EXCHANGING IDEAS ON CLIMATE CHANGE IN THE YUKON

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With support from our partners:

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EXECUTIVE SUMMARY

Project Description

The Northern Climate ExChange visited Yukon communities during the summer and fall of 2000. The community visits built upon recommendations from the Northern Climate ExChange May 2000 Workshop *Taking Action on Climate Change in the Yukon*.

Climate of Yukon

An understanding of regional climate and weather patterns is essential to understanding climate change. In 1987, Environment Canada released the most comprehensive study of Yukon Climate to date, called the *Climate of Yukon* (Wahl et al., 1987). This study sub-divided the Yukon into nine climatic regions. The climate of the Yukon, like its topography, is varied and complex. In fact, climatic variability in the Yukon is greater than anywhere else in Canada. Broadly classified as a sub-arctic continental climate, the Yukon climate is strongly influenced by the territory's high mountains, high latitude, and air masses from both the Pacific and Arctic Oceans.

Climate has been a major factor in the settlement, development and evolution of the Yukon. Long before the Yukon became a territory, Yukon First Nations survived here because they understood the natural environment and adapted to its demands. Climate influenced almost every aspect of their lives, including where they lived.

Climate Change Predictions for the Yukon

Climate change models predict that the North will receive the earliest and most extreme impacts of a changing climate. Some scenarios suggest that this region could warm up by 5 ^{o}C by the middle of the 21st century. This increase could affect the Yukon economy, wildlife, traditional cultures and recreational activities.

Climate Change Observations for the Yukon

During our community tour, residents of Yukon communities had many observations and concerns about climate change. Some of their comments are provided here; additional details are available in the project report.

Conclusions

There is tremendous value in sharing local observations about changes in the weather and the land. This is especially true considering even the most sophisticated computer models fail to produce reliable predictions on local climate change. Even more importantly, those who are close to the land know it best and are the real local experts. An understanding of local observations and concerns will help determine priorities for further research. The following general conclusions have been drawn from this work:

- Climate change is no longer an abstract idea in the Yukon
- Public opinion on what to do about climate change varies
- There is a tremendous amount of local information on climate change, but very little of this information is documented
- People are concerned about their observations
- There are more questions than answers
- There is a paucity of information to assist communities with understanding and preparing for climate change impacts
- Very little research is available at a scale that is useful to community-level decision-making processes
- Local observations on climate change are extremely valuable
- Observations and concerns on climate change vary among communities
- Community observations and model predictions on climate change are not always the same
- Everyone benefits when we share observations about changes in the weather and the land.
- Local communities are best positioned to understand and assess their vulnerability to climate change

Recommendations

Much work is required to fully prepare for the impacts of climate change. We need to understand more fully the relationship between climate, environmental conditions, and human activities. From this report, arose following list of recommendations for future work on climate change at the community-level in the Yukon

- Document local and traditional knowledge on climate change
- Develop a community-based environmental monitoring strategy
- Improve community access to information
- Fill in information 'gaps'
- Prepare for climate change
- Develop policy and decision-support tools

INTRODUCTION

Project Description

In May, 2000, the Northern Climate ExChange (NCE) hosted a workshop in Whitehorse called *Taking Action on Climate Change in the Yukon*. At the workshop, participants were asked to identify what needs to be done to address climate change in the Yukon, and to identify the role of the NCE in carrying out this work. The community tour, which took place in the summer and fall of 2000, developed out of recommendations from that workshop. Workshop participants recommended the NCE:

- Visit as many communities as possible as soon as possible
- Contact local stakeholder groups
- List community observations ('red flags') such as fewer birds, ice depth changes, then follow up on these.
- Ask communities what should be accomplished in the Yukon to tackle climate change over a three-year term.

The following report explains what we did, how we did it, what we found out, and how we shared what we found. We have also provided some context on climate and climate change science by providing an overview of the Yukon climate, and the latest in climate change scenarios and model projections for the Yukon.

Goals of the Community Tour

Four goals guided the work of the NCE Community Tour. These goals are described below:

Goal #1 Improve understanding of climate change issues in Yukon communities

One of our primary goals was to provide information on climate change through one-on-one meetings, participation in meetings and workshops, and public information sessions.

Goal #2 Document local concerns and observations related to climate change

Our discussions sought to identify local climate change issues, observations, and concerns related to climate change. For example, the following topics were discussed:

- What is climate change and why is the climate changing?
- What climate and environmental changes have you observed in your community?
- How do local observations compare to the climate change scenarios presented for the Yukon in the Canada Country Study?
- What are your concerns about a changing environment?
- What should we do to address these changes?
- What types of information do you need to take action on climate change?

Goal #3 Explore priorities for action on the climate change issue

Expanding on #1 above, we wanted to explore local and regional priorities for action on climate change, including:

- climate change research
- impact monitoring
- data management
- education
- technology development
- adaptation, both short and long term
- sensitive sectors, regions and biological systems
- policy

Goal #4 Define Local Information Sources and Information Needs

The community consultation program will contribute to one of the projects underway at the NCE, which is to define the quantity and quality of available information on the impacts of climate change in the North, and develop an information system for northern communities to share information on climate change.

Workplan

The NCE developed a workplan for a Community Tour that was based on suggestions from the *Taking Action on Climate Change in the Yukon* workshop. We carried out the following list of tasks:

1. Identify the scope of the consultation program.
2. Send out requests for a meeting to groups, organizations and government departments within each community to meet with the NCE.
3. Identify preliminary list of interested groups, organizations and government departments within each community to visit during the tour.

4. Identify other consultation initiatives to determine potential partnerships.
5. Schedule meetings with interested parties and where there is enough interest, schedule public information sessions.
6. Finalize list of up to 3 communities (or groups of communities) for more intensive community workshops. For these communities, identify local partners, and local organizers.
7. Prepare report, poster, and web site to communicate findings of the Tour.

The communities we visited were Whitehorse, Watson Lake, Teslin, Faro, Dawson, Mayo, Haines Junction, Beaver Creek, and Burwash Landing. We met with residents of the North Slope region during a special session of the September 2000 Yukon North Slope Conference.

As each community is unique, the approaches to our discussions varied among communities. One or more of the following approaches were employed in each community, depending on community-identified needs and desires, and available resources.

- Where possible, one-on-one meetings were scheduled with local stakeholder groups (government, industry, educators, band resource officers and community groups etc.) within each community. A complete list of agencies/organizations that we met with can be found in Appendix A.
- Where possible, we sought to participate in existing meetings and workshops (Moose Creek State of the Environment Workshop, Dawson District Renewable Resource Council Meeting, Yukon North Slope Conference)
- Community Workshop (Climate Change in the Central Yukon Workshop)
- Public Information Sessions (An evening public information session was held to raise awareness of climate change in several communities. Communities that expressed an interest in a public information session were Watson Lake, Teslin, Faro, Dawson, Mayo, Haines Junction, Beaver Creek, and Burwash Landing

CLIMATE OF YUKON

An understanding of regional climate and weather patterns is essential to understanding climate change. In 1987, Environment Canada released the most comprehensive study of Yukon Climate to date, called the *Climate of Yukon* (Wahl et al., 1987). This study sub-divided the Yukon into nine climatic regions. The following section summarizes the findings of this report and describes general climate, characteristics of the nine climatic regions, and climate monitoring in the Yukon.

