

Increasing aridification calls for urgent global adaptive solutions and policy action

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Standfirst:

Aridification threatens over 2.3 billion people by reshaping landscapes and increasing socio-economic vulnerabilities, demanding immediate policy actions and global cooperation to enhance resilience and develop transformative solutions.

Aridification is reshaping landscapes, diminishing water resources, and exacerbating socio-economic vulnerabilities across 40.6% of global lands (1). Affecting over 2.3 billion people, it threatens ecosystems, biodiversity, and livelihoods (2). To understand and address these challenges, we assess the future expansion of aridity, call for novel strategies to anticipate and manage critical thresholds, develop awareness and transformative land and water solutions, and enhance global cooperation. Immediate policy actions, financing, and an equitable governance framework are essential to ensure the resilience of social and ecological systems to aridification (3). Recently, aridification has garnered increasing attention in the international community (4). The United Nations Convention to Combat Desertification (UNCCD) emphasizes the need for comprehensive governance frameworks addressing both immediate and long-term aridification impacts. Currently, governance efforts are fragmented, with policies on drought, land degradation, and water management often uncoordinated. Many countries focus on short-term responses rather than adopting a comprehensive mix of proactive and prospective strategies. While proactive approaches anticipate and respond to impending risks, prospective strategies look at the emergence of new risks. Transitioning from responsive to proactive and prospective strategies calls for integrated approaches across landscapes. It also requires accounting for local capabilities and integrating traditional and indigenous knowledge with scientific advancements to foster effective and sustainable strategies that are both locally relevant and globally aligned.

Observed expansion of drylands and future projections of aridification are consistent with human-induced climate change (2, 3, 4). Future climate projections, particularly under high-emission scenarios such as the Shared Socio-Economic Pathways (SSP5), indicate further expansion of drylands in large regions. The global share of population living in drylands has increased from 22.5% in 1990 to 30.9% in 2020 and projections indicate that people living there could double by the end of the 21st century, reaching over 5 billion (SSP3) (4). Without significant mitigation efforts, aridification will have devastating impacts on global ecosystems and human societies (4, 5, 6).

Sustainable regional and sectoral land and water use and management necessitates developing aridity adaptation plans integrating local assessments, synergistic strategies, enabling conditions, and sustained monitoring efforts (Fig. 1). These strategies must be tailored to specific circumstances considering, e.g., food production, safe and sustainable drinking water, and governance. This also requires enhanced education, awareness programs, and community inclusion in decision-making, ensuring the scalability and social acceptability of these efforts.

Tensions and Lessons Drawn from Current Efforts

Aridification governance is fraught with tensions that largely mirror other global challenges where a major point of contention is the proper balance between global oversight and local autonomy. While centralized frameworks offer consistency and comprehensive oversight, they frequently clash with diverse local realities, priorities and knowledge systems. Tensions often lie in the prioritization of efforts — immediate, incremental adaptations *vs* transformative, long-term strategies. These tensions are further complicated by the highly varying capacities of different regions to successfully implement adaptation measures, with resource-limited areas often struggling to keep pace with the myriad of other livelihood demands.

Experience gained from governance frameworks applied to diverse environmental challenges highlights key lessons for aridification (7). Overlaps among the three Rio Conventions (UNCCD, UNFCCC, and CBD) underscore the need for integrated approaches to address the land-climate-biodiversity nexus. For example, land restoration efforts under the UNCCD can support climate mitigation under the UNFCCC but risk conflicting with biodiversity conservation goals under the CBD if not carefully aligned. Bridging these frameworks offers opportunities to harmonize actions and reduce redundancies. The importance of early and continuous engagement with impacted (and vulnerable) local communities cannot be overstated. Successful adaptation strategies often hinge on the integration of local and Indigenous knowledge and practices, which requires meaningful engagement well before the establishment of governance frameworks (8). The need for flexible, multi-scalar adaptive governance structures is clear. As aridification continues to evolve, governance frameworks must be able to adapt to new challenges and opportunities, ensuring that policies remain relevant and effective at multiple and overlapping scales. This adaptability will be critical as unexpected rates of change and feedback loops between aridification and other environmental factors, such as biodiversity loss and soil erosion, intensify (9). Finally, addressing the persistent gap between scientific research and policy implementation requires stronger collaboration between scientists, policymakers, and local communities to ensure solutions are evidence-based, culturally relevant, and scalable.

