Lessons from California’s 2012–2016 Drought

Jay Lund, Dist.M.ASCE1; Josue Medellin-Azuara, M.ASCE2; John Durand3; and Kathleen Stone4

Abstract: California’s 5-year drought has ended, even as its aftermath lingers. From 2012–2016 much or all of California was under severe drought conditions, with greatly diminished precipitation, snowpack, and streamflow and higher temperatures. Water shortages to forests, aquatic ecosystems, hydroelectric power plants, rural drinking water supplies, agriculture, and cities caused billions of dollars in economic losses, killed millions of forest trees, brought several fish species closer to extinction, and caused inconvenience and some expense to millions of households and businesses. The drought also brought innovations and improvements in water management, some of which will better prepare California for future droughts. This paper summarizes the magnitude and impacts of the 2012–2016 California drought. The paper then reviews innovations arising from the drought in the larger historical context of California water, droughts, and management institutions, policies, infrastructure, and organization. The onset of drought is slow. The water stored in soils, slowly diminishing springs, reservoirs, and aquifers dampens the onset of drought. The duration of droughts in California can be long and uncertain, perhaps lasting years, decades, and even centuries, compared with hours to days for fires and floods or minutes for earthquakes (Stine 1994). Therefore, signaling the onset and end of drought can be messy. Drought onset is usually slow, varying in local intensity, with an uncertain and often varying duration. Like all forms of disaster, preparation greatly diminishes drought losses, and organization is central to effective preparation and response. For humans, the impacts of drought vary with economic, infrastructure, and institutional conditions, as well as the drought’s hydrologic characteristics. The economic effects of drought depend on the economy’s reliance on water and the extent of regional and global trade. Global economic connections greatly reduce the impacts of drought (Summer 2015; Lund 2016a). Global food trade largely eliminates the existential threats of drought to civilizations, and greatly eases drought’s economic and public health impacts. Infrastructure networks and institutions that store, move, and reallocate water flexibly also greatly reduce drought impacts (Lund 2016a). Regional hydrologic characteristics, such as large freshwater aquifers, can dampen drought effects.

However, actions taken to minimize the impact of drought for humans often further jeopardize vulnerable ecosystems and other environmental resources. California has arguably restructured its infrastructure and economy to accommodate droughts, but many of these actions have further altered habitats and streams in ways that harm native species, which once were well adapted to California’s droughts using once-vast habitats connected to snowmelt, springs, groundwater, and seasonal floodplains. Losses to native species populations during drought are often not recovered before the next drought.

1Professor, Dept. of Civil and Environmental Engineering, Univ. of California, Davis, CA 95616 (corresponding author). Email: jrlund@ucdavis.edu
2Acting Associate Professor, Environmental Systems Engineering, Univ. of California, Merced, CA 95343. Email: jmedellin-azuara@ucmerced.edu
3Assistant Research Scientist, Center for Watershed Sciences, Univ. of California, Davis, CA 95616. Email: jrdurand@ucdavis.edu
4Graduate Student, Dept. of Civil and Environmental Engineering, Univ. of California, Davis, CA 95616. Email: katstone@ucdavis.edu

Note. This manuscript was submitted on January 2, 2018; approved on April 24, 2018; published online on July 30, 2018. Discussion period open until December 30, 2018; separate discussions must be submitted for individual papers. This paper is part of the Journal of Water Resources Planning and Management, © ASCE, ISSN 0733-9496.