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CANADA

How will Canada's North afford the great permafrost thaw?

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By **Caitrin Pilkington, Local Journalism Initiative Reporter Cabin Radio**

In 2017, experts estimated the annual cost of damage caused by permafrost thaw to be $51 million. With no easy solution in sight, what will happen as the problem intensifies?

N.W.T. Association of Communities chief executive Sara Brown first presented that figure in 2017 and has since lobbied the federal government for increased funding to address the issue.

The government has funded permafrost education and research like a $17,000 "information hub" in Inuvik, but no comprehensive strategy exists to address rapidly deteriorating infrastructure.

In the Northwest Territories, politicians say the N.W.T. government is sitting on $600 million in deferred maintenance costs, a figure that does not include roads and is at least partly attributable to the effects of permafrost. Thawing permafrost sinks, creating uneven terrain that can damage buildings or highways above, and climate change is accelerating that thaw.

Brown says strategically spending the limited available funding to combat permafrost thaw involves tough decisions.

"Do I invest more in this asset because it's having issues with permafrost thaw?" She asked, setting out the issue. "Or do I just let it go to the end of its life and replace it wholesale, and design a foundation that doesn't rely on permafrost the way the old one did?"

Brown is clear about the ongoing need for federal support. But in the absence of major funding for infrastructure initiatives or repairs, her organization has shifted focus to advocate for education and the importance of comprehensive hazard mapping to avoid building on vulnerable areas – a similar approach to the N.W.T.'s current flood response.

Still, questions remain about how best to handle the highways, airports, schools, hospitals and homes that are already built and now degrading far faster than most people initially imagined.

Bill Quinton, a researcher at the territory's Scotty Creek site, specializes in permafrost thaw. He thinks one solution involves broadening the application of thermosyphons.

"The theory is actually very simple. It's a pipe that extends above the ground and goes into the ground at maybe an equal distance, down to the permafrost table," he said.

Cold air naturally sinks due to its high density. As that air moves down the pipe, it freezes the surrounding ground and creates an ice bulb at its base. That ice bulb helps to preserve permafrost.

Quinton says thermosyphons are "underused" and "underdeveloped" in the N.W.T. He says at Scotty Creek, researchers have been experimenting with scaled-down, modified versions of the technology that "anyone, any homeowner, could insert into the ground and find really effective."

The problem? Thermosyphon technology is patented.

"Our company brought this technology to the Canadian North in the early '80s and we've been the sole proprietor of it ever since," said Justin Panagapko, the chief executive of Arctic Foundations, which owns the patent. "We are the only thermosyphon manufacturer and installer in Canada."

While the technology exists elsewhere, rights to use it in Canada belong exclusively to Arctic Foundations. The company has supplied the likes of Yellowknife's Giant Mine remediation project, which makes significant use of thermosyphons in its plan to safely freeze in place the former mine's toxic arsenic trioxide.

While Panagapko says Arctic Foundations is open to partnerships with the academic community, he says the company's focus is on large-scale industrial and institutional projects, not the broader permafrost concerns of the NWT's municipalities.

Thermosyphons are also costly, which keep them out of many communities' reach as a viable solution. But Binay Yadav, the N.W.T. Department of Infrastructure's director of transportation, is looking at expanding use of thermosyphons along strategic sections of the territory's highways.

For the past 10 years, Yadav says his department has worked with academic research groups to try various solutions on different sections of highway and see which work best. They have replaced peatland with blast rock, adapted culverts, and tried geotextiles – material designed to keep the ground cool and prevent water from seeping down, which would accelerate the thaw.

Yellowknife residents are used to the annual procession through construction zones on Highway 3 to Behchokǫ̀ as the ground beneath the highway heaves and thaws.

"We are trying to mitigate or minimize this [to] reduce these failures," Yadav said.

He says this is why his department is taking the time to ensure future practices are built on a solid foundation of research.

"If our design is not good, issues will be much more than we anticipated," he said.

Nonetheless, while these studies progress, the current approach – the same maintenance to the same sections of road – is a significant contributor to annual costs.

Susan Tighe, a University of Waterloo professor and pavement expert, says keeping spending down while adapting infrastructure to permafrost thaw is going to be extremely challenging.

"Sometimes you can avoid using some of these more expensive solutions by changing the types of material you're using," she said. "But what we're seeing is a little frightening, because the active layer of the permafrost is becoming larger and there's more thaw occurring every year."

The active layer is the area of ground that experiences seasonal freeze and thaw, located between the surface and the permafrost layer. As this area increases, building techniques that require drilling down to the permafrost table – and solutions that depend on reaching that permafrost layer – retreat further out of reach.

Tighe says increased research and predictive modelling can lower costs in the long run, but that process can't be rushed.

"If we want to build infrastructure that lasts 50 years, even 200 years, we really need to understand what the loss of permafrost will entail and the freeze-thaw cycles," she said.

"But it's a tricky time right now to be doing design because not only is the climate changing, it's changing much faster than we ever realized it would.

"And therefore we're having to alter a lot of our design codes and practices to make sure our infrastructure is safe."

Michelle Liu, a lawyer and engineer who studied this issue in the N.W.T., says the growing permafrost problem will only "add to that existing deficit in Indigenous infrastructure, and that is already very pronounced in northern Canada."

Liu said when she looked at solutions, expensive thermosyphons weren't ideal for communities that already had financial difficulties.

Her thesis, which included a comparison of surface temperatures for various kinds of materials such as asphalt, chip seal and gravel, had several results she didn't expect. She says the results emphasize the importance of more field work to understand how to proceed.

Liu argues there is a significant lack of research knowledge about cost-effective solutions that help isolated northern communities maintain infrastructure.

"Constructibility and feasibility are very important in a northern context. Some ideas may work, but who's paying for it? Are there local skills and technologies to maintain it? Or is it a one-time investment that may not work out in the long run?"

Brown, the association of communities' chief executive, agrees.

"We don't have a great history with infrastructure banks, competitions, things like that in the North. They get too complicated and are not accessible. We'd love to have innovation, but they need to be simple solutions. We can't technology our way out of this," she said.

"There is no panacea for permafrost thaw."

Lacking money and a one-size-fits-all tech solution, how will communities like Tuktoyaktuk, facing the climate-related crises of permafrost thaw and coastal erosion, survive?

Many communities are shifting efforts to the future, designing better buildings and finding solid locations for projects rather than salvaging infrastructure on shifting ground.

But simply giving up on decades of investment will be tough to swallow for a cash-strapped territory. As leading N.W.T. permafrost scientist Steve Kokelj noted in a 2018 presentation to a climate change forum, permafrost already "provides a foundation for billions of dollars of northern infrastructure."

Most importantly, new builds cannot begin until communities are armed with information about where it's safe to do so.

In response, Kokelj and the GNWT are creating a permafrost map of the territory. He believes the best way to proceed is increased monitoring of permafrost thaw and the introduction of data management systems that better inform new projects and help mitigate impacts on older ones.

The warning from his 2018 presentation appears truer than ever, four years of rapid thaw later.

"Expect surprises," one of the last slides read, adding the "consequence of a poor knowledge base will be bigger and more costly surprises."