Adaptation Strategies

Large-Scale Adaptation

Adaptation to aridification must transition from incremental changes, such as improving water-use efficiency, to transformative actions that address the scale of the challenge across regions, landscapes, and watersheds. Initiatives like the Great Green Wall, the African-led effort to restore degraded landscapes, exemplify transformative adaptation but require significant investment, coordination, and coherence among funding mechanisms to avoid counterproductive outcomes (10). Sustainable sectoral strategies—such as drought-resistant crops and innovative water management techniques—are crucial for building resilience in both developed and developing regions. If coordinated appropriately and accounting for a plurality of knowledge systems, decision-making processes and scales, sectoral strategies can pave the way towards the necessary transformative adaptation that will be urgent in the face of the compounding and cascading effects of aridification. However, uncoordinated sectoral approaches do not necessarily constitute large-scale adaptation; instead, integrated and coherent problem-oriented strategies across sectors are needed to truly address the scale of the challenge.

Regional and Sectoral Adaptation

Successful adaptation interventions in agrifood systems include enhanced drought-resistant crops, livestock species, and grazing systems better suited for arid climates (e.g., goats, camels), sustainable water management, circular economy approaches, agroforestry, shelterbelts, and livelihood diversification to reduce dependency on vulnerable farming practices. More than just the technologies themselves, strategies for scaling up and ensuring their acceptability and feasibility among local communities must be prioritized.

Figure 1: Suggested key steps towards successful aridity adaptation planning

Improving soil health through sustainable farming practices can increase resilience to both drought and aridification (agroecological approaches can be particularly beneficial). Additionally, financial mechanisms must be streamlined, avoiding competition and ensuring that resources are focused on reducing aridification without conflicting agendas. This requires public-private partnerships and coherence among existing funding mechanisms to enhance support for these efforts. Innovative water management strategies, like rainwater harvesting and greywater reuse, are essential to enhance human water security in arid regions. These strategies should be paired with investments in adapted infrastructure, technology, and capacity-building, especially for vulnerable communities. Discussions on the sustainability of urbanization in arid lands are also necessary (11).

Empowering Communities and Enhancing Inclusivity

Limited access to education in many drylands perpetuates cycles of poverty and vulnerability, hindering communities' capacity to adapt to environmental challenges. Improving education opportunities, especially for girls and women, plays a transformative role in resilience-building and mitigating the adverse impacts of aridification. Women, despite constituting half of the global agricultural workforce, hold less than 20% of land ownership globally, significantly limiting their influence on sustainable land management and adaptation strategies. Yet, female farmers in drylands often lead in adopting modern irrigation techniques and infrastructure upgrades, demonstrating their pivotal role in addressing climate risks.

Advancing land rights for women and girls is essential to the success of large-scale adaptation strategies. Efforts must prioritize inclusivity and amplify marginalized voices, particularly women, in decision-making processes. Without addressing underlying structural inequalities, even the best-designed adaptation strategies will fall short (12). Programs that raise awareness, provide practical knowledge, and secure gender equality are critical to building sustainable resilience.

Enabling Conditions for Aridification Adaptation

Effective adaptation to both aridification and climate change requires robust vertical and horizontal governance frameworks capable of coordinating actions across sectors, scales, and borders. International collaboration, supported by flexible and appropriate financing mechanisms, is essential for addressing the global challenge of aridification (4, 1, 13). Leveraging the strengths of different regions, sectors, and knowledge systems—through public-private partnerships, local-global collaboration processes and multi-stakeholder collaborations—can help mobilize requisite resources and expertise.

