

Prisms Drylands: Synthesising multiple disciplines, themes and management practices across Earth's drylands

Editorial

Cite this article: Eldridge DJ and Sala O (2025). Prisms Drylands: Synthesising multiple disciplines, themes and management practices across Earth's drylands. *Cambridge Prisms: Drylands*, 2, e1, 1–3
<https://doi.org/10.1017/dry.2024.3>

Received: 26 September 2024
Accepted: 27 September 2024

Corresponding author:

David J. Eldridge;
Email: d.eldridge@unsw.edu.au

David J. Eldridge¹  and Osvaldo Sala² 

¹School of Biological, Earth and Environmental Sciences, University of New South Wales, Sydney, NSW, Australia and
²Global Drylands Center, School of Life Sciences and School of Sustainability, Arizona State University, Phoenix, AZ, USA

Drylands are defined as areas where the ratio of precipitation to potential evapotranspiration (Aridity Index) is 0.65 or less. Drylands are critically important globally because they currently support about 38% of the global human population and occupy about 45% of Earth's terrestrial land surface (FAO, 2021). Ecosystem degradation currently occurs in about 15% of drylands and affects about 250 million people, mostly in the Global South. Many of these people are tied to pastoralism, so their well-being is closely linked to forage production. Drylands are geographically important and situated in particularly politically unstable parts of the world. The people are often marginalised, among the poorest, closely associated with natural and semi-natural systems, heavily dependent on primary production for their livelihoods, and are therefore susceptible to the vagaries of climate and global conflicts. Many drylands are also hotspots of human conflict, and this presents serious social and environmental challenges for governments. The majority of global studies based on the Aridity Index, a proxy for drylands, predict an increase in dryland extent by the end of the century (e.g., Polade et al., 2014), largely due to increased global warming (Feng et al., 2022). In some areas, however, the extent of drylands may decline due to predicted higher rainfall (Huang et al., 2016).

Drylands face a number of critical environmental, social and political challenges over the next century as we move to a hotter, drier world. Foremost among these challenges are climate change and climate variability. The IPCC predicts a greater frequency of extreme events (Foster et al., 2021), and an expansion in the area covered by drylands (Feng and Fu, 2013; Huang et al., 2016), but this will likely lead to reductions in the extent of temperate drylands (Schlaepfer et al., 2017). Attendant issues associated with greater climate variability are reductions in primary production, reduced crop yields and lower livestock production, resulting in potential threats to human livelihoods and pastoral production (Gherardi and Sala, 2015; Ndlovu et al., 2022).

Land degradation and in extreme cases, desertification (aridification) caused by changing climates and exacerbated by human-induced land use change, pose greater challenges to drylands than other biomes. Recent studies indicate that 6% of dryland areas, mostly in western Asia and South America, have undergone some type of degradation since 1982 (Burrell et al., 2020). An additional 20% of dryland areas risk future degradation due to unsustainable land use practices and human-induced climate change (Burrell et al., 2020). Thus, land degradation has not only direct effects, but there will likely be legacy effects on ecosystem production (Bunting et al., 2017) and soil-geomorphic processes (Monger et al., 2015) that impact peoples and their ability to produce food and survive in dryland areas.

Water and food insecurity are critical challenges of drylands under regimes of spatially and temporally variable precipitation (Feng and Fu, 2013). Water insecurity is exacerbated by poor water management (Stroosnijder et al., 2012; Wang et al., 2022), such as overexploitation of water resources, unsustainable irrigation practices and changes in water supply delivery mechanisms and structures (Piemontese et al., 2024). Despite this, significant progress has been made in developing land management practices in drylands that improve water use efficiency. These include more efficient storage, the use of wastewater, improved water harvesting techniques for smallholders (Oweis and Hachum, 2006) and improvements in precision agriculture (Arrúe et al., 2019).

