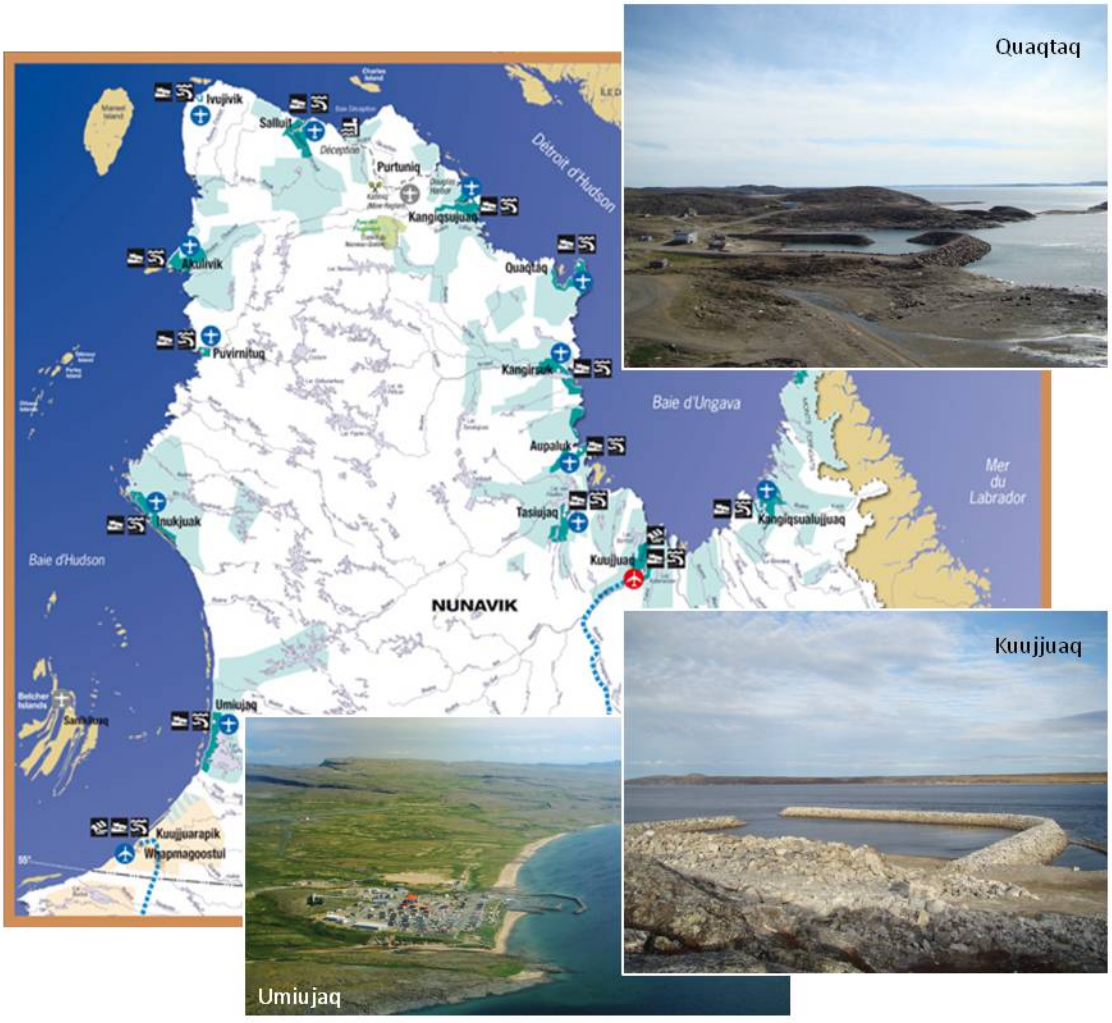
CLIMATE CHANGE AND MARINE INFRASTRUCTURES IN NUNAVIK – LOCAL EXPERT KNOWLEDGE AND COMMUNITY PERSPECTIVE IN QUAQTAQ, UMIUJAQ AND KUUJJUAQ

Rapport de recherche No R-1273a ***2011***

Climate Change and Marine Infrastructures in Nunavik – Local expert knowledge and community perspective in Quaqtaq, Umiujaq and Kuujjuaq.

April 2011



TRENT UNIVERSITY

Affaires indiennes et du Nord Canada
Indian and Northern Affairs Canada

INRS Université d'avant-garde

KATIVIK

Reference : Clerc, C., Gagnon, M., Breton-Honeyman, K., Tremblay, M., Bleau, S., Gauthier, Y., Aloupa, S., Kasudluak, A., Furgal, C., Bernier, M., and Barrett, M. 2011. Climate Change and marines infrastructures in Nunavik – Local expert knowledge and community perspective in Quaqtaq, Umiujaq and Kuujjuaq. Final report for Indian and Northern Affairs Canada. 140 pages.

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1. General Introduction

1.1 General Project Information

Project Name: « Climate Change and Marine Infrastructures in Nunavik - Local expert knowledge and community perspective from Quaqtaq, Umiujaq and Kuujjuaq »

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- Michael Barrett: Assistant Director, Renewable Resources Service, Environmental and Land Use Planning Department, Kativik Regional Government (ARK/KRG), Kuujjuaq (QC)
- Sarah Aloupa, Annie Kasudluak, Sarah Tukkiapik et Annie Baron: Interpreters

Date of Commencement and Completion of the Project:

April 2009 to March 2011

Location:

Nunavik and Northern Quebec

Terrestrial ecozone: Southern Arctic and Taiga Shield

Marine ecozone: Northwest Atlantic and Arctic Archipelago

1.2 Context

Up to the mid-1990s, Nunavik appeared to be affected by a gradual cooling of the climate. However, since this period an increase in temperatures predominates following the trend observed since the 1970s higher up north in Nunavut (Allard *et al*, 2007; Tremblay and Furgal, 2008). Many problems related to climatic changes have already appeared in Nunavik and some of these have even already been documented; for example, the thawing of the permafrost and its impacts on airport infrastructures and roads (Allard *et al*, 2007).

Many workshops conducted in different communities have already permitted the reporting of certain environmental changes observed by local Nunavimmiut (Inuit residents of Nunavik) (Lafortune *et al*, 2004; Tremblay et Furgal, 2008; Tremblay *et al*, 2006, 2008 and 2009). Over the last few years, Nunavimmiut have observed shorter and milder winters, which has an impact on the duration and intensity of the freeze-up on lakes, rivers and fast ice. Traditional activities such as hunting and fishing remain important for Nunavik communities and these environmental changes have impacted Nunavimmiut's security and access to territories (Furgal *et al*, 2002; Lafortune *et al*, 2004; Myers *et al*, 2005). Except for these few studies, very little information is available concerning the impact of these changes on the marine environment (e.g. water level, duration and intensity of freeze-up) and marine infrastructure (e.g. erosion and sedimentation).

Funded by the Indian and Northern Affairs department, the objective of the present project was to document environmental changes having occurred over the recent decades in three regions of Nunavik: Ungava Bay (Kuujjuaq), Hudson Strait (Quaqtaq) and Hudson Bay (Umiujaq). The exercise has focused in particular on the changes in ice conditions, the formation of fast ice, the water level regimes, the tides, the storms and extreme meteorological events as well as their impact on erosion and sedimentation zones, and in particular near marine infrastructure installations. Ultimately, this information will inform adaptation strategies that the local population will become engaged in the future to protect and support continuity in livelihood and marine travel activities.

Moreover, the traditional knowledge collected will be useful to validate and corroborate scientific data already available or to be gathered in the framework of a project on marine infrastructures with the Ministère des Transports du Québec and the Ouranos Consortium. This project aims to document the impacts of climate change on these infrastructures and should provide avenues for reflection on the potential of the marine infrastructures, their usage and improvements to be made, if required. Finally, these discussions also have another objective, which is to document the Inuttitut vocabulary relating to ice in a marine environment in order to complete the lists already being compiled in Nunavik (Tremblay et Furgal, 2008; Furgal *et al*., 2010) and in elsewhere (e.g. Nunavut; Laidler, 2007; Johns, 2010). It is important to capture and document this terminology today, while these terms and concepts which often best represent the phenomena of interest are still alive and used by current Inuttitut speaking experts in communities. There is concern that with the loss of traditional ways of life and adaptation of language, some concepts and terms, which are more accurately representative of critical sea ice constructions and dynamics, will be lost. This terminology, and the knowledge it conveys, is an important component of adaptation at the local scale.

This report, organized in three sections, presents verified and validated information from the workshops held in the communities of Quaqtaq, Umiujaq and Kuujjuaq between February 2009 and February 2011. For Quaqtaq and Umiujaq, the information has been corrected directly in the preliminary reports prepared by March 2010. For Kuujjuaq, the initial consultation has already been published without validation (Tremblay *et al*, 2009). So chapter 3 of this document is divided into two sections: the initial consultation and the validation of information.

1.3 Methodology

To document local expert knowledge of Nunavimmiut, group's workshops were organized in three communities. The first consultation workshop was held in Kuujjuaq from February 24 to 26 2009, the second in Quaqtaq the 10th and 11th November 2009 and the last one in Umiujaq from February 2 to 4 2010. Preliminary reports were first drafted in March 2010 for Quaqtaq and Umiujaq while the final non-validated report for Kuujjuaq workshop had already been published (Tremblay *et al*, 2009). Later, from November 22 to 26, 2010, information compiled

and maps produced have been validated with some of the elders of each community. This final validation meeting was held in Quaqtaq and was intended to gather the majority of experts from the three villages as well as students from each community schools. Meetings and discussions have taken place, both on climate change and on the transmission of traditional knowledge, between the different communities and between elders and students. However the validation of information gathered in Kuujjuaq was not held before February 2011.

All workshops, except the first one in Kuujjuaq conducted by Martin Tremblay (former ARK/KRG), were led by Kaitlin Breton-Honeyman (Trent University), with Stéphanie Bleau (INRS-ETE), Clément Clerc (INRS-ETE) et Mélissa Gagnon (ARK/KRG). All meetings were conducted in English and translated in Inuttitut by Sarah Aloupa (Quaqtaq), Annie Kasudluak (Umiujaq), Sarah Tukkiapik and Annie Baron (Kuujjuaq).

The questions addressed during the workshops focused mainly on the environmental change observed over time at the local and regional scale with an emphasis on the marine environment and ice regimes. The objective was also to try to measure the impacts of these changes on the existing marine infrastructures and to get an idea of the intensity of the use of these installations.

The questionnaire used to guide the workshops and interviews was conceived the first time for the Kuujjuaq workshop, held in winter 2009, for a river environment (Tremblay *et al*, 2009). It was then adapted for the marine environment of the Hudson Strait and Bay. The questionnaire used remains almost similar for the three workshops. This one is divided into two main sections (cf. Appendix 1). One refers to the marine environment and ice (fast ice, tide and currents, water level, erosion and security) while the other focuses on the use of the territory (hunting, fishing, harvesting, travel). In Umiujaq, the second section could not be completed and in Quaqtaq did not at all been addressed for reasons independent from the organizers will.

Information shared by Umiujamiut experts was noted throughout the workshop in writing and via audio recording.) Much of the information was also georeferenced on maps of the study region. Finally, photographs and videos were taken to give context to report and provide an

additional way of documenting the workshops and interviews. Generalization of findings based on the information provided was avoided whenever possible.



Figure 1-1 : Participants for the group workshop, held in Quaqtaq from November 22 to 26, 2010. From left to right, third row: José Gérin-Lajoie (UQTR), Stéphanie Bleau (INRS), Kaitlin Breton-Honeyman (Trent University), Numa Angnatuk[1], Willie Kumarluk[2], Kris Tukkiapik Papak[3], Jimmy Gordon[3], Charlie Okpik[1], Jobie Crow[2], Noah Inukpuk[2], David Oovaut[1], Simon Flemming[2] ; second row : Mélissa Gagnon (ARK/KRG), Tommy Saunders[3], Vicky Kulula[1], Ida Gordon[3], Annie Kasudluak[2] (interpreter), Clément Clerc (INRS), Matthew Bryan (KSB), Yves Gauthier (INRS), Lucassie Tookalook[2], Sylvain Fleury (KSB) ; first row : Véronique Gilbert (KSB), Bobby Nakoolak[1], Bobby Pootoolik[1], Sarah Aloupa[1] (interpreter), Davidee Sappa[2], Louisa Thomassie (ARK/KRG). ([1]Quaqtaq, [2]Umiujaq, [3]Kuujjuaq)

1.4 Study Area

In Nunavik, 14 communities are distributed along the coasts of Hudson Bay, Hudson Strait and Ungava Bay (Figure 1-2). Three of them were selected to conduct this study, Quaqtaq, Umiujaq and Kuujjuaq, respectively close to the Hudson Strait, Hudson Bay and Koksoak River which flows in Ungava Bay.

In each Nunavik village, marine infrastructures were built in the early 2000s following an agreement signed in 1998 between the federal government and the Makivik Corporation. The objective of this agreement was to facilitate access to the sea for fostering economic development and hunting, fishing and livelihood activities.

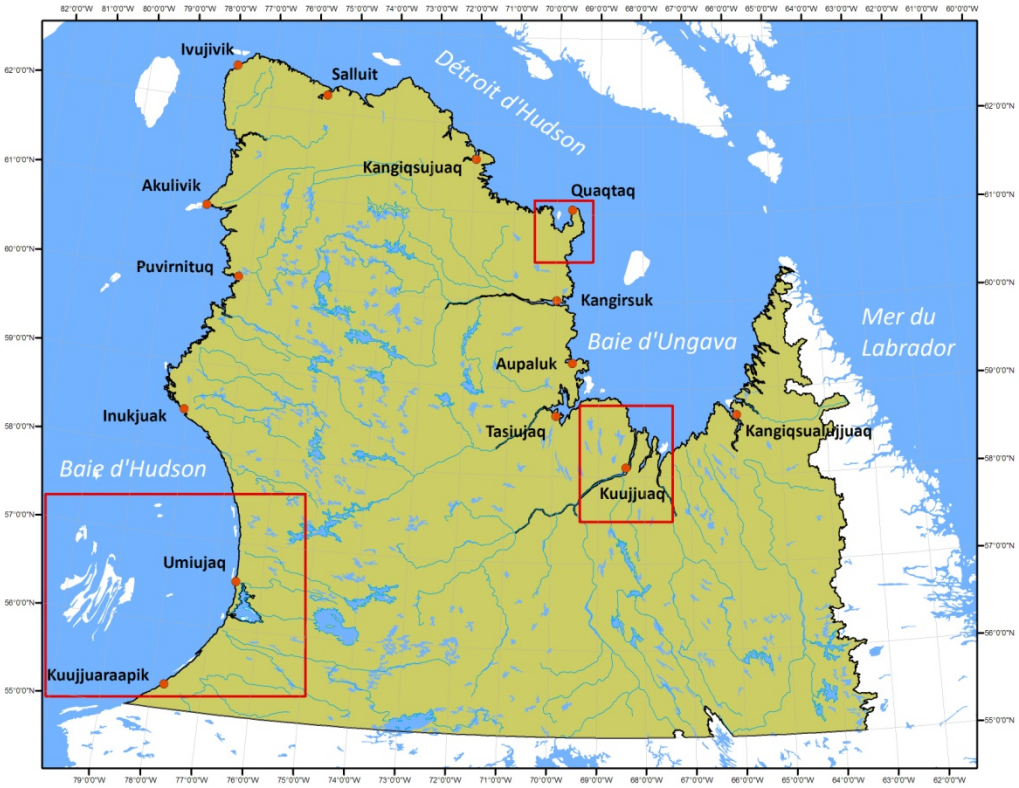


Figure 1-2: Distribution of the 14 Nunavik communities and the three study areas around Quaqtaq, Umiujaq and Kuujjuaq.

2. Study of the behavior of sea and lake ice close to marine infrastructure in Quaqtaq, Nunavik – Local expert knowledge and community perspectives.

Consultation workshop: February 2010

Validation workshop: November 2010





2.1 Abstract

A workshop was held in Quaqtaq (Nunavik) with local experts on November 10 and 11 to gather local expert knowledge on the environment. On November 26th 2010, a validation workshop was attended by the same experts to verify information produced in this report. Discussions dealt mainly with the marine environment of the Quaqtaq peninsula, the processes of freeze-up and break-up, the sea and river ice regimes, the water levels, the climate, the currents and the flows. At the same time, the Inuttitut terms associated with these themes were collected when possible. In the Quaqtaq peninsula and Diana Bay region, ice formation is today delayed by at least one month compared to the 1980's. When compact and fixed pack ice (*tuvaq*) has finished forming up to Diana Island, the Quaqtamiut can travel on the bay all winter long for their harvesting activities. The major risks during this period are associated with the appearance of cracks or ice pile-ups. The spring thaw occurs earlier than in the past but it is mainly the stability of the ice during the melt that has changed. The residents of Quaqtaq have noted that over the last approximately twenty years (i.e. the 1980's), the duration of winter has shortened by an average of two months (one month at the beginning and one month at the end). Quaqtamiut have only observed limited changes in the tide regime although some local currents could have been modified these last decades. According to them, the amount of precipitation in summer has significantly decreased while strong winds are on sharp increase since the 1980's. The lakes are drying up and some islands are emerging little by little. The marine infrastructures of Quaqtaq, built in early 2000s, are today used by part of the population although their access is rather limited, particularly at low tide in the case of the first breakwater. For example, the launching of rescue boats is rarely possible because of the low water level within the breakwaters. Additionally, the elders present at the workshop indicated the risk zones for erosion and sedimentation on the infrastructures made a few remarks and recommendations in relation to improvements that could be made to the infrastructure. In the end, the recent observations of the inhabitants of Quaqtaq provide concrete indications as to the problems to anticipate in relation to climatic and environmental changes.

1.2 Participants

To document local expert knowledge of Quaqtamiut, a group workshop was organized on November 10 and 11, 2009 in conference room at the municipal office. Under the direction of Kaitlin Breton-Honeyman (Trent University) and Stéphanie Bleau (INRS-ETE), the workshop was conducted in English and translated into Inuttitut by Sarah Aloupa. Charlie and David Okpik, Pallaya Ezekiel, Bobby Nakoolak were the experts present (Figure 2-1), accompanied by the new mayor of Quaqtaq, Bobby Pootoolik, and a young man, Alec Ningiuruvik, invited by the elders to promote the transmission of knowledge to the new generations. It should be noted that in addition, a private interview was organized on November 11 at the home of the eldest of the village, David Oovaut, since he could not be present. In all, seven residents of Quaqtaq with an average length of experience in the region of 36 years (range: 19-63 years) participated to the project.



Figure 2-1 : Kaitlin Breton-Honeyman and a few Quaqtamiut participants discussing the distribution of the different ice types in the Quaqtaq peninsula region (photo S. Bleau, 11/2009)

Consequently, on November 22 to 26, 2010, the information and map produced was validated with most Quaqtamiut elders who had participated in the group workshop. Charlie Okpik, Bobby Nakoolak, David Oovaut and Bobby Pootoolik were the local experts present for the validation. Conducted by Kaitlin Breton-Honeyman (Trent University), with Stéphanie Bleau (INRS-ETE), Clément Clerc (INRS-ETE) and Mélissa Gagnon (ARK/krg), the validation workshop was made in English and translated in Inuttitut by Sarah Aloupa.

2.3 Study Region and Local Marine Infrastructures

Quaqtaq is one of the 14 communities of Nunavik distributed along Hudson Bay, Hudson Strait and Ungava Bay (Figure 2-2). The village is located on the east coast of Diana Bay (or Tuvaaluk, « The large ice field » in Inuttitut), approximately 350 km north of Kuujjuaq, capital of Nunavik and 1700 km north of Montréal (Dorais, 1997). The closest communities are Kangiqsujuaq (150 km in a northwesterly direction along the Hudson Strait) and Kangirsuk (100 km to the south on the shores of Ungava Bay).



Figure 2-2: Location of the study region in relation to the other communities of Nunavik. The area outlined in green corresponds to the administrative limits of Nunavik.

Perched atop the shoreline and sheltered by Mission Cove, Quaqtaq is surrounded by a typical Arctic environment where tundra and rugged rocky outcrops dominate (Allard *et al*, 2007). Small mountains to the north and a few rocky hills to the southwest form the landscape in the vicinity

of the village (Nunavik Tourism Association, 2009). These are mainly covered by lichens and small shrubs, Quaqtaq being located approximately 250 km north of the northern tree line. The village as such is located in a valley bottom between rocky ridges, the oldest part stretching along a stream that flows into Mission Cove (Allard *et al*, 2007). Due to Quaqtaq's location between Diana and Ungava bays, the village of Quaqtaq lies in the middle of a fertile region for harvesting (fishing, hunting, trapping, harvest, etc…), in particular with the passage of the many animal migrations (for example: geese, beluga and caribou) (Dorais, 1997). For example, in Quaqtaq, belugas migrate right up to Mission Cove in front of the village and the marine infrastructures (personal communications with Quaqtamiut, 2009; Tyrell, 2007). It should be noted that Apatok Island in the middle of Ungava Bay (approximately 100 km southeast of Quaqtaq) is known for its abundance of its fauna and its polar bear, walrus and marine bird colonies.

Historically, the Inuit populations living in the area of Diana Bay installed their winter camps at the site of the present village of Quaqtaq because of its proximity to the edge of the fast ice where marine mammals are abundant (Nunavik Tourism Association, 2009). During the first half of the 20th century, many trading posts from different companies succeeded one another in Iggiajaaq on the shores of Diana Bay, approximately 25 km southwest of Quaqtaq. After the successive closings of these trading posts and the installation of a Catholic Mission at the site of the village of Quaqtaq in 1947, the Inuit ended up settling progressively close to the village. However, because of its small size and its limited population concentration (today the village numbers 336 inhabitants), Quaqtaq benefited from public services only after most of the other Nunavik communities (Nunavik Tourism Association, 2009). The airport and the landing strip were built at the turn of the 1990's. Management of resources and services is generally shared between many organizations such as the Kativik Regional Government (KRG or ARK), the Makivik Corporation, la Fédération des Coopératives du Nouveau Québec (FCNQ) and at a more local scale, the Landholding Corporation (Corporation Foncière) and the Municipality of Quaqtaq.



Figure 2-3: Aerial view of the two breakwaters in relation to the village of Quaqtaq (Google Earth, 11/2009)

In Quaqtaq, there are two distinct marine infrastructures (Figure 2-3, 2-4 and 2-5):

- The first was built in 1999 by the Makivik Corporation and is located in Mission Cove right in front of the village. The breakwater is thus the one located the farthest to the north. It was built at the site 60 meters off an old breakwater, the latter having been built summarily a few years before by the municipality of Quaqtaq to protect boats from waves and ice. The bottom is + 4m ZC (i.e. 4 meters above the zero of marine charts) at the end of the breakwater, which leaves the infrastructure accessible to boats and canoes approximately 35% of the time (Figures 2-5 and 2-6). (Personal communications, MTQ, 2009)

- The second infrastructure, built in 2007 by Makivik, is located to the southwest, just as close to the village. It was built mainly to compensate for the limited access to the water of the first infrastructure (longer accessibility even with lower water levels). The bottom is close to the zero of marine charts at the end of the tip of the breakwater, which is supposed to clearly increase accessibility to the water compared to the first

infrastructure (i.e. by about at least 4 m, Figure 2-7). It should be noted that as a consequence, the slope for boat launching is steeper.



Figure 2-4: Panoramic view of the two breakwaters (photo taken northeast of the infrastructures, 10/2009)



Figure 2-5: The two infrastructures at low tide (photo taken east of the infrastructures, S. Bleau, 11/2009)

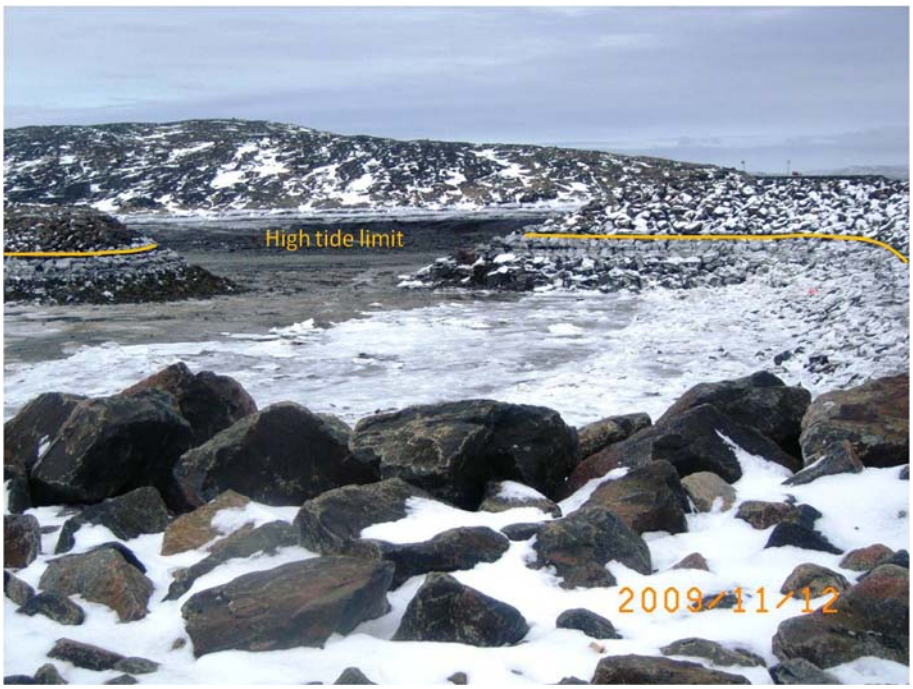


Figure 2-6: 1st infrastructure at low tide (photo S. Bleau, 11/2009)



Figure 2-7: 2nd infrastructure at low tide (photo S. Bleau, 11/2009)

2.4 Ice Cover

2.4.1 Ice Formation and Evolution in the Quaqtaq Region

The Quaqtaq elders explain that the process of formation of new ice occurs following different stages. First, new ice starts along the shoreline, especially in areas close to rivers, and Quaqtamiut call this stage *ilumajuq*. The contributions of fresh water (from rivers and streams) reduce the salinity of seawater on the surface and encourage the formation of new land fast ice in the bays (*qinngurusirtutuq*). Figure 2-8 shows the areas close to the village of Quaqtaq where the first ice generally appears. The onshore tidal movements encourage the accumulation of this ice layer along the shoreline. The ice formed accumulates little by little until it ends up by fixing itself to the foreshore during low waters and at the level of the backshore along the shoreline at high tide. One refers then to *qinngurusirtutuq* that accumulates in the bays (corresponds to shore or landfast ice in English). Gradually, the lakes and rivers finish by all being frozen and the contribution of fresh water decreases. Sea ice then forms in the middle of the bay and in the coves when the weather is cold and calm, generally when the winds blow from the continent (i.e. from the south). This thin ice cover in the process of formation that attaches itself to other chunks of ice already present is called *tuvatsaq*. It should be noted that although colder, north winds tend rather to generate waves that break this thin ice cover in the process of formation and bring about the formation of slush at the water surface. The term *sikulirutiit* translates the beginning of the formation in high waters of ice that will become pack ice. The pack that will form the Diana Bay pack, called *tuvaq*, is the sum of these different stages of ice formation, consolidated by chunks of ice arriving from offshore (i.e. from the north and northwest) (Figure 2-9). In the Quaqtaq region, we talk of solid freeze-up when the entire Diana Bay is covered by ice and forms a pack from the shoreline up to the entrance of the bay (Figure 2-9). This compact ice (*tuvaq*) is formed by the consolidation of ice fragments that tend to smoothen during winter.

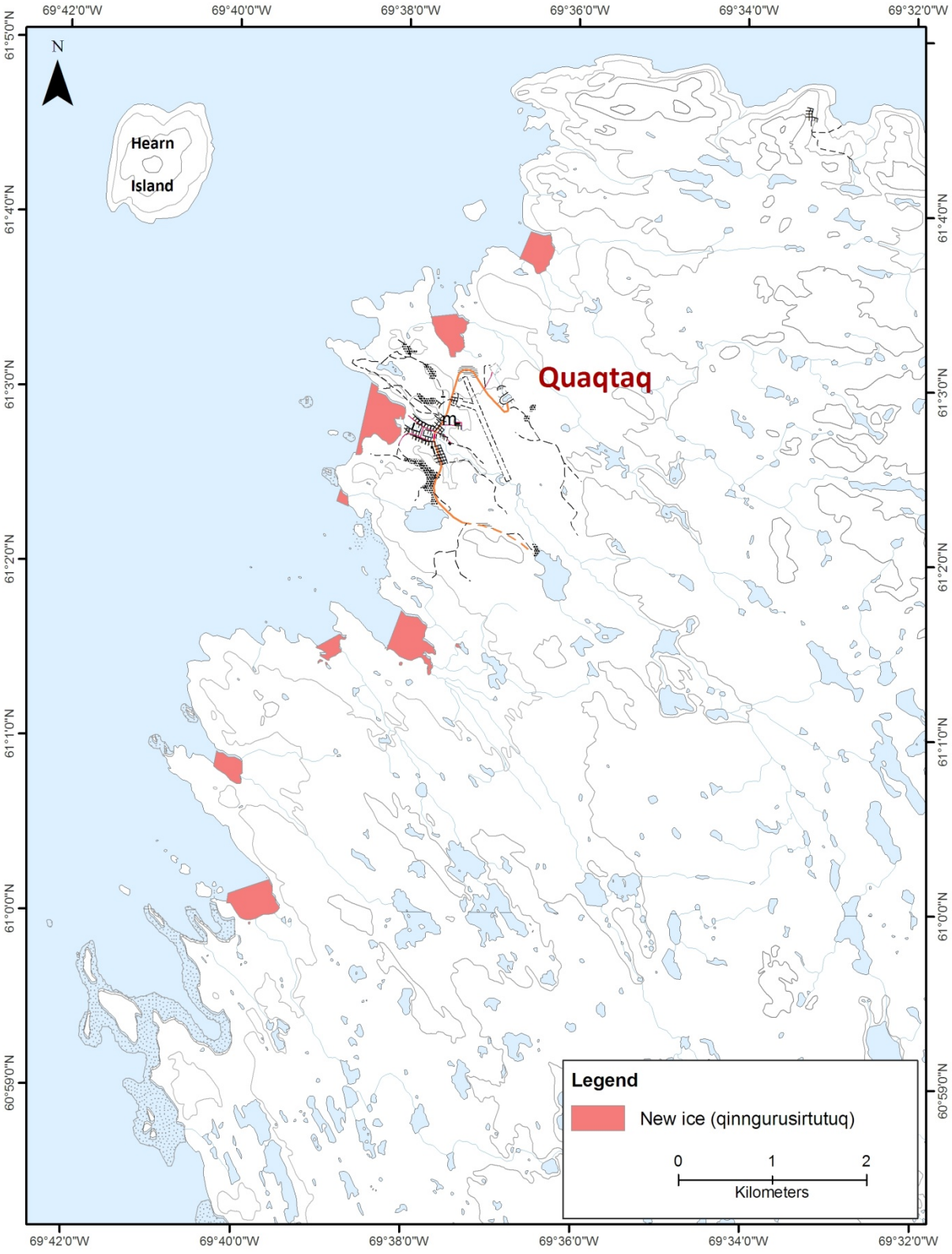


Figure 2-8: New ice (*qinngurusirtutuq*), i.e. first stage in the freeze-up process with the contribution of fresh water from rivers.

