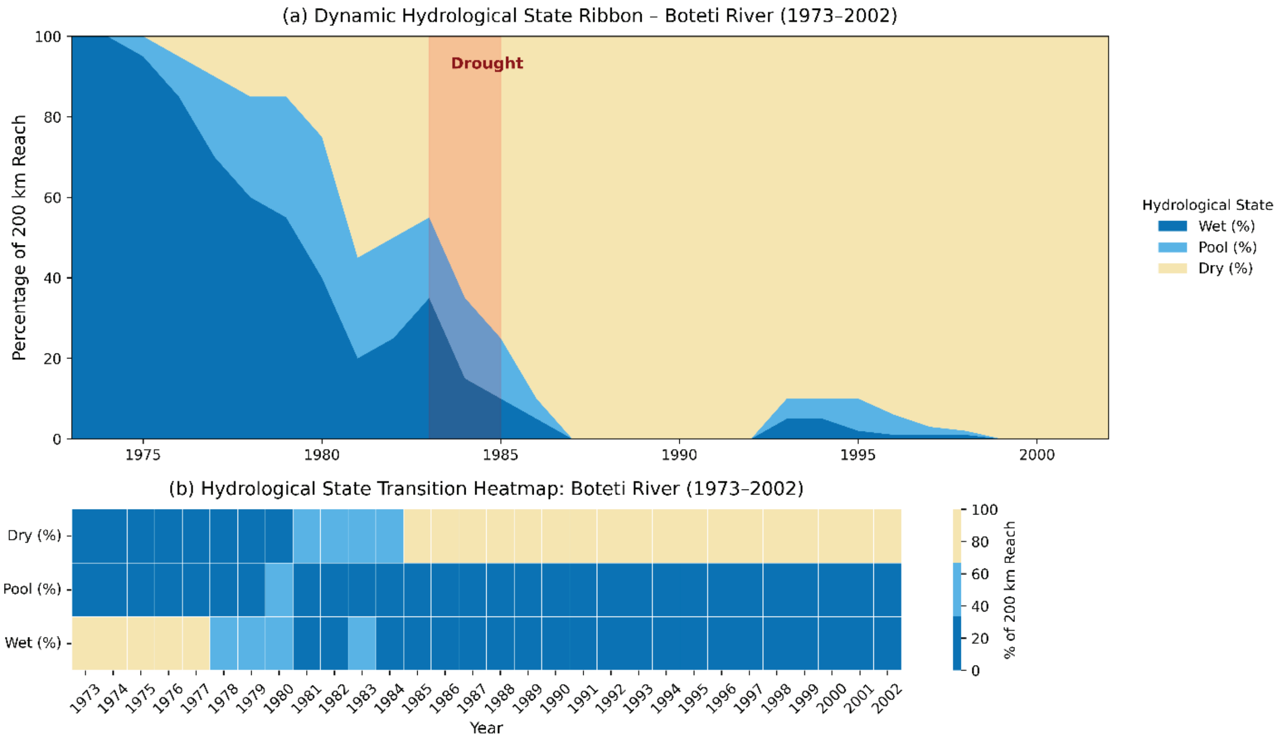


Figure SPM8: Hydrological state changes in the Boteti River reach *(1973 – 2002) (Data Source: King et al., 2009).*

From a hydrological-ecological perspective, the figure illustrates the cumulative effect of upstream water-resource developments, interannual climatic variability, and drought frequency on downstream environmental flows. The near-complete loss of sustained baseflows demonstrates that the Boteti's ecological functionality is now maintained primarily through episodic flood pulses rather than continuous discharge. These results underscore the importance of incorporating environmental-flow allocations and adaptive basin-scale water-management strategies to restore minimum ecological connectivity between the Okavango Delta and Boteti River systems (King et al., 2009) **{4.2.2}.**

D5. Strategic, climate-responsive governance is essential to balance water development, equity, and ecological sustainability *(Established but Incomplete).* The Aquatic and Wetland Ecosystem is facing significant pressures from climate change, agriculture, mining, and infrastructure development. While water infrastructure and abstractions deliver short-term benefits for irrigation, and urban supply, they impose significant long-term ecological and social costs. Environmental flow deficits and subsistence demands reduce firm yields at Ntimbale Dam by up to one-third under climate change, while high-development scenarios in the Okavango Basin cut flood volumes to two-thirds, extend dry seasons by 18 weeks, and threaten Delta and Boteti ecosystems. Subsistence farmers, pastoralists, fishers, and rural households face disproportionate impacts, exacerbating inequities. Addressing these trade-offs requires defining a development space, embedding environmental flows into Integrated Water Resource Management, and strengthening cooperative governance through Permanent Okavango River Basin Water Commission (OKACOM), Southern African Development Community (SADC), and national frameworks, alongside climate-resilient livelihoods, water-efficient technologies, invasive species management, sustainable grazing, transboundary monitoring, and community-led conservation to restore fish stocks and ecosystem resilience (Kgathi et al., 2006; Parker et al., 2015; Dougill et al., 2016; Mmopelwa et al., 2009; Ashton & Neal, 2003; Marcantonio, 2016; Kgathi et al., 2012) **{4.3.1}.**

D6. Traditional Knowledge and community-based governance are critical for sustaining forest biodiversity and ecosystem services, though they remain underutilised in formal governance systems *(Established but Incomplete).* Communities that are located around the Forest and Woodland Ecosystem have developed ethnobotanical knowledge that is useful to them (Pei et al., 2009). They know timber and non-timber forest products that are useful to them (Akalibey et al., 2024) as well as medicinal plants (Bultosa et al., 2020). These non-timber forest products include food, medicinal plants, resins, and fibers that they use sustainably (Ahenkan & Boon, 2011; Shrestha et al., 2020). Box SPM4 lists examples of the biodiversity conservation measures that are drawn from the Traditional Knowledge practices of Chobe communities.

Box SPM4: Customary Governance Practices in the Forest and Woodland Ecosystem
(Source: BW-NEA Chobe Community Dialogues).

Plants related governance practices using Traditional Knowledge

- To ensure sustainable production and regrowth, there are plants that the community does not allow to be cut at all, especially during the flowering and fruiting period. For example, the branches of the *Moretlwa,* Brandy bush *(Grewia flava),* and *Motsotsojane* Rough leaved raisin *(Grewia flavescens)* should not be cut, especially at the time when they bear fruits.
- Harvesters are not allowed to remove all the special roots of the Motlopi Shepherd's tree *(Boscia albitrunca),* which are used for processing into a hot beverage. They harvest enough soft roots for processing and cover the remaining ones with soil to allow for regeneration.
- The branches of the Motlopi Shepherd's tree *(Boscia albitrunca)* should not be cut to allow the tree enough vegetative growth to enable it to produce more fruits during the fruiting season.
- *Mokgalo* Buffalo thorn *(Ziziphus mucronata)* is a sparsely populated tree species, for which the communities have imposed limitations on how often and at what times it should be harvested for wood. Harvesting is allowed during the winter season to provide enough time for it to recover in spring and summer.
- The Morukuru Tamboti tree *(Spirostachys africana)* should only be cut when it has dried into dead wood, because if the live tree is cut, it takes time for it to recover and grow to maturity. There are established and sustainable methods of harvesting medicinal plants. When harvesting medicinal shrubs' roots/tubers, they leave the tap root or parts of the plant and fill back the soil from where the shrubs, roots, or tubers were dug out to encourage regrowth in the future.

Animal related governance practices using Traditional Knowledge

- Communities practice seasonal hunting to prevent the depletion of wildlife populations. It is only the mature males that are selected for hunting; while lactating mothers and young animals (males and females) are not hunted.
- Small game species such as *Phuduhudu, Steenbuck (Raphicerus Campestris)* are hunted all year round as the meat can be consumed within a short period without spoiling.
- The large species, such as the Tlou African bush elephant *(Loxodonta africana)* and *Thutlwa Giraffe (Giraffa Camelopardalis),* are hunted during the winter season when it is cold for purposes of meat preservation and to avoid spoilage.
- *Kgori Kori Bastard (Ardetois Kori)* was hunted only at the instruction of the Village's Chief *(Kgosi)*, as it is a rare bird not found in large numbers and therefore needs to be preserved.
- When *Phane*, Mopane caterpillar *(Impatiens belina)* reaches the stage of hibernation, it is not allowed to be harvested, as they serve as seed for the next cycle.