Malnutrition and food insecurity are pervasive challenges in drylands where smallholders produce almost half of the world's food from rainfed crops and pastures (Squires and Gaur, 2020). Yet, food production policies have failed many smallholders, and supply is largely controlled by large corporations and agribusiness (Martinez-Valderrama et al., 2020). Food production in drylands will need to double to feed a growing population by 2050 (Dar and Laxmipathi Gowda, 2013). Food shortage will lead to price instability, which is exacerbated by a declining rural workforce (Nel and Hill, 2008), despite accelerating population growth in drylands (Kniveton et al., 2012; Spinoni et al., 2021). The challenges faced by policy makers and land administrators should not be underestimated. In Zimbabwe, for example, about 90% of the population is dependent on rain-fed agriculture (Uganai and Murwira, 2010).

© The Author(s), 2024. Published by Cambridge University Press. This is an Open Access article, distributed under the terms of the Creative Commons Attribution licence (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted re-use, distribution and reproduction, provided the original article is properly cited.

 Cambridge Prisms

 CAMBRIDGE UNIVERSITY PRESS

Malnutrition and lack of access to clean water and sanitation exacerbate the cycles of poverty and vulnerability in dryland communities.

New technologies will enhance the ability of pastoralists, ranchers and farmers to improve their management skills and their economic returns. For example, the Land Potential Knowledge System (Herrick et al., 2016) is a mobile phone-based system designed to help managers adopt sustainable land management practices across the world. Mobile phone connectivity and GPS technologies are available almost everywhere. In Burkina Faso, Fulbe pastoralists use mobile phone technology to access weather and forage status information (Rasmussen et al., 2015). Phone communication allows a more efficient selection of potential grazing land and can reduce the risk of encroaching on the grazing lands of neighbouring pastoralists (Asaka and Smucker, 2016). Mobile phones allow improved demographic surveillance of pastoral communities, which is critical for effective vaccination programs (Brinkel et al., 2014), and they provide useful information on livestock health and migration patterns (Jean-Richard et al., 2014). These and other technologies such as the use of low-cost drones to deliver vaccines to isolated locations (Griffith et al., 2023) can improve the well-being of pastoralists and even reverse migration trends towards large cities.

The demands placed on drylands are increasing rapidly, and despite an uncertain *future*, there are substantial opportunities and challenges (Coppock et al., 2017). The global transition to clean energy production often uses the ‘wasteland’ narrative to view drylands as areas to locate large-scale solar and wind farms for energy production, yet this may threaten potential pastoral livelihoods. Any changes that these developments bring to drylands will not be distributed evenly, with a range of opportunities that will vary among regions. New energy initiatives in drylands can potentially bring employment to dryland regions but may disrupt local communities. The outcome of these changes will depend on society’s ability to cope with these changes.

The future of drylands. There are reasons to worry about global drylands but there is hope through novel understanding and new technologies. Prisms Drylands aims to play a central role in supporting the understanding that will reverse negative trends and sustain the cultural and biological diversity of drylands. The multi-disciplinary nature of drylands, the nuances of environmental, social, political and structural complexity, and the huge global extent of drylands means that there is an increasing need for a truly interdisciplinary outlet for research, management and sociology of drylands; topics that are not well serviced by current scientific journals. Cambridge Prisms: *Drylands* aims to be a forum for rapid publication of cross-disciplinary science relating to the understanding and social challenges of dryland ecosystems. The future of drylands is full of opportunities in terms of changing people’s perception, new technologies and new demands for drylands.

We are excited about a new scientific journal dedicated to the world’s drylands. We welcome manuscripts based on observational, theoretical or experimental studies of terrestrial, marine or freshwater systems, provided they have a dryland focus. Emphasis will be placed on new contributions to theory, bodies of empirical knowledge, or the practice of drylands management that have potential regional or global impact. Manuscripts that integrate fundamental questions associated with how drylands function, their sustainable development, and how they relate to social-human systems are particularly welcome. Drylands also welcomes original open-access reviews, perspectives, editorials and comments.

