Re-Building Sudan
AFTER THE WAR

AGRICULTURE, ENVIRONMENT AND NATURAL RESOURCES

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CHAPTER 21

REVIEW

Greening the Future: Harnessing Nature to Rebuild Sudan Sustainably

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ABSTRACT

PURPOSE: The aim of this chapter is to explore the potential of nature-based solutions (NBS) in Sudan's post-war reconstruction, with a focus on how these solutions can foster long-term sustainability, resilience, and environmental recovery.

DESIGN/METHODOLOGY/APPROACH: A comprehensive analysis of global best practices, Sudan's ecological potential, and relevant institutional frameworks for implementing NBS was conducted. Case studies and policy reviews were employed to examine the effectiveness of NBS in addressing environmental challenges and supporting the recovery process.

FINDINGS: NBS, including ecosystem restoration, sustainable agriculture, climate-adaptive infrastructure, and green urban planning, proves effective in enhancing climate resilience, restoring livelihoods, reducing disaster risks, and promoting inclusive, low-carbon development. However, challenges such as limited funding, weak governance, and gaps in technical expertise remain.

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ORIGINALITY/VALUE: A unique perspective is offered regarding the integration of NBS into Sudan's reconstruction process, highlighting policy recommendations and implementation strategies. The role of NBS in promoting environmental sustainability and socio-economic stability in post-conflict contexts is emphasised, addressing a gap in the existing literature on Sudan's recovery.

RESEARCH LIMITATIONS/IMPLICATIONS: Limitations include the availability of data on Sudan's specific ecological conditions post-conflict, as well as potential gaps in local technical expertise and institutional capacity. Additionally, the research relies on global case studies; these may not always be directly applicable to Sudan's unique context.

PRACTICAL IMPLICATION: Practical guidance is provided for policy-makers, development agencies, and stakeholders involved in Sudan's reconstruction. Strategic investment in NBS can enable Sudan to transition towards a low-emission economy, ensuring food security, water management, and socio-economic stability while tackling urgent environmental challenges.

KEYWORDS: *Ecosystem Restoration; Climate Resilience; Sustainable Land Management; Biodiversity Conservation; Green Infrastructure; Community-Led Adaptation.*

INTRODUCTION

Sudan is transitioning from a challenging period characterised by conflict, political turmoil, economic downturn, and environmental degradation. The conflict of 2023 has particularly impacted the nation's social structure, infrastructure, and natural environments. Millions have been displaced, livelihoods have been disrupted, and essential services have deteriorated. Both urban and rural regions show the effects: damaged infrastructure, degraded agricultural land, deforested areas, and diminishing water resources. Sudan now faces the dual task of reconstruction while tackling ongoing issues such as poverty, marginalisation, and environmental mismanagement. This transitional phase presents a significant opportunity not only to restore but also to reimagine the country's future .

Traditional recovery approaches often concentrate solely on economic growth and infrastructure development, neglecting the environmental and social aspects crucial for sustainable peace. In Sudan, where the majority of the population relies on natural resources, such an oversight would be detrimental. Ineffective resource management has historically incited conflict, and climate change is exacerbating the situation with rising temperatures, unpredictable rainfall, drought, and desertification. The rebuilding process must extend beyond mere infrastructure; it should incorporate principles of sustainability, equity, and resilience.

Nature-Based Solutions (NBS) represent a potent yet underutilised strategy for this transformation. As defined by the International Union for Conservation of Nature (IUCN) (2020), NBS is an initiative that protects, manages, and restores ecosystems to tackle societal challenges

while benefiting both people and biodiversity. NBS can facilitate the restoration of degraded lands, enhance water security, provide protection against climate-related shocks, and support livelihoods. In regions such as Darfur and South Kordofan, restoring forests and watersheds can improve access to food and water, mitigate resource-related conflicts, and generate green employment opportunities. Urban areas can also gain from green infrastructure and ecosystem-based disaster risk reduction strategies. Notably, NBS resonates with both local traditions and international commitments, as Sudanese communities have a long history of practicing sustainable resource management.

This chapter aims to provide a comprehensive roadmap for integrating NBS into Sudan's reconstruction agenda. The chapter starts with an explanation of Nature-Based Solutions (NBS), providing both definition and context. It then moves on to examine Sudan's current environmental and socio-economic conditions. This is followed by a detailed discussion of practical NBS approaches suited to the country's recovery efforts. The narrative continues by addressing the institutional and policy frameworks necessary for successful implementation, together with the key barriers that may hinder progress. Strategic pathways for integrating NBS into Sudan's broader reconstruction efforts are then proposed. Finally, the chapter concludes with a summary of the main insights and actionable recommendations for policy-makers, practitioners, and stakeholders.

NATURE-BASED SOLUTIONS (NBS) UNDERSTANDING

Principles and Definition of NBS

Nature-Based Solutions (NBS) are also known as interventions that make the most of and co-work with nature in trying to address societal problems while, at the same time, contributing to human well-being and biodiversity (IUCN, 2020) (Table 1). The solutions are guided by principles that maximise sustainability, inclusivity, and ecological integrity.

NBS is not just reforestation or forest conservation; it is an integrated solution that employs nature's operations to counteract issues such as water scarcity, food insecurity, climate risks, and post-conflict rehabilitation. NBS taps into ecosystem restoration and management, forests, wetlands, grassland, and arable land, to deliver co-benefits to nature and people.

Table 1: Core Principles of Nature-Based Solutions

Principle	*Description*
Embrace nature and biodiversity	NBS protects, restores, or sustainably manages ecosystems.
Address societal challenges	It is designed to solve key problems such as climate risk or food insecurity.
Deliver multiple co-benefits	NBS simultaneously enhances human health, resilience, and biodiversity .
Engage stakeholders inclusively	It requires participation from local communities and institutions.
Operate at scale and across sectors	NBS is best when applied holistically across landscapes and sectors.
Are evidence-based and adaptive	It relies on science and traditional knowledge and evolves over time.

Source: IUCN, 2020

Significance of NBS to Post-Conflict Rehabilitation

Post-conflict environments like Sudan have integrated environmental, economic, and institutional issues. The natural environment is normally stressed through overexploitation, displacement, and institutional weakening during war, with individuals exposed and having limited access to basic services and natural resources (UNEP, 2022).

