Changing Times

Climate Change Impacts and Adaptation in Nunavut

Summer | 2012

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Introduction

In this season's issue of Changing Times, we have focused on permafrost in Nunavut and how it is being impacted by a changing Arctic climate. Recent projections have shown a continued thawing of permafrost throughout Nunavut as a result of increased Arctic temperatures, which is expected to continue into the foreseeable future. This change has the potential to significantly affect Nunavummiut and how we go about our daily lives – impacting travel by trail and road, community infrastructure, and economic activities throughout Nunavut.

According to the report - *What we know, don't know, and need to know about climate change in Nunavut, Nunavik, and Nunatsiavut: A systematic literature review and gap analysis* (Ford & Pearce, 2010) - there is less published academic research on permafrost degradation in the Eastern Arctic than in the west; however there are currently projects underway in Nunavut that are attempting to address this issue. Permafrost related work has been conducted in the communities of Clyde River, Pangnritung, Iqaluit, Arviat, Whale Cove, Cambridge Bay, Kugluktuk, Pond Inlet, Arctic Bay, Igloolik and Resolute Bay. This work involved a range of scientific techniques and analyses including monitoring and assessing permafrost conditions, landscape hazards, and surficial mapping (the process of describing the distribution and qualities of unconsolidated sediment layers). The results of this research will be important in supporting land use planning, policy development, and community adaptation programs across Nunavut.

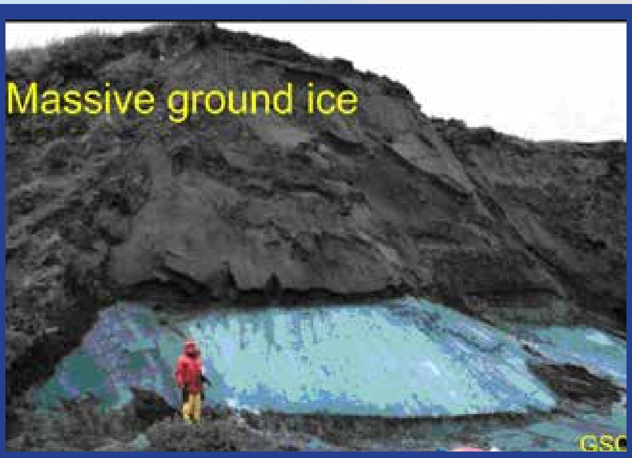
Changing Times endeavors to provide relevant and current information on climate change activities across Nunavut. We welcome your feedback on this season's issue, and hope you will enjoy reading about the exciting work that is going on in your back yard.

Permafrost Facts

Wendy Sladen
Geological Survey of Canada, Natural Resources Canada

Permafrost is defined as soil or rock that remains below 0ºC all year. For permafrost to form, the ground must cool enough in winter so that it does not completely thaw in summer, leaving a frozen layer that lasts all year.

Above the permafrost, near the ground surface, there is a layer that freezes and thaws each year called the active layer.



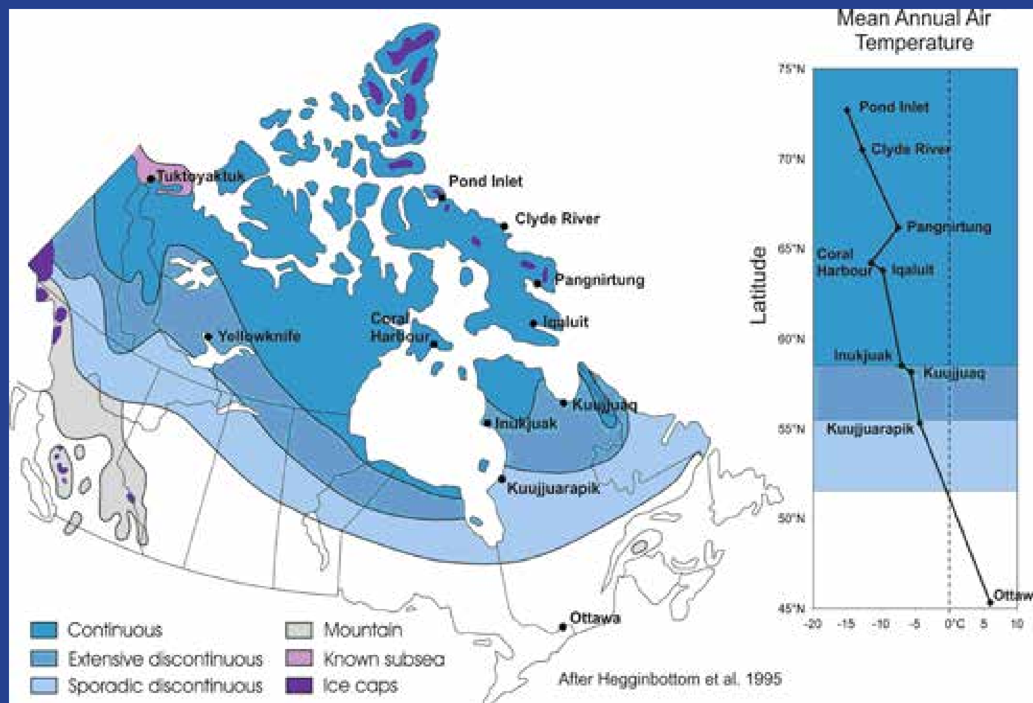
Ground ice

In permafrost, almost all the water is frozen. This ground ice occurs in the form of pore ice, ice lenses, or massive ice.

