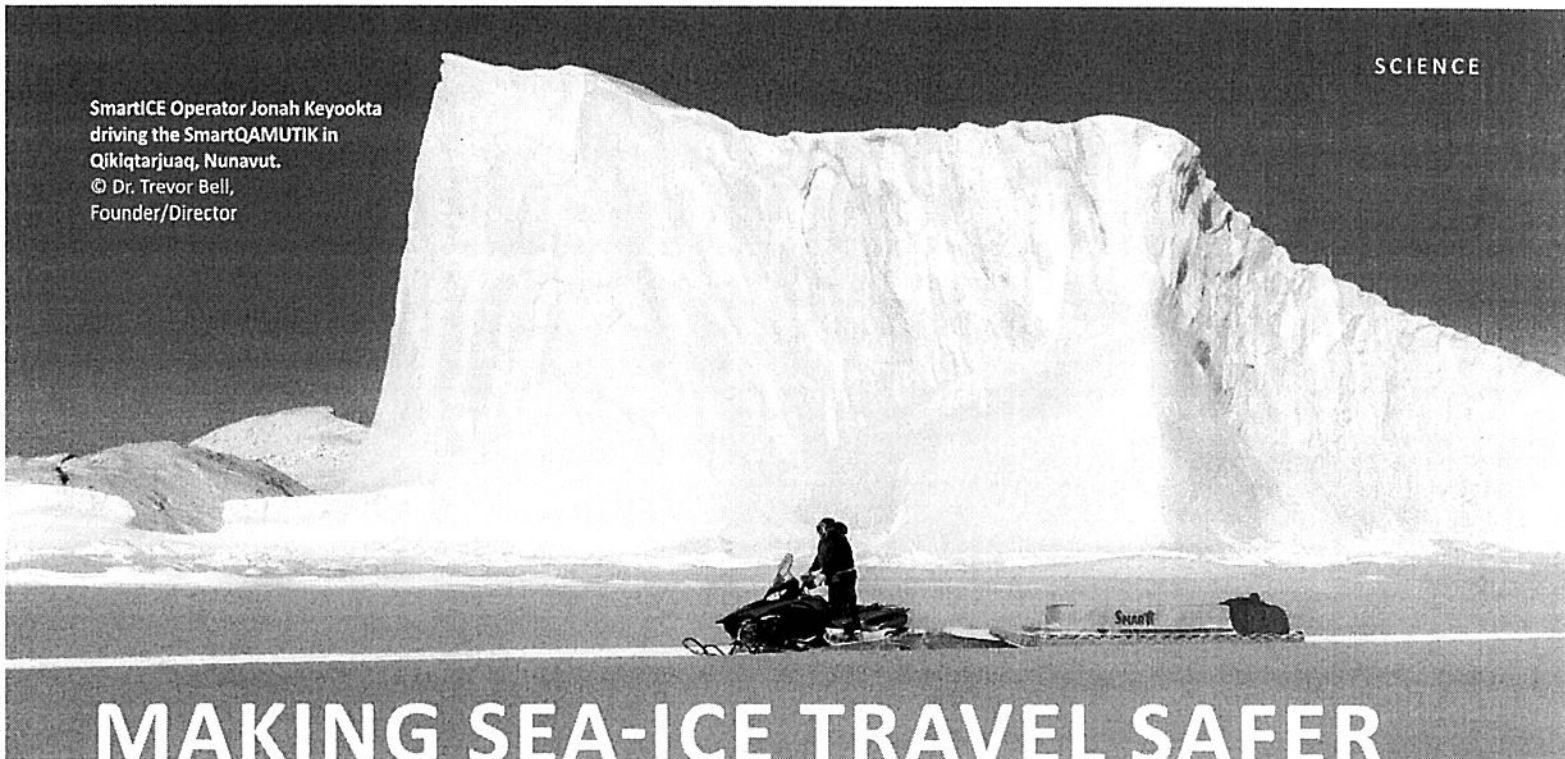


SmartICE Operator Jonah Keyookta driving the SmartQAMUTIK in Qikiqtarjuaq, Nunavut.
© Dr. Trevor Bell, Founder/Director



MAKING SEA-ICE TRAVEL SAFER

By Kelley Power

SmartICE started as a small research project in coastal Labrador. Today, it is a growing northern social enterprise servicing sites across eastern Inuit Nunangat. With its unique employment of novel technology, social innovation, and Inuit knowledge, SmartICE is helping Inuit find resilience in the face of climate change, while ensuring its business solutions are consistent with societal values and directly benefit communities.

