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Effects of human water management on California drought risk

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Contribution of human water management to the intensification or mitigation of hydrological drought over California is investigated using the PCR-GLOBWB hydrological model at 0.5˚ resolution for the period 1979-2014. We demonstrate that including water management in the modeling framework results in more accurate discharge representation. During the severe 2014 drought, water management alleviated the drought deficit by ∼50% in Southern California through reservoir operation during low flow periods. However, human water consumption (mostly irrigation) in the Central Valley increased drought duration and deficit by 50% and 50-100%, respectively. Return level analysis indicates that there is more than 50% chance that the probability of occurrence of an extreme 2014-magnitude drought event was at least doubled under the influence of human activities compared to natural variability. This impact is most significant over the San Joaquin Drainage basin with a 50% and 75% likelihood that the return period is more than 3.5 and 1.5 times larger, respectively, because of the human impact on drought. A detailed study of the relative attribution of different types of human activities (e.g., groundwater pumping, reservoir operation and irrigation) on changes in drought risk over California is conducted through a higher 10 km resolution simulation. This hydrological modeling, attribution and risk assessment framework is further extended to other drought-prone areas and major drought events in the contiguous U.S., including the 2006/2007 southeastern U.S. drought, the 2011 Texas-northern Mexico drought over the southern plains and the 2012 drought over the central Great Plains.