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Aug 20, 2013

Roads and seismic lines damage permafrost

Exploration for resources in northern Canada has created a dense network of linear disturbance such as winter roads and seismic lines. Now a team from Wilfrid Laurier University, Canada, has found that these disturbances have severely altered hydrology, ecology and ground thermal regime in a region of discontinuous permafrost. What's more, the permafrost does not regenerate.

(http://images.iop.org/objects/erw/news/8/8/36/news_200813.jpg)
Abandoned winter road (http://images.iop.org/objects/erw/news/8/8/36/news_200813.jpg)

"What we found suggests that when created with conventional techniques, these disturbances won't recover in this type of an environment," said researcher Tyler Williams. "Since there is concern as to the density of these disturbances and their impact on the environment, this is a significant finding when it comes to planning future exploration."

To come up with the result, Williams and colleagues studied disturbance from roads, access paths and seismic lines in a peatland 50 km south of Fort Simpson in Canada's Northwest Territories. By altering soil moisture content, the road and seismic-line disturbance caused permafrost thaw, followed by ground-surface subsidence. The subsidence led to the ground becoming wetter and encouraged more permafrost thaw. The result was water-logged linear disturbances where the permafrost did not regenerate.

"As long as the disturbances remain wet, summer thaw exceeds winter freezing and the black spruce canopy is unable to regrow, altering the land-cover type and creating a wetland environment that is more typical of bogs or fens," wrote the team in **Environmental Research Letters (ERL)** (http://iopscience.iop.org/1748-9326/8/2/025006/article).

The researchers measured snow depth, snow-water equivalent, frost-table depth, soil moisture and water-table depth, in what Williams said was a field-intensive study. "Such an approach seemed like a good fit for a master's degree where I can be sent out to live in a tent for three months in the middle of nowhere and go around spending most of my day sticking a metal rod in the ground until I hit ice."

Studies of disturbances on continuous, rather than discontinuous, permafrost have also found that soil moisture is important for thaw. In such cases, however, the active permafrost layer tends to increase temporarily before recovering. "Instead of a thickening active layer we've shown it is possible to lose permafrost entirely," said Williams.

In future the researchers recommend the use of low-impact techniques that can minimize ground surface disturbance by eliminating windrows – woody debris piled up along the edges of ground that is cleared for seismic exploration. Route planning should avoid areas of permafrost where possible, they said, particularly large permafrost plateaus that provide a greater supply of water to the disturbance, or should use pre-existing disturbances. Exploration should only take place when the ground is frozen and there is enough snow cover to protect the surface, while a narrow disturbance and selective, rather than comprehensive, removal of trees would be likely to minimize soil moisture increases near the surface because of reduced evapotranspiration.

Action could also be taken on brush disposal. "Windrows maintained permafrost directly below the pile of debris; however, they also act as a barrier to drainage that likely contributes to increased soil moisture and permafrost thaw on the opposite side of the disturbance," wrote the team in **ERL**. "Care should be taken to avoid changes in the surface topography, but if windrows are used, they should be restricted to the upslope side of the disturbance whenever possible."

Williams expects that these findings will be incorporated into best-management practices for resource exploration through a collaboration with Aboriginal Affairs and the government agency Northern Development Canada. Low-impact seismic strategies are commonplace in Alberta and northern British Columbia, the researchers said, but are not widely used in the Northwestern Territories.

The study was reported in **Environmental Research Letters** (**ERL**) (http://iopscience.iop.org/1748-9326/8/2/025006/article).

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Linear disturbances on discontinuous permafrost: implications for thaw-induced changes to land cover and drainage patterns, Tyler J Williams, William L Quinton and Jennifer L Baltzer 2013 **Environ. Res. Lett. 8** 025006 (http://iopscience.iop.org/1748-9326/8/2/025006/article)

ERL Focus on Changing Permafrost in a Warming World: Observation and Implication (http://iopscience.iop.org/1748-9326/focus/Changing%20Permafrost)

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About the author

Liz Kalaugher is editor of **environmentalresearchweb**.