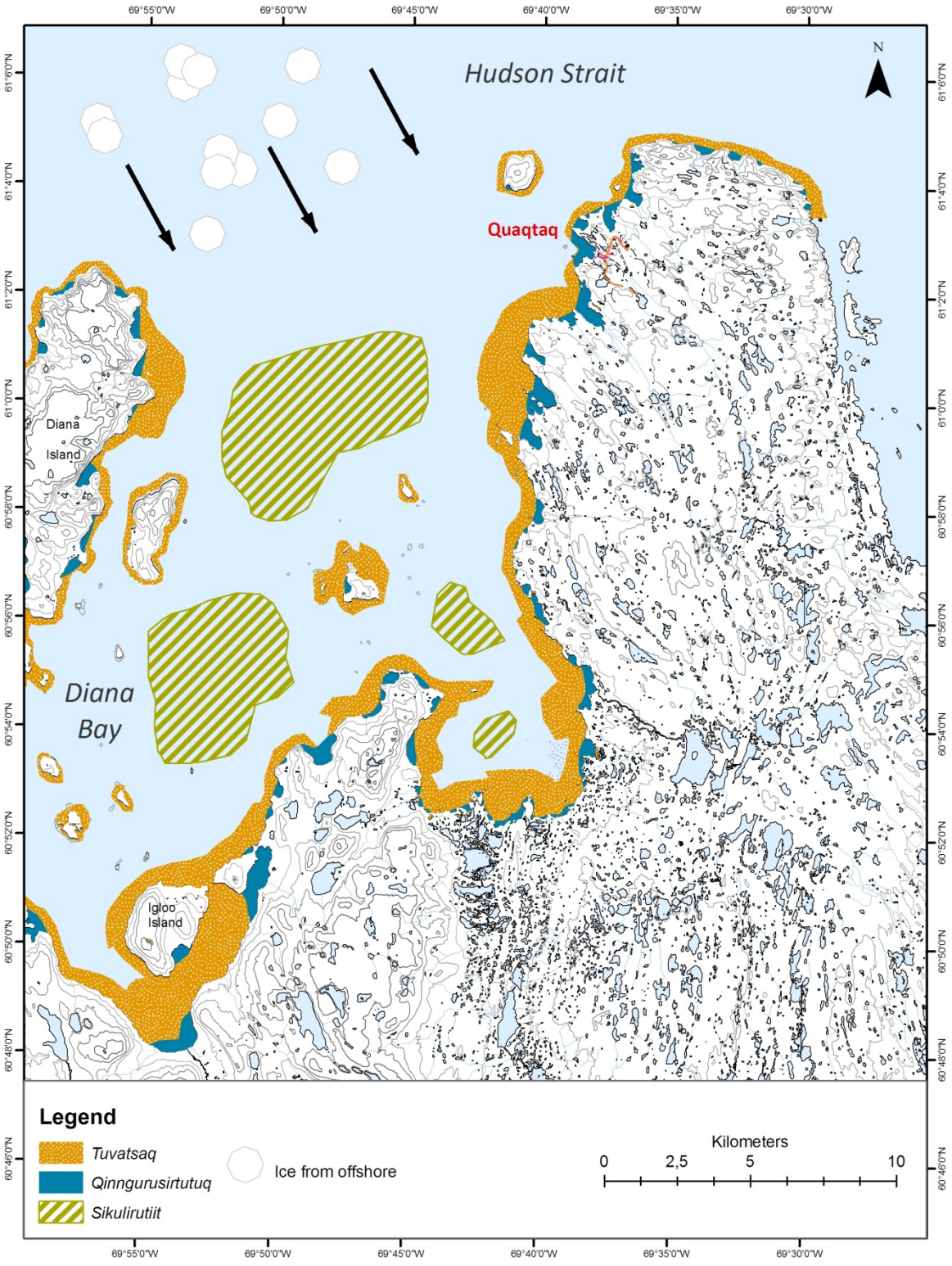


Figure 2-9: Process of formation of fast ice in Diana Bay with associated Inuttitut terms.

Nowadays, the formation of ice in the Quaqtaq region generally begins around the end of November and lasts approximately 4 weeks ending just before Christmas. The eldest of the village mentions to this effect that the ice takes today more time than in the past to stabilize and form a compact unit in the bay. According to some village elders, before (more than 20 years ago), snow storms occurred earlier around mid-October and the first ice appeared in October for a final freeze-up of Diana Bay at the end of November or early December. Quaqtamiut observe nowadays that the ice arrives later, appears more slowly and takes more time to form a full cover; the process of formation however has not changed. The years 2007, 2008, 2009 and 2010 corroborate the increasingly late arrival of ice in the bay. The higher solar radiation, the increase in temperatures, the increase and instability of the wind strength (especially the recrudescence of stronger winds), the changes in the local marine currents, the increase in waves, the decrease in precipitations and the decrease in humidity in the air (radical decrease during the periods with marine fog, *qisuktuq* in Inuttitut) are some of the factors perceived by the Quaqtamiut as potential causes of these changes. Generally, some Quaqtamiut consider that in the past, the temperature was more constant and colder and the weather calmer during the process of ice formation while today, strong winds are more frequent at that time of the year.

According to some local experts, the delay in ice formation could also have another explanation. Many lakes have seen a drop in their water level (Figure 2-11) while precipitations have decreased. Accordingly, the contribution in surface fresh water is lower and the ice takes more time to form. It should also be noted that the streams seem to freeze later than before. About thirty years ago, it was at the beginning of September. Today, we talk instead of mid-September before observing the first signs of frost in the Ruisseau Imirtaviup that crosses the village.

In the greater region of the Quaqtaq peninsula and Diana Bay, many types of ice coexist. Figure 2-10 illustrates the distribution of these different ice formations such as (the names are adapted from the ice code of the Canadian Ice Service, 2010):

a. Compact fast ice : safe in Diana Bay in Mid-December and in January in Ungava Bay (because of more currents in the string of islands)
b. Fixed fast ice but not very compact : it's an open area if winds come from the South and compact ice if they come from the North.
c. Open water with mobile chunks of ice
d. Occasionally open water area
e. Regularly open water area

The oldest residents of Quaqtaq indicate that there is no longer permanent multi-year ice in the region since at least 20 years. Only a few icebergs pass in the Hudson Strait in summer (occasionally in winter) and at least one remains for sometime each year in Diana Bay (Figure 2-11). On some occasions today, Quaqtamiut still obtain chunks of ice broken off from icebergs for drinking water. Offshore from Diana Bay, past the compact ice, the strength of the currents of the Hudson Strait prevents the formation of immobile ice. Hence, chunks of ice pass offshore from the Quaqtaq peninsula all winter long following the prevailing currents (i.e. from west to east). These are called *aulaniq*. It should be noted that the village elders have observed a reduction in the average size of the ice chunks that circulate in the Strait these last years. Moreover, along the coastline of the Quaqtaq peninsula there are some areas more favorable to the appearance of cracks or breaks in the ice (*aajuraq*). Cracks generally occur between the ice anchored to the shoreline and the compact ice of the bay. These areas are most often found in Ungava Bay since the current at low tide is quite strong and favors the opening of the ice. These open water areas can be spotty such as during high amplitude tides (such as at full moon during the spring tides - *ulilluatuq*) or regularly open in zones of eddies or where many currents join (green striped area on Figure 2-10). In this last case, these open water zones are called *imartait*. Note that the area in the south of Igloo Island is generally safe during winter but unstable during spring.

Table 2-1: Important points concerning ice formation and evolution.

- Pack ice forms following many stages (*ilumajuq*, *qinngurusirtutuq, tuvatsaq*) and finishes by forming a compact final freeze-up in Diana Bay (*tuvaq*).

- Today, the ice forms approximately one month later than 20 years ago and takes more time to form a full cover. The process begins around the third week of November and ends just before Christmas.

- The potential causes can be:

    - The increase in atmospheric temperatures;
    - The increase in water temperature;
    - The increase in the strength of winds and their recrudescence;
    - The increase of waves and periods of ocean mixing;
    - The changes in local currents;
    - The reduction of marine fog;
    - The higher salinity;
    - The reduction in the contribution of fresh water from the continent.

- In winter, there are different types of mobile and immobile ice in the Quaqtaq peninsula region.

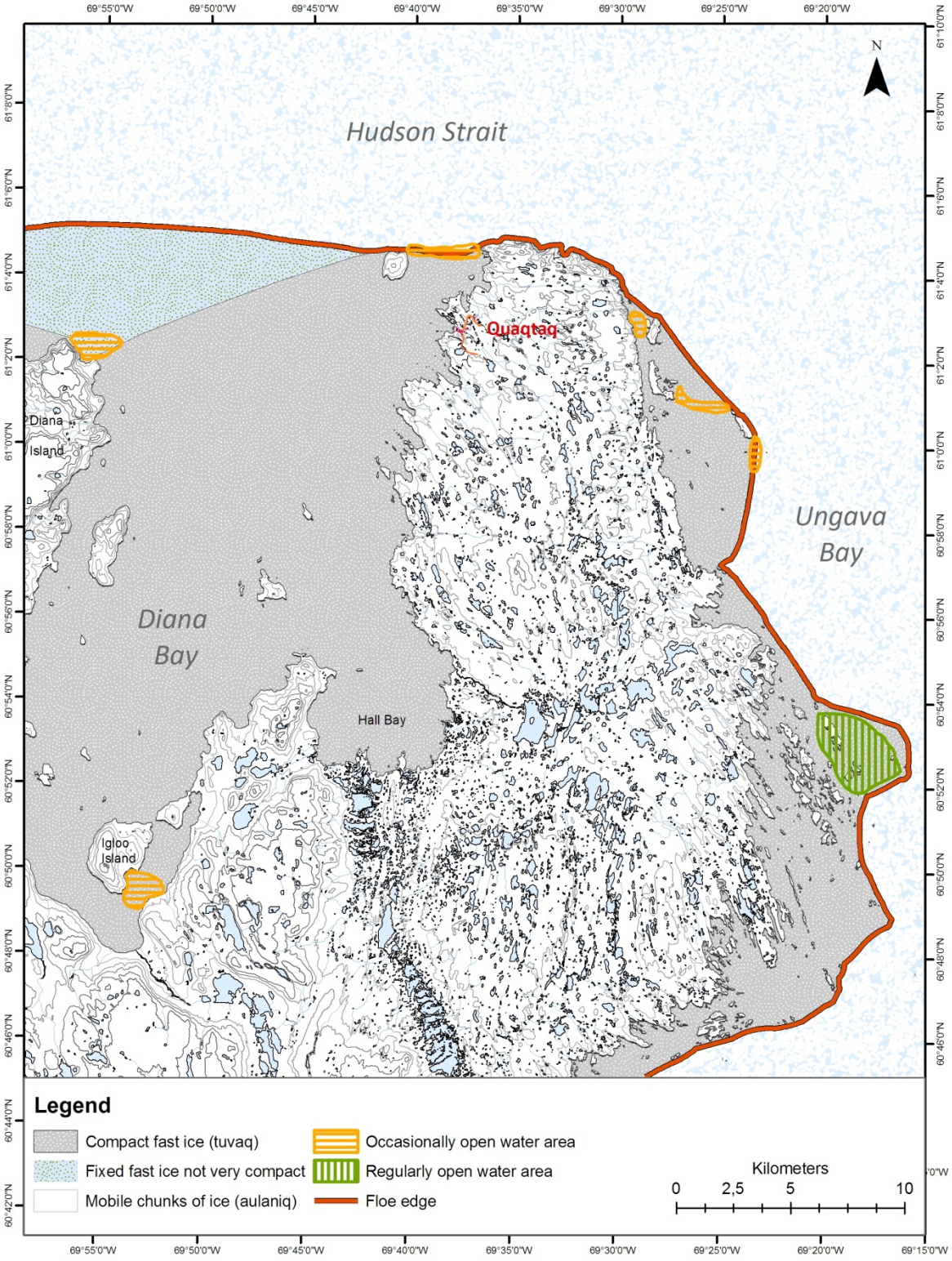


Figure 2-10: Distribution of the different ice forms in the greater Quaqtaq peninsula region.

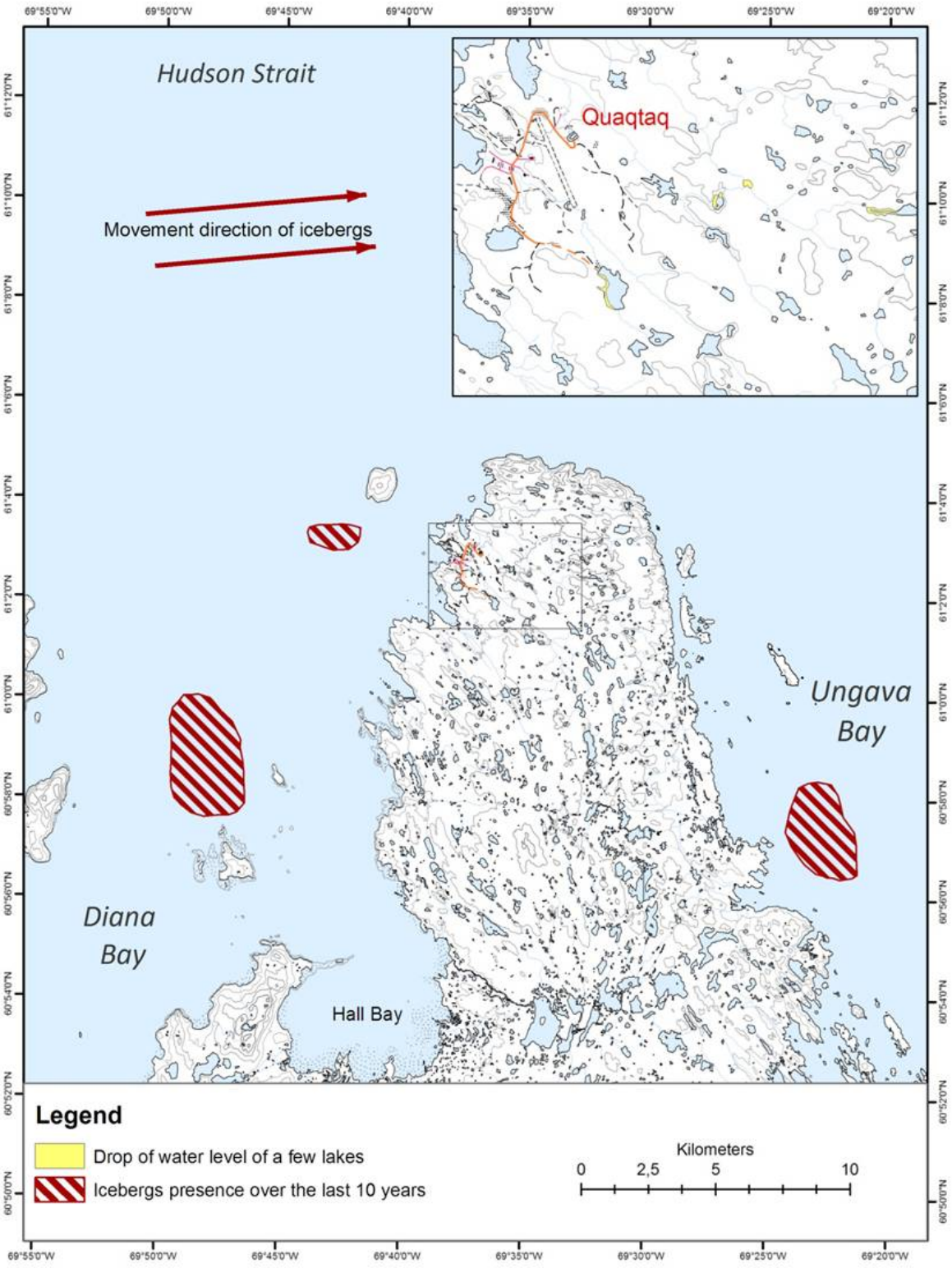


Figure 2-11: Presence of icebergs recorded by the Quaqtamiut over the last years near the Quaqtaq peninsula as well as the location of a few lakes close to the village whose water level has considerably dropped.

2.4.2 Stability of the Pack Ice and Safety in Winter

Travel for Quaqtaq inhabitants for their harvesting activities depends on ice conditions and their formation during winter. In Mission Cove, right in front of the village of Quaqtaq, once the ice has formed/attached and is solid, it remains there until spring. The residents of Quaqtaq use a harpoon to test the solidity of the ice and to know when it is safe for traveling. Moreover, Quaqtamiut consider that when the ice reaches Hearn Island (Figure 2-10), they can start to travel on the ice to go hunting and fishing in the vicinity of the village. Later, when the pack reaches Diana Island, they can travel anywhere on Diana Bay i.e. up to the edge of the fast ice for the rest of the winter (Figure 2-10). In winter, cracks appearing in the pack (*aajuraq*) are the main danger. New thin and fragile ice can form in these cracks or along the floe edge and transform those areas into unstable and dangerous zones for traveling. The risk is increased if there is also fresh snow (*qanittaq*) covering them. In the past, the sled dogs were able to detect these unstable areas. Today however, this mode of transportation is becoming increasingly rare, the majority of Quaqtamiut using snowmobiles to travel.

Twenty years ago (or 10 years ago according to some), the sea ice of the Diana Bay pack was safe to travel at the end of November. Today, the inhabitants of Quaqtaq must wait at least until mid-December before venturing on the pack and at least till January to be able to travel in all of Diana Bay. The ice must be at least 4 to 5 inches thick (10 to 12 cm) to support the weight of a snowmobile. As well, Quaqtamiut used to be able to go on the ice until July, a particularly good time of the year to hunt for seal. Today, it is risky to try to go out on the ice after mid-June. Accordingly, the period for ice hunting during winter has been shortened by at least 2 to 4 weeks since the beginning of the 1980's. Local experts point out that at the end of the winter 2010, they observed less cracks (*aajuraq*) in the pack ice than last years, because the ice was thinner. Elders emphasize on that these changes are increasing gradually over the years and that the floe edge tends to be closer to the shore over the winters. While in the past fast ice stretched offshore from Diana Island, today this island is the northern limit for stable ice in Diana Bay (see Figure 2-10 where the portion of loosely compact fixed ice could have been before part of the compact ice).

As winter approaches, many areas become impracticable or dangerous because of ice movements caused by currents, river flows, onshore tidal movements or strong winds. These areas can be unstable during winter but also sometimes in the spring when the temperature rises, a situation occurring increasingly earlier today. The elders say that it is becoming increasingly more complicated to predict the stability of the ice for travelling during winter and especially in spring, because of changing and random weather conditions. Now they have to more adaptive and be better equipped for their travels on the land.

Figure 2-12 shows unstable and dangerous area as well as areas where ice pile-ups (*ivuniit*) are formed during winter. The areas are generally the result of a combination of currents and strong winds. Along the Quaqtaq peninsula on the Ungava Bay side, some ice pile-ups reaching up to 120 feet high (approximately 36 m) have been observed in the past. Huge pile-ups are seen as increasingly more frequent in this area and elsewhere, because of the thinning and instability of ice. The tip of the peninsula and the edge of the compact ice are favorable areas for ice pile-ups and pressure ridges, and are consequently relatively unstable and dangerous areas all winter long and in the spring. The presence of water on the ice surface and the widening of water holes are an indication to hunters that the ice is starting to melt. At that moment, the most dangerous areas are those where black ice is found representing the last ice layer still present, which is often very thin. In July, it is unsafe to travel on the ice. Quaqtamiut also explain that today, they have much more difficulty in predicting the moment when the ice will be unstable at the end of winter because of all the changes they observe surrounding break-up.

Over the last few years the experts consulted in Quaqtaq have observed two outstanding events occurring at the beginning of winter. First, on December 31, 2002, a good portion of the fast ice anchored to the shoreline (*qinngurusirtutuq*) broke off and went offshore (Figure 2-12). The reason according to them for this breach could be a combination of strong winds and high tides that could have broken the ice and brought about the formation of cracks in the already formed pack. However, the exact cause is not known. For most of the Quaqtamiut present, this was the first time such an event occurred, except for David, the oldest, who said that he has observed a similar phenomenon a fifty years ago. Two years later, in the days following December 26, 2004, the ice cover broke and went on the shore at the northeast point on the Ungava Bay side. The tsunami in South-East Asia could have been the cause according to them. This opening of open

water attracted a lot of animals (polar bears in particular) and the harvest was very good for this period of the year in spite of the fact that ice movements did not facilitate access to the area. According to them, this cataclysm is thought to have changed the distribution of the stars in the sky.

Table 2-2: Important points concerning the stability of the pack ice in winter.

- When the fixed ice reaches Diana Island, Quaqtamiut can travel on the entire Diana Bay for the rest of the winter.
- The main danger in winter: open water when cracks are formed or near the floe edge, covered by thin ice (*uiguaq*) and/or fresh snow (*qanittaq*).
- One must wait one more month than twenty years ago to venture on the pack ice (December or January instead of the end of November).
- Dangerous areas appear during winter because of onshore tidal movements and high winds.
- Ice pile-ups (*ivuniit*) are larger than in the past and the highest can be found in the Ungava Bay side of the peninsula and the cliffs facing the strait.
- The tip of the peninsula not far from the village is the most unstable area in winter.
- Predicting the stability of the ice for travelling during winter and especially in spring, is more complicated than before because of changing and random weather conditions
- Outstanding events occurred at the beginning of winter these last few years: on December 31, 2002 and on December 26, 2004.

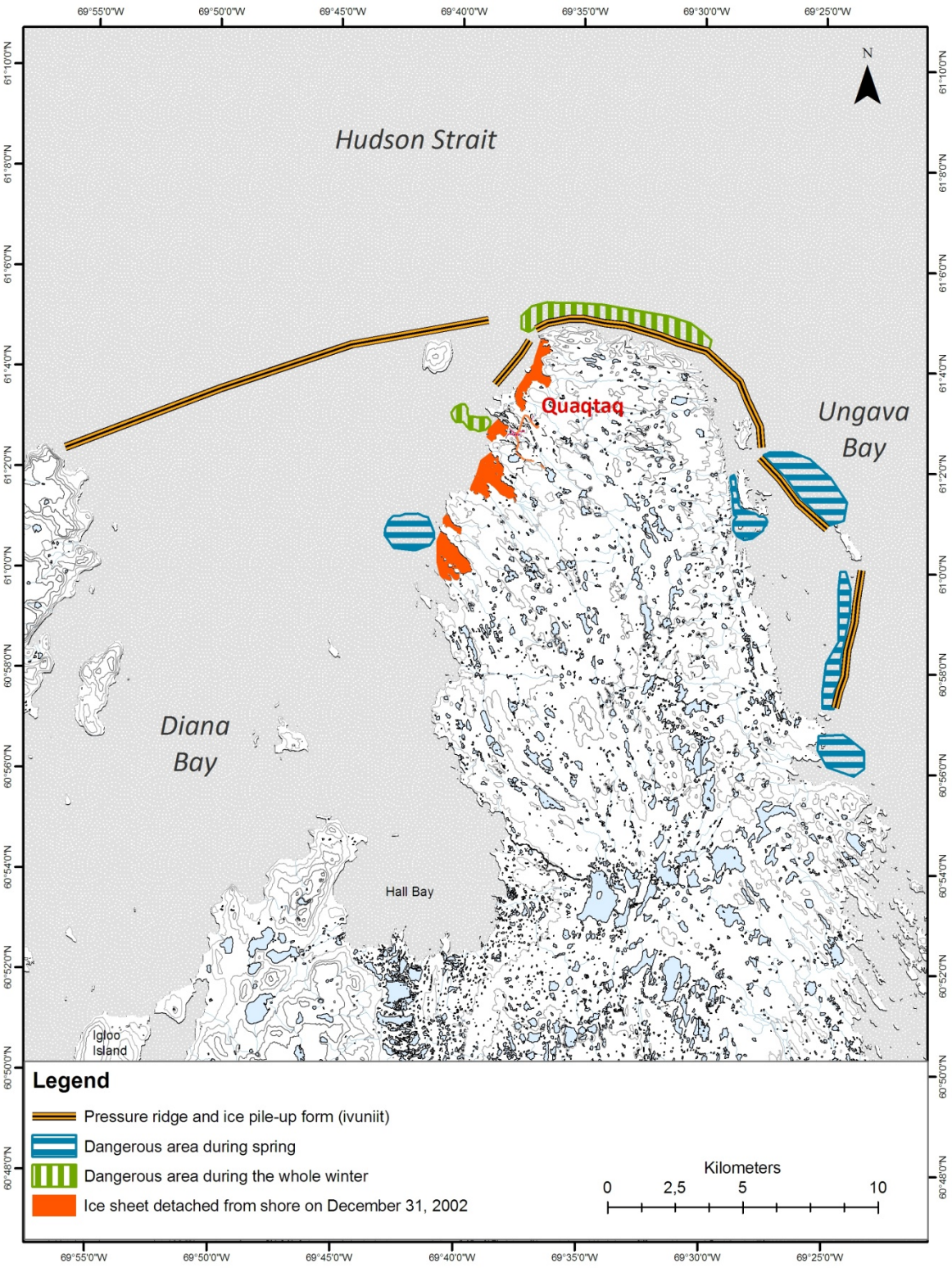


Figure 2-12 : Dangerous and unstable areas in winter and spring as well as the most favorable areas where pressure ridges and ice pile-ups form.

2.4.3 Spring Break-up

Today, melting of the pack ice begins during the month of May depending on the year and generally ends at the beginning of July. The time it takes for break-up varies according to the timing the melting begins but it generally lasts between 4 to 6 weeks. However, the duration can be difficult to estimate because northwest winds force ice debris to remain within the bay. Based on the evaluation of the Quaqtamiut interviewed, melting does not begin much earlier than before; however it seems to occur more rapidly. It appears to end earlier although the fresh water contribution from the continent is not as important as in the past. The eldest of the village confirms these observations by emphasizing that since the end of the 1990's, spring seems not to last so long.

As occurs during its formation, pack ice degrades itself following a cumulative process that involves erosion from the shoreline, from offshore, from under and over the pack ice. The ice first starts to melt at the mouths of rivers with the contribution of continental fresh water originating from the melting of river and lake ice and permafrost. According to the Quaqtaq elders, the contribution in fresh water has dropped during the last years and thus seems to have less importance in the degradation phase. However, melting of the snow cover on the ice and the onset of precipitations in the form of rain generate an increase in these fresh water contributions. Tidal movements simultaneously weaken the ice cover. Longer days combined with warm winds from the south also induce a warming of the pack ice from above while marine currents cause a warming at the base of the ice cover. The contribution of fresh water from the continent progressively weakens the ice anchored to the shoreline and it ends up by breaking off. At the same time, the edge of the pack ice erodes because of the waves from offshore. Quaqtamiut also report that in spring, the presence of a « fresh » snow cover on the ice will accelerate the melting speed of sea ice. Percolation of the melting snow towards the hardened base of the cover increases the temperature in the profile and simultaneously reduces the amount of snow protecting the ice cover as induced by spring incident radiation.

Since contributions from continental fresh water are lower, the ice in the bay should melt less rapidly than before and thus break-up should take more time. In the past, the arrival of fresh water was the main mechanism triggering the melting of sea ice. Today, this is not the case

anymore according to the local experts. Yet, the pack ice melts as quickly as before or even more rapidly in some years. According to Quaqtamiut, one of the reasons could be that precipitations in winter have dropped these last years. Thus the snow cover is not as thick and the ice less protected from solar radiation. Also, many elders report that the total thickness of the pack ice in winter has decreased these last decades.

Table 2-3: Important points concerning the spring breakup.

- Break-up lasts from 4 to 6 weeks, does not begin necessarily earlier than before but seems however more rapid.
- The thickness of the Diana Bay pack ice has dropped significantly these last few decades.
- Melting of pack ice and landfast ice is a combined process:
    - From the shoreline with the contribution of fresh water from the continent and the thawing of the permafrost;
    - From the edge of the pack ice with erosion by waves and winds;
    - From the base of the cover with marine currents;
    - From the ice surface with solar radiation, snow-melt and liquid precipitations.
- Factors conditioning the melting of the cover of oceanic ice:
    - Solar radiation;
    - Thinning of the insulating snow cover at the ice-snow interface;
    - Reduction in continental liquid precipitations;
    - Warm air mass from the south.
    - Brassage et marnage qui déstabilise la structure interne du couvert.
- Factors that retard the ice break-up :
    - Air temperature cooling ;
    - Wind from the north.

2.5 Tides, Marine Currents, Water Levels, Shoreline and Meteorological Observations.

2.5.1 The Tides

Storms and bad weather are announced by high waves from the northwest. According to Quaqtamiut, there is an increase in strong winds and storms these last few years. At the same time, the local experts have not observed any changes in the amplitude of tides, the highest occurring in November during the full moon. Figure 2-13 shows the high and low tides normally observed in Mission Cove and, in particular close to the marine infrastructures. It also shows extreme high and low tides. The elders present at the workshop explained that the amplitude of the tide was on the average 19 feet (5.8 m) and that extreme tides could reach up to 27.6 feet (8.4 m).

In winter, during high amplitude tides, cracks often open in the middle of the ice and animals come in higher numbers to feed. For instance, there are more foxes and marine mammals on the ice during the full and new moon (i.e. spring tides) since more areas can potentially open up. In summer, the abundance of algae along the shoreline seems to have increased than in the past and according to the Quaqtamiut could have a link with postglacial rebound, the lowering of water levels, the water temperature or salinity. Since at least three years, the inhabitants of Quaqtaq have noted an increase in the quantity of tubular algae in Mission Cove and around Diana Island (Figure 2-14). They believe that this abundance of algae could have an impact on beluga migrations.