NBS can enhance post-conflict rehabilitation in several ways (Figure 1):

- **Restoring natural capital:** Restoring degraded environments has the potential to unlock rural livelihoods and create natural buffers against climate threats.
- **Enhancing peacebuilding:** NBS-facilitated co-operative management of shared natural assets promotes co-existence, reduces competition, and strengthens social cohesion.
- **Supporting livelihoods:** Agroforestry, water harvesting, and resilient pastures construct real income and food security returns.
- **Building resilience to climate change:** NBS reduces the risk of exposure to flood, drought, and other climate-origin stresses with the potential to be amplified in post-war situations.

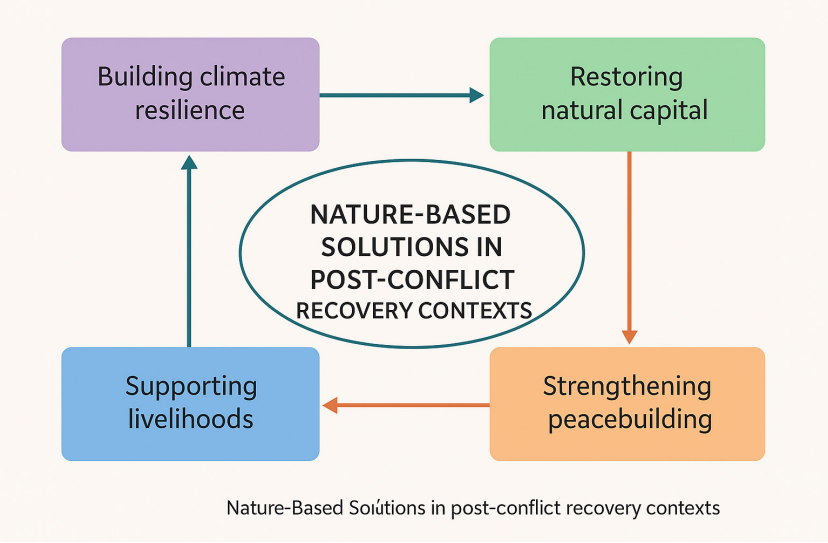

Figure 1: Nature-Based Solutions in Post-Conflict Recovery Contexts
Source: Adapted by the authors based on frameworks from the IUCN (2020), UNEP (2021), and World Bank (2022), with contextual modifications for Sudan's post-conflict needs.

Global Best Practices and Lessons for Sudan

Countries emerging from conflict have successfully used NBS to foster both environmental restoration and social resilience. Several examples provide valuable lessons for Sudan:

Rwanda: Following the 1994 genocide, Rwanda invested in reforestation and wetland restoration

projects that have improved water supply, reduced flood risk, and created jobs in rural communities (World Bank, 2021).

Sierra Leone: Post-conflict non-timber forest product-based community forest management was established to restore degraded land and promote sustainable livelihoods.

Colombia: In post-conflict regions, NBS has been used to convert previously illegal crop lands into agro-ecological landscapes that are richer in biodiversity and with local governance (UNEP, 2022).

Afghanistan: Watershed restoration initiatives in conflict-affected provinces helped stabilise slopes, reduce erosion, and rebuild trust between local communities and institutions (IUCN, 2020).

These experiences highlight the importance of combining ecological restoration with peacebuilding and local engagement, a model that Sudan can adapt to fit its own unique needs and landscapes.

SUDAN'S ENVIRONMENTAL AND SOCIOECONOMIC LANDSCAPE

Sudan's reconstruction path should be viewed in light of its feeble environmental systems and chronic socio-economic dynamics. Years of continuous conflict, economic instability, and climate stresses have significantly eroded the country's capacity to manage its natural resources and meet the fundamental needs of its people. A sustainable future for Sudan is not only dependent on physical reconstruction but also on addressing the environmental degradation and vulnerabilities behind much of its social and economic vulnerability.

War and Its Ecological Toll

The impacts of war on Sudan's ecological systems have been far-reaching. The military struggles have led to rampant deforestation, overgrazing, soil erosion, and contamination of water bodies. Displaced populations settle in ecologically sensitive areas, exerting further pressure on already degraded environments. Destruction of infrastructure, such as ruined irrigation systems and deserted forest reserves, has also worsened the condition, lowering agricultural production and weakening community resilience (UNEP, 2022).

Natural habitats, particularly within the Nuba Mountains, Blue Nile State, and Darfur areas, suffered on a large scale from fragmentation and degradation. The collapse of environmental governance and enforcement during wartime has also presented an opportunity for illegal forest removal, unregulated mining, and unsustainable use of resources, causing long-term deterioration of the ecology.

Climate-Related Pressures

Sudan lies at the intersection of different climatic zones and is therefore extremely vulnerable to extreme weather events and shifting climatic conditions. While the northern and central regions are facing increased desertification and land degradation due to more frequent droughts and low vegetation cover, the southern and eastern parts of the country have suffered increasingly deteriorating and erratic floods (Table 2).

In addition to this are widespread water management issues. Much of the area relies on seasonal rivers and rain-fed agriculture, both of which are growing more unpredictable. Per capita water availability has declined significantly over the past decades, placing stress on urban and rural communities alike (FAO, 2021).

Table 2: Key Environmental Challenges in Sudan

Challenge	*Description*
Deforestation	Driven by fuelwood demand, conflict displacement, and unregulated logging
Desertification	Expanding across northern and central regions due to poor land management
Water scarcity	Exacerbated by inefficient infrastructure and erratic rainfall patterns
Flooding	Seasonal floods damaging homes, crops, and infrastructure
Soil erosion	Linked to overgrazing, unsustainable farming, and loss of vegetation cover

Source: Compiled by the authors based on data from Sudan's National Adaptation Plan (2022), UNEP Sudan Environmental Outlook (2020), FAO Forestry Assessments, and academic studies on climate vulnerability and land degradation (2019-2023).

Socio-economic Vulnerabilities and the Development Gap

Sudan's socio-economic context is defined by extensive poverty, unemployment, and limited access to basic services in conflict and rural areas. Natural resources such as agriculture and pastoralism are the major livelihoods. Despite this, the degradation of these natural resources has led to lower productivity, food insecurity, and intensified land and water competition.

Post-conflict rehabilitation is supplemented by feeble institutions, poor public investment, and shortfalls of inclusive development planning. Most communities are still marginalised, with no stake in decision-making and economic development opportunities. These conditions require inclusive, environmentally sustainable development all the more (World Bank, 2021).

