

HYDROCLIMATIC EXTREMES AS CHALLENGES FOR THE WATER MANAGEMENT COMMUNITY: LESSONS FROM OROVILLE DAM AND HURRICANE HARVEY

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PROBLEM STATEMENT. Record-breaking extreme storms were a hallmark of 2017 in the United States. An extremely wet winter on the West Coast and brutally damaging hurricane season in the U.S. Southeast and the Caribbean challenged communities and power-, water- and flood-management systems in ways that raised climate change concerns. Among the most severe were two periods of heavy precipitation and high runoff that exposed dangerous weaknesses in water management infrastructure and land use practices in California and Texas. In California, a record-breaking string of atmospheric river landfalls and remarkably wet winter conditions came close to causing a catastrophic failure of the emergency spillway at Oroville Dam (France et al. 2018; Abbott 2018; White et al. 2019) and less publicized concerns elsewhere (Holland et al. 2018; CNRFC 2017). In Texas, near record-doubling rainfall accumulations from Hurricane Harvey led to massive flooding (Blake and Zelinsky 2018) and dam safety challenges in Houston (Wax-Thibodeaux et al. 2017). We use these events as examples to ground the concept that attribution studies, with careful management-focused framing, can help water management better navigate such unprecedented extremes.

As members of the AMS Water Resources Committee, we and our contacts include government and academic researchers, and consulting and municipal engineers. We approached this topic by leveraging our collective experiences and expertise regarding the hydroclimatology, meteorology, and hydrology of these events and others like them. We reviewed post-assessment and media reports and had conversations with managers who worked to reduce risks and damages during these events. In this essay, we briefly describe each event, highlighting concerns water managers confronted, and then list some lessons those experiences offered about framing attribution studies to serve management needs.

CASE STUDY: OROVILLE DAM AND NEW DON PEDRO INCIDENTS. On 12 February 2017, the structural integrity of the main and emergency spillways at the Oroville Dam (the tallest dam in the United States) was compromised, prompting an evacuation of nearly 200,000 people in northern California. Although not headlining national news, other California reservoirs were facing similar challenges, including controlled flooding downstream of New Don Pedro Reservoir on the Tuolumne River. Events that led to these incidents involved both hydroclimatic extremes and water management decisions (CNRFC 2017; White et al. 2019), the details of which provide insights into how attribution studies can help water managers.

The series of events that led to Oroville's evacuation began with unusual warmth in October–December 2016, which resulted in high snowlines where larger than normal areas of the upstream catchment received rainfall rather than snowfall. For water managers, this early season snow drought (snowpack in the Sierra Nevada was well below normal by 1 January) was particularly concerning following the extremely dry and snow-poor conditions of the previous five years. Snow droughts confront water managers with a tension between maintaining empty space for flood-management purposes and desire to capture early-season

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