

## ATULIQTUQ: ACTION AND ADAPTATION IN NUNAVUT



### CLIMATE CHANGE ADAPTATION ACTION PLAN FOR HAMLET OF ARVIAT

# 2010

**Written by:** Karen Nasmith, MCIP, RPP  
Michael Sullivan, MCIP, RPP

**ACKNOWLEDGEMENTS:**

ATULIQTUQ: Action and Adaptation in Nunavut is a collaborative project of the Government of Nunavut, the Canadian Institute of Planners, Natural Resources Canada and Indian and Northern Affairs Canada. The Climate Change Adaptation Action Plan for the Hamlet of Arviat was prepared by Karen Nasmith (planningAlliance) and Michael Sullivan (Nuna Burnside Engineering and Environmental Ltd.). The authors would like to recognize the contributions of the NRCan science team, Michelle Drylie and Hayley Imerman (planningAlliance), the Government of Nunavut's Department of Community and Government Services and Department of the Environment (Climate Change Coordinators office), Hamlet of Arviat Council and staff, as well as various local stakeholders and community members in the completion of this adaptation plan.



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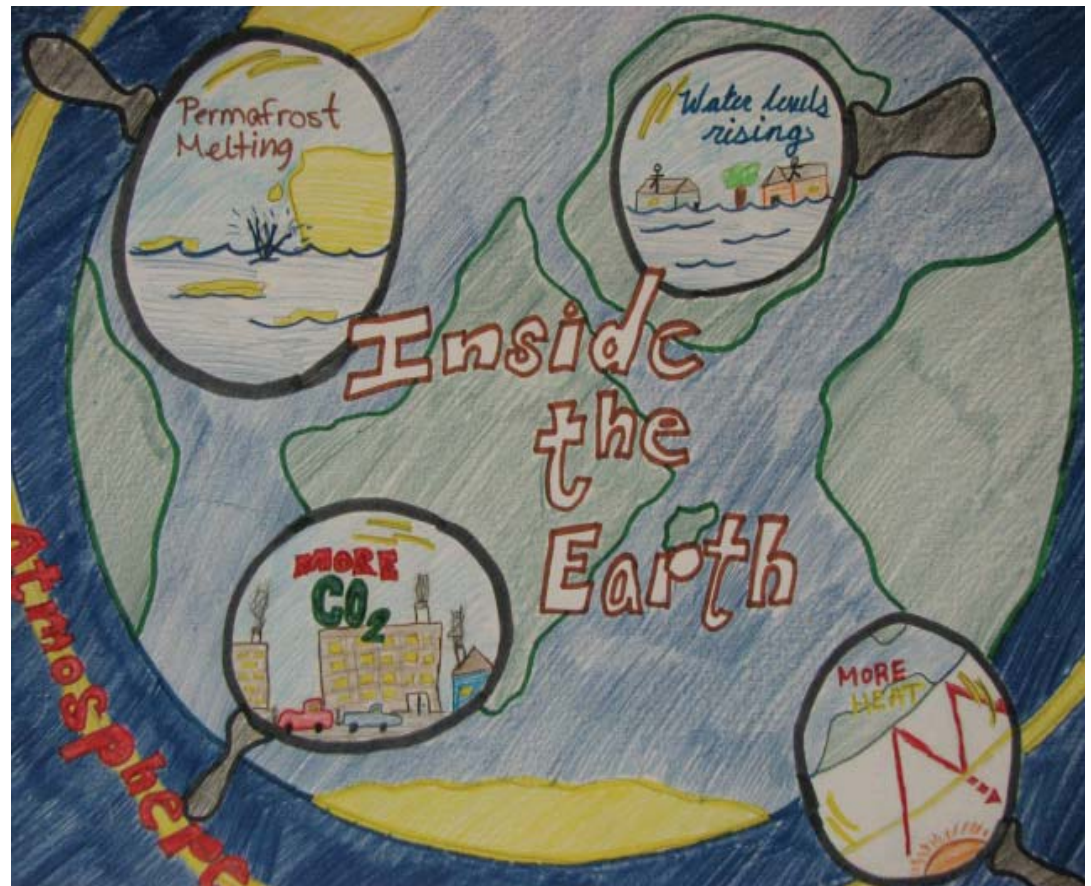
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Appendix A - Table 1: Arviat Climate Change Adaptation Action Plan



Artwork by winners of the  
Climate Change  
Adaptation Art  
Contest

Arviat, October 2009



High School:  
Simeon Koomak  
(Grade 12)



Middle School:  
Shelby-Tia Angalik  
(Grade 6B)

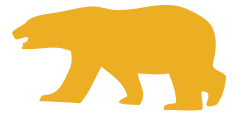
## Executive Summary

Nunavummiut have a strong connection with the land and an intimate knowledge of local climate and weather patterns. Increasingly over the past few decades, impacts of climate change are being observed, including the introduction of new plants, mammals and insects, changes to sea ice conditions and rapid changes in weather. These changes are impacting the Inuit way of life, making it challenging to travel safely on the land, and requiring changes to traditional hunting practices. Adaptation is required, to plan for the short and long term needs of the community and to support healthy and sustained community growth.

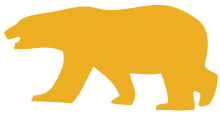
The objective of this project is to raise overall awareness of climate change and to assist the community with identifying appropriate responses to the potential local effects of climate change – resulting in the development of a Climate Change Adaptation Action Plan. While the project scope is limited to identifying actions for climate change adaptation for lands within the municipal boundary of the Hamlet of Arviat, this report also reflects issues that were identified beyond this scope that may impact the community. The information received and summarized in this report is based on community input, traditional knowledge and scientific analysis. Arviat is one of five pilot communities in Nunavut participating in the development of local adaptation plans. Michael Sullivan and Karen Nasmith, members of the Canadian Institute of Planners (CIP), worked with Regional Planner, Samuel Wahab (Community & Government Services) and Regional Engineer Wayne Thistle (Community & Government Services) on behalf of the Government of Nunavut to develop a climate change adaptation plan in partnership with Arviat. Project partners also include Natural Resources Canada, Indian and Northern Affairs Canada and Memorial University of Newfoundland. Special mention should be made of our local contact, Jerry Panegoniak, Community Lands Administrator with the Hamlet of Arviat, and the NRCan science team, who contributed significantly to the project.

The project began in March 2009 with a commitment for CIP planners to visit and work with community members during five trips over a 14 month period. Community visits took place in March 2009, July 2009, October 2009, and March 2010, and a final trip in June 2010. During each of these trips, a series of meetings and interviews were held with key stakeholders to identify and discuss in detail how climate change is affecting both themselves and their area of expertise. Community meetings were held in order to raise further awareness about the project and climate change in general. In July 2009, scientists from Natural Resources Canada and Memorial University of Newfoundland accompanied the planners to Arviat to carry out research in the community and take part in a community engagement activity as part of Nunavut Day celebrations. It is a result of the combined input of the scientists, key stakeholders and community members that this plan has been produced.