Traditional practices such as seasonal harvest restrictions, cultural taboos, and management by local community trusts promote sustainable resource use and reinforce cultural identity, yet they remain largely underutilized within formal governance systems. The Forest and Woodland Ecosystem is regulated under the Forest Act No. 23 of 1968 (amended in 1980 and 2005), which governs access to and protection of forest resources in Botswana. Communities, such as those around the Kasane Forest Reserve require official permits to utilize these resources, resulting in constrained access, use, and local stewardship (Lepetu & Garekae, 2015). Evidence indicates that women and youth are particularly dependent on fuelwood and non-timber forest products but face limited decision-making power and unequal access. Strengthening ecological stewardship and equitable benefit-sharing is therefore critical to ensure governance that is gender- and youth-responsive **{5.5.1; 5.5.2}.**

D7. The diminishing role of traditional rangeland management and misalignment between formal and customary governance undermine local stewardship and compromise incentives for sustainable ecosystem management *(Established but Incomplete).* In the pre-independence period, land was communally owned and administered by chiefs, with headmen allocating land and appointed overseers monitoring its use (Makepe, 2006; Moleele & Ntsabane, 2002). Resource-use disputes were traditionally settled at the Kgotla, and wildlife was selectively hunted using non-destructive methods during winter (Moleele & Ntsabane, 2002). Since then, customary governance systems have been marginalized, as modern scientific management has become the dominant framework for resource regulation and utilization. Consultations indicate that communities feel excluded from decisions on fire management, grazing, and veld product use, which undermines conservation attitudes. The erosion of intergenerational knowledge transfer, including early burning and mobility norms, has reduced adaptive capacity to climate variability. Historically, customary grazing systems sustained ecosystem resilience, but their decline has intensified pressures on rangelands. Harmonizing statutory and customary governance, reviving intergenerational knowledge on fire and grazing practices, and institutionalizing co-management frameworks are critical to rebuilding trust, strengthening local stewardship, and enhancing adaptive capacity **{6.5.1}.**

D8. Access to Grassland and Shrubland Ecosystem services is socially differentiated, with men primarily engaged in livestock production and controlling grazing, while women, youth, and other vulnerable groups depend on grasses and shrubs for livelihoods, income, and cultural practices, highlighting persistent inequities and gaps in inclusive resource governance *(Well Established).* Spatial differences in access, resource scarcity, and overharvesting highlight the need for gender- and youth-responsive management that combines sustainable harvesting, equitable governance, and value-chain opportunities to sustain livelihoods while reducing ecological pressure. Evidence from Ngamiland shows substantial spatial heterogeneity in women's access to craft materials, with Etsha and Maun exhibiting the highest reported difficulties and greater dependence on market purchases compared to other sites (DeMotts, 2017). These findings underscore the need for differentiated and site-specific resource management interventions. Furthermore, recognizing and integrating women's roles and constraints into community-based natural resource governance frameworks, such as those under Veld Product Development or Forest Management Plans, is critical to achieving equitable outcomes. Overharvesting of key species such as Palm tree (Hyphaene petersiana) and Devil's Claw (Harpagophytum spp) for weaving and medicinal trade further demonstrates unsustainable use pressures that threaten long-term availability (Watson & Dlamini, 2003). Policies should embed gender and youth-responsive approaches into Grassland and Shrubland Ecosystem governance by integrating women and youth in decision-making, promoting sustainable harvesting and rotational grazing, and strengthening value-chain opportunities **{6.5.3}.**

D9. Traditional Knowledge systems in Botswana are foundational to Agroecosystem sustainability, offering place-based practices that conserve agrobiodiversity, maintain cultural ecosystem services, and support climate adaptation in ecologically variable and resource-constrained environments *(Established but Incomplete).* Traditional Knowledge, rooted in generations of experience, is central to sustainable agriculture in Botswana, guiding site selection, flood-recession farming, and low-input pest control while enhancing soil fertility, genetic diversity, and food security. This knowledge supports cultural ecosystem services, spiritual rituals, heritage landscapes, and biodiversity critical for pollinators and medicinal plants, and provides vital climate adaptation tools like ecological weather forecasting. Farmers have exploited both plant and animal diversity to meet their social and developmental needs, a phenomenon referred to as 'planned biodiversity' (Kazemi et al., 2018). Some practices (Table SPM12) in planned diversity include the use of organisms in biological control and improving or managing soil fertility such as using nitrogen-fixing plants (Kazemi et al., 2018). The conservation of drought-resistant landraces of Bambara groundnut (Vigna subterranea) illustrates the adaptive capacity embedded within local systems (Massawe et al., 2005).

Table SPM12: Agrobiodiversity conservation through Traditional Knowledge *(Data Source: Batisani et al., 2021)*		
Aspect	**Practice**	**Contribution to Conservation**
Crop diversityAquatic & Wetland	Mixed cropping, landrace cultivation	Minimises risk, conserves genetic diversity
Soil fertility management ,	Use of nitrogen fixing plants, crop rotation	Enhances soil health and reduces chemical reliance
Pest Control	Natural repellents (tobacco, chilli, garlic mixture)	Ecofriendly, reduces pesticide dependence.
Example species	Bambara groundnuts (Vigna subtarrenea)	Resilient crop, key for food and livelihood

Despite its importance, Traditional Knowledge faces marginalization due to monoculture expansion, seed diversity loss, and agrochemical reliance, threatening both ecological functions and cultural heritage. Weaving this knowledge into Agroecosystem planning and resilience strategies is essential to future-proof Botswana's food systems and safeguard its biocultural legacy **{7.5.1}.**

D10. Human–Elephant Conflict in Ngamiland has intensified over the past two decades, with escalating crop damage, property loss, and safety risks undermining household food security, resilience, and tolerance toward elephants *(Well Established).* This conflict reflects the growing interaction between ecological and anthropogenic drivers at the wildlife–agriculture interface, highlighting the need for integrated, evidence-based management (Box SPM5). Addressing these challenges requires a paradigm shift toward coexistence models that combine community-based concessions, crop substitution with elephant-averse species such as chilli, eco-labelled value chains, and leveraging global biodiversity finance instruments and mechanisms. Complementary instruments such as risk-sharing schemes, corridor-based land-use planning, and incentive-linked insurance enhance socio-ecological resilience by protecting livelihoods while maintaining ecological connectivity. Aligning these strategies with Botswana's National Biodiversity Strategy and Action Plan (NBSAP) and global biodiversity financing frameworks is essential to secure funding, scale conflict prevention, and mainstream Human-Elephant Conflict (HEC) mitigation into Agroecosystem policy and practice **{7.3}.**

Box SPM5: Human–elephant conflict (HEC) in the Agroecosystem (Data Source: Department of Wildlife and National Parks, Unpublished)

Context and Magnitude

Ngamiland holds one of the largest elephant populations in Africa. HEC has escalated, with repeated crop destruction, property damage, and safety risks. Botswana's current approach, compensation for losses, has cushioned communities politically but is financially unsustainable and fails to reduce the underlying drivers of conflict. Reported HEC incidents (2015-2-23) show a significant upward trend over time, with marked inter-annual fluctuations and seasonal peaks (Figure SPM B1a). Monthly variation reveals incidents concentrate during the wet season (December–May), with highest peaks in March–May when crops are most vulnerable (Figure SPMB1b). These patterns highlight the need for seasonally targeted mitigation strategies and adaptive conflict management aligned with ecological and agricultural calendars.

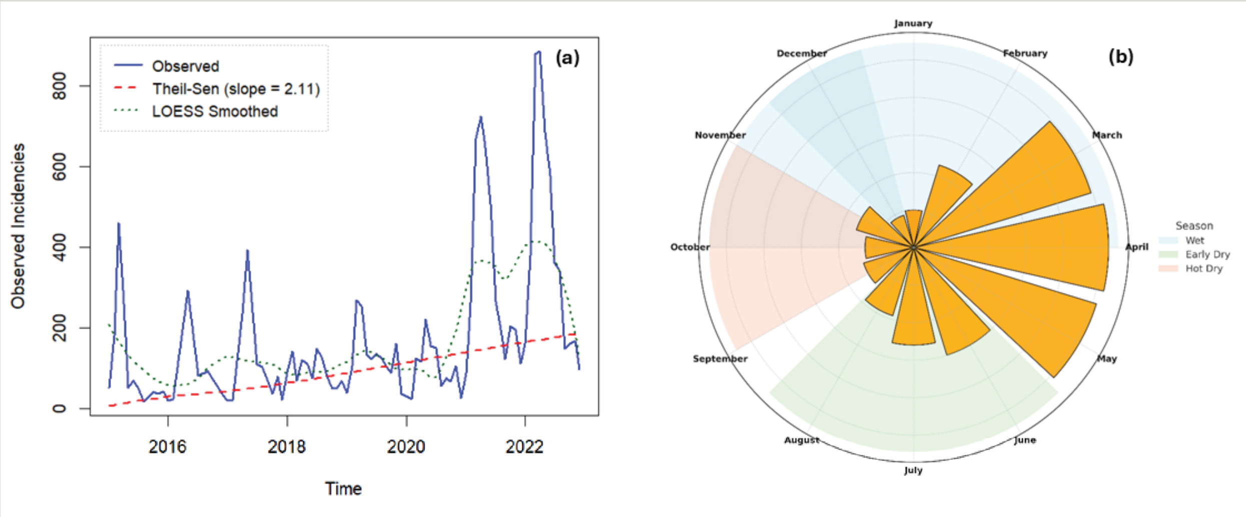
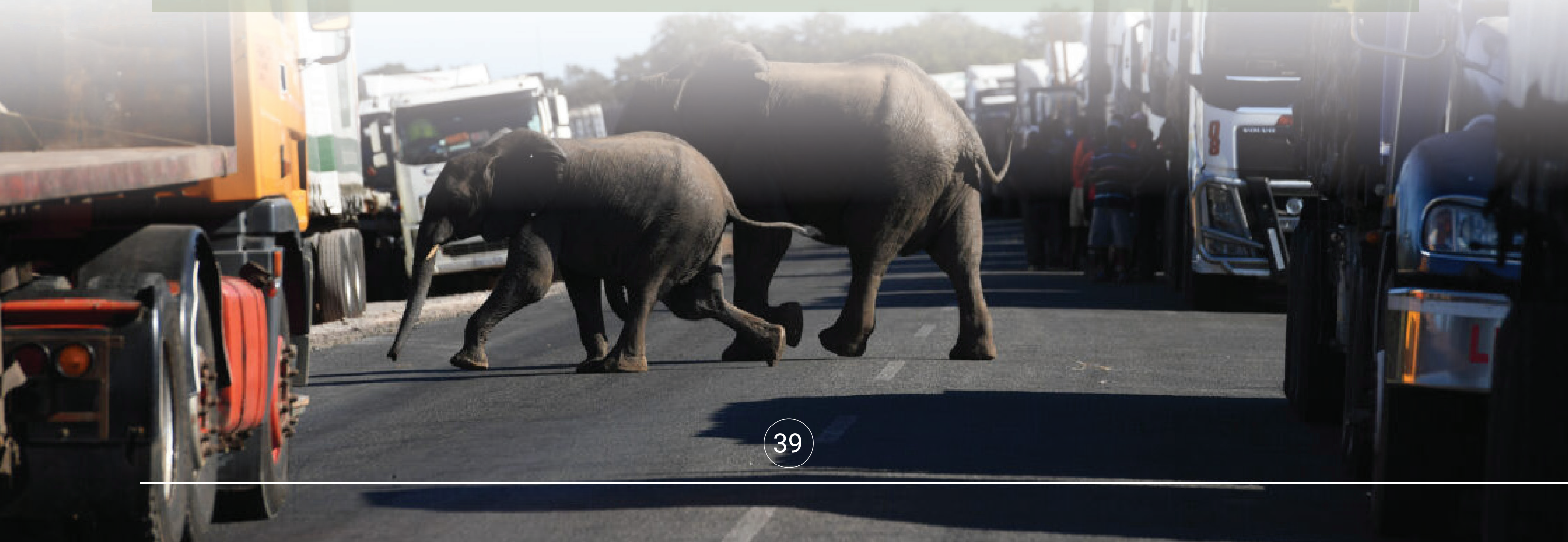


