


2013

# Pan-Territorial Information Notes

**MOVING FORWARD TOGETHER ON CLIMATE CHANGE  
ADAPTATION IN CANADA'S NORTH**





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Nunavut, and Yukon

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# Foreword

Communities across Canada's North are working to adapt to our changing climate. While there are some significant similarities in how northern communities in Yukon, the Northwest Territories, and Nunavut are experiencing climate change, our approaches in dealing with climate impacts are often diverse and creative.

The information notes found in this compendium show the commitment from the territorial governments to share information on adaptation work underway in each jurisdiction. Through the compendium project, government and community decision makers, research agencies, community groups and community members can benefit from new ideas relevant to northern communities and environments to strengthen adaptation efforts in all arenas.

Funding for this compendium, and for the research projects summarized in it, comes from Aboriginal Affairs and Northern Development Canada through its climate change adaptation program. The research projects support the goals set out in the Pan-Territorial Adaptation Strategy released in 2011. The strategy acknowledges that the North needs to build on climate change adaptation knowledge and harness more effective adaptation strategies for immediate and long-term solutions.

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# A Homeowner's Guide to Permafrost

Providing Nunavut homeowners with the necessary resources to keep their houses on solid ground

## CONTEXT

Changes to permafrost is one of the more significant climate change impacts communities are experiencing in Nunavut. Infrastructure is being (and will continue to be) severely compromised because of rapid changes in the terrain that can have serious effects on Nunavummiut (people of Nunavut).

In the past, Nunavut homeowners have not always had access to some of the necessary resources on permafrost and how it is a critical component of their home structures. Homeowners need relevant information on permafrost if they are to adapt to changes and protect their homes.

Photo credit: Government of Nunavut



## OBJECTIVE

The Government of Nunavut's Department of Environment has created *A Homeowner's Guide to Permafrost in Nunavut*. The objective is to provide homeowners in Nunavut with the knowledge and resources to make simple changes around their home to help the permafrost stay frozen beneath it. The guide also helps local decision-makers

take on adaptation actions that are relevant to the communities they serve. The guide was developed as part of a series with the Government of Northwest Territories' *A Homeowners Guide to Permafrost in the Northwest Territories*.

The Nunavut guide explains what permafrost is, how climate change is affecting it, the impacts to houses from thawing permafrost, and the importance of preventing thaw. It also explains how wind, snow, water, and the seasons affect permafrost, and how skirting, snow build-up, water build-up and other practices can all lead to permafrost degradation.

## APPROACH

The guide was written in a non-technical, plain language format for the average homeowner. The text is broken up with informative illustrations, check-lists, and useful photos displaying good and bad practices of home foundation management. A picture says a thousand words, and this philosophy is used to keep the guide user-friendly.

## EXPECTED RESULTS

Building degradation from permafrost thaw can be costly to not only homeowners, but also to government and private construction companies. By promoting good building maintenance practices and providing education and outreach around the importance of permafrost to buildings, it is expected that some of these costs might be reduced or delayed. This will lead to significant future cost savings. In using this guide, homeowners will be better equipped to make decisions about construction and upkeep of their homes.

## Significance

*The Homeowner's Guide to Permafrost in Nunavut is the first of its kind to provide education about the effects of permafrost thaw on homes and adaptation strategies for Nunavummiut to keep a strong foundation.*

## Partners

- Nunavut Housing Corporation
- Government of Northwest Territories
- Centre d'études nordiques, Université Laval
- Natural Resources Canada
- Aboriginal Affairs and Northern Development Canada

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# The Nunavut Climate Change Centre (NC<sup>3</sup>)

Creating the Nunavut Climate Change Centre (NC<sup>3</sup>) online resource centre as a tool for centralizing climate change resources in Nunavut

## CONTEXT

The Government of Nunavut's Department of Environment established the NC<sup>3</sup> website in 2012 to create a larger climate change resource site with a more interactive layout. There are many groups developing tools and community resources for climate change adaptation and research in Nunavut. Incorporating these resources into one, centralized location will help share and spread climate change knowledge in Nunavut.

Photo Credit: Nunavut Climate Change Centre



## OBJECTIVE

The NC<sup>3</sup> website provides a broad overview of climate change in Nunavut including: current climate change projects, news and activities happening in Nunavut, educational resources, adaptation toolkits, research tools, and an Inuit Qaujimagatuqangit (traditional knowledge). On a broader scale, the NC<sup>3</sup> serves to increase national and global awareness of climate change and its impacts on Nunavut.

## APPROACH

The NC<sup>3</sup> website is designed around individual Nunavut communities, so that information relevant to specific communities can be easily accessed and understood in both plain language and the four official languages of Nunavut. It provides a venue for researchers to report on relevant climate change projects and to share their findings with the general public. It also aims to connect communities with researchers and allows information (i.e. research results) to be shared back to communities that participated in these research activities.

Aside from receiving information from the NC<sup>3</sup> website, community members can also interact by posting questions, photos, and stories related to climate change in their communities. This lets people shape the content of the website and contribute to reducing the impacts of climate change on Nunavut.

## EXPECTED RESULTS

It is expected that communities will use the NC<sup>3</sup> website to participate in climate change initiatives across the territory and initiate more adaptation awareness activities in their own communities.

There is a lot of potential for the development and promotion of community-based and youth engagement initiatives in Nunavut. The NC<sup>3</sup> site can be the central meeting place for these interactions to happen. By working together, we can help our communities adapt and prepare for the environmental changes Nunavummiut (people of Nunavut) are experiencing, and will continue to experience. Together, we can promote happier and healthier communities.