General Climate of the Yukon

Climate has been a major factor in the settlement, development and evolution of the Yukon. Long before the Yukon became a territory in 1898, Yukon First Nations survived in this region for generations due to their strong understanding of the natural environment. Climate influenced the resources upon which First Nations were dependent, and shaped native culture and settlement patterns.

The climate of the Yukon, like its topography, is varied and complex. Greatly influenced by the proximity of the Pacific and Arctic Oceans, rugged topography, and northerly latitude, the Yukon climate is broadly classified as a sub-arctic continental climate.

The Yukon lies between 60°N and 69°39' N latitude. This northerly latitude limits the amount of incoming solar radiation, and influences the type and frequency of weather systems that reach the Yukon. Solar radiation, which varies by altitude and latitude, influences snowmelt, evaporation, and growth of vegetation and human comfort.

The Yukon climate is also the most variable in North America. The Yukon holds the record on the continent for extreme low temperature, -62.8°C degrees at Snag; yet its summer extreme maximum of 36.1°C at Mayo, due in part to the long hours of daylight, is comparable to summertime highs much further south (Wahl et al., 1987). The mean annual temperature is below zero in all areas.

Precipitation in the territory varies substantially depending on latitude and elevation. There is a significant St.-Elias-Coast Mountain rain shadow, but on the coastal side of these mountains precipitation can reach up to 4000 mm in some areas. 60% of the precipitation generally falls as rain at low levels, with the percentage of snow increasing as the elevation rises. The snow line reaches a maximum of 2000-2500 m. in July-August.

Winds are strongest in southwestern Yukon (average approx. 13 km/hr) and on the Arctic coast (average approx. 19.3 km/hr), though the topography exerts strong local influences throughout the territory. This is also the major factor influencing wind direction.

Climatic variability in the Yukon is greater than anywhere else in Canada, stemming from effects such as changing elevation, aspect, and differences in air masses coming into the territory.

Climate Regions of the Yukon

The Yukon is divided into 9 Climatic Regions (Wahl et. al., 1987):. A summary of the characteristics of these regions is provided below.

St. Elias-Coast Mountains

The St. Elias and Coast Mountains that rise from the Pacific Ocean contain some of Canada's highest mountains and the largest ice fields outside of polar areas. They lie in the southwest of the Yukon and act as a barrier to moist Pacific air getting to the interior. The precipitation varies from up to 4000mm on the coast to less than 300 mm in the Shakwak valley. A major snow accumulation zone lies in the St. Elias region, which also contains a network of glaciers. Mean annual temperature ranges from near 0°C on the Marine coast to ⁻5°C on the northeast end, though means can dip down to ⁻10 - ⁻15°C within the St Elias region. This zone is one of the windiest in the Yukon, due to the storminess of the Gulf of Alaska and the complex terrain that distorts wind patterns.

Upper Yukon-Stikine Basin

This area is a rough highland, 600-1200m in elevation, with mountains rising to 2000 m. The basin lies between the St. Elias-Coast Mountains and the Cassiar-Pelly Mountains, and extends to the southeast into British Columbia. Precipitation is low due to the rain shadow effect of the St-Elias-Coast Mountain barrier, and tends to stay below 300 mm annually. The temperature regime is variable, with the proximity to the Pacific often resulting in more frequent mid-winter mild spells than elsewhere in the Yukon. The high elevation of the area produces less extreme maximum and minimum temperatures. This basin is quite windy, particularly valleys with northwest to southeast orientations, such as the area around Whitehorse.

Pelly-Cassiar Mountains

The interior Cassiar Mountains extend northwest out of central British Columbia and join with Pelly Mountains over South-central Yukon. The range fades off into Yukon Plateau southeast of Dawson. Broad passes in the ranges allow air to flow, though the mountain group does have a significant impact on temperature and precipitation patterns. Summers are relatively cool, and the higher elevations result in less severe winter temperatures with frequent mid-winter mild spells. The total precipitation of the area is relatively high, with a

mean annual amount of 500-700 mm. Precipitation is heaviest in the fall and early winter. There is also an active storm track in this time period.

Central Yukon Basin

The Central Yukon Basin is the northward expansion of the Yukon-Stikine Basin. Elevations are lower however, and temperatures more variable and more extreme than the more southerly basin. Summers are warm, and there can be severe cold spells in the winter. This is a region of temperature extremes, with the coldest Yukon temperature being recorded in Snag (-62.8°C) and the hottest recorded in Mayo (36.1°C). There is moderate precipitation in this area, between 300 and 400 mm annually, mostly in the form of summer showers. Winds are relatively light.

Climate Regions of the Yukon

1. St. Elias-Coast Mountains
2. Upper Yukon-Stikine Basin
3. Pelly-Cassiar Mountains
4. Central Yukon Basin
5. Oglivie-Mackenzie Mountains
6. Liard Basin
7. Porcupine-Peel Basin
8. Northern Mountains
9. Arctic Slope

Oglivie-Mackenzie Mountains

This climate zone consists of the Mackenzie and westward part of the Ogilvie Mountains and runs in a swath across North-central Yukon, in a somewhat Northeast-Southwest direction. The Mackenzie Mountains attain elevations of 2500-3000m, and the Ogilvies reach 1500-2200m. There is moderate to heavy precipitation (400-700mm) and winds are generally light, though local effects of the chaotic topography can bring about strong gusts. Summers are cool and winters can be quite moderate due to inversion effects.

Liard Basin

The Liard Basin in Southeast Yukon is a broad valley with elevations of between 700 and 1000m. Summers are warm though winters can bring cold spells with arctic air being trapped in the valley. Precipitation is moderate with between 400 and 600mm falling annually; this is relatively high compared to the rest of the Yukon's interior. Winds are modest.

Porcupine-Peel Basin

The Porcupine-Peel Basin is in the northern Yukon, to the north of the Ogilvie-Wernecke Mountains and to the South and West of the Richardson and British Mountains. Short summers and long cold winters characterize the typical temperature regime. Inversions can make for more mild temperatures at higher elevations, but in general the area consists of relatively low, flat plains and plateaus with elevations near 300m. Precipitation is largely

blocked by the Ogilvie Mountains, with about 200-300 mm falling annually. Winds tend to be light and storms weak, though the occasional strong winter storm will pass through the Basin.

Northern Mountains

This climate zone is made up of the Richardson and British Mountains in the north of the Territory, which reaches elevations of 1200-1600m. Not a lot of climate monitoring has been done in this area, though inferences are made from the local topography and by extrapolating from nearby areas. Annual precipitation is estimated to be 300-400 mm annually. Temperatures are cool in the summer, but winters are mild relative to the surrounding lowlands. The topography brings about wind funneling and turbulence, with summer winds being less severe than those in winter.

Arctic Slope

The Arctic slope is a thin band of land along the Yukon's north coast, between the British Mountains and the Arctic Ocean. The land is quite flat, going from sea level to 300 m of elevation. The summers are cool without many warm spells, and winters are long and cold. There is not a lot of precipitation, less than 200 mm annually, mostly consisting of summer showers. Snow is not deep and tends to be blowing due to the lack of vegetation.

Climate Monitoring in the Yukon

The Yukon Territory currently has 66 stations monitoring various climatic parameters, however only 6 of them contain long-term climatological data, with continuous records longer than 30 years. Dawson began intermittently recording weather information in 1897, with continuous recording since 1901. In 1925, intermittent observations began in Mayo, Haines Junction, Whitehorse, Teslin and Watson Lake, which became continuous in the late thirties/early forties. Of the 32 locations in the Yukon with climate data, only 21 locations have 15 or more years of continuous record.