Figure SPMB1: Trends and seasonal patterns of human–elephant conflict incidences in Botswana. (a) Long-term trends in observed elephant-related conflict incidences (2015–2022), showing the observed monthly counts (blue), Theil–Sen trend line (red; slope = 2.11), and LOESS-smoothed pattern (green). (b) Proportion of annual conflict incidences distributed across months, overlaid with seasonal zones (Wet, Early Dry, Hot Dry), illustrating the seasonal concentration of conflict events.

Adoption and perceived effectiveness of mitigation strategies vary widely, with electric fencing and crop guarding emerging as more trusted options, while interventions such as beehive fences remain largely unused and poorly rated. Beyond technical performance, these patterns reflect cultural familiarity, path dependency, and fear of the unknown. Farming communities often trust strategies embedded in local practice, while novel approaches are perceived as risky or misaligned with lived experience (Figure SPMB1).



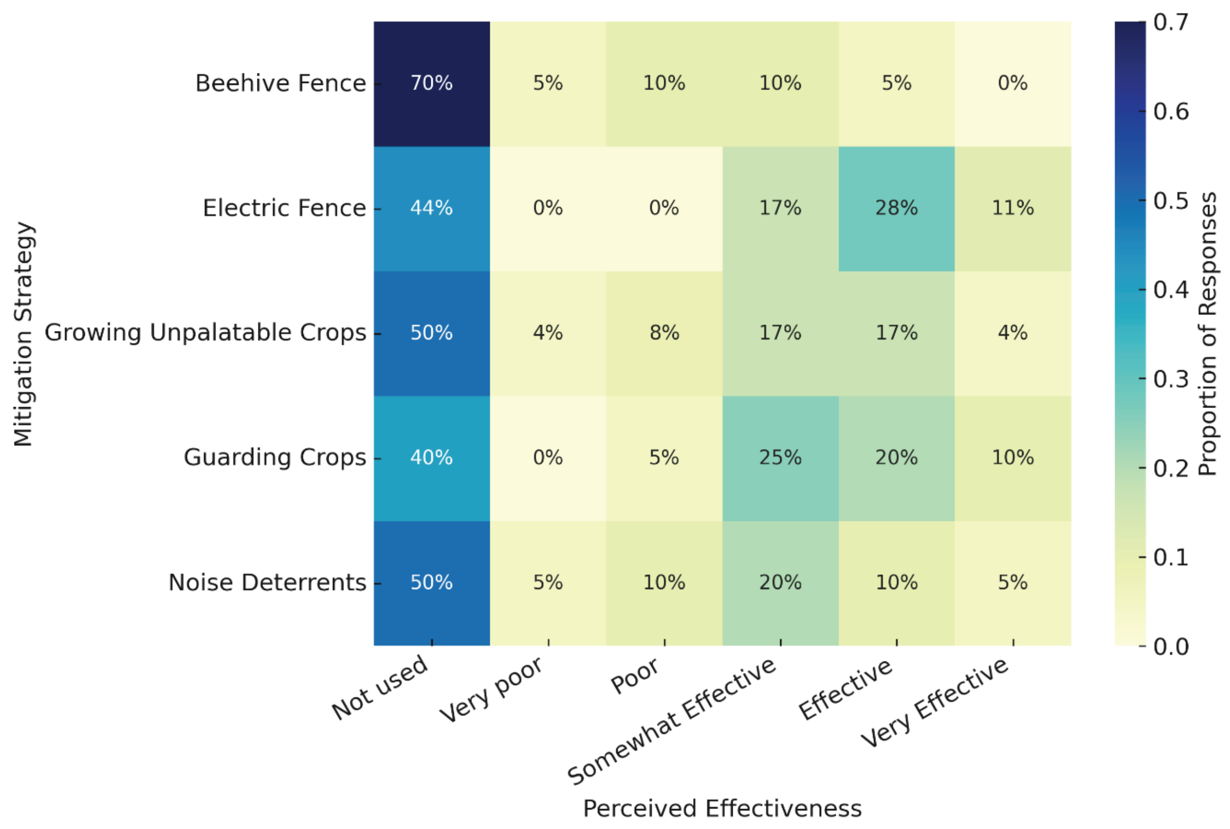


Figure SPMB2: Overall perceptions of human–elephant conflict mitigation strategies showing variation in adoption, perceived effectiveness, and the influence of cultural familiarity on uptake.

Similar interventions, such as beehive fences and unpalatable crops, have been widely adopted in east and southern Africa (Denninger Snyder & Rentsch, 2020; King et al., 2017, 2024; La Grange et al., 2022; Scheijen et al., 2019), suggesting that Botswana's limited uptake reflects not technical infeasibility but a lack of cultural acceptance, demonstration, and institutional support (Velempini, 2021). These insights highlight the need for policies that combine investment in proven strategies with pilot projects, training, and peer-to-peer exchanges to build confidence, reduce uncertainty, and foster wider adoption of context-appropriate innovations.

Livelihood and sustainability impacts

Weak incentives for prevention, coupled with over-reliance on state compensation, foster dependency and slow the uptake of effective deterrent strategies. In Botswana, the compensation policy covers selected high-profile conflict species; however, communities frequently report that the list is restrictive and does not adequately reflect the range of problematic species affecting livelihoods, particularly meso-carnivores such as hyenas that cause significant livestock losses. This perceived mismatch between policy design and lived experience undermines trust and weakens incentives for coexistence. At the national level, escalating fiscal costs from annual compensation payouts divert critical resources away from proactive conservation and community development (Akhmouch & Clavreul, 2016; Gontse et al., 2023; Mayberry et al., 2017). These dynamics are further compounded by declining tolerance towards wildlife more broadly, increasing the risk of retaliatory killings and eroding long-term support for conservation.

Paradigm shift, from compensation to coexistence

Addressing human–elephant conflict requires a fundamental transition from reactive compensation schemes toward proactive coexistence strategies that emphasize risk-sharing, prevention, and community incentives (Marangwanda, 2025). In high-conflict zones e.g., Ngamiland, establishing community conservancies with legally recognized rights to benefit from wildlife-compatible enterprises can provide both economic resilience and conservation incentives. Crop substitutions, such as promoting chilli and other elephant-averse crops, offer alternatives to highly palatable staples, while eco-labelled value chains (e.g., Elephant-friendly chilli and honey) can create premium markets that reward households adopting preventive measures. To sustain these approaches, Coexistence Funds should be capitalized through conservancy revenues, tourism levies, and biodiversity-linked finance, ensuring that communities directly benefit from living alongside elephants (Xiaoyu et al., 2025).

Reforming compensation mechanisms is equally critical to achieving long-term coexistence (Cernea, 2008). This requires moving beyond blanket ex-post payouts to performance-linked insurance models that reward proactive prevention, where households receive partial payouts only when approved deterrents are in place. Parametric insurance triggers, such as verified conflict incidents or corridor-use metrics, can further enhance transparency and speed in disbursements. To ensure sustainability and fairness, financial risk must be shared among the state, communities, and private actors through pooled funding mechanisms, creating an equitable, efficient, and resilient system for addressing the economic impacts of human–elephant conflict.

Leveraging Global Biodiversity Funds (GBFF/GEF)

Human–elephant conflict mitigation can be strategically positioned within Botswana's NBSAP and Agroecosystem priorities to unlock funding windows under the KMGBF, particularly Targets 1, 4, 10, and 19. Global Biodiversity Fund (GBFF) and Global Environment Facility (GEF) resources could finance prevention-first infrastructure, strengthen corridor governance (Zhang et al., 2025), and support eco-labelling certification schemes, alongside providing seed capital for risk-pooling facilities (Kumar, 2023). To maximize impact, these resources should be blended with domestic budget allocations, conservancy revenues, and private co-financing from actors such as eco-label buyers and tourism operators, ensuring a diversified and sustainable financing model for long-term coexistence interventions.

Policy and Action Priorities

Policy and action priorities must shift from compensation toward prevention, coexistence, and biodiversity-aligned financing. Human–elephant conflict should be mainstreamed into Agroecosystem policy as a core resilience and productivity challenge, with priority investments in cluster fencing, beehive barriers, early-warning systems, buffer cropping, and crop substitution with elephant-averse species. Market development for substituted crops and branded coexistence products can generate tangible household benefits, while district-level coordination platforms linking farmers, authorities, and wildlife agencies institutionalize governance and scale best practices. Embedding these strategies, alongside GBFF-supported risk-sharing schemes and community conservancies, enhances socio-ecological resilience, strengthens value chains, diversifies rural incomes, and safeguards Botswana's elephant populations as a global conservation asset.

