Degrading ice wedges reshape Arctic landscape

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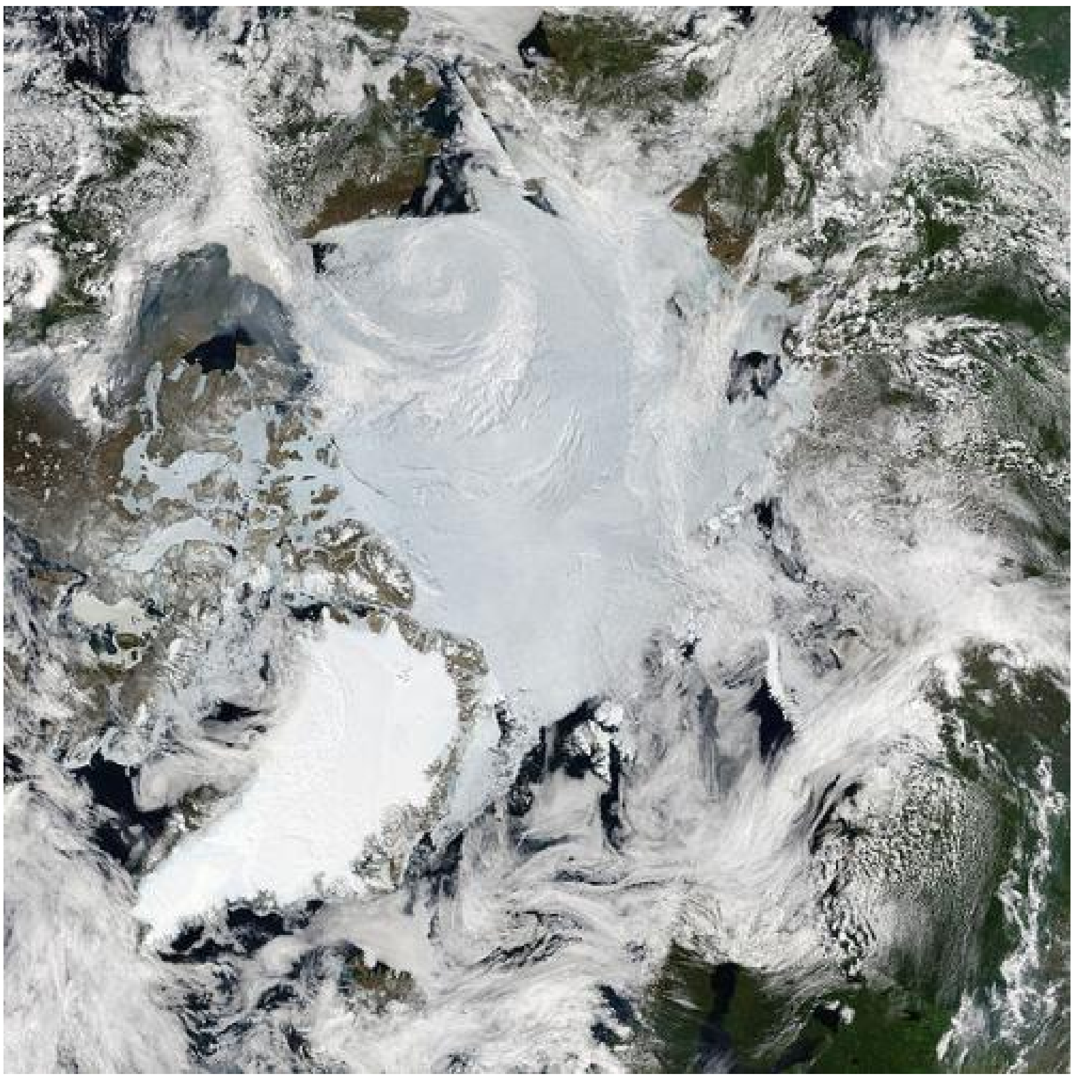

Mosaic of images of the Arctic by MODIS. Credit: NASA

Ice wedges, a common subsurface feature in permafrost landscapes, appear to be rapidly melting throughout the Arctic, according to a new study published today in the journal *Nature Geoscience*.

The wedges, which can be the size of a house, gradually formed over hundreds or even thousands of years as water seeped into permafrost cracks. On the ground surface, they form polygon shapes roughly 15-30 meters wide—a defining characteristic of northern landscapes.

The micro-topographic features of ice wedge polygons affect drainage, snow distribution and the general wetness or dryness of a landscape.

Anna Liljedahl, an assistant professor at the University of Alaska Fairbanks' Water and Environmental Research Center, and her co-authors gathered information about the types of ice-wedge polygons and how they changed over time across the Arctic. They collected the information while performing various other permafrost studies.

Although these regions contain "cold permafrost," with an overall average temperature of about 7 degrees Fahrenheit, surface thawing still occurred at all of the 10 study sites.

Ice wedge degradation has been observed before in individual locations, but this is the first study to determine that rapid melting has become widespread throughout the Arctic.

"Here we're combining observations from people working in the field across the Arctic—Russia, Canada and Alaska—where we're seeing the same ice wedge melting phenomenon," said Liljedahl, the lead author of the study.

Such thawing could bring significant changes to the hydrology of much of the Arctic as it alters the ground-surface topography. Melting of ice wedge tops makes the ground that surrounds the polygons subside, which in turn allows drainage of ice-wedge polygon centers. This can create a connective drainage system that encourages runoff and therefore an overall drying of the landscape.

"It's really the tipping point for the hydrology," Liljedahl said. "Suddenly you're draining the landscape and creating more runoff, even if the amount of precipitation remains the same. Instead of being absorbed by the tundra, the snowmelt water will run off into lakes and larger rivers. It really is a dramatic hydrologic change across the tundra landscape."

A comprehensive satellite image survey hasn't been done to determine how common polygon ice wedge patterns are in permafrost areas, but as much as two-thirds of the Arctic landscape is suited to their formation, Liljedahl said.

Gradual warming of permafrost has been well-documented in the Arctic, but the polygon study indicates that a brief period of unusual warmth can cause a rapid shift in a short time period.

At the sites that were studied, ice wedge degradation occurred in less than a decade. In some cases, a single unusually warm summer was enough to cause more than 10 centimeters of surface subsidence, enough to result in pooling and runoff in an otherwise relatively flat landscape.

Vladimir Romanovsky, a UAF geophysics professor who monitored ice wedge degradation for the study at a site in Canada, said the overall conclusions of the study were striking.

"We were not expecting to see these dramatic changes," he said. "We could see some other places where ice wedges were melting, but they were all related to surface disturbances, or it happened a long time ago. Whatever is happening, it's something new for at least the last 60 years in the Arctic."

More information: Pan-Arctic ice-wedge degradation in warming permafrost and influence on tundra hydrology, *Nature Geoscience*, DOI: 10.1038/ngeo2674

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