Specific activities for this project involved the identification of the potential impacts of climate change as well as the development of community responses in the form of adaptation activities. Impacts were prioritized based on the perceived risk to the community. In addition, community members and agencies were identified to oversee the implementation of the adaptation activities.







## 1.0 Goals and Objectives

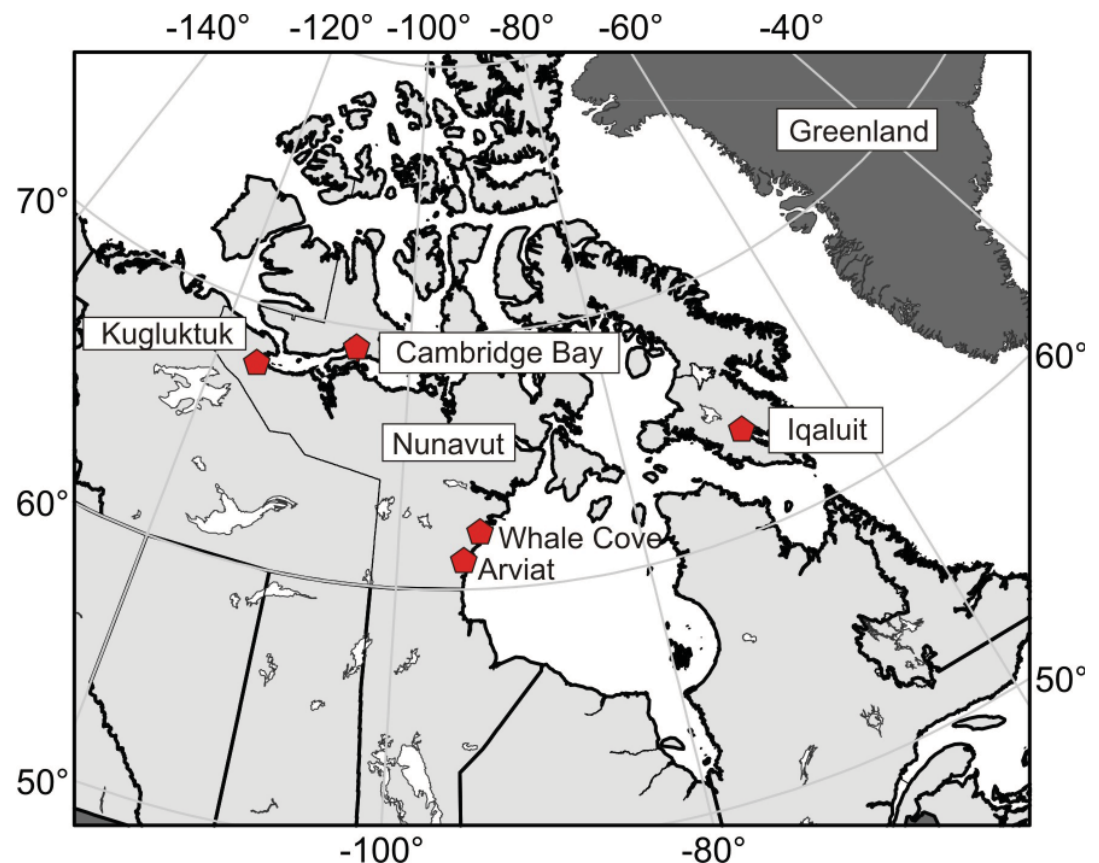
The Hamlet of Arviat is located along the west coast of Hudson Bay at 61°09'N, 94°14'W, in the Kivalliq Region of Nunavut (approximately 215 km south of Rankin Inlet and 260 km north of Churchill, Manitoba). Whale Cove, the other Kivalliq community involved in this pilot project, is located 140 km northeast of Arviat on the coast.



The Arviat Climate Change Adaptation Plan is the result of a collaborative effort involving the Government of Nunavut (GN), the Canadian Institute of Planners (CIP), and two federal departments: Indian and Northern Affairs Canada (INAC) and Natural Resources Canada (NRCan). Seven communities have been involved in pilot adaptation planning exercises as part of this project. In the first phase of the project (2007-2008), two Baffin region communities were involved (Clyde River and Hall Beach). In the current (second) phase of the project, two communities in each of the Kivalliq and Kitikmeot regions of Nunavut have been selected, as well as the capital city of Iqaluit. Kugluktuk and Cambridge Bay represent the communities selected in the Kitikmeot region. Arviat and Whale Cove are the communities involved in the Kivalliq region.



In each pilot community, a team of two volunteer planners from CIP have been engaged to work with the community and GN staff from Community and Government Services and the Department of the Environment to develop adaptation planning strategies to strengthen community resilience in the face of climate change.



Hamlet of Arviat Nunavut (Forbes et al, 2009)

### Project goals:

- To increase awareness about the potential impacts of climate change.
- To assist the community in preparing for potential impacts (positive and negative).
- To ensure that information is shared effectively with the community and key stakeholders.
- To develop adaptation measures for climate change based on accurate information and prioritized community concerns.

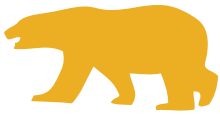


### To achieve these goals, specific objectives included:

- Identification of how climate change will affect the community, based on community input, Traditional Knowledge / Inuit Quajimajatuquangit (IQ) and scientific analysis.
- Consideration of a range of issues and potential impacts including sea level rise, water supply, landscape hazards and other social, environmental, physical and economic factors.
- Development of a Climate Change Adaptation Action Plan to respond to these affects.



Above: Hudson Bay shoreline; Below: Hudson Bay sea ice



## 2.0 Research and Community Engagement Activities

The project involved the following key activities:

- Introduction of the project to the community;
- Raising awareness about Climate Change;
- Engagement with community members and key stakeholders;
- Identification of potential impacts of climate change (based on Traditional Knowledge / IQ, community input and scientific research);
- Prioritization of potential impacts of climate change;
- Identification of community responses to climate change;
- Development of implementation plan (identification of community members / agencies responsible for specific activities);
- Presentation and revisions of draft Climate Change Adaptation Plan; and,
- Presentation of final Climate Change Adaptation Plan.



In order to raise awareness about climate change, understand how climate change is being experienced in Arviat and identify appropriate responses that can be taken at the community level, team members engaged in the following activities with community members:



- Meetings with key stakeholders;
- Presentations to Council;
- Hosting radio call-in programs;
- Hosting “The Race Against Climate Change” (part of Nunavut Day celebrations);
- Holding a community feast;
- Touring the land with key stakeholders and Natural Resources Canada scientists;
- Hosting community workshops; and,
- Holding a public meeting to present the Climate Change Adaptation Plan (scheduled for June 9, 2010).



“The Race Against Climate Change”, part of Nunavut Day celebrations in July 2009



### 3.0 Findings

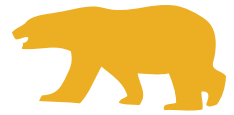
The following is a list of observations made by the community, regarding how individuals felt that climate change is affecting their way of life. Note: Observations represent findings reported by community members and may be contradictory.