Due to the high variability of climatic parameters in the territory, not a lot of extrapolation can be done from the data collected at each station. As well, most of the climate stations that exist are in the southern Yukon and are placed at lower elevations, further reducing our ability to get a meaningful depiction of the territory's climate.

Every ten years, Environment Canada releases *Canadian Climate Normals* for Northern Canada. "Normals" is the term used to describe climate values that have been averaged over a fixed, standard period of time. Climate normals in Canada are based on averages over a 30- year period, and have been produced for sites where at least 20 years of data are available. The first set of 20-year normals in the Yukon was computed for the 1921-1950 period. Additional sets were produced after the end of each subsequent decade. Stations

with only 5-19 years of data were also used in order to get as complete a picture as possible of the Yukon's variable climate. In such cases the data was adjusted by correlating the information with data obtained at nearby stations that do have longer records.

Is the Yukon Climate Changing?

In the Yukon, climate change is no longer an abstract idea.

We can conclude this from both local observational data that will be presented later on in this report, and climate data. Climate 'normals' are a useful way to track long-term changes. The term 'climate normals' refers to values of climatic elements averaged over a fixed, standard time period. The time period must be sufficiently long to eliminate year-to-year variations; generally a 30-year time period is used. Climate normals are updated every decade and can provide a useful insight into climate change.

The following monthly temperature data for Mayo, Watson Lake, and Whitehorse compares climate normals over two thirty-year time periods: 1951-1980 and 1961-1990. As evident from this data, warming at these Yukon stations has occurred mainly in winter and spring. There is a very weak warming trend exhibited in the summer, and temperatures in autumn have been gradually decreasing.

Mayo, Watson Lake and Whitehorse
Normal Mean Monthly Temperature
For 1951-1980 and 1961-1990

	Mayo		Watson Lake		Whitehorse	
	1951-1980	1961-1990	1951-1980	1961-1990	1951-1980	1961-1990
January	-29.0	-26.9	-26.7	-24.6	-20.7	-18.7
February	-19.9	-19.4	-18.7	-18.4	-15.2	-13.1
March	-11.7	-10.4	-11.3	-10.5	-8.2	-7.2
April	-0.4	0.0	-0.6	-0.4	0.3	0.3
May	7.5	7.9	6.9	6.9	6.7	6.6
June	13.4	13.6	12.7	12.5	12.0	11.6
July	15.2	15.6	14.9	14.9	14.1	14.0
August	12.6	12.8	13.1	13	12.5	12.3
September	6.5	6.5	7.6	7.4	7.5	7.3
October	-2.3	-2.2	-0.1	-0.1	0.6	0.7
November	-15.2	-16.8	-13.8	-15.3	-8.8	-10.0
December	-24.2	-25.5	-23.5	-22.9	-16.6	-15.9
Annual	-4.0	-3.6	-3.3	-3.1	-1.2	-1.0

Source: Environment Canada

Climate normal data is not yet available for the period of 1971-2000, however, we are likely to see a similar trend in temperature between the 1961-1990 1971-2000 time periods as seen between the 1951-1980 and 1961-1990 time periods.

At the time of this report was written, the Yukon experienced temperatures well above normal for the month of January, some were more above normal than others. This may be a reflection of normal irregularities in weather systems, it may also be an harbinger of what is to come.

Station	January 2001 Mean Temperature	Normal Mean January Temperature 1961-1990	January 2001 Mean Temperature Deviation from Normal
Stewart Crossing	n/a	n/a	+15.1°
Carmacks	-28.6	-14.3	+14.3°
Mayo	-26.9	-12.9	+14.0°
Drury Creek	n/a	n/a	+13.5°
Whitehorse	-18.7°	-5.4°	+13.3°

Source: Environment Canada

CLIMATE CHANGE PROJECTIONS FOR THE YUKON

In 1997, Environment Canada released Volume 1 of the Canada Country Study *Responding to Global Climate Change in British Columbia and Yukon, Climate Impacts and Adaptation*. This study provided a balanced, realistic picture of what climate change and variability means for Canada as a whole. This study was based on the best available information of past and projected climate conditions using climate data, climate models, and climate change predictions or scenarios, and is intended for use by policy makers, industry, non-government organizations and the general public with.

Summarized below are the findings from this report that pertain to the Yukon. Joan Eamer of Environment Canada assisted with the preparation of the following summary.

Climate Change Science

Both scientific evidence and local observations indicate that the Yukon climate is indeed changing. Why is this change taking place? It has to do with a natural process called the greenhouse effect that has been accelerated by human activities.

The greenhouse effect

If our planet had no atmosphere, radiation from the sun would reflect directly back into space and the earth would be a cold, lifeless place. Instead gases in the earth's atmosphere absorb the sun's heat and slow its escape back into space.

When the concentrations of these gases increase in the atmosphere, they create a natural greenhouse effect. Without greenhouse gases, the average temperature on the earth would be –18°C, instead of the current average of 15°C.

Increased concentration of key greenhouse gases: global warming

The main driving force is greenhouse gas increase. The main greenhouse gases are water vapour, carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_20). Ice-core records show a good linkage between temperature and carbon dioxide in the atmosphere. The level of CO2 in the atmosphere was steady at about 280 parts per million (ppm) in pre-industrial times (before 1800). It is now 360 ppm (30% higher) and is expected to increase to 500 to 900 ppm over the next 100 years. Since the Industrial Revolution, the concentration of methane in the atmosphere has grown by nearly 145%, and nitrous oxide by 15%.

Humans are causing this rapid buildup of CO_2 through the burning of fossil fuels (coal, oil, and natural gas), agricultural practices, and deforestation. Global warming theory predicts that the earth will warm more rapidly than it has in thousands of years because of this rapid build-up of greenhouse gases.

The result of global warming: climate change

The world's top climate scientists, including the 2,600 scientists advising the United Nations Intergovernmental Panel on Climate Change, agree that human activities are having an impact on the world's climate.

Models of the earth's atmosphere and circulation patterns give varying predictions of the effects of increases in greenhouse gases, and the predictions also are different for different regions. However, they all predict certain trends.

Climate Model Predictions for the Yukon

- Climate models consistently predict increases in temperatures year-round and increases in snow for the Yukon.
- Winters are predicted to warm more than summers, with the winter warming being greater the farther north you go. Conversely, because of the moderating effect of the Beaufort Sea, summers are predicted to warm up more in the south and central Yukon than in the north.
- Predictions for precipitation are considered to be more uncertain than predictions for temperature change. In general, models predict increased winter precipitation for the Yukon (as with winter temperatures, the change is predicted to be greater the farther north you go). Most models predict little change in average summer precipitation levels.
- More and bigger storms are predicted for the Yukon - both winter storms and heavy summer rainfall storms, with more thunder and lightning.

Sea Level

- Climate change is one factor affecting sea level and will contribute to rising levels in the Beaufort Sea.
- The sea is rising now along the Yukon's coast at a relatively high rate. How much this will change with warming climate depends on such factors as how much the major ice sheets in Greenland and Antarctica melt.

Glaciers

- Summer temperatures and winter snowfalls affect whether a glacier is advancing or retreating.
- In areas of high snowfall in the Yukon it is expected that the increase in snowfall will more than compensate for the warmer summer temperatures - meaning that glaciers that are advancing now will continue to advance. Some glaciers at lower elevations may start to retreat or retreat at a greater rate.
- This is in contrast to southern and eastern BC, where in general glaciers are expected to retreat at increasingly rapid rates, having great impacts on flows of rivers such as the Columbia.
- Impacts of changes in glaciers are related to increased land instability (such as debris flows) and changes in streamflow.

