A More Vulnerable World

A Problem Put on Ice

Olga Dobrovidova, December 1, 2015

Categories: Uncategorized Regions: Arctic

It is early Thursday evening in mid-September; the sun is setting into a veil of smog from the power plants and people are coming back from work. This could be any small industrial town in Russia, but it is Norilsk — a northern city of 180 thousand people with an average annual temperature of minus 9.8 degrees Celsius. There is a one in three chance the palladium in your mobile phone was mined here.

Norilsk is also officially the most polluted city in Russia and one of the most polluted in the world.

I was born in the capital of the Krasnoyarsk region, of which Norilsk is the second largest city. This is my first time so far north, some 1,500 kilometers away from where my family still lives. During a walk around town, I found myself standing in front of an apartment building whose aboveground foundations are big enough to walk into. It may sound strange to most, but this style of building has been adapted for the presence of permafrost.

In Norilsk and other northern cities, buildings are “lifted” above ground to ensure an air gap limits the amount of thermal impact on the frozen ground. Otherwise warm water and heat from the building can melt the permafrost cover, decreasing its bearing capacity or how much weight the foundation can hold. Often permafrost melts unevenly, which leads to cracks in larger, more complex structures and even partial collapses.

Peering into the lifted foundation of a building in Norilsk (Credit: Olga Dobrovidova)

I can see what the foundation looks like — through the gaping hole in the side of the housing structure. While this hole is there to prevent the melting permafrost, it may be adding to it. Some thermal impact is unavoidable, but it's clear that these permafrost-reinforced buildings are not getting the maintenance they need. And yet, no one returning

home from a long day of work appears to be worried that this hole is there.

Uncommon ground

Explorers of the Russian East during the 17th century had a difficult time convincing the capital that they really had found soil that stayed frozen year round, even in the summer when only a thin top layer would melt. We now know that permafrost actually covers two-thirds of Russia's territory —more than the total area of Canada.

This frozen land is home to more than a third of the country's proved reserves of oil and gas and over 90% of estimated reserves, some of the largest gold, tin, nickel, copper and coal deposits, as well as freshwater and forest resources. Large-scale industrial exploration of the region, which started in the 20th century, required building power plants, factories and housing that could withstand the frozen ground and extreme conditions of the North. A growing need to better understand the science behind permafrost sparked robust research efforts in the Soviet Union during this time.

By the 1960s, the country had a specialized permafrost research institution, with a vast network of monitoring stations in western and eastern Siberia. Experimental sites were also set up

to study permafrost under various stresses and conditions. The USSR held the world's second international conference on the subject in July 1973, in the East Siberian city of Yakutsk, where attendees could see "six-story apartment buildings being constructed" as well as the 117 meter "well", or Shergin shaft, used for the first scientific study of permafrost a century earlier.

Underground rainbow
(Credit: Olga Dobrovidova)

A history museum in the central Siberian town of Igarka tells the story of early settlers who started building a lumber mill in the summer of 1929. The town later rose to prominence as a regional hub for the international lumber trade, but the early houses and structures they constructed barely survived the winter as people were not prepared to

deal with complications stemming from building on the frozen surface. Igarka's permafrost research station was founded later that year.