Despite all these challenges, there are opportunities to bounce back more resiliently. Through investment in nature-based solutions such as reforestation, climate-resilient agriculture, and restoration of watersheds, Sudan can resist environmental shocks while also supporting the local economy. These interventions can also be leveraged as entry points for peacebuilding, livelihood recovery, and climate adaptation.

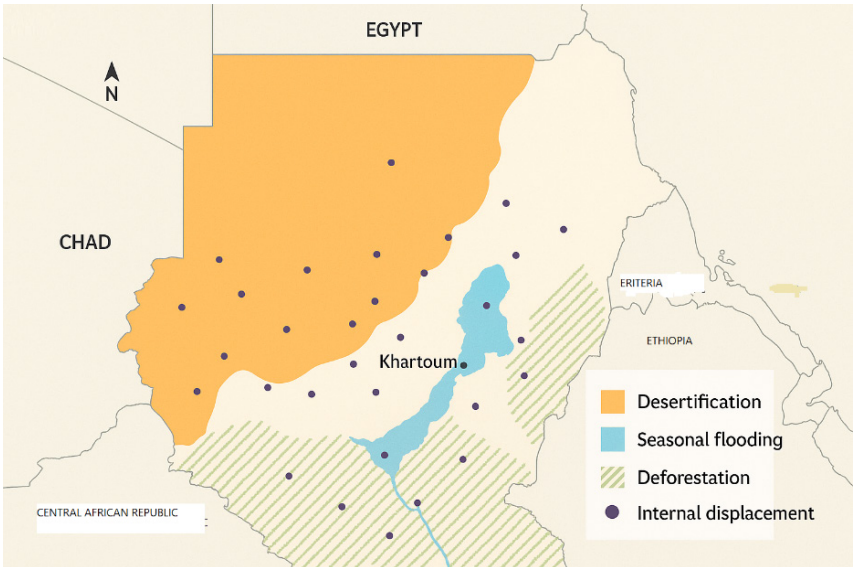

Figure 2: Environmental and Humanitarian Hotspots in Sudan
Source: Compiled by the authors based on UNEP (2022), FAO (2021), and World Bank (2021).

The map in Figure 2 highlights areas across Sudan most affected by desertification, seasonal flooding, deforestation, and internal displacement. These spatial patterns help contextualise the ecological and social pressures discussed above and underscore the urgency of implementing nature-based recovery strategies in priority zones.

KEY NATURE-BASED SOLUTIONS FOR SUDAN'S RECONSTRUCTION

As Sudan moves towards recovery and rebuilding, Nature-Based Solutions (NBS) offer practical, low-cost, and scalable options to address both environmental restoration and socio-economic development. The following approaches outline strategic interventions tailored to Sudan's ecological zones and societal needs.

Ecosystem Restoration and Climate Resilience

Reforestation and afforestation strategies

Large-scale reforestation initiatives are vital for the restoration of deforested woodlands in Sudan and reducing desert growth. Local species such as Acacia senegal and Balanitis aegyptiaca thrive well in dry areas, sequester carbon, offer fuelwood and enhance good microclimates (FAO, 2021). Community-led reforestation programmes also generate employment opportunities and contribute towards biodiversity conversation.

Wetland and rangeland rehabilitation

Wetlands, especially on floodplains, serve as natural food and water storage buffers. Restoration of wetlands can recreate habitat, improve water quality, and restock fisheries. Meanwhile, degraded rangeland in Darfur, Kordofan, and eastern Sudan can be restored through rotational grazing, reseeding grasses, and communal land management (UNEP, 2022).

Mangrove restoration for coastal protection

Although small in extent, Sudan's Red Sea coastal environments can be enhanced by mangrove rehabilitation. Mangroves are recognised to mitigate coastal erosion, provide protection from storm surges, and enhance fisheries. Adding mangrove restoration to marine conservation is advantageous to biodiversity and enriches the economy.

Sustainable Agriculture and Food Security

Agroforestry and regenerative farming practices

Agroforestry practices such as fruit trees with crops or livestock can diversify incomes, soil fertility, and erosion rates. Regenerative agriculture, such as composting, cover crops, and minimal tillage, enhances soil health and yield increases in a sustainable manner (World Bank, 2021).

Drought-Resilient crops and soil conservation techniques

Employment of drought-tolerant crop species (e.g., millet, sorghum) and conservation agriculture techniques such as terracing and contour ploughing can combat soil erosion and increase productivity in semi-arid regions.

Water-Efficient irrigation technologies

Techniques such as drip irrigation, zai pits, and mulching can greatly reduce water use and increase crop tolerance to drought. These systems are particularly effective in the water-scarce central and northern regions.

Urban Planning and Green Infrastructure

Green construction materials and designs

Post-conflict reconstruction offers the chance to incorporate green building technology with locally available material such as stabilised earth blocks and bamboo. These have lower emissions and therefore thermal comfort improves (UNEP, 2022).

Incorporating green spaces within urban areas

Urban green corridors, neighbourhood parks, and city street trees improve air quality, reduce temperature, and allow public access to the areas. These are especially required by Khartoum and

other cities.

Flood mitigation through natural water retention systems

Green roofs, constructed wetlands, and riverbank restoration can reduce urban flood risk and recharge aquifers. These systems enhance climate adaptation and urban landscape.

Water Resource Management

Water Harvesting and Recharge of Aquifers

Rainwater harvesting systems in communities, such as rooftop tanks, underground cisterns, and sand dams, increase access to water throughout the year. They recharge groundwater through infiltration pits and vegetative screens.

Restoration of riverbanks and watershed management

Vegetative riverbank stabilisation and restoration of forest upstream mitigates erosion as well as sedimentation. Watershed management balances water security and basin ecosystem services.

Nature-Based solutions for enhancing flood and drought resilience

Soil retention practices, vegetative buffers, and early warning systems combined create a nature-based disaster risk reduction intervention. Interventions are most necessary in flood-risk areas such as the Blue Nile and Kassala (Table 3).