## Significance

*The NC<sup>3</sup> website serves as a portal to SHARE information on how Nunavut is affected by climate change, what our elders are saying, and how individuals can change TAKE ACTION to adapt to our changing climate.*

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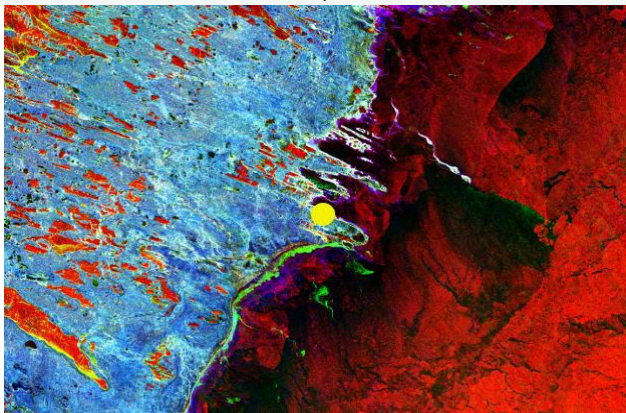
# Terrain Analysis in Nunavut

Using radar satellite images to assess climate change risks inherent with land development in Nunavut communities

## CONTEXT

Permafrost is ground that has been frozen for more than two years. In Nunavut, permafrost is under all of the land. The warming temperatures associated with climate change will affect the stability of the permafrost and therefore affect infrastructure in Nunavut. Currently, there are few resources available to assist developers building on unstable permafrost. This project enables the Government of Nunavut's Department of Community and Government Services and the Hamlets of Nunavut to acquire knowledge about site conditions of lands chosen for

*Photo Credit: 3V Geomatics Arviat (yellow dot) is imaged as ice forms during the fall and early winter. Blue is from the bright ground during the September. Green or yellow show areas that ice is beginning to form on Hudson Bay and lakes in October. Red areas show ice formed in by December.*



future development by conducting a terrain analysis in six communities.

## OBJECTIVE

Information from this project will be used by planners and engineers to assist the selected communities in the decision making process of selecting lands for future development. Community members are encouraged to participate in the planning process by

contributing their knowledge towards the development of their community's plans. By identifying and distinguishing lands that are more susceptible to the negative impacts of climate change (flooding, landslides and the shifting of land), communities will be better equipped to minimize the costs associated with the failure of foundations of buildings and infrastructure.

## APPROACH

This project monitors the shifting of permafrost by assessing the soil, permafrost and drainage conditions of the selected lands. The following monitoring methods are being used: radar satellite images, digital elevation models, optical images, site visits and local knowledge. Based on the data and information obtained, the studied terrains are ranked based on their suitability for future development. The communities of Arviat, Baker Lake, Kimmirut, Gjoa Haven, Cape Dorset and Kugluktuk were chosen based on their need for this information as well as the ability to build off previous work.

## EXPECTED RESULTS

This project will provide communities with tools and policies to assist in better land management. Information will be integrated into the municipal community plans. The results from this project will aid in reducing the costs, damages, and losses associated with the failure of foundations of buildings and infrastructure in Nunavut. Aside from the communities benefiting, the Territorial and Federal Governments, which have made considerable investments in the communities, will also benefit financially.

## Significance

*Terrain analysis provides information that enables communities to make better adaptation decisions when planning for new infrastructure developments in permafrost regions.*

## Partners

- Community and Government Services, Government of Nunavut
- Hamlets of Arviat, Baker Lake, Kimmirut, Gjoa Haven, Cape Dorset and Kugluktuk
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# Climate Change and Mining in Nunavut

Assessing the risks of climate change to Nunavut's mining sector and documenting existing best practices

## CONTEXT

Studies carried out across Nunavut reveal that climate change is impacting the territory in many ways, such as through sea-level rise, more intense storms and permafrost degradation. There is not a lot of information about the effects of these changes on the mining sector. The mining sector is becoming more important to Nunavut's economic future through job creation and promotion of educational opportunities. This sector can be dramatically affected by climate change.

Photo Credit: Baffinland Iron Mines Corporation



## OBJECTIVE

This project assessed the vulnerability of Nunavut's mining industry, including related infrastructure (such as, mine waste management facilities, docks, ports, roads, airstrips and railways) to climate change.

The goal is to understand possible climate change impacts while the mining sector is still fairly new in Nunavut, so that adaptation

measures can be considered, applied and incorporated into decision-making related to the sector. Applying appropriate climate change adaptation measures will help to ensure that new mining-related infrastructure will survive future environmental change. Additionally, the adaptation strategies developed and designed for large-scale mining infrastructure in Nunavut can be applied to similar community-based infrastructure (i.e. roads and ports).

## APPROACH

**Task One** of this project included a literature review and a workshop with key stakeholders. The goal of the workshop was to identify the main concerns of climate change impacts on mining infrastructure in Nunavut. **Task Two** of this project involved gathering best management practices from northern mining projects already happening, as well as preparing two case studies that examined engineering challenges posed by climate change to: (1) mine waste management facilities, and to (2) coastal infrastructure.

## EXPECTED RESULTS

The project identified vulnerabilities of Nunavut's existing and proposed mining infrastructure to climate change. It also recommended best management practices for climate change adaptation related to coastal infrastructure and tailings management facilities. These results are being shared with stakeholders and will ultimately influence the future development of the mining sector in Nunavut.

## Significance

*The vulnerability of Nunavut's mining related infrastructure was assessed, and best management practices were recommended, in order to inform future mining development in Nunavut.*

## Partners

- Department of Environment, Government of Nunavut
- Nunavut Research Institute
- NU Impact Review Board
- Nunavut Chamber of Mines
- Nunavut Tunngavik Inc.
- Newmont Mining
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- Natural Resources Canada

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# Municipal Hazardous Waste Assessment

Assessing climate change risk to municipal hazardous waste disposal sites in eight Northern NWT communities.

## CONTEXT

Hazardous wastes, such as used oil, fuel, batteries, paint and mercury items used by residents and the industrial, commercial and institutional sectors have accumulated in NWT community waste disposal sites. The northern part of the NWT has experienced rapid climate warming of at least 2.7°C during the past 50 years, a warming trend which is sure to continue. Permafrost thaw, coastal erosion and slumping have accompanied this warming. These landscape changes can result in traditional storage locations becoming unsafe and increasing the likelihood of hazardous wastes being released into the environment.



## OBJECTIVE

Develop an inventory, including a cost estimate for the transportation and disposal of hazardous wastes, now on municipal lands. This inventory and cost estimate assessment will be combined with a climate change risk assessment to prioritize management and removal options.

## APPROACH

Municipal hazardous waste sites in the following communities will be evaluated: Aklavik; Fort McPherson; Inuvik; Paulatuk; Sachs Harbour; Ulukhaktok; Tsiigehtchic; and, Tuktoyaktuk.

The evaluation will include a visit to each community by a hazardous waste contractor. During this visit an inventory of hazardous waste will be completed. This inventory will include cost estimates of removable hazardous waste and allow for communities to be ranked based on the risk presented by the hazardous waste.

Using this information, a workshop will be held with qualified professionals to complete a risk assessment for all the hazardous waste sites and to produce recommendations for future hazardous waste management options within communities. These recommendations will be aimed at avoiding hazards associated with climate change.

## EXPECTED RESULTS

Information from the project will be used to produce an inventory of hazardous waste in each community, assessments of the risk climate change poses to each hazardous waste site and a ranking system to be used to identify which sites should be prioritized for removal. This information will also assist in refining best practices for future hazardous waste management to minimize risk due to climate change.

