Trends in Snowfall versus Rainfall in the Western United States

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This report documents a shift in precipitation form from snowfall to rainfall that occurred across the western U.S. between 1949 and 2004. The full report is available HERE. [Permission to place a copy of this work on this website has been provided by the AMS. The AMS does not guarantee that the copy provided here is an accurate copy of the published work.]

Highlights from the study and related work follow:

- Of 261 stations in the 11 western (contiguous) states, 74% showed a downward trend in the fraction of total precipitation falling as snow over the period 1949-2004.

- Daily minimum temperatures on days that had rain or snow warmed an average of 1.4 degrees Celsius over the same period.

- Sites that were, on average, colder warmed more than other sites. These colder sites tended to be at higher elevations.

- As a result, most sites that showed significant reduction in snowfall were those that experienced warmings of between 0 and 3 degrees Celsius. Sites that experienced warmings of more than 3 degrees Celsius tended to be cold enough, on average, that even the larger warmings had little impact on precipitation form (rain vs. snow).

- The amount of snowfall was reduced an average of 26 mm (in liquid equivalent, i.e. depth of snow if melted) due to temperature changes alone, while changes in total precipitation further reduced snowfall amounts by an average of 1 mm. The temperature changes were widespread and coherent, while the precipitation changes were confined to particular regions and were more muddled.

- Of the 26 mm reduction in snowfall attributable to temperature changes, a total of 18 mm occurred in January and March, the two months that exhibited the greatest warmings.

- Using a reconstruction to extend the analysis back to 1920, we found that while some portion of the trends in temperature and snowfall may be due to natural climate variability, a significant portion appears to be due to a longer-term warming trend, consistent with the predicted effects of climate change.

- A continued shift from snowfall to rainfall could increase the risk of winter flooding as more water enters streams instead of accumulating as snowpack. The resulting diminished snowpack would also reduce dry-season freshwater availability.

- While the effects of the shift from snow to rain have so far been seen mainly at sites that already have relatively thin snowpacks, the areas where the bulk of snowfall occurs (e.g., higher elevations) continue to warm, and in fact tend to be warming more quickly. If this warming continues, the effects documented here may be expected to manifest in these areas of heavier snowpack, resulting in significant and problematic changes in the West's freshwater supplies.

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