#### Weather

- Changes to weather patterns have been noticed over the past few generations
- Less predictable weather patterns
- Earlier spring thaw
- Spring thaw is much faster (days versus weeks)
- Less snow is falling
- Colder temperatures are being observed
- Others felt that it is not as cold as in the past
- Stronger winds
- Five day storm is not as common now
- Prevailing winds are changing (used to be from the north-west, some community members reporting that winds are now from the north-east or direction of the ocean, making travelling and fishing more difficult)
- More fog is being observed
- Snow drifts used to be north-north, now north-northeast
- Harder to make igloos, travel on the land
- The sun's rays are much stronger
- More observations of thunder and lightening storms

#### Wildlife

- Introduction of new species:
  - Bees, wasps, hornet, mosquitoes, dragonflies and other insects
  - Sparrows, snow buntings
  - Fish
  - Killer whales
- Fewer:
  - Caribou
  - Arctic char
  - Seals
- More harp seals, harp seals are pushing ring and harbour seals out of the area
- More ravens, other birds, staying longer in fall
- More frequent observations of polar bears in and around the community
- Seals are being seen further south (Nunala at the Manitoba border)
- More geese and ducks (good for hunting)





### Vegetation

- Vegetation is changing
- Introduction of dandelions
- More willows can be seen
- More moss growing



### Sea ice

- Earlier break-up of sea ice (June versus July)
- Later freeze up of sea ice (November versus October)



### Hunting and Trapping

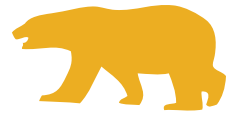
- Permafrost is melting earlier, affecting caribou migration
- Harder to get to traditional hunting grounds because of melting permafrost
- Spring thaw is fast, makes goose hunting more dangerous, hunters stay closer to town
- Used to be easier to catch arctic char when it was colder / less stormy
- Lower waters levels mean less char can be found up river
- Harder / more dangerous to travel by sea ice
- Caribou skins are of poorer quality compared to in the past
- Seals and fish not as healthy, less meat
- Need to spend more time hunting as a result of poorer quality/ lower yields of meat
- Harder to travel by All-terrain vehicle (ATV) in warmer temperatures



Traditional hunting may be affected by climate change

### Water levels

- Inland rivers and lakes have lower water levels, fewer ponds
- Near shore islands are now points or peninsulas or new islands appearing
- Can see higher water marks on Maguse River
- Quikitaaryuk - used to be an island near town, now a point
- Increased sedimentation in mouths of rivers affects fish stocks and food security



### Housing

- Piles shifting due to permafrost thaw
- Porches shifting
- Increased maintenance costs resulting from permafrost melt
- New technologies need to be considered for building in warming climates



### Infrastructure

- Concern that water supply is at risk because of melting permafrost
- Sewage lagoon does not have a liner, may result in contamination if permafrost melts
- Longer storms that keep people inside would require larger water and sewage tanks



### Health

- Concern that introduction of new species will result in new germs

### Other Issues

- Emphasize recycling
- Consider banning plastic bags
- Talk to school children, raise awareness

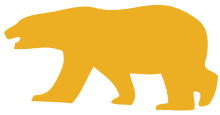


In addition, scientists from Natural Resources Canada carried out research on the physical affects of climate change on Arviat with a specific focus on sea level change; water supply; and, landscape hazards. A summary of key findings has been provided:

#### 1. Local Climate Predictions:<sup>1</sup>

- Approximate average temperature increase of 5°C over the next 100 years (based on moderate emissions scenarios)
- Approximate average increase in precipitation of 12% over the next 100 years





## 2. Sea Level Change:<sup>2</sup>

- The major contributor to sea level rise is the thermal expansion of the water in the world's oceans as they heat up. In addition, sea-level change may result from melting glaciers and ice sheets, as well as vertical land motion (uplift) caused by glacial isostatic adjustment (a delayed response of the earth caused by deglaciation at the end of the last Ice Age). This is of particular importance in the vicinity of Arviat.
- The range of probable sea level change for Arviat over the next 100 years (from 2010 to 2100, relative to present-day mean sea level rise):
  - Sea level will not fall more than 70cm
  - Sea level will not rise more than 25cm
- As a result, access to the community wharf may become an issue due to the shallower water conditions in the bay
- In addition, more wave action (from increased frequency and intensity of extreme weather events, as well as potential sea level rise) may cause permafrost melt and erosion of the sea shore



*Note: Uncertainty around the projected amount of future sea level rise may or may not offset the amount of current and future vertical land motion, thereby resulting in a broad range of scenarios. This uncertainty is an issue for coastal zone planning. Any new initiative or project must be flexible in its design or of limited life expectancy. For example, the hamlet might consider a temporary solution to the wharf access issue because conditions may change within one or two decades.*



## 3. Local water supply:

- Current raw water supply is sourced from a large river and the community reservoir storage system appears to be adequate
- Additional or back-up reservoir storage for water may be required in the future
- Warming climate may cause water quality issues, requiring additional and more costly treatment processes to be added and resulting in fewer useable traditional sources of raw



## 4. Landscape Hazards:

- A map has been produced that identifies hazard areas within the community (see page 10)
  - This tool can help the community to identify areas more appropriate for development. Poor surface drainage exists throughout the community, as much of Arviat is built on a thin layer of fill covering a wetland area. In some areas, the edge of the fill is quite thin, suggesting that it may not provide adequate insulation to keep the underlying organic soils frozen. If underlying soils become unstable, subsidence may occur.<sup>3</sup>

