

# Nature-based Solutions for Drought Resilience

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# Introduction

## **Drought is a critical issue with profound implications for global prosperity.**

Drought is responsible for more than 650,000 deaths in the last 50 years, contributing to climate-related economic damages of \$3.6 trillion, with widespread impacts on food and water security (Vigerstøl et al. 2023, WMO 2021, UNCCD 2022). 75% of the global population is likely to face water shortages by 2050 because of drought (UN, 2022).

## **Drought is a multidimensional hazard that is intertwined with environmental, socioeconomic and climatic factors.**

Drought is often perceived as a seasonal deficit in precipitation, that disrupts atmospheric and terrestrial water cycles. Its persistence escalates to community and ecosystems impacts, eroding resilience, productivity and health (Magero, et al., 2024, Vigerstøl et al. 2023). Drought impacts are particularly severe on human health, water and food systems, as demonstrated by the 2022–2023 drought in the Horn of Africa, where over 23 million people were faced with multi-year food and water insecurity crisis. Droughts impact ecosystems directly, reducing streamflow, causing wildfires and heatwaves, and indirectly, causing pests and diseases outbreaks (Vigerstøl et al. 2023).

## **Ecosystems that sustain water supplies and meet multiple needs in diverse landscapes are indispensable anchors for water security and building drought resilience.**

Aquifers and wetlands provide natural water storage, particularly in dynamic ecosystems like rangelands, grasslands and drylands. Conversely, climate change will have some of its most significant impacts on freshwater resources and dependent ecosystems. Freshwater species are experiencing some of the highest overall global population decline in the last 50 years, totaling over 83% loss of freshwater species populations, with a quarter of all freshwater species classified as threatened (Dudgeon & Strayer 2024; WWF, 2022; UN Water, 2020).

## **Healthy land is central to the wellbeing of the planet's ecosystems and biodiversity.**

Healthy land feeds, shelters, and provides the backbone to a thriving global economy. When land is degraded by drought, it loses its capacity to sustain life, and results in multidimensional socioeconomic and environmental consequences, including crop failure, migration and conflict among others (Magero, et al. 2024; Vigerstøl et al. 2023; UNCCD 2022).

## **Shifting attention to proactive drought resilience building is a sure path to achieving an integrated, cost-effective and comprehensive drought solution, that also addresses the triple planetary crisis.**

Integrated water and land resources management addresses droughts alongside other natural disasters, like floods and fire, and builds comprehensive solutions, both for water and land, rather than solely relying on reactive and siloed disaster-management interventions. Nature-based Solutions (NbS) play a critical role in proactive and multi-dimensional resilience building approaches.

# Nature-Based Solutions as a Foundation for Resilience Building

Nature-based Solutions (NbS) are defined as actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems that address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services, resilience and biodiversity benefits (UNEP, 2022).

The global goals on climate change, biodiversity and water security will not be reached without significant investment in NbS. NbS are critical to achieving drought resilience through their ability to buffer direct ecosystem impacts, deliver numerous co-benefits, and complement other drought resilience measures such as crop insurance, early warning systems, and traditional engineering solutions (Vigerstøl et al. 2023). Integrating NbS with commonly applied drought strategies including grey infrastructure offers a robust, adaptive approach for addressing water scarcity and land degradation (Figure 2). NbS works alongside grey infrastructure to ensure that short-term needs like soil stabilization and water storage are met, while restoring long-term ecosystem functions. (Magero et al. 2024; Browder, 2019; TNC, 2022). Figure 1 introduces types of NbS approaches that are relevant and that are already showing success building resilience in drought-prone environments and related sectors.

## Examples of NbS for drought resilience are already on the ground.

The [Greater Cape Town Water Fund](#) works to cost-effectively avoid losses of up to two months of water supply for the City of Cape Town with the removal of invasive vegetation and restoration of native vegetation.

The [Upper Tana - Nairobi Water Fund](#) works with more than 50,000 small-scale farmers in the Upper Tana Watershed using terracing, agroforestry and on-site water pans to increase resilience of on-farm water management and improve water quality for Nairobi's water supply.