## Significance

*Climate change increases the risk of municipal hazardous waste being released into the environment. The Beaufort Delta and High Arctic are experiencing rapid climate warming resulting in thawing permafrost, slumping, and coastal erosion.*

## Partners

- Community Governments
- Aboriginal Affairs and Northern Development Canada
- NWT Association of Communities
- Northwest Territories Water Board
- Gwich'in Land and Water Board
- Government of the NWT, Municipal and Community Affairs
- Government of the NWT, Environment and Natural Resources

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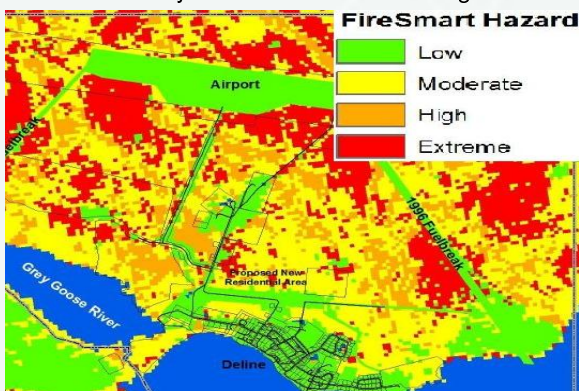


# Community Wildfire Protection Plans

Identify and reduce the risk of wildfires in NWT communities through Community Wildfire Protection Plans (CWPPs).

## CONTEXT

Wildfires are a natural occurrence in the boreal forest ecosystem and an essential component of the health, productivity, and diversity of its forests. Balancing this with the protection of people, property and forest values presents a complex challenge. It is complicated by climate change, which is predicted to result in an increase in the number and severity of wildland fires and a lengthening of the fire season during the next century. Mitigating risk from wildfire to NWT communities and infrastructure, most of which are located in a forest environment, is necessary to address these challenges.



## OBJECTIVE

CWPPs are tools for community land use planning and risk mitigation. The goals are to identify fire risks and plan for mitigation measures in communities, to promote and support community involvement in the creation and ownership of CWPPs, to increase local knowledge about wildfire risks and FireSmart principles and to provide a framework for implementing community protection initiatives.

## APPROACH

First, a meeting between the community, ENR and other parties will be held, to assess past, current and future Wildland Urban Interface (WUI) issues and concerns and to explain the project to interested parties. Next, a community/wildland interface wildfire risk analysis will be conducted to identify the risk of wildfire within a 2km radius of the community. This analysis considers factors such as fire behavior, values at risk, risk of ignition and suppression or mitigation constraints.

On-site assessment and discussion follows this and a draft CWPP is prepared and presented for review. After additional concerns are incorporated into the draft CWPP, a final CWPP is created, allowing recommendations to be initiated. The final CWPP will be reassessed and revised at five-year intervals.

## RESULTS

CWPPs can be downloaded from: <http://www.nwtfire.com/cms/cwpp>.

Completed CWPPs help communities to make sound decisions about which areas are most important to address in order to reduce wildfire risk, to develop funding applications to assist in the implementation of recommendations and to work with private land- and home-owners, to help them take responsibility for addressing their own exposure to risk.

## Significance

*The number and severity of wildfires in the NWT is expected to increase due to climate change. By creating CWPPs, the risk of and loss from wildfires can be reduced.*

## Partners

- GNWT Environment and Natural Resources, Forest Management Branch
- Aboriginal and Northern Affairs Canada
- Natural Resources Canada
- NWT Communities
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- Valhalla Consulting Inc.

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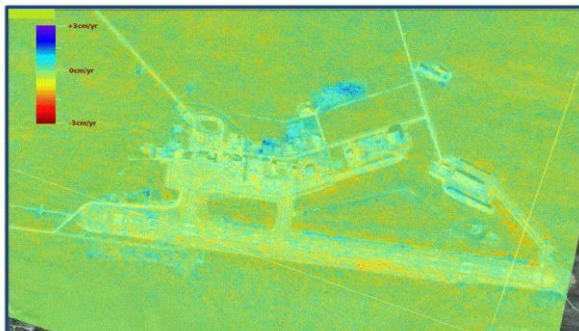
# Mapping Permafrost Displacement

Satellite images are being used to map locations in NWT communities susceptible to permafrost thaw.

## CONTEXT

The warming of air and ground temperatures in the Northwest Territories is thawing permafrost. This creates challenges and potential hazards for new and existing infrastructure built on permafrost. This project facilitates the application and further development of techniques and methods to monitor and predict the effects of permafrost subsidence and upheaval as a tool for climate change adaptation planning.

Inuvik Airport – DInSAR temporal analysis - C-Band; Feb-Sept 2012  
AANDC - GNWT ENR CCAdapt SAR CMP  
Surficial Displacement Rate ~ +/- 1.5 cm @ 2m GSD



## OBJECTIVE

This project uses satellite imagery to produce community permafrost subsidence hazard maps. Information products, such as GIS maps, can help inform decisions about selection of sites for future development. Maps identifying current terrain compositions and conditions provide critical information needed for future development and current infrastructure monitoring.

The project can also help to create best practices for satellite permafrost hazard mapping, specifically Differential Interferometry Synthetic Aperture Radar (DInSAR).

## APPROACH

DInSAR is able to measure earth surface displacements with great precision, often to less than centimeter levels. Multiple RADARSAT-2 satellite images will be acquired during the summer and fall, when satellite images are at the highest quality.

A minimum of five images, taken at different times, are required to detect change. As best results are obtained over several years, long-term monitoring over a multi-year period will improve the overall quality of the RADAR data (15 images for optimum quality).

## EXPECTED RESULTS

Initial permafrost monitoring for the NWT is underway for Inuvik, Tuktoyaktuk, Fort Simpson and Norman Wells. Building on this work will result in the production of an important body of knowledge related to permafrost changes in these areas. It also complements a similar Natural Resources Canada led project for Yellowknife and the NWT.

The data are anticipated as potential support for new projects and exploration areas. They provide important temporal information on terrain conditions which can support effective climate change adaptation strategies. The imagery and products are intended to be incorporated in the GNWT Spatial Data Infrastructure (SDI).

After processing this data, products will be available depicting the movement of buildings and other infrastructure including roads and airports. Data will be produced by community showing vertical displacement and will be publically available.