SmartICE's story begins on the landfast sea-ice that hugs the Arctic coastline more than six months of the year. This ice is integral to the lives and livelihoods of Inuit living in Inuit Nunangat, serving as a vital travel link and harvesting platform.

In the past decade, climate change has seen the character of sea ice deteriorate. It is thinning from below, leaving treacherous conditions undetectable at the surface; it forms later in winter and breaks up earlier in spring; and it is more limited in extent.

Seeing the impacts of climate change on landfast sea-ice and the direct threat it posed to the safety and wellbeing of Inuit living in Nunatsiavut, a community research partnership began in 2013 to develop technology to help reduce the risk of sea-ice travel. And so SmartICE began.

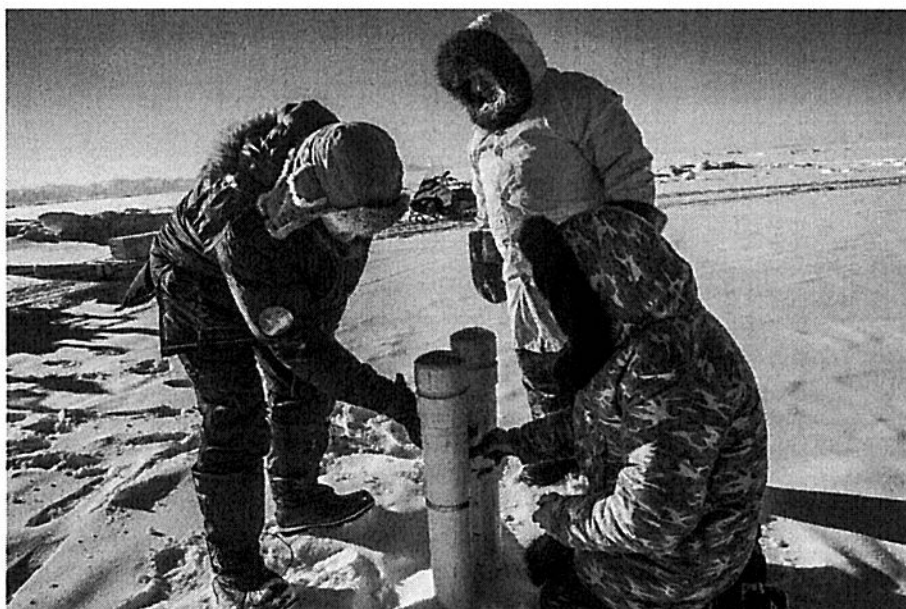
SmartICE focuses on making sea-ice travel safer by providing near real-time information on ice conditions. We use both autonomous sensors (SmartBUOYs), set up anywhere on the ice, and operator-run sensors (SmartQAMUTIKs), towed by a snowmobile along trails, to measure and report ice thickness to the community. Where useful, we also use satellite imagery to make

travel hazard maps of sea-ice conditions (for example: open water, moving ice, leads and cracks) around communities.

After its successful development and demonstration in two pilot communities (Nain, Nunatsiavut and Pond Inlet, Nunavut), and in response to increasing demand for its services from other communities, SmartICE established a not-for-profit social enterprise. Winning the Arctic Inspiration Prize in 2016 made this

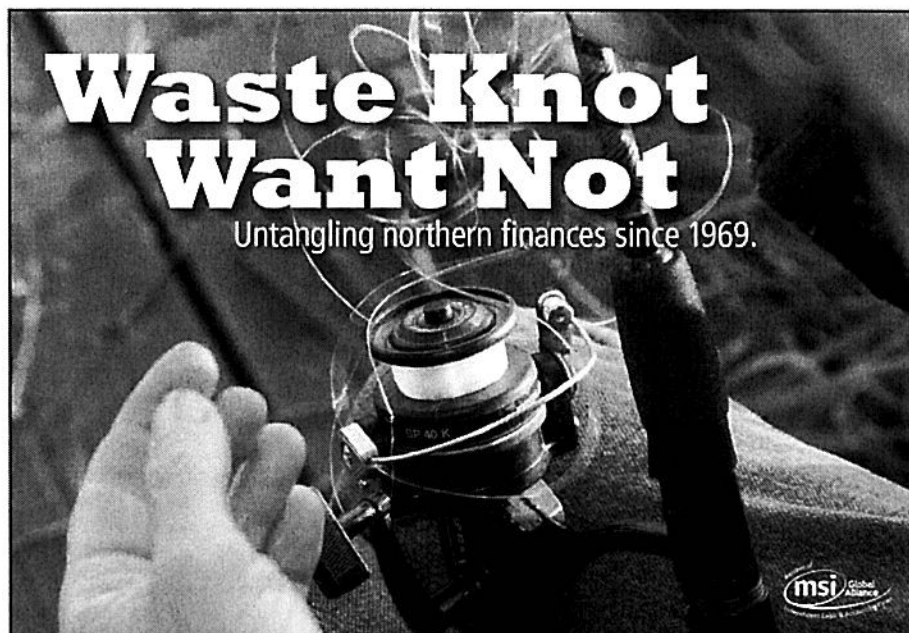
transformation possible — it was the game-changer that allowed SmartICE to shift its outlook from a community-university research project to a sea-ice monitoring and information service provider.