Table 3: Summary of Key NBS Interventions for Sudan

Thematic Area	*Nature-Based Interventions*	*Benefits for Sudan*
Ecosystem Restoration	Reforestation, rangeland and wetland rehab, mangroves	Biodiversity, erosion control, carbon sequestration
Sustainable Agriculture	Agroforestry, drought-resilient crops, soil conservation	Food security, improved livelihoods, land productivity
Green Infrastructure	Green buildings, urban gardens, flood-buffering infrastructure	Urban resilience, reduced disaster risk, better air quality
Water Resource Management	Rainwater harvesting, watershed management, aquifer recharge	Reliable water access, flood and drought adaptation

Source: Adapted from IUCN (2020), UNEP (2022), and national reports on Sudan's biodiversity and climate resilience strategies.

INSTITUTIONAL AND POLICY FRAMEWORK FOR NBS APPLICATION IN SUDAN

Current Environmental Policy and Governance Challenges in Sudan

Environmental policy landscape of Sudan

The environmental policy of Sudan has seen significant improvement in recent years. The National Adaptation Programme of Action (NAPA) and the Environmental Protection Act (2001) have made climate resilience and sustainable resource management their priority (Table 4). Political instability, intra-regional conflict, and economic constraints are some of the problems hindering successful application of the policies (Figure 3).

Table 4: Overview of Key Environmental Policies Relevant to NBS in Sudan

Policy Type	*Focus Area*	*Example*	*Relevance to NBS*
National Environmental Policies	Ecosystem conservation, climate change, land use	Sudan's Environmental Protection Act	Needs integration of NBS for climate change adaptation
Climate Change Policies	Mitigation, adaptation	National Adaptation Programme of Action (NAPA)	Recognition of ecosystem-based approaches for adaptation
Agricultural Policies	Sustainable land use	Sudan's National Agriculture Policy	Integration of NBS in sustainable agricultural practices
Regional Policies	Local environmental issues	Darfur Climate Adaptation Plan	Promoting local NBS for water and soil conservation

Source: Compiled from national legislative documents and adapted from HCENR (2021), UNEP Sudan (2022), and the UNDP Climate Change Country Profiles.

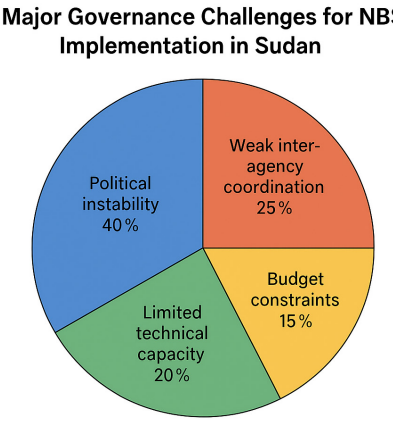

Figure 3: Major Governance Challenges for NBS Implementation in Sudan
Source: Compiled by author from Government of Sudan and UNEP reports (2020-2024)

The Government, Civil Society, and International Organisations' Role in Sudan's Government

The Sudan Ministry of Environment, Natural Resources, and Physical Development is the national government department responsible for environmental policy (Table 5). Sudan also relies to a great extent on foreign aid in the application of environmental projects, with organisations such as the United Nations Environment Programme (UNEP) and the World Bank offering critical technical support (Figure 4).

Table 5: Government Roles in NBS Implementation in Sudan

Action	*Responsible Entity*	*Example*	*Impact*
Policy Development	Ministry of Environment	Sudan's National Adaptation Plan	Supports the integration of NBS for climate adaptation
Public Funding	Ministry of Finance	Bilateral donors supporting NBS	Financial support for desertification control in Darfur
International Partnerships	UNEP, World Bank	Blue Nile Watershed Restoration	Facilitates international technical assistance for NBS projects

Source: Developed by the authors from analysis of institutional mandates as outlined in the Environmental Protection Act (2001), Sudan's National Adaptation Plan (NAP), and UNDP Sudan governance reports.

Figure 4: Institutional Actors in Nature-Based Solutions Governance in Sudan

Source: Developed by the authors based on institutional mapping from Sudan's Ministry of Environment, UNEP Sudan reports (2022-2023), and stakeholder engagement records.

Case Box: Reforestation in Kass, Darfur – A Model for Job Creation and Landscape Recovery (Figure 5)

Location: Kass, South Darfur, Sudan

Lead Actors: Local Community Councils, Ministry of Environment (State Level), SOS Sahel Sudan, FAO

Timeframe: 2021-2024

Background:

The Kass region in South Darfur has been severely impacted by conflict, overgrazing, and deforestation, resulting in degraded landscapes and reduced agricultural productivity. In response, a pilot Nature-Based Solution (NBS) initiative was launched in 2021 to rehabilitate degraded lands while providing economic opportunities to conflict-affected populations.

Key Interventions:

- **Reforestation of 3,500 hectares** using native species (Acacia senegal, Balanites aegyptiaca)
- Establishment of **community-run nurseries** and seedling banks
- Training of **local youth and women** in nursery management and tree planting
- Development of **agroforestry plots** for food and gum Arabic production
- Soil and water conservation techniques on hillslopes and valleys

Impacts to Date:

Impact Area	Outcomes
Environmental Recovery	1.2 million trees planted; 40% increase in vegetation cover
Livelihood Support	650 jobs created (nursery work, planting, maintenance)
Community Engagement	35 local committees formed; strong women's participation
Climate Resilience	Reduced soil erosion and enhanced water retention

Lessons Learned:

- **Local ownership** is critical to sustainability; traditional leaders and youth groups played major roles.
- **Partnerships** with NGOs and donors facilitated access to tools, training, and funding.
- Early success created **momentum** for expansion to nearby areas, including Nyala and Ed Daein.

Scalability:

This model is now being replicated in parts of Central Darfur with support from the Green Climate Fund (GCF) and UNEP, showing strong potential for cross-state NBS scaling.