## Significance

*Climate change adaptation planning can take place by mapping areas where permafrost is thawing. Areas that are at risk can be identified and community planning can benefit.*

## Partners

- NWT Center for Geomatics
- Aboriginal Affairs and Northern Development Canada
- Natural Resources Canada
- Canadian Space Agency
- 3V Geomatics Inc.

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# Assessing Building Vulnerability

The Government of the Northwest Territories is developing tools for evaluating the effects of climate change on buildings. assets.

## CONTEXT

The Government of the Northwest Territories (GNWT) maintains more than 750 public buildings including schools, hospitals, offices, correctional facilities and many other community assets. Climate change has serious impacts on building foundations. Increased temperatures result in permafrost thaw, which can compromise building foundations. Also, changes in snow patterns may result in increased snow on buildings, possibly resulting in damage or collapse. Addressing these issues can be some of the largest and most costly actions associated with climate change in the North.



## OBJECTIVE

This project develops tools for evaluating risks associated with changing snow loads and thawing permafrost occurring because climate change.

These tools will be used to assess GNWT building assets and to prioritize repairs and replacement.

## APPROACH

GNWT Department of Public Works and Services is leading a team of consultants to

develop the tools needed to evaluate buildings. This team is assessing building assets, inspecting buildings, completing a risk assessment and analysis, developing recommendations, and updating the state of knowledge.

Initial tools for risk assessment and evaluation will be piloted on GNWT building assets in Fort Simpson in 2013. Priority in the pilot evaluation will be given to older buildings. After refinement, the tools will be used in other NWT communities

## EXPECTED RESULTS

Data from the climate change evaluation of buildings gathered during this four-year project will be integrated into the GNWT maintenance database. This data will allow for facility condition indices (FCI) to be calculated for buildings. FCIs are calculated using the following formula:

$$\text{FCI} = \frac{\text{Total Maintenance, Repair, and Replacement Deficiencies of the Facility}}{\text{Current Replacement Value of the Facility}}$$

The FCI will be used to determine if it is cost-effective to invest in repairs or if the GNWT should instead consider building new structures.

This project will help adaptation and capital planning within the GNWT by completing a risk evaluation of public buildings in many NWT communities. Buildings in need of maintenance, or those with an FCI score suggesting replacement is necessary, will be identified and addressed, based on the project results.

## Significance

*Permafrost that supports building foundations and snow loads on roofs are changing with a warming Northern climate. Buildings designed for different climatic conditions could now be becoming at risk.*

## Partners

- Government of the NWT Public Works and Services
- Aboriginal Affairs and Northern Development Canada
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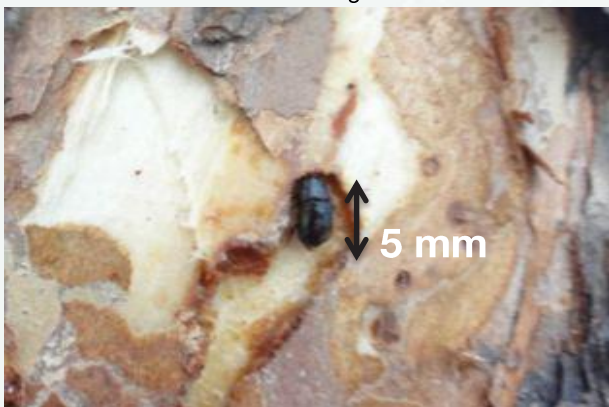
# Mountain Pine Beetle Vulnerability

Determine the risk and management options for invasive Mountain Pine Beetle in Northwest Territories pine forests.

## CONTEXT

Mountain Pine Beetle (MPB) has historically been found in the pine forests of British Columbia (BC), but not Alberta or the Northwest Territories (NWT). After a recent MPB epidemic in BC, the insect crossed the Rocky Mountains into Alberta in 2006.

In the fall of 2012, MPB was detected at sites along the NWT/Alberta border. A survey in March 2013, found beetles had survived the winter in the NWT for the first time. The movement of MPB further north is being aided by warmer winter temperatures, the result of climate change.



MPBs spread blue stain fungus that, combined with larval feeding, can kill pine trees by blocking their conductive tissue. The blocking of tissue makes it impossible for trees to access nutrients and water and often resulting in the death of infested trees. MPB attacks both pine species found in the NWT, jack pine and lodgepole pine. While the potential impact of MPB in the NWT is unknown, it has impacted the wood supply for forest harvesting, wildlife habitat and hydrology in BC.

## OBJECTIVE

To determine the risk of MPB to NWT forests and investigate management options.

## APPROACH

Working with the Alberta Government, monitoring is in place along the NWT/Alberta border using pheromone traps. During winter and spring of 2013, an overwinter survival survey was completed and MPB management strategies from other jurisdictions, including BC, Alberta, Saskatchewan and the Yukon were reviewed.

For this project, the GNWT plans to work with consultants to complete a pest risk analysis for MPB which will include a risk assessment and the determination of potential risk response options for a management strategy. The project will also refine the inventory of pine in the NWT that may be vulnerable to the MPB.

## EXPECTED RESULTS

This project will produce maps of pine forests in the NWT vulnerable to MPB and assist in sustainable forest management decision-making. It will also provide a risk assessment, including the determination of future information needs, and identify management strategies and tactics at a management unit level. Management units will be defined by values at risk (e.g. property, boreal caribou) and the proportion of pine trees within a stand, known as pine hazard. Management options will also be identified.

## Significance

*Climatic conditions now allow Mountain Pine Beetle to survive in the NWT. Pine forests and values depending on them may be at risk.*

## Partners

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- Natural Resources Canada
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# Flood Risk Mapping

Using LIDAR imagery to help predict Yukon community flood risks

## CONTEXT

Yukon communities are likely to encounter more frequent flooding into the future as a result of a changing climate. Government of Yukon's Emergency Measures Organization recognizes the need to better identify potential floodable areas. This project will provide clear data about where and how communities may be at risk of flooding, so that Yukoners can protect their property and prepare for emergency situations. The results will enable community leaders to make more informed decisions related to building structures, town designs and development planning.

Photo Credit: Government of Yukon



## OBJECTIVE

The flood risk mapping project will acquire detailed elevation data, especially around lakes and rivers, to increase understanding and prediction capabilities of high risk flood areas in Yukon communities, both now and in the future.

## APPROACH

A LIDAR (light detection and ranging) imagery survey will capture elevation data in and around 13 Yukon communities in 2014-15. Presently, Yukon has limited elevation data for communities bordering lakes or rivers. Areas for targeted research will be chosen based on community members' traditional and data knowledge of historical flooding threats gathered in 2013. Elevation data will feed into mapping or modeling programs that will identify flood prone areas.