New times

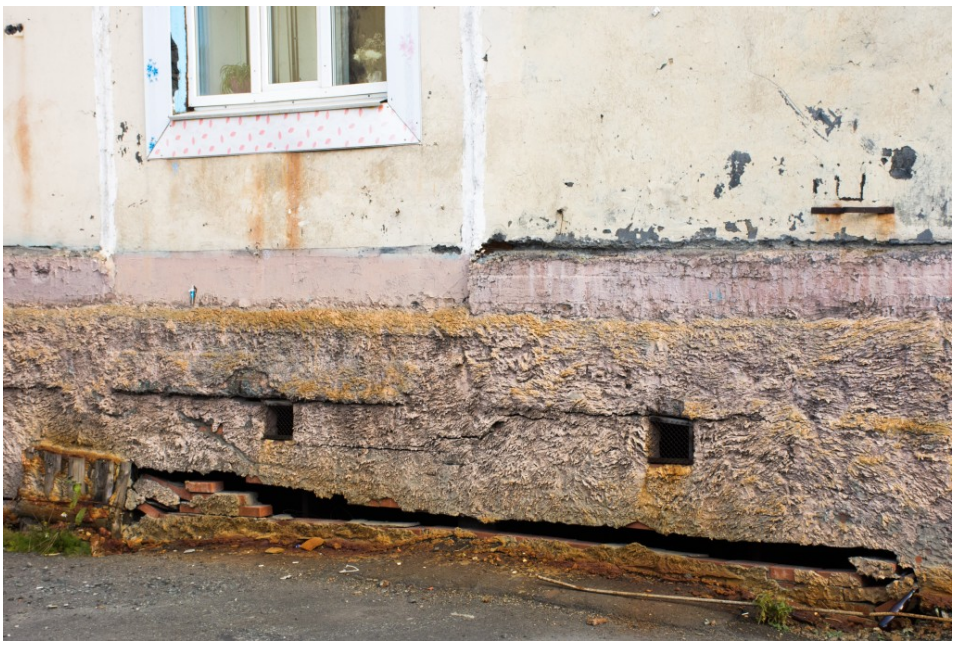
Today, the people and industry that drove migration to the inhospitable region are still there. The Russian Arctic is home to some 2 million people who produce around 4% of the country's GDP and 20% of its exports. Another 5 million live in the so-called sub-Arctic regions. Most of these estimates can vary quite significantly across sources, in part because legal boundaries of what is now officially called the Russian Arctic zone were not defined until the spring of 2014.

Unlike the rest of the global Arctic, Russia's Far North is already a highly urbanized region with over 80% of the population living in settlements of 5,000 people or greater. Approximately 40 towns in the area have populations of over 10,000 people; at least five – Arkhangelsk, Murmansk, Noyabrsk, Novy Urengoy and Norilsk – have more than 100,000 people.

But most of these settlements are getting smaller, mainly due to economic migration. Murmansk, the world's largest city north of the Arctic Circle, and Norilsk have lost about a third of their populations

since 1990. For smaller settlements such as Igarka or Tiksi on the Arctic coast of Yakutia, the figure is closer to 60 or 70%. Overall, the region is estimated to have lost a quarter to a third of its population in the last 25 years.

Shrinking populations and general socioeconomic stagnation in towns that are no longer connected to oil and gas, or mining industries are partly to blame for the neglect visible in older buildings, not unlike the one I walked into in Norilsk. Local municipalities responsible for this upkeep receive little to no support from the higher levels of government and often have no means of adequately funding the continuous maintenance required for Soviet-era infrastructure.



Poor housing maintenance is no laughing matter (Credit: Olga Dobrovidova)

Over the last few decades, interest in permafrost has also plummeted. Russian papers on the subject and a 2014 state report on climate change give an overview of the extent of damage to buildings in Igarka, Tiksi and other smaller settlements on permafrost in the Siberian North and further to the east. Numbers range from place to place, between 40 or 50 percent of all structures with deformations in some cities and even 100 percent in unnamed remote settlements in the Siberian Arctic. This review relies mainly on a non-peer-reviewed source from 2001.

Dr. Oleg Anisimov of the State Hydrological Institute in Saint Petersburg, who was one of the lead authors of the 2014 report, agrees the data is old but says there is simply no newer information because hardly anyone is studying this issue now. “Permafrost itself is a really simple thing, actually, all processes there are incredibly well understood. The difficulty lies in the fact that there’s very little data on its current state and trends”, he adds.

A lot of Russian research on permafrost conditions such as temperature or active layer thickness – how deep it melts in the short summers – ceased in the 1990s when political and economic turmoil left research stations severely underfunded and understaffed. Data from Roshydromet, the state weather and climate service, suggests that in 2014,

only 36 out of 64 Russian stations involved in the global Circumpolar Active Layer Monitoring (CALM) project actually collected data, and most had continual measurements for no longer than 10 to 15 years. This lack of data complicates any estimate of long-term trends, says Dr. Anisimov.

“Only 12 to 15 of these stations in Russia have long time series, and they are used in the analysis. And now try and picture those 12 to 15 stations, most of which are located along the Arctic coast, against the whole area of Russian permafrost,” Anisimov, who is also involved in gathering and processing this data, notes. Overall, the CALM network has 168 stations in 15 countries; Canada, where permafrost covers about half the landmass, has some 60 stations with measurements dating back to the start of the project in 1991.

