Mountain snow and inland Pacific Northwest agriculture

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Much of the irrigation water that feeds Pacific Northwest agriculture originates as snowmelt. While human-made reservoirs provide some storage of spring snowmelt that can be released during the summer for consumptive use, reservoir storage is only a small fraction of the storage that snow provides in most basins. Consequently, anything that affects snow storage could have a profound effect on summer water supply and thus agricultural production.

Research has shown that year-to-year variations in many hydrologic variables are strongly influenced not just by total precipitation but also by seasonal temperatures. Statistical analysis establishes strong relationships between springtime temperature and: (1) timing of snowmelt, (2) amount of snow on the ground on a given date in spring, and (3) summer flow in unregulated (undammed) rivers. For example, in March 2004, the western United States experienced extremely warm conditions and record high rates of snowmelt.

IMPACT

Mountain snowpack is vital for irrigated crops in the inland Pacific Northwest. Predicted long-term warming trends may impact the timing of snowpack melt and consequently affect water storage, irrigation systems, and production costs in the region.

In addition, long-term trends of these variables also reflect long-term warming trends. For example, Figure 1 shows that most stream gauges with long enough records (since 1948) have seen a long-term reduction in the 25th percentile of lowest annual flows; the dry years are getting drier. Figure 2 compares April snowpack from high-resolution regional climate modeling for 1960 through 2009 (supported in part by REACCH) with observed trends for 1960 through 2002. (More recent data have not been analyzed.) Mountain areas generally see declines in spring snowpack except at higher elevations, which see the effects of warming later in the year.

Our data show springtime temperatures in the Pacific Northwest rose for awhile and then cooled again. The warming that produced the changes shown in Figures 1 and 2 was followed by cooler than average spring seasons in the past 5 years, which have also seen generally healthy snowpack (except 2013, a drought year).

Long term, scientists expect warming to resume and, with it, the reductions in spring snowpack and summer streamflow that were observed over the past 50 to 60 years.

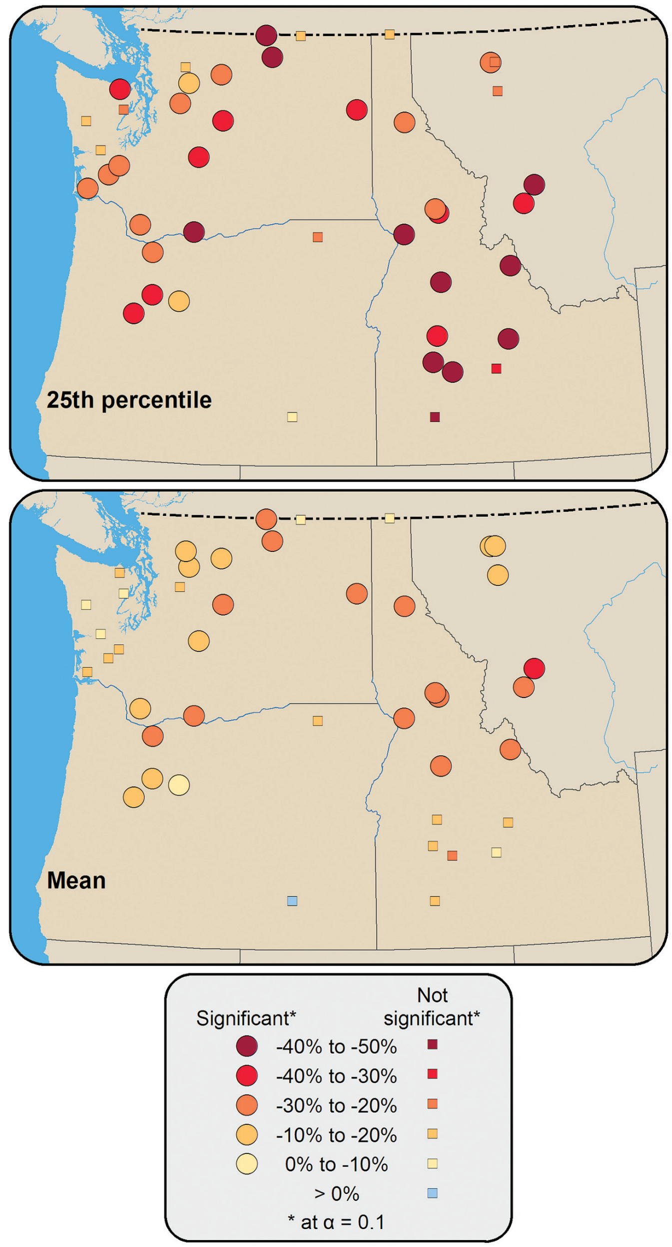

Figure 1. *These maps depict the changes in 25th percentile annual flow (top) and mean annual flow (bottom) at streamflow gauges across the Northwest for 1948–2006. Circles represent statistically significant trends (at α = 0.1), whereas squares represent locations where the trend was not statistically significant.*