D11. Despite its critical role in sustaining ecosystem services, biodiversity, livelihoods, and human well-being, the Desert Ecosystem remains under-researched, resulting in significant gaps in evidence-based conservation, policy development, and sustainable development planning *(Well Established).* The biodiversity status in this ecosystem remains largely under-documented and poorly studied. Apart from studies of herbivores in the Central Kalahari Game Reserve and Kgalagadi Transfrontier Park on the migration patterns of springboks, wildebeest and gemsbok, socio-ecological research across the Desert Ecosystem is limited. Much of the existing knowledge remains fragmented and mainly on Prosopis spp. The current gap in comprehensive floristic and faunal inventories not only limits effective conservation planning but also underrepresents the true ecological value of this ecosystem in national biodiversity frameworks. Addressing this knowledge deficit through targeted research, participatory biodiversity monitoring, is important in enhancing their long-term ecological function and resilience **{8.2}.**

D12. Gendered and generational inequalities in ecosystem access, use, and governance roles constrain inclusive management of Hill Ecosystem and threaten the long-term sustainability of associated benefits *(Well established).* Field evidence indicates women rely more on direct provisioning services, such as thatching grass, fuelwood, and wild fruits, while men often dominate governance forums such as Land Boards and community trusts. This results in gendered exclusion from decision-making and unequal benefit-sharing. Simultaneously, youth participation in customary governance and Traditional Knowledge transmission is declining due to urban migration, cultural disconnection, and absence of incentives (Box SPM6) **{9.5.3}.**

Box SPM6: Differentiated perspectives on ecosystem service priorities

The analysis of data from community dialogues in Tswapong reveal distinct patterns of prioritization across provisioning and cultural services (Figure 9.2). The heatmap provides a comparative visualization of how different community groups, Women, Youth, Elders, and Traditional Leaders, prioritize key ecosystem services in the Tswapong Hills, using a Likert scale ranging from 1 (low importance) to 5 (high importance). The ecosystem services considered include wild fruits, firewood, medicinal plants, spiritual sites, and thatch grass, all of which underpin both subsistence and cultural livelihoods in the region.

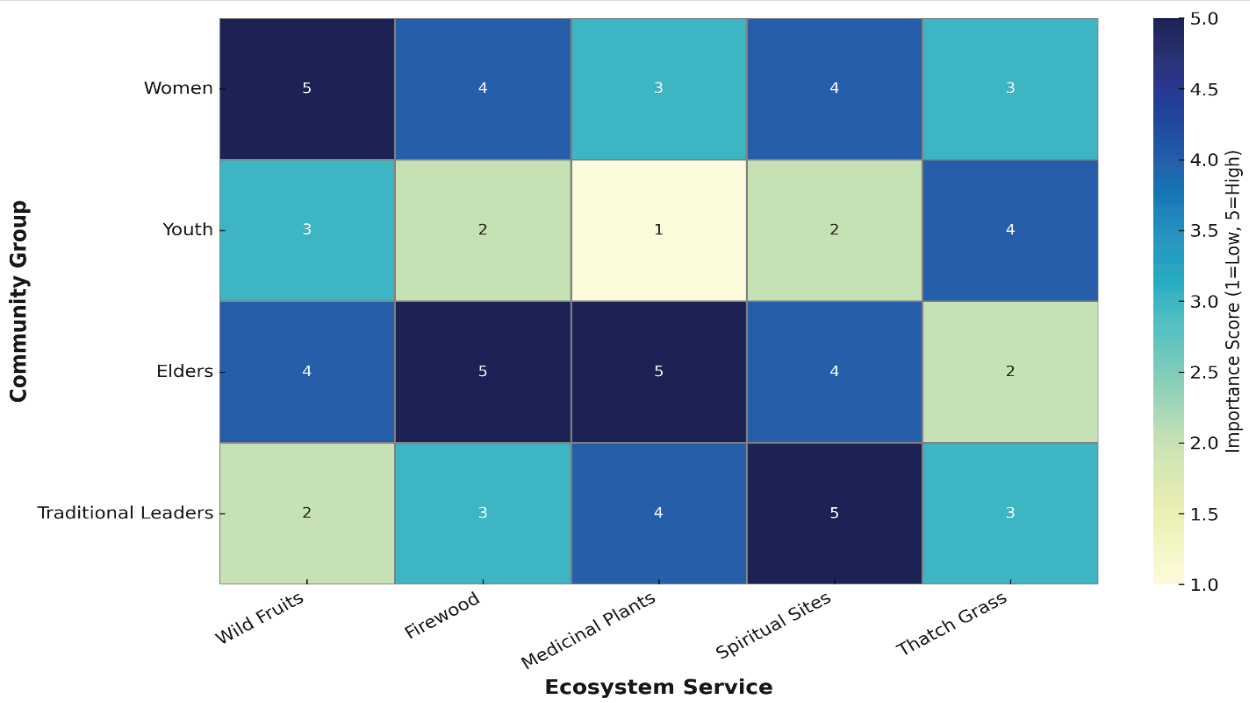


Figure SPMB3: Perceived Importance of Ecosystem Services Across Community Groups in Tswapong and Tsodilo Hills, Botswana *(Source: BW-NEA Community Dialogues, 2024, 2025).*

The results reveal marked divergence in priorities that reflect both gendered, functional roles and cultural identities:

- Women rate wild fruits (5) and spiritual sites (4) highest, reflecting their central role in household well-being and local food security.
- Youth assign lower values across services, with medicinal plants lowest (1), indicating weakening connection to traditional ecological knowledge and potential loss of biocultural continuity.
- Elders prioritize medicinal plants (5) and firewood (5), reflecting experiential reliance on local resources.
- Traditional Leaders emphasize spiritual sites (5) and medicinal plants (4), reinforcing their role in safeguarding sacred and healing landscapes.
- Divergent valuations reflect distinct ontologies and socio-cultural roles, youth undervaluation versus elder reverence signals risk to intergenerational knowledge transfer and ecological stewardship.
- Inclusive governance frameworks that recognize these differentiated values, and youth-focused strategies such as experiential learning, school curricula, and intergenerational dialogues, are essential to sustain biodiversity and cultural heritage in the Tswapong Hills.

Addressing these gaps requires gender-sensitive policy reforms, training and empowerment of women and youth in ecosystem stewardship, and revitalization of intergenerational knowledge-sharing through education, ritual, and local institutions

D13. Strengthening Traditional Knowledge, participatory resource mapping, and community-based ecological monitoring is essential to achieve holistic ecosystem governance, evidence-based ecosystem valuation, and responsive policy frameworks (Well established). The Hill Ecosystem holds profound symbolic, spiritual, and religious significance for adjacent communities, serving as sacred landscapes, dwelling places of deities (Badimo), and expressions of cosmological and religious values (De Beer, 1999). Traditional custodians hold critical knowledge of sacred springs, seasonal harvesting, medicinal plant habitats, and culturally restricted zones, often missed in conventional surveys. Participatory approaches like mapping and cultural inventories identify ecosystem hotspots and strengthen governance. Generational and gendered differences show Elders and Leaders prioritize oral traditions, Youth prefer school-based learning and arts, and Women balance both (Figure SPM9). Declining youth engagement with ceremonies risks knowledge continuity, emphasizing the need for hybrid strategies integrating rituals, education, and creative arts to sustain Traditional Knowledge and ecological stewardship. Institutionalizing these methods, through national conservation frameworks, impact assessment protocols, and biodiversity information systems, would ensure that both scientific and Traditional Knowledge systems inform sustainable land-use decisions, conservation planning, and benefit-sharing mechanisms **{9.5.1}.**

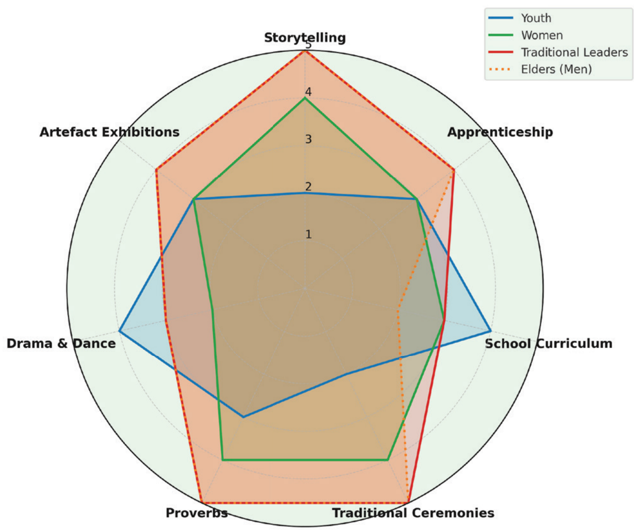


Figure SPM9: Differential effectiveness of Traditional Knowledge transfer mechanisms across community groups in the Tswapong and Tsodilo Hills, Botswana *(Data Source: BW-NEA Community Dialogues, 2023, 2025)*

