BY JASON PRNO

WE'RE BREAKING UP

Climate change is leading to everything from potholes to the cleaving of ancient ice shelves in the North. UHB asks what this means for the future of the territorial mining industry.

ELLESMERE FROM SPACE: This photo, taken by the NASA Earth Observatory, shows the ice shelves running along Ellesmere Island's northwest coast. Ward Hunt Island, circled, has anchored the massive Ward Hunt ice shelf for 3,000 years, but scientists say it is destined to disappear. Canadian Rangers who visited it in April, 2008 found dozens of deep cracks in the 40-metre thick ice. Courtesy NASA Earth Observatory.

The Ward Hunt ice shelf is falling apart. Tuktoyaktuk and the buildings in Baker Lake are sinking. The sea ice that used to protect Resolute and Hall Beach is gone for longer periods each year, allowing the ocean to whittle away their shorelines. Pangnirtung was just about washed into the sea this spring.

"The Northern landscape is definitely changing," says Tristan Pearce, a climate change researcher from the University of Guelph who has been working in the North for five years. "All you have to do is look at the newspaper these days." And with temperature increases of between three and five degrees predicted for Arctic regions by 2100, you can be sure more of these changes will happen. For mining companies, these altered climatic conditions will create new risks and challenges, ones they are perhaps unaccustomed to. Site infrastructure will be affected, as will operations and transportation networks. "The political and regulatory implications of climate change could also be significant," says Pearce. *Continued ...*

BREAKING UP

Most Northerners don't need to be told that climate change will affect them. Many are already dealing with it, while evidence of change has been the subject of numerous scientific reports. "Warmer temperatures, melting permafrost, eroding shorelines, extreme weather events: Our research team has time and again documented these things across Northern Canada," says James Ford, one of Pearce's research colleagues. "These changes are happening now and we can expect them to continue, even intensify, well into the future." What's important is not just mitigating the causes of climate change by reducing greenhouse gas emissions, but developing successful adaptation strategies to manage the risks associated with climate change. "Such strategies are a priority because there is increasing consensus that current mitigative initiatives can minimize but not reverse the climate trend," says Ford.

Pearce and Ford recently collaborated with researchers from across Canada in an interdisciplinary study on the effects of climate change on the Canadian mining sector. The study, initiated by the David Suzuki Foundation, involved a mix of industry surveying, case-study research and interviews with mining company representatives in an effort to raise awareness of climate change. It aimed to work with stakeholders from the mining sector to examine the effects of climate change and assess adaptation strategies that could be implemented to mitigate those effects.

While the research has been Canada-wide, an important focus has been the North. "This is where we'll likely see the most significant impacts, the earliest" says Ford. "The North also has enormous potential for further mineral development. We needed to see what climate change is going to do to the region and to the mining that will undoubtedly occur there."

Canadian Ranger Samson Ejanqiaq looks along the length of one of the gaping new cracks in the Ward Hunt Ice Shelf, the largest ice shelf left in the Arctic. During a patrol in April, Rangers helped locate and document the new cracks, which scientists say put the shelf on an irrevocable course toward breaking up.

(TOP) THE CANADIAN PRESS/BOB WEBER (ABOVE AND LEFT) JASON PRNO

In March, 2008, the team conducted an industry survey at the Prospectors and Developers Association of Canada conference in Toronto. It revealed just how vulnerable Canadian operations are to climate change: 76 per cent of the 42 respondents said their operations are sensitive to climatic hazards, while 48 per cent said climate change is already having a negative impact on some mine-sector operations. Disconcertingly, nearly half of the respondents indicated their companies were taking no action at all to plan for climate change.

