Managing green water for healthy rangelands and sustainable pastoral futures: A Call to Action

IYRP Global Alliance Working Group on Pastoralism and Water

GLOBAL ALLIANCE FOR RANGELANDS & PASTORALISTS

Green water - the rainfall captured and stored in soils and used by vegetation - is the hidden foundation of healthy rangelands, resilient pastoral livelihoods and sustainable water futures.

A Call to Action

Active management of green water in rangelands is essential for maintaining ecosystem health and resilience, safeguarding water and food security, and sustaining pastoral livelihoods under a changing climate. This includes recognizing rangelands, which cover 50% of our planet's land surface, as critical water-producing landscapes, valuing the ecosystem services provided by rangelands, and aligning incentives so that restoration and sustainable grazing are financially and institutionally supported. To realize this, we call on:

- National governments and regional bodies to recognize green water, as well as pastoral tenure and mobility rights, in policies and planning instruments related to rangeland, water, climate, livestock and agriculture. This recognition will then support integrated plant–soil–water management and restoration at the landscape scale.
- Financing institutions to prioritize investments in green water management solutions that enhance soil health, infiltration, soil moisture retention and soil carbon storage in rangelands. Ensure that climate and biodiversity finance instruments reward pastoral and community-led practices for green water that enhance soil health, infiltration, soil moisture retention and soil carbon storage in rangelands.
- Research organizations and universities to co-produce knowledge with pastoral communities, combining traditional knowledge with scientific research and local indicators of rangeland health, and make results accessible through tools and training.
- Pastoral organizations, civil society and local authorities to promote pastoral knowledge and innovations that regulate grazing, resting periods and access to water in ways that sustain green water and other ecosystem services. In combination with monitoring of rangeland health and water resources, this will support adaptive rangeland management.

If collectively pursued, these actions can contribute to protecting and restoring rangelands and the green water resources that underpin pastoral livelihoods and food systems. This Call to Action recognizes that while technical interventions to improve soil and water conditions are essential, their effectiveness depends on broader contexts – including markets, governance, gender equality, conflict dynamics and infrastructure – that shape how pastoralists and farmers can manage their lands. Managing green water is a cornerstone of sustainable pastoral futures and global water security.

Introduction

Healthy rangelands and pastoral livelihoods hinge on rainfall that infiltrates the soil and that is retained as soil moisture. This "green water" underpins soil health, vegetation productivity that sustains livestock and wildlife, biodiversity, climate regulation and, ultimately, the food security, livelihoods, and cultures of (agro)pastoral peoples who rely on and manage these rangelands.

Soil degradation and loss of plant cover reduce infiltration of water into the soil, thereby increasing surface runoff and erosion, and diminishing soil moisture and groundwater recharge. Up until now, much of the policy work related to water, rangelands, and pastoralists has focused on "blue water", i.e., the visible and divertible water stored in aquifers, rivers, lakes and reservoirs. Yet even the availability and quality of this blue water critically depend on how rainfall is intercepted, infiltrated, stored in soils and taken up by vegetation, as well as on how land users manage green water, based on e.g., market opportunities, governance, mobility rights, gender relations and access to infrastructure and services.

We therefore call on all those working in and with rangelands and pastoral areas to recognize the fundamental role of green water in shaping healthy rangeland ecosystems and sustainable pastoral futures. Active management of green water is essential for maintaining ecosystem health, strengthening water and food security, enabling sustainable blue water development, and sustaining pastoral livelihoods and cultures.

Background

Green and blue water cycles are inextricably interconnected through the hydrological cycle. Green water is the fraction of rainfall that infiltrates into the soil and is stored as soil moisture and taken up by plants. Across the world's rangelands, vegetation productivity largely depends on this soil moisture, which in turn is shaped by soil structure, organic matter, vegetation cover and land use. When rangelands become degraded, a greater share of rainfall flows as surface runoff, increasing the risk of erosion and flooding and reducing water quality, rather than replenishing soil moisture and groundwater. Globally, there are growing concerns about transgressing the freshwater planetary boundary, which now includes both blue and green water. Shifts in soil moisture and evapotranspiration patterns risk destabilizing ecosystem functioning as well as local and regional climate systems.

Managing the soil-plant-water nexus in rangelands for resilient pastoral systems. Pastoral systems are highly dependent on green water because the forage base for livestock is almost entirely rainfed. Across many rangeland regions, declining vegetation cover and soil degradation are reducing the ability of soils to capture rainfall and retain moisture, leading to lower soil moisture, reduced forage productivity, and increased vulnerability to drought and climate extremes. Managing the plant–soil–water nexus is therefore critical for sustaining healthy rangelands, pastoral livelihoods and climate resilience. Where soils are healthy, well-structured and rich in organic matter, more water can infiltrate into the soil, replenishing soil moisture and contributing to the recharge of groundwater that sustains and feeds wells, springs, and dry-season flow in

streams. On the contrary, where soils are bare, crusted, or compacted, a greater share of rainfall flows more rapidly as surface runoff, increasing erosion and flooding risks while reducing groundwater recharge, thereby shortening the period during which wells, boreholes, and streams provide water during the dry season. These outcomes are "not inevitable," but strongly shaped by policy, markets and social choices that can either constrain or enable adaptive pastoral strategies.

