DUST DEPOSITION MELTS MOUNTAIN SNOWPACK

Dust concentration is measured in snow samples collected from a 30-centimeter-deep snow column; the samples are later melted, filtered, weighed and analyzed.

Dust settled on snow in the San Juan Mountains of southwestern Colorado, where a new study showed that dust deposition is causing snowpack to melt almost two months earlier.

Bottom: McKenzie Skiles, JPL Snow Optics Laboratory/UCLA; top: Center for Snow and Avalanche Studies

The deep, preserved ruts of the Oregon Trail, worn into rock by the passage of hundreds of thousands of wagon wheels, are a reminder of westward expansion, an important chapter in U.S. history. But they're also emblematic of something else: that the building of trails, roads, railroads — and the clearing, plowing, grazing and mining that followed — have led to unprecedented soil erosion, which has created vast amounts of dust. Now, scientists have found that dust is causing the Rocky Mountain snowpack to melt earlier, moving up the timing of peak runoff of the Colorado River, which affects vital sources of many Western water supplies.

In a two-part study published in Water Resources Research, McKenzie Skiles, a geography doctoral student at UCLA, and her colleagues examined spring snowmelt in an area of the San Juan Mountains of southwestern Colorado over a period of six years from 2005 to 2010. The team measured the amount of incoming and outgoing solar energy received at micrometeorological towers, as well as how much dust accumulated on the snowpack each winter.

The team then calculated the albedo, or reflectivity, of clean snow under the same conditions (dust increases the absorption of solar radiation and speeds melting). Finally, they modeled snowmelt and runoff under both clean and dusty conditions. "The difference between the modeled melt-out dates for these scenarios is the number of days that dust advances melt," says Skiles, who found that the increased dust load reduced the duration of snow cover by 25 to 51 days during spring, depending on the amount of dust loading.

In a related, earlier study in Proceedings of the National Academy of Sciences (PNAS), co-author Thomas Painter, a research scientist at the NASA Jet Propulsion Laboratory at Caltech and an adjunct professor of geography at UCLA, and his colleagues linked increased dust deposition to the earlier occurrence of peak runoff of the Colorado River by more than three weeks. In addition, dust caused a 5 percent reduction in runoff, which the authors of the PNAS study attributed to increased evapotranspiration from exposed, rather than snow-covered, vegetation and ground.

The researchers also factored into the model the predicted regional 2 to 4 degree Celsius warming that is expected under certain climate scenarios, which revealed that dust is a bigger driver of snowmelt than warming air temperatures.

"We investigated the impact from warming temperatures only during the spring melt season and found the additional impact from warming temperatures to be smaller than the dust forcing," Skiles says. "This, however, does not mean that warming temperatures do not impact snow cover."

Skiles says that although dust was found to be a larger driver of melting during the spring melt season, the warming would have a bigger impact during the accumulation season.

"As the climate warms, some of what would have been snowfall will instead be rainfall, so the snow-covered area would be smaller to begin with," she says. "This, combined with dust impacts in the spring, would contribute to the overall reduction of snow-covered area in the future in this region."

"The extra dust has an anthropogenic source, in that grazing and off-road activity have weakened the crust that normally would form on desert soils," says Jeff Dozier, a snow hydrologist at the University of California at Santa Barbara who was not involved in the study. "In some situations, therefore, human modification of the land surface significantly affects some aspects of the climate, especially the rate of snowmelt."

Dozier notes that "other mountain ranges worldwide, for example in Central Asia, probably also experience similar events when there are upwind sources of dust."

The authors say that understanding how dust impacts snow cover will help efforts to forecast runoff and manage water supplies in the arid West.

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