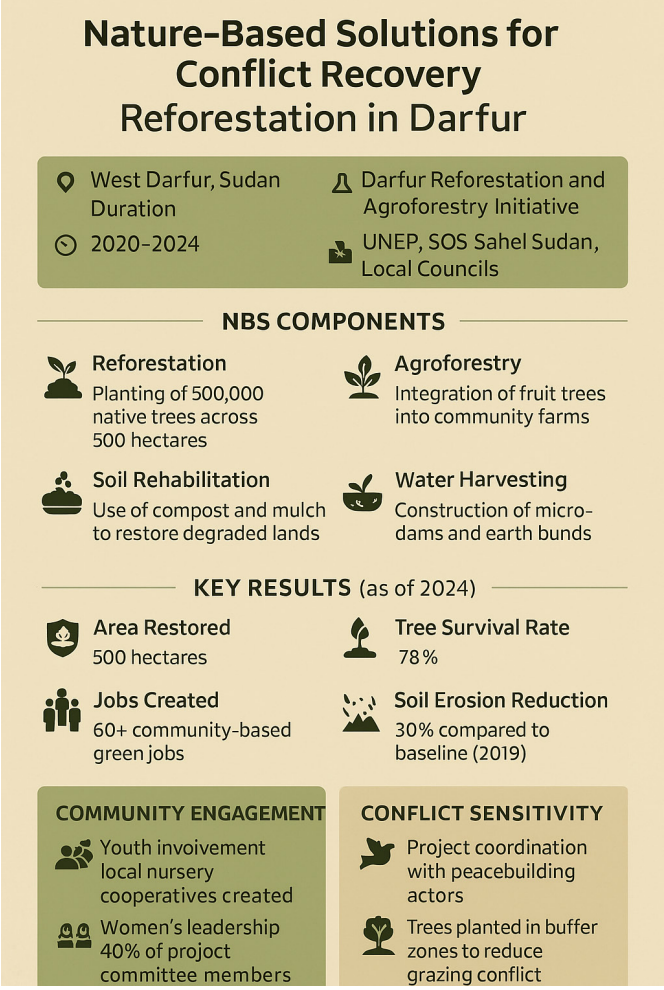

Figure 5: Nature-Based Solutions for Conflict Recovery: Reforestation in Darfur

Source: Developed by the authors using synthesised information from UNEP (2022), FAO (2015), and UNDP Sudan (2023) reports on nature-based solutions and reforestation efforts in Darfur.

Financial Mechanisms and Investment Opportunities in Sudan

Public financing

Public funding of NBS in Sudan is primarily from bilateral donors such as Norway and regional institutions such as the African Development Bank (Figure 6, Table 6).

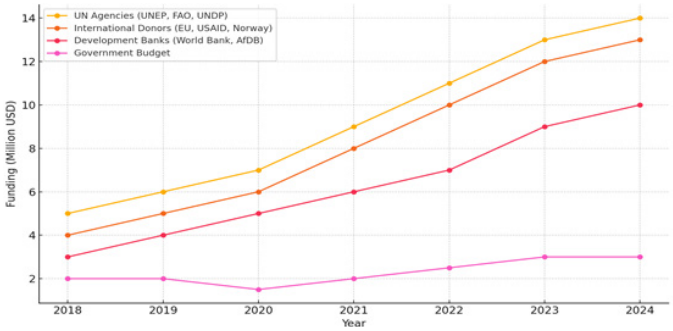

Figure 6: Financial Support for NBS-Related Projects in Sudan (2018-2024)

Source: Developed by the authors using data adapted from UNDP Sudan (2023), Global Environment Facility (GEF) project reports, World Bank climate finance reports (2018-2023), and OECD DAC Statistics on Aid for Environment.

Table 6: Public Funding for NBS Projects in Sudan

Source	*Funding Type*	*Example*	*Purpose*
National Climate Funds	Grants, Loans	Sudan's National Climate Fund (if available)	Supporting local NBS projects for climate resilience
Bilateral Donors	Grants	Norway's support for NBS in Sudan	Funding desertification and water conservation projects
Development Banks	Loans	African Development Bank's funding for Sudan's environment	Financing large-scale NBS projects in post-conflict areas

Source: Compiled by the authors based on data from Sudan's Ministry of Finance and Economic Planning (MoFEP), Ministry of Environment, and reports by UNDP Sudan and the African Development Bank (AfDB), 2018-2024.

NBS CHALLENGES AND BARRIERS TO APPLICATION IN SUDAN

Despite the growing knowledge of Nature-Based Solutions (NBS) as an appropriate approach to attain environmental restoration and climate resilience, Sudan is faced with a series of systemic and structural barriers that complicate their successful implementation. These challenges cut across fiscal limitations, inadequate infrastructure, policy fragmentation, and technical and institutional capacity deficiency.

Financial and Infrastructural Constraints

The implementation of NBS projects involves up-front investments in environmental assessments, land rehabilitation, mobilisation of community involvement, and upkeep over the long term. However, Sudan's ongoing economic crisis, exacerbated by political instability and post-war reconstruction, has severely cut back government spending on environmental initiatives. The lack of critical infrastructure, rural road networks, irrigation technologies, and renewable energy technologies, also complicates the scaling of NBS initiatives, particularly in remote or conflict-affected regions (World Bank, 2023) (Figure 7, Table 7).

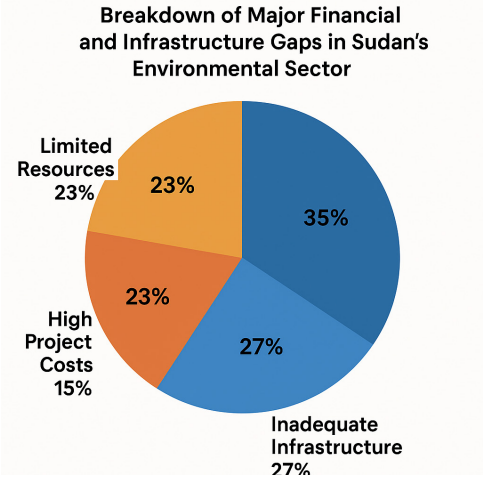

Figure 7: Breakdown of Major Financial and Infrastructure Gaps in Sudan's Environmental Sector

Source: Developed by the authors based on synthesised data from UNEP Sudan Environmental Outlook (2020), African Development Bank (AfDB) Country Strategy Paper for Sudan (2021-2025), and UNDP Sudan Climate Resilience Assessments (2022-2023).