Through a combination of headwaters protection, on-farm agricultural best practices, improved irrigation diversions, and innovative funding, collaborators in the [Verde River Watershed](#) are taking a multi-faceted approach to address increasing water scarcity threats.

In the Cantareira System, which provides a significant portion of São Paulo's water supply, nature-based solutions are working to address water scarcity and water quality issues. A recent report, [The Invisible Reservoir](#), explores how scaling of these solutions would have measurably reduced the impact of the city's 2018 drought.

# Nature-Based Solutions for Drought Resilience

Figure 1

Supporting healthy lands and waters can provide a foundation for drought resilience.

## Management

### Agricultural Best Management Practices

Using natural ecological and hydrological processes to increase yields, build soil health, and reduce runoff.



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### Aquifer Recharge

Increasing water infiltration into the aquifer by capturing and directing water towards high infiltration areas.



©Tim Calver

### Ranching Best Management Practices

Reducing soil compaction and enhancing aquifer infiltration through rotational grazing, silvopasture, and land treatment.



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### Forestry Best Management Practices

Improving water quality, terrestrial biodiversity, and reducing catastrophic fire risk, along with providing social and economic benefits.

## Restoration

### Native Revegetation

Restoring native habitat and reducing water use via active planting or removal of thirsty invasive species.



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### Wetland Restoration

Restoring the natural hydrology, vegetation, and soil structure of a degraded wetland ecosystem to enhance water storage and recharge groundwater supply.



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## Protection

### Natural Ecosystem Protection

Avoiding conversion and improving protection of existing forest, wetland, and grassland ecosystems to retain high infiltration, soil moisture, and to prevent future harm.



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### Floodplain and River Restoration

Restoring floodplain functions, including water retention capacity and soil nutrient replenishment, by reconnecting the floodplain to the river.

### Riparian Restoration

Improving the health of riparian areas through revegetation, lowering water temperatures, improving water quality, slowing down runoff, and reconnecting biological linkages between terrestrial and aquatic ecosystems.

# Challenges and Opportunities

Despite a growing body of evidence that demonstrates the cost-effective impacts of proactive NbS drought approaches, and the ability to deliver multiple co-benefits, there are barriers to adequately integrate and support these as a high-priority drought solutions (Peñailillo et al. 2022, Vigerstøl et al. 2023). These challenges cut across areas of planning and design, policy and governance, funding and finance and have multi-faceted root causes. However, there are tangible ways of addressing these challenges with clear opportunities to adopt and scale up NbS, and help drive resilience to drought in natural and built systems.

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## Common Challenges

Although NbS continues to grow as an important pathway for resilience building, breaking out of the mold of existing policies and systems to facilitate and incentivize NbS in planning processes and design still remains challenging. For example, government entities in many areas of the world involved in drought resilience planning typically **lack training or awareness of NbS**, particularly when compared with other solutions such as built infrastructure and early warning systems. NbS often **requires complementary work across sectors**, such as water utilities and agricultural ministries, to design and implement best practices in rural and urban areas to improve drought resilience across the same watershed. Finally, NbS often **requires operations at a watershed or landscape level**, involving collaboration with a broader group of stakeholders compared to more localized infrastructure solutions. The long-term success of NbS depend on engagement with local communities and agricultural groups, as well as groups representing women and indigenous peoples, who often play a critical role in land management. ([Stakeholder Engagement Guide, 2022](#))

Procurement of experts who can effectively select, design and implement NbS, as well as develop programs of governance or maintenance of NbS that may be required for its long-term success, can be a challenge for those who are more familiar with grey infrastructure-focused professionals. The Nature for Water Facility, launched in 2022, was borne out of the recognition of this lack of knowledge and experience, and today includes more than 20 engagements underway to help develop landscape-scale water security NbS programs. The swell of interest this group has seen over the last two years demonstrates the growing interest for NbS solutions and the persistent struggle to meet this demand.

