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Advancing Knowledge for Proactive Drought Planning and Enhancing Adaptive Management for Drought on Rangelands: Introduction to a Special Issue

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On the Ground

- Drought adversely affects land managers, ranching enterprises, and pastoral systems.
- As an ecological driver, drought historically shaped vegetation composition, structure, diversity, and productivity of rangelands leading to varying levels of resilience in these ecosystems.
- Drought influences risk management in decision making by rangeland managers, resulting in a renewed emphasis on the importance of *proactive* drought planning and adaptive management for drought with monitoring-informed decision making.

Keywords: drought, rangelands, adaptive management, proactive drought management, translating research, extension and outreach.

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Drought is a prolonged period of abnormally low rainfall that adversely affects vegetation growth and negatively impacts land managers, ranching enterprises, and pastoral systems. As an ecological driver, drought historically shaped vegetation composition, structure, diversity, and productivity of rangelands leading to varying levels of resilience in these ecosystems. As a result, drought must be a major consideration when rangeland managers are making risk management decisions. Ingrained memories from the Dust Bowl years of the 1930s, for example, have had long-term resonating effects on rangeland management, conservation program emphasis, and national policies on drought for agriculture.

In this special issue of *Rangelands,* articles provide the foundation for a renewed emphasis on the importance of *proactive* drought planning and adaptive management for drought with monitoring-informed decision making for rangelands. This renewed emphasis is needed given the economic effects—$210 billion of direct losses,[1] adjusted for inflation—from 16 droughts/heat waves in the United States between 1980 and 2011. Furthermore, additional billion-dollar droughts/heat waves in 2012–2015 cumulatively resulted in >$46 billion of direct losses.[2] Although these economic effects are staggering, they underrepresent the effects associated with indirect losses and non–billion-dollar droughts.[1]

Many rangeland managers continue to struggle with *proactive* drought planning, despite multiple generations of experience with ecological, economic, and social effects from previous droughts. These struggles can be attributed to the following:

1. The complexity of drought, because no two droughts are the same in terms of spatial extent, duration, or intensity;
2. Limited ability of drought prediction and reliable seasonal weather/climate forecasts to assist managers in drought monitoring, including onset of drought conditions and when recovery begins[3];
3. Drought policies are in place to provide livestock feed and financial assistance associated with drought declarations, which deemphasize the importance of *proactive* planning; and

4. Lack of knowledge transfer from one generation of managers to the next regarding "lessons learned."

In This Issue

Land managers in the western United States have been challenged since settlement to strategically and *proactively* plan for drought, mitigate adverse effects and/or adapt to changing conditions during a drought, and to recover from drought. Adaptive management by land managers is needed for drought on rangelands, where monitoring key information directly relevant to management objectives is used in a timely manner to adjust management (i.e., close the feedback loop for decision making). Given the rapid development of technology, the deeper understanding of global processes influencing drought patterns, and recent drought events, this special issue provides the latest information for rangeland resource managers to elevate the importance of proactive drought planning and prevalence of adaptive management using monitoring-informed decision making.

A diverse set of authors has risen to the challenge of providing a synthesis of contemporary, advanced knowledge on the importance of *proactive* drought planning and adaptive management for drought with monitoring-informed decision making for rangelands. Recent monitoring tools such as the Drought Risk Atlas for vegetation and Soil Moisture Active Passive (SMAP) for soil moisture are highlighted as well as adaptation strategies for drought including building adaptive capacity into a ranching operation, and matching livestock to the environment.

Looking Ahead

Translating Research: Accessible, Useful, and Useable

The predicted increase in drought severity, duration, and frequency[4,5] reinforces the need to translate and effectively deliver empirical findings to natural resource professionals, and agricultural producers in a timely manner. Ensuring drought information is accessible and useable to those making resource decisions, and facilitating communication between researchers and the users will increase the utility and functionality of decision support tools. Through these efforts, society can work together to adapt to drought and mitigate negative effects of drought on the structure, function, and productivity of rangeland ecosystems.

Traditional outlets for drought-related resources have been available through Cooperative Extension programs administered by land-grant universities and field-based Extension professionals since 1914. More recently, legislation has established national efforts through the National Drought Policy Act (1998),[6] and the National Drought Integrated System (NIDIS) Act (2006 and reauthorized in 2014) that strive to better inform and prepare land managers, and agricultural producers for drought.[7] These efforts include the development of drought early warning systems (DEWS; e.g., NIDIS drought monitor), and initiating the development of drought resilience plans. Additionally, the USDA announced the creation of Climate Hubs[i] in 2014, which are designed to deliver science-based weather and climate information to managers of working lands recognizing this delivery is founded on two-way communication. Hearing and understanding the information and decision tool needs of managers is a key element for Climate Hubs. The USDA Climate Hubs have seized the opportunity to work with their long-time partners, cooperative extension, to achieve the two-way communication, and ensure science-based information is accessible, useful, and useable.

Advancing Drought Science, Management, and Policy

As readers will learn, great strides have been made to develop drought decision tools, to better understand the effects of drought, and to learn how to adapt to the associated effects. This said, the rangeland and ecological scientific community has largely failed to coherently and/or systematically investigate pre-drought, drought, and post-drought recovery responses of plant and soils across rangeland ecosystems. The current hodgepodge of scientific findings often are short-term and small-plot experiments that do not quantify the grazing–drought interaction, and often are only in a single system. New global networks, such as Drought-Net,[ii] are investigating, in a coordinated experimental framework, mechanisms underlying sensitivity of rangeland ecosystems to drought and responses of these ecosystems following recovery (post-drought). Similar efforts are needed to address the grazing–drought interaction with actual grazers rather than simulated grazing using clipping or defoliation, as animal selectivity and grazing patterns during and after drought merit increased understanding.

Transferring of knowledge to other rangeland stewards, and *proactive* drought planning, which incorporates adaptive management using monitoring-informed information to assist decision making as a keystone element, will require much greater management–science collaboration.[8] Researchers also need to continue to enhance prediction capacity and develop more reliable seasonal weather/climate forecasts. This includes better understanding of the effects of drought and anticipated recovery of rangeland ecosystems from drought, and more specifically the grazing–drought interaction.

The importance of drought effects on rangelands, and the management of these lands for the production of provisioning, regulating, cultural, and supporting ecological services,[9] necessitates the renewed emphasis on the importance of *proactive* drought planning and adaptive management for drought with monitoring-informed decision making for rangelands with changing climate. It is our collective desire that this special issue of *Rangelands* will bring to the forefront recognition among researchers, decision and policymakers, and land managers to collaboratively enhance decision making for drought and rangelands.

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[i] For more on the USDA Climate Hubs see http://climatehubs.oce.usda.gov.

[ii] For more on Drought Net see http://drought-net.org/.

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