References

- Arrúe JL, Álvaro-Fuentes J, Plaza-Bonilla D, Villegas D and Cantero-Martínez C (2019) Managing drylands for sustainable agriculture. In Farooq M and Pisante M (eds.), *Innovations in Sustainable Agriculture*. Champ: Springer. https://doi.org/10.1007/978-3-030-23169-9_17.
- Asaka JO and Smucker TA (2016) Assessing the role of mobile phone communication in drought-related mobility patterns of Samburu pastoralists. *Journal of Arid Environments* 128, 12–16.
- Brinkel J, Krämer A, Krumkamp R, May J and Fobil J (2014) Mobile phone-based mHealth approaches for public health surveillance in sub-Saharan Africa: A systematic review. *International Journal of Environmental Research and Public Health* 11, 11559–11582.
- Bunting EL, Munson SM and Villarreal ML (2017) Climate legacy and lag effects on dryland plant communities in the southwestern U.S. *Ecological Indicators* 74, 216–229.
- Burrell AL, Evans JP and De Kauwe MG (2020) Anthropogenic climate change has driven over 5 million km² of drylands towards desertification. *Nature Communications* 11, 3853. <https://doi.org/10.1038/s41467-020-17710-7>.
- Coppock DL, Fernandez-Gimenez M, Hiernaux P, Huber-Sannwald E, Schloeder C, Valdivia C, Arredondo JT, Jacobs M, Turin C, Turner M (2017) Rangeland systems in developing nations: Conceptual advances and societal implications. In Briske D (ed.), *Rangeland Systems*. Springer Series on Environmental Management. Cham: Springer. https://doi.org/10.1007/978-3-319-46709-2_17.
- Dar WD and Laxmipathi Gowda CL (2013) Declining agricultural productivity and global food security. *Journal of Crop Improvement* 27, 242–254.
- FAO (2021) *Drylands: Key Facts and Statistics*. Rome: Food and Agriculture Organization of the United Nations.
- Feng S and Fu Q (2013) Expansion of global drylands under a warming climate. *Atmospheric Chemistry and Physics* 13, 10081–10094.
- Feng S, Gu X, Luo S, Liu R, Gulakhmadov A, Slater LJ, Li J and Zhang X (2022) Greenhouse gas emissions drive global dryland expansion but not spatial patterns of change in aridification. *Journal of Climate* 35, 6501–6517. <https://doi.org/10.1175/JCLI-D-22-0103.1>.
- Foster J, Smallcombe JW, Hodder S, Jay O, Flouris AD, Nybo L and Havenith G (2021) An advanced empirical model for quantifying the impact of heat and climate change on human physical work capacity. *International Journal of Biometeorology* 65, 1215–29.
- Gherardi L and Sala OE (2015) Enhanced precipitation variability decreases grass- and increases shrub-productivity. *Proceedings of National Academy of Sciences* 112, 12735–12740.
- Griffith EF, Schurer JM, Mawindo B, Kwibuka R, Turibyarive T and Amuguni JH (2023) The use of drones to deliver Rift Valley fever vaccines in Rwanda: Perceptions and recommendations. *Vaccine* 11, 605. <http://doi.org/10.3390/vaccines11030605>.
- Herrick JE, Beh A, Barrios E, Bouvier I, Coetzee M, Dent D, Elias E, Hengl T, Karl JW, Liniger H, Matuszak J, Neff JC, Ndungu LW, Obersteiner M, Shepherd KD, Urama KC, Bosch R and Webb NP (2016) The land-potential knowledge system (LandPKS): Mobile apps and collaboration for optimizing climate change investments. *Ecosystem Health and Sustainability* 2, e01209. <http://doi.org/10.1002/ehs2.1209>.
- Huang J, Yu H, Guan X, Wang G and Guo R (2016) Accelerated dryland expansion under climate change. *Nature Climate Change* 6, 166–171.
- Jean-Richard V, Crump L, Moto Daugla D, Hattendorf J, Schelling E and Zinsstag J (2014) The use of mobile phones for demographic surveillance of mobile pastoralists and their animals in Chad: Proof of principle. *Global Health Action* 7, 23209. <https://doi.org/10.3402/gha.v7.23209>.
- Kniveton DR, Smith CD and Black R (2012) Emerging migration flows in a changing climate in dryland Africa. *Nature Climate Change* 2, 444–447.
- Martinez-Valderrama J, Guirado E and Maestre FT (2020) Desertifying deserts. *Nature Sustainability* 3, 572–575.
- Monger C, Sala OE, Duniway MC, Goldfuss H, Meir IA, Poch RM, Throop HL and Vivoni ER (2015) Legacy effects in linked ecological–soil–geomorphic systems of drylands. *Frontiers in Ecology and the Environment* 13, 13–19.
- Ndlovu D, Begbie-Clench B, Hitchcock RK and Kelly M (2022) The Tshwa san of Zimbabwe—Land, livelihoods, and ethnicity. In Helliiker K, Chadambuka