A case study conducted by the researchers on diamond mining operations in the Northwest Territories unveiled further vulnerabilities. Melting permafrost, the cost of reducing greenhouse gas emissions, and a deteriorating ice road network (see sidebar) topped the list of concerns. While modest adaptations were noted in some of these areas, it is obvious that much work lies ahead. "There's a definite recognition among diamond miners that climate change is a threat to their operations," says Ford. "Largely missing are adaptation strategies for the future." *Continued ...*

This sinkhole formed on an ATV trail outside Kugluktuk, Nunavut in 2008. LEFT: Kugluktuk received 178.2 mm of rain over two days in July, damaging roads, blowing out culverts and washing away foundations. Extreme weather events are often tied to climate change.

COOL DEVICE: Thermosyphons are self-powered refrigeration devices that are used to help keep the permafrost cool. Inserted vertically in the ground, tubular thermosyphons contain liquid carbon dioxide at the bottom. The CO_2 absorbs permafrost-menacing warmth from the ground, turns to gas, rises up the tube, and offjets the heat into the atmosphere. It then cools, re-liquifies, and drips down the tube. They're used extensively in the North.

ILLUSTRATION JOHN BARROCHE

THE BIG MELT: What is the future for our winter roads?

Very possibly a harbinger of the economic cost of climate change, 2006 was a bad year for the ice road that connects the NWT's diamond mines to the all-weather road east of Yellowknife. The miners wound up paying the price of having to fly in some of their basic supplies.

The 2006 season for the Tibbitt-to-Contwoyto ice road was more than a month shorter than in 2005, dropping from 76 to 42 days. The miners – BHP Billiton, Rio Tinto, De Beers and Tahera Diamonds – didn't get all their loads in and were saddled with some expensive airborne alternatives.

Understandably, climate change has been seen as the likely culprit and similar changes are predicted for the region in the future. With the number of trucks on the road expected to grow in coming years with increased regional mining activity, melting conditions are an obvious concern. At 568 kilometres long, with 64 portages and three support camps, managing this road is no easy task.

The financial costs of a reduced ice-road season are significant. Freight that is not transported overland must be flown to mine sites, with the expected increase in price that air travel brings. Sixty per cent of the trucks on the road are carrying fuel, and fuel is notoriously expensive to fly in. In the shortened 2006 season, Diavik alone had to fly in 15 million litres.

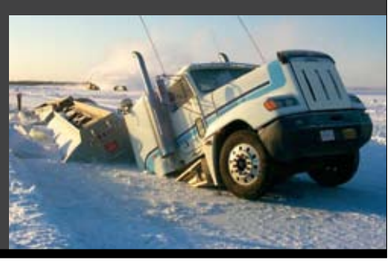
ABOVE: PATRICK KANE RIGHT: COURTESY THE HISTORY CHANNEL

In light of future threats and the 2006 wake-up call, solutions are now in the works. Lighter and amphibious machinery has been purchased to facilitate road construction earlier in the season, alternative road routings have been developed, and operations have been made more efficient.

Longer-term alternatives to the ice road are also being explored, including the extension of the all-weather road, the construction of a second ice road, or the use of the proposed Bathurst Inlet Port and Road.

The miners are also looking into alternative sources of energy, particularly hydroelectricity, to try and reduce the number of loads of fuel that need to be transported over the ice road.

BREAKING THE ICE: A fuel truck doesn't make it all the way along an ice road. (Left) The massive Russian M-26 helicopter was brought in to fly loads – up to 20 tonnes at a time – to mines after an NWT ice road closed early.



So, what does climate change mean for all these Northern mining operations in the future? Ask a miner and they'll often respond "not much." After all, most current mines won't be operating in 2050, let alone 2100. While it's true that short operational lives likely preclude large investments into adaptation, climate change can by no means be ignored. New mines will inevitably come on-line and operate well into the future and mine closure planning will undoubtedly need to consider the changing climate. So, what exactly does climate change mean for Northern mining operations? And what needs to be done?

"We're likely to see a number of risks associated with mine infrastructure," says Pearce. "Left unprepared for, climate change has the potential to seriously affect buildings, transportation routes, slope stability, tailings structures and site drainage, to name a few things." Indeed, buildings erected on thaw-sensitive land could see shifting – and in the worst case, collapse – as permafrost melts. Land-based transportation routes could face similar risks and slopes could increasingly slump and slide as underlying material loses cohesion due to melt.