Despite the growing and urgent need for investment in drought resilience, there is also a clear gap between the current level of funding and the ambition, to adequately fund resilience-building globally. Drought financing is minimal, with most resources directed toward emergency disaster response rather than proactive drought resilience-building. Only about 1% of funds from the Global Environment Facility and Green Climate Fund and 24%

of Adaptation Fund project financing target drought, despite growing investments by those facilities in countries (Magero et al. 2024). Funds directed towards NbS for water security are growing, but are still far below what is needed to maximize the opportunity. There are a few reasons for this. Drought impacts are poorly understood and documented, which makes estimation of costs and benefits difficult leave alone addressing the impacts. Certain investments such as in reforestation and land restoration take several years to mature, making it challenging to identify and assign financial or economic values to the interventions and co-benefits. Finally, NbS are sometimes considered as risky investments due to uncertain and difficult-to-quantify outcomes, long project timelines, and their vulnerability to climate change impacts.

## Key Opportunities

### Design

Despite these challenges, there are multiple opportunities for deeply integrating NbS into drought resilience efforts, and many clear advantages for doing so. NbS can be designed and planned alongside new grey infrastructure projects to enhance their effectiveness (Browder, 2019). For example, NbS practices like reforestation and the creation of vegetative buffers can reduce soil erosion and prevent excessive sediment from entering storage reservoirs designed for drought resilience, helping to maintain storage capacity and decreasing the need for expensive dredging (UNEP, 2014; Browder et al., 2019). NbS can also complement and enhance already-established traditional infrastructure and management systems. For example, there are extensive efforts in the Colorado River Basin to create and restore wetlands as part of NbS implementation, to capture, store, and filter runoff from rainfall and snowmelt while also acting as a buffer against flooding (Vigerstøl et al., 2023).

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AGRICULTURAL BMPs



ENHANCED AQUIFER RECHARGE



DAM/RESERVOIR

There are several publicly available reports, guides, tools, and frameworks that provide examples for planning, design and implementation of NbS and helpful approaches to assessing full costs and benefits of NbS for water security, and specifically drought resilience (see [Supporting Resources](#) below). With the scale-up of NbS across the globe for water security outcomes, there are established methodologies for modelling and case studies that can help provide the basis for drought resilience cost-benefit assessments, and that can be further developed to integrate elements of NbS.

# The future of drought resilience requires a proactive and integrated approach to infrastructure.

Figure 2

Nature-based Solutions

Grey Infrastructure and Management Solutions



**Investment**

Investing preventatively in integrated solutions would increase the return on investment, with the ability to deliver on a triple bottom line of avoided losses, social and environmental benefits, and economics benefits (Figure 3). Combined portfolios of NbS and grey infrastructure offer strong options for investors, providing in many cases some short-term outcomes, while aiming for sustainable longer-term impact. Additionally, as grey infrastructure declines over time, NbS can provide a complimentary solution and benefits that continue into the future. A blended portfolio of NbS solutions can deliver on a variety of primary and secondary benefits (or co-benefits), which can attract different types of funders and investors, including those who desire or require multiple outcomes for a single investment. This could include funders interested, for example, in carbon sequestration or biodiversity benefits, in addition to drought resilience building. Blended finance cushions the investments from short-term risk allowing the engagement of long-term investors.

**Policy**

Policies and changes in institutional processes play a critical role in supporting and incentivizing the integration of NbS into planning and design of drought responses. These may include legislations protecting riparian and floodplain areas, wetlands, headwaters and groundwater recharge zones, including the creation and sustainable management of protected and conserved areas; incentives for regenerative agriculture; regulations for wastewater reuse, artificial aquifer recharge; integration of drought risk management into national water plans and basin management plans; implementation of early-warning systems; water demand management; amendments to procurement laws to require consideration of, or place a premium on, NbS; amendments to impact assessments legislation to require consideration of NbS in combination with development alternatives and integrating the full costs and benefits of grey and green infrastructure into economic analyses; among others.

For example, in Peru and the U.S. state of California, policies passed in 2013 and 2016 incentivizing water utilities to invest in watershed protection and restoration as part of their water supply mandate (Coxon et al. 2021, Gammie et al. 2022, Cal. Legis. Assemb., 2016). Funding and investment organizations for water infrastructure and agricultural development programs, including Development Banks, are increasingly interested in incorporating NbS in their investments, in line with their commitments to increase their climate and biodiversity finance. Development Banks have a crucial role to play to provide financing for NbS. One option would be to invest up-front in supporting policy reforms that could accelerate uptake of NBS, where they can work with governments to develop bankable NbS drought projects and provide concessional lending, guarantees and grants



**Investments in drought resilience have a triple dividend. UNCCD 2023**



to support those investments and attract other finance sources, including private funds.