D14. Botswana's ecosystems hold substantial untapped potential to drive nature-based economic diversification and strengthen community resilience *(Established but incomplete).* Prioritised ecosystems hold significant but underdeveloped value-chain opportunities that can meaningfully advance national economic diversification. Biodiversity and ecosystem services already support a wide range of community enterprises, including traditional teas and coffees, edible and medicinal oils, herbal medicines, indigenous brews and wines, fruit juices, cosmetics, and construction materials, yet these remain small-scale and largely informal. Box SPM7 presents a case study of what pertains in Aquatic and Wetland Ecosystem. Strategic investment, value-addition, standards development, and market linkages unlock these nature-based value chains, strengthening rural livelihoods, enhancing resilience, and positioning biodiversity as a key driver of inclusive, sustainable economic growth taking account the sustainability of the ecosystem services **{10.1.6; 10.3.4; 10.4.4; 10.5.4; 10.6.4; 10.7.4; 10.8.4}.**

Box SPM7: Aquatic and Wetland Ecosystem value chain opportunities: Makgadikgadi Case Study

Traditional teas

The tea industry is almost non-existent in Botswana as there is no tea plantation but packaging plants of imported leaves. Tea consumption in the country is expected to reach 0.63 thousand metric tons by 2026 compared to 1 thousand metric tons in 2021 (Report Linker, 2022). The decrease may be associated with the market failures that happened during COVID-19. In 2023, the value of tea exported to South Africa from Botswana was reported at USD737 thousand (Trading Economics, n.d.). Therefore, there exists an opportunity for home grown tea considering that globally, tea is the second most consumed beverage and thus its production and marketing make a significant contribution to many economies (Deka & Goswami, 2022). Common plants used to prepare herbal teas with medicinal and economic value in Botswana are Lippia javanica (Musukudu), Lippia scaberrima (Musukujane), Artemisia afra (Lengana), Combretum hereroense (Mokabi), Myrothamnus flabellifolius (Galalatshwene) (Motlhanka & Makhabu, 2011). The following plant species are used by the Makgadikgadi community for tea: Sheperd's tree/ Boscia albitrunca (Motlopi), Buffalo thorn/ Ziziphus mucronata (Mokgalo) and the African Baobab/ Adansonia digitata (Mowana), and Purple-pod cluster-leaf /Purple-pod terminalia/ Terminalia prunioides, (Motsiara/Motsiyara) and Manketti tree/ Ricinodendron rautanenii (Mokongwa/Mongongo). Furthermore, the Makgadikgadi pans area is endowed with the herbal infusion of Lemon Bush/ Lippia javanica (Mosukujwane) which is brewed with tea to make it a pleasant and minty aroma and flavour.

Edible and medicinal oils

The Botswana edible oil market is projected to grow by 7.2% annually while its revenue market amounted to US$118.62m in 2025 and is expected to show a volume growth of 3.3% in 2026 (Statista, 2025). One of the most common plants used for edible and medicinal oils is the Sclerocarya birrea (Morula) whose nut is an important source of oil, which is rich and edible (Motlhanka & Makhabu, 2011). Additionally, the oil is used in cosmetic formulations such as marula soap and marula oil. Manketti tree/ Ricinodendron rautanenii (Mokongwa/Mongongo) used to make oil is be extracted from the fruit and used for cooking. Cooking oil is made from the Mosisi tree.

Medicinal plants

The herbal tea plants mentioned in preceding sections also have medicinal value i.e Lippia javanica (Musukudu), Lippia scaberrima (Musukujane), Artemisia afra (Lengana), Combretum hereroense (Mokabi), Myrothamnus flabellifolius (Galalatshwene) also have medicinal properties. According to Motlhanka and Makhabu (2011), Lippia javanica (Musukudu) is known for treating coughs, colds, and bronchial problems; Lippia scaberrima (Musukujane) possesses anti-oxidative properties; Artemisia afra (Lengana) is used for ailments like coughs, colds, fever, loss of appetite, and headache, Combretum hereroense (Mokabi) is medicinally used for stomach disorders; and Myrothamnus flabellifolius (Galalatshwene) is used for hypertension, diabetes mellitus, and stroke.

Traditional brew and wine

Ozoroa paniculosa (Monokane), Cassine transvaalensis (Monamane), Myrothamnus flabellifolius (Galalatshwene) Sclerocarya birrea (Morula) according to Motlhanka and Makhabu (2011) are some of the plants traditionally used for beer preparation in Botswana. In Makgadikgadi, traditional wines, beers, and other alcoholic beverages are made from fermented fruits of the following plants; Wildberry/ Grewia flava DC. (Moseme/Moretlwa), False brandy bush/ Grewia bicolor Juss (Mogwana), Wild medlar/ Vangueria infausta (Mmilo), and Sclerocarya birrea (Morula) fruits.

Edible fruits and insects

The fruits of Baobab Adansonia digitata (Mowana) can be processed into yoghurt. The fruits of the False brandy bush/ Grewia bicolor J (Mogwana) and is also processed into yoghurt. The Wildberry/ Grewia flava DC. (Moseme/Moretlwa), and wild medlar/Vangueria infausta (Mmilo) fruits are processed into fruit juice. The Makalani palm/ Hyphaene petersiana (Mokolwane), Grey/silver sultana/ Grewia bicolor (Mogwana), and Velvet brandy bush/ Grewia flava (Moretlwa) is processed into oils, packaged snacks, jams, and drinks. Melon/ Citrullus lanatus var.citroides (lerotse), is used to make melon jam and dried melon (mpale in the local language). Sclerocarya birrea (Morula) fruits are also used to produce jam. The Mophane caterpillar/ Imbrasia belina Westwood (Phane) is processed by grinding into powder as stockfeed. Usually, people from outside the area come to purchase the Mophane Caterpillar to process it into livestock feed.

Cosmetics

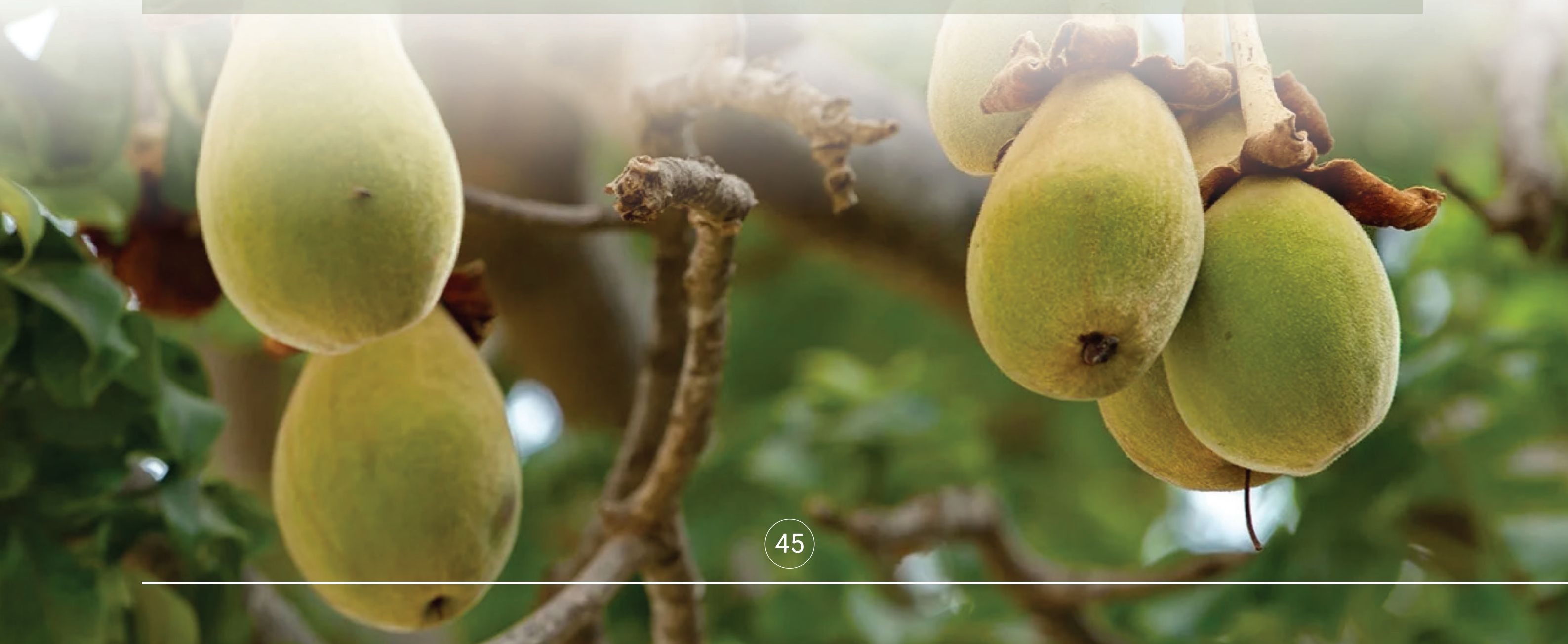
Hair relaxers and cosmetics are made from the Sour Blue Plum/ Ximenia americana (Moretologa wa podi), Ximenia caffra, /Moretologa wa kgomo), Bowstring hemp/ Senservaria ethiopitika, and Commiphora spp. (Mokomoto).

Construction material and household utensils

Basket weaving is made using the following: Brown ivory or bird plum Makalani/ Berchemia discolour (Motsentsela/Motsintsila), The Palm/Hyphaene petersiana (logang/mokola/ Mokolwane) and Mountain kirkia/wild pepper tree/ Kirkia wilmsii (Modumela).

Many species of grasses, like Broom Love Grass/ Eragrostis pallens (Motshikiri) and Broad-leaved Grass (Rantafole), are used to create ceilings during the construction of traditional huts. The Broad-leaved turpentine grass/ Cymbopogon excavatus (Hochst.)/Andropogon connatus A. Rich. (Mokamakama/Mosegaseolo/Moteko/Rantafole) and Silky Bushman Grass/ Stipagrostis uniplumis Licht. (Tshikitshane) De Winter var. uniplumis) are the three species which are preferably used for ceiling construction in thatched houses.