A social enterprise is not your typical business model. SmartICE selected it specifically for its social objectives and commitments. Rather than being driven by profit making for shareholders and owners, a social enterprise reinvests any




Dr. Trevor Bell and community members with deployed SmartBUOY in Pond Inlet, Nunavut.

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
SmartICE Operator on Winter Trail in Pond Inlet, Nunavut. © Michael Schmidt



surpluses in the business or in the community to maximize positive social change. It is also a business philosophy consistent with Inuit societal values such as caring for the environment (Avatittinnik Kamatsiarniq) and community (Pijitsirniq), while being innovative and resourceful (Qanuqtuurniq).

Over the past two years, SmartICE has been gradually expanding to new communities and discussing start-up opportunities with others. The company's growth continues to be grounded in its founding principles. Foremost is the aim to augment—not replace—Inuit knowledge of sea ice, while also involving Inuit in all aspects of its operation and decision-making. To this end, each client community convenes a management group comprised of a cross-section of sea-ice users to advise SmartICE operators on when and where to survey and how to share the information.

SmartICE sees itself as a social innovator, creating solutions to challenges, while putting people and communities first. The SmartICE mission is to empower communities to adapt to changing climate while maximizing local benefits. This includes re-designing the SmartBUOY for assembly by trained Inuit youth in Nunatsiavut and setting up business services so they can be delivered and managed locally by Inuit operators.

Sustainability is a fundamental business objective of SmartICE. Given the intensifying nature of sea-ice change for the foreseeable future, we need to find ways to maintain our services in every community that needs us. Although some are able to pay, most communities cannot. So, we are approaching commercial clients who rely on safe sea-ice operations for their own profitability—for example, tourism and fisheries—to purchase our services and make the information freely available to nearby communities.

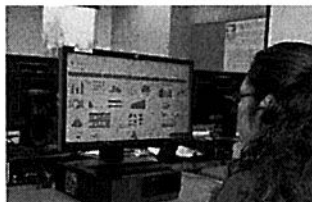

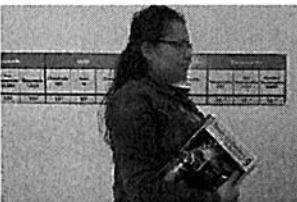
SmartICE welcomes inquiries from communities, companies and organizations interested in its services and social enterprise business model. An overview of its operations is available online at smartice.org. 

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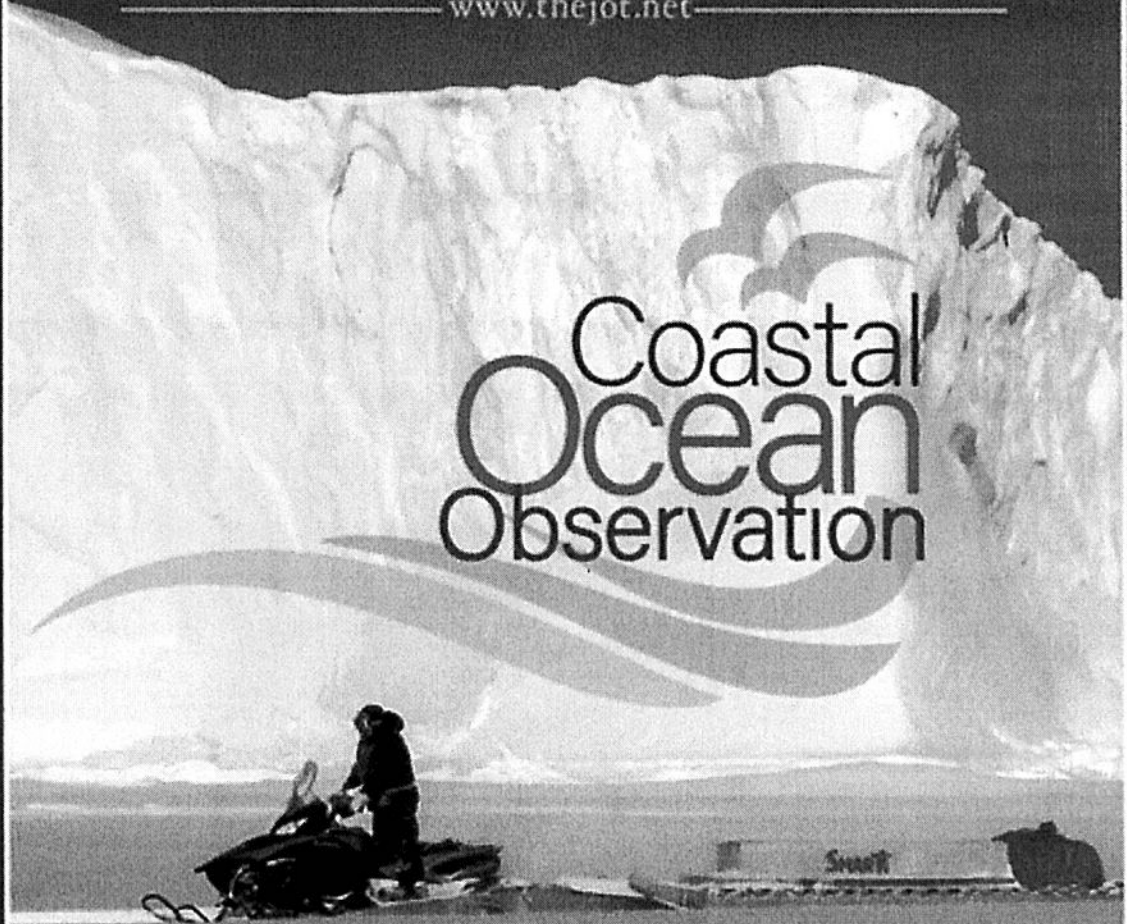




