New study finds charred forests increase snowmelt rate

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A new Oregon State University study in the high Cascades documents how charred wood, bark and debris darkens the snow, lowers the reflectivity, and increases solar radiation, leading to more rapid snowmelt. Credit: Kathy Gleason, OSU

(Phys.org) —When a major wildfire destroys a large forested area in the seasonal snow zone, snow tends to accumulate at a greater level in the burned area than in adjacent forests. But a new study found that the snowpack melts much quicker in these charred areas, potentially changing the seasonal runoff pattern of rivers and streams.

The study by Oregon State University researchers, which was funded by the National Science Foundation, documented a 40 percent reduction of albedo – or reflectivity – of snow in the burned forest during snowmelt, and a 60 percent increase in solar radiation reaching the snow surface.

The reason, the researchers say, is that fires burn away the forest canopy and later, the charred tree snags shed burned particles onto the snow, lowering its reflectivity and causing it to absorb more solar radiation.

Results of the study were published this week in the journal *Geophysical Research Letters*.

"As the snow accumulates in the winter, you don't see much of a difference in albedo between a healthy, unburned forest and a charred forest," said Kelly Gleason, an OSU doctoral student in geography and lead author on the study. "But when the snow begins to melt in the spring, large amounts of charred debris are left behind, darkening the snow to a surprising extent."

In the study site, at an elevation of nearly 5,000 feet in the Oregon High Cascades near the headwaters of the McKenzie River, the researchers founded that the snowpack in the charred forest disappeared 23 days earlier and had twice the "ablation" or melting rate than an adjacent unburned forest in the same watershed.

Burned debris from forest fires darkens the snow, decreases the reflectivity, and increases solar radiation - leading to more rapid snowmelt, according to an Oregon State University study. Credit: Kathy Gleason, Oregon State University

Anne Nolin, who is Gleason's major professor and a co-author on the study, said the researchers have not yet examined the hydrological effect of this earlier melting, but "logic suggests that it would contribute to what already is a problem under climate change – earlier seasonal runoff of winter snow."

"The impact of these charred particles is significant," said Nolin, a professor in OSU's College of Earth, Ocean, and Atmospheric Sciences. "They are really dark – much darker than the needles, lichens and other naturally occurring materials that fall in a healthy, unburned forest.

"We know that the shedding of the charred particles lasts at least two years – and it might extend as long as eight to 10 years before the trees fall," she added. "It has a major impact on snowmelt that hasn't fully been appreciated."

The problem may be compounded in the future as climate change is expected to significantly increase the occurrence of wildfires in the western United States – and perhaps beyond.

"Most of the precipitation in the mountains of the western U.S. falls as snow and the accumulated snowpack acts as kind of a winter reservoir, holding back water until summer when the highest demand for it occurs," Gleason pointed out. "Our findings could help resource managers better anticipate the availability of water in areas that have been affected by severe forest fires."

Such areas are increasingly plentiful, according to Nolin. The OSU researchers conducted a spatial analysis of major forest fires from 2000 to 2012 and found that more than 80 percent of those fires in the western U.S. were in the seasonal snow zone, and were on average 4.4 times larger than fires outside the seasonal snow zone. Nearly half of those major fires were within the Columbia River basin, especially in Idaho and the northern Rockey Mountains.

Other areas are affected as well, including the southern Oregon/northern California mountain regions, and the high country of Arizona and New Mexico. The amount of burned area since 2000 that the OSU researchers examined in their spatial analysis of where forest fires occurred in the seasonal snow zone was roughly the size of Ohio.

"It's a bit of a paradox," Nolin said. "Other studies have shown that when you remove the dark forest canopy and expose the snow, the area gets brighter and acts as a negative forcing on atmospheric temperatures, slowing climate change. But hydrologically, the effect is the opposite – the increased solar radiation and decreased snow albedo causes much earlier snowmelt, potentially amplifying the effects of climate change.

"What does it mean for your water supply when headwater catchments burn, the snow melts faster and the spring runoff begins even earlier?" she added. "It is a provocative question for resource managers."

Provided by Oregon State University

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