Ice contributes to the strength of the ground. If it thaws, it can cause landslides or weakening and settlement of the soil, especially in areas where there is excess ground ice.

Permafrost and climate

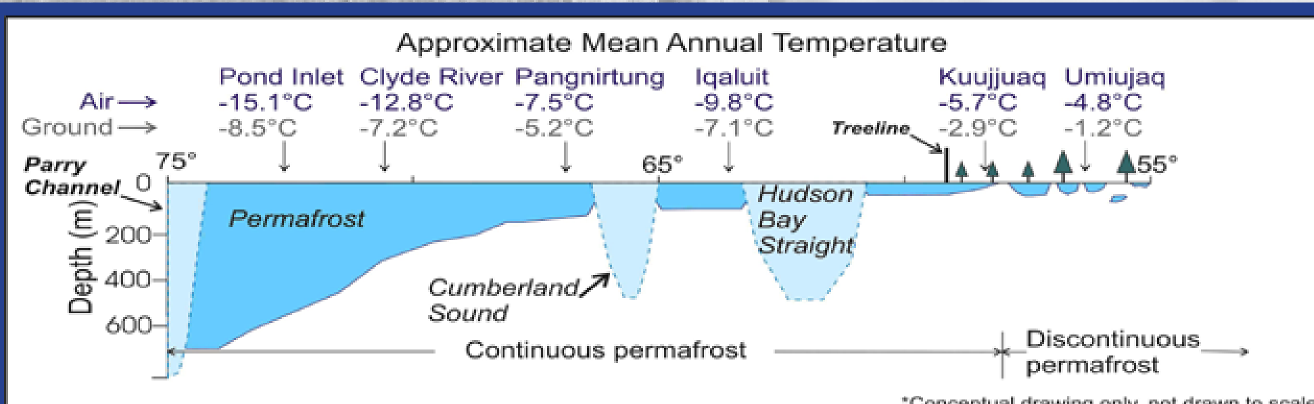
Climate is the main factor determining the existence of permafrost. However, latitude, water bodies, mountains, and local climate also influence where you find permafrost and how thick it is. The permafrost region, which underlies 50% of Canada, is divided into zones of continuous and discontinuous permafrost. Continuous permafrost means that permafrost occurs everywhere except beneath large bodies of water. In discontinuous permafrost, areas of frozen ground are separated by areas of unfrozen ground. In the far North, permafrost can be more than 500m thick.



The graph (below, on the right) shows how mean annual air temperature (MAAT) decreases as latitude increases. Mean annual ground temperatures are usually warmer than MAATs because of surface environment effects. For continuous permafrost to form, typically MAATs of -6 to -8ºC or colder are required (French, 1996).

Vertical distribution and thickness

Typically in Canada, the extent and thickness of permafrost increases as latitude increases. This figure illustrates how mean annual air and ground temperatures and permafrost thickness can vary with latitude in the eastern Arctic.



Permafrost and local climate

The temperature at the ground surface influences the temperature, thickness and geographic distribution of permafrost. The ground surface temperature depends on local climatic conditions and such things as vegetation, snow cover, lakes, rivers, and soil properties.

For example, snow insulates the ground causing warmer ground conditions in the winter, whereas thin or no snow cover leads to colder ground conditions. The type of vegetation and the characteristics of the ground surface will affect where snow accumulates.

Impacts of permafrost thawing

Permafrost affects how people live in the North; construction of roads, buildings and bridges, and delivery of community services such as water and sewage must be modified to account for frozen ground.

Natural or human changes to the environment can cause warming or thawing of permafrost. Depending on soil conditions, thawing of ice-rich permafrost can result in subsidence and settlement of the ground. This can lead to foundation issues and landslides.

References
French, H.M. 1996. The Periglacial Environment. 2nd Edition, Addison Wesley Longman Ltd, Essex, England, 341p.
Hegginbottom, J.A., Dubeuil, M.A., and Harker, P.T. 1995. Canada, Permafrost. National Atlas of Canada, 5th Edition, National Atlas Information Service, Natural Resources Canada, MCR 4177.

*The above text is taken from “Sladen, W.E., 2011. Permafrost; Geological Survey of Canada, Open File 6724”.

Permafrost Monitoring Network in Nunavut

David Mate, Natural Resources Canada

Permafrost in an important component of the northern landscape and underlies communities and its supporting infrastructure throughout Nunavut. Permafrost and the ground ice it contains presents challenges to engineering design as techniques must be utilized to prevent or avoid thawing ice-rich soil during construction and operation of infrastructure. Climate change presents an additional challenge which may lead to additional thawing of the ground over time and have implications for infrastructure performance. This is particularly important for structures that may have a long operating life or where there are high consequences of failure as could be the case with waste containment facilities and linear structures such as roads and runways. Knowledge of permafrost conditions including its thermal state (temperature) is therefore essential for informed landuse planning decisions, engineering design and the development of adaptation strategies to respond to the impacts of climate change.