- P and Matanzima J (eds.), *Livelihoods of Ethnic Minorities in Rural Zimbabwe*. Cham: Springer Geography. Springer. https://doi.org/10.1007/978-3-030-94800-9_2.
- Nel E and Hill T** (2008) Marginalisation and demographic change in the semi-arid Karoo, South Africa. *Journal of Arid Environments* **72**, 2264–2274.
- Oweis T and Hachum A** (2006) Water harvesting and supplemental irrigation for improved water productivity of dry farming systems in West Asia and North Africa. *Agricultural Water Management* **80**, 57–73.
- Piemontese L, Terzi S, Di Baldassarre G, Menestrey Schwieger DA, Castelli G and Bresci E** (2024) Over-reliance on water infrastructure can hinder climate resilience in pastoral drylands. *Nature Climate Change* **14**, 267–274.
- Polade S, Pierce DW, Cayan D, Gershunov A and Dettinger MD** (2014) The key role of dry days in changing regional climate and precipitation regimes. *Scientific Reports* **4**, 4364. <https://doi.org/10.1038/srep04364>.
- Rasmussen LV, Mertz O, Rasmussen K and Nieto H** (2015) Improving how meteorological information is used by pastoralists through adequate communication tools. *Journal of Arid Environments* **121**, 52–58.
- Schlaepfer DR, Bradford JB, Lauenroth WK, Munson SM, Tietjen B, Hall SA, Wilson SD, Duniway MC, Jia G, Pyke DA, Lkhagva A and Jamiyansharav K** (2017) Climate change reduces extent of temperate drylands and intensifies drought in deep soils. *Nature Communications* **8**, 14196. <https://doi.org/10.1038/ncomms14196>.
- Spinoni J, Barbosa P, Cherlet M, Forzieri G, McCormick N, Naumann G, Vogt JV and Dosio A** (2021) How will the progressive global increase of arid areas affect population and land-use in the 21st century? *Global and Planetary Change* **205**, 103597. <https://doi.org/10.1016/j.gloplacha.2021.103597>.
- Squires VR and Gaur MK** (2020) *Food Security and Land Use Change under Conditions of Climatic Variability*. Cham: Springer Nature, p. 355.
- Stroosnijder L, Moore D, Alharbi A, Argaman E, Biazin B and van den Elsen E** (2012) Improving water use efficiency in dryland. *Current Opinions in Environmental Sustainability* **4**, 497–506.
- Unganai LS and Murwira A** (2010) Challenges and opportunities for climate change adaptation among smallholder farmers in southeast Zimbabwe. *2nd International Conference on Climate, Sustainability and Development in Semi-arid Regions*, Ceará Convention Center, Fortaleza, August 16, 2010 (pp. 16–20).
- Wang L, Jiao W, MacBean N, Rulli MC, Manzoni S, Vico G and D’Odorico P** (2022) Dryland productivity under a changing climate. *Nature Climate Change* **12**, 981–994.