



Arctic permafrost might contain ‘sleeping giant’ of world’s carbon emissions

As temperatures rise in the Arctic, permafrost, or frozen ground, is thawing. As it does, greenhouse gases trapped within it are being released into the atmosphere in the form of carbon dioxide and methane, leading to previously underestimated problems with ocean acidification and potential mercury poisoning.

12 December 2018 - By SANDRINE CEURSTEMONT

About one quarter of the region is covered in permafrost, which is soil, sediment or rock that has been frozen for at least two years. With its retreat, the carbon that is released could contribute significantly to global warming.

‘We call it the sleeping giant of the global carbon cycle,’ said Professor [Örjan Gustafsson](#), an environmental scientist at Stockholm University in Sweden. ‘It’s not really accounted for in climate models.’

Prof. Gustafsson and his colleagues are trying to determine exactly what permafrost consists of, how quickly it is warming and what happens when it thaws. To do this, they are drilling into three types of permafrost around the East Siberian Sea as part of a project called [CC-Top](#).

In addition to the most common type found in soil on land, they will also be looking at high-carbon permafrost that formed about 50,000 years ago called Yedoma, and another type found under the seafloor of shallow coastal shelf areas that were flooded as sea levels rose about 11,650 years ago. '(This) subsea permafrost is the most vulnerable of the three so that's the major focus of the project,' Prof. Gustafsson said.

The researchers have been comparing the temperatures of permafrost on land and underwater. About 10,000 years ago, the temperature of both permafrost types was about -18°C. They found that permafrost on the ground has now warmed up to about -10°C but under the sea it has reached 0°C. 'That was surprising,' Prof. Gustafsson said. 'I had no idea that subsea permafrost was thawing so quickly.'

Ocean acidification

They've also examined what happens when thawed permafrost from land reaches the sea. Some of the released carbon reacts with water to form carbonic acid - the same gas present in fizzy water. Although it's a weak acid, Prof. Gustafsson and his colleagues [found that it contributes significantly to acidification of the Arctic ocean](#). This affects marine biodiversity. Acidic water, for example, dissolves the carbonate skeletons of organisms such as plankton.

The team's findings point to much higher levels of ocean acidification than that predicted by the Intergovernmental Panel on Climate Change (IPCC) in [their report published in 2014](#), which largely considered the effect of anthropogenic carbon emissions.

'Acidification could be 100 times more severe,' Prof. Gustafsson said. 'Ocean acidification by permafrost carbon from land is a new mechanism we hadn't thought about much, and we didn't think it was so strong.'

Next, the team plans to investigate the methane that is escaping from subsea permafrost. In many parts of the Arctic, the concentration of the gas in seawater is high but the researchers aren't exactly sure of its source. It could be the result of thawing permafrost soil or methane hydrates - solid methane buried underwater. Or it might originate from natural gas much deeper down that is reaching the surface through cracks in permafrost as it melts.

'We really need to understand that to predict how methane releases will develop in the coming decades or centuries,' said Prof. Gustafsson.

Permafrost thaw is already a growing concern for those living in the region who experience its effects. In coastal areas, where it is particularly prone to thawing, buildings constructed on permafrost are collapsing or becoming damaged due to thaw while roads are [cracking](#). Escaping carbon and organic matter are also likely to have an impact on the wildlife that communities rely on for food.

Dr Hugues Lantuit, a researcher at Alfred-Wegener Institute in Potsdam, Germany, and his colleagues are interested in what happens to carbon and other substances that seep out from permafrost in these coastal areas as part of a project called [Nunataryuk](#). They will be conducting fieldwork in Russia, Svalbard, Greenland, Canada and Alaska.

The project is involving local communities in their work. In Aklavik, a hamlet on the Yukon coast in Canada, for example, the team is consulting Inuit communities to pin down relevant sites for their research, such as areas where fish is plentiful or where erosion is pronounced.

Through meetings, the researchers gain insight into local issues that could be addressed in their research. In Svalbard, for example, where the coastline is rocky, permafrost thaw is mostly affecting infrastructure on land whereas coastal erosion is more of a concern in Russia and North America. At the same time, locals can learn scientific techniques from researchers. 'It's truly a learning experience on both sides,' Dr Lantuit said.

Subsistence

Some communities are worried about the effect of climate change on wildlife, which they depend on for subsistence. One of the project's goals is therefore to investigate the release of organic matter from thawing permafrost into the Arctic Ocean. 'This has a direct impact on the fish population but we do not exactly understand how,' Dr Lantuit said.

The team is trying to figure out whether thawing permafrost will make the sea cloudy by releasing sediment into the water, thus allowing less light to penetrate. This could result in fewer fish as the algae and plants they depend on for food can't photosynthesise in dark water. Alternatively, it could have a positive effect. 'More carbon could also mean more nutrients, so big party time for microorganisms, phytoplankton and potentially fish,' said Dr Lantuit.

Thawing permafrost is also a health concern as it is expected to release contaminants and pathogens. In a study published earlier this year, members of the team found that permafrost contains more mercury than any other source on the planet when it was previously thought to contain an insignificant amount. Since mercury is a poison, it could have serious health implications, ranging from impaired memory to vision problems if it gets out. 'Now we're trying to quantify the release of mercury and to see which regions are susceptible,' said Dr Lantuit.

Eventually, the team hopes to come up with solutions to manage the effects of thawing permafrost. They're developing models that should help. In one project, they are looking at what would happen if permafrost was the source of an outbreak of Anthrax – a bacteria that can infect the skin, lungs and intestines. They are also creating models to predict damage to infrastructure.

Improvements are already underway. Nunataryuk researchers have been working on developing buildings that can better resist thawing permafrost by getting communities in North America and Russia to exchange strategies. In North America, for example, there was a tendency to build lightweight constructions using wood or metal whereas buildings are made from concrete in Russia.

'There is a move towards using some of the knowledge on both sides to create new and better infrastructure,' said Dr Lantuit. 'We now have 40 to 50 years of warming in some areas so we can really see what works and what doesn't.'

The research in this article was funded by the EU. If you liked this article, please share it on social media.

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