Between 2008-2010, with funding obtained through the federal government's IPY program, NRCan collaborated with the Government of Nunavut (GN) and 10 communities (Resolute, Igloolik, Arctic Bay, Pond Inlet, Clyde River and Pangnirtung, Repulse Bay, Gjoa Haven, Taloyoak and Kugaaruk) forming the Permafrost Monitoring Network, which has worked to install permafrost monitoring sites in Nunavut. These sites will generate ongoing information on the thermal conditions of the ground to depths of 15 m. This will provide baseline information required for engineering design and community planning. It will also help understand the response of permafrost to changes in climate. In addition these sites contribute to a larger National Permafrost Monitoring Network with the goal of increasing the knowledge of current conditions across Canada's permafrost region and building a baseline against which to measure change.

To learn more about this Permafrost Monitoring Network, please visit: http://geopub.nrcan.gc.ca/moreinfo_e.php?id=287873

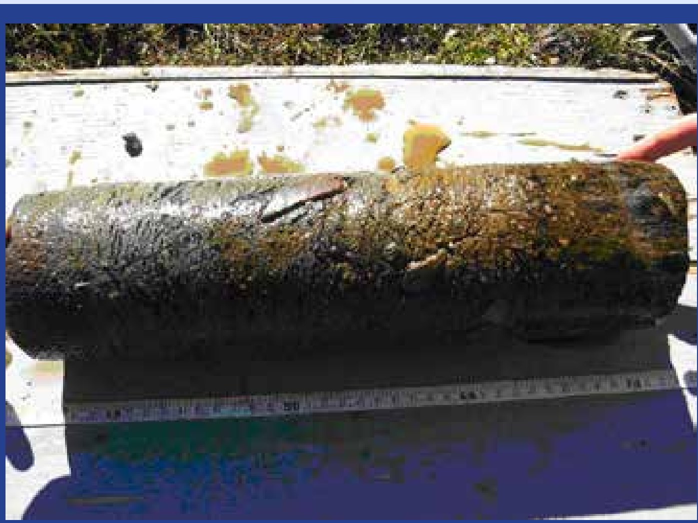
Mapping of surficial geology and permafrost characterization in Iqaluit

Anne-Marie LeBlanc, Michel Allard, Valérie Mathon-Dufour, Jérémie Doyon-Robitaille, Emmanuel l'Hérault, Greg Oldenborger, and Wendy Sladen

In Iqaluit, permafrost temperatures at a depth of 5 m have increased by about 2 °C per decade since the early 90's in response to recent warming. At the Iqaluit airport, this increase in permafrost temperatures has led to noticeable and localized ground subsidence. Iqaluit is also a city that is growing rapidly and contains much of the territory's strategic infrastructure. It is thus essential to acquire good knowledge on the surficial geology and the permafrost conditions to maintain the integrity of existing infrastructure and to ensure that new infrastructure is designed appropriately.

In summer 2010, a scientific crew spent most of August using different techniques to acquire information about the permafrost and to produce a new detailed surficial geology map. The work was done in close collaboration with the city of Iqaluit (Michèle Bertol and Meagan Leach) in order to identify areas of priority and of new development, and also with airport authorities (John Graham), the Nunavut Research Institute (Mary Ellen Thomas, Jamal Shirley and Rick Armstrong), and the GN (John Hawkins, Economic development and Transportation, and FrØydis Reinhart and Michael Horlink, Environment).

Surficial geology was first assessed prior to the field work through air photo interpretation. This interpretation was then reassessed in the field using stratigraphic sections and core samples. To achieve this, pits were dug to the thaw front and the underlying permafrost was cored with a portable earth drill. The samples were kept frozen for laboratory analysis to measure ice and water contents, salinity and grain size. These parameters are important in order to determine how sensitive the ground is to any natural or human disturbances. For example, when a soil consisting of fine sediments and ice thaws, it is more susceptible to settlement than bedrock or ice-poor and well drained sand. Deep holes of about 15 m were also drilled with the help of a local contractor, and sensors for measuring ground temperatures were installed in the boreholes. Finally, two types of shallow non-invasive geophysical surveys were conducted in the study area to allow a deeper characterization of the subsurface: ground penetrating radar and electrical resistivity.



In Iqaluit, the surficial map shows that the older part of the city is built on a deposit of marine veneer characterized by raised marine beaches, where few ice lenses near the permafrost table could be found. The newer sectors are on bedrock and till, which are in general unlikely to be destabilized by climate or human disturbances. The airport is mostly built on gravelly sand, however, the original terrain does indicate a dense network of ice wedge polygons. These permafrost features, together with the effects of other parameters (climate change, snow cover, surface and subsurface water, etc.), make the runway, the aprons and the access roads more vulnerable than before. A deposit of massive ice buried in gravel and sand was also found in the new municipal gravel pit. This will have an impact on the availability of granular aggregate resources for the development of the town.

One complete year of permafrost temperatures will be available in the summer of 2011 when the team returns to Iqaluit to collect more field data and improve their understanding of permafrost and its surrounding environment. The results will help city planners, the Iqaluit airport and the Government of Nunavut when designing infrastructure and making land-use decisions.

UPAGIAQTAVUT: Setting the Course

Lauren Solski, Government of Nunavut

Do you remember when TV shows were broadcast in black and white or when the internet became a household possession? Do you remember when cell phones were unable to text or when VHS was the latest video media? Times certainly change. Like technology, another continuous change in the world is the climate. While climate change is natural, humans have contributed to the speed of this process by burning fossil fuels. Unlike a new technical gadget, climate change does not come with a manual. People are expected to adapt to this change with little guidance.