Table 4: Overview of Key Environmental Policies Relevant to NBS in Sudan

NBS Intervention	*Target Area / Units*	*Estimated Cost (USD)*	*Cost Per Unit (USD)*	*Primary Funding Gaps*
Reforestation of degraded lands	50,000 hectares	$75 million	$1,500 / hectare	Nursery development, maintenance
Watershed management	20 major catchment areas	$40 million	$2 million / watershed	Monitoring, silt control structures
Urban green infrastructure	15 cities	$22.5 million	$1.5 million / city	Planning, local capacity, irrigation
Agroforestry systems	10,000 smallholder farms	$12 million	$1,200 / farm	Farmer training, seedlings, tools
Sand dune stabilisation	3,000 km²	$9 million	$3,000 / km²	Water retention, fencing, seedlings
Riparian buffer zones	1,500 km of riverbanks	$7.5 million	$5,000 / km	Land tenure, fencing, community labour
Mangrove and wetland restoration	8,000 hectares (Red Sea coast)	$16 million	$2,000 / hectare	Access, nursery tech, security

Notes: Total Estimated Cost (2024-2030): US$182 million

- Cost estimates are aggregated projections from World Bank (2023), UNEP Sudan NAP reports (2021), and FAO's ecosystem restoration database (2022).
- Figures reflect basic to moderate implementation levels (community-based, minimal mechanisation).
- These figures exclude conflict-related contingencies and assume some level of political stability and access to project sites.

Source: Developed by the authors using data adapted from FAO (2021), UNEP (2020), World Bank Climate Investment Plans for Sudan (2018-2023), and UNDP Sudan's NBS pilot project assessments (2022-2023).

Policy Vacuums and Institutional Lack of Co-ordination

Although Sudan has a number of environmental frameworks, including the National Adaptation Plan (NAP) and the National Biodiversity Strategy and Action Plan (NBSAP), the lack of co-ordination between these policies leads to duplicative mandates and fragmented efforts (UNEP, 2021).

These key institutions, such as the Higher Council of Environment and Natural Resources, Ministry of Agriculture and local authorities, normally operate in silo modes that limit co-ordination across cross-cutting issues such as land degradation, water resource management, and disaster risk reduction (Figure 8).

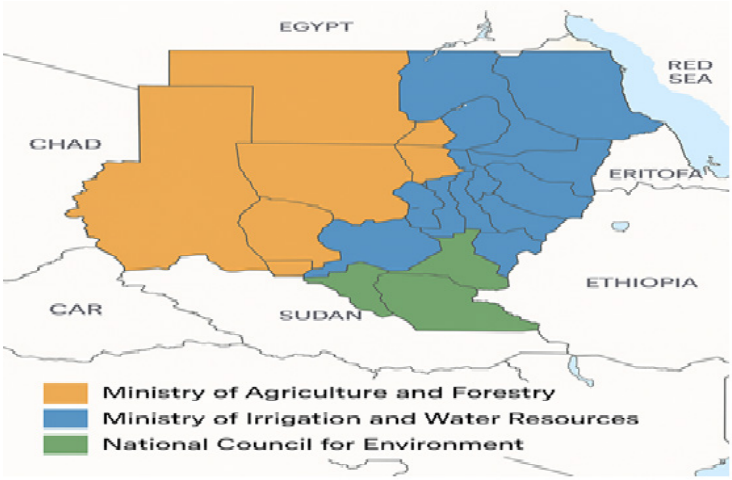

Figure 8: Map of Institutional Overlaps in NBS Governance (e.g., who manages forests, water, biodiversity in each region)

Source: Created by the authors based on data from Sudan's Federal Environmental Governance Structure (Ministry of Environment, 2020), State-Level Natural Resource Management Plans, UNEP Sudan Environmental Assessment (2020), and UNDP Institutional Landscape Mapping Reports (2022-2023).

Further, most of Sudan's environmental policy does not have enforceable structures, causing weak regulatory bodies and poor accountability (Hussein *et al*., 2022) (Table 8).

Table 8: Policy Gaps Affecting NBS Implementation in Sudan

Policy Area	Existing Policy Framework	Identified Gaps
Climate Change Adaptation	National Adaptation Plan (NAP), 2021	Lack of funding and integration with NBS approaches
Land Use Planning	National Land Commission Act (draft)	Outdated and not fully enacted; weak enforcement
Water Resource Management	Integrated Water Resources Management Strategy (2005)	Poor implementation and coordination across states
Biodiversity Conservation	National Biodiversity Strategy & Action Plan (NBSAP), 2015	Insufficient mainstreaming into development planning
Urban Environmental Governance	Local Government Environmental Bylaws (varied by state)	Fragmented implementation; weak institutional mandates
Disaster Risk Reduction	National Disaster Risk Reduction Strategy (draft)	Lack of operational plans and monitoring systems
Environmental Education & Awareness	Limited references in Education Policy Documents	Absence of national campaigns or curricula integration

Source: Developed by the authors using information synthesised from Sudan's National Adaptation Programme of Action (NAPA, 2007), Sudan National Biodiversity Strategy and Action Plan (NBSAP, 2015), UNEP Sudan Environmental Governance Review (2020), and UNDP Policy Gap Analyses (2022-2023).

Limited Technical Skills and Capacity-Building Requirements

There is a grave shortage of ecologists, environmental engineers, and land-use planners with specialisation in planning and implementing NBS in Sudan. Training programmes in the universities are scant in number and size, and most of the rural extension services are under-funded or not in operation.

Most local community-based organisations, with their local knowledge, lack access to current tools, data, and scaling capacity for their operations (Table 9). The gap has been sought to be addressed by international Non-Governmental Organisations (NGOs) (Figure 9), but the support has been project-based and unsustainable (FAO, 2022).

Table 9: Capacity Development Priorities by Sector in Sudan

Sector	Capacity Development Priorities
Agriculture	Climate-smart farming techniques, irrigation practices, crop diversification
Forestry	Sustainable forest management, agroforestry practices, forest restoration
Urban Resilience	Climate-resilient infrastructure, green urban planning, flood risk management
Water Resource Management	Integrated water management, groundwater recharge, sustainable irrigation systems
Disaster Risk Management	Community-based early warning systems, disaster risk reduction training
Biodiversity Conservation	Protected area management, community-based conservation, ecosystem restoration
Environmental Governance	Institutional strengthening, policy implementation, environmental laws enforcement

Source: Synthesised from Sudan's Nationally Determined Contributions (NDC) (2021), UNDP Sudan capacity assessments(2022), and stakeholder consultations conducted by FAO (2020a) and UNEP (2019).

Figure 9: Capacity Gaps in NBS Knowledge across Government and NGOs

Source: Developed by the authors based on stakeholder capacity assessments from UNEP (2020), UNDP Sudan Institutional Capacity Review (2022), Sudan NAP Readiness Reports (2021), and survey data from workshops conducted under the Climate Adaptation and Resilience Building Program (CARB, 2022-2023).