## EXPECTED RESULTS

Information acquired in this project will allow individuals and community representatives to prepare for potential flooding situations. It will increase the ability of Yukon government to understand and predict where likely flooding areas exist in Yukon communities and when they are likely to flood.

Results of this work will allow community members to become more prepared for potential floods. It will also help decision makers prioritize areas where land-use planning and infrastructure (ex: buildings and bridges) development may need to be modified and better prepare for emergency situations.

## Significance

*Flood risk mapping will provide community members and leaders with a clearer understanding of flood prone areas so they can protect property and prepare for emergency situations.*

## Supporters

- Northern Climate Exchange, Yukon Research Centre, Yukon College
- Geomatics, Highways and Public Works, Government of Yukon
- Vuntut Gwitchin First Nation
- City of Whitehorse
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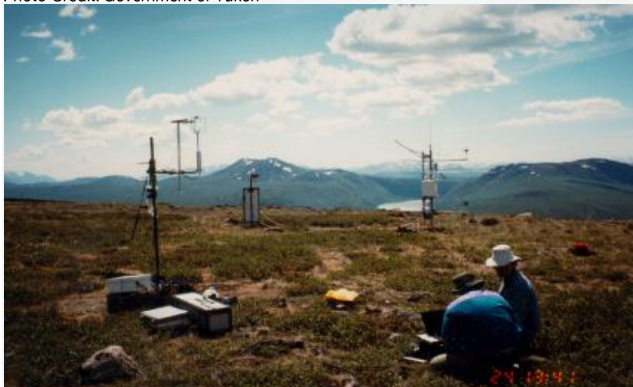
# Hydrology

Examining how changing temperatures, precipitation and permafrost thaw affect Yukon hydrology

## CONTEXT

Hydrology is the study of processes associated with the water cycle such as precipitation, evaporation, and water transport through the ground or in rivers. Current research in Yukon's Wolf Creek Research Basin uses a model to investigate the impacts of altered precipitation, temperature, permafrost and vegetation patterns on Yukon's water regions. The Wolf Creek Research Basin is an ideal study area because it flows through three main ecosystems: forest, alpine tundra and sub-alpine taiga.

Photo Credit: Government of Yukon



## OBJECTIVE

To better understand how climate change alters Yukon's hydrology. With this data in hand, researchers are able to provide adaptation measures to the mining, hydro-electric, transportation, oil and gas, agriculture, forestry, tourism, recreation and municipal sectors.

## APPROACH

The Water Resources Branch will use a water model tool that involves a variety of future precipitation and temperature scenarios to understand how sensitive water resources are to these changes. The model also considers changes in permafrost, vegetation, and evaporation processes. These allow it to predict flows in scenarios that feature warming air temperature and precipitation changes. The model will then be applied elsewhere in Yukon, extending findings beyond the Wolf Creek Research Basin.

## EXPECTED RESULTS

With the water model tool, researchers will better understand:

- The effects of changing precipitation, temperature, permafrost and vegetation on the water system;
- The possibility of further droughts or floods;
- The changes to expect in the volume of seasonal and annual river flows, as well as the timing and magnitude of peak flows.

Adaptive strategies for various Yukon sectors can then be made to improve:

- Land-zoning;
- Community structure designs;
- Future flood warnings.

## Significance

*Additional work is required to improve our understanding of how a changing climate is impacting Yukon's hydrology. This work will help us develop strategic adaptations for our communities, like improved flood warning systems and dike designs.*

## Partners

- Water Resources Branch  
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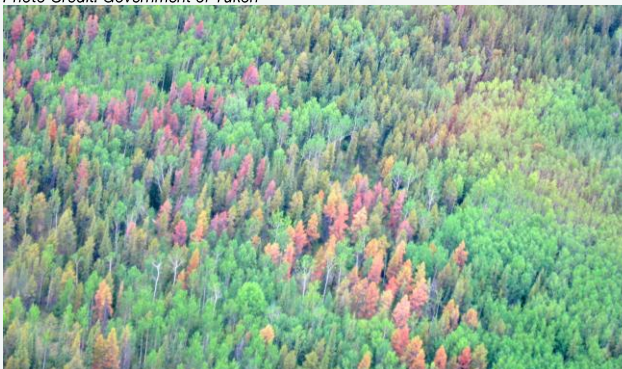
# Mountain Pine Beetle

The mountain pine beetle in novel habitats: Predicting mountain pine beetle impacts on northern forests in Yukon's warming environment

## CONTEXT

Climate change is having an impact on northern boreal forests. One of the reasons is because of increased temperatures. Beetle outbreaks are becoming more common, and the biggest health concern for lodgepole pine forests in western Canada is the mountain pine beetle. Currently the beetle is not present in Yukon; however, it has been moving northward (where it has not historically been established) and is near the Yukon/B.C. border. This research will provide a realistic assessment of the risk that the beetle has on Yukon pine forests before it arrives in Yukon.

Photo Credit: Government of Yukon



## OBJECTIVE

The objectives for this project are to:

- Develop a climatic model for the mountain pine beetle relevant to northern pine forests;
- Create an index for northern lodgepole pine forests that have not co-evolved with the beetle;

- Combine the climate models with future climate projections to predict the potential for the beetle to establish, spread and impact the lodgepole pine forests in southern Yukon;
- Develop decision support tools that will provide forest managers with tools to manage the beetle in Yukon.

## APPROACH

Computer software will assist researchers in looking at three models of climate characteristic ideals for mountain pine beetle. Another approach will be to identify the susceptible host trees in order to see abundance and distribution to measure the possibility of an outbreak. Mapping software will identify 'high risk areas' where climate ideals and pine tree abundance overlap considerably.

## EXPECTED RESULTS

The expected results from this project will:

- Provide forest managers with the ability to predict how susceptible Yukon pine trees are to mountain pine beetle;
- Deliver projections of rates of spread and impacts by the beetle to lodgepole pine trees;
- Provide decision support tools to forest managers to facilitate management of the beetle in the short and long term.