Symbolically, a decades-old map documenting permafrost cover adorns the wall of the director’s office in the Igarka research station. Dated 1991, it’s a comprehensive picture of permafrost conditions across Siberia and elsewhere, but it’s also a map of a different country – the Soviet Union. Dr. Nikita Tananaev, former head of the research station and a research scientist with the Melnikov Permafrost Insitute in Yakutsk, says newer maps of permafrost conditions do exist, but they cover smaller areas and much of the information gathered, for instance,

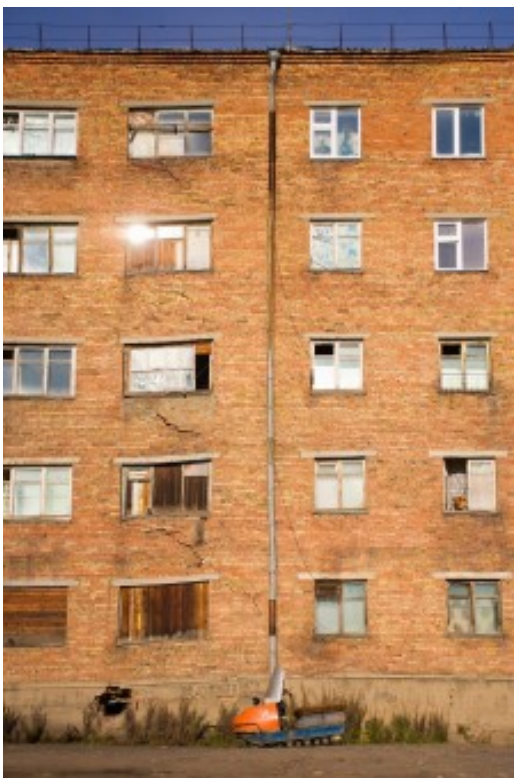
by oil and gas companies is proprietary. “To make a new map at this scale — this one is quite detailed — we would have to collect lots and lots of new data. And there is no one to make everyone share the information they do have.” he says.

A cold topic

According to WWF Russia’s Dr. Alexey Kokorin, who works to develop climate change awareness in these regions, there is little interest in sharing this information and building a more accurate picture of the state of permafrost. Oil and gas companies who have invested in this research have already built their infrastructure to be “almost immune to changes in permafrost.” Government estimates, however, indicate that it may still cost them up to 55 billion rubles (a little over $800 million) a year in maintenance. And since a decrease in population is naturally followed by a decrease in demand for housing, the plight of the people remaining in these crumbling Arctic settlements “is not really sounding the alarms”, says Kokorin.

There’s also a surprising complacency from those left to deal with “building deformities” on a daily basis. A section of apartments in a residential building in Igarka had to be abandoned after damage to the foundation had rendered them unsafe — but residents still live in other parts of

that complex. Two houses down that street, an entire half of another building had to be demolished. It seems like much of this acceptance of present conditions stems from a peculiar fatalism common to all Russians but particularly striking in the North. When I asked a woman who had lived in that apartment building for 10 years if she was scared to stay there, she expressed a sentiment I would continue to hear throughout my trip: of course I am, but what is there to do?



Building degrading from permafrost (Credit: Olga Dobrovidova)

During my travels, I passed a shiny new youth activity center in Dudinka, a major river port town the Siberian Arctic. The building had a memorable poem written on its side: “If we have to, then we

have to, then our gardens here will bloom." It's a quote from a Soviet song called "70th Parallel Kids." Sitting at the 69th parallel, Dudinka is close, but it's so cold you can barely grow onions here.

Residents of the North are quite aware of the changing climate realities they face, but the issue of thawing permafrost has taken a backseat to other concerns. In casual conversations about the weather, people often lament that traditional predictions of weather patterns based on years of observation no longer hold. The Yenisey, Lena and other Siberian rivers are also experiencing marked shifts in their fall freeze and spring melt times. In the Taymyr peninsula, the northernmost part of central Siberia, both indigenous communities and scientists have confirmed that deer have already started wintering in places they used to leave because of the extreme cold. While locals are worried about the future impacts of climate change on infrastructure, these problems are nothing new. Many residents have lived in these crumbling buildings for decades.

Despite a lack of perceived urgency, the threat posed by thawing permafrost to these settlements is real. The IPCC's Fifth Assessment Report states that, with a high level of confidence, "rising temperatures, leading to the further thawing of permafrost, and changing precipitation patterns

have the potential to affect infrastructure and related services in the Arctic," with particular concerns for damage to residential buildings and storage facilities for hazardous materials.