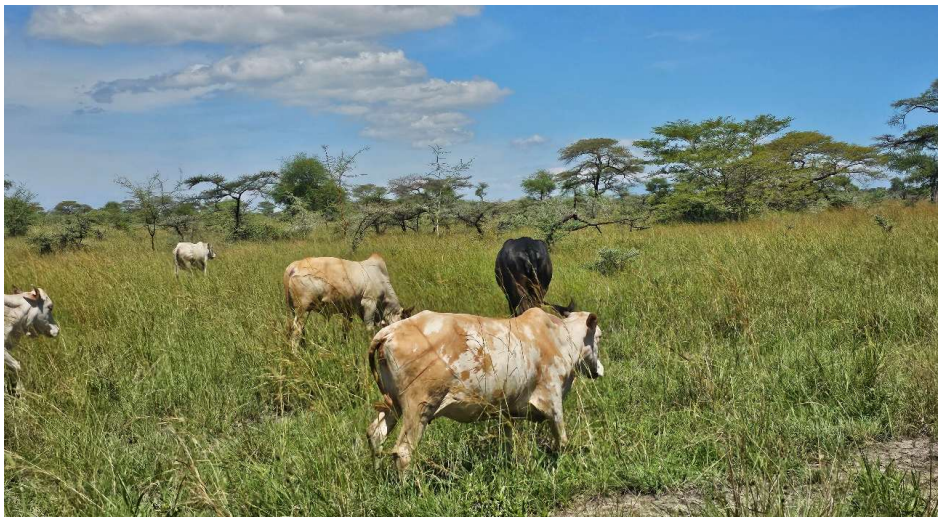
Herbaceous and woody vegetation both influence the hydrological cycle in rangelands. Research shows that a healthy herbaceous cover plays a crucial role in protecting soils from erosion, enhancing infiltration and retaining soil moisture. Scattered trees at low to intermediate densities can further support soil infiltration and moisture retention through organic matter inputs, shading and microclimate improvement, and root and soil fauna activity. However, high tree densities and bush encroachment can increase evapotranspiration and water use beyond local recharge levels. The challenge is therefore to maintain vegetation structures that maximize total water benefits for both people and ecosystems.

Land degradation, climate change and increasing human pressures are undermining the resilience and productivity of rangelands. Across many rangelands, fragmentation, land conversion and restrictions on pastoral mobility are increasing pressure on remaining grazing areas and undermining the ecological functioning of rangeland systems, including their capacity to store and cycle water. Fencing, settlements, cropland expansion, and large-scale mining and energy developments reduce access to grazing lands and livestock migration routes, concentrating livestock in smaller and often more vulnerable areas. This can lead to prolonged grazing pressure without adequate recovery periods, increasing trampling, soil compaction, and vegetation loss, further reducing rangelands' ability to retain soil moisture and regulate water flows. Climate change further intensifies these pressures through rising temperatures, higher evapotranspiration demand, and increasingly variable rainfall patterns. More frequent and intense hydroclimatic extreme events, such as meteorological droughts, heavy rainfall and flooding, challenge traditional grazing calendars and reduce the predictability of forage availability across spatial and temporal scales. Enhancing green water through rangeland restoration and improved soil health must be a central component of climate change adaptation in pastoral systems, as healthy soils with a high capacity to infiltrate and retain water are fundamental to buffering against hydroclimatic extreme events and ensuring water and food security. Sustaining resilient rangeland and pastoral livelihoods requires managing soils, grasses, forbs, shrubs and trees together as part of an interconnected plant–soil–water system that supports both green and blue water resources.

The enabling environment influences green water management. Effective green water management in rangelands depends not only on sound soil and water practices, but also on policies, institutions and economic incentives with impact on sustainable land management practices. Policy and legal frameworks that secure land tenure, ensure fair access to water, and recognize pastoral mobility rights are essential for land users' willingness to invest in long-term land and water stewardship. Social and power relations, such as gender norms and customary institutions and traditions, shape who can access land, water and decision-making spaces, but also whose knowledge, labor and benefits drive or constrain change. When markets function and prices for livestock and other products are fair and predictable, and when export demand is coupled with safeguards for rangeland health, pastoralists and farmers have stronger incentives to turn rainfall into productive transpiration. These opportunities are amplified by infrastructure such as roads, storage facilities and communication networks that reduce transaction costs, connect producers to markets and services, and make investments in sustainable, green water-positive practices economically viable.