Salt from freshwater systems is utilized in the manufacturing of cosmetics such as soaking salts and bath soap.



D15. Fragmented policy and institutional frameworks, with overlapping mandates and weak coordination, limit coherent governance and effective management of ecosystems and biodiversity *(Well established).* Current institutional arrangements and policy and legal frameworks that support all the prioritised ecosystems straddle across different ministries and departments indicating fragmentation as it poses coordination challenges. For example, water allocation and conservation, infrastructure development, irrigation as well as utilisation for cultural and spiritual activities have a bearing on the Ministries of Water and Human Settlements, Environment and Tourism, as well as Lands and Agriculture. Additionally, duplication of roles between the Water Apportionment Board and Land boards has resulted in crowding of boreholes in tribal areas especially within the arable zone with potential for affecting aquifer productivity and risks to pollution. This results in coordination gaps, weak integration between national and local authorities, a disconnect between formal and informal institutions and conflicting priorities that hinder effective ecosystem management. Institutional coordination is equally weak. Responsibilities for biodiversity management are spread across multiple ministries such as Environment, Finance, Agriculture, and Water without a central coordinating authority or legally mandated integration mechanism **{12.3}**

D16. Inadequate recognition and weaving of Traditional Knowledge and customary leadership within ecosystem policy and legal frameworks constrains inclusive governance and adaptive ecosystem management *(Well Established).* Despite extensive research and documentation of ecosystems, decision-making frequently overlooks Traditional Knowledge linked to sensitive areas. This marginalizes community insights, cultural practices, and locally adapted management strategies vital for sustainable resource use and biodiversity conservation. The predominance of central government legal and institutional frameworks over customary governance, historically reinforced by the transfer of authority from traditional leaders to state institutions, creates conflicts between statutory policies and local governance systems, affecting community rights, access, and stewardship over ecosystem services. While some communities have proactively established Village Conservation Committees (adopted names include Natural resources Committees and Green Scorpion) to manage local resources such as sandbanks and veld products, these initiatives remain voluntary and lack formal legal empowerment. Without institutional recognition and weaving of Traditional Knowledge, policies risk being top-down, culturally misaligned, and less effective in sustaining ecological and social outcomes **{12.3}.**

D17. Market-based financing instruments such as biodiversity offsets, carbon credits, and payments for ecosystem services remain insufficiently developed, leaving Botswana reliant on donor funding and conventional revenue streams *(Established but Incomplete)*. While these mechanisms are conceptually recognised within policy discourse, their practical implementation is incomplete, hindered by regulatory gaps, insufficient institutional capacity, and lack of market infrastructure. There are significant gaps regarding lack of binding legal instruments for biodiversity offsets and green finance; weak provisions for community revenue retention and transparent benefit-sharing; and no dedicated biodiversity finance authority or regulatory mandate for climate finance integration. While the Wildlife Conservation and National Parks Act make provisions for fee adjustments and revenue collection, it lacks a legal requirement to reinvest revenues into park management or community benefit-sharing. Similarly, the CBNRM Act (2025) provides limited financial autonomy and transparency in benefit distribution, whilst ecotourism certification exists under tourism regulations but carries no binding compliance or incentives. Environmental Assessment Act (2011) provisions address mitigation, yet mandatory biodiversity offsets are not legally required. Forestry Act (2008) has provisions that allow invasive species removal but does cater for market-based or commercial utilisation. Legal and policy reforms are needed to create an enabling environment for biodiversity financing across the eight priority areas of the 2019 Biodiversity Finance Plan. Without such reforms, Botswana struggles to mobilise sustainable, locally driven funding for ecosystem management and climate resilience (Table SPM12).

Table SPM12: Legal and policy reforms needed to support biodiversity finance	
Prioritised biodiversity finance solution	**Legal and policy reform**
Protected area fee reform and revenue retention	• Amend the Wildlife Conservation and National Parks Act to include: • Provisions for automatic fee review every 3–5 years • Mandated retention and reinvestment of park revenues into conservation and community benefit-sharing • Develop a Protected Area Revenue Management Regulation for transparent allocation and auditing
Improvement of CBNRM benefit sharing	• Amend the CBNRM policy to legally guarantee community trusts financial autonomy and require public disclosure of revenue flows and annual audits • Expedite the enactment of the CBNRM Act to formalise community rights and n=benefit sharing mechanisms
Explore DWNP Parastatal Model	• Amend the Wildlife Conservation Act to authorise transformation of DWNP into semi-autonomous parastatal for financial flexibility • Develop a new policy that outlines DWNP governance framework defining roles, accountability and revenue retention.
Introduction of biodiversity offsets into Environmental Impact Assessment (EIA)	• Amend the Environmental Assessment Act to: • introduce mandatory biodiversity offsets for projects impacting ecosystems. • Define valuation standards and offset ratios • Develop Biodiversity Offset Guidelines aligned with international best practice
Enhancement of the Eco-tourism Certification System Enhancement	• Amend the Tourism Act to: • Provide for tax incentives for certified operators • Require biodiversity criteria in eco-certification standards • Launch a National Eco-Certification Program with compliance monitoring.
Sustainable beef certification	• Integrate certification into agricultural subsidy programmes to incentivise compliance
Commercial use of invasive species	• Amend the Plant Control Act and the Forestry Act to permit regulated commercialisation of invasive species • Establish market frameworks for invasive biomass products (e.g., energy, crafts)
Access global climate change funds for projects with biodiversity co-benefits.	• Enact a Climate and Biodiversity Finance Act to create a legal mandate for mobilizing funds from the Green Climate Fund (GCF), carbon markets, and biodiversity credits. • Establish a National Biodiversity Finance Authority to coordinate National Environment Fund (NEF), BIOFIN, and climate finance initiatives.

It is worth noting that there are other biodiversity financing mechanisms that present opportunities for the country though not currently prioritised. These include bioprospecting (biochemical and genetic material to develop commercially valuable products for pharmaceutical, agricultural, cosmetic and other applications); Reduced Emissions from Deforestation and Degradation (REDD+, secures financing for protecting forests and for enhancing sustainable forestry practices available through voluntary carbon markets); Disaster Risk Insurance (Green measures to reduce insurance premiums); Green bonds (mobilisation of resources from domestic and international capital markets for climate change adaptation, renewables and other environment-friendly projects); Green lending through community finance (lending practices such as community revolving funds and credit unions with the community as the main shareholder or sole source of capital such as in village savings and loans); Payment for Ecosystem Services (BIOFIN Catalogue of Finance Solutions, nds) **{12.3 iv}**

Conclusion and policy recommendations

Table SPM 13 presents the conclusion and policy recommendations per SPM thematic area.

Table SPM13: Conclusions and Policy Recommendations	
Conclusion	**Recommendations**
A. Botswana's ecosystems at crossroads: the condition of the prioritised ecosystems and outlook. Botswana's prioritised ecosystems face escalating climate stress, land use pressure, and declining ecological integrity. Wetlands are shrinking, forests and rangelands degrading, agroecosystems strained, and desert and hill systems increasingly vulnerable. Without strengthened governance and restoration, several ecosystems risk crossing irreversible thresholds, threatening biodiversity and community resilience	• Set up long-term monitoring programs to detect changes in ecosystem area extent and species diversity. • Adoption of ecosystem-based mitigation and adaptation strategies to mitigate climate change impacts, and to promote biodiversity and ecosystems conservation and preservation. • Intensification of adaptation and mitigation strategies across key sectors of the economy including water, agriculture, and tourism. • Institutionalise participatory fire management and early-warning systems integrating Traditional Knowledge and remote sensing. • Prioritize the expansion and upgrading of wastewater treatment infrastructure to match increasing domestic and industrial effluent, ensuring consistent and effective effluent management. • Develop a robust monitoring system to track changes in waste assimilation overtime through a centralised database accessible to policy makers, researchers and the public. • Strengthen enforcement of the Aquatic Weeds Control Act, introduce a national boat biosecurity labelling system; enhance capacity of customs and environmental officers on aquatic biosecurity protocols. • Scale rangeland rehabilitation programmes using reseeding, erosion control structures, riparian buffer restoration, and invasive species management. • Avoid high-input, chemical-intensive farming that accelerates land degradation and instead incentivise low-input ecological alternatives such as organic fertilisation, crop–livestock integration, and mulching. • Reform fencing and corridor policies to restore ecological connectivity. • Enforce strict regulation of mining, quarrying, and sand extraction near hill slopes, aquifers, sacred sites, and erosion-prone zones. • Embed research funding streams in desert conservation budgets.
B. Unlocking the green and blue economy potential for national transformation All the six prioritised ecosystems hold the key to inclusive growth in Botswana. This will be achieved by leveraging Traditional Knowledge, equitable access to ecosystem services, circular economy opportunities, community-based fisheries, sustainable forestry, resilient rangelands and natural capital valuation.	• Scale biodiversity-compatible livelihood diversification (avi-tourism, game ranching, carbon markets, sustainable veld product value chains). • Support value-chain upgrading and local enterprise development linked to ecosystem services. • Support inclusive market access for traditional and smallholder producers through aggregation centres, processing hubs, certification schemes, and value-chain upgrading • Support community entertprises and cooperatives, particularly women- and youth-led initiatives, to diversify incomes linked to hill landscapes. • Invest in Research and Development in partnership with academic intuitions, private research institutions and local communities to commercialise products and the sustainability of the enterprises thereof. • Strengthen Community-Based Natural Resource Management (CBNRM) to support community veld product processing enterprises as well as enabling communities to manage rangelands, veld products, and molapo fields for both ecological and livelihood benefits. • Conduct ecosystem service valuation (fisheries, tourism, flood mitigation) and integrate results into national accounts and sector budgets. • Practice responsible spatial planning which includes ethical and traditional considerations, stakeholder engagement, environmental sustainability, risk management, and social responsibility. This practice can help mitigate the adverse effects of land-use changes on biodiversity.