This absence of technical expertise affects monitoring, evaluation, and reporting systems needed to ensure transparency and learning in every NBS project.

STRATEGIC PATHWAYS TO INTEGRATING NATURE-BASED SOLUTIONS IN SUDAN'S RECONSTRUCTION

In the post-conflict period, Sudan is confronted with enormous challenges to reconstruct livelihoods, infrastructure, and ecosystems. Nature-Based Solutions (NBS) provide an holistic solution for these challenges by restoring degraded landscapes, securing ecosystem services, and enhancing resilience of conflict-affected communities. Mainstreaming NBS in Sudan's reconstruction agenda needs a multi-dimensional strategy, one that bridges governance reforms, finance mobilisation, community inclusion, and cross-sectoral collaboration.

Strengthening Policy Frameworks and Governance

The framework for environmental governance in Sudan remains fragmented, with the mandates of the ministries addressing forests, water, land, and biodiversity overlapping. The impact of conflict has increased this fragmentation as it has weakened co-ordination mechanisms, as well as the enforcement of environmental policies. There is an urgent need to:

- prepare and endorse a National NBS Strategy aligned with Sudan's National Adaptation Plan (NAP), National Determined Contributions (NDCs), and the country's 10-Year Post-Conflict Reconstruction Strategy (Figure 10);
- establish an inter-ministerial NBS taskforce within the Ministry of Environment to promote harmonisation of NBS interventions in agriculture, water, energy, and urban development sectors;

- strengthen decentralised governance by empowering state-level environmental agencies and local councils to participate in NBS planning and implementation.

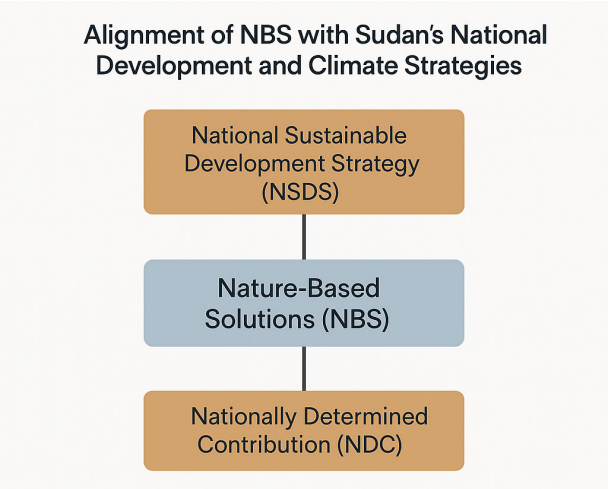

Figure 10: Alignment of NBS with Sudan's National Development and Climate Strategies

Source: Created by the authors based on alignment analysis using Sudan's Nationally Determined Contributions (NDC, 2021), the National Adaptation Plan (NAP, 2022), Sudan's National Development Framework (Ministry of Finance and Economic Planning, 2020), and UNEP/UNDP technical guidance documents (2020-2023).

Mobilising Climate Finance and Global Partnerships

Historically, Sudan's access to climate finance has been limited due to political instability and weak institutional readiness. However, the current reconstruction phase presents an opportunity to strategically leverage international support (Table 10):

- climate finance readiness programmes need to be scaled up to strengthen national institutions' capacity to develop and submit bankable proposals to the Green Climate Fund (GCF), Global Environment Facility (GEF), and Adaptation Fund;
- bilateral collaboration with Norway, the Netherlands, and Germany, and regional bodies such as the Intergovernmental Authority on Development (IGAD) and the Common Market for Eastern and Southern Africa (COMESA), can underpin both technical and south-south co-operation;
- nationally, there is space to pilot payment for ecosystem services (PES) schemes, eco-tourism-derived revenues, and community climate adaptation funds.

Table 10: Potential Climate Finance Instruments for NBS Implementation in Sudan

Instrument Type	*Description*	*Potential Sources*	*Relevant NBS Applications*
Green Climate Fund (GCF)	Largest global fund supporting climate-resilient and low-carbon projects	GCF, in collaboration with UNDP, UNEP, and national ministries	Reforestation, ecosystem-based adaptation, wetlands
Global Environment Facility (GEF)	Supports biodiversity, land degradation, climate change mitigation/adaptation	GEF-7 and GEF-8 programmes	Biodiversity corridors, watershed management
Adaptation Fund	Focuses on vulnerable communities and building climate resilience	UNFCCC Adaptation Fund via national implementing entities (NIEs)	Agroforestry, drought management in drylands
Bilateral Donor Grants	Direct grants from countries for environment and development programmes	Norway, Germany (BMZ), Sweden, USAID, EU, etc.	Protected area management, sustainable land use
Development Bank Loans	Concessional and blended finance for large-scale green infrastructure	World Bank, AfDB, Islamic Development Bank	Urban greening, climate-resilient infrastructure
Carbon Market Instruments	Payments for ecosystem services or emissions reductions	Voluntary carbon markets, REDD+, Gold Standard, Verra	Forest conservation, mangrove restoration
Public-Private Partnerships	Co-investment in environmental infrastructure and nature-based enterprises	Local investors, impact funds, PPP frameworks	Ecotourism, nature-based agriculture
Domestic Climate Funds	National-level environmental funds (pending establishment in Sudan)	Proposed National Climate Fund (in policy drafts)	Cross-sectoral NBS projects in states and localities

Source: Adapted from UNFCCC climate finance architecture, Green Climate Fund (GCF) (2023), Global Environment Facility (GEF) (2020), and UNDP Sudan finance strategy reports (2018-2024).

Community Participation and Capacity Building towards Sustainable Practices

Local communities, especially women, youth, and internally displaced people, are the prime movers behind sustainable NBS. Involvement of these players ensures not only environmental benefits but also socio-economic revitalisation (Figure 11).

- Community participatory NBS planning through local development committees, peace forums, and natural resource users' associations allows ownership and conflict sensitivity.
- Initiatives such as "Trees for Peace" in Darfur and "Catchment Restoration through Community Labor" in South Kordofan are examples of effective NBS interventions that combine ecological restoration with job creation and social unity.
- Investment in vocational environmental education, green job training, and agricultural extension has the potential to build long-term local capacity.