Nunavummiut have witnessed climate change impacts such as decreasing sea ice, changes in ice condition, permafrost degradation and new animal species. How are we supposed to adapt to a land where wildlife habitats are changing and hunters can no longer reach game? How can we possibly save our infrastructure, which was built for a land of permafrost? These questions are challenging and the perfect answer may not exist. However, the Department of Environment (DOE) has completed the Government of Nunavut's (GN) strategic document on climate change, Upagiaqtavut – Setting the Course, Impacts and Adaptation in Nunavut. This strategy provides strategic direction, helping Nunavummiut adapt and prepare for the future impacts of climate change.

Upagiaqtavut has been created with the full respect for Nunavummiut and Inuit knowledge. This strategic document has been produced with Inuit Qaujimajatuqangit, which is a system of traditional Inuit societal values. These values, such as Pijitsirniq (serving and providing for family and/or community) and Avatittinnik Kamatsiarniq (respect and care for the land, animals and the environment), provide full insight into climate change.

Upagiaqtavut sets a unique climate change adaptation approach, with its key agenda modeled after an Inuit sled, or qamutik. The crossbars on the qamutik are called *napuit*, which are used to outline the strategy's primary objectives. Each napuk holds an important step towards helping Nunavummiut adapt to the future of our changing world.

Below is a summary of each of the napuit and their objectives:

Napuk 1: Partnership Building

This napuk focuses on the importance of building partnership with other stakeholders to address climate change. By working together, we can facilitate information exchange, pooling of resources, and increasing skills and capacity in Nunavut.

Napuk 2: Research and Monitoring

This napuk will provide a better understanding of the impacts of climate change on our communities, culture, health, environment and economy. By exploring these impacts using scientific, community and Inuit knowledge, we will better prepare Nunavummiut for change and help close current knowledge gaps.

Napuk 3: Education and Outreach

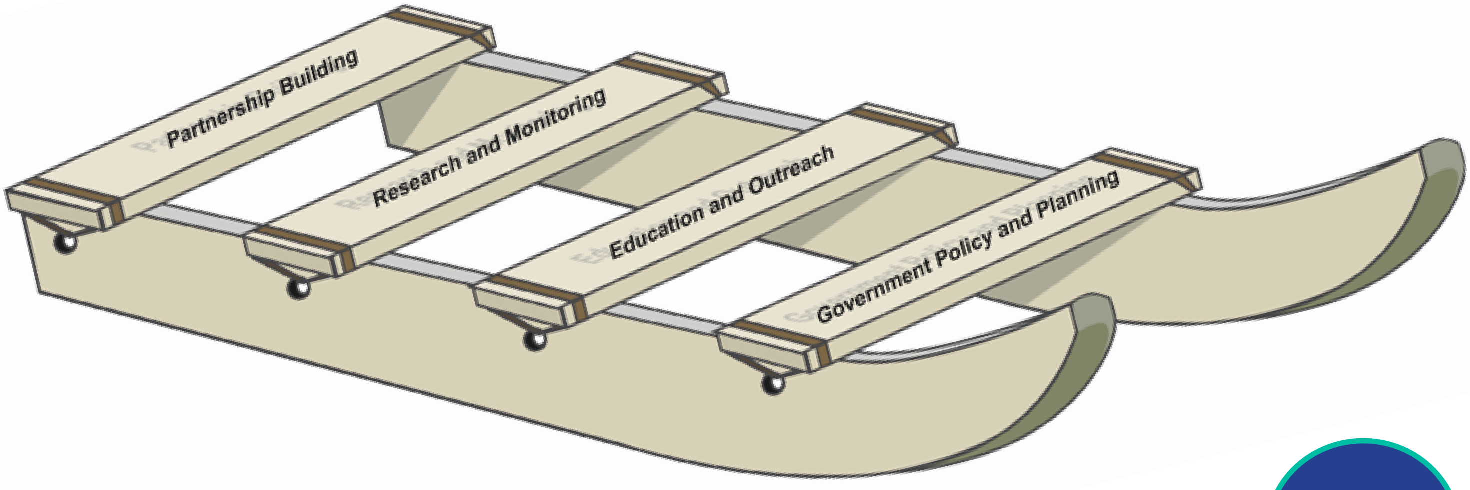
Nunavummiut must be educated about climate change. This napuk shows how we plan to assist Nunavummiut gain access to current and accurate climate change information, via websites, education institutions, local elder knowledge, Nunavut research activities, etc.

Napuk 4: Government Policy and Planning

This napuk ensures the GN will consider climate change adaptation in all government decision-making, and that future development is carried out with consideration for the environment. We will continue to work with stakeholders to identify new economic opportunities associated with climate change, like jobs for Nunavummiut.

The GN is committed to increasing the adaptive capacity in Nunavut's communities and the government itself. Nunavummiut have traditionally overcome many challenges by working together, and Upagiaqtavut has set the course for how the GN will continue working with communities to meet the challenges presented by climate change.