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Coastal Ocean Observation

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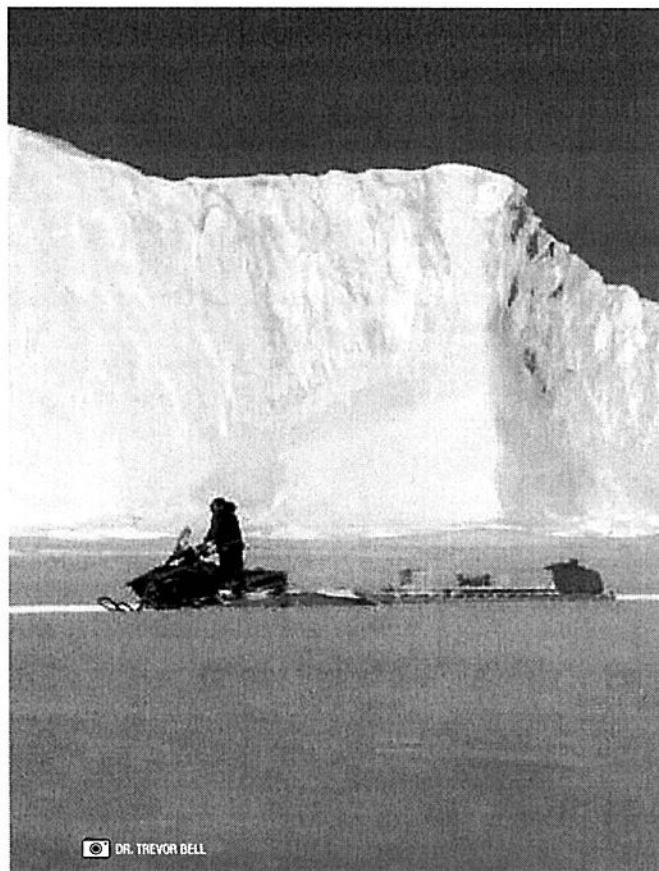
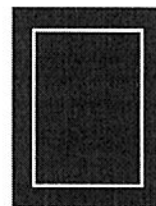
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On the Cover



 DR. TREVOR BELL

SmartICE operator Jonah Keyookta from Qikiqtarjuaq, Nunavut, operates the SmartQAMUTIK on local trails and an ice road used by hunters, fishers and cabin owners. The SmartQAMUTIK is towed by a snowmobile and measures sea-ice thickness in real-time as well as provides a colour-coded map representing the ice thickness along the route travelled. Once the operator returns, the map is made available to the entire community. This technology, coupled with Inuit Qaujimajatuqangit (knowledge and values), helps to ensure the safety of Inuit who rely on ice travel for subsistence and livelihood (e.g., outfitting, ice fisheries). www.smartice.org

Editor's note: Read more on SmartICE Sea-Ice Monitoring and Information Inc. under *Trade Winds* in this issue.