Permafrost and Land Stability

- In northern permafrost areas, the further decay of permafrost as a result of continued warming trends is likely to increase the occurrence of thaw-flow slides and other types of landslides. Locally, forest fires will amplify this effect.

Coastal Ecosystems

- The entire Yukon coast is subject to increased erosion and coastal flooding from predicted increased frequency and magnitude of summer storms, and from sea level rise interacting with melting ice-rich permafrost.
- Related potential impacts are: loss of wetlands and changes in coastal species distribution.
- The Beaufort coastal zone is critical for many birds, fish and marine mammals.
- Impacts on coastal ecosystems are difficult to predict, as there are a number of factors interacting, such as changes to habitat structure, temperature and timing of the seasons.
- The productivity of the coastal Arctic waters is also related to the extent of sea ice and its annual cycle of freezing and thawing.

Biodiversity

- Habitat shifts are predicted to occur with latitude and with altitude (for example, more forest and less tundra in the Yukon - with trees expanding up mountainsides and northward). This would mean a loss of habitat for some plant and animal species and a gain for others.

- Most at risk are populations that live at the edge of their range and have very set habitat requirements, or species that do not easily move into new areas.
- A complicating factor is the rate of change - human-induced climate change is predicted to occur at an unprecedented rate. Some species adapt much more rapidly to new conditions than others. This means that certain species favoured by a shift in climate might come to dominate ecosystems.
- These habitat changes are also related to land management practices. For example, both commercial forestry practices and climate change may favour the increase of forest insect pests.

Ungulates (caribou, moose, etc.)

- One of the main aspects of climate change that is predicted for the Yukon is an increase in snow. Snow affects the movements and feeding of ungulates in the winter. The distribution and the reproductive success of many ungulates are related to snow patterns on a year-to-year basis. Long-term changes in snow are predicted to alter distributions and abundance of ungulates.
- Changes in the timing of spring are also important, as this affects the availability of food during the calving season.

Forests, Alpine and Tundra Ecosystems

- On an ecosystem level, predicted changes are: decline in wetlands (especially bogs), increased fire frequency and increased forest productivity.
- A warming climate is predicted to lead to changes in treeline (movement of forests northward and upward). This may be offset to some extent by increases in winter snowpack.
- Changes in vegetation communities in forests, alpine and tundra are influenced by local conditions and species mixes. Studies suggest that shrubs will dominate at the expense of smaller, herbaceous plants in alpine and tundra communities. In forests, white spruce and lodgepole pine are likely to dominate whereas black spruce is expected to become less abundant. Southern plants species will move into the area.

Fish

- Although warmer temperatures should bring increased productivity in northern spawning areas, deteriorating conditions in the marine environment may offset this. (Southern BC salmon stocks are predicted to decrease.)
- Some freshwater species (such as lake trout) may increase due to greater productivity in warmer waters - but there also could be deterioration in stream habitat related to changes in water flows.

Agriculture

- Increase in the length of the growing season would allow production of crops that cannot be produced now in the Yukon (especially grain).
- Moisture is also a limiting factor in the Yukon, but projected increases in annual precipitation would probably not be significant for agriculture.
- Overall the projected impact of climate change should be positive for agricultural production in the Yukon.

Aboriginal Lifestyles

- Aboriginal lifestyles are strongly tied to resources on their traditional lands. Impacts of climate change on distribution and abundance of key fish and wildlife resources would affect the economy and culture of aboriginal communities.
- In the Yukon, the best-studied example of this is the Porcupine Caribou Herd. Research has established links between climate variables and the Herd's productivity. Predicted changes in the Herd's range - increased snow depth, earlier spring and warmer summers - are projected to have detrimental effects on Porcupine Caribou numbers.

Energy Production

- The hydroelectric sector is identified as the energy sector most sensitive to climate change (because of predicted changes to stream flow).

COMMUNITY OBSERVATIONS AND CONCERNS ABOUT CLIMATE CHANGE IN THE YUKON

Yukon Communities have been experiencing changes to their environment, economies and social conditions that are directly or indirectly related to a change in climate. Below is a description of some of the observations and concerns shared with the Northern Climate ExChange during the Exchanging Ideas about Climate Change in the Yukon community tour. Wherever possible, we have documented observations and concerns verbatim within this report.

Mayo/Central Yukon

The Central Yukon Basin is characterized by variable temperatures with cold winters are common, precipitation tends to be moderate, and winds relatively light. Mayo, lies within the Central Yukon Basin. Typical for this basin, it has some of the most extreme temperatures in the territory. With an average annual temperature of -3.6^{0}C, the extremes have reached between $^+$36.1^{o}C and –62.2^{o}C. Precipitation is relatively low, with a mean annual average of 318.4 mm, broken down into 201.4 mm of rain and 145.0 cm of snow in a year. Conditions tend to be calm without a lot of heavy winds or storms.

The following observations arose during a Public Information Session in Mayo (July, 2000), and a session the First Nation of Nacho N'yak Dun Lands and Resources Department State of the Environment 2000 Workshop held at the Moose Creek Lodge in Stewart Crossing (August 2000) attended by residents of Mayo, Pelly Crossing, and Stewart Crossing.

Below is a list of some of the local observations on climate and environmental change from the Central Yukon:

- More weather extremes
- More moderate winters
- More storms, stronger winds, more hail and rain
- Wet summer in 2000 resulted in no mushrooms (not enough heat?), and lots of mosquitoes

- Snow is "spottier", and volumes of snow are no longer predictable; harder to make trails as snow texture is sandier
- Catching fewer fish, and fish catches are less predictable
- Animal distributions are changing, and their behaviour is less predictable
- Fewer bees and wasps, and no hornets
- Permafrost melt allowing banks to be eroded
- Leaf miners in poplar trees increasing
- Timing of seasonal changes (come on more gradually, then a sudden sharp change)
- No mushrooms this year (not enough heat?)
- Snow lasts longer into the summer
- Later spring this year, but this hasn't been a trend
- Air mass patterns have changed
- More northerly winds in the winter
- More parasites found on vegetation and deer
- More tourists coming to Mayo
- Permafrost melt allowing banks to be cut-up
- There are often high-water years, but this year the high water doesn't seem to be going down
- Fewer cold spells in winter make beetle hazard greater
- Tatchun caribou herd sex ratio is off- more bulls than cows
- Concern of lakes drying out over long term
- Thinner, softer ice in winter
- Willows and spruce trees drying up, not just along highway but also in bush
- More dead moose being seen in rivers
- Fewer female salmon for spawning in the Stewart river
- Fewer flying ants
- Itchy skin and hotter sun in the past few summers
- Changing incidence of lightning storms
- Wetlands are drying
- Permafrost is melting
- Dry moss has been observed in the mountains
- Not much snow, results in colder ground temperatures because of less insulation
- Creeks drying up
- Thinner and softer ice
- Willows grow right down to river (wasn't like that before)
- Less and less berries, birds, and rabbits causing bears and wolves to come right into towns
- Trees dying and drying out along highway
- Bugs killing stands of trees
- Less and less migratory birds, and swans are now nesting here (this never used to happen)
- Fewer lambs being seen
- Fewer rats and rat houses being seen

Mayo residents also had specific concerns about climate and environmental change. Land stability, municipal infrastructure, water levels (in particular as they relate to the hydroelectric dam), fish and wildlife management, and forest management were identified as areas of concern for Mayo. Some of the concerns raised related to policy issues, for example what types of decisions can be made with respect to climate change and issues of mitigation or adaptation, and who should be making these decisions?