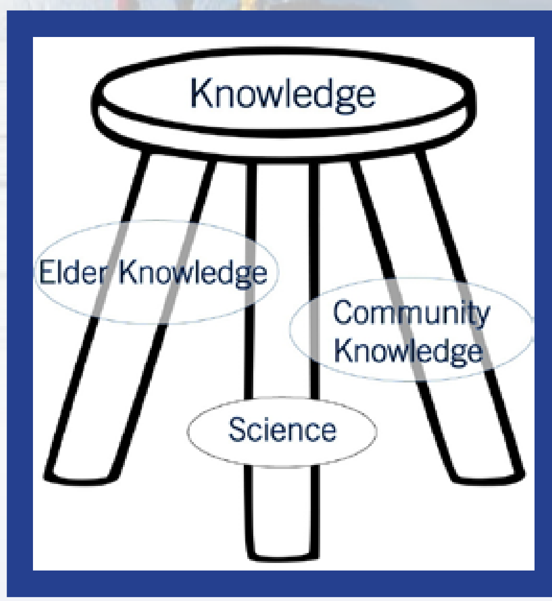
For more information on Upagiaqtavut, and to obtain copies in the 4 official languages of Nunavut, please visit *www.climetechangenunavut.com*. You can also visit our website to find relevant links to climate change adaptation activities and publications developed by the GN.



Climate Change Planning in Whale Cove, NU

Beate Bowron, Canadian Institute of Planners (CIP)

Traditional knowledge and scientific data indicate that climate change has begun to seriously affect Nunavut communities, including the hamlet of Whale Cove. Here, temperatures have increased by 2 degrees Celsius since 1980, and expectations are that the annual average temperature in Whale Cove will climb by a further 2 to 4.5 degrees over the next 75 years.



In 2009/10 a CIP planning team (Katie Hayhurst and Taylor Zeeg) worked with Elders, the community-at-large, NRCan scientists and the GN to complete a Climate Change Adaptation Plan (CCAP) for Whale Cove. The Whale Cove CCAP was one of five CCAPs developed by CIP planning teams in the context of the Nunavut Climate Change Partnership which was supported by Indian and Northern Affairs Canada.

Based on the work of Michel Allard (Centre d'études Nordiques, Université Laval), the Whale Cove CCAP found that the hamlet is more resilient and less sensitive to permafrost thawing than many northern communities, since a large part of it is located on bedrock. However, there is evidence that the depth of the thawing permafrost is increasing, affecting especially the softer ground in the lower town. With rising temperatures the thawing will get deeper, potentially destabilizing buildings and damaging infrastructure. Drainage is already poor as the perched water table on top of the permafrost is close to the surface.

It appears, though, that the hamlet has made good development decisions in the past. Some seemingly suitable areas of the town were surveyed for development, but were not built on, because they were located on the site of a former pond where the ground is still soft and wet. Whale Cove has also employed good building practices on difficult sites such as using space frames, deeper piles and thermosyphons. In addition, the hamlet is fortunate that flat land on top of bedrock is available to accommodate the community's growth.

The close cooperation between the planning team and climate change scientists in completing the Whale Cove CCAP was one of the hallmarks of the Nunavut Climate Change Partnership. CIP added its professional expertise and its community-based planning approach involving a large number of stakeholders, community organizations, institutions and interested individuals. For example, Michel Allard presented his permafrost findings at a community feast cum workshop with caribou stew and bannock and 200 cupcakes produced by volunteers under the leadership of one of the planners. The planning team also produced a climate change workbook and poster which were distributed to all Whale Cove households.

CIP's climate change adaptation planning initiatives in Nunavut have resulted in Climate Change Adaptation Planning: A Nunavut Toolkit (2011). The purpose of this Toolkit is to help other northern communities plan for climate change adaptation in a cost-effective way under the guidance of a planner. The Toolkit outlines a straightforward 5-step process for completing a climate change adaptation plan with a community. One of the Toolkit's special features is the recognition of the importance of traditional knowledge (IQ) as one of the three pillars of climate change knowledge.

The Nunavut Adaptation Planning Toolkit and the Whale Cove CCAP are available from CIP's special website *www.planningforclimatechange.ca.*

Nunavut Regional Adaptation Collaborative (R.A.C.)

Jared Fraser and Colleen Healey, Government of Nunavut

Numerous national, circumpolar and global scientific assessments highlight the importance of climate change in influencing northern economic development. Governments, industry, and communities all have diverse but linked roles to play in the development of adaptation measures and strategies to ensure economic resilience in northern Canada in the face of climate change.

The Northern Regional Adaptation Collaborative (RAC) project is being funded by Natural Resources Canada (NRCan) and the Government of Nunavut, Department of Economic Development and Transportation to facilitate collaborative activities within Nunavut which are needed to build capacity and develop adaptive measures to climate change that relate to infrastructure in support of northern development. In Nunavut, mining is and will continue to be a cornerstone of the regional economy, and contributes to northern development through the creation of jobs, triggering a wide range of spin off economic activities.

The objectives of the Nunavut RAC projects are to improve Nunavut's resilience to a changing climate through collaborative activities that will examine infrastructure to support mining activities, particularly managing the risks that climate change presents to tailings facilities and port infrastructure and to enhance capacity to advance adaptation decision making in these areas. The project will consist of three tasks which include: 1) a 'Vulnerability Assessment of the Mining Sector to Climate Change'; 2) documentation of 'Good Environmental Practices for Arctic Exploration and Mining'; and 3) documenting engineering challenges for large-scale infrastructure related to tailings facilities and port design.

The project will benefit Nunavut governments and industry by advancing adaptation decision making into planning and operations and, in so doing, reduce vulnerabilities and capture opportunities within the region to a changing climate.The results of the Nunavut RAC will be posted online at www.climatechagenunavut.ca in March 2012.