Trade Winds

An agent for transformational change of coastal monitoring in Inuit Nunangat

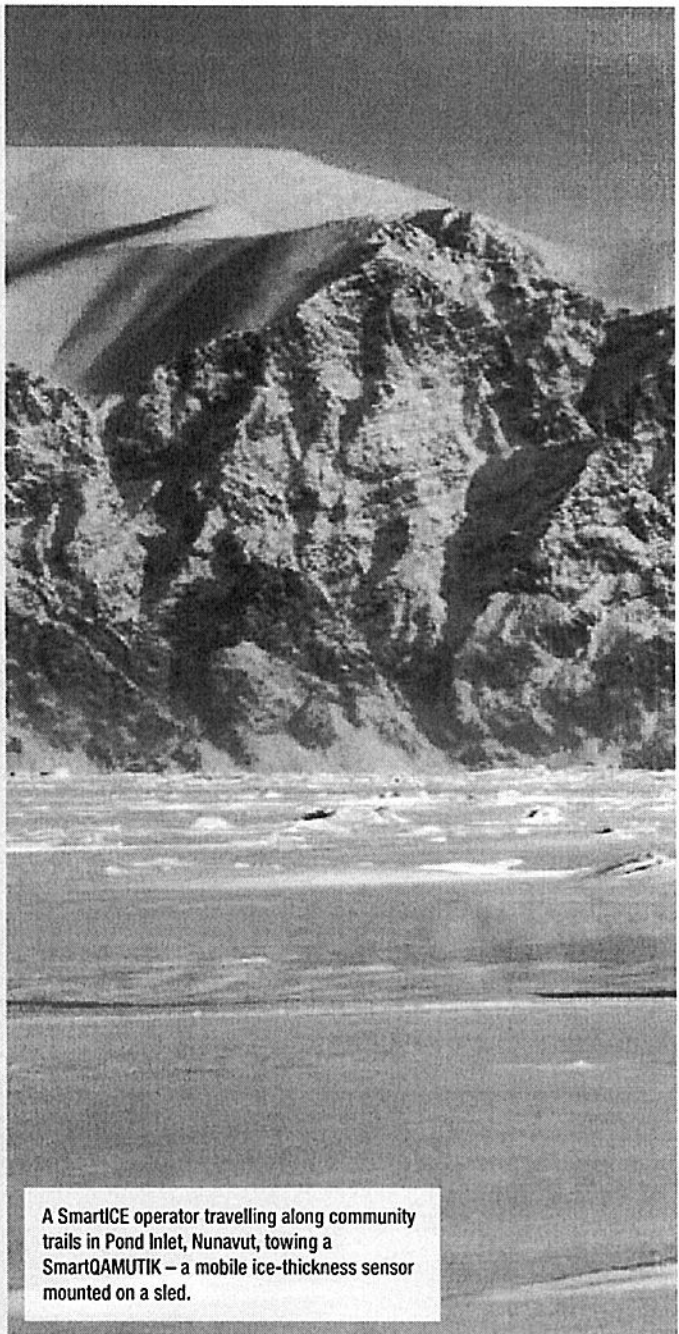
SmartICE

Inuit Qaujimajatuqangit (IQ; Inuit knowledge and values) of sea-ice has been acquired from centuries of observation and use. But in the last few decades this traditional knowledge has become less dependable in the face of unprecedented environmental changes. Land-fast ice is becoming thinner, forming later and breaking up earlier than before, resulting in increasingly dangerous travel. As Inuit use sea-ice to access country foods and maintain cultural and family practices, increased risk or fear of travelling on the ice has severe repercussions for food security and physical and mental health. Both young and old are falling victim to these unpredictable ice conditions.

SmartICE is a northern social enterprise focused on empowering communities through technology to adapt to unpredictable sea-ice conditions. The innovative and award-winning technology is the world's first climate change adaptation tool that integrates on-ice instruments, remote sensing and IQ to support safe sea-ice travel. As a result, SmartICE reduces individual risk, while building resilience to rapidly changing climate in northern communities.