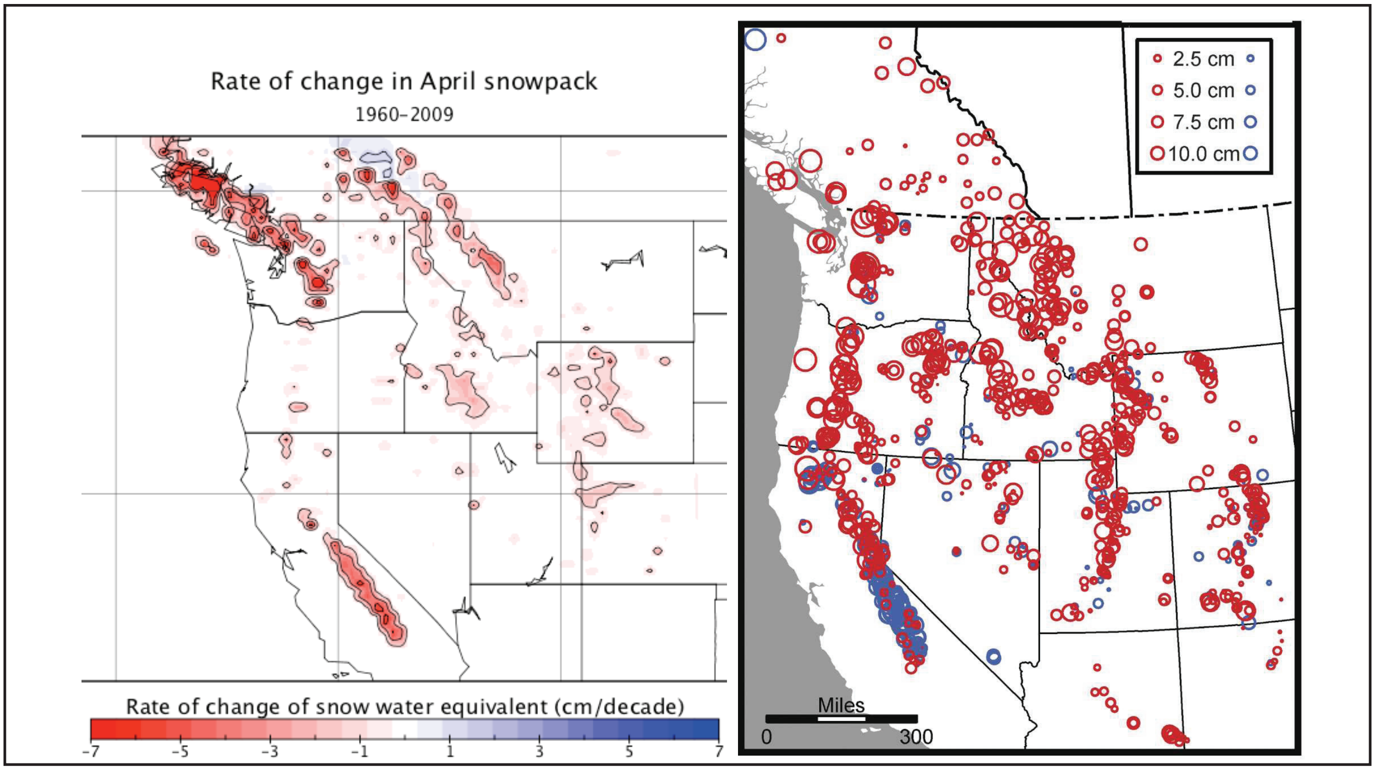

Figure 2. *Linear trends in snow water equivalent from: (1) the weatherathome simulations (1960–2009), averaged for the month of April, and (2) observations (1960–2002) for April 1. Red indicates declines and blue increases. Approximately 75% of the observations experienced declines, and most of the increases are in the southern Sierra Nevada mountains, where precipitation increased over the period shown here.*

Center pivot irrigation system. Photo by Sylvia Kantor.