At the global level, there is a strong argument for protection and restoration of terrestrial and aquatic areas to provide biodiversity and ecosystem services, deal with water scarcity and build drought resilience. The Sustainable Development Goals (SDG, Target 15.3) under Agenda 2030, the Global Biodiversity Framework (Target 8) under the Convention on Biological Diversity, and the Global Goal on Adaptation (Targets 'a' and 'd') under the UN Framework Convention on Climate Change, provide perspective on this, in addition to being embedded throughout the UNCCD Strategic Framework 2018-2030. The Freshwater Challenge (FWC) is a good example of a country-led, multistakeholder initiative aimed at accelerating the adoption of robust national freshwater ecosystem protection and restoration targets and policy measures, and including them into national climate, biodiversity and sustainable development plans, as well as future implementation. The FWC may play a key role not only in building drought resilience in member countries, but also support the UNCCD implementation, including through new or updated land degradation neutrality (LDN) targets.

As the UNCCD considers the adoption of a Global Framework on Drought Resilience at COP16, it is an opportune time to promote the integration of NbS into the convention's implementation processes at all levels. Nature offers proactive drought resilience strategies that can create links across global commitments on planetary health, and drive a concerted approach for addressing climate change, biodiversity loss, and land desertification and drought (Vigerstøl et al., 2023). The future drought response framework(s), should strongly consider integrating NbS implementation across the above-referenced international agreements and agendas, and create ease for integrated monitoring and reporting, so that countries can efficiently develop and implement drought resilience plans. The framework should also explicitly include freshwater and terrestrial ecosystems protection and restoration as drought resilience strategies, especially wetlands and other natural features and functions that enhance hydrologic retention capacity and nature's resilience. Lastly, the framework should consider the harmful effects of drought on nature and include strategies to prevent drought from exacerbating the biodiversity crisis.



# The Way Forward

As drought risks accelerate across the globe, a major shift is needed towards a proactive, multi-hazard resilience-building focused investments approach, that reduces risk and exposure, and delivers social, economic and biodiversity benefits. System transformation in drought management requires proactive, integrated and innovative solutions across the entire drought management cycle. Some of key recommendations that can support proactive NbS drought approaches include:



**Promoting the adoption of drought policies that include proactive and multi-hazard responses, including NbS, as a way of building cross-sectoral coherence and driving innovative solutions.** NbS should be included in local, national, transboundary, regional, and global drought management policy frameworks to ensure integration with the assessment, planning, management and monitoring processes of drought management. The promotion of cross-sectoral policy coherence and linking drought-related sectors, including water, forestry, agriculture, infrastructure, climate and biodiversity, among others, will strengthen coordination, avoid negative externalities, and provide incentives for NbS.

**Scaling up innovative and accessible drought finance for NbS through public and private sector investments.** Financing and funding assessment frameworks, including those for disaster management, climate change, biodiversity, and ecosystem restoration, need to consider the inclusion of drought as a nature-related risk for projects and incentivize the adoption of NbS. Innovations, including go-to-market solutions for drought, should be harnessed and developed to grow private investments in drought management. This could include building collaboration through public-private-partnerships, that promotes assessment, derisking and redirecting financial flows towards NbS drought approaches (Vigerstøl 2023; UNCCD 2023).

**Promoting the adoption of integrated ecosystem-based approaches that address drought and other natural disasters, while providing environmental and socioeconomic gains.** Integrated water management, ecosystem protection and restoration, payment-for-ecosystem-services, agroecology, and regenerative food production are among nature-based solutions contributing to healthy lands and waters, which build on the triple dividend approach of avoiding future losses, reducing drought risk and providing co-benefits, including human health, food and water security, among others (Magero et al. 2024; Vigerstøl 2023; UNCCD 2023).