At the Moose Creek State of the Environment Workshop, Elders noted the following seasonal observations in timing of environmental conditions. Concern was expressed about how climate change would affect the timing of these events.

- Spring – we used to hunt rats and beavers in the lakes
- June – dry white fish
- May – harvest roots
- June – sap
- August – gophers, porcupines and soap berries
- September – waterfowl
- May to August – we used to leave ducks, rabbits and grouse alone so that they could raise their young
- November to January – fish under lake ice

Central Yukon residents also had ideas about what should be done to address these climate change. Education about climate change and why things are changing, in particular for local youth, was recommended by some as a top priority (classroom presentations, monitoring projects etc). Some suggested that future work needs to focus on how we adapt to changes in our environment (for example, should harvest levels be limited?). Others suggested that humankind needs to reflect on their actions, and incorporate spiritual teachings, traditional knowledge, and scientific research into action plans.

The Village of Mayo, with the assistance of Chris Burn and Vicky McCoy of Carleton University, initiated a project (funded by the Community Development Fund) to compile information about climate history and changes in the environment for the central Yukon for the past 100 years. Results of this work were presented at the Climate Change in the Central Yukon Workshop.

The Central Yukon Climate Change Workshop was held in February 2001 to review all available information to determine the impacts of climate change on the environment of central Yukon, understand the specific consequences of climate change on infrastructure, renewable resources, community energy requirements etc., and explore long-range planning requirements. The Village of Mayo, Nacho N, jointly organized this workshop'yak Dun First Nation, and the Northern Climate ExChange. Proceedings of the workshop were prepared, and are available from the Northern Climate ExChange.

Dawson

Dawson City, in West-central Yukon is located at the confluence of the Yukon and Klondike rivers. It is part of the Central Yukon Basin climate zone, which is characterized by moderate precipitation, variable and extreme temperatures, and relatively light winds.

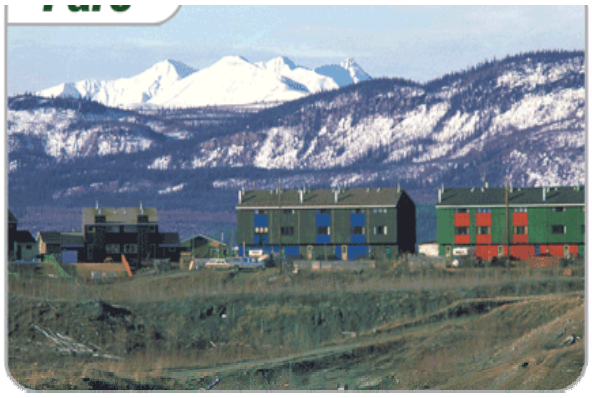
Below is a list of some of the observation from Dawson residents on climate and environmental change:

- Weather patterns in the area do not seem typical - many extremes (wet/dry summers, warmer winters) are being observed
- Uncertainty over whether town dyke will withstand levels of flooding in the future
- Wildlife concerns: habitat loss and gain, new bacteria and parasites in wildlife, new fungus in salmon stock, changing wildlife migration patterns
- Awareness that permafrost is vulnerable in the area, close to its melting temperature.
- Ice conditions: ice-bridge connecting the two sides of town was much thinner than usual, and also opened later than in past winters

Dawson residents also expressed concern about aspects of climate and environmental change. Fisheries (in particular salmon) are a major concern for some residents, in particular the uncertainty over how environmental changes will impact population levels. Some residents recognized that the town dyke was built to withstand a certain level of flooding, and wondered how reliable this dyke will be in the future if water levels rise. There is also awareness that permafrost in the area is 'warm' or close to its melting temperature, small changes in ground temperatures make infrastructure, in particular the underground sewer system, and valuable heritage structures vulnerable to climate change. One resident noted that millions of dollars at stake should land instability result from climate change. Other residents wondered how forest fires and tourism will be affected by climate change, and some questioned if new agricultural opportunities will arise.

Faro

Faro, with an elevation of 694 m, lies in the Central Yukon Basin, which is characterized by moderate precipitation, variable and extreme temperatures, and relatively light winds. Extreme temperatures range from over 30°C in the summer, to approximately –55°C in the winter.



There is a relatively short record of climate data available for Faro from Environment Canada, making it difficult to gain a long-term perspective on local climate variability. However, additional sources of data do exist. For example, the Faro mine recorded weather data when operational, and engineering firms commonly record ground temperatures when drilling for foundations. Lloyd Johb, a long-term resident who has calibrated and maintained a long-term record of weather observations using a hobby weather station. Lloyd has been scrupulously collecting and recording temperature, wind, barometer, precipitation, and snow depth data for over 20 years. His data has shown that winters have been much warmer than in the early 1970s, and less snow has fallen in the past 5 years than 15 years ago. He also observed an "Omega High" on January 31, 1989 which he had not previously observed.

Below is a list of some of the observations from Faro residents on climate and environmental change:

- Long cold spells now rare in the winter
- Winds have increased in velocity over past 20 years and strong winds now occur more frequently
- More downpours and thunderstorms
- No more large flocks of birds, but unusual species being spotted
- Low, dark rotating clouds now being seen
- Less snow over past 10 years
- Warmer winters
- Larger mushrooms, and new species seen in area that have never been seen before
- Longer spring season
- Weather patterns are less predictable
- More severe storms
- Used to be rare to have storms and high winds late in the evening
- Lower water levels in local creeks
- Don't see large flocks of birds anymore, and new species are being observed
- Snows earlier at mine site

Faro residents also expressed concern about aspects of climate and environmental change. For example, in the past unstable ground related to permafrost has affected the local hotel and school. From these experiences, lessons were learned on how to construct foundations under these conditions to prevent problems. It was pointed out that the permafrost issue is not a new issue, rather an ongoing issue, but some residents wondered if lessons learned will

apply under future conditions. One resident wondered if the new species and greater abundance of mushrooms will provide new economic opportunities. Another resident questioned if warmer winter temperatures will have economic implications for fur bearing animals because of thinner fur.

Other concerns related to collection of data and information to monitor changes. For example, data is available from different locations in town, and each location does records different observations – the mine at higher elevation than town and shows temperatures to be cooler in summer and warmer in winter (temperature inversions). Temperatures recorded at the airport also differ from those taken in town. Quite frequently, residents notice that forecasts from Environment Canada (EC) do not match local conditions, and some wonder if this is because weather data is remotely collected by EC offices in Kelowna, and forecasting takes place at EC offices in Vancouver. This, in combination with the fact that it is too expensive to obtain climate data from EC, has generated an interest by some residents for local monitoring.

Village staff are supportive of local research, education or capacity-building on the climate change issue and are keen to work in partnership with Ross River on any potential projects that may arise. Some of the topics suggested for research include tourism, wildlife management, fuel cell research, documentation of traditional knowledge, and monitoring. Village staff also had ideas about on how to proceed with addressing the climate change issue locally. They suggested that a local person or agency be identified to explore opportunities, needs and options for local climate change-related work. Once a focus has been determined, a proposal should be developed to look for partners to assist with the work.

