

Hydroclimatology of Southwestern Droughts

Michael Dettinger, U.S. Geological Survey, Scripps Institution of Oceanography, La Jolla, CA (mddettin@usgs.gov) and Gregory McCabe, U.S.G.S., Lakewood, CO

Drought in the southwestern U.S. arises from the confluence of a variety of regional to global climatic influences. The large-scale climatic underpinnings of Southwestern droughts, along with their global-to-regional scale influences on Southwestern precipitation, streamflow, baseflows, and ground-water levels, provide a basis for understanding and tracking the current drought. Historically, extended periods of Southwestern drought have been associated with ocean-atmosphere interactions in the Tropical and North Pacific Ocean basin, and in the North Atlantic. Pacific climate influences tend to steer storms and precipitation either into, or away from, the Southwest, and thus are particularly important controls on drought in this region. The net effect of the Pacific influences on year-to-year and decade-to-decade time scales is to spatially reorganize precipitation within western North America as a whole, but not to change the overall amount of precipitation delivered. Depending on the state of Pacific climate, the Southwest can be the beneficiary of this reorganization, or the loser. In contrast, North Atlantic influences, on decade-to-decade time scales, are associated with almost Northern Hemisphere-wide changes in midlatitude westerly winds and thus with the overall amount of precipitation delivered to western North America, yielding simultaneous droughts or wet periods over much of the western U.S. These influences of Pacific and North Atlantic variations on Southwestern drought are just regional aspects of the global reorganizations of precipitation associated with changes in the two ocean basins. Finally, recent analyses suggest that a third component of drought occurrence in the Southwest may parallel the 20th Century Northern Hemispheric warming trends, in a sense that is increasing the frequency of droughts in the Southwest and in the Northern Rockies.

On decadal time scales, the influences on Southwestern drought of these Pacific, North Atlantic, and Northern Hemispheric climatic variations can be separated from each other, in historical observations, because the variations are largely uncorrelated on that time scale. As the Pacific and North Atlantic influences vary—more or less independently—through the decades, their combination sometimes enhances and sometimes reduces the frequency of droughts in various parts of western North America. In particular, though, during epochs when both the Pacific and North Atlantic are positioned to contribute to drought in the Southwest, the results can be extremely deep, extensive, and prolonged droughts (i.e., in the 1950s). The present (1999-2003) Southwestern drought began during just such a confluence of drought influences (with onset in 1999 of a La Nina-like Pacific climate state following a transition in 1995 of the North Atlantic into a warm state), and thus the possibility of a severe prolonged drought currently exists. Such speculation, however, hinges on long-term continuation of that configuration of ocean climates and winter 2003 brought a partial reversal of both the Pacific and North Atlantic ocean climates, which provided some hope for relief but which already may be reverting back into the “drought” configuration.