Thawing permafrost in the Arctic

Published On: 16-05-2023

Why in News: With rising global temperatures, thawing permafrost is likely to destabilise thousands of industrial sites and linked contaminated areas in the Arctic, which could result in the spread of toxic substances across the region, according to a new study. Nearly 2,100 industrial sites and between 5,600 and 10,000 contaminated sites are under threat of destabilisation by the end of this century.

A Study of Permafrost Thawing

The study, 'Thawing permafrost poses environmental threat to thousands of sites with legacy industrial contamination', was published in the journal Nature Communications earlier this year.

It was carried out by a team of researchers including Moritz Langer, Thomas Schneider von Deimling, Rebecca Rolph, Sofia Antonova, Volker Rachold, Alexander Oehme, and Guido Grosse — all from Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (Germany) — Sebastian Westermann from University of Oslo (Norway), Ralph Rutte, a freelance researcher based in Germany, and Michael Schultz from Heidelberg University (Germany).

What is permafrost?

Permafrost is essentially any ground that stays frozen — 0 degree Celsius or lower — for at least two years straight.

These permanently frozen grounds are often found in Arctic regions such as Greenland, Alaska (the United States), Canada, Russia and Eastern Europe.

Contrary to common perception, the Arctic is far from an uninhabited and untouched region. It's dotted with countless industrial facilities such as oilfields and pipelines, mines and military bases.

All this infrastructure is built on permafrost, which was once believed to be perennially stable and reliable.

The toxic waste from these industrial facilities has been buried in the permafrost, on the assumption that it would stay locked away permanently. But danger looms as the planet continues to heat up.

A major problem is that for a long time (before and in the 1990s) the consequences of global warming and thawing permafrost were not taken into account and definitely underestimated.

There are many engineering studies from that time that consider permafrost as a favourable condition for the disposal of industrial legacies and other wastes.

Today, these former practices (some of which are still in use) are becoming an increasing problem as large parts of the Arctic are already affected by thawing permafrost

Reason for Permafrost thawing

According to the National Aeronautics and Space Administration (NASA), permafrost is composed of “a combination of soil, rocks and sand that are held together by ice.

The soil and ice in permafrost stay frozen all year long.” However, although the ground remains perennially frozen, permafrost regions aren’t always covered with snow.

It was because of these characteristics that countries and corporations began building infrastructure on the Arctic’s permafrost.

The region witnessed a further expansion of industrial and economic development during the Cold War — it became a centre for resource extraction and military activities, as per Langer. This led to the accumulation of industrial and toxic waste on or in permafrost which was never removed

“Known industrial waste types (in the region) include drilling and mining wastes, toxic substances like drilling muds and fluids, mine waste heaps, heavy metals, spilled fuels, and radioactive waste,” the study mentioned.

But as the Arctic is getting warmer nearly four times as fast as the rest of the planet due to climate change, permafrost is thawing rapidly, which could destabilise not only the industrial sites but also the contaminated areas.

And once the destabilisation takes place, toxic substances would be unleashed across the region, threatening numerous species living there and the health of people who depend on them.

Major findings of the report

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To identify sites at risk of destabilisation in the Arctic permafrost regions, Langer and his team analysed publicly available data on industrial sites — from portals such as OpenStreetMap and the Nordregio Atlas of Population, Society and Economy in the Arctic — and contamination sites located in Canada and Alaska.

As there was no data available for the largest permafrost region in Russia, the team had to rely on media reports and other sources to identify contaminated sites in the area.

Using all this data, they extrapolated where industrial contamination and permafrost might coexist across the entirety of the Arctic and found that the 4,500 industrial facilities in the permafrost regions have most likely produced between 13,000 and 20,000 contaminated sites.

The team then used computer simulations to find out the impact of climate change on these sites.

According to the study, as of now, around 1,000 of the known industrial sites and 2,200 to 4,800 of the known contaminated sites are already at risk of destabilising due to thawing permafrost.

These numbers will jump to more than 2,100 industrial sites and 5,600 to 10,000 contaminated sites by the end of the century under the low emissions scenario consistent with the 2-degree Celsius global warming target.

And if the world continues to get warmer at present levels, almost all of the known industrial and contaminated sites would be affected.

The above numbers are a gross underestimation as the data on industrial sites and contaminated areas in the Arctic permafrost region remains incomplete.

Consequences of thawing permafrost

According to experts, thawing permafrost can severely impact the planet. One of its most dangerous consequences is the release of greenhouse gases into the atmosphere.

A 2022 report by NASA said, “Arctic permafrost alone holds an estimated 1,700 billion metric tons of carbon, including methane and carbon dioxide. That’s roughly 51 times the amount of carbon the world released as fossil fuel emissions in 2019.”

Moreover, “Plant matter frozen in permafrost doesn’t decay, but when permafrost thaws, microbes within the dead plant material start to break the matter down, releasing carbon into the atmosphere,” it added.

The report also said that current models estimate that there would be “a pulse of carbon released” from the permafrost to the atmosphere within the next hundred years, probably even sooner.

It remains unclear how much of the carbon will be released from permafrost in the following years.

A 2022 study by Columbia University observed that thawing permafrost would unleash thousands of dormant viruses and bacteria.

Some of these “could be new viruses or ancient ones for which humans lack immunity and cures, or diseases that society has eliminated, such as smallpox or Bubonic plague.”