Russia's own second assessment report on climate change and its consequences paints a more detailed picture. It asserts that climate change has already led to "a decrease in the permafrost bearing capacity by 17% on average and by up to 45% in some regions relative to the 1970s." This means that in some parts of western Siberia, permafrost degradation is already approaching the limits of operational safety. According to the same research, degradation is less severe in the central Asian part of the Arctic, northern Yakutia and the Krasnoyarsk territory.

A Soviet-era sign urging people to keep their houses safe and avoid permafrost degradation by keeping water and trash out of the basement (Credit: Olga Dobrovidova)

While Dr. Anisimov agrees that climate change is contributing to the thawing permafrost, he says

there are more urgent problems to address. “A building itself really does not care why a decrease in the permafrost bearing capacity happened — it just happened. Right now the dominant factor for us is bad maintenance, and attributing this to climate [change] would be silly. It does not diminish the issue, though, it just means one problem is compounded by the other”, says Anisimov. “You cannot separate them: construction standards have to be reviewed and updated to reflect changing climate norms.”

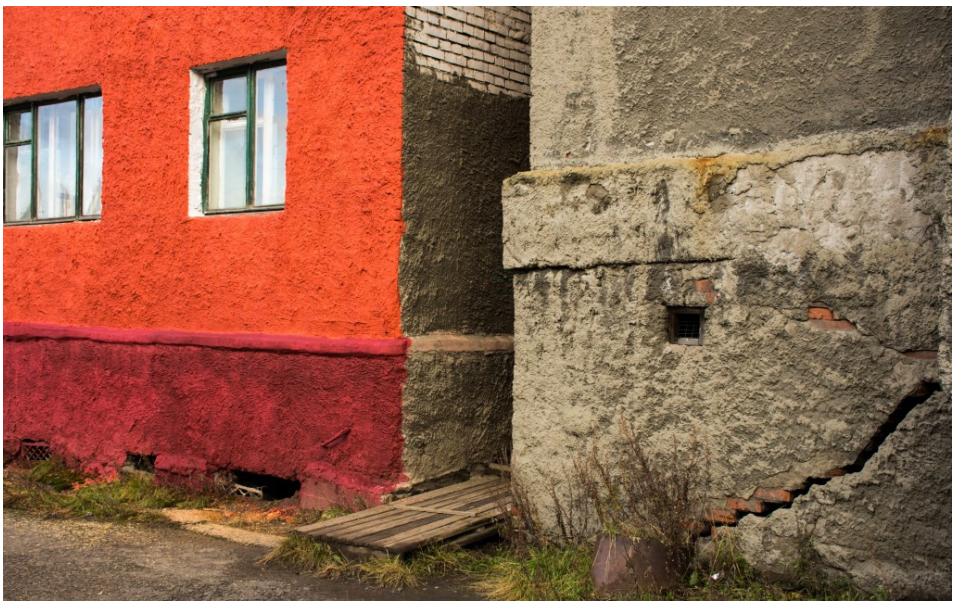
Limits of risk

In theory, any new construction in the north should be planned with climate change in mind, but Anisimov says he has yet to come across a project whose developers are accounting for this risk. “There is this very clear idea among engineers that climate change is completely made up and a hoax. Yes, sometimes it’s warmer — but there are always fluctuations and that is why safety factors exist,” he says. “Climate science is in one corner and engineering is in another.”

This reluctance to bring climate change into the engineering equation may seem somewhat understandable. The second national assessment report claims that improper management and maintenance are having a far more damaging affect

on infrastructure built on permafrost than climate change. In fact, one of the major changes between this report and its predecessor from 2008 is a more conservative approach to the link between climate change and infrastructure risks and a more nuanced representation of the problem.

Climate change may not yet trump poor maintenance, but that does not mean it can be discounted. “Since the ultimate reason behind most failures and accidents is a decrease in bearing capacity, which is projected to continue throughout this century, the current problems with infrastructure <…> can be viewed as a physical model of what can happen due to climate change in the absence of other impacts”, the report continues.



Dudinka, a city of contrasts in housing maintenance (Credit: Olga Dobrovidova)

In other words, just as with extreme weather events, even though climate change may only be partly responsible for what we are seeing now, it is a very useful snapshot into what can happen in the future, even with proper construction and maintenance. It may well become the straw that breaks the camel's back or, in this case, the foundation pile.