Waste rock piles and tailings ponds are also relatively unique to mining, relying on sound engineering to ensure their stability and safety. In the North, some of these structures rely on frozen cores to impound materials. The implications of a warming climate are that these structures could lose their integrity over time. A tailings dam failure, for example, could wreak havoc on the sensitive Northern environment, never mind repercussions for the corporate image.

Mine site drainage and hydrologic regimes could also be affected by climate change. More frequent extreme weather events could unleash large amounts of precipitation in relatively short periods of time, evaporation trends may be altered, and the timing of expected seasonal events could change. Large amounts of precipitation arriving during the spring freshet in the Arctic, for example, could create a significant operational issue.

Infrastructure isn't the only thing that will be affected by a changing climate. Business risks also present themselves. For one, there are obvious regulatory issues and the threat of impending legislation. Talk of cap and trade systems and carbon taxes has led many in industry to consider how new legal landscapes might look and how business would be affected. Those companies caught off guard by new legislation stand to face significant economic repercussions, while those who act early could find benefits for the bottom line.

Some publicly traded companies have seen their shareholders demand that management disclose carbon emissions. In light of impending and existing climate-related legislation, shareholders have said these emissions represent a significant business and investment risk.

Projects that are moving from advanced exploration into production need to be especially cautious with climate change, as the environmental impact assessment process increasingly demands that it be considered. In a Northern context, Rio Tinto's Diavik mine, BHP Billiton's Ekati, Zinifex's High Lake project, Agnico-Eagle's Meadowbank gold project, Newmont's Doris North project and Sherwood Copper Corp.'s Minto copper mine all considered climate change, at least to some degree, in their assessments.

So what can miners do in light of our changing climate? Is there hope? Engineering solutions exist for a number of the problems posed by climate change, and while not always cheap, they can be effective. In instances where building on permafrost is unavoidable, thermosyphon technology may be an appropriate option. Already employed in many parts of the North to stabilize thaw-sensitive areas, thermosyphons are self-powered refrigeration devices that are used to keep permafrost cool.

They have their applications in mining as well: The Ekati and Diavik diamond mines already use thermosyphons to ensure thermal integrity of various structures. Similarly, tailings cover can be modified in a number of ways to ensure the materials below ground stay frozen and ground-based transportation networks can be built with insulating layers to minimize disturbance to the frozen soil below. These modifications will be especially important where frozen conditions are essential to the integrity of structures and designs.

To be most effective, however, engineering designs will need to incorporate predictions from climate change models. Climate forecasting is an important and evolving area of climate change science, but has yet to produce the detailed regional data needed for pinpoint engineering design. Climate models now provide us with useful, albeit generalized, pictures of predicted changes, but a need exists for their further refinement. In the absence of detailed modelling, adaptive management and active monitoring of mine site conditions will become even more important into the future.

In some cases, changing climatic conditions may be favourable to mining companies. Longer ice-free shipping seasons in some parts of the Arctic could mean lower freight costs, for example. Similarly, warmer temperatures could result in lower fuel costs for heating and lengthened exploration seasons. Producers of potash and uranium could especially benefit, as demand for non fossil-based fuels grow. "The degree to which any company successfully adapts to climate change will depend not only on how well they handle the impacts, but also on the degree to which they embrace opportunities that arise," says Ford.

"Climate change will change the way people live and the way they do business and mining will be no different," says Pearce. "Greenhouse gas reductions are undeniably important, but so too are the development of effective adaptation strategies."

There is a flipside to all the doom and gloom for Canadian businesses: The development of strategies to cope with climate change provides a real opportunity for Canadian companies to become leaders in climate change mitigation and adaptation. As canaries in the climate-change coal mine, the North will face the challenges soonest. The lessons we learn and the responses we apply could be put into practice around the globe as humanity struggles to deal with the effects of climate change.

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