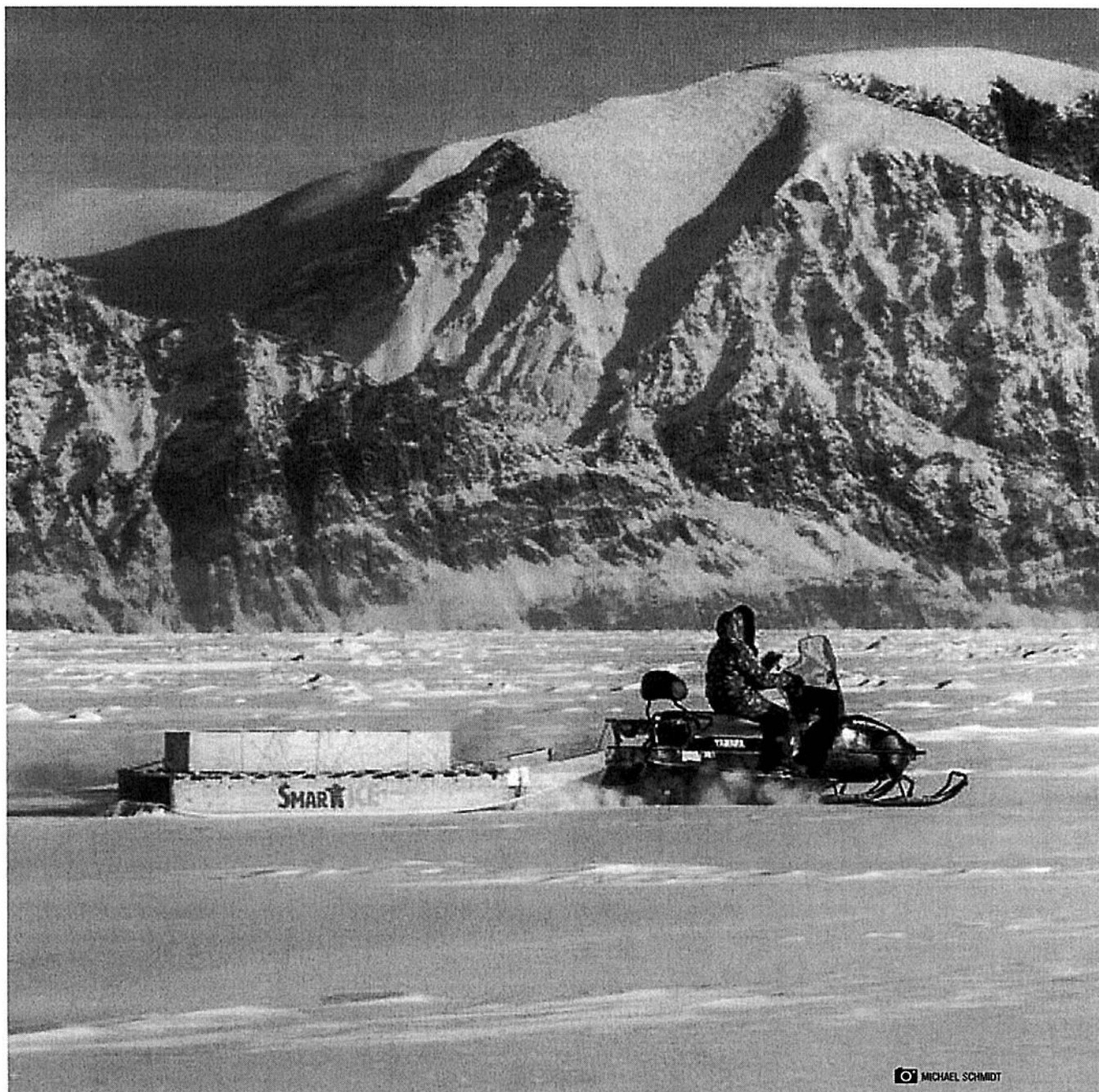
For example, at least once a week – more often during ice freeze-up and break-up periods – SmartICE operators travel along community trails towing a mobile ice-thickness sensor on sleds (SmartQAMUTIK; see photos above and on front cover). The operator's track is colour coded according to ice thickness and made publicly available upon their return. Community members then use this new information to modify and adapt their traditional travel routes.

Through a social enterprise business model, SmartICE is expanding to benefit all northern



A SmartICE operator travelling along community trails in Pond Inlet, Nunavut, towing a SmartQAMUTIK – a mobile ice-thickness sensor mounted on a sled.

coastal communities that rely on sea-ice information to adapt to a changing Arctic. It also has strong potential to grow as a service provider that not only delivers personal travel safety but also supports economic activity during diminishing and unpredictable sea-ice conditions. For example, the impacts of climate change on sea-ice conditions have the potential to negatively affect community-based tourism such as floe-edge and marine coastal tours that depend on a safe and predictable sea-ice platform to deliver their products.



Unpredictable ice break-up at the floe edge or ice break-through in areas that in the past were normally safe to travel represent risks to an industry where travel safety is paramount for market confidence and growth, and predictable ice conditions are essential for smooth operation and profitability. SmartICE works closely with tourism operators to deploy SmartICE services to identify hazardous ice in operational areas, while developing a predictive ice break-up model based on Inuit knowledge, sea-ice climatology and weather observations.