For more information please visit: http://adaptation.nrcan.gc.ca/collab/index_e.php

The Nunavut Climate Change Partnership 2011 Workshop

David Mate, Natural Resources Canada

The Nunavut Climate Change Partnership (NCCP) began in 2006 between the Government of Nunavut, the Canadian Institute of Planners, Natural Resources Canada and Indian and Northern Affairs Canada. This partnership was focused on helping Nunavut communities adapt to climate change and increasing adaptive capacity and climate change knowledge in the territory. Specifically, the goals of the NCCP were to: 1) create scientific information that is regionally and locally targeted to help communities adapt to climate change, 2) build capacity for climate change adaptation planning within the Government of Nunavut and in Nunavut communities and 3) develop tools to collect, publish, share and communicate climate change adaptation knowledge across Nunavut and beyond. Work through this partnership was conducted in the communities of Clyde River, Hall Beach, Iqaluit, Arviat, Whale Cove, Cambridge Bay and Kugluktuk.

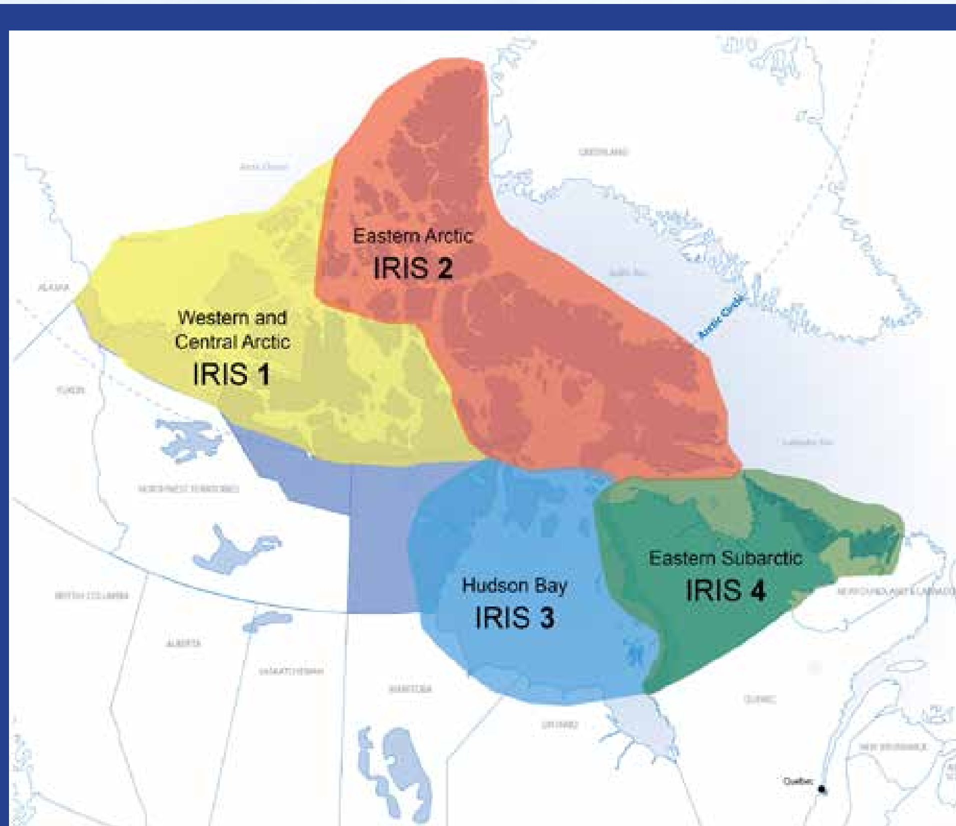
The NCCP held a workshop in Iqaluit on February 15-16th, 2011 with the aim to report back on all activities and outputs, explore new opportunities and discuss lessons learned. Speakers and participants from across Canada including Nunavut communities, governments, scientific, policy and planning organizations and universities participated in the workshop. On February 15th, results from scientists and government officials were presented on climate change geoscience research (including permafrost research), community climate change adaptation planning work and opportunities for new work. On February 16th, participants were asked to focus their attention on two key themes: 1) what research, information and climate change adaptation resources will be needed in the future (a needs assessment); and 2) what lessons can be learned from the current partnership that would enable research and planning to be undertaken more effectively (lessons learned). In total nearly 100 people participated in this workshop.

For further information on the outcomes of the NCCP Workshop, please visit: http://geoscan.ess.nrcan.gc.ca/cgi-bin/starfinder/0?path=geoscan.fl&id=fastlink&pass=&search=R%3D288645&format=FLFULL

Introducing ArcticNet

Philippe LeBlanc and Trevor Bell, ArcticNet

ArcticNet is a research program and network of scientists and managers with northern expertise in the natural, human health, and social sciences partnering with Inuit Organizations, businesses, and provincial, territorial and federal government departments. The central objectives of the network are to study the impacts of climate change in the coastal Canadian Arctic and disseminate this knowledge to help northern societies and industries prepare for the challenges and opportunities that lie ahead. ArcticNet is supported by the Government of Canada through the Networks of Centres of Excellence programs. Over 145 ArcticNet researchers from 30 Canadian Universities, 8 federal and 11 provincial agencies and departments collaborate with research teams in Denmark, Finland, France, Greenland, Japan, Norway, Poland, Russia, Spain, Sweden, the United Kingdom and the USA.