2.5.2 The Currents

The strongest currents are located around the tip of the Quaqtaq peninsula. The ice chunks follow the shoreline in a westerly direction at high tide while another strong inverse current (in an easterly direction) dominates offshore from the peninsula (Figure 2-15. This west to east current is the main current of the Hudson Strait. According to the local experts, the average speed of the current is 3 knots (approximately 5.5 km/h) close to the peninsula, as estimated

from the movements of the ice and icebergs. A turbulent area of strong currents is located along the shoreline between Quaqtaq, Hearn Island and the tip of the peninsula (Figure 2-15). Another precarious area is located along the peninsula on the Ungava Bay side. On this same side of the peninsula, there are also converging marine currents that, when added to the strength of the winds, could be at the origin of the recrudescence of very large ice pile-up these last few years (36 m and more). Quaqtamiut also observe regularly that during spring tides strong currents and eddies form in some areas along the peninsula transforming them into particularly dangerous areas. These are not mapped but could correspond to some dangerous areas on Figure 2-12.

2.5.3 The Shoreline

The typical soil profile of the shoreline is composed of a layer of sand approximately 6 feet (1.8 m) thick on top of the rock. Permafrost approximately 3 feet (0.9 m) deep covers this sand layer while another sand layer of more than 2 feet (0.6 m) constitutes the soil surface. The local experts explain that the combined effects of the waves, winds and ice during the break-up generate shoreline erosion and the transport of sand offshore. Although the predominantly rocky shoreline is less sensitive to erosion than the shorelines covered by superficial deposits, it was mentioned that the rocky blocks of metric size can be picked up by larges ice floes. Although not common, these observations were made from the shoreline near the first infrastructure.

2.5.4 Meteorological Observations

Finally, a few inhabitants of the village think that precipitation patterns have changed these last few years. For instance, according to them it rains much less in summer. As shown in Figure 2-11, many lakes close to the village have seen their water levels drop considerably these last ten years. The marks on the emerged rocks could be evidence of these water level decreases. One of the lakes is said to have seen its level reduced by up to 6 to 7 feet (2 m) while another, the smallest, is today completely dry. Furthermore, the stream that crosses the village dries up nearly completely in summer, which was not the case in the past. Also during the fall, they observe that there is less and less water flowing in the rivers. The water levels in Diana and

Ungava Bay are also said to have dropped, which could have caused the emergence of formerly small submerged islands (Figure 2-14). These now show on the surface at low tide causing problems for canoe travel since a lot of people do not know them and can run into them. However according Quaqtamiut, isostatic rebound would better explain the emergence of these new islands than a depletion of the water level. These same experts explain that with the greater extreme tidal range, it is easier now to see these new islands during extreme low tides

Quaqtamiut have also observed a noticeable increase in the abundance of flies during summer compared to the past. Also, during a storm, the local experts explain that it rains a lot at first during the first few days before the winds pick up and blow hard during a few more days instead of everything happening simultaneously as in the past. The elders of Quaqtaq also report having observed many other changes associated with the sky and the Sun. First of all, the color of the sky seems to be clearer than before the 1980's. In spring, and early summer the night appears darker than in the past. In spring the sunsets earlier than before for the same season. According to some elders, the location of the moon and stars in the sky may have changed from their childhood. Lastly, solar radiation is thought to be not as strong today and in general the moisture released by the earth has reduced.

Finally the extreme tidal event that occurred on October 9, 2010 was observed in Quaqtaq an similarly in other villages along the Hudson Strait. No major damage was recorded, though there was up 2 to 3 feet of water over the road connecting the village to the hotel. The elders said that although the tides are bigger in autumn, none of them had ever seen high tide like this one. They also explain that the tide was up and down very quickly.

Table 2-4: Important points concerning the tides, the currents and the shoreline.

- Quaqtamiut have noted an increase in high winds and storms and consequently an increase in high waves from the northwest.
- No significant changes in the tide cycles or their amplitude.
- Average tide amplitude: 19 feet
- Maximum amplitude: 27.6 feet
- The tip of the peninsula is the area where currents are strongest and most dangerous.
- Shoreline erosion causes the transport of sand offshore.
- It rains less and many lakes close to the village have dried up over the last years.
- Small new islands have begun to emerge in Diana Bay.

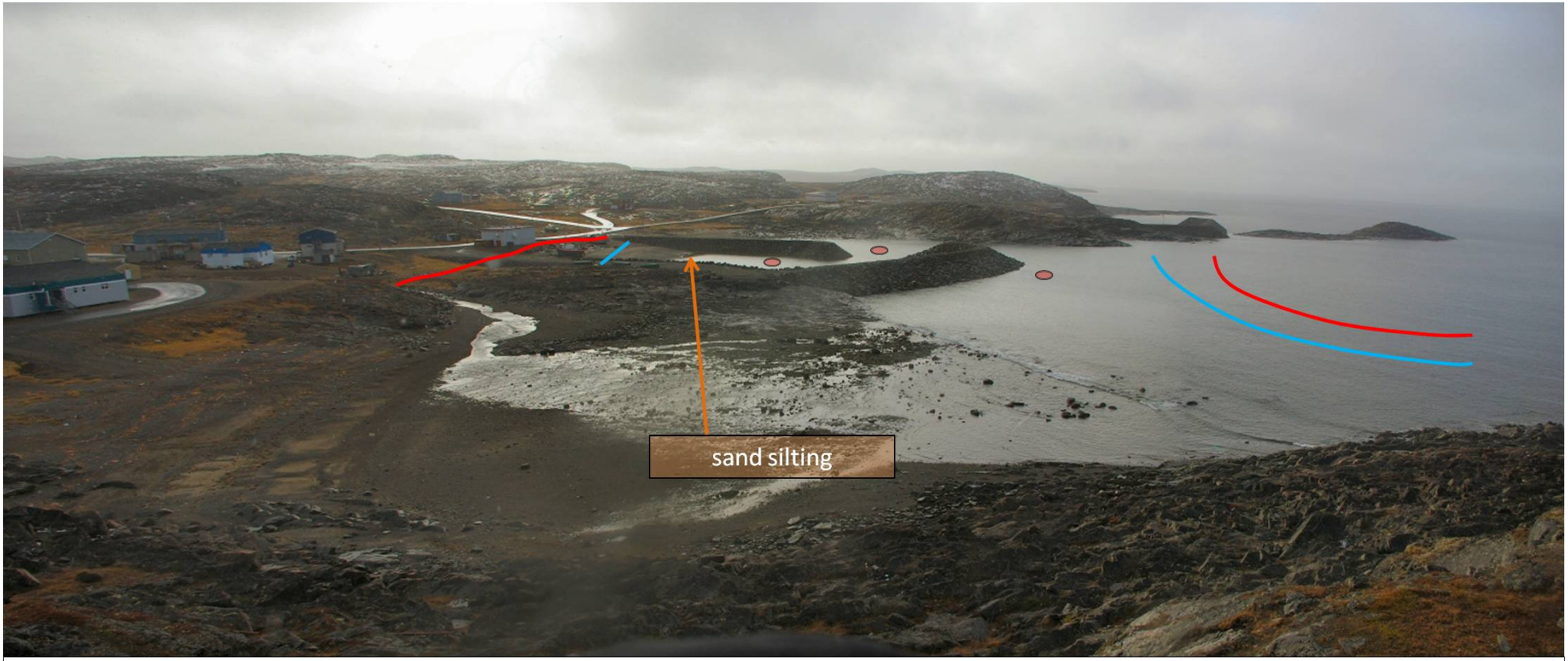


Figure 2-13 : Tide levels and problems associated with the Quaqtaq marine infrastructure.

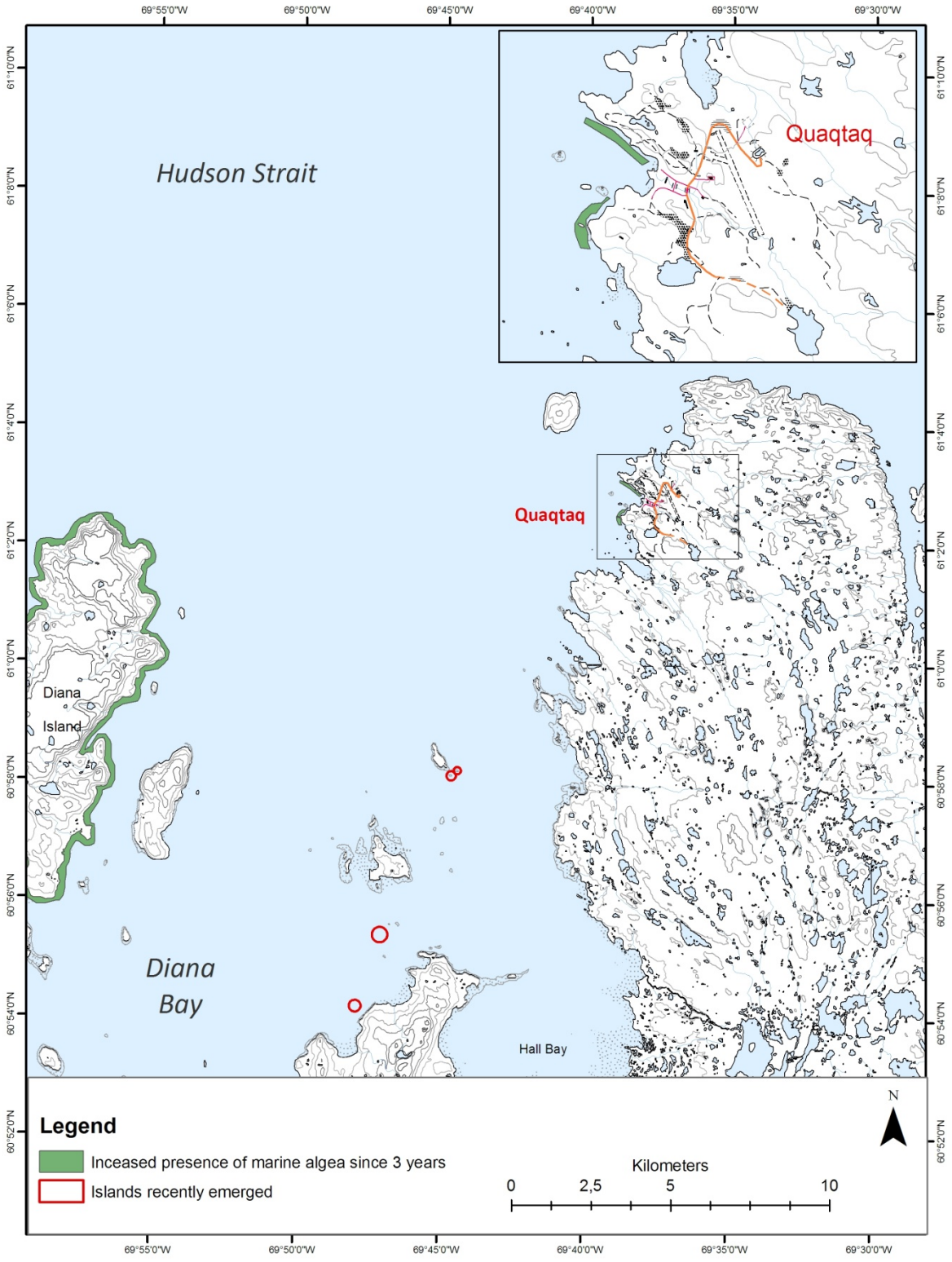


Figure 2-14: Recent changes observed in the distribution of marine algae in Diana Bay and in the appearance of certain new small islands.

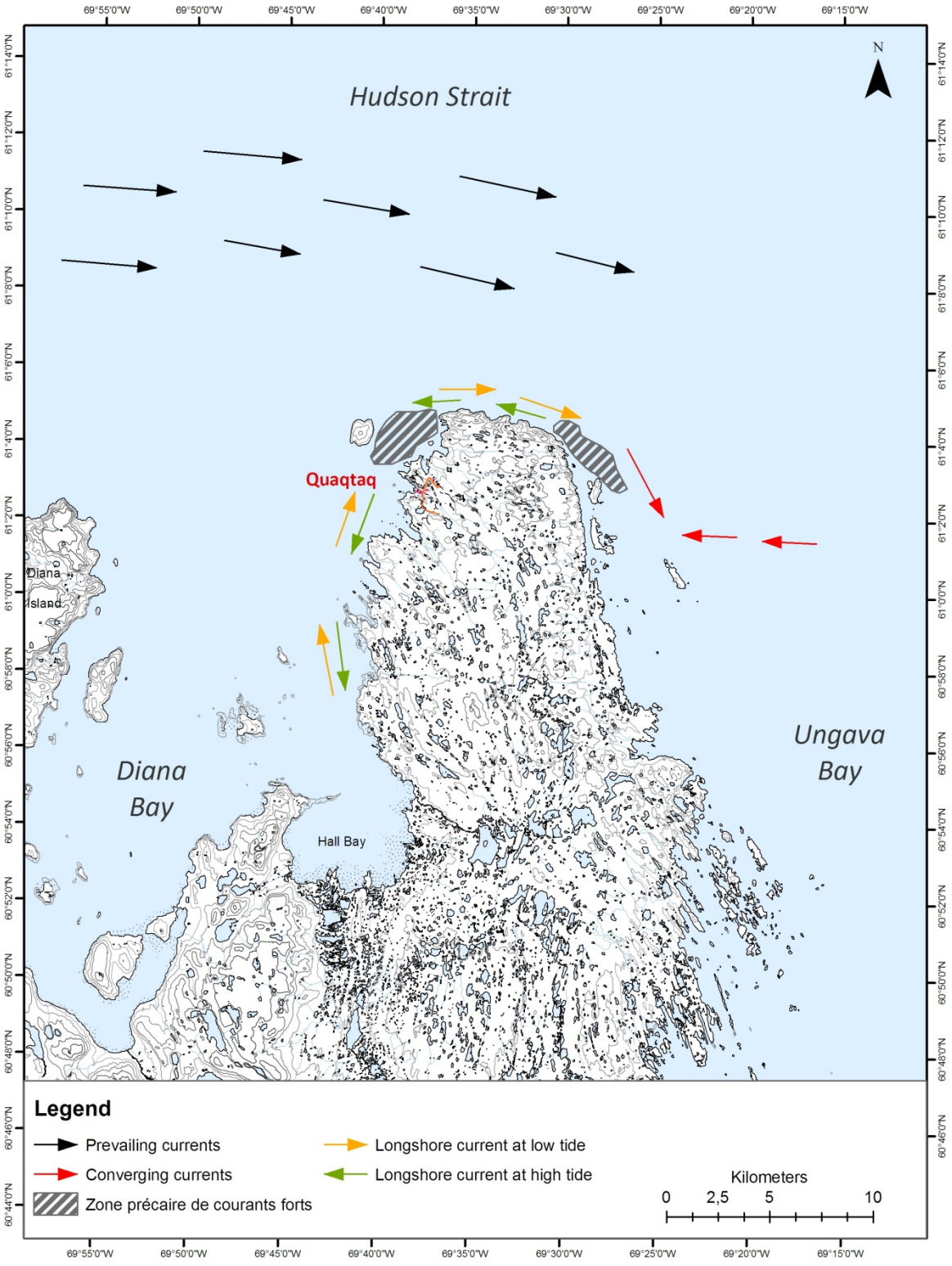


Figure 2-15: Distribution pattern of the prevailing currents close to the Quaqtaq peninsula.

2.6 Marine Infrastructures: Description, Use and Problems Associated with their Presence.

During the spring break-up, even if the water is nearly completely ice-free in Diana Bay, rugged ice accumulates in Mission Cove in front of the village. Due to this fact, open water remains very often difficult to access by canoe until July, in spite of the existence of the infrastructures. Moreover, with the presence of the first infrastructure, this ice remains captive even longer within the enclosure of the breakwater. Consequently, at that time of the year (i.e. at the beginning of summer), if the wind also blows from the northwest for a few days, it is extremely difficult to launch boats. The second infrastructure offers better protection than the first from high waves from the northwest (except in the case of a heavy storm). Furthermore, during winter, pile-ups in Mission Cove occur much more often than before the construction of the infrastructure leading Quaqtamiut to believe that the breakwater obstructs the general circulation of the ice in the cove. It is mainly at the beginning of spring break-up when the ice breaks up that the inhabitants of Quaqtaq find this dangerous since the ice, in this case, can crush the canoes.

Generally, the infrastructures are used during the summer by Quaqtamiut (i.e. as soon as the ice permits) up to the end of September (i.e as soon as the ice covers the bay). Of the four participants in the workshop who own boats, two said they did not use the marine infrastructures and that they launched their canoes elsewhere. One only uses the first infrastructure while another uses both.

The second infrastructure has the advantage compared to the first of not having accumulated sand within the enclosure of the breakwater. It is thus easier to launch boats with a vehicle. The bottom of the first infrastructure is too soft for this type of use. The gradual silting and sloughing of the latter is ongoing since its construction. The perpendicular arm of the breakwater slows the transport of sand offshore. However, it should be noted that for launching a canoe, the slope of the second infrastructure is judged too steep and does not provide a comfortable alternative for the population as a whole, particularly elders. The second marina also does not permit access to the water at all times for canoes. In most cases, the inhabitants of Quaqtaq continue to launch their canoes at another place located closer to their homes.

The first infrastructure is more widely used when people return from hunting with seals, polar bears or belugas. It is located closer to the village and is thus more practical for meat cutting. The inhabitants consider it useful to protect the bigger boats from prevailing winds but most of the time, there is no water in the basin within the enclosure of the breakwater (Figure 2-13). Access is thus rather limited. Although the second infrastructure makes it possible to leave boats even at low tide, it does not seem deep enough for the entry and exit of boats at all times. Nevertheless, the second infrastructure seems to be the one that is most widely used by cargo companies during summer and fall for the unloading of material. In any case, it's the one used by barges.

The marine infrastructures of Quaqtaq are not really affected by erosion or wrenching of part of their material because of the waves or the ice. According to the local experts, it is mainly during the degradation phase of the ice (June) that glacial transport could be dangerous for the breakwaters, although until now there has been no major problem. Some boulders appear to have been displaced by ice in winter (Figure 2-13) but local experts do not seem to be sure they come from the infrastructure. The surface at the bottom of the second marina would become increasingly rough due to the movement of waves. No ice pile-ups have ever been observed close to the infrastructures.

Finally, the Quaqtaq community owns two rescue boats. Unfortunately, the two cannot be launched at low tide in both infrastructures. At high tide, boat launching is possible in the second infrastructure but it remains difficult in the first. A tractor is required to set the boat in the water. Unfortunately, the marina is affected by silting and thus is dangerous for this type of vehicle. Even at high tide, the tractor must move from 15 to 20 feet (approximately 4 to 6 m) into the water for a successful launch. Moreover, because of the way the second infrastructure was built i.e. in the form of a corridor, the tractor cannot turn around making launching operations more complex. Although access is more accommodating in the case of this infrastructure, the tractor operator must still wait for high tide before being able to launch the boat. These various observations show that rescue boat launching is conditioned by many elements and cannot be carried out at all times. The local experts regret this situation since it's

critically important for them to be able to launch the rescue boats at all time and not only during high tides.

Table 2-5: Important points concerning the marine infrastructures.

- First infrastructure:
    - Not deep enough and access to water very limited;
    - Heavy sedimentation of sand inside the enclosure of the breakwater;
    - Used mainly when returning from hunting for its proximity to the village;
    - Can act as a barrier for the movement of ice in the cove;
    - The wind and the currents invite the ice to remain longer in the enclosure;
    - The ice is very rugged;
    - Break-up coincides with the spring tides;
    - Public safety: one must wait outside for the next tide to enter the marina.
- Second infrastructure:
    - Deeper than the first but access to the water still limited;
    - Slope too steep for boat launching;
    - Used more widely for unloading barges than for canoe launching;
    - Public safety concern in regards to the rescue boat also applies.
- The ice remains in the cove in front of the village and in the enclosures until July.
- Launching of the lifeboats cannot be done at any time.
- Infrastructures are used as soon as the ice goes back until it comes back in autumn.

2.7 Terminology

Nunavimmiut use a great variety of terms to describe and explain their subarctic environment. The marine environment and in particular sea ice are no exception and one can find a great richness of very precise words that describe both ice forms and the processes associated with freeze-up or break-up. Also, the same word can have two different meanings (Tremblay et Furgal, 2008; Laidler, 2007) in two different communities. Moreover, it is not rare that two different words have the same meaning. The list below identifies a few words collected during the November 2009 workshop in Quaqtaq in order to complete the list initiated by Tremblay et Furgal (2008) in six communities of northern Québec (5 of them are Inuit). Some of these words have already been placed in their context in the preceding paragraphs.

Aajuraq: Lateral and oblique cracks in the sea ice produced by onshore tidal movements.

Aulaniq: Moving ice located between the edge of the immobile fast ice (Tuvaq) and the open water in Hudson Strait.

Ikkaruk: Island showing at the surface at low tide.

Ilumajuq*:* When the ice starts to form. In the sea, ideal conditions are at low tide and this formation of a thin layer of ice is further encouraged in areas where there is a contribution of fresh water from the continent.

Imartait: Open water because of the presence of currents.

Ingirrangisaqtuq: Period of low tide.

Ivuniit: Ice pile-up.

Kavvatuq: Accumulation of ice on the shoreline.

Mamilittuq: Period of rising tide.

Puttaaq : Thick floating ice sheet.

Qaattuq: Ice-free water in spring.

Qanittaq: Fresh snow from the day before (fluffy snow)

Qikirtaguluk: Small island.

Qinngurusirtutuq: Beginning of the formation of land fast ice in rivers mouth in the bays.

Qinu : At low tide, when thin ice is accumulated on the shore and began to become thicker.

Qisuktuq: Humidity in the air, marine fog that announces the formation of ice in an open water area.

Sikurjuajait: Ice that does not degrade itself during melting.

Sikusiilaq: For the community of Cape Dorset in Nunavut; permanent ice-free area.

Sikusiilaq: For the community Quaqtaq; river that never freezes.

Sikutuqait: Ice that lasts more than one year.

Sikulirutiit: New floating ice, not yet attached to the shore.

Sinaa: Sea ice.

Tarqiila: Black moon

Tarqivaluttuq : Full moon

Tinusimajuq: Ice transported by the tide cycles during spring break-up.

Tuvaq: Compact ice formed by solid, immobile and permanent ice that tends to smoothen during winter. In the Quaqtaq region, the fast ice of Diana Bay is a good example.

Tuvatsaq: As the tide moves in, the ice formed on the foreshore accumulates little by little until it anchors itself to the bottom of the water and the shoreline. The term represents the ice that accumulates along the shoreline (in English shore or landfast ice).

Uiguaq: In an ice-free area, a new piece of thin and smooth ice that attaches itself to the floe edge. Covered by fresh snow, this type of ice becomes highly dangerous since it is difficult to distinguish from the more solid ice.

Ulilluatuq: High tide during the full moon.

2.8 Conclusion and Recommendations

Finally, there seems to be a consensus as to the fact that pack ice forms at least one month later than twenty years ago and that it also breaks up more rapidly than before. Nevertheless, Diana Bay today still forms a solid and fixed pack all winter long, although its thickness has diminished over the last decades. The most dangerous area remains the tip of the peninsula facing the cliffs close to the edge of the pack. In terms of meteorology, all the local experts agree that since the 1990's, there are more strong winds from the northwest, that they are more intense and that they last longer generating higher waves more often. At the same time, a decrease in precipitations during the ice-free season has brought about a gradual drying up of some lakes. Certain small islands are also said to have emerged these last few years as a consequence of the lowering of the water level in the bay or postglacial rebound.

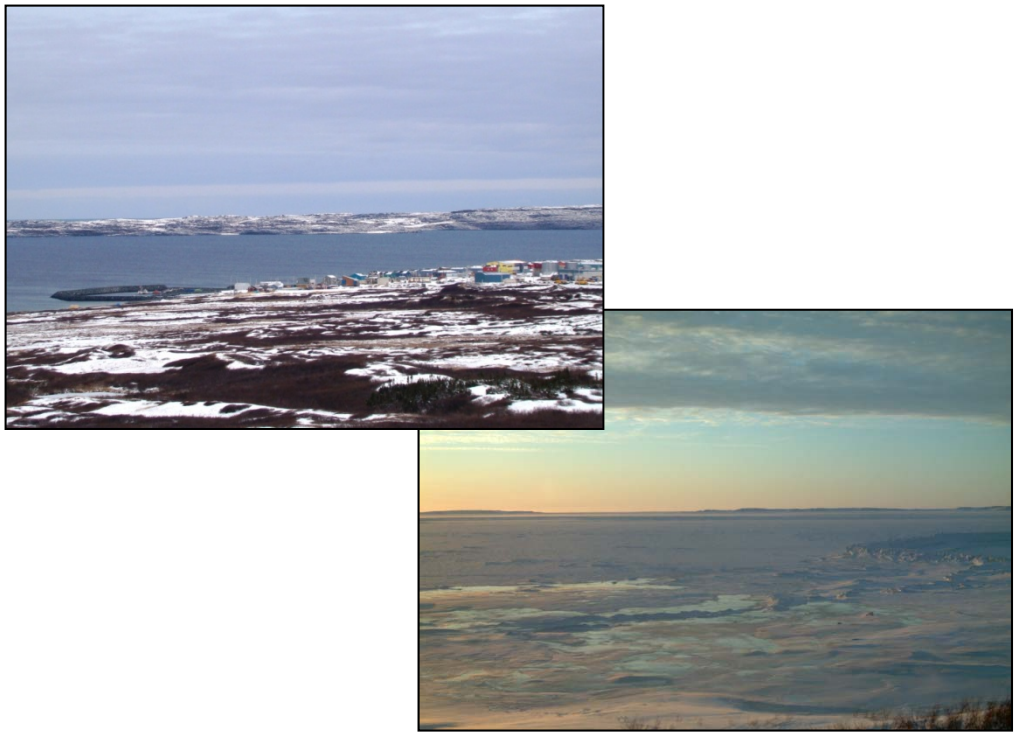
Moreover, the two marine infrastructures built in Quaqtaq offer limited access, especially at low tide. It is difficult to estimate exactly the proportion of Quaqtamiut that use them but in view of the opinions expressed during the workshop, the population is divided on this issue. One of the major problems associated with the breakwaters is the difficulty in launching rescue boats at all times. Lastly, various remarks and recommendations were expressed by the residents of Quaqtaq who were present at the November 2009 and 2010 workshops:

- Quaqtamiut would have liked it if the public consultations held before the construction of the marine infrastructures had taken into consideration their local needs, which was not the case according to them. They state that the engineers did not take into consideration their suggestions and that their ideas were ignored;
- They would appreciate that stairs be installed outside the enclosure of the first infrastructure;
- The mayor would like to have access to the photographs taken by cameras on an internet site;
- The elders suggest that scientists carefully observe the behavior of the ice at the time of freeze-up and break-up as well as the tide cycles before making changes to the infrastructures. For example, construction of the infrastructures began while there was still some ice, which seems to them not to be the best time.

3. Study of the behavior of sea and lake ice close to marine infrastructure in Umiujaq, Nunavik – Local expert knowledge and community perspectives.

Consultation workshop: February 2010

Validation workshop: November 2010



3.1 Abstract

A workshop was held in Umiujaq (Nunavik) with local experts, from February 2 to 4, 2010, to gather local expert knowledge on the environment. On November 24th 2010, a validation workshop was conducted with the same experts to verify information presented in this report. Discussions in these workshops focused mainly on the marine and continental environment of the southeast portion of Hudson Bay and in particular in the Lake Guillaume-Delisle area. The emphasis was focused on freeze-up and break-up processes, the sea and river ice regimes, the water levels, the climate, the currents and the river flows. Throughout the workshops, the Inuttitut terms associated with these themes were documented when possible. In the area of Umiujaq, sea ice generally appears two to three weeks after river ice and ends up forming solid pack ice for a month approximately (generally March) between Kuujjuarapik, Sanikiluaq and Umiujaq. Freeze-up begins, on average, six weeks later than when it did each year fifty years ago and has been more acutely delayed since the 1990s. The presence of the Nastapoka Islands and Lake Guillaume-Delisle and strong currents supports the existence of unstable areas. This is the reason why these areas are subject to the appearance of cracks and ice pile-ups as well as the persistence of ice-free areas . In the spring, the melt usually begins in mid-May, approximately six weeks earlier than it did each year fifty years ago and lasts from three to four weeks in duration. Sea ice today is less protected and stable because many climatic and maritime factors, such as the reduction of the snow cover, the increase in temperatures and the thinning of the ice, have changed. Moreover, the local experts estimate that the amplitude of the spring tides has increased and that their impact is more important when associated with violent winds, themselves on the increase. At the same time, atmospheric systems have become unpredictable and today spring, summer and fall are cooler while winter is generally warmer in the Umiujaq area. Local hunters explain that many species have already modified their migration routes. The participants to this project themselves have had to change the use of many of their winter routes because of the increase in unstable areas. Marine infrastructure is used by a majority of the community and maintained occasionally by the municipality. Similar to the rich data individuals provide about the land and travel routes on the sea ice based on their observations and experiences, Umiujamiut share knowledge and observations of climate related changes

today, and anticipated for the future, that have implications for marine infrastructure in the community as well. This knowledge represents concrete and valuable information on the topic.

3.2 Participants

To document local expert knowledge of Umiujamiut, a group workshop was organized on February 2, 3 and 4, 2010 in a classroom at Kiluutaq School in Umiujaq. Directed by Kaitlin Breton-Honeyman (Trent University) and accompanied by Stéphanie Bleau (INRS-ETE), Clément Clerc (INRS-ETE) and Mélissa Gagnon (ARK/KRG-Kuujjuaq), the workshop was held in English and translated into Inuttitut by Annie Kasudluak (ARK/KRG-Umiujaq). Noah Inukpuk, Jobie Crow, Willie Kumarluk and Davidee Sappa (new mayor of Umiujaq) were the experts present during the workshop (Figure 3-1). In addition, Daniel Kumarluk and Joshua Sala participated in individual interviews and this information was added to the qualitative data presented here (Figure 3-2). In all, there were six participants with many years experience of the Lake Guillaume-Delisle region who participated to the workshop. They have all lived in the community for 24 years i.e. since the construction of the village in 1986. Moreover, most were originally from Kuujjuarapik (on the shores of Hudson Bay, south of Umiujaq) or Sanikiluaq (on the Belcher Islands, west of Umiujaq, in Nunavut) and have always lived in the southeast area of Hudson Bay or close to Lake Guillaume-Delisle.