Watson Lake

Watson Lake, in the southeast corner of the territory, is located within the Liard Basin. The average annual temperature is -3.1°C, with temperatures ranging between an extreme minimum of -58.9°C and an extreme maximum of 34.2°C. Annual precipitation is low to moderate, with much of it falling as snow. The mean annual precipitation is 413.8 mm, made up of 256.7 mm of rain, and 218.9 cm of snow.

Below are some of the concerns from Watson Lake residents on climate and environmental change:

- What will the impacts be of climate change on the nearby Finlayson woodland caribou herd?
- Will climate change result in an increase in forest fire and insect outbreaks?
- Will vegetation change and if so, will these changes affect ecosystems and forest management practices?

Some Watson Lake residents shared ideas about what should be done to address climate change in the region. One resident noted that trappers in the area have decades of experience, wealth of knowledge, and valuable journals of information relating to conditions on the land. This information should be reviewed to improve our understanding background or 'natural' variability, to better grasp the impact of current climate warming. Some residents expressed an interest in establishing ongoing monitoring projects, in the Watson Lake area, that would complement existing monitoring on rabbits, birds and small mammal populations. This type of program should include monitoring of changes in vegetation, and how these changes affect other ecosystem components. However, it was noted that at the present time there is neither the time or resources to initiate this type of work and suggested that this work could be coordinated across the Yukon through a larger agency. Another resident recommended that educational programs should link climate change to forestry issues. Forestry is one of the greatest issues of concern to residents of Watson Lake, and more people may become engaged in the climate change issue if it is related to forestry in a concrete way.

Teslin

Teslin is located in the Upper Yukon-Stikine Basin, which is characterized by low precipitation, continental temperature, and relatively strong and frequent winds. The annual mean temperature is $^{-}1.6^{o}C$, with extreme temperature ranging from $^{-}52.8^{o}C$ to $^{+}33.3^{o}C$. Annual precipitation averages 340.5 mm, with an average 190 mm of rainfall, and 160 cm of snow.

A list of observations on climate change from residents of Teslin is provided below:

- More rain than usual during last few summers
- Spring and summer reversed in 2000 (hot sunny spring and rainy cooler summer)
- Little snow in winter, making it harder for snowmobiling

- Mushroom pickers around Squangua have found mushrooms in July that usually come out in the fall
- Fewer porcupines in the area
- Salmon are going out to sea, but are not coming back to the rivers to spawn
- Unusual amount of rain in summers for the past few years
- Used to drill 5" holes in the ice, now lucky to get down 3"
- Unusual spring and summer weather conditions have prevented berries from developing

It was pointed out by one resident that there is currently little discussion about climate change and how to address change in the Teslin area, however interest in the issue does exist. A number of concerns about climate change impacts emerged during our discussions with Teslin residents. For example,

- Will there be more problems in the future for pipelines, highways and powerlines due to frost-heaving?
- Will bison find suitable habitat in the Teslin area in the future?
- Will salmon populations continue to decline?
- Ticks are a concern for moose around Teslin, will this become more of an issue if the temperatures increase and ecosystems shift north?
- Will bear populations be affected by climate change?
- Are freshwater fish vulnerable to climate change?
- Will climate change have an impact on mining operations or abandoned mine sites?

A number of residents suggested that their elders may be good information sources for this issue, and encouraged work to collect traditional knowledge on climate change within the Teslin Tlingit territory.

Haines Junction

Haines Junction in the Southwest of the Yukon is also in the Upper-Yukon Stikine Basin, though situated just by the western boundary with the St. Elias range. Average annual temperature is –2.9°C, with extremes ranging from –53.9°C to +32.9°C. Annual precipitation averages 305.7 mm, with a mean annual rainfall of 154.3 mm, and mean annual snowfall of 159.8 cm. Winds in Haines Junction tend to be lighter than in the rest of the basin due to the orientation of the valley.

Below is a list of some of the observations from Haines Junction on climate and environmental change:

- High water levels are causing nesting swans to lose more young, so they are moving away from nests on local lakes
- Severe spruce beetle infestation believed to be due to mild winters and low precipitation in summers of last decade)

- As beetle-killed spruce trees die and fall down, more radiation can reach the ground and melt the permafrost; different plants now invading where spruce had grown
- No gophers this year (related to rain crusts and ice in snowpack?)
- Snowcrusting potentially responsible for low numbers of grouse and sharp-tails
- More extreme weather events, such as warm spell and rain in late December '99, high precipitation in summer 2000
- Many leaf-miners found in poplars this past year

Some specific concerns were raised about impacts of climate change in the regions. For example, some residents are concerned that, if warming continues, will melting of discontinuous permafrost in northern Aishihik affect habitat (ground squirrel is one example)? Others noted that increasing leaf miner populations may have implications for fire behaviour since poplar stands can act as a fire break. Others wondered that as glaciers retreat, will lake trout and other organisms that depend on this steady source of fresh water be affected, for example in Dezdeash Lake and streams that flow into the lake? On a positive note, some residents expressed an interest in emerging opportunities for agricultural production in the area that may arise as climate changes.

Burwash Landing

Burwash Landing is within the Upper Yukon-Stikine Basin climate region. Windiness is prominent in this community, as winds regularly gust to 55 kilometres per hour. Mean annual temperature is –4.0°C, with the extremes going from –55.°C to +31.7°C. Precipitation is relatively low with a mean annual amount of 290 mm, 90.6 mm fall as rain, and 110.5 cm fall as snow.

Residents of Burwash Landing had many observations to share on climate and environmental change:

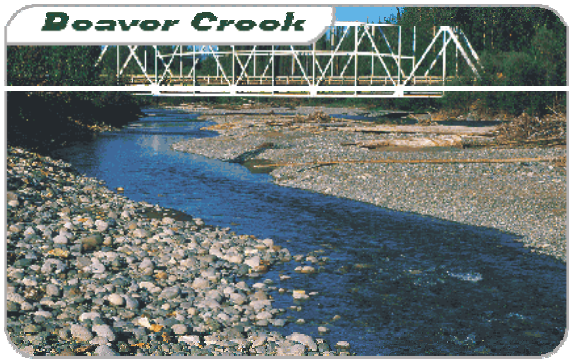
- Very high lake level in 2000 washed out the highway (highest level one elder has ever seen it)
- Few lambs in last couple of years
- Few moose this year, possibly due to a large snowfall in fall '99 (moose tend to move away from heavy snow areas where travel is difficult)
- Fire in summer of 1999 led to flooding in 2000 due to the loss of mosses and other groundcover
- Decrease in number of gophers attributed to the '99 fire season and ice layers in the snow pack the following winter (layers of ice caused by rain during the winter could cause small mammals living under the snow to suffocate)
- Lake trout numbers down
- One elder remembers 1973 as being the last "normal" year (i.e. cold winters, regular lake-freezing patterns, etc.)
- High water levels in rivers
- Melting glaciers
- Warmer winters and warmer summers
- Fewer caribou, sheep, fox, and salmon
- Much snow this past winter
- High water levels in rivers
- Animals disappearing
- No more rats

- Geese used to blacken the sky, and there would always be lots of ducks, now you have to search for them
- Near Silver City (by the east side of Kluane Lake) there used to be a population of 80 rams, now just 8
- Used to have thick wet moss, now even after the rain the ground completely dries up, which affects sheep browse. Speculation that this caused by melting permafrost
- Despite the high precipitation and rising lake + river levels this summer, water levels in creeks stayed were low until end August.
- Water seeps down and drains where previously it was held in place by permafrost.