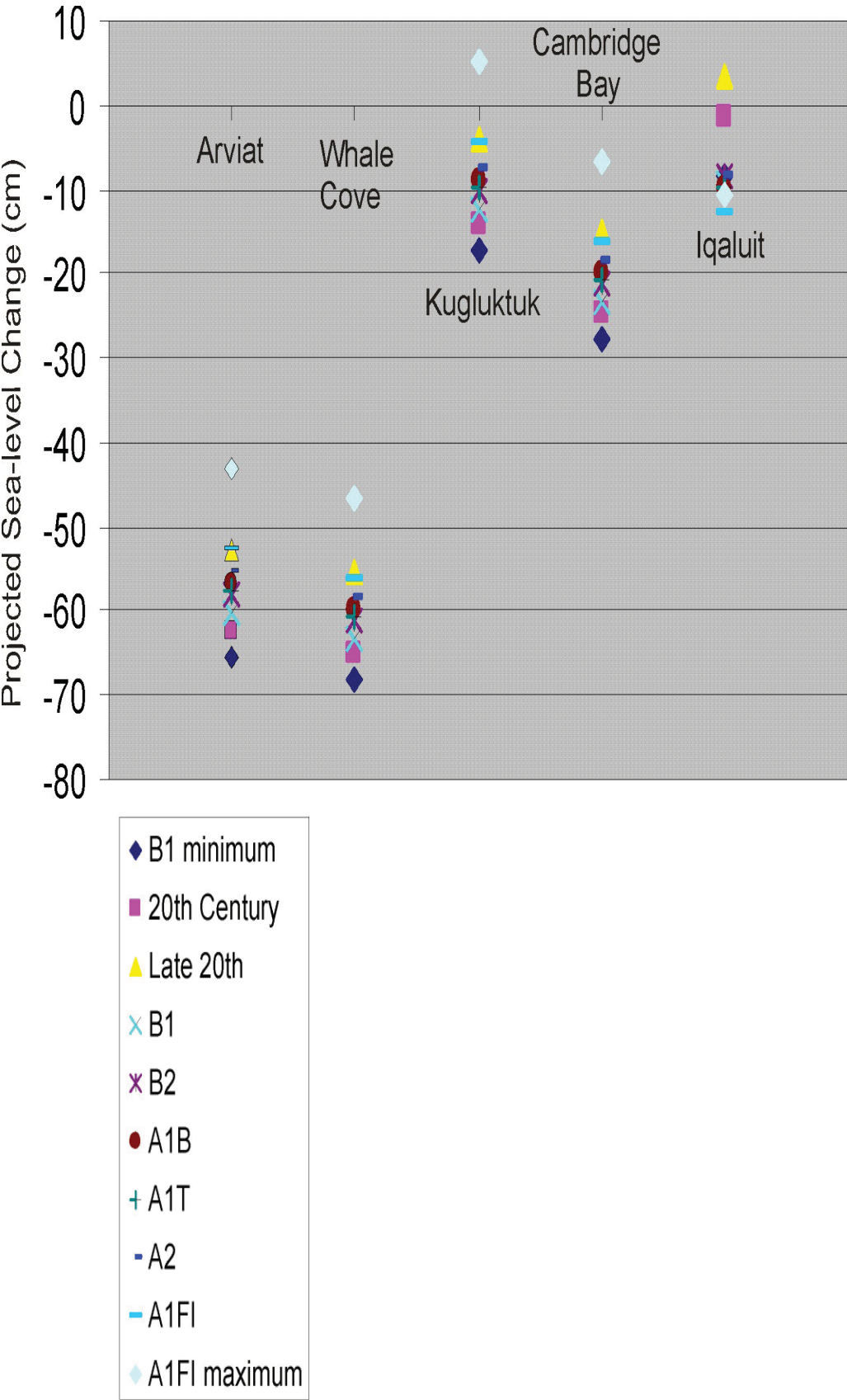


<sup>1</sup>Temperature predictions: Canadian Standards Association, 2010. Precipitation predictions based on Environment Canada climate modeling tool, using IPCC assessment data from 2007.

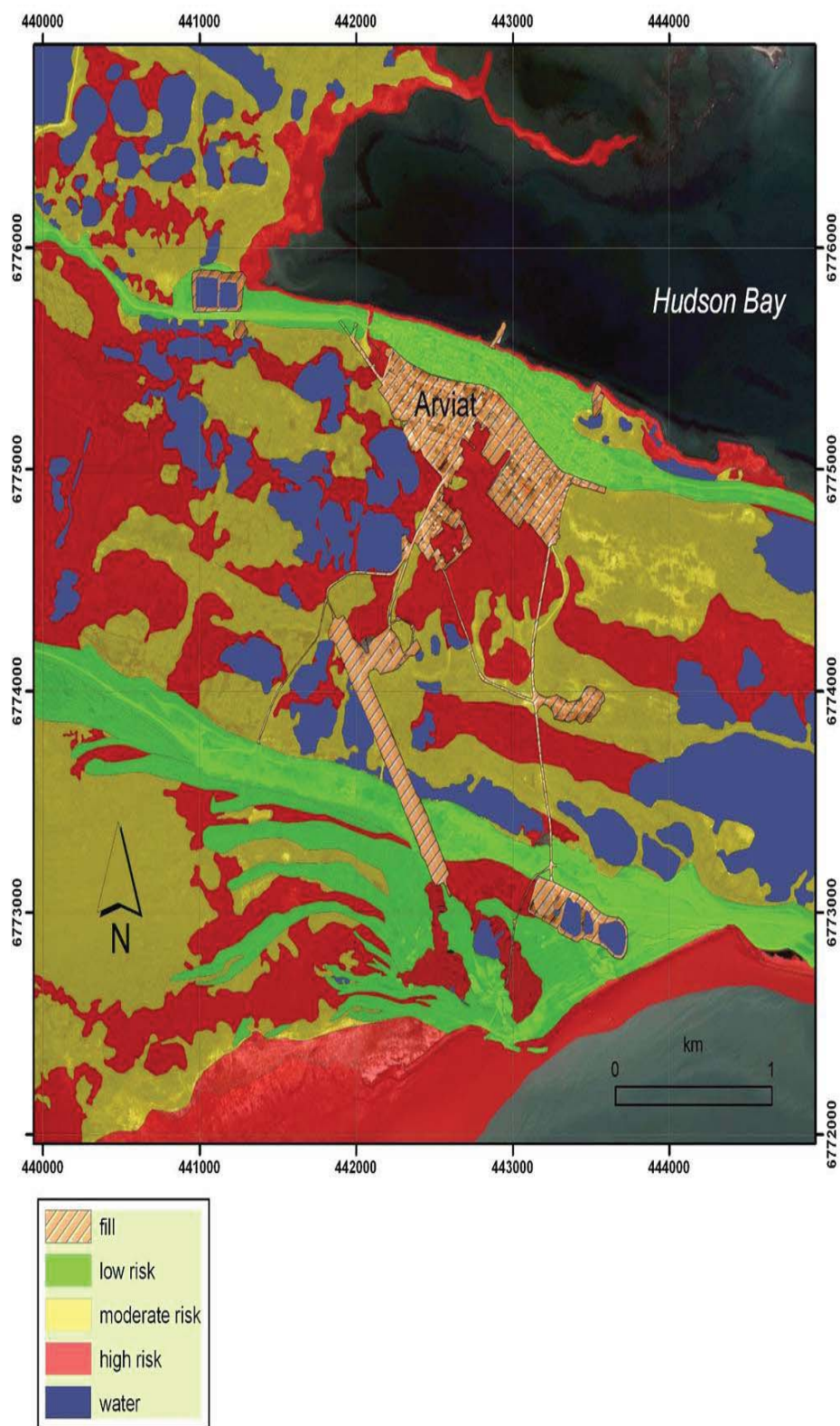
<sup>2</sup>James et al, 2009.

<sup>3</sup>Forbes et al, 2009.



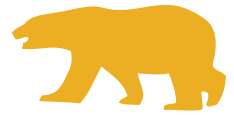


Sea-level projections for the minimum, mid-points, and maximum IPCC projections (Meehl et al., 2007) and for the Twentieth Century and Late 20th Century scenarios. (James et al, 2009.)



Surficial map of Arviat (top of page) and landscape hazards map (above). (Forbes et al, 2009.)