Figure 3-1: From left to right: Willie Kumarluk, Davidee Sappa, Jobie Crow, Noah Inukpuk, Annie Kasudluak (interpreter) and Clément Clerc in a classroom at Kiluutaq School in Umiujaq (photo, M. Gagnon, 02/2010)



Figure 3-2: Joshua Sala sharing his knowledge with Kaitlin Breton-Honeyman during an individual interview carried out at the Umiujaq Coop-Hotel (photo, C. Clerc, 02/2010)

Consequently, on November 22 to 26, 2010, the information and maps produced were validated with the Umiujamiut elders who had participated in the group workshop. Noah Inukpuk, Jobie Crow, Willie Kumarluk and Davidee Sappa participated to the vaidation meeting (Figure 3-3). Conducted by Kaitlin Breton-Honeyman (Trent University), with Stéphanie Bleau (INRS-ETE), Clément Clerc (INRS-ETE) and Mélissa Gagnon (ARK/KRG), the validation workshop was conducted in English and translated in Inuttitut by Annie Kasudluak and Sarah Aloupa.



Figure 3-3 : Validation workshop in Quaqtaq. Left to right: Stéphanie Bleau, Noah Inukpuk, Jobie Crow, Davidee Sappa, Willie Kumarluk et Annie Kasudluak (photo, C. Clerc, 11/2010)

3.3 Study Region and Local Marine Infrastructures

Umiujaq is one of the 14 communities of Nunavik distributed along the coasts of Hudson Bay, Hudson Strait and Ungava Bay (Figure 3-4). The village is situated on the east coast of Hudson Bay in the Eastern Hudson Bay arc approximately 500 km west of Kuujjuaq, capital of Nunavik, and 1 200 km north of Montréal. The closest communities are Kuujjuarapik (160 km south) and Inukjuak (230 km north) both located on the east coast of Hudson Bay.



Figure 3-4: Location of the study region in relation to the other communities of Nunavik. The area outlined in green corresponds to the administrative limits of Nunavik.

The village of Umiujaq was established in 1986 at the foot of a hill that looks like an *umiaq*, a traditional Inuit boat constructed with walrus or seal skin. Located close to the northern tree line, the surroundings of the village are relatively hilly and readily accessible. A trail accessible by vehicle, approximately 15 kilometers long, joins Umiujaq to Lake Guillaume-Delisle (*Tasiujaq* in

Inuttitut), a veritable inland bay of brackish water linked to Hudson Bay by a narrow channel where onshore tidal movements generate a zone of very strong currents (Nunavik Tourism Association, 2010). Large cliffs and beaches border the west bank of the lake. With the added benefit of its richness and abundance of wildlife, these characteristics confer to the lake immense beauty. Tursujuq Provincial Park, which covers lakes Guillaume-Delisle and à l'Eau Claire, will be officially completed in the near future. The brackish waters give this immense lake a marine environment ideal for a good number of bird and fish species and marine mammals such as seals and beluga whales. Additionally, offshore from Umiujaq, the string of islands formed by the Nastapoka Islands (called cuestas by geomorphologists) hosts a large number of colonies of marine birds. A little over 100 km inland, Lake à l'Eau Claire is also favored by Inuit and Cree because of the abundance of fish species and access to caribou during their migration. This is why, located at such a crossroads of territories rich in resources, the Lake Guillaume-Delisle region has always been inhabited and used by Inuit (Figure 3-5).

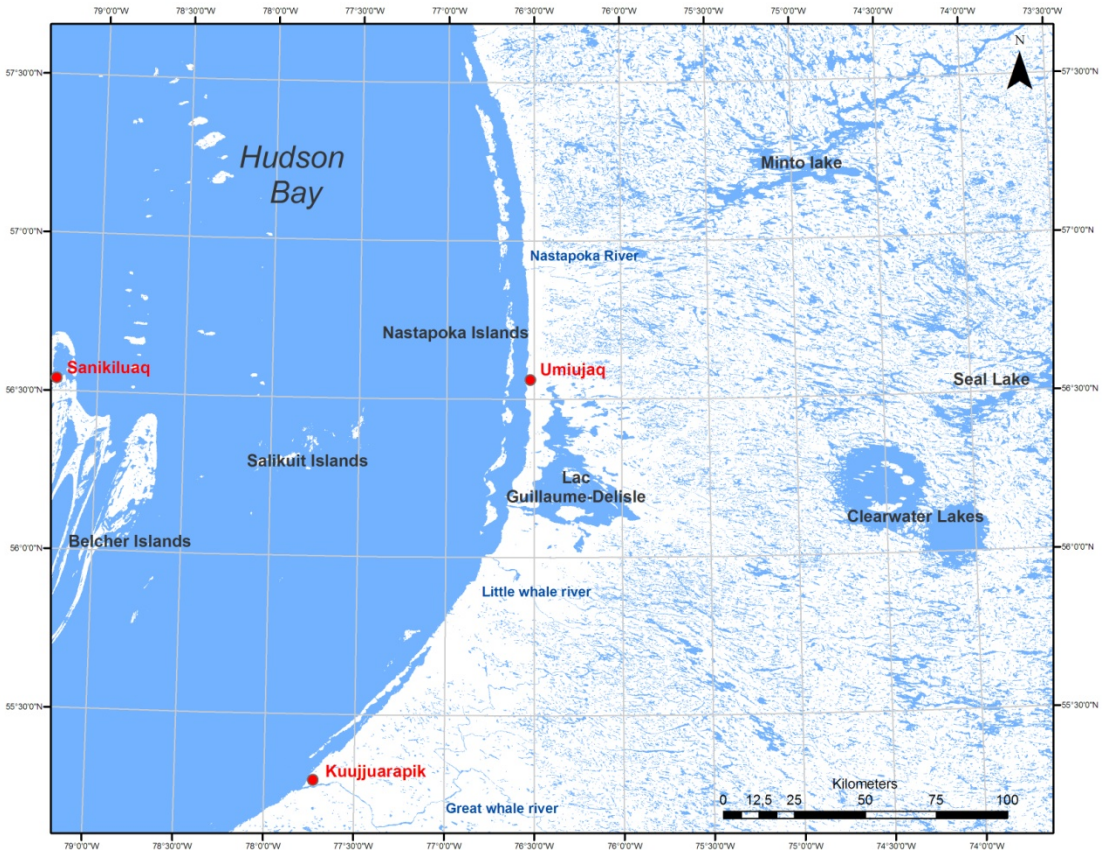


Figure 3-5: Locations and names of the main sites in the greater area of Umiujaq and lake Guillaume-Delisle.

The most recently created community in Nunavik, Umiujaq was rapidly populated at the end of the 1980s by Inuit families originating from Kuujjuarapik reducing that community's population by approximately one-third (Martin, 2005). These families established in Umiujaq at that time in order to preserve a certain traditional way of life faced with the potential construction of a hydroelectric complex on the La Grande Rivière de la Baleine. The project was postponed in 1994 by the Government of Québec but the James Bay and Northern Québec Agreement signed in 1975 had planned to give the Inuit of Kuujjuarapik the opportunity to build a new community close to Lake Guillaume-Delisle, where wildlife would be less affected by the large hydroelectric development. Although construction of the village is recent, it seems that its' history is much longer since the families that established the community were, for the most part, families that already frequented the trading posts of Petite Rivière de la Baleine and Lake Guillaume-Delisle (Martin, 2005). The population of Umiujaq was the object of an important demographic increase over the last few years, growing from 260 inhabitants in 1995 to 390 in 2006 (Statistics Canada, 2010) and may number closer to 441 residents today, the majority of which are Inuit (Répertoire des municipalités du Québec, 2010). Similar to other communities of Nunavik, resource and service management is shared between many organizations such as the Kativik Regional Government (KRG or ARK), the Makivik Corporation, the Fédération des Coopératives du Nouveau Québec (FCNQ) and, at a more local scale, the Landholding Corporation (Corporation Foncière) and the Municipality of Umiujaq.

In each Nunavik village, marine infrastructures were built in the early 2000s following an agreement signed in 1998 between the federal government and the Makivik Corporation. The objective of this agreement was to facilitate access to the sea for fostering economic development and hunting, fishing and livelihood activities. In Umiujaq, the infrastructure was built in two phases. Phase I was carried out in the summer of 2001, during which the main breakwater, a secondary breakwater, and an access ramp and service area for meeting community needs were erected. Phase II was carried out during the summer of 2008 and responded to specific needs of the sea lift while improving the infrastructure in place following feedback from Umiujamiut. The main breakwater was thus lengthened and another secondary breakwater was built to create an access ramp designed only for sea lift. The service area was also expanded and floating docks were installed in the basin to provide access to boats (Personal communications, Makivik Corporation, 2009). Figure 3-6 and Figure 3-7 show a Google Earth

video screen capture of the marine infrastructure, however likely due to the date of satellite imaging, the improvements carried out in 2008 do not appear.



Figure 3-6: Aerial view of the breakwater in relation to the village of Umiujaq (Google Earth video screen capture, 02/2010)



Figure 3-7: View of the breakwater looking west (photo C. Clerc, 10/2009).

3.4 Ice Cover

3.4.1 Formation and Evolution of the Ice in the Umiujaq Region

Umiujamiut explain that the first signs of the arrival of winter appear on the continent in the freshwater systems. Ice begins to form on the lakes and rivers during November preceding by at least two to three weeks the beginning of freeze-up in the marine environment, i.e. in Hudson Bay (Figure 3-8). A mixture of salt water from the bay and a contribution of fresh water from numerous waterways, the brackish waters of Lake Guillaume-Delisle begin to freeze in November, one to two weeks before the new ice appears along the coast. Some experts say that it is not rare at this time of the year to see ice chunks exit from the Goulet of Lake Guillaume-Delisle and move northward between the Nastapoka Islands and the continent.

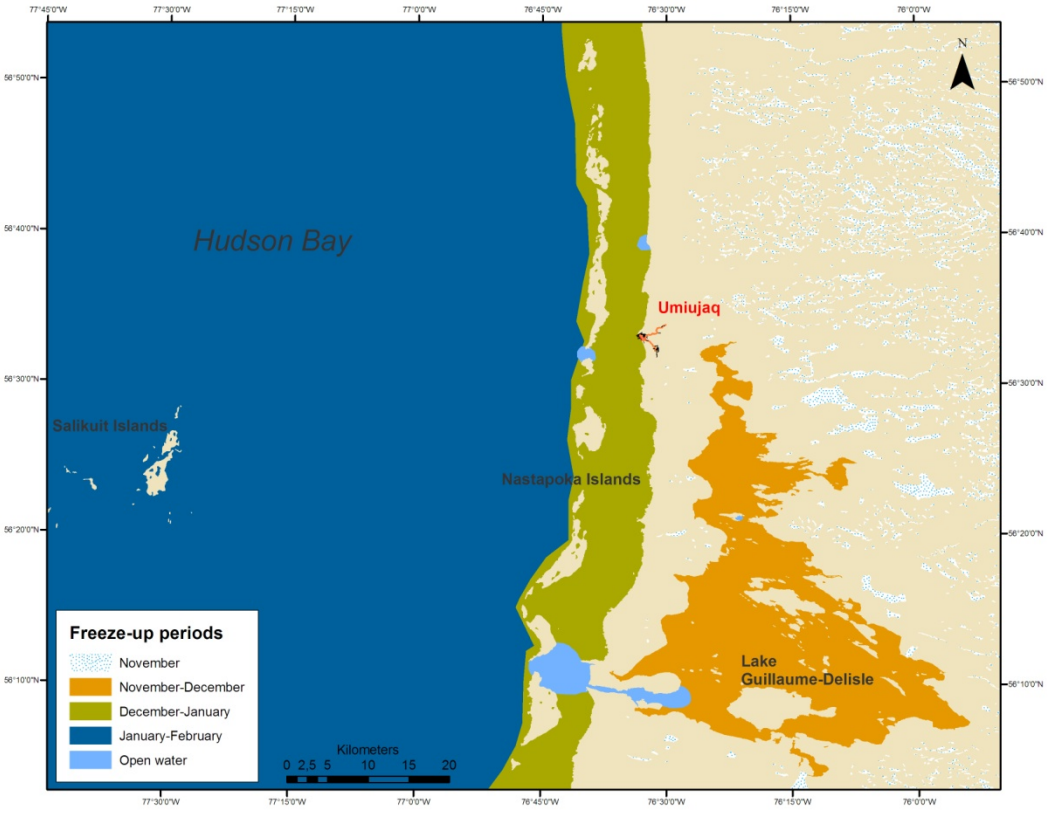


Figure 3-8: Freeze-up periods for the coastal region of Lake Guillaume-Delisle (average over the last forty years).

The formation process of the pack ice in Hudson Bay happens in many phases and it can take a few weeks before formation of fast ice that is solid and safe for travel. At first, waves generated by heavy winds from the west push the slush accumulated at the surface of the water (*matsaq* or *qinu* in Inuttitut) in the direction of the coast. During cold weather, the latter adheres to the sand, rocks and points along the coast and forms a sheet of hard ice that will remain and thicken (*qaiguitt)*. Umiujamiut call this process *quingusattut* (Figure 3-9). It is the beginning of the formation of fast ice between the Nastapoka Islands and the continent (*kangilinik*). It should be noted that at the beginning of the formation, strong winds from the east can loosen this ice accumulation layer (Figure 3-10). The second stage of the formation of fast ice arrives with the lowering of temperatures. Fog appears at the surface of the water indicating that it is cooling and that a first layer of fine ice (*siguliak*) is forming on the surface (Figure 3-9 and Figure 3-10). Umiujamiut call this phenomenon *qisututuk* (or *qisuq*). When this layer of ice forms during calm weather, they talk of *amiartuq*. If the weather is very cold, this layer can become thick enough within one or two nights that a person can walk on it very carefully. This ice, broken or not by the winds, thickens as winter progresses (Figure 3-11 and Figure 3-12). The residents of Umiujaq call *tuuvaqtuq* the process of thickening that brings about the formation of solid and fixed fast ice that they call *tuuvaq* (Figure 3-12).



Figure 3-9: Ice accumulation on the shoreline under the action of waves (*quingusattut*) near the Umiujaq breakwater (photo Reconyx camera, 12/11/2009, ext. T°: -5°C).

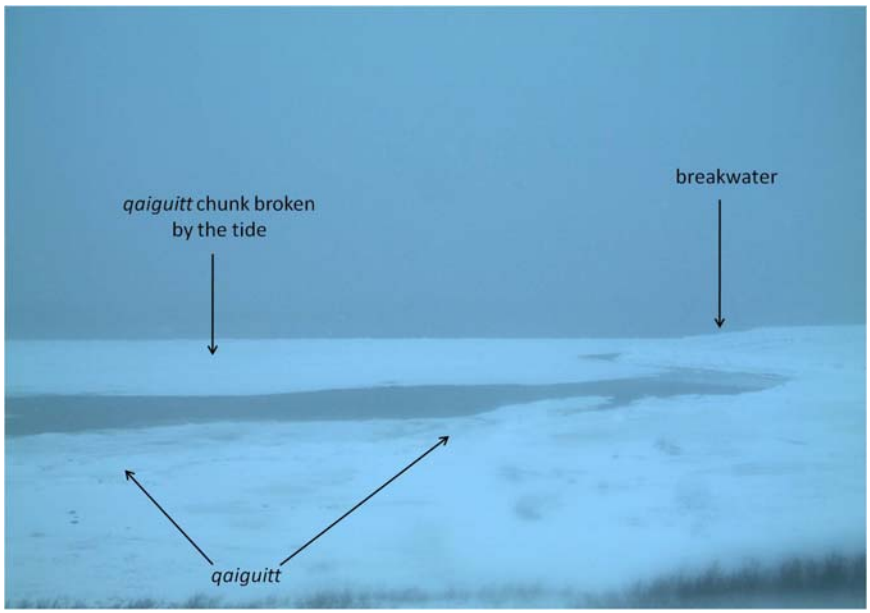


Figure 3-10: Formation process of a fine ice sheet (*siguliak*) in foggy conditions, called *qisuttuk*. It should be noted that a portion of the ice already attached to the shoreline has detached itself with the onshore tidal movements and is moving out to sea. (photo Reconyx camera, 12/22/2009, ext. T°: -6°C).

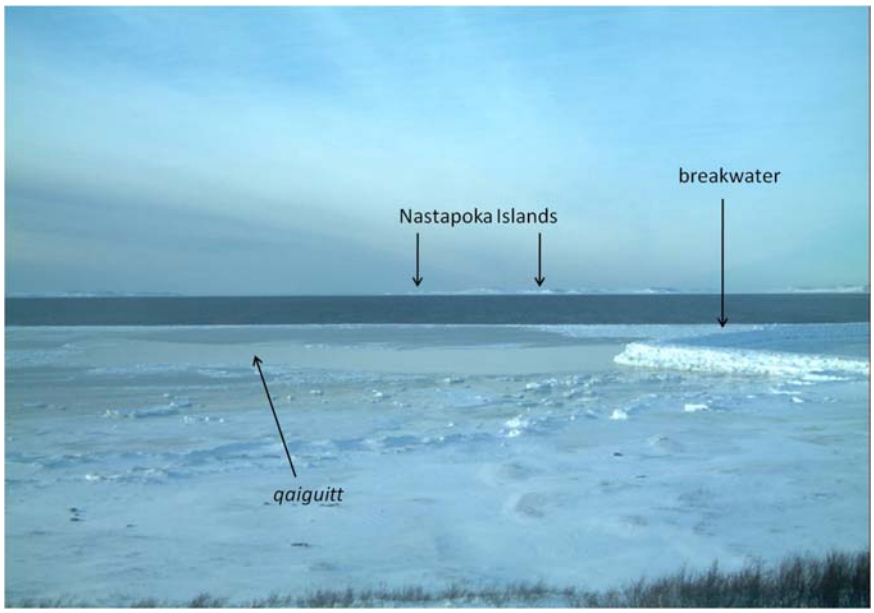


Figure 3-11: At the same time as the landfast ice (*qaiguitt*) continues to move west, it thickens to form in the end compact fast ice all the way to the islands. It should be noted that the chunk that had broken off was reunited by the formation of an ice sheet between it and the shore (photo Reconyx camera 12/26/2009, ext. T°: -10°C)

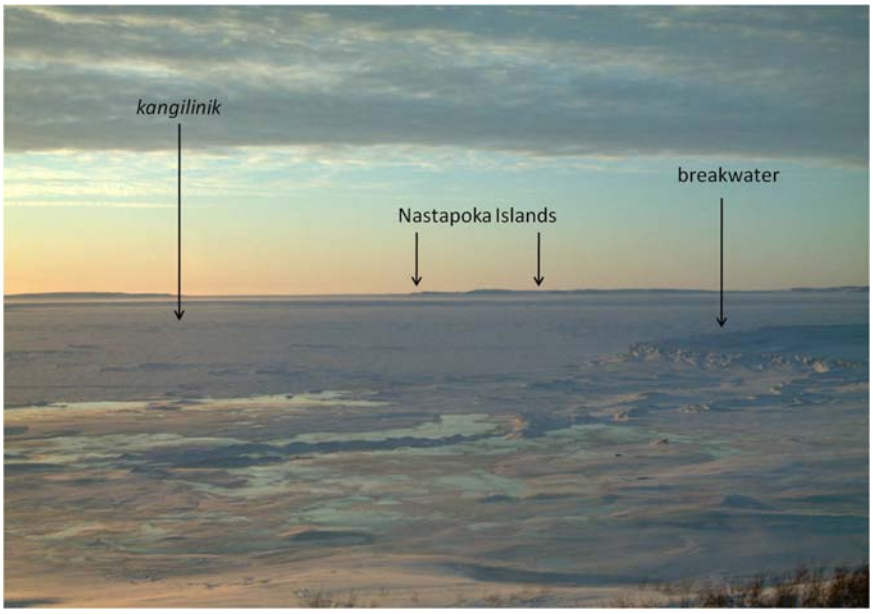


Figure 3-12: Final compact fast ice (tuuvaq) here between the continent and the Nastakopa Islands where Umiujamiut call it specifically kangilinik. (photo Reconyx camera, 01/22/2010, ext. T°: -17°C)

Firstly, the fast ice is fixed and stable by the end of December (*kangilinik*) (Figure 3-8) in between the Nastapoka Islands and the continent. In January, the bay remains open beyond the islands and is occupied by large mobile ice floes (*siquttinik*). Ice beyond the islands is called *Killiniq*. Only a strip of fast ice measuring a few tens of meters wide remains attached to the western shoreline of the islands. At that time of the year, numerous cracks (*aajurak*), oriented north-south, form along the Nastapoka Islands. Moreover, an area remains dangerous rather regularly northwest of the islands (Figure 3-14). Depending on the year, the currents, the onshore tidal movements and the extent of the fast ice, one or more cracks can appear at this spot. As winter progresses, a block of compact fast ice ends up by forming in the southeast half of Hudson Bay, between the Belcher Islands, the north of the Nastapoka Islands and the continent (Figure 3-14). This block called *tuuvaq* includes the fast ice between the continent and the Nastapoka Islands (*kangilinik*). Umiujamiut experts explain that the formation of this fixed fast ice is possible since in this portion of the bay (i.e. between Kuujjuarapik, Umiujaq and Sanikiluaq) marine currents are not as strong. This immense floe remains fixed during part of the winter (from mid-February to the end of March depending on the year) but can break up if the weather warms up. The rest of the bay is generally occupied by large mobile floes (Figure 3-13 and Figure 3-14) that can be more or less secure from one year to another. Moreover, there are many areas in the Lake Guillaume-Delisle region that remain free of ice all winter long (Figure 3-15). For example, the mouth of the lake in the form of a channel is one area where the ice does not form except rarely when the weather is calm, but it never stays for very long. The changing circulation of the currents is the main cause for the open area. Umiujamiut experts explain that water enters the lake during the rising tide and exits the lake with the descending tide. In the channel, the currents are so strong that it is not rare to see blocks of ice being drawn to the bottom and resurfacing offshore.

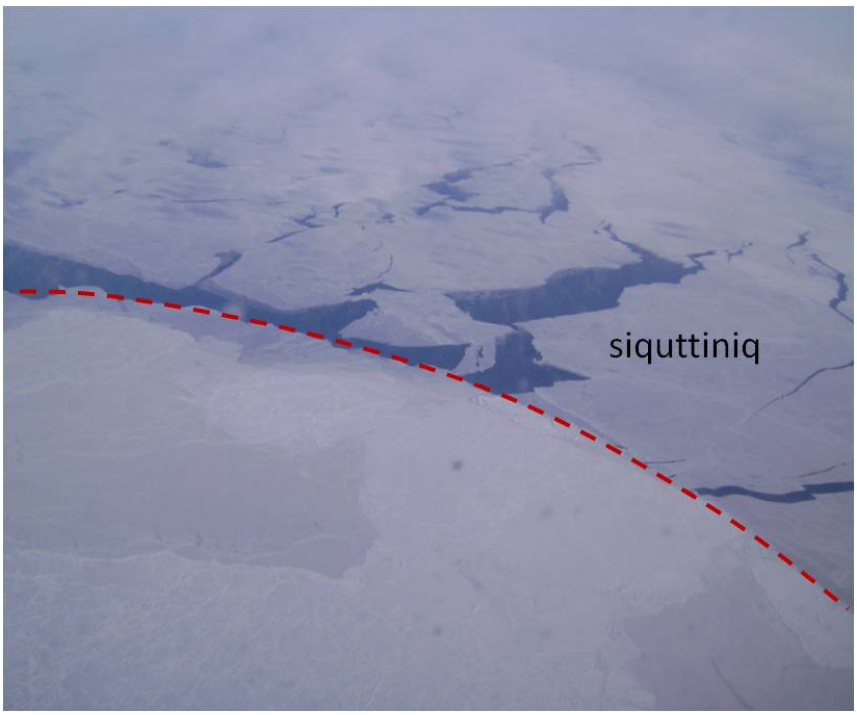


Figure 3-13: Above the red line large mobile ice floes (*siquttiniq*) in Hudson Bay. Photo taken between Kuujjuarapik and the Belcher Islands (02/2010, K. Breton-Honeyman).

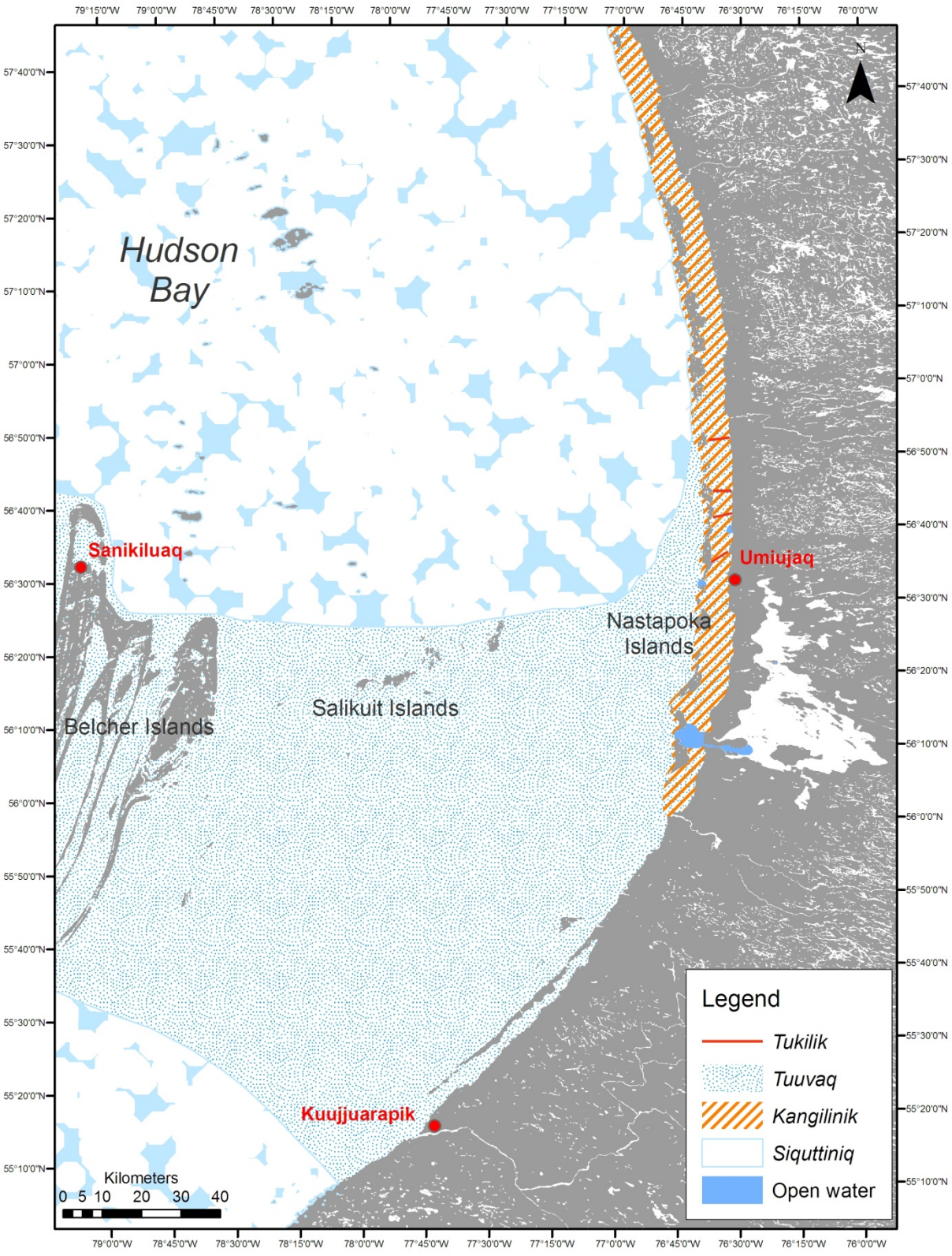


Figure 3-14: Distribution of the main ice forms in the southeast half of Hudson Bay.

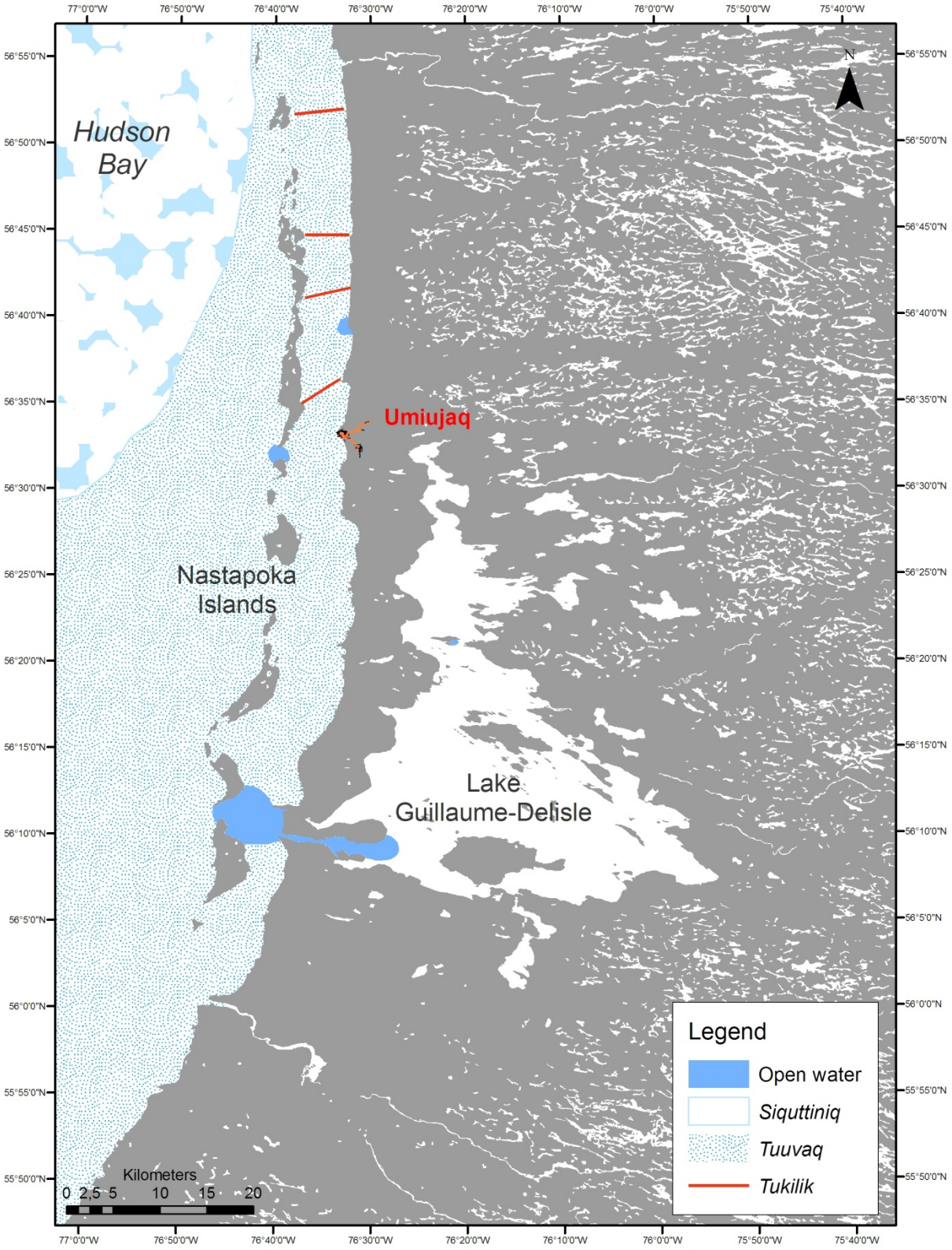


Figure 3-15: Ice-free areas and other ice forms in the Lake Guillaume-Delisle region.

