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NEWS

Oct 18, 2013

How badly does wildfire damage permafrost?

The permafrost regions of the far north contain vast amounts of stored carbon that's protected from decomposition by the freezing conditions. As climate warms this carbon will come under threat, not only because rising temperatures will melt permafrost but also because of increased incidences of wildfire, which destroys the soil organic layer

Now a team from the US and Russia has found that in upland black spruce forests, wildfire could completely degrade permafrost, even without climate warming. But the permafrost in lowland black spruce forest, where organic soil layers are thicker, is more resilient and could persist after a moderate burn and climate warming.

"The ability of permafrost to recover after fire depends on the thickness of the organic layer remaining," Elchin Jafarov of the US National Snow and Ice Data Center, University of Colorado at Boulder and University of Alaska Fairbanks, US, told **environmentalresearchweb**. "Our analysis indicates that recovery of the permafrost thermal conditions after moderate to severe fires could be initiated as soon as the moss layer starts to re-accumulate."

A thick surface layer of organic soil can insulate permafrost from thaw. As well as burning away some or all of this soil organic layer, a wildfire tends to increase soil moisture by destroying vegetation and decreasing plant water uptake via evapotranspiration. This effect tends to wane over a period of 10 years or so following the fire.

"The increase in the post-fire soil moisture content and changes in soil thermal properties have the potential to accelerate permafrost degradation through effects on heat transfer in the soil," said Jafarov. That said, the situation is complex as damp soil can also aid moss re-growth, promoting permafrost resilience.

Jafarov and colleagues studied the effects of the fire in the

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summer of 1983 in the Bonanza Creek Experimental Forest near Fairbanks, Alaska. The upland areas of the forest had organic soil layers around 30 cm thick, whereas the soil layer in the lowlands was roughly 80 cm thick. The organic soil contained three layers – moss, dead moss and peat.

Lowland black spruce forest tends to have a low rate of evapotranspiration, giving it a relatively damp forest floor where soil organic layers can accumulate and mosses can flourish, the researchers say. Forests at higher elevations have shallower organic layers, drier soil and less moss but better growth of vascular plants.

"The effect of fires on permafrost is an important question that is not well addressed in climate and ecosystem models," said Jafarov. "We choose a transient modelling-sensitivity analysis framework to better understand the factors that affect post-fire permafrost thermal dynamics, where the factors include climate, burn severity, soil organic layer thickness, and soil moisture content."

The team used the Geophysical Institute Permafrost Laboratory (GIPL) permafrost model and Dynamic Organic Soil version of the Terrestrial Ecological Model (DOSTEM) to study the factors that determine post-fire ground temperature dynamics, simulating behaviour for 120 years to represent a typical fire-free interval for this type of forest.

"The current limitation of the permafrost model used in this study is that the effects of changes in soil moisture were not fully addressed, since changes in soil moisture were not coupled with changes in soil thermal properties," said Jafarov. "So future work is needed to better address the changes in soil moisture content in the GIPL model. One of the potential improvements could be coupling terrestrial ecosystem and permafrost models to better represent soil moisture dynamics and its effect on soil thermal properties."

Jafarov and colleagues reported their findings in **Environmental Research Letters (ERL)** as part of the ERL Focus on Changing Permafrost in a Warming World: Observation and Implication.

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