- Warmer temperatures may cause permafrost melt resulting in:
  - Ponding in low lying areas
  - Increased potential for flooding/erosion
  - Deterioration of roads (and/or realignment of roads)
  - Subsidence beneath buildings if foundation insulation is insufficient
  - Potential for increased frost jacking of piles with a thicker active layer
  - Potential for contamination of surface water around the waste disposal area
  - Potential for contamination and/or damage to the water reservoir liner
  - Shoreline structure (houses/wharves) may be undermined



Permafrost is ground that has a temperature of less than zero degrees Celsius year-round and persists from one year to the next. The upper two to three feet of permafrost is called the “active layer.” Since it is closest to the surface, the active layer melts each summer. In the vicinity of Arviat, the active layer typically has a thickness of about 1 metre. If climate change results in longer periods of warmer weather, the summer thaw can penetrate deeper into the permafrost, causing the active layer to become thicker. When the upper part of the permafrost is ice rich – a possibility in Arviat due to the ice-rich fine organic soils underlying the community – the ground will subside as the active layer thickens due to warmer temperatures and/or human disturbance. An increased potential for subsidence due to climate change makes the more stable esker sands and gravels and former beach gravels, such as those found beneath the centre of town and the airport, the best building sites in the area. Present-day wetlands, former lake basins, or sites with marine muds are subject to both frost jacking and subsidence.<sup>4</sup>



These findings highlight the sensitivity to climate change inherent in the north, where sea ice and permafrost are components of a delicate system that Inuit rely upon for hunting, transportation, building construction, and other cultural and societal needs. The findings were presented at various meetings with community members, in order to begin to identify appropriate actions to respond to potential climate change impacts.

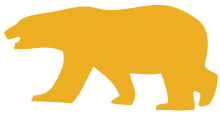


Permafrost melt can cause subsidence beneath buildings and infrastructure



<sup>4</sup>Forbes, 2010.





## 4.0 Adaptation Action Plan

The Adaptation Action Plan (see **Table 1**) is the main outcome of the Climate Change Adaptation project. This framework presents the key issues identified by the community that may result from climate change. Impacts may be perceived as positive and/or negative. For example, the increased presence of polar bears may present an opportunity for greater tourism potential; however, this may also result in greater danger for community members and increased costs related to wildlife patrolling. Issues have been grouped in the following categories: built environment, natural environment, livelihoods, human health and safety, and traditional knowledge.



The potential impact to the community is identified for each issue, based on community input, traditional knowledge and scientific analysis. Adaptive capacity is an indicator developed by the planners based on their understanding of the community's exposure to the potential impact and the community's capacity to respond. This was presented to the community and revised based on community feedback. Adaptive capacity was measured based on a high level assessment of community preparedness; availability of economic and human resources; amount of information available / understanding of potential impacts; institutional support; ability of the entire community (all genders/age groups) to respond; and the current health of ecological and social systems (referring to the degree of stress already present).

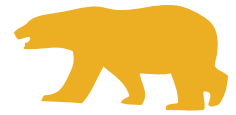


Above: Community elders participate in radio call-in program; Below: Community elders provide input to the Adaptation Action Plan





Community response represents the activities identified by the community that should be undertaken to increase the resiliency of the community, and the ability to adapt to potential climate change impacts. Responsibility refers to the community member or agency that volunteered to oversee implementation and monitoring of the activity. Priority is a ranking applied to each issue based on community feedback, representing the community's concern and need for more immediate action. Desired outcome represents the state that the community wishes to achieve as a result of the identified actions.



## 5.0 Issues Identified Outside of the Scope of this Plan

Community members identified a number of issues outside of the scope of work for the project. Some of these issues fall outside of the municipal boundary of the Hamlet of Arviat but have potential impacts on community members. Others are issues that can be addressed through adaptation, but also require a strategy for proactive mitigation. Finally, some issues were identified that are potentially related to climate change, but have not yet been scientifically confirmed.



**Alternative Energy:** The community's reliance on diesel for energy generation has been identified by some community members as both financially and environmentally unsustainable. The development of alternative energy sources, such as small-scale wind generation, photovoltaic panels, or geothermal systems, was identified by some community members as a community action that could reduce the Hamlet's reliance on diesel and provide a renewable, low-impact source of energy in the future.



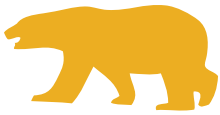
**Employment:** Due in part to an extended mining exploration season (May to September) caused by climate change, mining companies require larger work forces to expand their operations. A number of community members currently work in Baker Lake where mining operations are expected to continue for the next 20 years. Expanded mining operations in the region have been identified by some in the community as an employment and skills training opportunity directly related to climate change.

**Worldwide natural disasters and/or catastrophic events:** It has been noted by a member of the community that past and future asteroid impacts may affect global events, and that volcanoes, earthquakes, tsunamis and/or other natural disasters may add to the effects of climate change.



Hudson Bay shoreline





## 6.0 Implementation

The planners have explored the feasibility of the Hamlet of Arviat taking responsibility to act as the overall champion of the Adaptation Action Plan, ensuring that each year a stakeholder meeting is held to determine the progress of the Action Plan, allowing for modifications as required. In meetings with community members, the planners learned that an Interagency Directorate, chaired by the Mayor, would be established in April 2010 in order to bring together representatives from various Hamlet departments, including Health and Wellness, Lands, Economic Development, Justice, and Recreation.



The purpose of this Directorate is to share information and coordinate programs within the community. Since climate change deals with a broad range of topics, and needs a coordinated approach to managing any adaptation activities, the planners see this Directorate as the right group to identify and act on the recommendations in the Adaptation Action Plan (see Table 1). The Directorate is likely to be made up of community leaders, who are best able to take on the various tasks in the Action Plan and to make sure they are done correctly and also monitored to ensure long-term success.



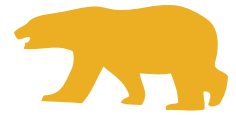
It is also recommended that a community member be appointed as the Climate Change Coordinator, responsible for monitoring the implementation of the Plan and working with stakeholders, including community members, the Directorate, and the Department of Environment.

Following presentation of the draft Climate Change Adaptation Action Plan, Hamlet Council adopted the Plan and further identified the following priorities: (1) Relocate the metal dump, (2) Explore potential for an incinerator, and (3) Evaluate locations for extending the airport runway.



Adapting to changes in the natural environment to ensure a successful future

The Action Plan (Appendix A - Table 1) highlights the corresponding relationship (identified by the community) to climate change adaptation and mitigation, and increasing overall community preparedness. For example, by relocating the metal dump to more stable land and/or introducing a liner, the potential for soil and/or surface water contamination from permafrost thaw will be decreased. The hazard map developed by NRCan scientists as part of this project can assist decision makers with identifying appropriate locations for future infrastructure development.