The local experts say that some 40 or 50 years ago, sea ice began to form around mid-November. However, since the beginning of the 1980s, freeze-up seems delayed each year to a point that since the beginning of 2000, sea ice does not start to form before the middle or the end of December. For example, in the early 1960s, the first ice accumulations on the shore (Figure 3-9) were observed as of October. Nowadays it is rarely before December. During the last winter (2009-2010), freeze-up started at the end of December and at the time of the workshop (i.e. early February, 2010), Umiujamiut indicated that freeze-up was not yet fully completed. This meant that all the regular harvesting areas were not yet accessible, with some areas still being ice-free or with ice much thinner than usual. During the validation workshop (November 2010), the same elders explained that the arrival of the winter was more delayed than in fall 2009 and that during a flight on November 22nd 2010, the lake Guillaume Delisle was completely ice-free, a phenomenon observed for the first time by all present. Today, on the average, sea ice begins to form six weeks later than this period fifty years ago (some say that since the mid 2000s, it's almost 2 months later). Even more so, the elders present at the workshop agreed that this delay tends to have increased exponentially over approximately the last dozen years (i.e. the end of the 1990s).

To illustrate their remarks, the local experts provided many examples of situations that used to occur but no longer occur today:

- In the past, it was not rare that one inch thick ice could form within one night;
- Before, solid fast ice (*tuuvaq*) was safe for travel as soon as January; today, it is not generally safe except during March;
- The sea ice appears to have changed color around the village and seems today to be slightly more yellowish;
- Davidee Sappa remembers that when he was young, around 1967-1968, at the end of October, he could play hockey on the ice of the La Grande Rivière de la Baleine;
- In the past, hunters could usually begin to hunt for fox on the rivers from November 1st;
- In the Goulet of Lake Guillaume-Delisle, the area of ice-free water or with very fine ice has considerably expanded since the 1980s (Figure 3-16).

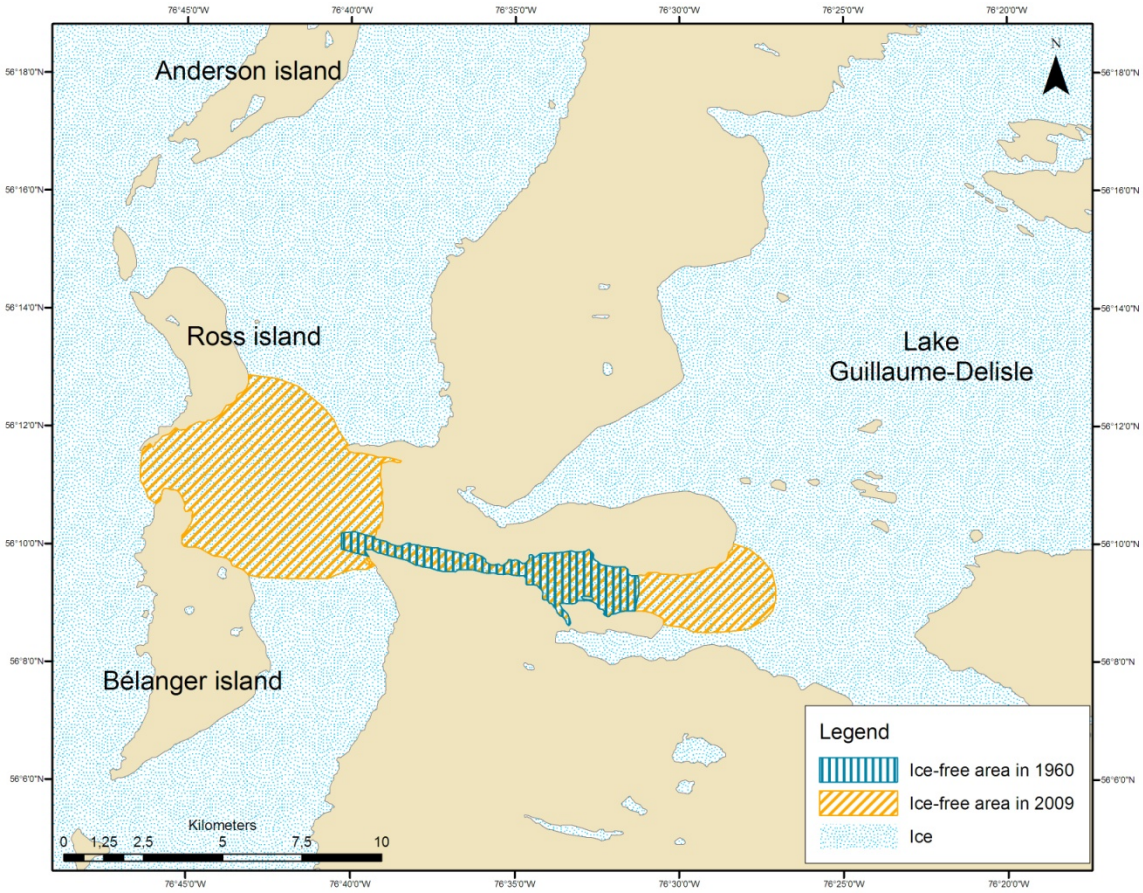


Figure 3-16: Evolution of the ice-free area in the Goulet of Lake Guillaume-Delisle, between the years 1960 and the end of the years 2000.

Moreover, the local Umiujamiut enumerate many factors that could explain the delay in the freeze-up:

- The air temperature is the main factor. Consequently the water temperature, is warmer than in the past;
- The sharp decrease in precipitation as snow in autumn is an important parameter which, among others, helped to reduce the ice thickness since the years 1960-1970.In the past, the large quantities of snow that fell between September and December were pushed towards the east coast of Hudson Bay and encouraged the rapid formation of thick ice. Many elders insisted on the fact that the decrease in the ice thickness has also accelerated since the 1980s;
- The local experts finally explained that this delay could also be partly explained by changes in the wind patterns during the fall. The wind has considerably changed since

the years 1990-2000. Before, strong winds from the west dominated during ice formation. Today, the direction and strength of the winds are completely irregular and unpredictable during the fall and at the beginning of winter.

Table 3-1: Important points concerning ice formation and evolution.

- Lake ice forms 2 to 3 weeks before sea ice.
- Formation process of solid fast ice or *tuuvaq*:
    - *Qaingusattut*: accumulation of *matsaq* on the shoreline and formation of landfast ice (*qaigiutt*);
    - *Qisututuk*: formation of thin ice *siguliak;*
    - *Tuuvaqtuq*: thickening of the ice.
- Fast ice is called *kangilinik* between the Nastapoka Islands and the shoreline and *killinig* offshore islands.
- *Siquttiniq*: mobile ice floes, *tukilik*: cracks in the ice during winter and *aajurak*: cracks in the ice during spring.
- During at least one month, fast ice becomes fixed between Kuujjuarapik, Sanikiluaq and Umiujaq. Rarely observed in recent years.
- The formation of sea ice occurs 6 weeks later than 50 years ago and is delayed more and more since the years 1990-2000.
- Factors responsible of the delay: increase in temperatures, thinning of the ice and changes in wind patterns in fall.

3.4.2 Stability of the Pack and Safety during Winter

The Lake Guillaume-Delisle region is a very heterogeneous environment encompassing an immense brackisk water lake, numerous fresh water lakes and rivers and a unique shoreline environment where cuestas face the continent. The local experts report that these conditions are responsible for the coexistence of both safe and unstable areas. Moreover, they estimate that since the 1990s the environment has become more unstable and travel on the ice more difficult to anticipate. For example, the thickness of the snow cover is a determining factor for safety. However, these last few years, precipitation patterns in the region seem to have been largely disturbed. The elders add that in Umiujaq, the majority of hunters have noted that many areas have become increasingly unsafe since the year 2000.

Within the first weeks of the formation of fast ice, certain areas can be safe to travel on foot or on snowmobile, while others remain dangerous. The elders via the HFTA (Hunting Fishing and Trapping Association) generally look at ice conditions and communicate this information to the rest of the community, usually by radio. They check the thickness of the ice with a harpoon or by the sound ice returns when they move around on snowmobile. Depending on the season and the stage of formation of the ice, ice can also show a variety of colors that define its thickness and resistance thus providing information hunters can use to plan their movements.

Although the ice starts to form in December, fast ice is not generally stable before the first or second week of January between the shoreline and the Nastapoka Islands. Nowadays, it takes two or three months before the ice becomes enough safe and one month less if the weather is very cold for a long. The elders explain that in December they can usually already travel on snowmobile on Lake Guillaume-Delisle while they still travel by canoe along the shoreline. However, note that in the 1950s and 1960s the sled dogs teams' could go on the lake in November. The safest month of the year for travel is March. At that time of the year, the fast ice reaches its maximum thickness and it forms a stable triangle between Umiujaq, Sanikiluaq and Kuujjuarapik. It should be noted that in the past this area was solid and safe starting in January or February. Moreover, Umiujamiut interviewed were somewhat divided when it comes to the stability of the fast ice and the risks one faced when traveling on it. One person recounted having traveled to the Salikuit Islands on snowmobile twice over the last years. This was at the

end of February or the beginning of March. Nevertheless, he said that this is not possible anymore because the ice is more unstable and more sensitive to the marine currents close to the islands. The thinning of the ice could be the main reason. Others confirm that in recent years land fast ice (*tuuvaq*) is being replaced by mobile ice floes (*siquttiniq*). According to them, an increase in current strength is added to the thinning of the ice in the Hudson Bay.

Many areas remain ice-free most of the time during winter (Figure 3-15). The Goulet of Lake Guillaume-Delisle is the best example and remains a very dangerous area. For example, up till the 1980s, lake residents could travel between the Goulet and Ross and Bélanger islands that face them (Figure 3-16). Today, they have to use new trails (Figure 3-28). Some even recount that they passed sometimes in the gulch on snowmobile and this up to the 1990s. South of Lake Guillaume-Delisle, a dangerous area persists from the beginning of freeze-up until March. As in the case of fast ice, at this time the ice is only safe for approximately for one month. Other areas of open water open up occasionally when strong winds blow from the northeast or because of the onshore tidal movements or the strength of the currents. Umiujamiut call aajurak the cracks that open up west of the Nastapoka Islands while the limit between the water and the ice is called *sinaa* (Figure 3-17). The points along the shoreline or the Nastapoka Islands and the mouths of the rivers are the most favorable areas for the occurrence of cracks and openings in the ice specially at the time of freeze-up and melting in the bay (Figure 3-18). High tides encourage the infiltration of water in the ice that mixes with the snow and causes the more rapid thinning of the fast ice in these areas.

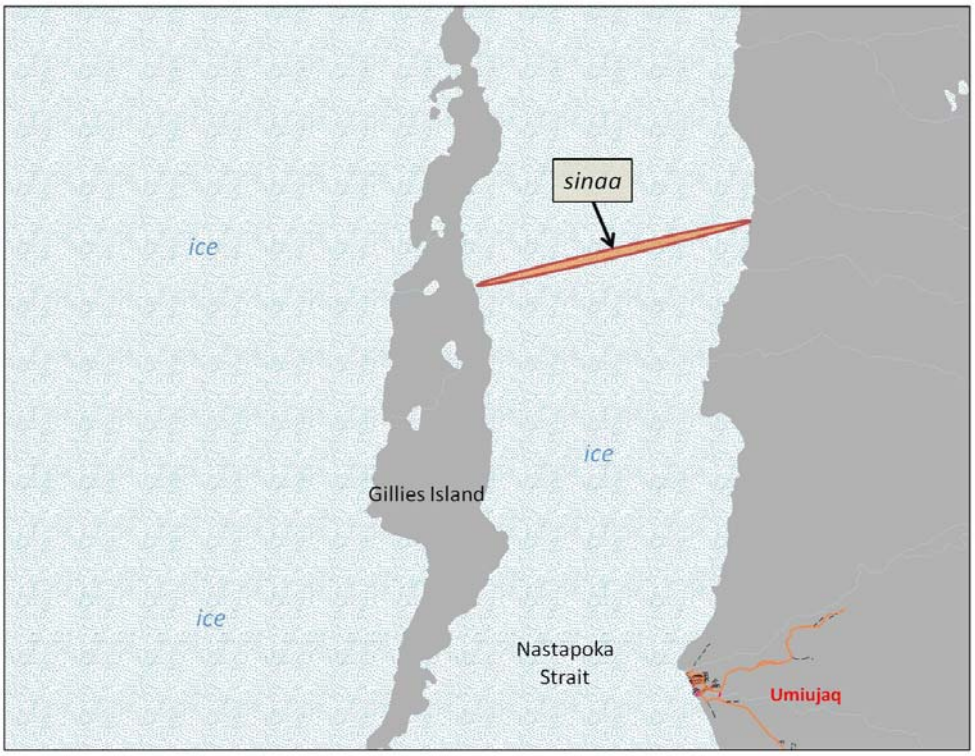


Figure 3-17: Schematic representation of the Inuttitut terms associated with the appearance of a crack (*tukilik*) in the fast ice off the Nastapoka Islands.

Pile-ups of ice blocks or overlapping of floes are regular occurrences in the region especially because of the presence of the Nastapoka Islands. Winds from the northwest, onshore tidal movements or marine currents are factors that can generate pressure ridges or overlapping of ice floes. The west coast of the Nastapoka Islands is an area often prone to the appearance of pressure formations (Figure 3-18). Umiujamiut report that it is not rare to see ice floes move up on the shoreline and form pile-ups (*ivuniq*). Some experts suggest that these are smaller in size and appear less regularly since the end of the 1990s.

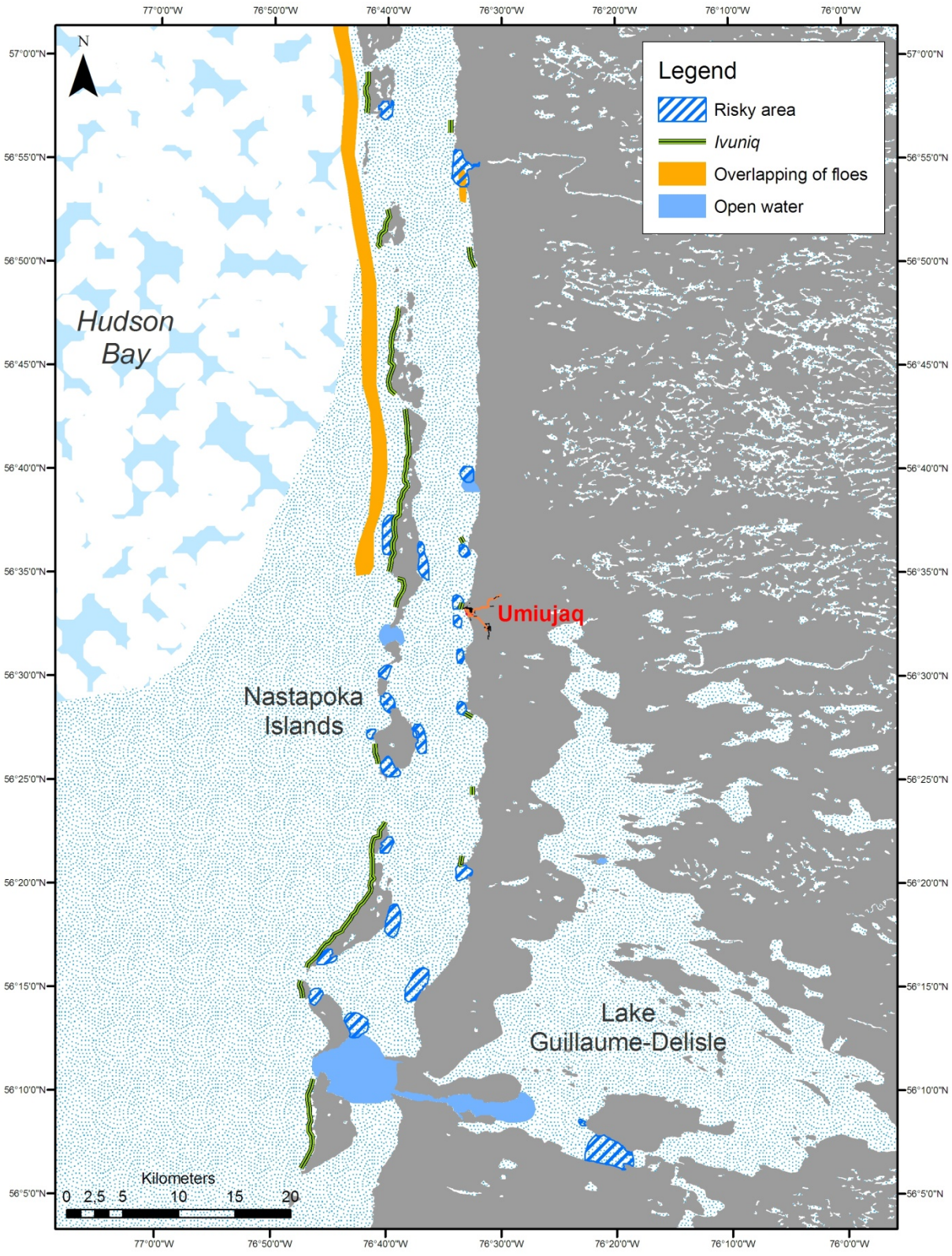


Figure 3-18: Distribution of dangerous and unstable areas that appear during winter in the Lake Guillaume-Delisle and Nastapoka Islands.

Table 3-2: Important points concerning the stability of the pack ice during winter.

- There are more unstable areas since 1990-2000.
- The elders communicate the thickness and quality of the ice at the beginning of winter to the rest of the community.
- Fast ice is usually stable between mid-January and the end of March, depending on the conditions.
- March is the month when it is the safest, but in the past it was as early as the month of January.
- The Nastapoka Islands are responsible for the existence of unstable and open water areas as well as the appearance of overlapping, pile-ups or cracks in the ice.

3.4.3 Spring Break-up

The local experts explained that the start of the melt can occur between the end of April and mid-May and last until June, though usually break-up begins around the second or third week of May. It takes at least three to four weeks for the melt to complete. The elders of Umiujaq recount that in the 1950s, break-up began at the end of June and ended in mid-July. Therefore the melting of the ice occurs roughly six weeks earlier than sixty years ago. At the same time, Umiujamiut have noted that the duration of the break-up had considerably shortened over this period. The melting process of the fast ice is rather simple and depends on the following combination of factors:

- the strength of the winds that generate waves;
- onshore tidal movements;
- solar radiation;
- the air and water temperature;
- the thickness of the snow cover;
- the action of marine currents.

Generally, water holes appear first where the ice is thinner. This is the reason why the first areas affected by the melt are generally the most unstable areas during winter (Figure 3-18). Further on, the combination of factors listed above slowly increases the size of these holes and they end up being joined together to form a larger open water area (Figure 3-19). As these openings appear, the ice floes begin to separate and to migrate to the surface of the water. The large ice floes are called *annisak* by Umiujamiut (instead of siquttiniq during winter) and the smaller fragments are called *putta* (Figure 3-20). Break-up generally begins in the south of Hudson Bay, near Kuujjuarapik and gradually moves northward. The presence of the Nastapoka Islands forces some of the floes to remain wedged for some time between them and the shoreline. The ice chunks present west of the islands can themselves move offshore at the moment they begin to separate from one another (Figure 3-20). The local experts report that in the past, the large ice floes located between the Belcher Islands and the Nastapoka Islands often remained in place until July. Since the 1980s, as soon as the pack ice breaks up, they move offshore nearly immediately. It should also be noted that the elders estimate that the pack ice is today less

protected during the melt because of the reduction in the thickness of the snow cover. The ice has a tendency to degrade itself more easily and more quickly. Finally, Umiujamiut indicate that even if the water is already free of ice in front of the village, they are still able to travel on snowmobile on Lake Guillaume-Delisle.

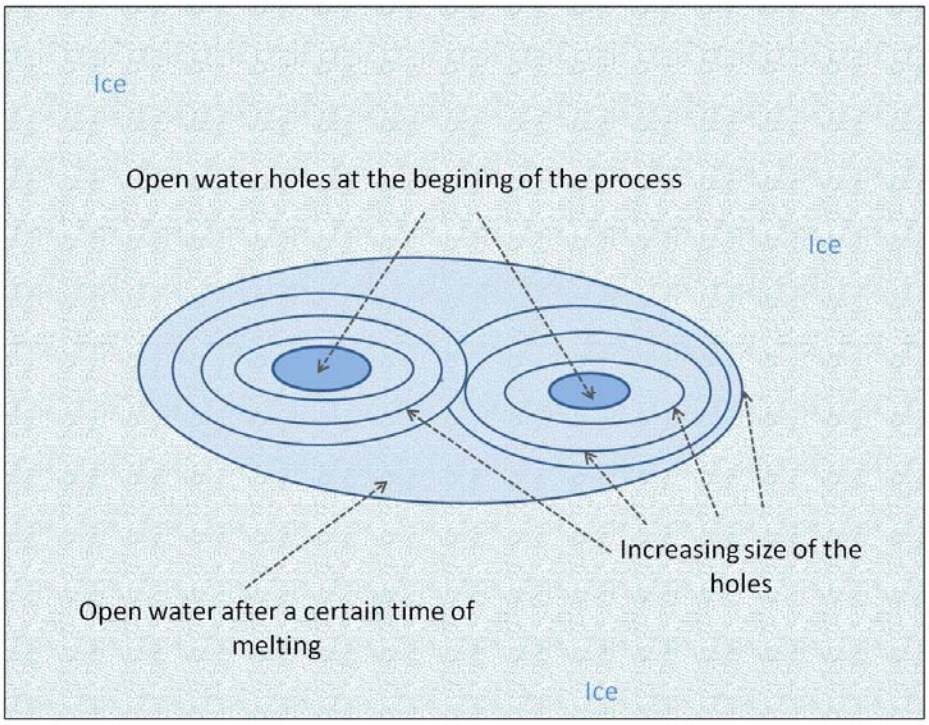


Figure 3-19: Fast ice melting process as explained by Umiujamiut experts.

Table 3-3: Important points concerning the spring break-up.

- The melt begins in mid-May and lasts 3 to 4 weeks.
- In the past, break-up began 6 weeks later.
- The melt of the pack ice is the result of a combination of many factors.
- The pack ice today is less protected during the melt because the snow cover is not as thick.

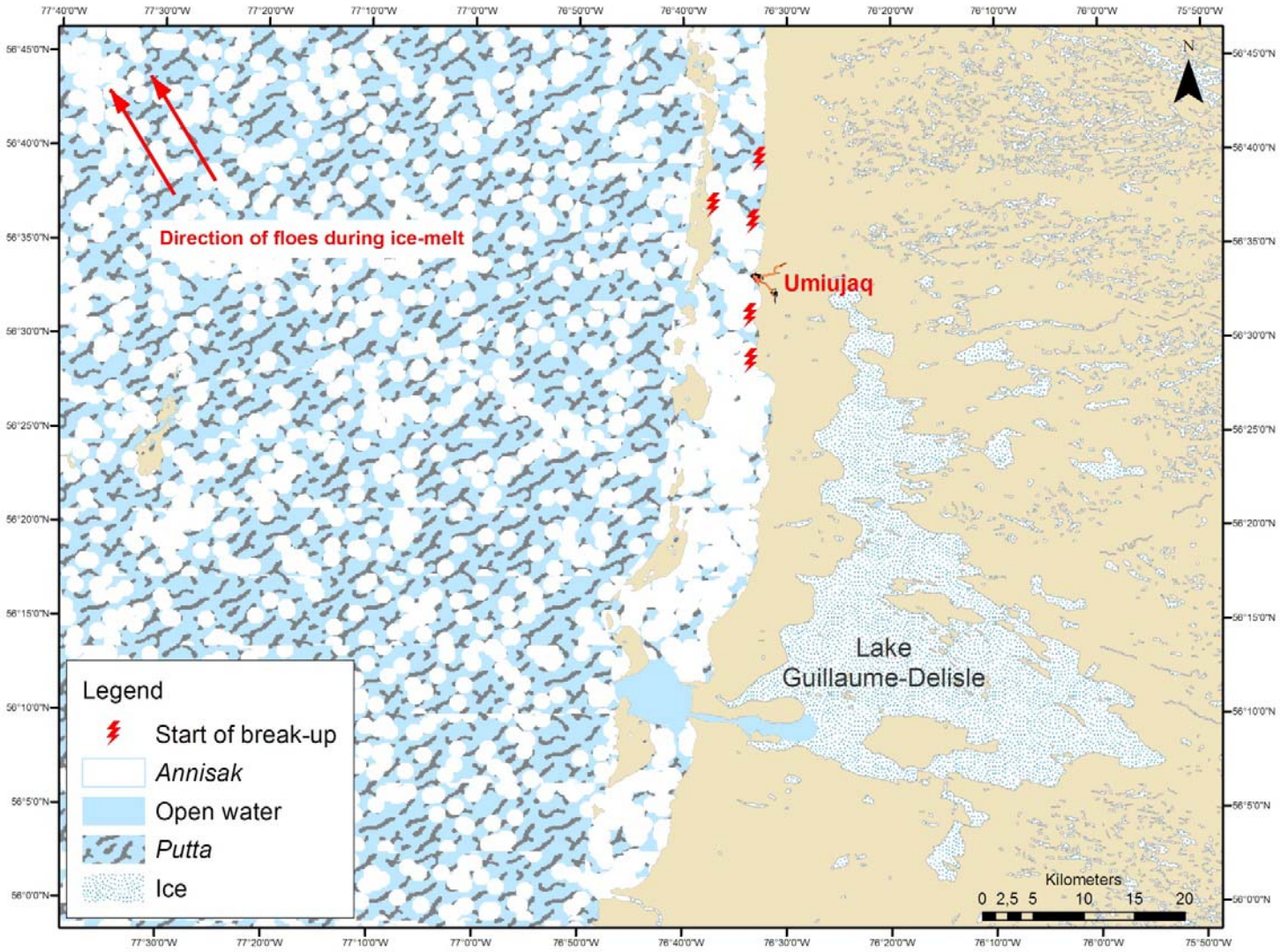


Figure 3-20 : Status of the ice-melt in the Lake Guillaume-Delisle region at the beginning of the spring melt, i.e. around mid-May.

3.5 Tides, Marine Currents, Water Levels, Shoreline and Meteorological Observations.

3.5.1 The Tides

According to the Umiujaq elders, the amplitudes of the tides today are, on average, higher than in the past. Moreover, the maximum water levels at high tides have more impacts on the erosion of the foreshore and are moving closer and closer to the homes and areas where the canoes are parked. Some experts explain that these high tides occur more often than before but when they are combined with high winds, their impact on the shoreline is more severe. They report that this phenomenon actually occurred once in the fall of 2009, around October 31 (statements confirmed by photos taken in real time (see Figure 3-24). On October 9, 2010 there was an extreme event of high tide in Nunavik, but no damage was observed near Umiujaq (only one elder said that he heard about a cabin along the shore drift into the bay, halfway between Inukjuak and Umiujaq). Finally, others mention that in general the highest tides occur at the end of October and the lowest at the beginning of November (for example, low tide is the best time to harvest mussels).

3.5.2 The Currents

At the scale of Hudson Bay, water circulation occurs in a counter clockwise manner. The main surface current enters to the northwest of the bay from the Canadian Archipelago and moves downward towards James Bay, before coming around the East coast of Hudson Bay. It then rejoins the current oriented in a westerly-easterly direction of Hudson Strait. For some elders of the community, other secondary currents could exist along the Belcher, Salikuit and Nastapoka Islands. However, those currents are calculated by observing the movement of ice floes. Note that the local experts did not all agree on these observations for the secondary currents, but they all indicated that the currents are not as strong between the Nastapoka Islands and the shoreline. At high tide, the shoreline current moves towards the north and, at low tide, it descends southerly moving along the coast (Figure 3-21).

3.5.3 The Shoreline

Umiujamiut interviewed for this project indicated that the year 1995 had the greatest levels of shoreline erosion. However, they did not notice any particular increase in the phenomenon these last decades, while featuring that erosion continues to progress. The areas indicated on Figure 3-26 are the sensitive areas to erosion near the village. The elders indicate that a small wall, 8 to 10 feet high, has replaced the natural slope that was going to the beach and some cabins even have had to be moved further inland in recent years. Particularly when high tides are combined with high winds, erosion becomes a problem, and the frequency of these occurrences is increasing. Moreover, some suggest that the water is less salty than before between the Nastapoka Islands and the continent since the salt marks on the rocks along the shoreline are no longer as visible as they were in the past.

Many Umiujamiut have noticed that certain islands seem to have emerged i.e. to have a larger area above the water while others have appeared (Figure 3-22). According to them, the isostatic rebound could explain this phenomenon. Some are also under the impression that the Nastapoka Islands tend to migrate towards the north although this observation is not shared by all the village elders. Others think that it is rather the water level of Hudson Bay that has dropped because when they travel by canoe, they touch bottom with their motors at spots near the shoreline where they would not reach bottom before. However, it should be noted that on the following point there is consensus among all of the workshop participants. The island in front of the village of Kuujjuarapik, which was located at the mouth of the La Grande Rivière de la Baleine seems to have migrated towards the northwest since the years 1950-1960.