The SmartICE social enterprise empowers Inuit communities, and especially their youth, to view research and local expertise as part of the knowledge economy. With the appropriate training, experience and supports, enterprises such as SmartICE can inspire and empower a new generation of Inuit entrepreneurs to provide such information services through their own local businesses, for the benefit of their communities.

For more information
www.smartice.org

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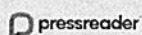
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Moses Amagoalik, a SmartICE operator in Pond Inlet, measures sea-ice thickness in Eclipse Sound using the SmartQAMUTIK (March 2018). SmartICE puts into the hands of communities the tools they need to travel safely on changing sea ice. *Michael Schmidt photo*

SmartICE: Innovating Climate-Change Adaptation in Canada's North

Trevor Bell

For Canada's Inuit communities, melting Arctic ice affects everything. Memorial University geography professor Trevor Bell co-founded SmartICE, a system of ice mapping and measurement that incorporates Inuit knowledge and relies on community input to provide near real-time information on ice conditions. It shared the Arctic Inspiration Award in 2016, a \$1 million prize endowed by Arnold Witzig and Simi Sharifi to thank the country that became their home.

Innovation responds to many types of opportunities and drivers. For SmartICE, recent unprecedented changes in sea-ice conditions, and the associated impacts on Inuit safety and livelihoods motivated our technological innovation. Severe social inequity between Inuit and most other Canadians, together with first-hand experience working with Inuit communities, drove our social innovation. And to grow our northern enterprise will require further innovation—this time in social financing.

SmartICE integrates on-ice technology, remote sensing and Inuit knowledge to generate near real-time information on ice conditions. To understand the enterprise's origins and relevance, it's important to appreciate that for more than six months of the year, sea ice hugs the Arctic coastline, where Inuit have lived and travelled for millennia. Sea ice is therefore not only a hunting platform and travel highway, it defines Inuit culture and identity.

Unfortunately, Arctic climate change is causing sea ice to be thinner, form later and break up earlier than before, resulting, for instance, in a decrease of 20 per cent per decade in September sea-ice extent along the Baffin Island coast. More troubling for ice users, warmer ocean currents are thinning the ice from beneath, leaving treacherous conditions undetectable at the surface.

Although often expressed as a gradual change, the greatest impacts of climate warming are typically experienced through the increasing frequency and magnitude of extreme events. Sea ice is no exception. The extremely warm winter of 2009-10 in the eastern Canadian Arctic provides insight into the impacts felt by communities when sea-ice conditions are severely compromised.

A survey of Nain residents (Nunatsiavut Inuit) revealed that about half of the respondents couldn't use their typical on-ice travel routes and took more sea-ice travel risks, while about three-quarters reported they were unable to predict ice conditions and were afraid to use the ice. Conditions prevented more than a third from going hunting and accessing country food (the traditional Inuit diet; Arctic char, seal, caribou) in a community where 80 per cent of households are food insecure. Close to one-in-twelve sea-ice users surveyed had fallen through the ice.

These statistics tell the real story of the widespread impacts of climate change happening now in Inuit communities and demonstrate the

“ A survey of Nain residents (Nunatsiavut Inuit) revealed that about half of the respondents couldn't use their typical on-ice travel routes and took more sea-ice travel risks, while about three-quarters reported they were unable to predict ice conditions and were afraid to use the ice. ”

critical need for both mitigation and adaptation actions. SmartICE was initiated as an urgent response to these impacts. Building on a close research partnership with the Nunatsiavut Government, the project team set about exploring how monitoring and information technology could be adapted for both the harsh sea-ice environment and the specific needs of Inuit travelers.

“ In response to community feedback, our maps have a straightforward legend that recommends Go, Slow Go, and No Go travel areas, based on ice stability, roughness, occurrence of leads and open water, and other travel hazards. ”

From the outset, SmartICE had some key principles and goals that helped direct its development. Foremost, it is designed to augment—not replace—Inuit knowledge of sea ice through involvement of Inuit in all aspects of its operation and decision-making. For it to be an effective climate-change adaptation for Inuit, SmartICE had to generate relevant sea-ice information at the community scale, in a timely manner, and in a format that is both comprehensible and accessible.

In practice, SmartICE operators travel along community trails towing our mobile ice-thickness sensor (SmartQAMUTIK, from the Inuktitut (Baffin) word for an ice sled). The sensor generates real-time ice thickness data to help guide the operator, while the operator's track is colour-coded according to ice thickness for the benefit of the community. Sea-ice users then modify their traditional travel routes based on this up-to-date information.