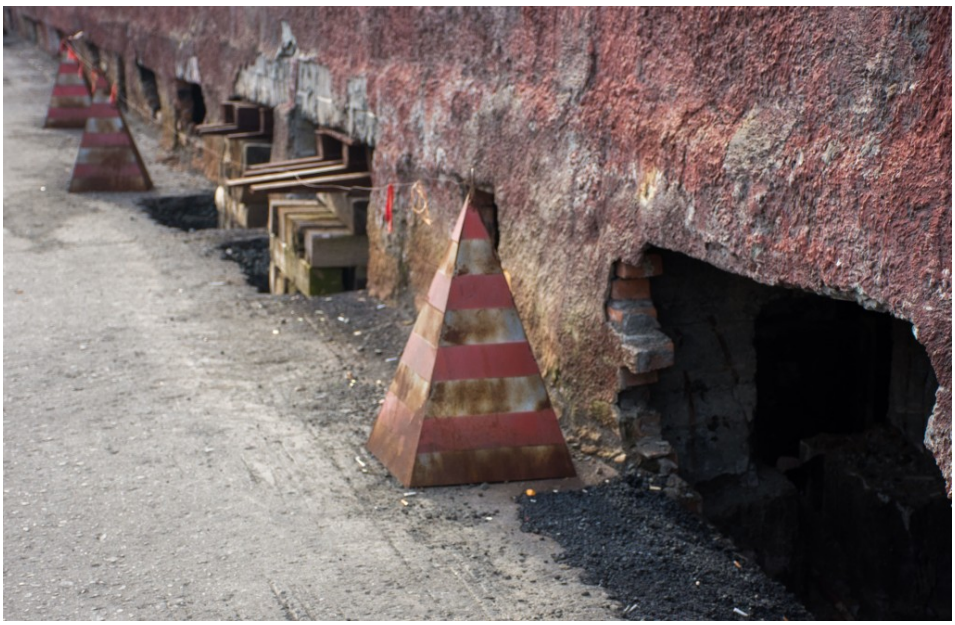
Anisimov also notes that the common safety factor Russians use for bearing capacity, whether or not permafrost is involved, is around 40%. This number means that a Russian foundation pile can potentially hold 40% more weight than it will actually have to once a building has been constructed — it's a margin left for safety purposes. In other countries like the U.S. or Canada it's closer to 90%, so "this means an eventual decline in bearing capacity due to rising temperatures in the permafrost will approach the safety limits much sooner here [in Russia] than in other places," he says.

Left out in the cold

Permafrost degradation and the resulting risks to infrastructure used to fall under the responsibility of the Ministry of Regional Development. In a report submitted to the UN in 2013, Russia announced that its ministry was "leading the development of a

science–based set of measures to minimize risks to buildings, transport and infrastructure from the southern permafrost border shifting to the north."

According to court documents and information from the federal procurement system, the ministry did contract work on this initiative out to a Moscow construction research institute in August 2012. But then in September 2014 this ministry was dissolved, and experts say it is not immediately clear which agencies, if any, took over its climate change portfolio. A representative of the Gersevanov Research Institute of Bases and Underground Structures confirmed that it completed a $270,000 study for the government, but is still waiting to be paid. Its research has not been released to the public.



Some maintenance being done in Norilsk may be too little, too late (Credit: Olga Dobrovidova)

At the 2014 UN climate conference in Lima, countries from Chile to Finland met to discuss the impacts of climate change on glaciers, ice caps and the Polar Regions. Russia has the largest amount of permafrost in the world, yet its delegation was noticeably absent. That was a public outreach event with no direct impact on the negotiations but it was still striking to see the same indifference found everywhere from official strategies to city streets.

Climate change may continue to trail engineering issues in its impact on Arctic buildings, or it may eventually force us to reinvent construction on permafrost altogether. A new building in the early stages of construction that I found in Norilsk may one day crack due to simple neglect — or it may do so because of failure to account for climate change risks in the project. The need for accurate and relevant information on the state of permafrost in a changing climate has never been more pressing. Whether or not Russia is willing to study or discuss this problem, extensive infrastructure damage in the North as well as the worries of those who live there are unlikely to melt away.