3.5.4 Meteorological Observations

For most of the participants at the workshop, the first noticeable environmental and meteorological changes began in the 1980s and have become more marked since the 1990s and 2000s. According to Umiujamiut, September is one of the months that illustrate best these changes. While in the past it was the gradual beginning of winter, it is today rather a mild end of summer. They cite for instance the last four years (2007, 2008, 2009 and 20010) where there

was nearly no precipitation while the weather was warm and there were a lot of flies. The elders add that solar radiation in the Lake Guillaume-Delisle region is not as important nowadays. Generally, they explain that the weather is cooler during the spring, summer and fall and warmer during winter. At the same time, some Umiujamiut report that today it has become harder to anticipate the weather. Atmospheric systems change much more rapidly than in the past.

It's the same for storms that come with much stronger winds than in the past and that are also much more unpredictable. This increases the size of the waves and contributes to the rise of water levels along the shoreline in particular at high tide. Even if the amplitude of extreme tides seems to have increased since the 1970s. The increase in the strength of the winds is thought to be mainly responsible for the increase in the water level along the shoreline (usually when the winds are from the South or the Southwest). This is especially true during the fall but also during the spring, according to the local experts, when the calm days without wind become increasingly less frequent. September, on the other hand, is considered the most pleasant since the 1980s, with much less storms than before. Finally, the eldest two experts add that the water of Hudson Bay is today generally warmer than during the 1960s. It should also be noted that an extreme meteorological event occurred in September 2002 during which Umiujamiut lost boats (six or seven) and camps along the coast.

Table 3-4: Important points concerning the tides, currents, shoreline and weather.

- Increase in the amplitude of the tides over the last few years.
- Added to violent winds, the impact of spring tides on the shoreline is more important than in the past.
- Between Sanikiluaq, Umiujaq and Kuujjuarapik surface currents are not as strong as in the rest of Hudson Bay.
- Some islands are said to have appeared and others have emerged even more since the 1980s.
- Atmospheric systems have become more unpredictable since the 1980s.
- Summer, spring and fall are cooler while winter is warmer.

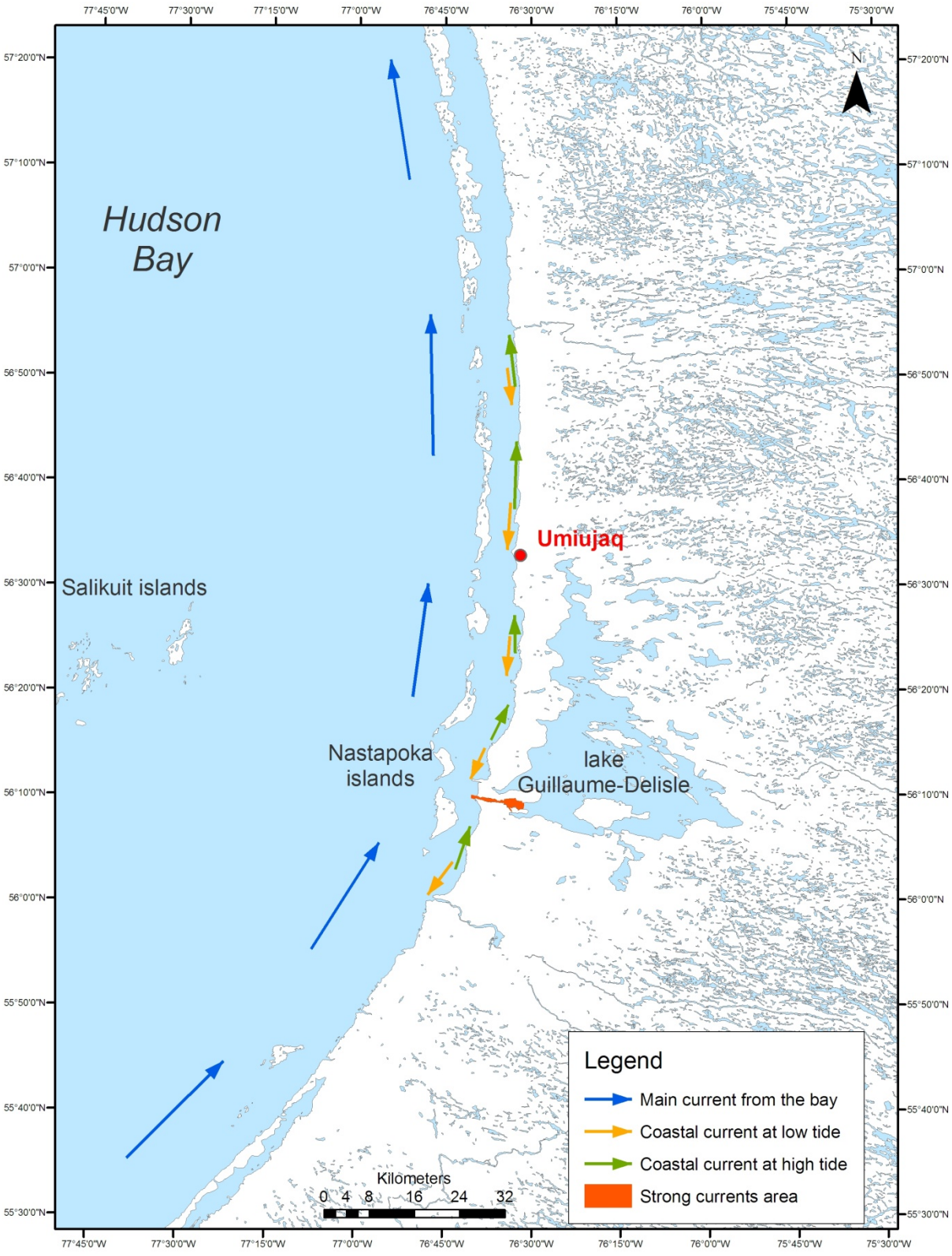


Figure 3-21: Coastal currents and area of strong currents in the Lake Guillaume-Delisle and Nastapoka Islands area.

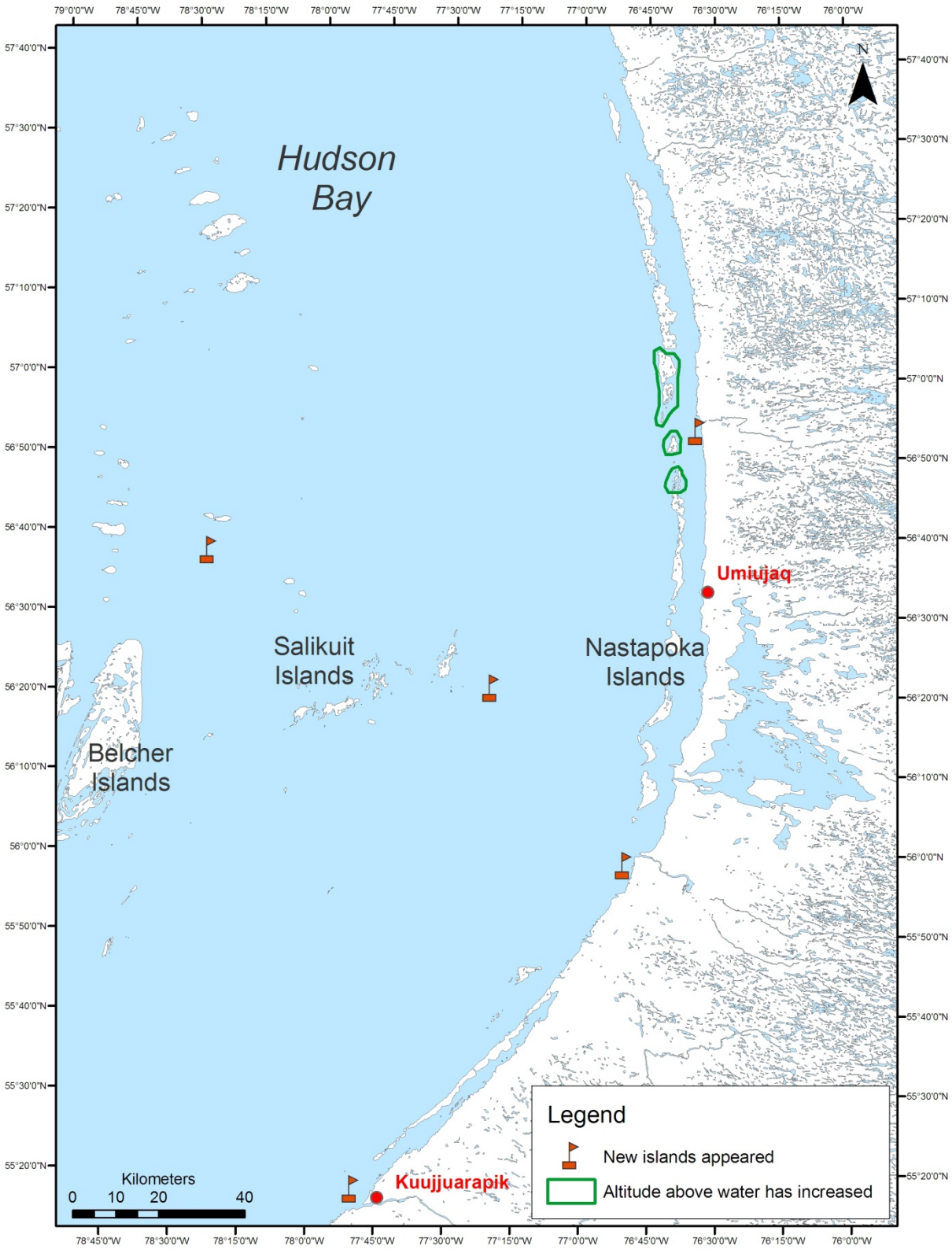


Figure 3-22: A few of the islands that have appeared in eastern Hudson Bay over the last few years as well as others whose altitude above water has increased.

3.6 Marine Infrastructures: Description, Use and Problems Associated with their Presence.

Umiujamiut say they use the marine infrastructure quite regularly when the weather permits, from June to October. The marina is used as a boat ramp by a majority of residents during the ice-free season as it's the point of departure of most of the canoes in the community (Figure 3-23) and motorboats and it is also the only place to store and launch Peterhead boats (Figure 3-23).



Figure 3-23: Canoe (left) and Peterhead boat (right) on dry land for the winter close to the Umiujaq marine infrastructure (photo, S. Bleau, 02/2010)

The elders interviewed report that there are no major problems with the structure and the use of the breakwater since the realization of Phase II of the project in 2008. However, the bottom of the marina is too soft to launch motorboats. Moreover, at low tide, the local experts say they have difficulty getting their canoes out of the water, the water level being too shallow, and the rocky bottom and the edge of the access ramp making the operation more difficult. They also say the enclosure of the breakwater is getting shallower due to the gradual silting in the marina and the presence of large boulders at the bottom in the southern portion (Figure 3-26).

The waves have to be very high for the water to pass over the breakwater. However, during the fall, a combination of high winds and high tides can sometimes bring some high waves to splash some sea spray over the breakwater (Figure 3-24). At that moment, the canoes must be taken out of the water and relocated for protection. These conditions generally occur during extreme

storms accompanied by heavy rain and winds between 50 and 80 knots from the south. However, according to Umiujamiut these phenomena are rare.



Figure 3-24: Large waves close to Umiujaq (photo Reconyx camera, 10/31/2009, ext. T°: 0°C).



Figure 3-25: Ice floe compression close to the Umiujaq breakwater (photo S. Bleau, 02/2010).

Sometimes during ice formation or melting, some ice chunks are compressed against the marine infrastructure. However, pile-ups never exceed 4 or 5 feet high (maximum 1.50 m) and they do not appear to have an impact on the breakwater as shown in Figure 3-25. Some elders explain that the current at high tide weakens and breaks the ice into small fragments that accumulate

against the breakwater. Inside the marina, the ice melts very slowly and stays until the very end of the break-up.

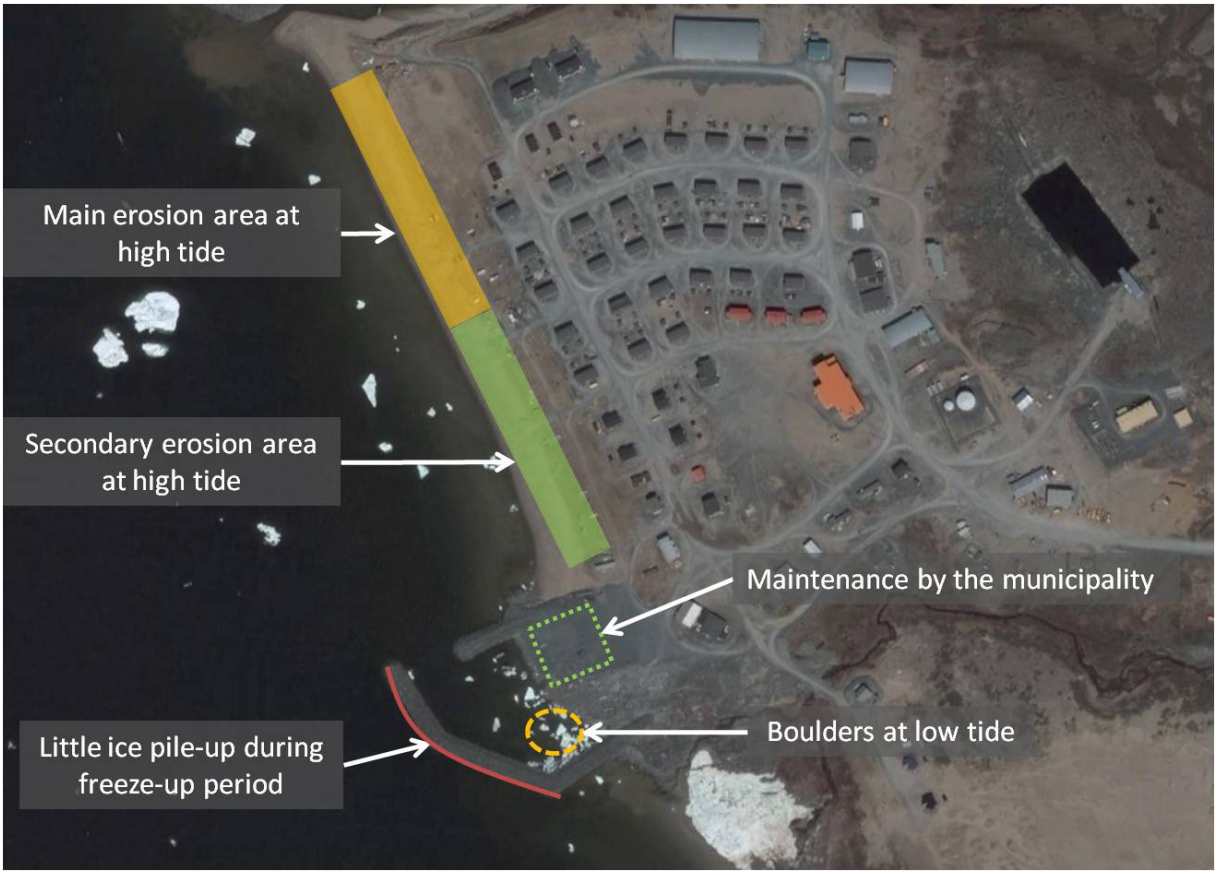


Figure 3-26: Google Earth screen capture on which are represented the different problems associated with the use of the Umiujaq marine infrastructure as well as an area prone to erosion at high tide.

Umiujamiut have noted that the breakwater was not really damaged by the waves or the ice. As a result, it does not require much maintenance. The municipality ensures limited major maintenance of the marina service area by providing on going minor maintenance: leveling and redistributing the rubble that has washed up ashore (Figure 3-26). The local experts present think that a cement base would eliminate this type of maintenance and according to the manufacturer it should have been arranged during the Phase II of the project. At the same time, this would permit the installation of moorings for the canoes since there is a lack of space to store all the boats of the village. The elders present at the workshop insist on the fact that this specific recommendation, as well as others, is part of a few promises not honored by the builder

of the infrastructure. For example, the builder said he would remove the boulders south of the marina, which was not done (yellow circle on the Figure 3-26). Finally, a majority of residents believe that the lighting system on the breakwater is inadequate and does not facilitate safe boat entry at night.

Table 3-5: Important points concerning the infrastructures.

- Since Phase II of the construction of the infrastructure, there are no longer any major problems associated with its use.
- The majority of Umiujamiut use the infrastructure.
- The municipality carries out the little maintenance required for the service area.
- A few ice pile-ups occur close to the enclosure of the breakwater but without any major incidence.

3.7 Harvesting History, Use of the Marine Environment and Adaptation to Climate Changes.

3.7.1 Territory

The hunting territory of Umiujamiut is relatively vast and straddles many other territories namely those of the Cree of Whapmagoostui, the Inuit of Kuujjuarapik and the Inuit of Sanikiluaq. In addition to Lake Guillaume-Delisle, lakes Minto, à L'eau Claire, des Loups marins (Seal Lake) and the Nastapoka river are the main water bodies used for hunting and fishing. In the bay, the Nastapoka, Salikuit and Belcher Islands are generally used for harvesting mussels or sea urchins and hunting eider or seal. Many Umiujamiut originate from Sanikiluaq and have a good knowledge of this part of the marine territory.

3.7.2 Harvesting

The traditional way of life of Umiujamiut depends largely on the terrestrial and marine environment around Lake Guillaume-Delisle and in all of southeastern Hudson Bay. According to the hunters met by the research team, many animal species have already been affected by climatic changes since the 1980s. For example, marine mammals and caribou no longer pass at the same times and do not follow the same migration routes. Snow geese have completely changed their migratory route and today they do not pass close to the village in September. Some explain that this is because their behavior depends largely on environmental conditions. Caribou, foxes or geese are affected by variations in temperature, weather conditions and food availability observed these last decades. The same local experts add that fish and marine mammals are rather sensitive to changes in the water temperature, the tide cycles and variations in the salinity of the brackish waters of Lake Guillaume-Delisle. In the same way, some hunting areas have changed over the last years (Figure 3-27). However, it should be noted that these hunting areas have been identified by only two local experts (the others being absent at the time of these discussions) and would merit being reconfirmed, especially because government regulation have also impacted beluga hunting.

Fall and winter (from September to April) remain the best seasons for seal hunting since they have more fat and they taste better during this period. In the bay, the harvest is most favorable

when openings (*aajurak)* appear in the ice (i.e. high winds and/or spring tides), which happens often in January. The Goulet of Lake Guillaume-Delisle is also a favored area for this type of hunt, especially when there is wind. Ice accumulations and the fog disappear thus permitting a fruitful harvest.

3.7.3 Routes

During winter, Umiujamiut have easy access to all the continental portion of their territory. They can travel by snowmobile during December, January, February, March, April and part of May. On the bay side, it is possible to travel between the Nastapoka Islands and the shoreline when the pack ice is set, but it is much more tricky to venture offshore from the islands (see the stability section above). With the changes in the stability of the ice and the reduction of the freeze-up period, many snowmobile trails have been modified since the 1980s, particularly near dangerous areas such as at river mouths or the Goulet of Lake Guillaume-Delisle. This instability is responsible for a reduction in the number of hunters that travel between the islands and the coast, preferring instead the safer route of Lake Guillaume-Delisle. During this time of year, the calm and snowy weather make travel riskier since it is difficult to distinguish between ice and water. Many hunters present at the workshop indicated having lost one or more snowmobiles. This occurred mainly at the end of the 1980s during the years following their relocation to Umiujaq, because they did not yet have a good knowledge of the territory. Finally, the eldest participants add that in the past not only was the pack more stable, but it was also easier to travel with a dogsled than today on snowmobile. The dogs would help anticipate dangerous areas on the ice. In winter, because of ice instability, they do not venture as further on the bay and generally prefer to go hunt seal near the mouth of Lake Guillaume-Delisle. On the other hand, they go very far inland in the fall and in winter to fish and to hunt caribou, i.e. up to Lake à l'Eau Claire, at Minto Lake and at Lake aux Loups Marins (Figure 3-28) In the spring and fall, they also sometimes go fishing at Lake Minto in groups, by airplane, since there are no routes for all terrain vehicles (ATV) to reach the area. ATVs are mostly used close to the village or around Lake Guillaume-Delisle. During the open water season, the most dangerous areas are located between the islands because these act as wind tunnels. Today, Umiujamiut travel by canoe from the end of June to the end of October. They usually use the same routes as in the past (Figure 3-28). It should be noted that the experts present indicated that there were no kayak routes in the past at least none they could remember. Most of the time, they travel along the

shoreline between the continent and the Nastapoka Islands and, when they go offshore, it's to go to the Salikuit Islands or to Sanikiluaq (Figure3-28) for fishing crustaceans (mussels, sea urchins) but also to hunt for eider and seal.

Finally, it is worth noting that the winter and summer routes mapped on Figure 3-28 and Figure 3-29 represent only a fraction of the routes used by the inhabitants of Umiujaq, specifically as it relates to snowmobile routes. Although these are « main » routes used by a large majority of the population, there are nearly as many routes as there are Umiujamiut hunters. This is without taking into account the many other routes used only by the Cree of Whapmagoostui or the Inuit of Kuujjuarapik. The routes indicated represent only a fraction of the routes used by Umiujamiut since there were only two local experts present at the end of the workshop when this section was addressed.

Table 3-6: Important points concerning the use of the environment and the adaptations to changing conditions.

- The harvesting territory of the Umiujamiut is quite vast and straddles those of the Inuit and the Cree of Whapmagoostui and Sanikiluaq.
- Certain terrestrial and marine animal species are already subjected to the impacts of climate changes and have modified their migration behavior. Consequently, hunting areas have also changed over the last decades.
- The harvesting season has substantially been reduced with the shortening of winter considerably reducing access to the territory during the fall and spring.
- The summer routes used by canoes and motorboats have not been modified in the last few years.
- Winter routes in particular have changed because of the increase in unstable areas during winter or the expansion of open water areas like the Goulet of Lake Guillaume-Delisle.
- There are a large number of snowmobile and canoe routes and the present report only presents part of these routes.

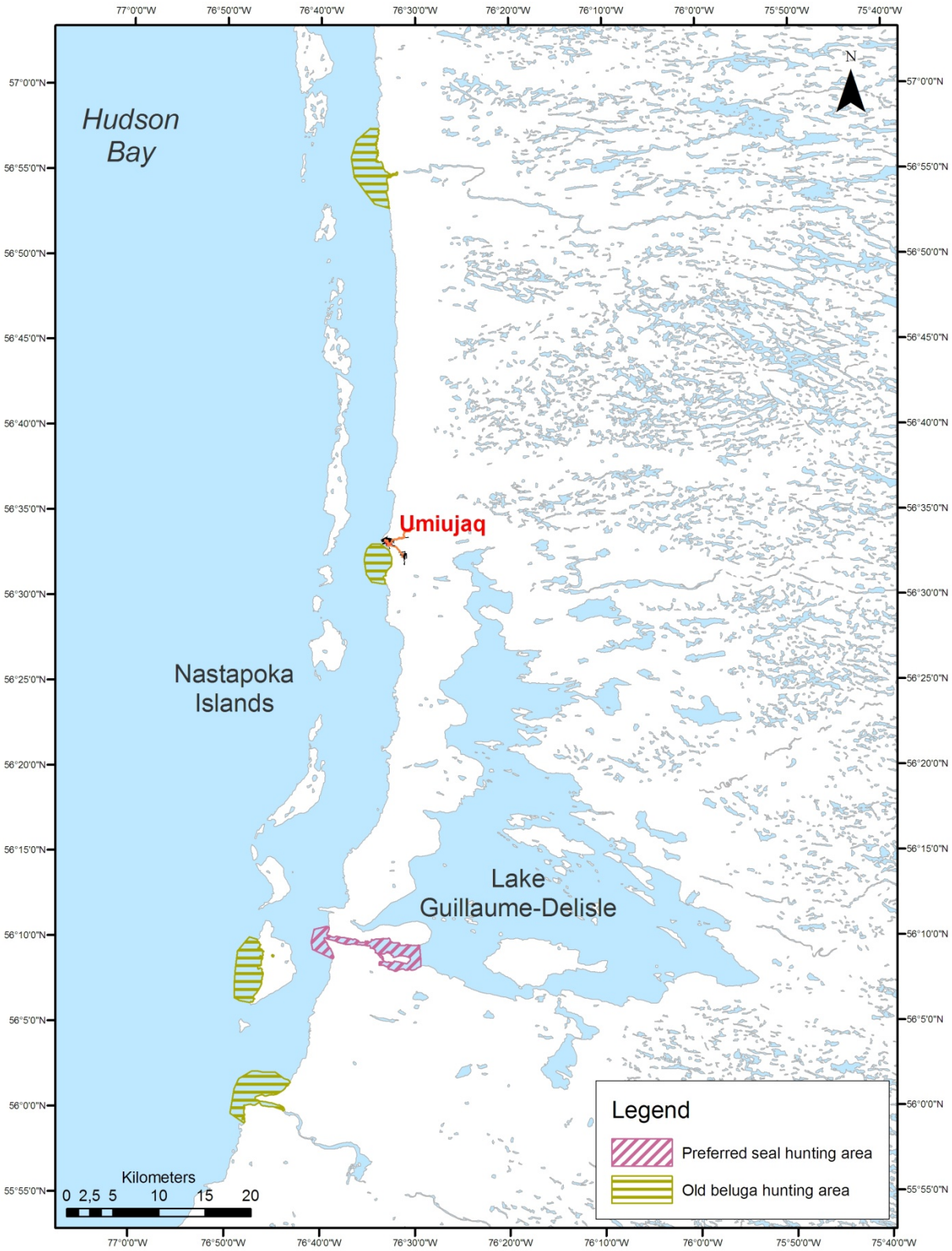


Figure 3-27: Old beluga hunting areas and preferred seal hunting area in the Lake Guillaume-Delisle region.

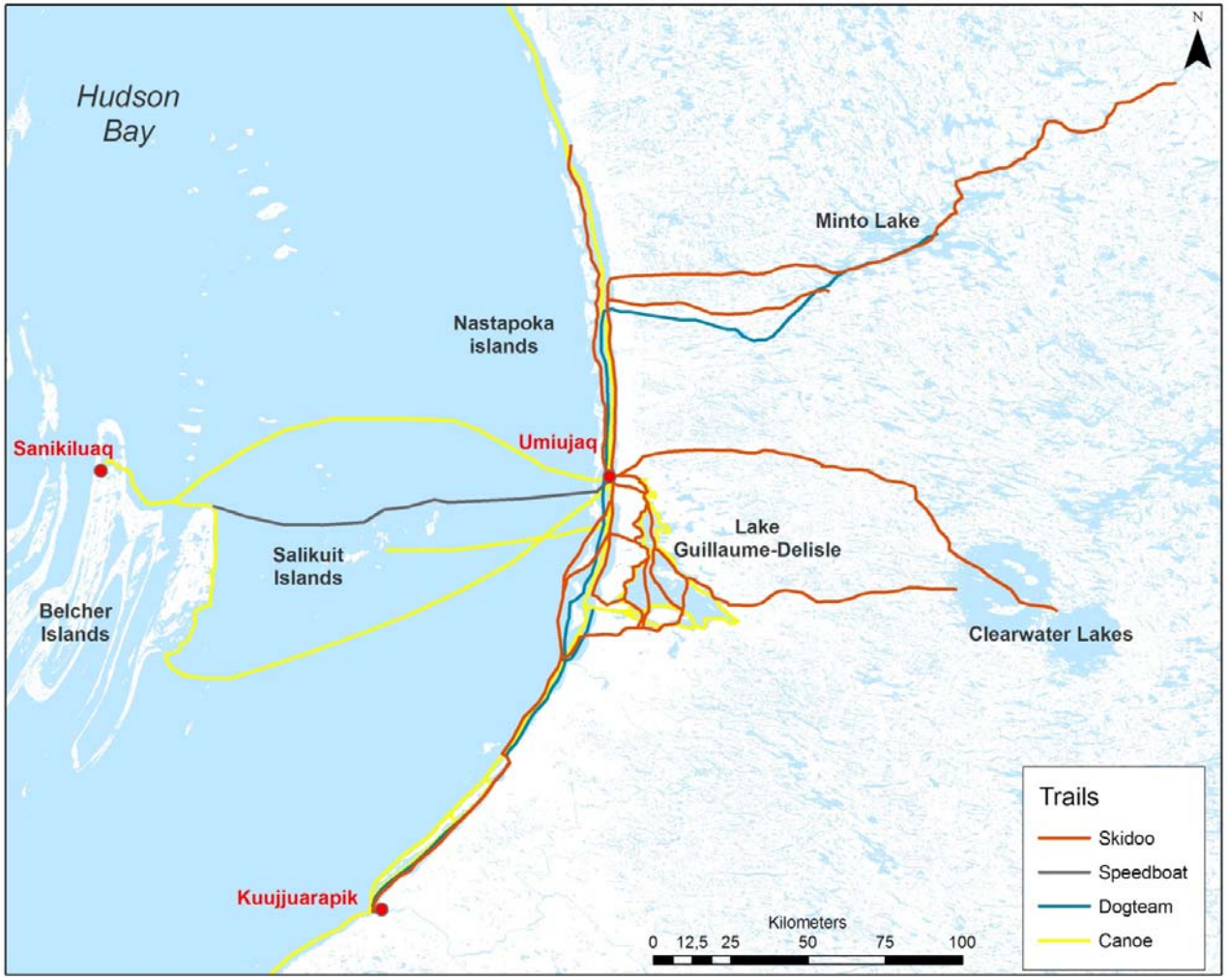


Figure 3-28: Routes used by Umiujamiut during winter and summer in the southeast of Hudson Bay in 2010.