Likewise, our stationary ice-thickness sensor—the SmartBUOY—is designed to be affordable and efficient in measuring sea-ice thickness and snow depth at strategic locations identified by the community. These locations are usually representative of larger ice areas or early indicators of dangerous ice conditions. Its advantage over the SmartQAMUTIK is that the SmartBUOY operates autonomously at any distance from the community and transmits data by satellite.

SmartICE is preparing sea-ice travel hazard maps at the community scale every couple of weeks and more often during shoulder seasons when ice conditions are particularly dynamic. The maps are validated through the observations, measurements and traditional knowledge of our SmartICE operators. In response to community feedback, our maps have a straightforward legend that recommends Go, Slow Go, and No Go travel areas, based on ice stability, roughness, occurrence of leads and open water, and other travel hazards.

But SmartICE is not just a technological fix. It strives to be a social innovator, empowering communities to adapt to unpredictable ice conditions while maximizing societal impact. Following its successful demonstration in two pilot communities (Nain and Pond Inlet), and in response to increasing demand for its services, SmartICE established a northern social enterprise. The Arctic Inspiration Prize (2016) made this transformation possible—it was the game-changer that allowed SmartICE to shift its outlook from community research partnership to northern service provider.

Why a social enterprise business model? That was an easy choice. First, it is consistent with Inuit societal values, such as caring for the environment (Avatittinnik Kamatsiarniq) and community (Pijitsirniq) and being innovative and resourceful (Qanuqtuurniq). Second, it commits to creating positive community change—not profit for “southern” shareholders—while applying an entrepreneurial approach to the delivery of its services. To illustrate this social innovation, we are re-designing our SmartBUOY technology so it can be assembled by trained Inuit youth in Nunatsiavut for distribution across Inuit Nunangat. This technology production centre—the first of its kind up North—will not only harness the vast potential of Inuit youth, which can make up 60 per cent of local populations, but also inspire a new generation to embrace knowledge, technology and research as a vehicle for economic development and community well-being.

In the spirit of reconciliation and self-determination, and for SmartICE to be effective, Inuit are involved in all aspects of its operation and decision-making. Community sea-ice user groups created by SmartICE are made up of elders, youth, experienced and young hunters, and representatives from key local organizations (e.g., hunters and trappers). The groups, self-named ‘Sikumiut’ (“people of the ice”), advise

SmartICE Inuit operators when and where to survey and how the information should be shared with their communities.

“In the spirit of reconciliation and self-determination, and for SmartICE to be effective, Inuit are involved in all aspects of its operation and decision-making. Community sea-ice user groups created by SmartICE are made up of elders, youth, experienced and young hunters, and representatives from key local organizations (e.g., hunters and trappers).”

As SmartICE expands across the Arctic—currently nine communities, with about another dozen pursuing start-up opportunities—the enterprise needs to think ahead to its long-term sustainability and expanded market needs. This includes both scalable services and ongoing technology development to respond to more intensive climate impacts. For example, warmer temperatures and increased snow accumulation will turn sea-ice surfaces into slush, resulting in increasingly more dangerous ice travel. SmartICE is developing and integrating a new sensor that measures the occurrence and thickness of slush, for deployment on the SmartQAMUTIK.

Although less featured in the popular media than sea ice, freshwater ice on lakes and rivers is also experiencing shorter and less predictable seasons. It is estimated that almost 10,000 km of winter trails provide surface access to re-supply remote, mostly Indigenous communities across the

northern provinces and territories of Canada. With few exceptions, these trails are not monitored for ice travel safety, despite the evidence of increasingly warmer winters and documented break-throughs of resupply vehicles. SmartICE is adapting its monitoring systems and services to generate near real-time information on freshwater ice conditions for the benefit of both communities and businesses across the Arctic interior.

Mining, shipping, fisheries, tourism, emergency response, national defense and environmental monitoring are all carried out to some degree on or through ice in the Arctic and therefore information on ice conditions, especially during the dynamic freeze-up and break-up periods, reduces their risk and improves operational performance.

SmartICE is actively engaging industries and government services to explore how it can meet their ice information needs on a commercial basis, while subsidizing services for communities. It is also exploring opportunities for social financing, which mobilizes private capital to deliver both a social dividend and an economic return to achieve societal and environmental goals. Being an Arctic Inspiration Prize laureate opens doors to prospective investors and we are extremely grateful for the generosity of Sima Sharifi and Arnold Witzig in creating the prize and recognizing the importance of Arctic innovation. **P**

Trevor Bell is University Research Professor in Geography at Memorial University of Newfoundland. Since its inception Trevor has led the development of the SmartICE initiative, a recipient of the 2017 United Nations Climate Solutions Award.