#### Recommended Next Steps:

- Appoint Climate Change Adaptation Coordinator
- Coordinator to work with Hamlet Directorate and/or Senior Administrative Officer and Department of Environment regarding potential funding for Climate Change adaptation and mitigation initiatives (community responses identified in the Climate Change Adaptation Action Plan (Appendix A - Table 1))
- Coordinator to monitor progress of Climate Change Adaptation Action Plan by holding biannual or annual reviews to ensure implementations of the Plan
- Coordinator to discuss potential for NRCan scientists to review and update sea level change, permafrost degradation and water supply impacts as climate change science and findings evolve



## 7.0 Resources

- Canadian Standards Association Special Publication, Technical Guide: Infrastructure in permafrost: A guideline for climate change adaptation. Mississauga, 2010.
- D.L Forbes<sup>1,2</sup>, T. Bell<sup>2</sup>, T.S. James<sup>1,3</sup>, K.M. Simon<sup>3</sup>, Landscape Hazards and Constraints in Arviat, Nunavut: Geoscience Background for Climate-Change Adaptation Planning DRAFT NRCan, October 24, 2009.
- Thomas S. James<sup>1,3</sup>, Karen M. Simon<sup>3,1</sup>, Donald Forbes<sup>1,2</sup>, and Arthur S. Dyke<sup>1,2</sup>, Nunavut Sea-level Projections DRAFT, NRCan, October 16, 2009



<sup>1</sup> Geological Survey of Canada, Natural Resources Canada

<sup>2</sup> Department of Geography, Memorial University of Newfoundland

<sup>3</sup> School of Earth and Ocean Sciences, University of Victoria



## APPENDIX A

**TABLE 1: COMMUNITY CLIMATE CHANGE ADAPTATION ACTION PLAN  
HAMLET OF ARVIAT, NUNAVUT**

ISSUE	POTENTIAL IMPACT TO COMMUNITY	ADAPTIVE CAPACITY <sup>1</sup>	COMMUNITY RESPONSE	IDEAS FROM OTHER JURISDICTIONS	PROPOSED RESPONSIBILITY	RISK <sup>2</sup>	DESIRED OUTCOME
<b>Built Environment</b>							
Community Wharf	<ul style="list-style-type: none"> <li>Wharf may be affected by sea level change</li> <li>Access to the wharf, safe boating routes may be affected</li> </ul>	Medium	<ul style="list-style-type: none"> <li>Use navigational markers</li> <li>Evaluate need to relocate, or lengthen wharf</li> </ul>		HTO: <ul style="list-style-type: none"> <li>Monitor bay depth</li> <li>Coordinate</li> </ul> Hamlet: <ul style="list-style-type: none"> <li>Coordinate further discussions with HTO / Economic Development + Transportation regarding retrofit / relocation of wharf</li> </ul>	High	<ul style="list-style-type: none"> <li>Decrease potential danger to community</li> <li>Ensure safe access for boats and sea lift</li> </ul>
Roads	<ul style="list-style-type: none"> <li>Greater permafrost melt may result in ponding in low-lying areas</li> <li>Increased potential for flooding and erosion and deterioration of sub-base</li> <li>Increased need for realignment and/or maintenance</li> </ul>	Medium	<ul style="list-style-type: none"> <li>Build smarter (e.g. in higher areas)</li> <li>Follow natural contours of the land</li> <li>Geotechnical work required to identify appropriate locations</li> <li>Focus on solutions in existing locations (minimize relocations)</li> <li>Locate new aggregate source for community</li> <li>Focus construction of new roads on higher, non-wetland areas</li> </ul>	<ul style="list-style-type: none"> <li>Review budget for increased grading</li> <li>Research potential for new construction/design methods</li> <li>Organize community volunteers to help maintain roads to lower costs</li> </ul>	Hamlet – overall coordination  CGS to provide funding for road construction	High	<ul style="list-style-type: none"> <li>Minimize maintenance costs</li> <li>Maintain structural integrity of roads</li> </ul>
Solid Waste Dump	<ul style="list-style-type: none"> <li>If permafrost degrades, melt may increase potential for contamination</li> </ul>	Medium	<ul style="list-style-type: none"> <li>CGS currently evaluating relocation site</li> <li>New location will need to have suitable cover material</li> <li>Incineration could be</li> </ul>	<ul style="list-style-type: none"> <li>Also need to consider mix of strategies to landfill including incineration, waste reduction strategy (recycling)</li> <li>3R's (Reduce/Recycle/Re-use)</li> </ul>	Hamlet – overall coordination  CGS to provide design assistance and funding	High	<ul style="list-style-type: none"> <li>Reduce potential for contamination</li> <li>Raise awareness about the RRR's</li> <li>Reduce storage and</li> </ul>



ISSUE	POTENTIAL IMPACT TO COMMUNITY	ADAPTIVE CAPACITY <sup>1</sup>	COMMUNITY RESPONSE	IDEAS FROM OTHER JURISDICTIONS	PROPOSED RESPONSIBILITY	RISK <sup>2</sup>	DESIRED OUTCOME
			considered	require innovative approach due to climate and disposal methods <ul style="list-style-type: none"> <li>Educational campaign on 3R's</li> </ul>	Hamlet Economic Development Office – look for local business opportunities in recycling.		exporting of recyclables
Water Reservoir	<ul style="list-style-type: none"> <li>Permafrost melt could impact integrity of liner</li> <li>May result in contamination of water</li> </ul>	Medium	<ul style="list-style-type: none"> <li>Monitor permafrost temperature and potential shifts in ground</li> </ul>	<ul style="list-style-type: none"> <li>Initiate regular water sampling to check for changes in quality due to sedimentation</li> </ul>	Hamlet– overall coordination  CGS to provide design assistance and funding	Medium	<ul style="list-style-type: none"> <li>Ensure safe supply/quality of water</li> </ul>
Water Supply	<ul style="list-style-type: none"> <li>Potential contamination of water sources (quality and quantity)</li> </ul>	Medium	<ul style="list-style-type: none"> <li>Monitor water quality for signs of contamination</li> </ul>	<ul style="list-style-type: none"> <li>Monitor water levels on Magoose River</li> <li>Review delivery costs and undertake engineering review to determine cost-effective alternatives</li> </ul>	Hamlet– overall coordination  CGS to provide design assistance and funding	Low	<ul style="list-style-type: none"> <li>Ensure safe supply of water</li> <li>Reduce cost and GHG emissions related to delivery of water</li> </ul>
Sewage Lagoon	<ul style="list-style-type: none"> <li>Permafrost melt would result in contamination of wetlands</li> </ul>	Medium	<ul style="list-style-type: none"> <li>Not a serious concern</li> <li>Adjacent wetlands act as a natural filter</li> <li>No other water source is available in the vicinity</li> </ul>	<ul style="list-style-type: none"> <li>Move sewage lagoon to new location, away from Hudson Bay.</li> </ul>	Hamlet– overall coordination  CGS to provide design assistance and funding	Low	<ul style="list-style-type: none"> <li>Ensure sewage treatment is maintained at high standards with no negative impact on environment</li> </ul>
Building Foundations	<ul style="list-style-type: none"> <li>Greater risk of subsidence or frost jacking/heave due to permafrost melt</li> </ul>	Medium	<ul style="list-style-type: none"> <li>Future development to be located in stable areas</li> </ul>		Hamlet– overall coordination  Nunavut Housing Corporation – technical resource  CGS to provide design assistance and funding	Medium	<ul style="list-style-type: none"> <li>Minimize impact on building users</li> <li>Minimize maintenance / relocation costs</li> </ul>
Infrastructure (telephone poles)	<ul style="list-style-type: none"> <li>Greater risk of subsidence due to permafrost melt</li> </ul>	Medium	<ul style="list-style-type: none"> <li>Future development to be located in stable areas</li> </ul>		Hamlet– overall coordination	Medium	<ul style="list-style-type: none"> <li>Minimize impact on infrastructure</li> <li>Minimize maintenance / relocation costs</li> </ul>
Building Practices	<ul style="list-style-type: none"> <li>Warmer temperatures may require changes to design/standards</li> <li>Current buildings are prone</li> </ul>	Medium	<ul style="list-style-type: none"> <li>Housing authority to consider thermal properties of materials to improve cooling and retrofit energy efficient air conditioning</li> </ul>	<ul style="list-style-type: none"> <li>Subsurface mapping to detect depth to bedrock and thickness of permafrost across the community for future planning and foundation</li> </ul>	Nunavut Housing Corporation  CGS to to provide design	Medium	<ul style="list-style-type: none"> <li>Ensure safe built environment</li> <li>Reduce/minimize structural repairs</li> </ul>