	• Conservation strategies need to be inclusive of traditional governance systems and be considerate of unequal power relations as Traditional Knowledge resides with lesser empowered sections of society. • Management strategies of Sacred Natural Sites need to be based on bottom-up measures under cultural terms of communities. • Strengthen intergenerational knowledge transfer and gender-inclusive participation mechanisms. • Expand Payments for Ecosystem Services, carbon finance, and biodiversity credit mechanisms to align economic incentives with ecological outcomes. • Leverage green finance (carbon markets, climate funds, biodiversity credits) to support sustainable agriculture, land restoration, and conservation-compatible enterprise growth under Agriculture Forestry and Other Land Uses (AFOLU). • Invest in gender-responsive agricultural support, recognising the different roles of women and men in food production, seed conservation, wild food harvesting, and resource use. • Shift from eradication-only to integrated Prosopis spp utilization (e.g. charcoal, timber, bio-products). • Strengthen community-based enterprises to add value from Prosopis spp. products. • Diversify the cultural tourism product beyond the Tsodilo and Tswapong Hills and consider others like Gcwihaba caves. • Promote intergenerational knowledge transfer through youth engagement programmes, ranger training, cultural schools, and documentation of rituals, healing knowledge, and sacred geographies.
C. Scenario pathways for sustainable socio-ecological futures The integrity of the prioritised ecosystems hinges on governance, land-use decisions and restoration of degraded areas. Scenario analysis shows that strong spatial planning, protection of ecological connectivity, and integration of traditional knowledge can reverse degradation, while weak governance accelerates fragmentation and biodiversity loss.	• Adopt a National Priority Ecosystem Map using Ecosystem Integrity Index, Habitat Quality, Habitat Degradation and Mean Species Abundance to guide planning, identify high-risk/high-value landscapes and target restoration zones. Establish a coherent national rangeland governance framework that formally integrates statutory and customary systems. • Safeguard wildlife corridors and grazing connectivity as national economic infrastructure. • Use appropriate technology and spatial tools to guide decisions that directs development away from sensitive ecosystems and ensures restoration investments have maximum impact. • Mainstream scenario modelling in national planning (SEAs, EIAs, basin plans, district plans, concession allocations).
D. Enabling governance conditions for resilient socio-ecological systems Botswana's socio ecological resilience depends on integrating Traditional Knowledge, strengthening participatory and gender responsive governance, safeguarding environmental flows, and aligning statutory and	• Mandate cross-sector policy harmonisation between Environment, Agriculture, Land, and Local Government authorities. • Establish a coordinated national framework for invasive species management that harmonizes mandates across key institutions, including Departments of Water and Sanitation, Forest and Range Resources, Crop Production, Wildlife and National Parks, to strengthen capacity, improve surveillance, and enable joint action. • Institutionalise ecosystem valuation in national planning to ensure environmental benefits and costs are not treated as externalities allowing trade-offs to be openly assessed and environmental impacts minimized before decisions are finalized.

Reference

Akhmouch, A., & Clavreul, D. (2016). Stakeholder Engagement for Inclusive Water Governance: "Practicing What We Preach" with the OECD Water Governance Initiative. *Water*, *8*(5), Article 5. https://doi.org/10.3390/w8050204

Atlhopheng, J. R. (2004). Terrain Evaluation and the Botswana Environment. *Botswana Notes & Records*, *36*(1), 37–47. https://doi.org/10.10520/AJA052550590_153

BIOFIN Catalogue of Finance Solutions. *Retrieved October 5, 202, from https://www.biofin.org/finance-solutions*

Botswana Climate Change Network. (2023). *Closing the Loop: Embracing the Circular Economy in Botswana*. https://www.botswanaclimatenetwork.org/post/closing-the-loop-embracing-the-circular-economy-in-Botswana

BW-NEA. (2023). *BW-NEA Palapye Community Dialogues*.

BW-NEA. (2025). *BW-NEA Tsodilo Community Dialogue*.

Cabernard, L., Pfister, S., & Hellweg, S. (2024). Biodiversity impacts of recent land-use change driven by increases in agri-food imports. *Nature Sustainability*, *7*(11), 1512–1524. https://doi.org/10.1038/s41893-024-01433-4

Cassidy, L., & Barnes, G. D. (2012). Understanding Household Connectivity and Resilience in Marginal Rural Communities through Social Network Analysis in the Village of Habu, Botswana. *Ecology and Society*, *17*(4). https://www.jstor.org/stable/26269205.

Cernea, M. M. (2008). Compensation and benefit sharing: Why resettlement policies and practices must be reformed. *Water Science and Engineering*, *1*(1), 89–120.

De Beer, F. C. (1999). Mountains as cultural resources: Values and management issues. *South African Journal of Ethnology*, *22*(1), 20–25.

Deka, N., & Goswami, K. (2022). Organic cultivation and sustainable value chain development for tea smallholders: Findings from Assam, India. *Sustainable Production and Consumption*, *32*, 562–579. https://doi.org/10.1016/j.spc.2022.05.004

Denninger Snyder, K., & Rentsch, D. (2020). Rethinking assessment of success of mitigation strategies for elephant‐induced crop damage. *Conservation Biology*, *34*(4), 829–842.

Dichaba, T. S. (2010). From monuments to cultural landscapes: Rethinking heritage management in Botswana. Rice University.

Feurer, M., Markovic, J., Starke, M., Wilkes-Allemann, J., & Wolf, O. (2025). Drivers of deforestation and forest degradation between 1990 and 2023-A global meta-analysis. *Environmental Science & Policy*, *173*, 104242.

GoB. (2022). *Botswana—State of Environment and Outlook Report 2022*.

Gontse, K., Mbaiwa, J. E., & Thakadu, O. T. (2023). Human-elephant conflict: Implications for rural livelihoods and wildlife conservation. In *Handbook on Tourism and Conservation* (pp. 37–53). Edward Elgar Publishing.

Hald-Mortensen, C. (2023). *The Main Drivers of Biodiversity Loss: A Brief Overview* (SSRN Scholarly Paper No. 4579821). Social Science Research Network. https://papers.ssrn.com/abstract=4579821

Kazemi, H., Klug, H., & Kamkar, B. (2018). New services and roles of biodiversity in modern agroecosystems: A review. *Ecological Indicators*, *93*, 1126–1135.

Kebonye, N. M., Eze, P. N., & Akinyemi, F. O. (2017). Long term treated wastewater impacts and source identification of heavy metals in semi-arid soils of Central Botswana. *Geoderma Regional*, *10*, 200–214. https://doi.org/10.1016/j.geodrs.2017.08.001

Keitumetse, S., & Nthoi, O. (2009). Investigating the impact of World Heritage site tourism on the intangible heritage of a community: Tsodilo Hills World Heritage site, Botswana. *International Journal of Intangible Heritage*. (4). 144-149.

King, L. E., Lala, F., Nzumu, H., Mwambingu, E., & Douglas‐Hamilton, I. (2017). Beehive fences as a multidimensional conflict‐mitigation tool for farmers coexisting with elephants. *Conservation Biology*, *31*(4), 743–752.

King, L. E., Tiller, L., Mwambingu, E., Serem, E., Nzumu, H., Mugo, G., Raja, N., Brennan, E., Kisiang'ani Wanjala, D., & Ndombi, V. (2024). Impact of drought and development on the effectiveness of beehive fences as elephant deterrents over 9 years in Kenya. *Conservation Science and Practice*, *6*(11), e13242.

Kgathi, D. L., Mmopelwa, G., Mashabe, B., & Mosepele, K. (2012). Livestock predation, household adaptation and compensation policy: A case study of Shorobe Village in northern Botswana. *Agrekon*, *51*(2), 22–37. https://doi.org/10.1080/03031853.2012.695148

Kgosikoma, O., Harvie, B., & Mojeremane, W. (2012). Bush encroachment in relation to rangeland management systems and environmental conditions in Kalahari ecosystem of Botswana. *African Journal of Agricultural Research*, *7*(15), 2312–2319.

King-Okumu, C., Tsegai, D., Sanogo, D., Kiprop, J., Cheboiwo, J., Sarr, M. S., da Cunha, M. I., & Salman, M. (2021). How can we stop the slow-burning systemic fuse of loss and damage due to land degradation and drought in Africa? *Current Opinion in Environmental Sustainability*, *50*, 289–302. https://www.sciencedirect.com/science/article/pii/S1877343521000658

Kirilenko, A. P., & Sedjo, R. A. (2007). Climate change impacts on forestry. *Proceedings of the National Academy of Sciences*, *104*(50), 19697–19702.

La Grange, M., Matema, C., Nyamukure, B., & Hoare, R. (2022). The Virtual Fence Dynamic: A Breakthrough for Low-Cost and Sustainable Mitigation of Human-Elephant Conflict in Subsistence Agriculture? *Frontiers in Conservation Science*, *3*. https://doi.org/10.3389/fcosc.2022.863180

Lepetu, J. P., & Garekae, H. (2015). Attitudes of local communities towards forest management practices in Botswana: The case study of Kasane Forest Reserve. *International Journal of Agriculture and Forestry*, *5*(2), 138–145. https://www.academia.edu/download/95622013/showpaperpdf.pdf

Lori, T., Ditlhogo, M., & Koosaletse-Mswela, M. S. P. (2019). Classification, description and mapping of the vegetation in Khutse Game Reserve, Botswana. *Botswana Journal of Agriculture and Applied Sciences*, *13*(2), 8–23.