## Significance

*Understanding the potential for mountain pine beetle outbreaks in Yukon is important for protecting the health of pine forests. Research can establish management steps to lessen the impacts and spread of the beetle.*

## Partners

- University of British Columbia
- Forest Management Branch, Energy, Mines and Resources, Government of Yukon
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# Thawing Permafrost and Highways Integrity

Determining the vulnerability of the North Alaska Highway to climate change

## CONTEXT

This project will examine the potential effects of climate change on permafrost underlying the northwestern 200 km of the Alaska Highway. This stretch falls within the traditional territories of the White River First Nation and Kluane First Nation, and passes through the communities of Destruction Bay, Burwash Landing and Beaver Creek. The highway is critical for distributing food, supplies and medical necessities to these communities as well as to Alaska. Thawing permafrost affects road beds leading to significant increase in maintenance costs. Government of Yukon's Highways and Public

Photo Credit: Fabrice Camels



Works is partnering with the Northern Climate ExChange (NCE) of the Yukon Research Centre to map the occurrence and type of permafrost in the area.

## OBJECTIVE

This project identifies and characterizes permafrost underneath the Alaska Highway, establishes future climate scenarios for the region, and evaluates the potential effects of climate change on the area's permafrost.

## APPROACH

This project will use geophysical data, geotechnical reports, Highways and Public Works maintenance records, air photos and field investigations to identify thaw-sensitive areas under the highway. This information will be combined with future climate scenarios to inform decision making.

## EXPECTED RESULTS

Developing an understanding of the impacts of climate change on highway infrastructure is critical for the continued maintenance of the North Alaska Highway into the future. Information gained from this study will:

- Serve as a model for future studies in other regions of Yukon and the North;
- Help develop specific, efficient and effective policies, highway engineering designs and highway maintenance plans;
- Provide transportation security for Yukon communities, Alaskans and visitors to the region.

## Significance

*Exploring how permafrost thaw impacts the North Alaska Highway corridor will result in increased transportation security for Yukon.*

## Partners

- Highways and Public Works, Government of Yukon
- Northern Climate ExChange, Yukon Research Centre
- Climate Change Secretariat, Government of Yukon
- Aboriginal Affairs and Northern Development Canada

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# Forest Vulnerabilities

Examining forest vulnerabilities to climate change and developing resilience enhancement strategies through long-term community partnerships in Yukon

## CONTEXT

Climate change has been documented as having multiple ecological and economic impacts on northern forests and communities. This study builds on previous research done on impacts of climate variation on Yukon's forests and it was determined that communities are likely to face unique ecological and social challenges.

Photo Credit: Government of Yukon



## OBJECTIVE

Through community-based research, this project will develop a better understanding of forest vulnerabilities and potential adaptation opportunities in Teslin.

## APPROACH

Teslin community members will be central in the design of research objectives and methodologies. Information will be gathered through 'sharing circles', polling technology, fieldtrips and attendance at local events, followed by workshops and open-houses.

Community economic, social, and cultural interests will determine which forest areas and research methods will be focused upon. Possibilities include computer mapping, tree-ring dating and determining standards for the community to continually monitor the impacts of climate change on local forests. Another priority of this project is the engagement of local youth.

## EXPECTED RESULTS

Information generated from this study will inform local planning, policy, and management practices through:

- Adaptation strategies to deal with climate change;
- A framework for community engagement to use in other communities;
- New partnerships and economic possibilities for Teslin.

## Significance

*This project will demonstrate how forest management practices geared toward adaptation to climate change can be influenced by community values.*

## Partners

- Arctic Institute for Community-Based Research
- Teslin Renewable Resource Council
- Teslin Tlingit Government
- University of Northern British Columbia
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# Ecosystem Models

Using bioclimate ecosystem models to interpret the effects of climate change on Yukon

## CONTEXT

“Bioclimate” is the link between living organisms and the climate. Yukon communities rely upon surrounding ecosystems for drinking water, shelter and firewood. Understanding how Yukon ecosystems will be affected by a changing climate is important, especially for residents who rely on traditional food sources. As part of a larger cross-Canada study, Yukon researchers are studying “bioclimate envelopes”, the climate variables that influence ecosystem change within a particular landscape. Knowledge of how

Photo Credit: Government of Yukon



ecosystems respond to a changing climate can help us understand and prepare for future changes.

## OBJECTIVE

To develop a field guide and map of Yukon’s bioclimate ecosystem zones and to produce detailed climate models that project current and future climate change impacts on ecosystems.

## APPROACH

Building on existing bioclimatic ecosystem classification work in Yukon, researchers will describe climate patterns for each zone using climate models and climate station data. The models will use ecosystem classification data to predict future ecosystem changes due to climate change. Information about ecological communities (species sharing the same geographical area) will also be collected from field research and from local experts.

## EXPECTED RESULTS

The anticipated outcomes of this project are to:

- Improve understanding of Yukon forest ecosystem resiliency (ability to withstand change);
- Use ecosystem resiliency knowledge to understand how the use of land and resources may change;
- Inform land planners and managers in their planning of forest resources and habitat stressors;
- Create a specific Yukon bioclimatic ecosystem classification system that facilitates sharing of ecology and climate change knowledge between Yukon communities and the scientific community;
- Share information with the Canadian Forest Service to support bioclimate ecosystem models across Canada.

## Significance

*Knowing how Yukon forest ecosystems may be affected now and in the future will help Yukoners make better forest management decisions and effective adaptation strategies.*

## Partners

- Canadian Forest Service, Natural Resources Canada
- Department of Environment, Government of Yukon
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# Traditional Foods Adaptation

Vuntut Gwitchin First Nation determine ways to adapt to changing traditional food sources

## CONTEXT

The Vuntut Gwitchin First Nation people of Northern Yukon traditionally enjoyed fairly predictable food sources around Old Crow and Old Crow Flats. Recently, however, residents have been experiencing the impacts of a changing climate, especially on food sources. The Vuntut Gwitchin First Nation government invited the Arctic Institute of Community-Based Research to work with them to address changes to their traditional harvesting and hunting areas, including changes in the distribution and abundance of several traditional food sources.

Photo Credit: Arctic Institute of Community-Based Research



## OBJECTIVE

To establish what the Vuntut Gwitchin people can do about the changes and unpredictability of local food sources due to a changing climate.

## APPROACH

The first phase of this project involved collaboration between youth, elders, community members and International Polar Year researchers at workshops to learn about environmental changes in the Old Crow area.

The next phase of research focused on learning what food security adaptation strategies the community was already doing, and on what community members could do in the future to address the impacts of climate change. Youth were provided training on interview skills and film editing to communicate these recommendations.

The final phase involved assisting the community in determining how the Vuntut Gwitchin First Nation could implement their recommendations to address food security issues.

## RESULTS

The project wrapped up in 2010 with the following outcomes:

- Recommendations from the community helped Vuntut Gwitchin First Nation take actions towards increased food security in times of rapid changes to their homelands;
- Old Crow youth were trained in research methods including interviewing and filming skills;
- Youth produced videos of community interviews for public viewing.