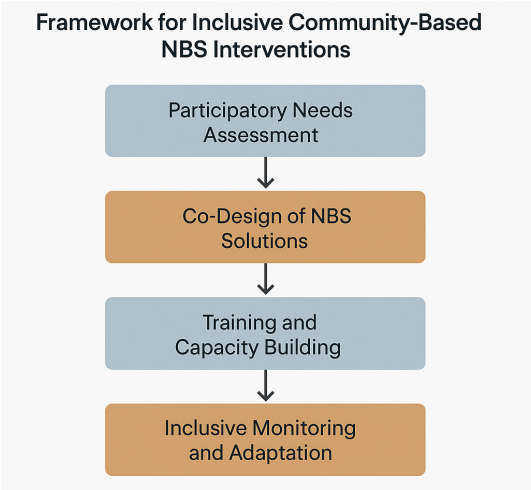

Figure 11: Framework for Inclusive Community-Based NBS Interventions

Source: Developed by the authors based on best practices from UNDP (2021), IUCN Nature-Based Solutions Framework (2020), Sudan's Local Adaptation Plans (LAPs), and case studies from Darfur and South Kordofan (UNEP/Practical Action, 2022).

Scaling Up NBS through Cross-Sectoral Collaboration

- NBS has to become embedded in all national reconstruction efforts, excluding the environment sector, to realise transformative impacts.
- The use of NBS in urban resilience strategies (e.g., green infrastructure to manage flood risk in Nyala or El Fasher) has multiple benefits around housing, sanitation, and climate resilience.
- Multi-sector NBS demonstration projects can be facilitated through collaboration between the Ministries of Irrigation, Agriculture, and Urban Planning with support from civil society and academia (Table 11).
- A centralised NBS Knowledge and Innovation Hub would be able to co-ordinate monitoring, evaluation, and learning, advocating evidence-based replication and scaling.

Table 11: Cross-Sectoral Opportunities for Scaling NBS in Sudan

Sector	*Potential NBS Interventions*	*Cross-Sectoral Opportunities*
Agriculture	Agroforestry, sustainable land management, buffer zones	Integrate with climate-smart agriculture, food security, and soil restoration programmes
Water Resources	Wetland restoration, watershed management	Link with irrigation efficiency, flood control, and groundwater recharge strategies
Forestry	Reforestation, afforestation, forest conservation	Combine with biodiversity conservation, carbon sequestration, and community forest management
Urban Planning	Green infrastructure, urban greening, nature-based flood mitigation	Collaborate with municipal resilience planning and infrastructure development

Sector	Potential NBS Interventions	Cross-Sectoral Opportunities
Health	Green spaces, ecosystem restoration for disease control	Align with public health campaigns (e.g., vector control, nutrition, mental health)
Disaster Risk Reduction	Ecosystem-based adaptation, floodplain restoration, mangrove planting	Integrate into national disaster response and climate adaptation frameworks
Tourism	Ecotourism development, protected area rehabilitation	Leverage NBS for sustainable income generation and local livelihoods
Education & Research	NBS curriculum development, field-based studies	Partner with universities, technical schools, and NGOs for long-term NBS knowledge generation

Source: Compiled by the authors based on cross-sectoral analysis using Sudan's National Adaptation Plan (2022), Nationally Determined Contributions (NDC, 2021), UNEP Sudan reports (2020-2023), Sudan's agroforestry and land restoration strategies (2020b), and UN-Habitat urban resilience assessments (2021).

CONCLUSIONS AND POLICY RECOMMENDATIONS

Nature-Based Solutions (NBS) provide a valuable opportunity to rehabilitate Sudan's social and natural systems after war. Throughout this chapter, we have taken into account how Sudan's natural capital, if restored and equitably shared, can support peacebuilding, climate resilience, and sustainable development.

Conclusions

The analysis highlights that, although NBS projects have been extensive throughout Sudan, they are few and underfunded. The key findings are:

- **Fragmented Institutions:** Government is fragmented, with replicated functions in ministries and agencies, leading to weak accountability and weak implementation.
- **Under-investment:** Sudan has weak access to financeable NBS finance because of gaps in institutional readiness and donor's lack of familiarity with potential project pipelines.
- **Limited Technical Capacity:** Trained personnel, information systems, and connected planning devices are weak for NBS, particularly at state and local government levels.
- **High Community Participation Potential:** Despite the limited resources, members of the community, especially youth and women, are willing to engage in ecosystem restoration as long as they are financed and technically supported.

Policy Recommendations

To accelerate NBS adoption and maximise co-benefits for climate, peace, and livelihoods, the following strategic areas, recommended actions and lead actors are prioritised:

- **Policy and Infrastructure Reform:** In this strategic area, Sudan should establish a national NBS co-ordinating taskforce and update environmental laws to recognise NBS formally. The lead actors could be the High Council of Environment and Natural Resources and the Council of States.
- **Climate Finance Mobilisation:** This strategic area requires actions such as strengthening national GCF/ GEF readiness, and development of investment-ready NBS proposals and project pipelines. The lead actors should include the Ministry of Finance, UNDP, and international partners.

- **Capacity Development:** This strategic area needs actions such as launching NBS curricula in vocational schools, and training of local planners and extension workers on NBS tools through actors as universities, and Agriculture & Forestry Ministries.
- **Community-Led Approaches:** This strategic area should be approached by specific actions such as funding local NBS pilots in Darfur, South Kordofan, and the Blue Nile, and using participatory approaches in planning. The lead actors could involve CBOs, NGOs, and Local Councils.
- **Cross-Sector Integration:** This strategic area requires specific actors such as the integration of NBS into agriculture, urban planning, and DRR strategies, and use of GIS tools for monitoring impact. The lead actors could include all sectoral ministries, and the National Statistics Bureau.

NBS as a Pillar of Sudan's Resilient Future

NBS must be scaled up from pilot projects at the project level to mainstream pillars of Sudan's reconstruction and resilience effort. Reforestation, restoration of watersheds, agroforestry, and green infrastructure are not optional add-ons, they are vital tools for:

- reducing the root causes of conflict, such as land degradation and water scarcity.
- supporting displaced communities through employment and ecological restoration.
- enhancing urban resilience in cities vulnerable to heatwaves and flash floods.
- attaining SDGs and NDC ambitions, especially on land restoration and climate adaptation.

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BIOGRAPHY

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