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	to greater likelihood of structural failure <ul style="list-style-type: none"> <li>Cracking/bending foundations</li> </ul>		<ul style="list-style-type: none"> <li>To avoid pile jacking ensure piles are properly installed so that they do not adhere to the freezing ground and remain anchored in permafrost</li> <li>Initiate educational campaign with housing clients to assist in identifying potential structural problems, to address problems early</li> </ul>	design. Could be accomplished with Ground Penetrating Radar from the surface.	assistance and funding  NRCan/MUN to carry out Ground Penetrating Radar / surface mapping		
<b>Natural Environment</b>							
Coastal Erosion	<ul style="list-style-type: none"> <li>If sea level rises, wave action or ice movement may affect shoreline stability with negative impacts on waterfront houses/buildings</li> <li>Reduced sea ice coverage may mean increased wave action further affecting shoreline stability</li> </ul>	Medium	<ul style="list-style-type: none"> <li>CGS to identify risk zones in Community Plan and locate new development away from high risk areas</li> <li>Rate of land uplift currently offsets sea level rise in this region, although some climate change scenarios suggest a possible reversal to raise sea levels at Arviat</li> <li>Minor erosion already a problem along hamlet shoreline.</li> <li>To avoid pile jacking ensure piles are properly installed so that they do not adhere to the freezing ground and remain anchored in permafrost</li> </ul>	See recommendation for Ground Penetrating Radar (Building Practices).	Natural Resources Canada has provided hazard mapping. Hamlet / CGS to incorporate in Community Plan.  Economic Development + Transportation – are responsible for coastal issues, including the sea lift  Department of Fisheries and Oceans – overall regulatory responsibility for works in or near water	Medium	<ul style="list-style-type: none"> <li>Minimize impact of sea level rise on structures and livelihoods</li> <li>Increase local awareness of hazards related to reduced sea ice coverage</li> </ul>
Seasonal Flooding	<ul style="list-style-type: none"> <li>Potential damage to buildings / infrastructure in low lying areas</li> </ul>	Low	<ul style="list-style-type: none"> <li>Identify hazardous building sites via updated Community Plan and Drainage Master Plan</li> <li>No new building should occur on hazardous lands</li> </ul>		Natural Resources Canada has provided hazard mapping.  Hamlet / CGS to incorporate in Community Plan.	Medium	<ul style="list-style-type: none"> <li>Minimize impact of flooding</li> <li>Increase local awareness of flood hazards</li> </ul>

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Changing Weather	<ul style="list-style-type: none"> <li>Less predictability in weather patterns; sudden storms/thaw; greater danger for those out on the land</li> </ul>	Medium	<ul style="list-style-type: none"> <li>Raise awareness about danger of changing weather</li> <li>Explore strengthening communication channels (e.g. CB) so that people are aware as soon as possible of signs of sudden change</li> <li>Use local radio to broadcast weather alert</li> <li>Ensure adequate drainage culvert system and grade to natural basins or sea when planning new developments.</li> <li>Maintain existing culvert system</li> <li>Plan snow clearing and dumping to efficiently remove meltwater and avoid increased flooding</li> <li>Ensure that emergency response facilities are not vulnerable to isolation due to flooding</li> </ul>	<ul style="list-style-type: none"> <li>Identify community 'Champions' to monitor weather and notify residents of changing weather</li> <li>Increase cell phone coverage so that travelers can keep in contact with communities along the coast</li> </ul>	HTO– overall coordination HTO to provide pictures to facilitate on-going monitoring of climate conditions on the land		<ul style="list-style-type: none"> <li>Ensure people are aware of potential dangers / better prepared for sudden weather changes</li> <li>Educate people of dangers associated with changing/extreme weather</li> <li>Reduce threat of weather-related hazards to young and elderly</li> </ul>
Reduced Sea Ice	<ul style="list-style-type: none"> <li>Danger for hunters / people travelling on the ice</li> </ul>	Medium	<ul style="list-style-type: none"> <li>Consider how other HTO/Snowmobile clubs have adapted</li> </ul>	Some communities such as Igloolik already have near real-time Radarsat imagery provided by CIS	<p>Canadian Ice Service (Environment Canada) to provide data on annual sea ice cover and near real-time imagery.</p> <p>Adapt community trail and ice monitoring strategy being pioneered in Clyde River (Ittaq Heritage and Research Centre).</p>	High	<ul style="list-style-type: none"> <li>Minimize danger for hunters/people travelling on the ice</li> </ul>
Loss/change in habitat	<ul style="list-style-type: none"> <li>Concern about significant changes to caribou and</li> </ul>	Low	<ul style="list-style-type: none"> <li>Change hunting routes/patterns/timing to</li> </ul>	<ul style="list-style-type: none"> <li>Develop new cache locations/technologies for new</li> </ul>	HTO to correspond with Department of	Medium	<ul style="list-style-type: none"> <li>Minimize impacts to subsistence hunting</li> </ul>