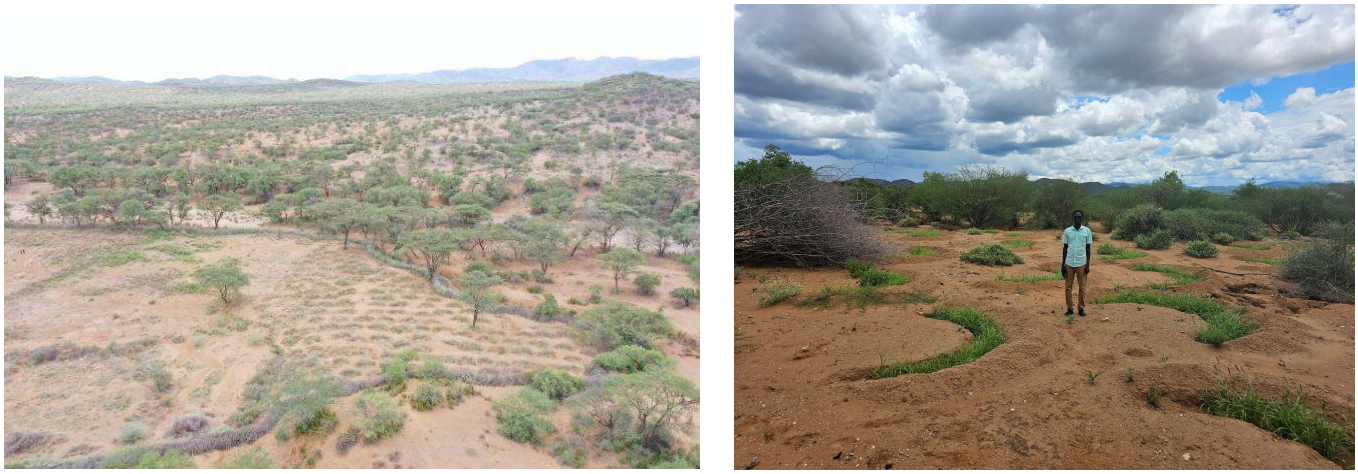
Green water solutions and innovations for resilient rangelands

Support pastoral systems that sustain green water. Pastoral mobility is a core green water management strategy that ensures adequate use and rest periods for key pastures. By moving herds across landscapes and seasons, pastoralists spread grazing pressure, avoid overuse of any single pasture, and allow vegetation and soils to recover. These practices include traditional grazing calendars, grazing capacity rules and penalties, rotational use of wet- and dry-season grazing areas and negotiated access arrangements. Supporting pastoral institutions, securing mobility corridors, and carefully planning blue water infrastructure in relation to seasonal grazing patterns and livestock mobility can greatly enhance the resilience of water resources. Mobility depends on secure corridors, negotiated access to land, peace and conflict resolution mechanisms, and cross-border agreements and trade arrangements that make mobility economically worthwhile.



Pastoral systems that sustain vegetation and soils also sustain the green water resources that underpin forage and livestock production. Napak District, Uganda. Photo credit: Aida Bargués Tobella (Restore4More).

Restore and manage soils and landscapes to capture and retain rainfall. At the local level, managing the plant–soil–water nexus is central to restoring degraded rangelands and improving green water availability. Practices include reseeding native herbaceous species, assisted natural regeneration, planting native trees, targeted control of woody encroachers, temporal exclosures, the establishment of micro-catchments and other water harvesting structures, and gully control measures. These interventions slow down runoff, promote infiltration, reduce erosion, and rebuild soil organic matter, thereby increasing the amount of water retained in soils and the time it remains available to plants. At the landscape scale, ecosystem-based approaches to green water management interventions can connect upstream and downstream communities while linking local practices with watershed management and policy planning. For long-term success in restoration, it is necessary to ensure that land users have secure rights and expect to gain benefits from their investments, there is economic value in higher productivity (e.g. access to markets, value chains), and support services (extension, finance, technology) are available. Participatory co-learning and knowledge-sharing initiatives can help land and water managers better understand how changes in vegetation and soil properties influence infiltration, soil moisture and groundwater recharge.



Half-moon water harvesting structures slow runoff, increase infiltration and soil moisture, and support vegetation recovery in degraded rangelands. Lokiriama, Turkana County, Kenya. Photo credit: Stephen Mureithi and Aida Bargués Tobella (Restore4More).

Embed green water management in governance and finance frameworks. Green water considerations need to be integrated into international and national water, land, climate and agricultural policies, planning instruments, and investment frameworks. Strengthening customary governance systems and local/pastoral institutions that regulate access, timing and intensity of grazing and water use is crucial for maintaining landscape-scale green water functions. Climate finance, payments for ecosystem services and blended finance mechanisms can be designed to incentivize and reward practices that increase infiltration, soil moisture and carbon storage in rangelands, thereby enhancing both green and blue water resources as well as the resilience of rangeland ecosystems. Local engagement in green water management should be strengthened by ensuring that climate and biodiversity finance reaches pastoral communities who manage rangelands, rather than only large-scale projects.

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