ArcticNet core research program comprises 36 research projects grouped into four Integrated Regional Impact Studies (IRIS) – see map on the right. Although ArcticNet's research program is broadly based and covers the entire coastal Canadian Arctic, it has structured its knowledge transfer by region, which recognises the diversity of issues facing different parts of the Arctic and helps facilitate locally-relevant information exchange. For more information on ArcticNet research network please visit *www.arcticnet.ulaval.ca*.

ArcticNet in the Eastern Canadian Arctic (IRIS-2)

To encourage knowledge translation from science to policy, ArcticNet is conducting a Regional Impact Assessment for the Eastern Arctic (IRIS-2). The assessment will focus on key priority issues or systems, identified by both scientists and decision-makers, and will analyse how they are being affected by ongoing changes in environment and society. The impact assessment report will be published as a series of short illustrated chapters that are presented in an accessible style. Its key findings will convey a synthetic vision of the impacts of change across the region.

The role of this report is to assemble the relevant knowledge that could help support Nunavut decision makers and policy analysts in their ongoing effort to address climate change related issues at all levels. It also responds to Inuit regional need for an accurate and reliable assessment of climate change impacts.

The IRIS-2 team is working closely with ArcticNet scientists, Inuit organizations, local government, industries and other networks to prepare a regional report that draws on ArcticNet knowledge to inform regional issues.

To learn more about the Eastern Arctic IRIS process please visit our website at:
www.arcticnet.ulaval.ca/research/iris_2_info.php

Further Resources:

ArcticNet is pleased to inform you that the research network's most recent publication: Impacts of Environmental Change in the Canadian Coastal Arctic: A Compendium of Research Conducted during ArcticNet Phase I (2004-2008) is now available for download on their website at:
http://www.arcticnet.ulaval.ca/research/compendium.php.

Photos used in this article are courtesy of ArcticNet

Energy And The Environment – Art Contest 2011 Winners

Natural Resouces Canada (NRC) says that when we work together, we can all make an environmental difference!

NRC's annual Energy and Environment Art Contest for students promotes environmentally-friendly living! One winner is chosen from each territory and province. Winners see their artwork published, and receive a prize package!

Here are this year's finalists for Nunavut!