International funding mechanisms, such as those provided by the Global Environment Facility (GEF) and Green Climate Fund (GCF), play a critical role in supporting adaptation efforts, particularly in vulnerable regions (14, 15). More innovative, public-private funding mechanisms are increasingly necessary as international agreements are difficult to enact and enforce, requiring agile responses to rapidly changing environmental conditions. Monitoring and reporting mechanisms are essential for tracking the evolution of aridity, the progress of adaptation efforts and ensuring accountability. Regular assessments can provide valuable insights into the effectiveness of adaptation strategies, enabling continuous improvement and informing future actions (16).

Framework for Action

Aridification is an escalating global challenge that requires immediate and sustained action. To effectively combat aridification, decisionmakers in policy and practice must adopt a comprehensive framework that integrates adaptation with broader climate, environmental and agricultural strategies. The UNCCD Conference of the Parties (COP) Decision 16 negotiated during the COP16 in Riyadh, Saudi Arabia in December 2024, (**ICCD/COP(16)/24/Add.1**), provides a robust foundation for such an integrated approach, emphasizing science-based aridity monitoring, cross-regional collaboration, and knowledge-sharing to support adaptation and mitigation efforts. Key recommendations include four categories:

1. Strengthen aridity monitoring:

Building on Decision 16/COP.16, which calls for integrating aridity information into existing drought monitoring and early warning systems, efforts should focus on developing comprehensive monitoring approaches that enhance forecasting and evaluation for land and water resources. Standardized, science-based aridity assessments should be implemented to identify critical ecological, environmental, and socio-economic thresholds, facilitating timely responses to water stress. Collaboration through systematic data-sharing and leveraging advanced technologies such as artificial intelligence for predictive analysis can significantly improve local and regional monitoring.

2. Adopt a global aridity impact framework:

In alignment with Decision 16/COP.16, particularly, developing science-based standards and guidelines for assessing the socio-economic and environmental impacts of aridification is essential. This framework should enable consistent cross-regional monitoring and analysis, support adaptation strategies that enhance resilience among vulnerable communities, and integrate Indigenous knowledge and grassroots innovations into monitoring and response mechanisms. Additionally, efforts should prioritize capacity-building initiatives to address aridity and drought impacts effectively.

3. Integrate aridity adaptation and drought planning:

Following the call in Decision 16/COP.16 to develop a supplement to the National Adaptation Plan (NAP) technical guidelines, national and regional strategies must consolidate aridity adaptation and drought planning. These efforts should actively involve local communities, ensuring participatory approaches that combine traditional knowledge with scientific methodologies. Establishing a robust monitoring framework for aridity-specific indicators will support sustainable adaptation efforts, backed by flexible funding mechanisms and innovative water conservation technologies.

4. Coordinate large-scale transformative solutions and local enabling capabilities:

In response to Decision 16/COP.16, which emphasize the need for comprehensive and integrative sustainable land and water management approaches, policymakers must develop governance mechanisms to evaluate the socio-environmental impacts of large-scale interventions, such as nature-based solutions and sustainable land management. Mobilizing international funding and fostering public-private partnerships will drive innovation in land-use and water management practices. Furthermore, ensuring equitable access to education and livelihood opportunities will strengthen local resilience and enhance adaptive capacities to combat the long-term effects of aridification.

We stress that the broader implementation of this framework should align with Decision 16/COP.16's broader call for action, which encourages coordinated efforts across multilateral agreements and collaborative initiatives, ensuring a systematic and synergistic approach to aridity and drought risk mitigation at local, national, and global levels.

Conclusion

Aridification is an escalating global challenge that requires immediate and sustained action. By understanding its impacts and implementing adaptive strategies, we can mitigate the insidious cascading effects of this phenomenon and protect vulnerable ecosystems and communities. Timely intervention is crucial, as the relentless advance of aridification threatens to displace millions, exacerbate global food and water crises, and heighten geopolitical tensions over dwindling natural resources. Policymakers, researchers, and global stakeholders must prioritize aridification adaptation within the broader context of climate change resilience. Prospective and proactive measures, supported by robust governance and international cooperation, are essential for ensuring a sustainable and resilient future in the face of increasing aridity. Without informed and timely intervention, the combined effects of aridification, climate change, and resource scarcity could trigger more severe humanitarian crises.

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Competing interests

The authors declare no competing interests.