**Integrated drought solutions should recognize and engage all stakeholders.** Because of the crucial roles played by local communities, women, indigenous peoples, and other stakeholders in land management, drought approaches must therefore ensure that their rights are recognized and upheld as the beneficiaries, and the primary agents of change, and that they are meaningfully engaged in any change process (Magero et al. 2024, Vigerstøl et al. 2023).

# Supporting Resources

## General Resources on NbS & Drought Resilience

- [Accelerating Adaptation: The promise and limitations of Nature-based Solutions in the race to adapt to increasing floods and droughts](#) (TNC)  
- Provides in-depth descriptions and case studies of NbS, including trade-offs and synergies of NbS for drought and flood mitigation.
- [The Nature-Based Solutions Opportunity Scan](#) (GFDRR, WB) - A tool designed for World Bank operations to identify investment opportunities in NbS to reduce disaster risk and to build climate resilience.
- [Financing Nature for Water Security](#) (TNC) - Provides guidance on designing, implementing, and financing NbS investment programs for water security outcomes. Outlines a development process and case studies on watershed investment.
- [Nature-based Solutions to mitigate impacts of droughts](#) (Deltares, IDMP & IUCN) - Outlines enabling conditions to design, implement and upscale NBS for drought resilience as well as case studies.

## Design & Planning Resources

- [Planning for Drought: Moving from Crisis to Risk Management](#) - Outlines a 10-step drought planning process with emphasis on risk assessment and mitigation actions.
- [Integrating Green and Gray: Creating Next Generation Infrastructure](#) (WB, WRI) - Guide for developing country service provides to integrate nature into infrastructure. Includes case-studies for green infrastructure in project processes and investments.
- [Building Community Resilience with Nature-Based Solutions: A Guide for Local Communities](#) (FEMA)  
- Guide for communities to implement nature-based solutions for natural hazards, covering planning, funding, implementation, and more.
- [Preliminary Analysis of the National Drought Plans](#) (UNCCD) - Analyzes 35 national drought plans, discusses proactive vs. reactive mitigation strategies, and addresses issues of gender in drought.
- [Green Infrastructure Guide for Water Management: Ecosystem-based management approaches for water-related infrastructure projects](#) (UNEP, IUCN, TNC) - Provides overview of green infrastructure solutions and benefits, and methodology for options assessment of green and grey investments.
- [Assessing the Benefits and Costs of Nature-Based Solutions for Climate Resilience: A Guideline for Project Developers](#) (WB, GFDRR) - Guide covering how to evaluate NbS costs and benefits, NbS decision framework, and case studies.
- [Stakeholder Engagement Guide For Nature-Based Solutions](#) (PI, CEO WM) - Guide presenting general principles and best practices for all stages of an NbS project, as well as outlining specific steps for incorporating stakeholder engagement throughout NbS project stages

## Funding & Finance Resources

- [Investing in Resilience](#) (UNCCD) – Details the Triple Dividend from investing in drought resilience and innovative finance for drought resilience. Provides actions for governments and development partners to finance drought resilience.
- [The Economics of Resilience to Drought](#) (USAID) – Case study of cost savings from proactive drought response in the Horn of Africa.
- [Pathways to Unblocking Financing for Nature-based Solutions](#) (WRI) – Discusses barriers to scaling NbS projects in Mexico. Provides stakeholder perspectives and interviews.
- [Investing in nature-based solutions](#) (EIB, EC) – Assesses the deployment of NbS in Europe and provides recommendations to increase support for NbS.
- [Toolbox on Financing Nature-Based Solutions](#) (CPI) – Details 12 case studies showcasing key tools for scaling investment in NbS.

## Example Funding & Finance Programs

- The [NBS Invest project](#) aims to increase funding and mainstream Nature-Based Solutions (NBS) into climate mitigation and adaptation projects in the world's Least Developed Countries (LDCs) [World Bank, GEF].
- The [Future Drought Fund](#) provides secure, continuous funding for drought resilience initiatives. It is helping Australian farmers and communities prepare for the impacts of drought [Australian Govt].
  - The [Green Climate Fund](#) provides flexible financing solutions and climate investment expertise to accelerate transformative climate action in developing countries.
    - The [Adaptation Fund](#) finances projects and programs that help vulnerable communities in developing countries adapt to climate change.



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