Mafokate, D., Mathowa, T., & Mojeremane, W. (2013). A survey of the exotic woody plant species in the city of Gaborone, Botswana. *International Journal of Research in Agriculture and Food Sciences*, *1*(2).

Makhabu, S. W., Tshireletso, K., Setlalekgomo, M. R., Kgosiesele, E., Akanyang, L., Legwatagwata, B., Nsinamwa, M., Seletlo, Z., & Majaga, S. (2021). *Herbaceous communities' heterogeneity in the Kalahari sandy soils environment: A case study of Kweneng, Kgatleng Districts and Mahalapye Sub-District of Botswana*.

Malagnoux, M., Sène, E., & Atzmon, N. (2008). Forests, trees and water in arid lands: A delicate balance. *Unasylva-Fao-*, *229*, 24.

Marangwanda, A. (2025). Nature Needs Underwriters: Redefining the Role of Insurance in African Conservation Policy. *International Journal of Advanced Business Studies*, *4*(4), 39–61.

Massawe, F., Mwale, S., Azam-Ali, S., & Roberts, J. (2005). Breeding in bambara groundnut (Vigna subterranea (L.) Verdc.): Strategic considerations. *African Journal of Biotechnology*, *4*(6), 463–471.

Mayberry, A. L., Hovorka, A. J., & Evans, K. E. (2017). Well-being impacts of human-elephant conflict in Khumaga, Botswana: Exploring visible and hidden dimensions. *Conservation and Society*, *15*(3), 280–291.

Mbaiwa, J. E. (2004). The Success and Sustainability of Community-Based Natural Resource Management in the Okavango Delta, Botswana. *South African Geographical Journal*, *86*(1), 44–53. https://doi.org/10.1080/03736245.2004.9713807

Mbongwe, B., Legrand, M., Blais, J. M., Kimpe, L. E., Ridal, J. J., & Lean, D. R. S. (2003). Dichlorodiphenyltrichloroethane in the aquatic ecosystem of the Okavango Delta, Botswana, South Africa. *Environmental Toxicology and Chemistry*, *22*(1), 7–19. https://doi.org/10.1002/etc.5620220102

McCulloh, G., Kootsositse, M. V., & Rutina, L. (2009). *Botswana's Protected Important Bird Areas: Status and Trends Report.* BirdLife Botswana.

MOA. (2024). *Thuo Letlotlo Programme Guidelines*. Ministry of Agriculture. Gaborone, Botswana.

Mosigi, W. (2000). Role and procedures of natural resources accounting (NRA): an NRA framework for Botswana.

Mosweu, S., Munyati, C., & Kabanda, T. (2013). *Modification of soil properties by Prosopis L. In the Kalahari Desert, south-western Botswana*.

Motlhanka, D. M., & Makhabu, S. W. (2011). Medicinal and edible wild fruit plants of Botswana as emerging new crop opportunities. *Journal of Medicinal Plants Research*, *5*(10), 1836–1842.

Mugari, E., Masundire, H., Bolaane, M., & New, M. (2018). Perceptions of ecosystem services provision performance in the face of climate change among communities in Bobirwa Sub-District, Botswana. *International Journal of Climate Change Strategies and Management*, *11*(2), 265–288. (world). https://doi.org/10.1108/IJCCSM-09-2017-0178

Murray-Hudson, M., Wolski, P., & Ringrose, S. (2006). Scenarios of the impact of local and upstream changes in climate and water use on hydro-ecology in the Okavango Delta, Botswana. *Journal of Hydrology, Water Resources in Regional Development: The Okavango River*, *331*(1), 73–84. https://doi.org/10.1016/j.jhydrol.2006.04.041

Nellis, M. D., Bussing, C. E., Coleman, T. L., Nkambwe, M., & Ringrose, S. (1997). Spatial and spectral dimensions of rural lands and grazing systems in the southern district of Botswana. *Geocarto International*, *12*(1), 41–47.

Ngwenya, B. N., Mosepele, K. K., & Magole, L. (2012). A case for gender equity in governance of the Okavango Delta fisheries in Botswana. *Natural Resources Forum*, *36*(2), 109–122. https://doi.org/10.1111/j.1477-8947.2012.001450.x

Owen-Smith, N., & Chafota, J. (2012). Selective feeding by a megaherbivore, the African elephant (*Loxodonta africana*). *Journal of Mammalogy*, *93*(3), 698–705.

Pei, S., Zhang, G., & Huai, H. (2009). Application of traditional knowledge in forest management: Ethnobotanical indicators of sustainable forest use. *Forest Ecology and Management*, *257*(10), 2017–2021.

Rijal, S. (2023). The Importance of Community Involvement in Public Management Planning and Decision-Making Processes. *Journal of Contemporary Administration and Management (ADMAN)*, *1*(2), Article 2. https://doi.org/10.61100/adman.v1i2.27.

Report Linker. (2022). *Botswana Tea Industry Outlook 2022—2026* [Dataset].

Rutiņa, L., Dikobe, M., & Perkins, J. S. (2017). Inappropriate use of agrochemicals poses potential threats to Botswana vultures: a call for research and legal instruments. *Botswana Notes and Records*, *49*, 106-116.

Safriel, U., Adeel, Z., Niemeijer, D., Puigdefabregas, J., White, R., Lal, R., Winslow, M., Ziedler, J., Prince, S., & Archer, E. (2005). Dryland systems. In *Ecosystems and human well-being: Current state and trends* (pp. 623–662). Island Press.

Scheijen, C. P., Richards, S. A., Smit, J., Jones, T., & Nowak, K. (2019). Efficacy of beehive fences as barriers to African elephants: A case study in Tanzania. *Oryx*, *53*(1), 92–99.

Seleka, T. B., Mmopelwa, D., & Lekobane, K. R. (2023). Growth and diversification in Botswana's agriculture. In *Mogotsi: Economic Diversification in Africa: Lessons from Botswana* (pp. 131–166). UNAM.

Selwe, K. P., Head, C. R., Phokedi, G. N., Andersen, J. E. T., Sallach, J. B., & Dessent, C. E. H. (2024). Suspect and non-targeted screening of chemical pollutants in Botswana's aquatic environments. *Emerging Contaminants*, *10*(3), 100377. https://doi.org/10.1016/j.emcon.2024.100377

Sianga, K., Mojeremane, W., Abdeta, A. A., Makgobota, K., & Mabula, S. (2025). Impacts of Forest Fires in Botswana: Implications for Forest Resources Conservation and Management. In W. L. Hambira, A. A. Abdeta, D. B. Moalafhi, V. K. Muposhi, & K. Mosepele (Eds.), *Environmental Change and Biodiversity Conservation in sub-Saharan Africa: Volume 1* (pp. 251–263). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-73136-5_13

Silo, N., & Serome, S. (2018). Resilience and Coping Strategies against Socio-Ecological Risks: A Case of Livelihoods in a Botswana Rural Community. *Journal of Rural and Community Development*, *13*(4), Article 4. https://journals.brandonu.ca/jrcd/article/view/1503

Skelton, P. (2016). Name changes and additions to the southern African freshwater fish fauna. *African Journal of Aquatic Science*, *41*(3), 345–351. https://doi.org/10.2989/16085914.2016.1186004

Statistics Botswana. (2020). *Annual Agricultural Survey Report 2019*. Statistics Botswana.

Tatay, J., & Merino, A. (2023). What is sacred in sacred natural sites? A literature review from a conservation lens. *Ecology and Society*, *28*(1), art12. https://doi.org/10.5751/ES-13823-280112

Tsheboeng, G., Maseko, D., Dludlu, M. N., & Nkonyane, N. (2025). Effects of Bush Encroachment Control on Herbaceous Plant Species Composition, Ecological Status, and Grazing Value in a Semi-arid Savannah Ecosystem. In W. L. Hambira, A. A. Abdeta, D. B. Moalafhi, V. K. Muposhi, & K. Mosepele (Eds.), *Environmental Change and Biodiversity Conservation in sub-Saharan Africa: Volume 1* (pp. 343–357). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-73136-5_18

Tweddle, D., Bills, R., Van der Waal, B., Skelton, P., Kolding, J., Nengu, S., Alonso, L., & Nordin, L. (2003). Fish diversity and fisheries in the Okavango Delta, Botswana. *RAP*, *27*, 97–110.

UNDP. (2023). *Integrated Land Use Management Plan (ILUMP) for Kgalagadi District. For the Kgalagadi -Ghanzi Drylands Ecosystem Project (KGEP)*.

Velempini, K. (2021). About the human–elephant conflict in Botswana, what did people in the Okavango Delta panhandle have to say from their experience? *Socio-Ecological Practice Research*, *3*(4), 411–425.

Xiaoyu, H., Cuiying, Y., & Yiying, H. (2025). Building Sustainable Ecological Barriers Through Ecosystem Synergies and Socio‐Ecological Integration. *Land Degradation & Development*.

Yang, F., Huang, J., He, Q., Zheng, X., Zhon, C., Pan, H., Huo, W., Yu, H., Liu, X., Meng, L., Han, D., Ali, M., & Yang, X. (2019). Impact of differences in soil temperatures on the desert carbon sink. *Geoderma*, *379*.

Zhang, Z., Cao, D., Ma, T., Liu, H., & Mao, Z. (2025). International cooperation for a biodiverse future: Opportunities and challenges under the Kunming - Montreal Global Biodiversity Framework. *Global Ecology and Conservation*, e03385.

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