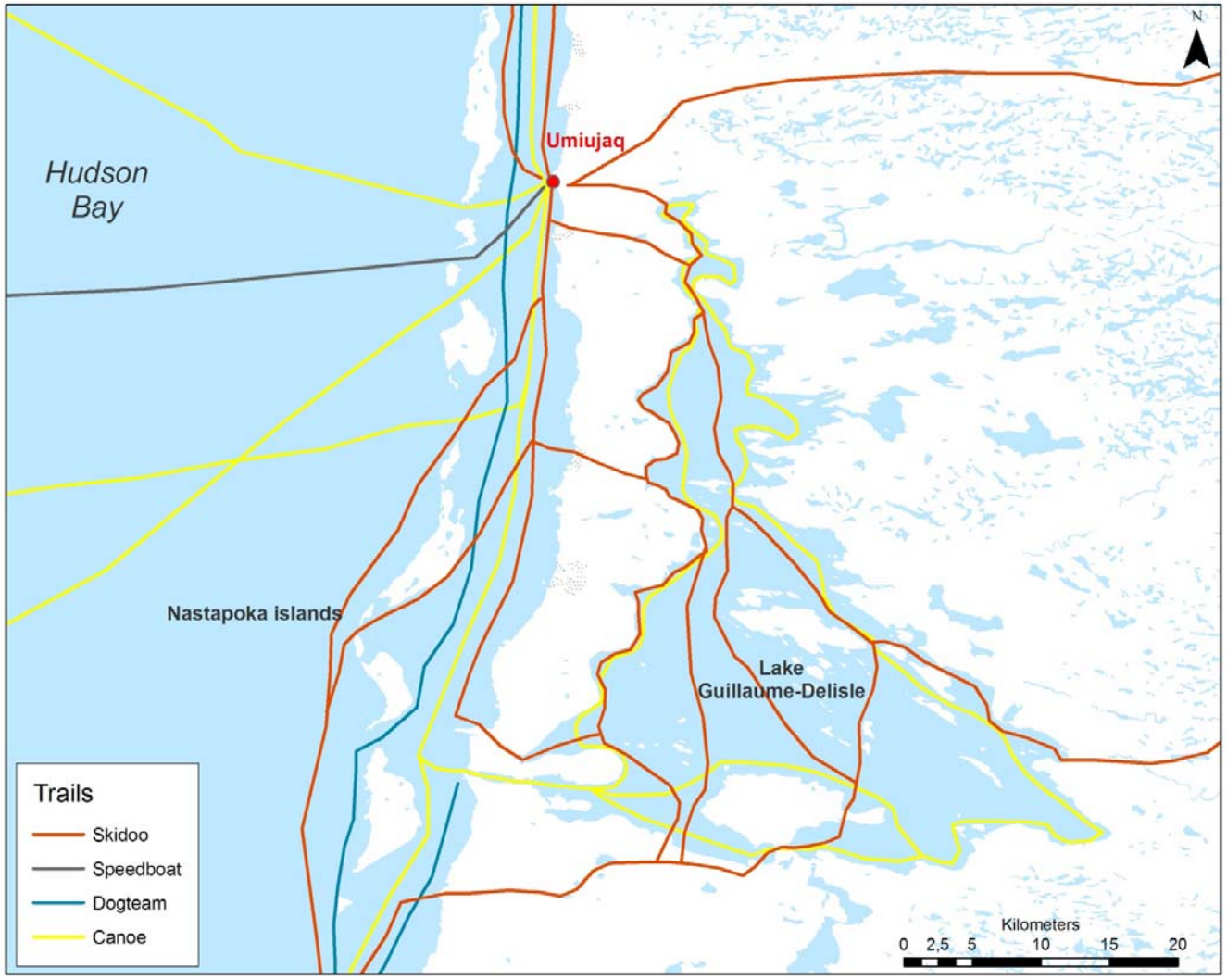


Figure 3-29: Routes used by Umiujamiut during winter and summer in the Lake Guillaume-Delisle region in 2010

3.8 Terminology

Nunavimmiut use a great variety of terms to describe and explain their subarctic environment. The marine environment and in particular sea ice are no exception and one can find a great richness of very precise terms that describe both ice forms and the processes associated with freeze-up or melting. In this context, a same word can have two different meanings in two different communities (Tremblay et Furgal, 2008; Laidler, 2007). Moreover, it is not rare that two different words have the same meaning. The following list includes the words documented during the February 2010 workshop in Umiujaq and verified in November 2010 in order to complete the list initiated by Tremblay et Furgal (2008) in six communities of Northern Québec (5 of which are Inuit). It should be noted that certain words have already been placed in their context in the preceding paragraphs

Aajurak: Ice-free water, cracks in the ice in spring, oriented East-West.

Amiartuq: When the ice starts to form at the surface of the water in the absence of wind.

Annisak: Large mobile ice floes in spring.

Aulaniq: Current.

Ivuniq : Ice pile-up on the ice or on the shoreline when the ice is pushed by currents.

Ivuniaruq : ice pile-up during ice freeze-up.

Kangilinik or kangilini: Landfast ice formed between the Nastapoka Islands and the continent.

Killiniq: Ice beyond the Islands,(for Umiujaq, the Nastapoka Islands).

Matsaq: Mix of snow and ice on the surface of the water (slush in English).

Matuartuq: When the water freezes more permanently.

Pullait: Ice with bubbles inside.

Putta: An ice floe detaches itself to become a mobile ice chunk.

Qaiguitt: Ice formed along the shoreline by the accumulation of a mixture of snow and ice pushed by waves and west winds. First sign of freeze-up in Hudson Bay.

Qainguit: When ice forms in the areas where there are currents.

Qisuttuk: When it's very cold and there is the formation of a thin ice layer at the surface of the water. At this time, there is fog is usually present.

Qaingusattut: Beginning of ice accumulation on the shoreline.

Qikittaruttatuk : The islands that now emerging at low tide

Sikuliak: When the ice starts to freeze, i.e. when the ice starts to form (in general during the night)

Sinaa: The exterior limit between the ice and the water when there is an opening in the ice.

Siquttiniq ou siquktinik : Broken and mobiles ice floes during the winter.

Tukilik : Ice cracks in winter.

Tuuvaq: Ice that thickens and becomes smooth during winter. Corresponds to the final stage of the formation of fast ice, i.e. attached to the land.

Tuuvaqtuq: Thickening of the ice in place.

3.9 Conclusion

Finally, there seems to be a consensus as to the fact that pack ice appears approximately six weeks later than fifty years ago. Nevertheless, solid and fixed pack ice remains stable for at least the month of March between the Belcher Islands (Sanikiluaq), Umiujaq and Kuujjuarapik. Melting also occurs on the average six weeks earlier than in the past.

The Nastapoka Islands off the shoreline encourage the persistence all winter long of fixed fast ice (*kangilinik*). At the same time, these islands are responsible for the existence of areas of turbulence (ice pile-ups, appearance of cracks, ice-free water) that cause instability in the pack ice. Hunters estimate that the number of risk areas in winter has considerably increased since the 1980s. The Goulet of Lake Guillaume-Delisle is a particularly dangerous open water area during most of the winter.

The marine infrastructure in Umiujaq is used by the majority of the population during the ice-free season. Umiujamiut are generally satisfied with it since the construction of Phase II although the municipality must insure to some extent maintenance of the service area. However, a few improvements could be made such as the implementation of an adequate lighting system.

In final analysis, the workshops made it possible to document part of the local expert knowledge concerning the marine and terrestrial environment of the southeast portion of Hudson Bay and, in particular the Lake Guillaume-Delisle region situated close to Umiujaq. The meteorological and environmental changes observed by the local experts corroborate observations collected by Tremblay and Furgal (2008) in six other communities of Northern Québec. Discussions on the construction, maintenance and future of the two infrastructures also took place. Finally, a few Inuttitut terms of Umiujamiut were indexed, terms especially associated with the marine environment, ice types and regimes.

4. Koksoak river Environment: From the perspective of Kuujjuamiut. Validation and additions to the information provided in the final report published in March 2009.

Consultation workshop: February 2009

Validation workshop: February 2011



4.1 Preamble

The workshop held in February 2009 in Kuujjuaq on the environment of the Koksoak River originally began as an independent project. However, during the implementation of a new project entitled "Climate Change and Marine Infrastructure: Impacts and Adaptation", it was decided that the workshop format and questions from the original Kuujjuaq workshop would be helpful as the new project included a component on local expert knowledge and remote sensing. The format and questions were adapted from the original Kuujjuaq workshop and used for local expert workshops in Umiujaq and Quaqtaq. At the same time, a decision was made to include the validation of the Kuujjuaq workshop in these other workshops. Two workshops were then conducted in both Quaqtaq and Umiujaq: a first for the initial collection and documentation of information and a second to verify and validate the collected information. As well, since the information collected in Kuujjuaq in February 2009 had not been validated prior to the publication of the final report (Tremblay *et al*, 2009), it was decided to organize a validation workshop in this community. The current addendum presents corrections and clarifications proposed by the experts at the validation-workshop held in Kuujjuaq on February 24 and 25, 2011, regarding the information contained in the March 2009 report. Taking into account that the objectives and methodology of the workshops in Kuujjuaq, Quaqtaq and Umiujaq are analogous and presented in the introduction of the actual report, this addendum focuses solely on the results of the workshop (i.e. sections 6 and 7 of the initial report Tremblay *et al*, correspond to sections 4.2 and 4.3 below). Moreover, only the modified figures are included in this report, with their original titles, legends and figure numbers, though the numbers no longer match. Note that Figure 4-1 and Figure 4-13 are additions to the original text of Tremblay *et al* (2009).

Two of the validation-workshop experts (Johnny Gordon and Johnny Watt) participated at the initial workshop. The remaining original participants were not able to participate in the verification workshop and therefore the above-mentioned participants suggested including Tommy Saunders as an additional local expert to aid in the verification workshop as he is also very knowledgeable of the area. Mélissa Gagnon (KRG/ARK) and Kaitlin Breton-Honeyman (Trent University) did the verification workshop because Martin Tremblay, who conducted the original workshop, was not available. Sarah Aloupa was the interpreter.

It is important to note that the validation-workshop experts indicated that “Koksoak” is not an Inuktitut name. The place name used by Inuit to refer to the river is *Kuujjuaq*, meaning “great river” in Inuktitut. Taking into account that the place name used by the *Commission de toponymie du Québec* (geographic names) is “Koksoak” and to avoid confusion, the term “Koksoak” continues to be used in this report. This use is in no way intended to diminish the clarification regarding the Inuktitut name for the river. Rather, in a report presenting traditional and local knowledge of the river environment, it was considered essential to highlight this place name clarification.



Figure 4-1 : Validation workshop avec Sarah Aloupa (interpreter), Johnny Gordon (local expert), Monica Nashak (environnemental technician, ARK/KRG), Johnny Watt (local expert) and Tommy Saunders (local expert) (picture: Kaitlin Breton-Honeyman, 02/2011).

4.2 Koksoak River Environment

The validation-workshop experts all agreed that conditions continue to change significantly to the extent that the changes noted two years ago (at the time of the initial workshop) are no longer accurate. In their words, every year has become exceptional and conditions are more and more unpredictable, especially in regards to ice conditions and temperature. The validation-workshop experts stated that the temperature is increasingly milder and the sun increasingly hotter.

4.2.1 Ice Cover

According to the information gathered during the initial workshop, first ice on the Koksoak River appears between mid-October and the beginning of November and is concentrated along the shoreline. The validation-workshop experts indicated that the spelling of the Inuktitut term for this shore ice needed to be clarified, specifically *uluaguti* instead of *uluagutik* (Figures 4-2, 4-3, 4-4 and 4-5). Moreover, they stated that, although some ice was observed in the river, no ice cover was truly present during these two months.

The initial-workshop experts indicated that the river ice (*puttaat* and *uluaguti*) continues to increase, becoming immobile and sufficiently solid to permit travel by snowmobile around December 25 about five kilometres upstream from Kuujjuaq, after December 25 at Kuujjuaq, and in February at the community's marine infrastructure. In the winter of 2010–2011, it became possible to cross the river about five kilometres upstream from Kuujjuaq one week later than expected, which is to say around December 31, and the first crossing at Kuujjuaq was made on February 23 (Figure 4-6). At the time of the validation workshop, crossings at the community's marine infrastructure were still not possible. The validation-workshop experts also specified that, at the time of the validation workshop, the ice at the marine infrastructure had just formed less than two weeks earlier. This year's (2011) ice formation is the latest that the validation-workshop experts have ever witnessed, since the ice generally forms around December 25.

The validation-workshop experts confirmed that the diversion of the Caniapiscau River (*Kaniuapiska*) has had a major impact on the river and that ice cover is now rougher (less smooth). They seemed to tie this observation to the fact that more rocks are now visible in the river due to the lower water level.

The initial-workshop experts indicated that several sections do not freeze around Elbow Island (*Qikirtaaluk*) and upstream from Whale Point as illustrated in figures 4-7 and 4-8. According to the initial-workshop experts, these zones regularly froze over up until the 1970s, but also contained certain risk areas that were not identified at the time of the initial workshop. At the validation workshop, Johnny Watt added that, to his knowledge, ice had only formed all the way to Ungava Bay twice before. The validation-workshop experts also added that ice conditions are now almost impossible to predict in terms of timing and that recent years have been so variable it is difficult to transpose any information onto a map. Figures 4-7 and 4-8 were therefore not modified and, it should be noted, they may no longer correspond to the reality of changing conditions.

The validation-workshop experts made corrections to Inuktitut terms for different types of ice (Figures 4-9 and 4-10). The term ivurnik should instead be written ivuniit and effectively represents solid ice that has formed roughly due to the currents. According to the validation-workshop experts, the term tuvaq is adequate but designates complete ice cover and not necessarily smooth ice as it may include other types of ice. The validation-workshop experts indicated that the term iturnik does not exist in Inuktitut and that the proper term to refer to shoreline ice that has a rough surface or that is piled up due to the tides is ittiniit. The validation-workshop experts also indicated that the terms qimutjuk and manilaat must also be replaced with qimutjuit and maniiligaat, although the definitions remain unchanged. The term qimutjuit refers to snow drifts on the surface of the ice and the term maniiligaat refers to ice that forms roughly due to winds or currents (Figure 4-9).

Table 4-1: Ice cover summary

- First ice appears in October or November;
- Compared with the 1970s, ice forms roughly three weeks later and breaks up three weeks earlier on the Koksoak River, and even later and earlier in the last two years;
- Strong winds, especially north winds, further delay the ice formation and influence the future ice cover causing it to be rougher;
- There are several types of ice: *uluaguti, sikuat, puttaat, illaujaq, ivuniit, ittiniit,tuvaq*;
- The ice is unstable or there is open water, specifically from Whale Point to the mouth of the Koksoak River. Conditions are so unpredictable, it's almost impossible to mark the unsafe ice areas on the map;
- The reduction in the flow of the Caniapiscau River (*Kaniuapiska*) has impacted water levels and the quality of ice.



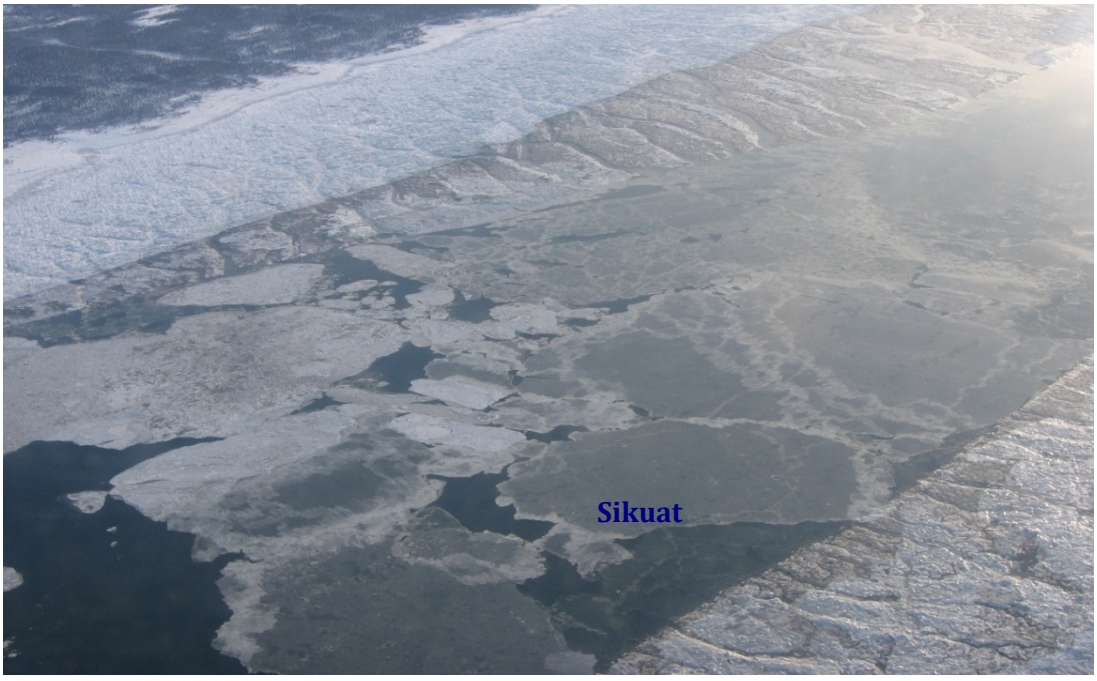


Figure 4-2: Early ice formation on the Koksoak River. (Picture: Martin Tremblay).

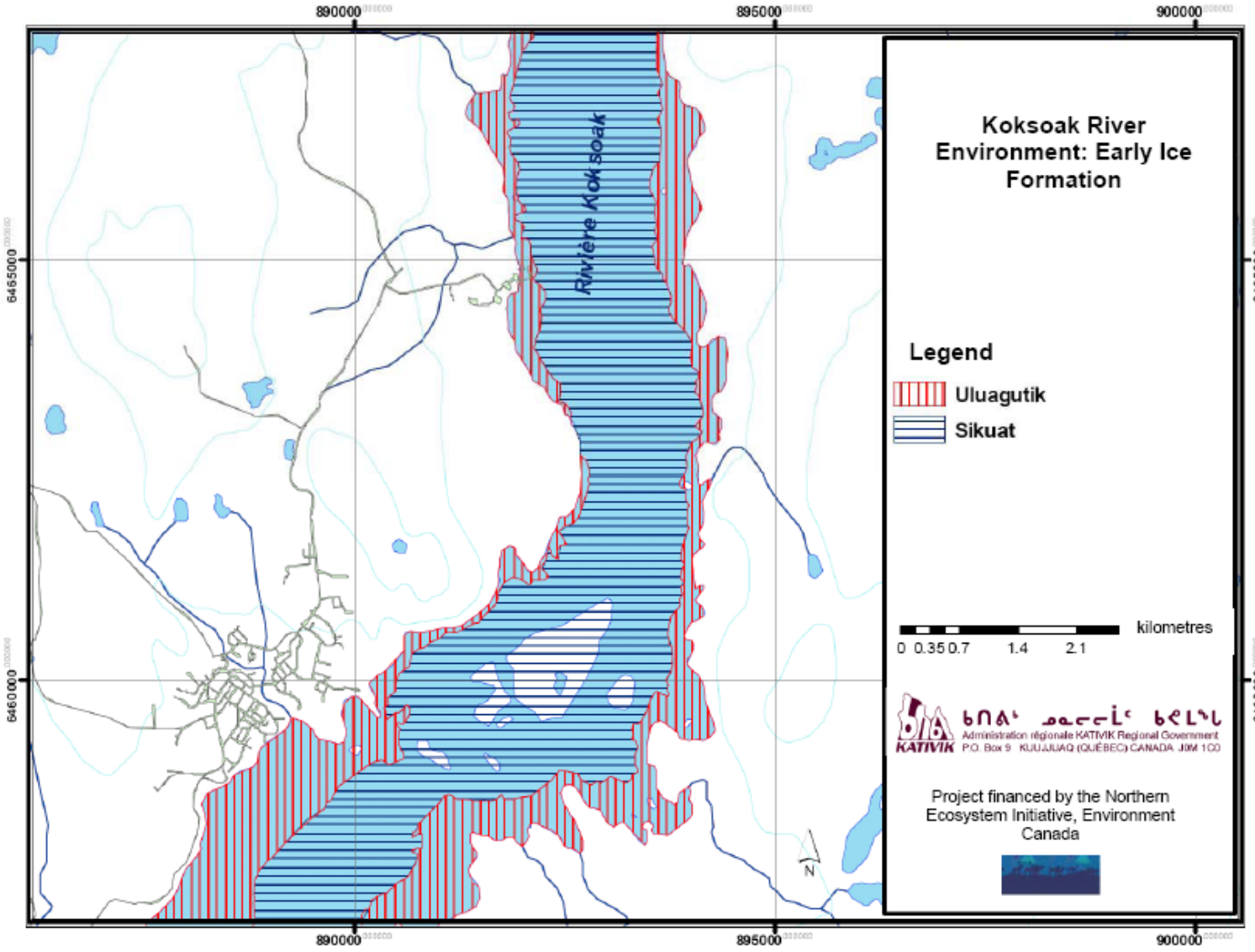


Figure 4-3: Map of early ice formation on the Koksoak River.

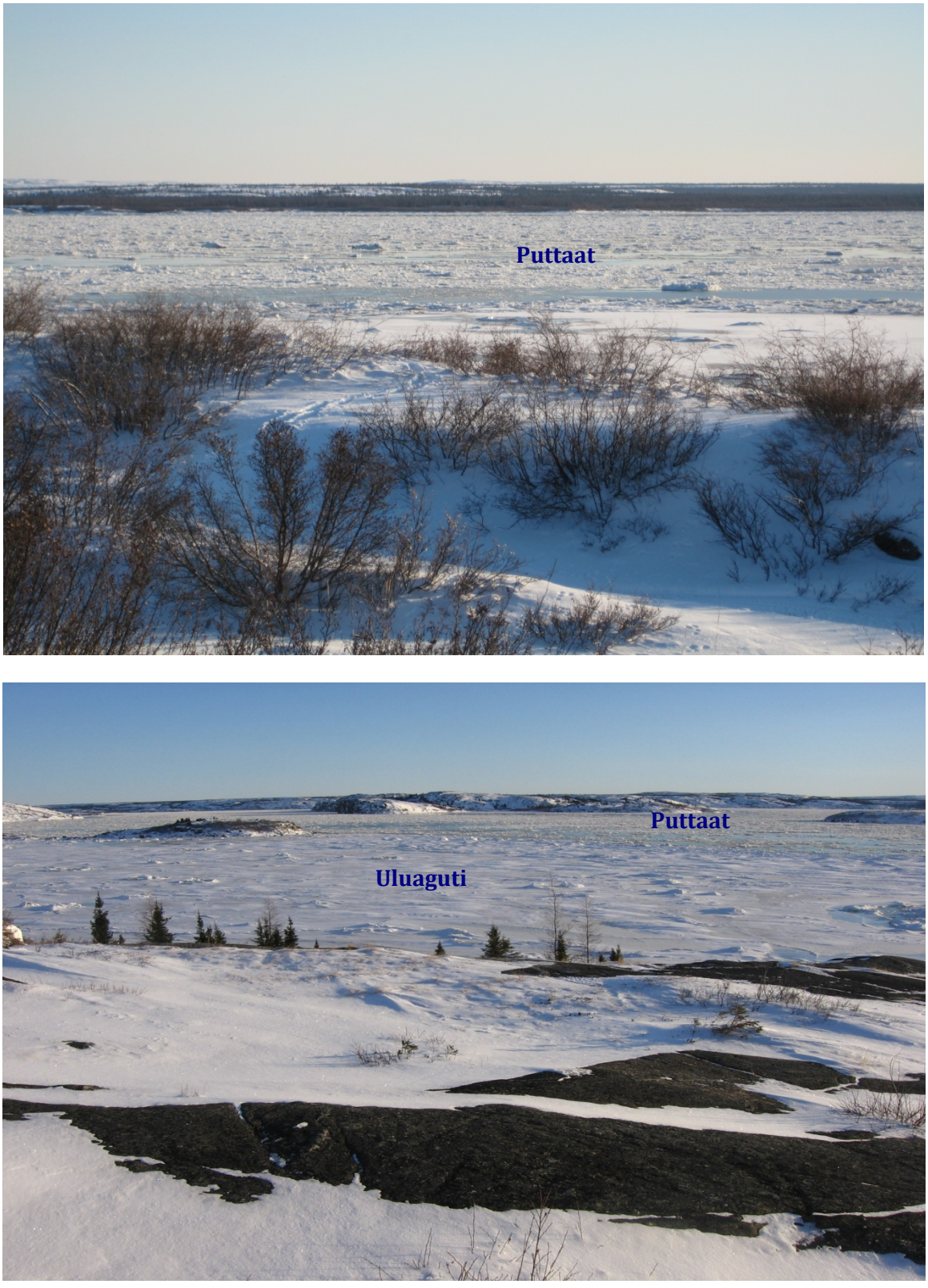


Figure 4-4: Intermediary ice formation on the Koksoak River (Picture: Martin Tremblay).

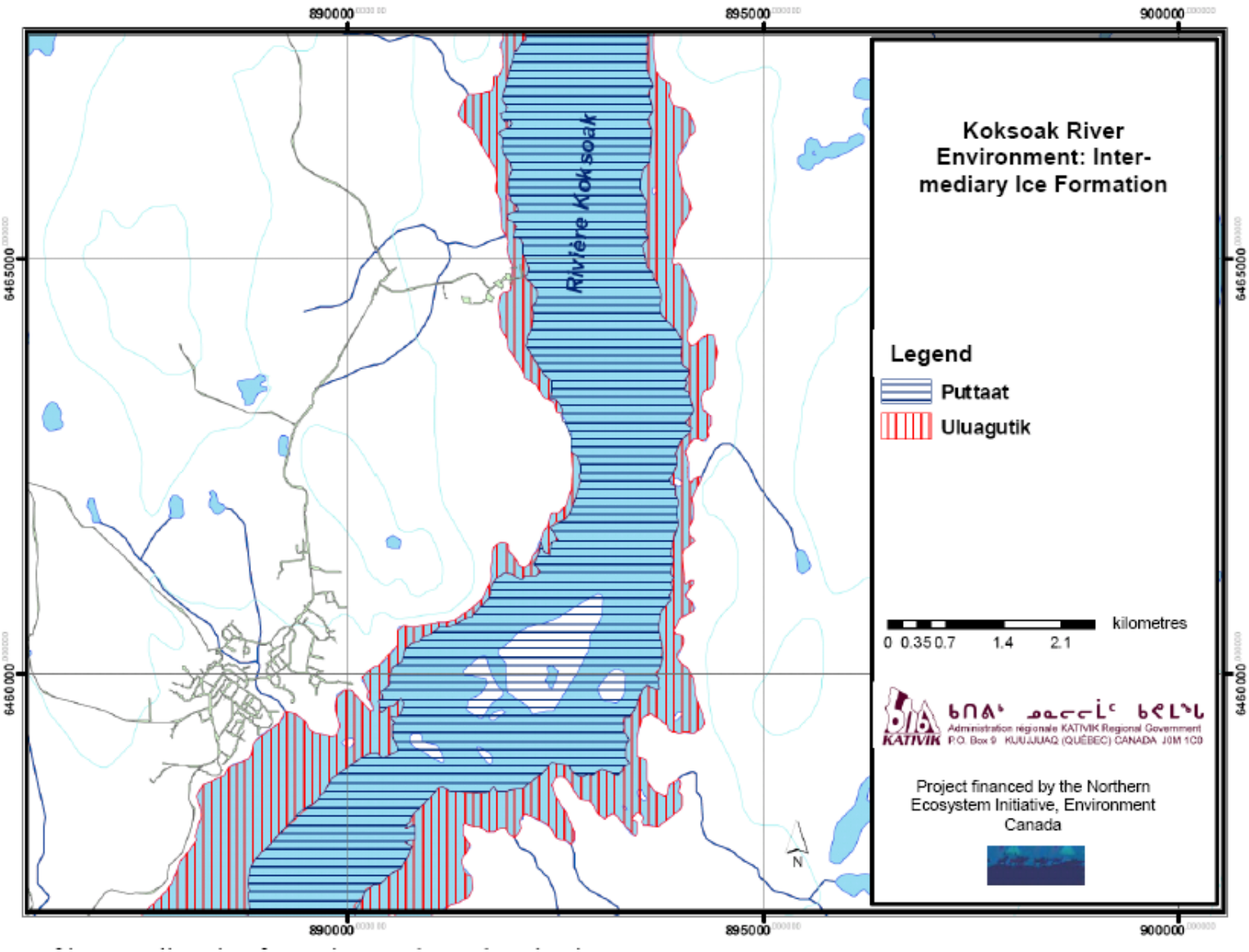


Figure 4-5: Map of intermediary ice formation on the Koksoak River.

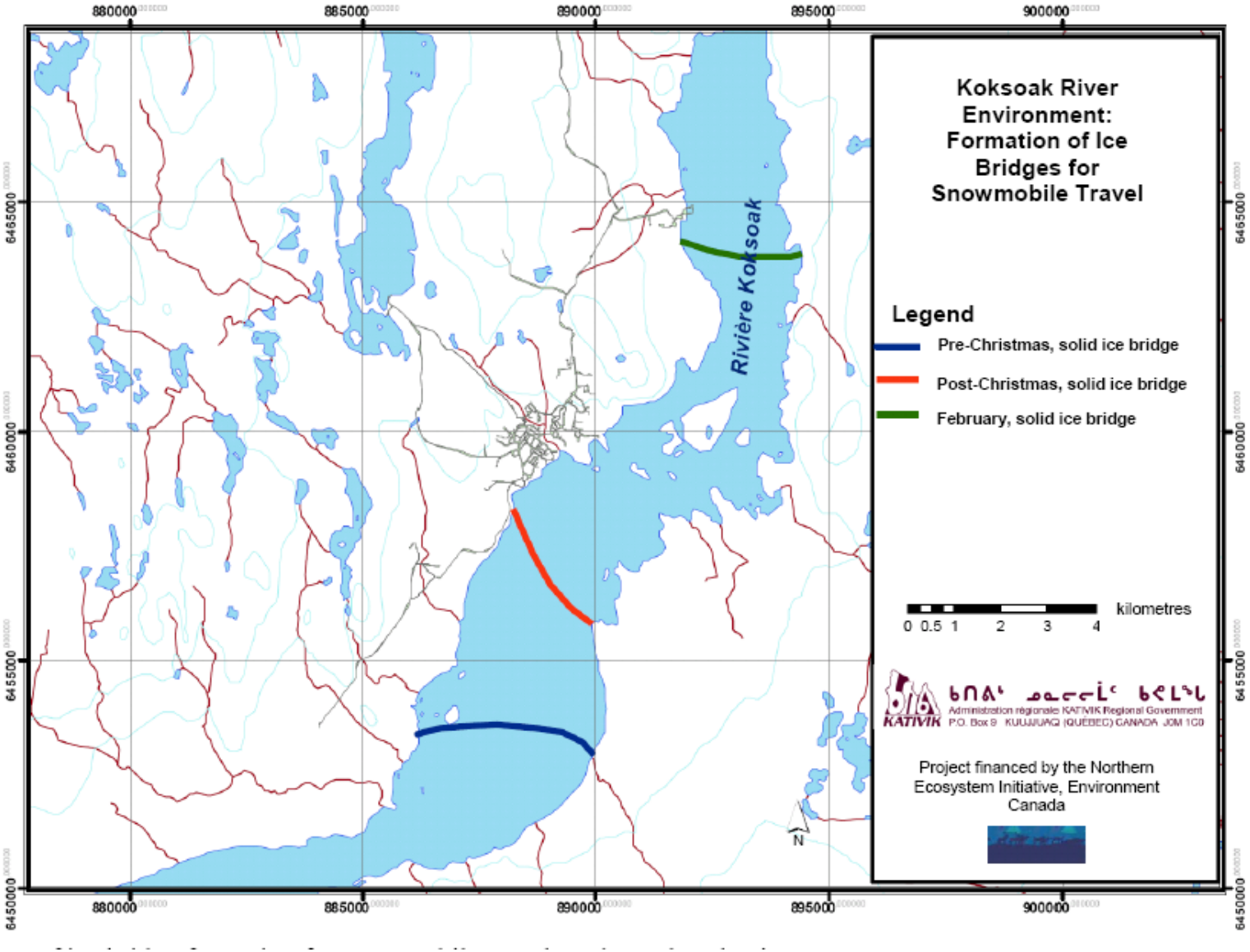


Figure 4-6: Map of ice bridge formation for snowmobile travel on the Koksoak River.