## Significance

*Climate change continues to impact the traditional food sources that Yukoners rely on. This project helped the people of Old Crow and Old Crow Flats adapt to their changing food sources.*

## Partners

- Vuntut Gwitchin First Nation
- Arctic Institute of Community-Based Research
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# Environmental Assessment

Including climate change considerations in assessments under YESAA (Yukon Environmental and Socio-economic Assessment Act)

## CONTEXT

The Yukon Environmental and Socio-economic Assessment Board (YESAB) is an independent assessment organization that works closely with Yukoners, governments and stakeholders. YESAB provides recommendations to decision makers about Yukon projects, whether they should go ahead or not and under which conditions. The Northern Climate ExChange (NCE) of Yukon Research Centre and YESAB recognized that climate change considerations should be included in Yukon project assessments. Funded by YESAB, the two partners began working together in 2011

Photo Credit: YESAB



to continue bringing climate change into the assessment process.

## OBJECTIVE

To provide YESAB with the tools to incorporate climate change expertise into its environmental assessments.

## APPROACH

NCE and YESAB worked together to:

- Assemble historical climate information and future climate projections for Dawson City, Haines Junction, Mayo, Teslin, Watson Lake and Whitehorse (YESAB's six districts), as well as Beaver Creek, Carcross, Faro, Pelly Crossing and Old Crow;
- Add climate information to YESAB's Geolocator, (a web based GIS tool);
- Deliver a presentation to YESAB assessors on the effects of climate change on projects in Yukon, the importance of including climate change considerations in environmental assessment and how to use the climate predictions in an assessment context.

## EXPECTED RESULTS

NCE and YESAB have advanced the continuing integration of climate change considerations into assessments. As a result, potential project assessments will be more reflective of the changing realities of northern communities.

YESAB will publish a discussion paper later in 2013 to highlight strengths and uncertainties associated with these data and their applicability to environmental assessments.

## Significance

*Including climate change considerations will help YESAB protect the environmental and social integrity of the Yukon, while fostering responsible development in the territory.*

## Partners

- Northern Climate ExChange, Yukon Research Centre, Yukon College
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# Hydroelectricity

Examining climate change impacts on the Yukon River's headwaters and the effects on hydroelectricity generation

## CONTEXT

Climate change is affecting the headwater region of the Yukon River watershed. We are seeing changes in snowpack accumulation, the timing of snowmelt, and the volume and timing of water released by glaciers. These affect the flow of water through Whitehorse and have the potential to impact hydroelectric power generation. The Northern Climate ExChange of the Yukon Research Centre is partnering with Yukon Energy Corporation, the University of Alberta, and the Yukon Geological Survey to better

Photo Credit: Yukon College



understand these changes and resulting impacts.

## OBJECTIVES

To develop predictive tools that will improve our understanding of climate change on the amount and timing of water flow in the upper Yukon River watershed and the implications on downstream energy generation.

## APPROACH

Researchers are installing weather and snowpack monitoring stations across the upper Yukon River watershed. These record seasonal fluctuations and form the basis of a long-term monitoring network. Researchers will also conduct ground-penetrating radar and velocity surveys for glaciers in the study area.

The data collected will be used to develop models of regional glacier characteristics and hydrology, which will then be used to identify how both might change under various climate scenarios. Ultimately, this approach will provide predictive tools for determining responses to future climate variability.

## EXPECTED RESULTS

Potential current and future changes to runoff in response to climate change will be identified. This information will help Yukon Energy Corporation operate its hydro-generation equipment more efficiently. Most importantly, the project will also provide the corporation with tools to help predict, plan for and adapt to climate change and to ensure hydroelectric security for Yukon.

## Significance

*Understanding and preparing for changes in the Yukon River flow will allow the Yukon Energy Corporation to provide Yukoners with renewable energy efficiently.*

## Partners

- Northern Climate ExChange  
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- Yukon Energy Corporation
- University of Alberta
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# Mainstreaming Climate Change

Including climate change considerations into decision making in Yukon

## CONTEXT

'Mainstreaming' means making something part of the norm. The Climate Change Information and Mainstreaming Program (CCIMP) works to incorporate climate change considerations into the decision making of governments and organizations. The program was established in 2010 and is a partnership between the Northern Climate ExChange of Yukon Research Centre and the Climate Change Secretariat of Yukon government (YG). CCIMP helps YG departments blend climate change considerations into projects, planning and decision making.

Photo Credit: Government of Yukon



## OBJECTIVE

To provide support and expertise to decision and policy makers in governments and organizations in order to help reduce emissions and adapt to climate change.

## APPROACH

CCIMP offers technical expertise, Yukon climate trends, projections and scenarios, presentations, and workshops. CCIMP accomplishes this through strong relationships and the "Decision Making for Climate Change" course, an overview of climate change science and policy.

## RESULTS

Since its inception in 2010, more than 100 government employees across eight departments have participated in the "Decision Making for Climate Change" course and five government departments or non-government organizations have taken advantage of climate change project support.

This project and partnership is also leading the way in normalizing climate change considerations throughout government departments and organizations' decision making.

## Significance

*The Climate Change Information and Mainstreaming Program supports inclusion of climate change considerations into government and organization planning and decision making.*

## Partners

- Northern Climate ExChange, Yukon Research Centre, Yukon College
- Climate Change Secretariat, Government of Yukon

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# Mapping Landscape Hazards

Using geoscience mapping to identify permafrost challenges and opportunities

## CONTEXT

How climate change affects permafrost is a major challenge to Yukon communities. Many Yukon communities are built on permafrost terrain, which can be altered by climate change. More information is needed to understand climate change impacts on permafrost, surficial geology and hydrology and to identify opportunities, challenges and new ways of developing infrastructure and buildings. Landscape hazard maps can provide some of this information.

Photo Credit: Yukon College and Yukon Geologic Survey



## OBJECTIVES

This project investigates current landscape hazards, or problem areas, related to permafrost, surface geology and hydrology in Yukon communities. It explores how thawing landscapes may be altered in response to climate change.

## APPROACH

To create hazard maps, researchers gather and map geoscience data including surface geology, permafrost and groundwater data. Future climate projections, including temperature, precipitation and freeze/thaw dates are used to understand potential future landscape evolution.

## EXPECTED RESULTS

Data collected is used to classify landscape hazards in each community. Landscape hazards are ranked in three categories – low, moderate, high – represented graphically in stoplight colours. By incorporating climate projections, landscape hazard classifications will reflect both present and potential scenarios.