Beaver Creek

Beaver Creek, the Yukon's most westerly community, is in the Central Yukon Basin, characterized by moderate precipitation, variable and extreme temperatures, and relatively light winds. Summers tend to be mild, though can reach 30°C. Daytime winter temperatures are usually around –24°C, but have been known to drop to –55°C.

Residents of Beaver Creek had the following observations to share about climate change in their area:



road can arise overnight from frost heaving

- Highway being damaged by substantial amounts of frost heaving, sometimes causing large bumps to appear overnight
- Winters much milder than before
- The highway is becoming distorted- frost heave is making it rise up and sink down substantially
- Road maintenance is increasing significantly, 6" potholes in the

Whitehorse

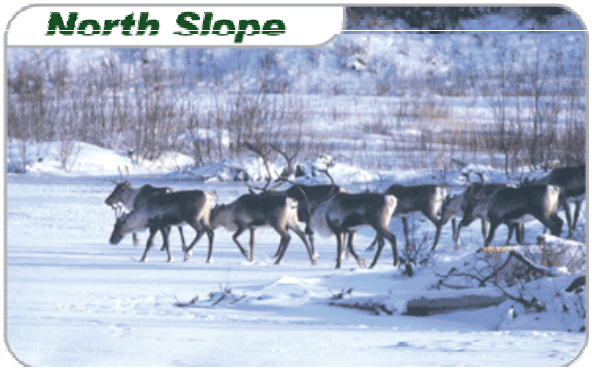
Whitehorse is located in the Upper Yukon-Stikine Basin climate region. The average annual temperature is –1.0°C, with mean January temperatures of –18.7 °C and mean July temperatures of 11.6°C. Whitehorse receives an average of 268.8 mm of precipitation per year, of which 159.6 mm is in the form of rain.

- Because insects live within a narrow temperature range, insects seem to be a good barometer of climate change - some elders are seeing insects they have never seen before
- Warmer winters, more rain in summers
- In the past few years, it has become more difficult to forecast hydro power capability
- Sightings of Monarch butterflies in Whitehorse
- Concerns about oil and gas development in the Yukon, and how this will contribute to levels of greenhouse gases in the atmosphere
- Concerns about methane emissions (a greenhouse gas) from municipal landfills

At the *Taking Action on Climate Change in the Yukon* workshop in Whitehorse in May 2000, specific recommendations for governments, communities, industry, and researchers on the climate change issue arose. Firstly, governments should consider climate change in

management agreements for natural resources and environmental impact assessments for development projects, and should encourage and support community-based monitoring and archiving programs. Communities should participate in monitoring programs and begin discussing strategies for adapting local infrastructure to a change in climate. Private sector industries such as forestry, transportation, mining, construction and oil and gas should include climate change considerations in research, planning and design of projects such as pipelines, dams and tailing ponds. Lastly, researchers should consider developing a centralized archive of data relating to climate change and consider community needs in the design of research programs.

North Slope



The climate on the North Slope is quite different from any of the southern zones. In the Yukon, the North Slope is located within the Porcupine-Peel Basin climate zone, and experiences winters that are cold and long, and summers that are short and variable. Light winds and relatively little precipitation characterize the community and the area.

Residents of the North Slope shared the following observations on climate change with us at the Yukon North Slope conference in September, 2000:

- More storms, stronger winds
- For the first time in 1999, a ship crossed the Northwest Passage in one season
- Whaling has become difficult because it is more stormy - storminess makes it more difficult to follow the whales
- Snow geese are changing their migration patterns
- Concern about availability of nesting sites for migrating birds in the future
- Within 100 years, the community of Tuktoyaktuk expected to be untenable due to high rates of coastal erosion
- New species of salmon appearing – pink and sockeye
- Herring and char are skinnier than they used to be
- Blueberries and other berries are small and they aren't tasting right
- Lesions on people's skin after they get back from the flats in the summer
- The snowfall is changing, it rained last December! This impacts caribou as it crusts over the snow and makes it difficult for them to forage. The caribou that we got were less healthy.
- The lakes in the Old Crow Flats are beginning to drain into the Porcupine River and into the Beaufort. We depend on the wetlands for our subsistence and we depend on the permafrost to keep the water in the lakes.

At the North Slope Workshop, we discussed what people in North Slope communities do, and what is of concern relating to climate change. The question 'so what?' was used to challenge most comments. This was to keep the focus on practical applications of climate change research and knowledge, relating to the communities' seasonal activities. From this discussion, a number of things were found to be important:

Increases in storms. Why? Boating becoming more hazardous; risk of camp evacuation increases; it is more difficult to hunt whales; fewer planes and less tourist activity. There are observations of windier summers in recent years.

Landslides and erosion. Why? They can contribute to land recession on the coast (which could affect human and harvested animal habitat, such as nesting birds) and muddying of water (which could affect harvested fish populations). There have been observations of change to several local populations, including char, herring and salmon.

Ice in water. Why? It is often an obstacle to boating west from Kay Point. Icepack factors are also important to landing float planes at Hershel Island.

Wetness of tundra. Why? Caribou hunting is often done by skidoo in summers, wetness affects ability to skidoo.

Thinner Ice. Why? It causes extra risk and less security in winter travel.

This workshop identified that wind is of fundamental importance to most of the activities occurring on the North Slope. It brings in the ice and takes it away and it is the main control over storms and water levels, and thus affects human safety, water levels and erosion rates, amount of air traffic, amount of sea traffic west of Kay Point, and potential camp evacuations. Also identified were issues considered to be less important to residents of the North Slope. For example, planning adaptive strategies to harvest whales in rougher waters may be a good idea, but the idea of having bigger boats that could be out in storms would not be helpful. Beluga are difficult to spot in whitecaps no matter how large a boat one is using.

Aspects of life that are important and could change with climate change have been noted above. Based on discussions at this workshop, a better understanding of changes to wind patterns, storminess, and ice dynamics are a priority, as is a better understanding of these climate impacts on coastal fish and bird habitat. The North Slope has a Research and Monitoring Plan that provides additional direction on actions required to address climate change in the region.

CONCLUSIONS

In the Yukon, climate change has emerged as a major issue of public concern and is now receiving considerable attention in this area and across the Canadian north. Climate change is not new, it has happened in the past but the rate at which it is currently occurring is believed to be unprecedented. How will climate change affect wildlife, hunting and trapping, and other activities in the Yukon? Should we be doing anything about it? How should we approach the challenges that climate change has presented to us?

The NCE *ExChanging Ideas on Climate Change in the Yukon* community tour provides insight into the local dimension of the climate change issue. The following general conclusions have been drawn from this work:

Climate change is no longer an abstract idea in the Yukon There is a high degree of awareness and concern about climate change in the Yukon. This may be a reflection of considerable media coverage devoted to this issue, the availability of traditional and local knowledge, the growing accessibility of research results, and/or to a strong connection to the land.

Public opinion on what to do about climate change varies Despite the high degree of awareness, there are widely varying opinions on how serious the issue is, and what should be done to address the issue. Some of the opinions shared with us include

- "I am overwhelmed by conflicting information"
- "It is going to happen anyway"
- "It is going to be very hard on us"
- "There is nothing I can do"
- "Northerners aren't the cause of the problem"
- "It is not as bad as they say"
- "Some technology will be developed to fix the problem"

There is a tremendous amount of local information on climate change, but very little of this information is documented The primary goals of this work were to gauge the degree of understanding of climate change in Yukon communities, and to identify local climate change issues, observations, and concerns related to climate change. We discovered that a wealth of anecdotal observations exists, but in many cases, this information has yet to be recorded in a systematic or comprehensive fashion.