Winner- Natasha Qatsiya, Cape Dorset

Second Place- Kolola Kolola, Clyde River

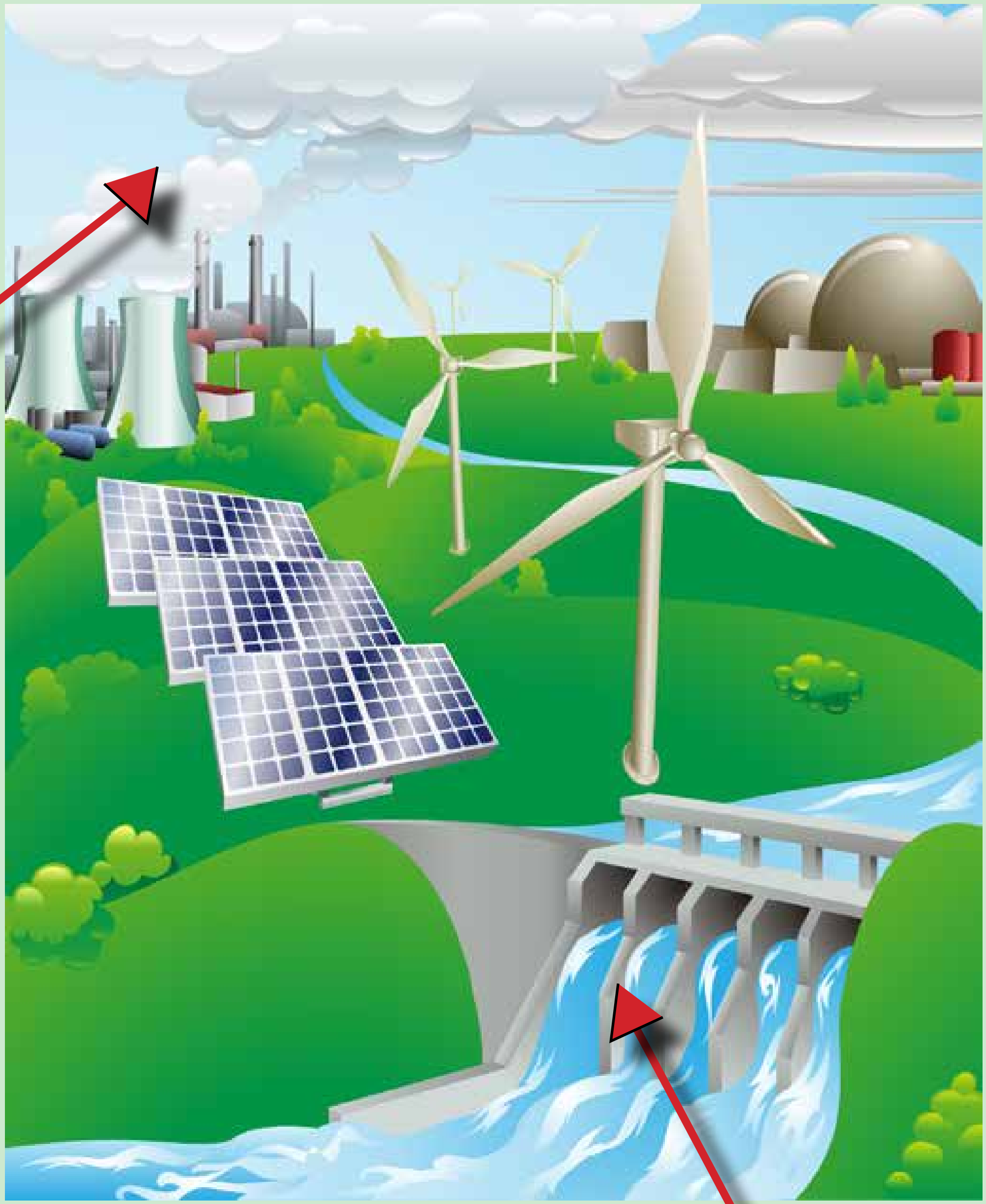
Third Place- Lou Diamond, Clyde River

Kids' Corner

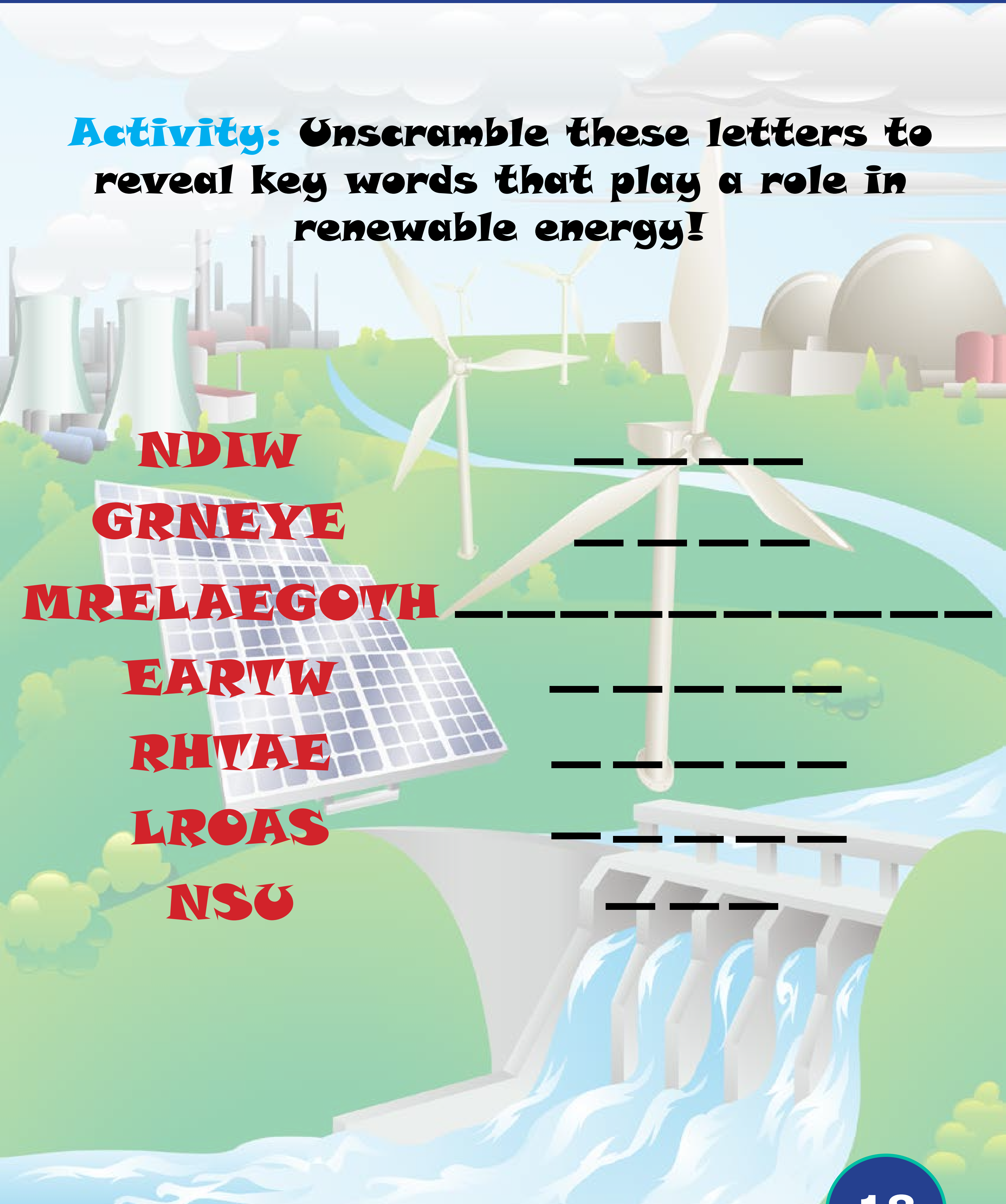
Renewable VS. Non-Renewable Energy

What's the difference?

Nunavut uses non-renewable energy. This type of energy comes from the ground, and will eventually run out. Sources like gas, coal and oil are non-renewable, meaning they can't be replaced. Non-renewable energy also causes pollution.



Energy sources like wind and sun are renewable. We can trap this energy and use it to heat homes and supply power. Renewable energy also does not pollute and will last forever.



Activity: Unscramble these letters to reveal key words that play a role in renewable energy!

NDIW _ _ _ _

GRNEYE _ _ _ _

MRELAEGOTH _ _ _ _ _ _ _ _ _ _ _ _

EARTW _ _ _ _ _

RHTAE _ _ _ _ _

LROAS _ _ _ _ _

NSU _ _ _