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	other animal migration routes and loss of significant food sources. <ul style="list-style-type: none"> <li>New mammals, birds, insects being introduced may introduce new opportunities</li> </ul>		adjust to new habitat and/or new species	species/longer hunting distances <ul style="list-style-type: none"> <li>Develop new methods for hunting</li> <li>Consider hunting new species, if possible</li> </ul>	Environment regarding changes to migration routes		<ul style="list-style-type: none"> <li>Increase community caching</li> <li>Develop new economic opportunities for species harvesting</li> </ul>
<b>Livelihoods</b>							
Traditional Food Sources	<ul style="list-style-type: none"> <li>Caches may be affected by change temperature; potential for loss or contamination of harvest</li> </ul>	Medium	<ul style="list-style-type: none"> <li>Education and awareness program for improved food storage</li> </ul>	<ul style="list-style-type: none"> <li>Make use of refrigerated community caches provided by Hamlet</li> <li>Hold community events to raise funds for new/expanded cache for food</li> </ul>	HTO - overall coordination	Medium	<ul style="list-style-type: none"> <li>Minimize loss of harvest</li> </ul>
Hunting safety	<ul style="list-style-type: none"> <li>Changing migration patterns reduce available harvest</li> <li>Reduced hunting quotas</li> <li>Increased hazards due to reduced sea ice cover</li> </ul>	Medium	<ul style="list-style-type: none"> <li>Support traditional hunting practices by strengthening IQ</li> </ul>	<ul style="list-style-type: none"> <li>Use probing sticks to test ice thickness before and during travels</li> <li>Encourage use of Personal Flotation Devices (lifejackets) by hunters</li> <li>Use caribou antlers as ‘ice picks’ (local job creation)</li> <li>Attach flotation devices to snowmobiles and/or sleds</li> <li>Implement new regulations to improve hunter safety</li> </ul>	HTO – overall coordination  Hamlet Economic Development Office - identify potential business ideas for local craftsmen (i.e. Ice picks,	High	<ul style="list-style-type: none"> <li>Minimize changes to traditional hunting</li> <li>Maximize safety for hunters and others</li> </ul>
<b>Health and Safety</b>							
Introduction of New Disease / Changing quality of existing food sources	<ul style="list-style-type: none"> <li>Climate Change may result in changes to disease vectors, exposing residents to new illnesses.</li> <li>More parasites found in caribou</li> <li>Increased incidence of cancer and allergies.</li> <li>Berry quality may change due to changing climate - studies have shown that</li> </ul>	Medium	<ul style="list-style-type: none"> <li>New information needed to educate and inform hunters and other residents of parasites and how to deal with them</li> <li>Building materials may contain cancer or allergen causing ingredients.</li> <li>Education and awareness program regarding new parasites and diseases.</li> </ul>	<ul style="list-style-type: none"> <li>The Health Centre should be kept informed as new species are identified. This will allow them to identify any species carrying potentially infectious diseases.</li> <li>Educational campaigns should be designed and implemented when new diseases are identified.</li> <li>Social and cultural networks (ie. Family and friends) should be used to circulate the message to all.</li> </ul>	Hamlet Health Centre– overall coordination  HTO - work with Hamlet Health Centre to develop and circulate information to residents  Dept of Environment – Provide information to residents	Medium	<ul style="list-style-type: none"> <li>Minimize exposure to new diseases</li> <li>Track introduction of new species to the area</li> <li>Raise Inuit awareness of effects of new diseases.</li> <li>Minimize spread of new disease and parasites</li> </ul>

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	they are better quality under colder conditions (more antioxidants)						
Increased exposure to UV rays	<ul style="list-style-type: none"> <li>Greater potential for sun damage / skin related illnesses</li> <li>UV and sunlight can negatively affect berries and leaves</li> </ul>	Medium	<ul style="list-style-type: none"> <li>Travellers should be advised of need for sun screen when out on the land</li> </ul>		Hamlet Health Centre – overall coordination. Health Centre to monitor complaints / related illnesses and raise awareness about sun exposure.		<ul style="list-style-type: none"> <li>Increase awareness about sun exposure and related hazards</li> <li>Ensure that sun screen products are available at local food markets.</li> </ul>
Increased polar bear activity	<ul style="list-style-type: none"> <li>Greater polar bear observations both in and around the community (including at the dump), particularly at night.</li> <li>Safety is a concern. Costs for patrolling are increasing.</li> <li>Increased potential for bear interaction with people.</li> </ul>	High	<ul style="list-style-type: none"> <li>Increase patrolling</li> <li>Consider alternative methods of waste containment at the dump</li> <li>Also consider tourism potential</li> </ul>	<ul style="list-style-type: none"> <li>Consider relocating dump and other bear ‘attractions’ away from the community (Community Plan)</li> <li>Install early warning beacons at lands edge to warn of approaching bears</li> <li>Contract local hunters to assist in patrolling for bears ( Training from Dept of Environment)</li> </ul>	<p>Dept of Environment is responsible for patrolling and training of patrollers</p> <p>Community + Government Services to look into options for the dump, including burying organic waste separately.</p> <p>Economic Development could look into eco-tourism opportunities</p>	High	<ul style="list-style-type: none"> <li>Minimize danger from increased polar bear presence.</li> <li>Take advantage of potential tourism opportunities</li> <li>Increase awareness about bears and related hazards</li> </ul>
<b>Cultural Traditions</b>							
Loss of IQ (traditional knowledge)	Changes in climate may affect traditional practices	Low	<ul style="list-style-type: none"> <li>Incorporate traditional knowledge in school curriculum through elder review of government curriculum</li> </ul>	<ul style="list-style-type: none"> <li>Elders look to the past to raise awareness about practices that respond to changes in weather patterns</li> <li>Story telling to pass on historical adaptation practices to adapt to new circumstances</li> </ul>	<p>HTO – overall coordination</p> <p>Kivalliq Inuit Association – to develop programs / class material / field trips</p> <p>GN Department of Education – to coordinate opportunities to incorporate for curriculum development</p>	Medium	<ul style="list-style-type: none"> <li>Incorporate climate change awareness into IQ</li> </ul>



**Notes:**

**<sup>1</sup> Adaptive Capacity is measured by:**

- Exposure**           The degree of potential impact on the community
- Capacity to respond**   Measured by community awareness/preparedness; availability of economic and human resources; amount of information available / understanding of potential impacts; institutional support; ability of entire community (all genders/age groups) to respond; current health of ecosystem (degree of stress already present)

**<sup>2</sup> Risk to community is ranked based on the following definitions:**

- High**               Identified by the community as a primary concern; impacts seen as significant
- Medium**           Identified by the community as a secondary concern; impacts seen as moderate
- Low**               Identified by the community as a longer-term concern; impacts seen as limited, indirect

Acronyms: HTO – Hunters and Trappers Organization, CGS – Government of Nunavut Department of Community and Government Services, GN – Government of Nunavut, IQ = Inuit Quajimajatuquangit (Traditional Knowledge)

WARMING OF THE CLIMATE SYSTEM IS UNEQUIVOCAL, AS IS NOW  
EVIDENT FROM OBSERVATIONS OF INCREASES IN GLOBAL AVERAGE AIR  
AND OCEAN TEMPERATURES, WIDESPREAD MELTING OF SNOW AND ICE,  
AND RISING GLOBAL AVERAGE SEA LEVEL.

*IPPC Fourth Assessment Report*