People are concerned about their observations Many individuals we spoke with are disturbed by what they consider to be severe climatic and ecological changes, and many report that the changes they are witnessing are unprecedented.

There are more questions than answers When it comes to deciding what to do about climate change impacts there are more questions about what changes to expect, and what to do to respond to these changes, than answers.

There is a paucity of information to assist communities with understanding and preparing for climate change impacts We discovered that there are many issues surrounding information on climate change, ranging from inadequate monitoring of environmental conditions to restrictions on information access. From this poor information base arises considerable confusion about how to address climate change impacts.

Very little research is available at a scale that is useful to community-level decision-making processes Many individuals we spoke with lament the fact that there are few studies are available on the probable impacts of climate change at local and regional levels, and even fewer studies exist that provide guidance on how to adapt to a changing environment.

Local observations on climate change are extremely valuable to assist in pinpointing areas of research, provide a "window" into impacts of climate change at a local level, identify issues that require attention

Observations and concerns on climate change vary among communities There are subtle local and regional differences in observations on climate change. It is apparent that variations in culture, economy, and location will mean that climate change will impact communities in different ways. The concerns expressed about what impacts climate change will have on local economic and social conditions tend to be a reflection of unique local circumstances.

Community observations and model predictions on climate change are not always the same There are similarities and differences between local observations and climate change scenarios or model projections. Both models and anecdotal information indicate that the Yukon climate is indeed changing, and many of the observations are consistent with model predictions. Local knowledge tends to provide greater detail on local conditions and more context on local concerns.

Everyone benefits when we share observations about changes in the weather and the land. We need information from the real climate change experts – the people who are close to the land – as even the most sophisticated computer models still lack good climate information. Climate change research will be more effective if guided by local observations and concerns.

Local communities are best positioned to understand and assess their vulnerability to climate change, and therefore, define what should be done to address the changing conditions at the local level. Community participation in research and decision making is essential to long term resource, environmental and cultural sustainability.

RECOMMENDATIONS

Much work is required to fully prepare for the impacts of climate change. We need to understand more fully the relationship between climate, environmental conditions, and human activities. From this report, arose following list of recommendations for future work on climate change at the community-level in the Yukon.

Document local and traditional knowledge on climate change

Traditional knowledge enhances our capacity to understand climate change impacts on northern ecosystems, economies, cultures, traditions and communities. However, since traditional knowledge is open-ended as are other bodies of scientific knowledge, it is ever evolving and for the most part is still being held in the minds and memories of the Yukon First Nation elders and storytellers. It is clear that much information on climate change exists in publications and documents, although very little of this information is aimed at the specific topic. Conducting oral history research aimed exclusively at climatic and environmental change is likely to produce rich results.

Develop a community-based environmental monitoring strategy

Northern Canada needs to regain its capacity to monitor changing environmental conditions. Over the past decade or so, funding cutbacks has resulted in substantial decrease in the amount of monitoring taking place. It is extremely important that agencies, organizations and communities in northern Canada work together to develop a strategy to monitor these changes. Currently, a number of efforts are underway or proposed to document these changes. A community based climate change monitoring strategy is required to examine ways to coordinate and expand upon existing initiatives to make the best use of limited resources, avoid duplication of efforts, and provide communities with a single point of contact in each region of the North. The Northern Climate ExChange is spearheading an effort to develop this strategy for northern Canada.

Improve community access to information

A northern, climate change information system is needed to share knowledge and information on climate change. This information system should do the following:

- Provide a database of climate change information sources and contacts
- Provide regular updates when new relevant information is available, and provide some means for non-electronic distribution of information
- Provide a forum for discussion on current issues and events

- Record case studies of what communities are doing to respond to impacts of climate change
- Provide checklists of climate-related considerations for communities i.e. decision support tools or a resource guide for communities to aid in long-range planning exercises
- Keep track of information needs, and formalize a system to document and distribute these needs to interested groups
- List community observations to assist in matching community questions to researchers and to assist communities with similar issues to get in touch with each other
- Provide an opportunity to keep track of questions people have related to climate change for which they have not been able to find an answer
- Include case studies or pilot projects that describe how northern communities that are developing or implementing adaptation strategies
- Include guidance on "what should be done" to respond to climate change
- Describe what is known about climate change impacts for the various regions as well as by natural and human systems
- Provide a list of codes, standards and regulatory processes in place where climate change should be considered
- Identify collaborative research opportunities

The NCE is currently working on a web-based Climate Change Knowledge System for northern Canada that will seek to incorporate the above recommendations.

Fill in information 'gaps'

A recent task force found that Canadian northern research is in a state of crisis. If action is not taken to improve the situation, northern Canada will be in a very poor position to understand global change, what global change means at local and regional scales, and how to respond to change. A recent project by the Northern Climate ExChange *An Assessment of the State of Knowledge of Climate Change Impacts in Northern Canada* identifies "gaps" in our knowledge base. Products of this work will assist northern communities, researchers, and policy makers in establishing priorities for further research.

Prepare for climate change

Northern communities need to prepare for climate change. Communities should begin to develop strategies to get ready for a change in climate and environmental conditions, and recognize that the choices made today will influence future vulnerability to climate change.

A regional perspective on climate change is needed, and responses to climate change should be developed at the local and regional level. Communities need to assess their vulnerability to change, and develop a regional vision on how to grow and develop into the future, and take climate change into account when managing land, resources and infrastructure. Strategies should be flexible, adaptive (account for trial and error), and be responsive to unpredictable events. When developing responses, we need to think not only in terms of the short-term but also the long-term -- the climate change issue will not go away any time soon so we need to consider how actions today will affect future generations. Responses to climate change should be prioritized and the time frame in which each action should be addressed should be considered.

The Northern Climate ExChange is proposing to develop a manual to assist communities in determining the local consequences of climate change, and to facilitate a planning process to incorporate climate change into local decision making and planning exercises.

Develop policy and decision-support tools

Communities need decision-support tools, and higher-level policy decisions to support action on climate change at the local level, not just information. Tools that will enable communities to better understand climate change, reduce their greenhouse gas emissions, and adapt to changing climatic and environmental conditions should be developed. New and existing policies, standards, regulations, legislation, and management agreements will need to become consistent with the goal of reducing greenhouse gas emissions and our vulnerability to climate change.

The Northern Climate ExChange is exploring the possibility of undertaking a strategic planning exercise to determine where linkages and gaps exist in current policies and climate change. Such an exercise could model possibilities and consequences of policy options, and outline where and when climate change considerations should be integrated into planning and decision-making processes. Products of this work could include a tool for local practitioners, consisting of perhaps a computer-based model or an innovative early-warning program that highlights linkages between various programs and policies and climate change.

HOW WE SHARED THESE RESULTS

A number of methods are being used to communicate the findings of the NCE tour *Exchanging Ideas on Climate Change in the Yukon*:

Method	**Description**
Report	A report was produced that summarized what we did, how we did it, and what we found out.
Web site	Findings of the Community Tour are available on the NCE web site (www.taiga.net/nce).
Presentations	Presentations were given throughout the year at conferences and meetings.
Poster	A poster was produced to summarize the findings of the community tour and this poster was widely distributed across the Yukon
Newsletter	Findings of the community tour were summarized in the NCE newsletter (Issue #2, December 2000)

APPENDIX A
COMMUNITY CONTACTS

(A list of community contacts for this project is available upon request)