Landscape hazard maps are complete for Mayo and Pelly Crossing. Maps for Burwash Landing and Destruction Bay will be completed in Spring 2013. Projects are scheduled to begin in 2013 in Dawson, Faro and one other Yukon community (still to be decided).

## Significance

*Landscape hazard maps help Yukon communities understand how land responds to environmental change. Hazard maps are a climate change adaptation tool that inform policy and planning decision.*

## Partners

- Northern Climate ExChange  
Yukon Research Centre,  
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- Yukon Geological Survey
- Universities of Montreal,  
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# Adaptation Plans

Helping Yukon communities assess and address climate change challenges and opportunities

## CONTEXT

The Community Climate Change Adaptation Project (CCCAP) helps Yukon communities prepare for the impacts of Yukon's changing climate. Led by the Northern Climate ExChange of the Yukon Research Centre, the research and final adaptation plans and reports for this project were carried out in 2006-2012 for Dawson City, Mayo, Atlin and Whitehorse.

## APPROACH

Community meetings with researchers, scientists, and locals evaluated community climate change challenges and opportunities, produced climate change adaptation plans, and established pilot adaptation initiatives.

Community coordinators advised on project development and facilitated communication between project leaders and communities.

The plans used a variety of methods to evaluate climate change impacts including risk management (Dawson and Whitehorse), scenario planning (Whitehorse and Mayo) and strategic development (Atlin).

A variety of organizations helped with this project, including: Tr'ondëk Hwëch'in, Tã'än Kwachan Council, Kwanlin Dun First Nation First Nation of Na-Cho Nyäk Dun, Dawson City, Mayo, Stewart Crossing, Keno and Whitehorse, Universities of British Columbia and Ryerson, Conservation Klondike Society, Yukon Conservation Society and Government of Yukon's Community Services.

## RESULTS

Climate change adaptation plans were created for the communities of Dawson, Mayo, and Whitehorse; The City of Whitehorse formally adopted CCCAP's plan as a guiding document. Examples of completed adaptation pilot projects include: homesteading workshops in Whitehorse, a community greenhouse in Dawson, and a farmer's market in Mayo.

## OBJECTIVE

To increase the ability of Yukon communities to respond to climate change impacts through the development and implementation of community adaptation plans that set out targets, timelines and outcomes.

## Significance

*Community climate change adaptation plans inform citizens about the risks and opportunities in their communities and help decision makers develop action plans to reduce risks.*

## Partners

- Northern Climate ExChange, Yukon Research Centre, Yukon College
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Photo Credit: Government of Yukon





# Community Needs Assessment Surveys

Improving our understanding of community climate change needs and priorities in Yukon

## CONTEXT

Yukon communities are already adapting to climate change by, for example, responding to different migration patterns by hunting in new places. To further prepare communities for climate change, they first need to know which key areas need attention. Food security? Infrastructure? Climate change education? Energy issues? Results from the 2010-2011 *Yukon Climate Change Needs Assessment*, based on answers from Yukon community members, will help define future adaptation priorities.

Photo Credit: Council of Yukon First Nations



## OBJECTIVE

Identify priority areas of community concern related to climate change, and provide insight into priority areas for future climate change programming.

## APPROACH

Project partners took time to review previous surveys in order to gather ideas and background knowledge for this project. In 2010 the Council of Yukon First Nations, the Northern Climate ExChange and the Climate Change Secretariat worked together to develop survey questions, including:

- What are Yukon residents observing about climate change in their communities?
- What factors limit the use of traditional knowledge in climate change planning?
- What is the general level of knowledge that Yukon residents have about climate change?

Hired contractors then distributed surveys to residents of 13 Yukon communities.

## RESULTS

Highlights of the 2011 survey results were:

- The majority of survey respondents think that the climate is changing (96%);
- Climate, wildlife and food security are areas of key and current concern;
- Energy-related initiatives were deemed a priority;
- Education/training and information management are barriers to individual and organizational participation;
- 75% of respondents stated that climate change is having a direct impact on their lives.

## Significance

*The Yukon Climate Change Needs Assessment provides key recommendations for priority climate change adaptation projects to increase Yukoners' ability to respond to climate change.*

## Partners

- Circumpolar Relations, Council of Yukon First Nations
- Northern Climate ExChange Yukon Research Centre, Yukon College
- Climate Change Secretariat, Government of Yukon
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# Agriculture and Permafrost

Effects of changing permafrost conditions on agriculture and agriculture capability classification in Yukon

## CONTEXT

Permafrost is susceptible to climate change's warming trends. Agricultural development, infrastructure and production is impacted by changing permafrost conditions such as excessive wetness, hummocky topography and ground subsidence.

Past and present Yukon farmers have adapted conventional agriculture methods to accommodate for northern specific permafrost conditions. The warming effects of climate change are expected to increase the rate of permafrost decay.

Photo Credit: K.Davies



## OBJECTIVE

This project aims to identify challenges and barriers to agriculture caused by changing permafrost conditions. Adaptations to conventional agriculture methods will be documented and best management practices summarized.

The project also aims to identify key permafrost indicators and timelines to use in conjunction with the Land Suitability for Agriculture Rating System.

## APPROACH

Researchers will use GIS modeling to identify areas of past and current agriculture development prone to changing permafrost conditions. GIS analysis will help predict which regions and soil types will be most affected. Lastly, GIS models will examine future scenarios involving effects of changing permafrost conditions and agriculture capability.

Researchers will also conduct field visits to compare GIS data with land-based observation and results.

Interviews with farmers and owners of adjoining lands will be conducted to gather information, timelines and best management practices within the agriculture community.

This four-year project will focus on four distinct agricultural regions: Whitehorse/Southern Lakes, Haines Junction, Dawson and Central Yukon.

## EXPECTED RESULTS

- Document successes and challenges of agriculture production in areas of changing permafrost conditions;
- Summarize existing best management practices for agriculture in areas of changing permafrost conditions;
- Determine key permafrost criteria to use with the Land Suitability for Agriculture Rating System.

## Significance

*Knowledge gathered from this project will assist current and future Yukon farmers as they adapt their agriculture operations to changing permafrost conditions.*

## Partners

- Agriculture Branch, Energy, Mines and Resources, Government of Yukon
- Cryogeographic Consulting
- Agriculture and Agri-Food Canada
- Yukon Geological Survey, Energy Mines and Resources, Government of Yukon
- Aboriginal Affairs and Northern Development Canada

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