Figure 4-7: Sectors of the Koksoak River where the ice is unstable or there is open water. Sikuittuq is the Inuktitut word for open water (Picture: Martin Tremblay).

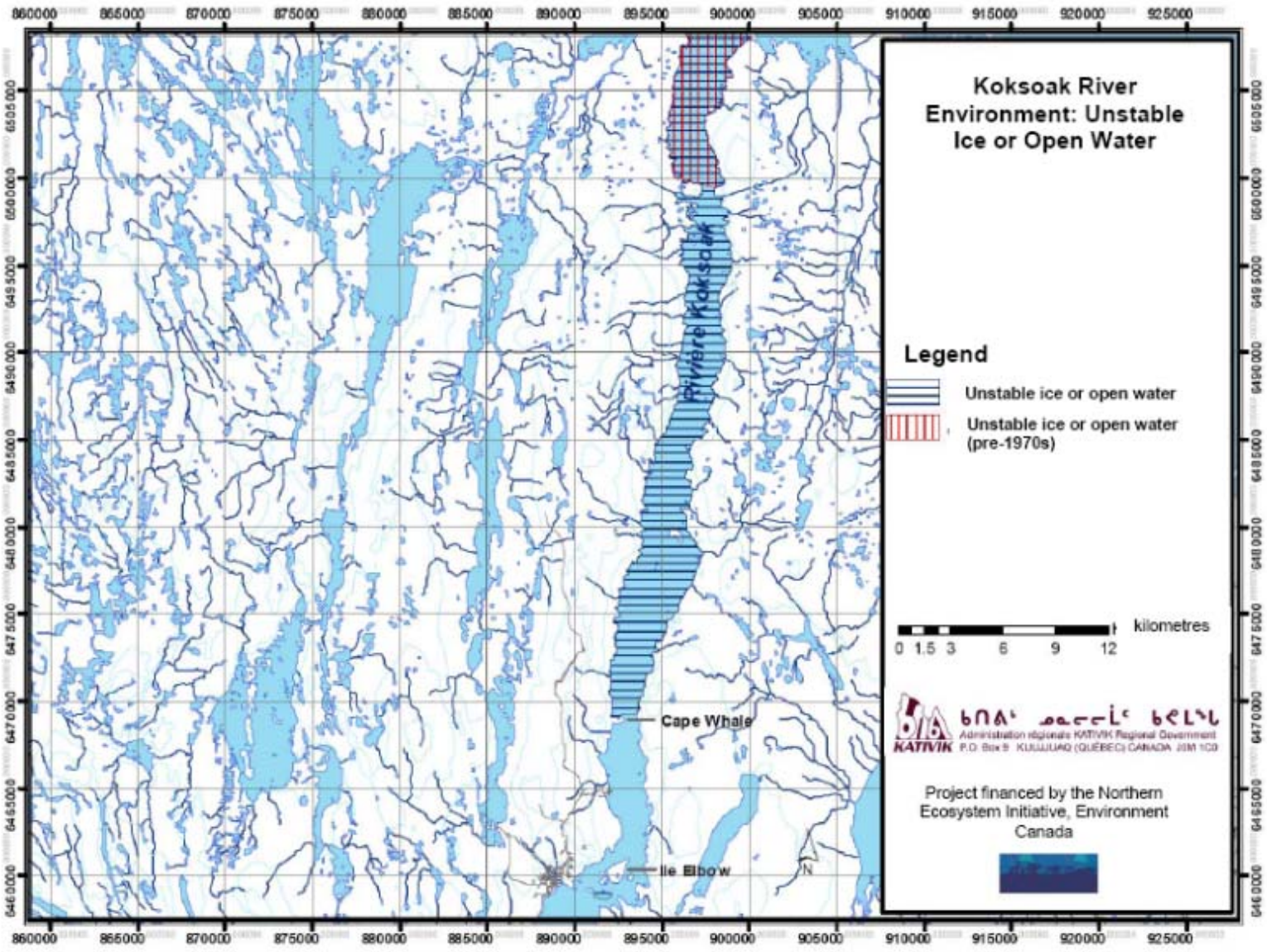


Figure 4-8: Map of unstable ice on the Koksoak River

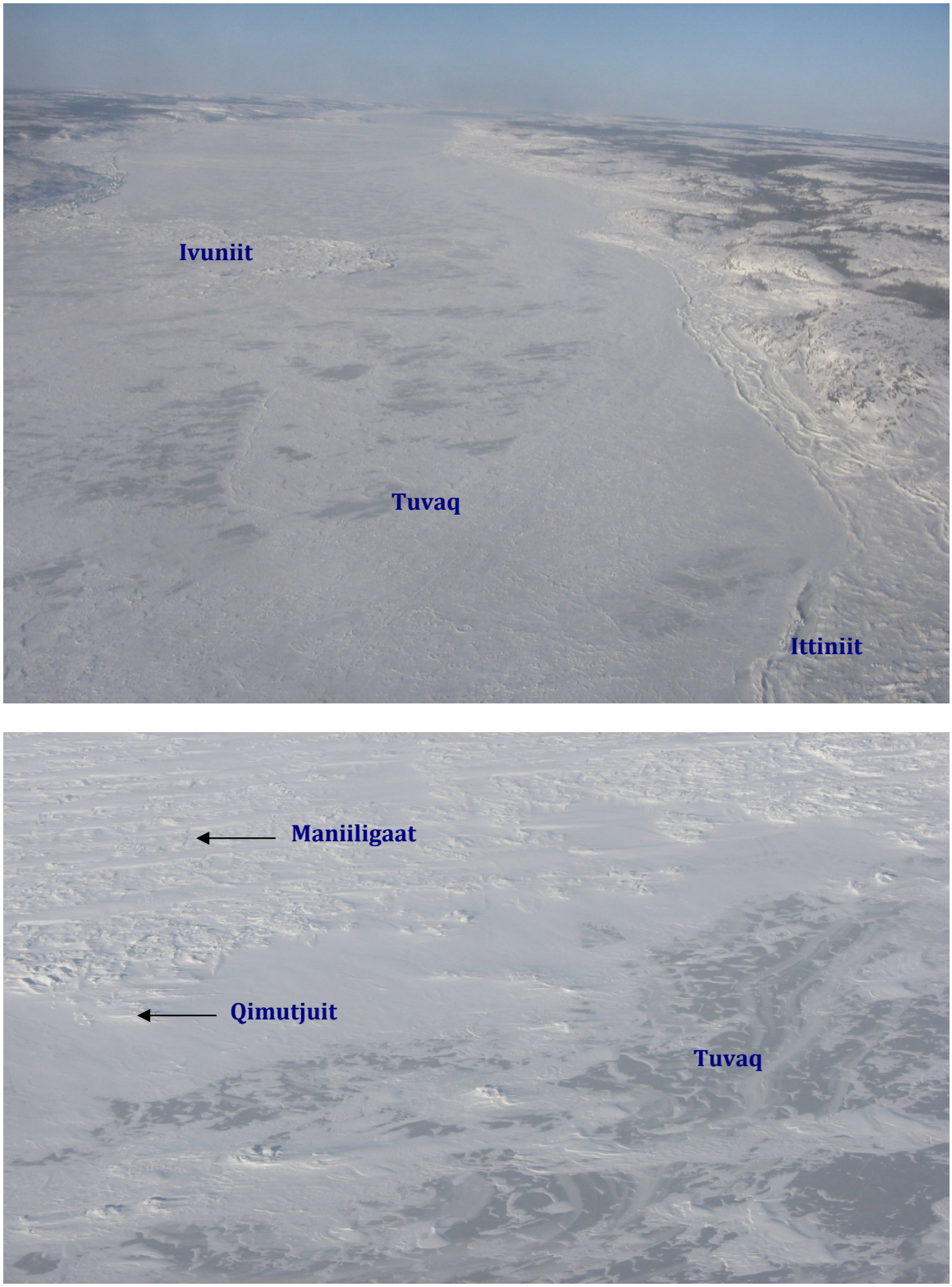


Figure 4-9: Types of immobile ice on the Koksoak River (Picture: Martin Tremblay).

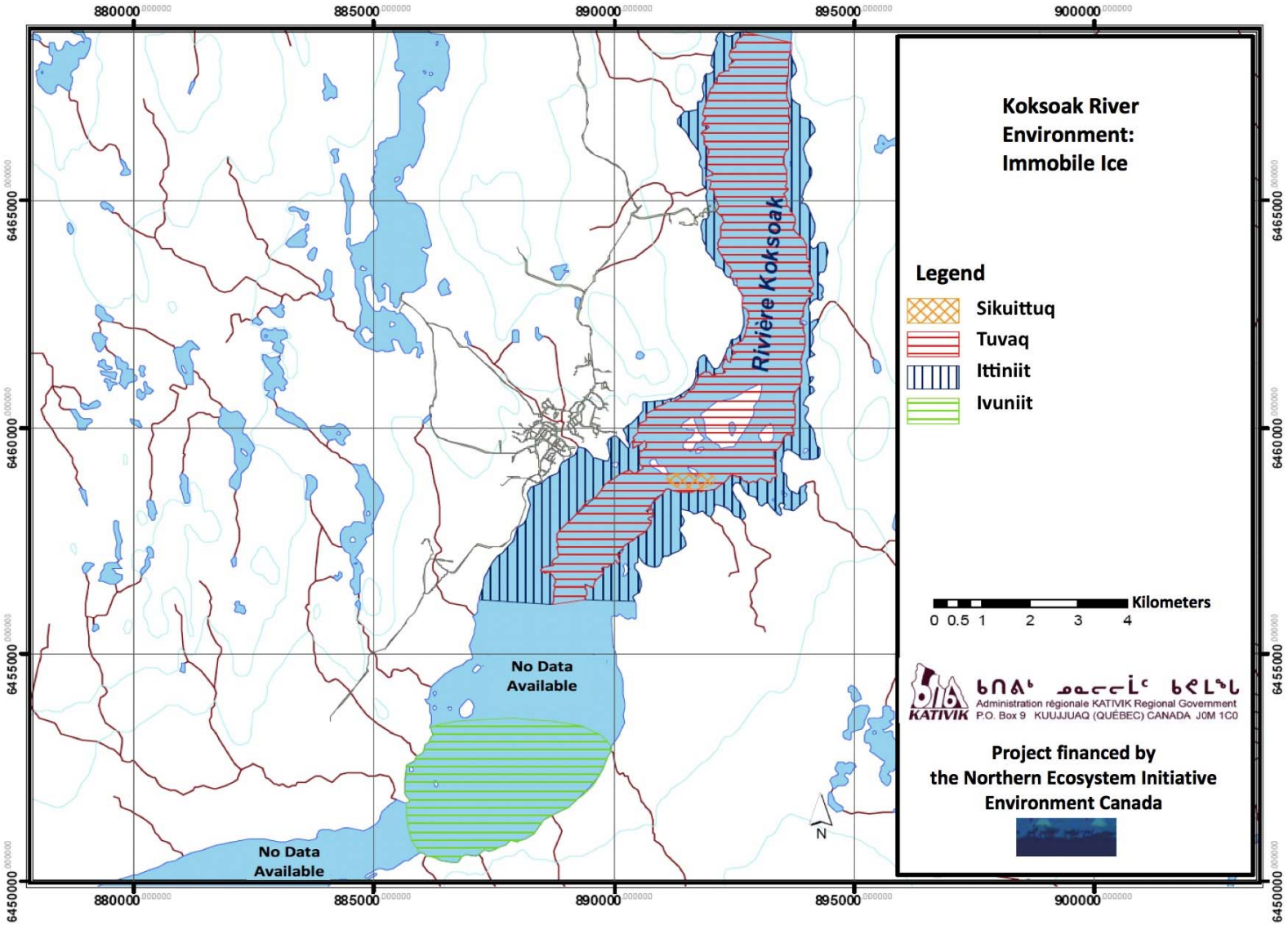


Figure 4-10: Map of immobile ice on the Koksoak River.

4.2.2 Tides, water levels, flooding and currents.

The validation-workshop experts indicated that tides have been more noticeable in the Koksoak River since the diversion of the Caniapiscau River (Kaniuapiska). Among other information, they indicated that the flooding tide is stronger than before. The validation-workshop experts nonetheless specified that, contrary to the information recorded during the initial workshop, river currents are not stronger since the diversion, but rather weaker. It is possible that there was confusion between the river currents and the tidal currents.

Regarding periods of high and low water levels, one of the validation-workshop experts suggested a rationale to explain the high water levels that can occur in September. In his opinion, strong winds from Ungava Bay can have a significant impact on water level. It was also was confirmed that the average water level at low tide on the Koksoak River has dropped by roughly three metres since the diversion (Figure 4-11). One of the validation-workshop experts indicated that he had observed an approximately eight-foot (2.5-m) drop of the water level upstream from Kuujjuaq. According to the validation-workshop experts, lower water levels may be observed upstream from Cape Whale. As indicated in the initial report, navigation is difficult due to several shallow areas and boulders that are now exposed to the extent that summer sealift ships are no longer able to reach the marine infrastructure.

The upstream tidal limit on the Koksoak River was corrected. According to the validation-workshop experts, there was a misunderstanding and the distances should be in miles not kilometers. This means that the tides affect water levels as far as 30 mi upstream from Kuujjuaq around the new and full moons and as far as 15 mi upstream from Kuujjuaq halfway between the new and full moons. The validation-workshop experts also indicated these changes directly on the map which, following measurement, put the high tide boundaries at roughly 15 and 20 mi upstream from Kuujjuaq (Figure 4-11).

The initial-workshop experts indicated that to their knowledge and during their lives, the water levels observed in the summer of 2008 were the lowest ever (figures 4-11 and 4-12). The validation-workshop experts added that the low water levels observed in 2010 were even more extreme than in 2008. They referred in particular to the unusual tides at the beginning of October for which low-tide water levels were the lowest ever observed (Figure 4-13). It was the same for the high tides where the water almost covered the tops of the walls of the marine infrastructure (Figure 4-13). It seems that such an event

might also have occurred in September, 10 to 15 years earlier, although this earlier event was less extreme than in October 2010.

Table 4-2: Tides, water levels, flooding and currents summary

- The highest water levels occur in June and sometimes in September;
- The lowest water levels occur at the end of winter and in the fall;
- Flooding occurred three times: May 1979, September 1970 and in August or September 1945 or 1946;
- Since the diversion of the Caniapiscau River, the low water levels at low tide makes navigation difficult due to obstacles and the cargo ships can't go all the way to the marine infrastructure;
- Water levels during summers of 2008 and 2010 were extremely low;
- Marine infrastructure could not be used at low tide during the extremely low water levels period in the summers of 2008 and 2010;
- Tides around the time of the new and full moons affect water levels as far as 20 to 30 miles upstream from Kuujjuaq;
- Tides halfway between the new and full moons affect water levels as far as 15 to 20 miles upstream from Kuujjuaq;
- Water currents are weaker halfway between the new and full moons;
- Water currents are stronger around the new and full moons;
- Tides have greater effects on the river since the diversion of the Caniapiscau River (Kaniuapiska) in 1985 and ebb tides are particularly strongere.

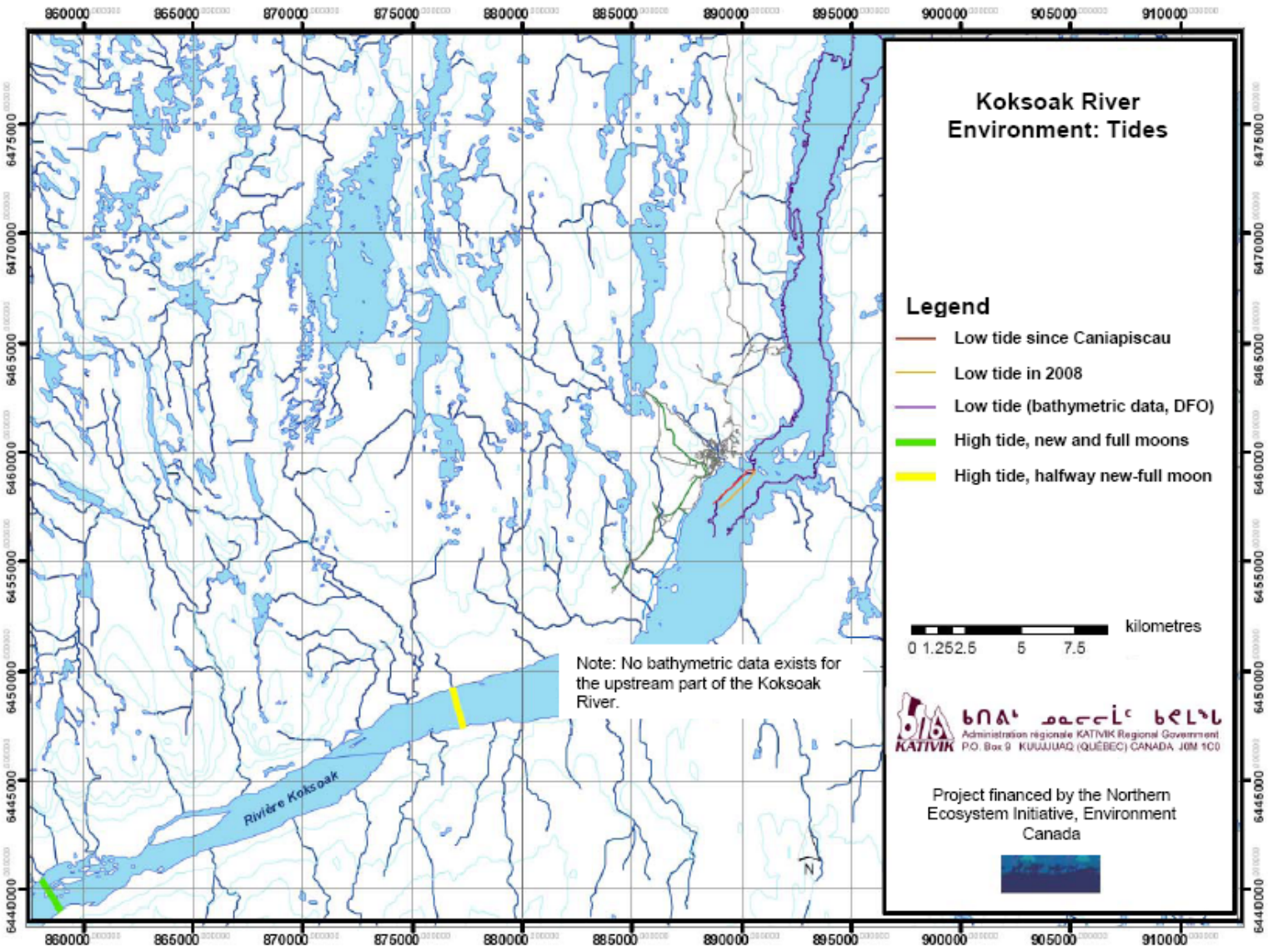


Figure 4-11: Map of high and low tides on the Koksoak River.



Figure 4-12: Average low tide mark at the marine infrastructure at Kuujjuaq (Source: Google Earth).



Figure 4-13 : Extreme water levels cause by the tides, beginning of October 2010 (Source: INRS and KRG).

4.2.3 Drift Ice Erosion and Sedimentation

The validation-workshop experts did not completely agree with the information presented in this section and in figures 20 and 21 into initial report (Tremblay *et al*, 2009). First regarding drift ice erosion, the validation-workshop experts confirmed that ice does in fact get pushed and piled up along the shoreline, and may move rocks; notwithstanding, they indicated that there was no significant erosion occurring along any particular portions of the river. In fact, the validation-workshop experts indicated that erosion has diminished with the weakening of the river currents since the diversion of the Caniapiscau River (*Kaniuapiska*). Consequently, the drift ice erosion zones indicated on Figure 20 (here, Figure 4-14) were removed. One zone where rocks tend to be moved by drift ice was identified and added to the map, although the validation-workshop experts indicated that this phenomenon may occur anywhere in the centre of the river where the currents are strongest. Regarding sedimentation, the validation-workshop experts indicated that, every spring, the bed of the river is different (deeper zones may be filled in and shallower zones may be dug out) and that this process is affected by the tides. The validation-workshop experts nonetheless agreed that sedimentation occurs especially in front and downstream from Kuujjuaq. They indicated that some zones become shallower year after year and that this was the case prior to the diversion of the Caniapiscau River (*Kaniuapiska*), which is not to say that sedimentation has not intensified since the diversion. The river's lower water level likely has an impact on sedimentation in some zones. Regarding the 2008 sedimentation zone indicated on the map, they recalled that a ship had settled on the bottom in this zone that summer, which explains why a particular zone was identified that year.

Finally, the validation-workshop experts confirmed that drift ice piles up along the walls of the marine infrastructure and may cause damage, although they specified that they were not aware of the details of any damage caused by drift ice and strong currents. The validation-workshop experts indicated that the marine infrastructure was constructed at this location because the currents are less strong, reducing the risk of damage. They recommended that Jimmy Gordon Sr., who is responsible for marine infrastructure maintenance, be contacted for more specific information. The validation-workshop experts also indicated that when ice becomes jammed at Cape Whale, more rocks and boulders tend to be shifted when the jam breaks. The validation-workshop experts concluded that, because ice cover is becoming progressively thinner year after year, these conditions may continue to change. For example, the ice may

one day become so thin that it simply melts away, reduce the river substrate changes produced by drift ice during the spring break-up.

Table 4-3: Drift ice erosion and sedimentation summary

- Possibility of drift ice erosion in the river, but no precise zone of erosion identified;
- Sand sedimentation is variable from year to year and the main zones of accumulation are in front of Kuujjuaq and downstream from Whale Point; accumulations are more significant since the diversion of the Caniapiscau River (Kaniuapiska);
- A sand sedimentation zone was observed in the summer of 2008 downstream from the marine infrastructure;
- The ice often causes boulders movement in the river, mainly in the center of the river and where currents are the strongest.

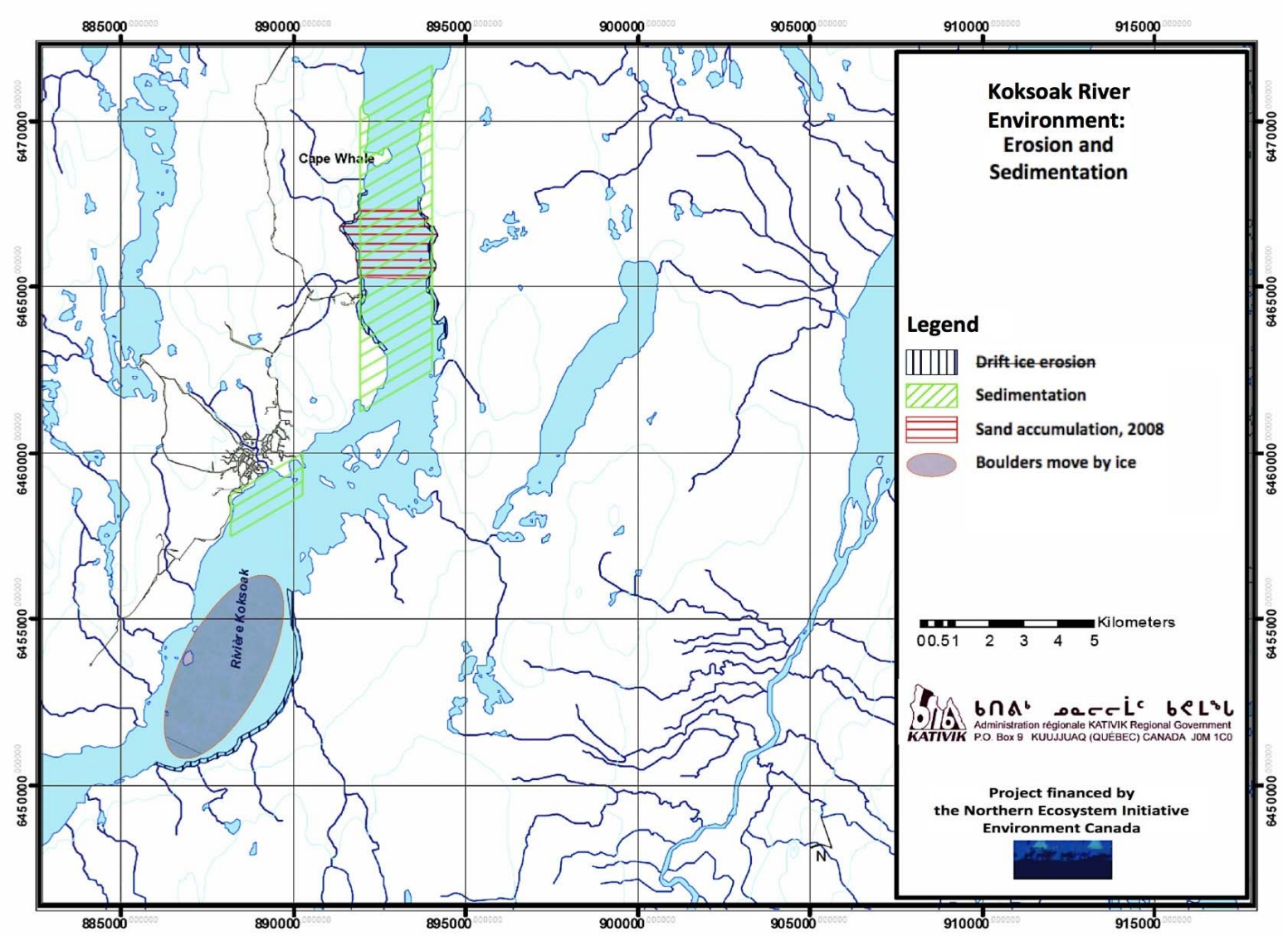


Figure 4-14: Map of drift ice erosion and sedimentation in the Koksoak River.

4.2.4 Marine infrastructure at Kuujjuaq

Most of the information presented in this section was validated, except regarding damage caused to the infrastructure by ice since, as indicated above, the validation-workshop experts specified that they were not aware of the details of any damage. The validation-workshop experts also indicated that the water levels observed in 2010, in particular in October, were more extreme than the water levels observed in 2008.

Table 4-4: Marine infrastructure summary

- The marine infrastructure in Kuujjuaq are used frequently for hunting and fishing activities in summer;
- In the summer of 2008, the water level was low and boulders were close to the surface of the water;
- Marine infrastructure may be affected by drift ice erosion in the winter.

4.3 Use of Koksoak River

No corrections needed to be made to the maps showing snowmobile trails and boat routes. The only clarification made by the validation-workshop experts was that travel is becoming more and more difficult due to more extreme conditions, unpredictable ice and weather conditions, and the increased presence of trees and bushes (problematic for snowmobiles and all-terrain vehiclese.

4.3.1 Travel by snowmobile

Table 4-5: Travel by snowmobile summary

- Traditional dogsled trails are still used by snowmobilers;
- The section of the Koksoak River between Whale Point and the river mouth no longer freezes in winter, since the 1970s;
- Kuujjuamiut use an alternative trail that runs parallel to the Koksoak River to travel to Ungava Bay;
- Ice on the Koksoak River is now rougher making travel more difficult and slower, since the diversion of the Caniapiscau River.

4.3.2 Travel by boat

Table 4-6: Travel by boat summary

- Koksoak River downstream from Kuujjuaq: accessible regardless of whether the tide is ebbing or flowing;
- Koksoak River upstream from Kuujjuaq: accessible only when the water level is high;
- Caniapiscau River (*Kaniuapiska*): no longer navigable;
- Larch River (*Kuujjuaq Tarrasiq*): used more often since the diversion of the Caniapiscau River (*Kaniuapiska*) but punctuated with rocky shallows that can damage boats;
- The low water level of the Koksoak River has modified access routes to traditional caribou hunting areas;
- Belugas are no longer observed upstream from Kuujjuaq.

4.4 Conclusions et recommandations

At the validation workshop, the main changes made involved Inuktitut terminology, the strength of the currents in general, the tidal zone, drift ice erosion and sedimentation zones, as well as the level of damage caused to marine infrastructure. Additional clarifications were made and supplementary information was also obtained, specifically for the two years that had elapsed since the initial workshop. Notwithstanding, conditions are so variable that the validation-workshop experts indicated that, for several years, they have found it difficult to describe the river environment. The current year has been especially different and marked by extremes: very low water levels and the very late formation of ice.

Further to a review of the recommendations, the validation-workshop experts explained the rationale behind two of their recommendations regarding the regulation of water flow through the Caniapiscau River diversion structure. Water is currently diverted in order to improve navigation and access to this section of the river during the caribou hunting season. The validation-workshop experts indicated that, when the decision was made to divert the river, it was agreed Inuit would be informed regularly of any changes in water flow. According to the validation-workshop experts, Kuujjuaq residents do not receive adequate information in this respect, despite it being important for the safety of river users who must be prepared for changes in water flow through the Caniapiscau River (*Kaniuapiska*) diversion structure. As Inuit use small watercraft, such as freighter canoes, a sudden increase in water flow and current strength represents a significant danger. Emphasis should therefore be placed on the first two recommendations.

A new recommendation should also be added. As discussed above, it is important that the information collected at workshops such as this one be validated before publication. Preferably, this validation should be carried out as quickly as possible after the information has been collected, especially in the context of a continually changing Northern environment.

5. General Conclusion

On one hand the group workshops with resident's experts of three Nunavik communities made it possible to document numerous observations on recent changes in ice formation and regimes in this part of Canadian Arctic. There seems to be a consensus as to the fact that pack ice forms later than in the past (between one and two month delay depends of the region) and that it also breaks up more rapidly than before (from three to six weeks earlier). The harvest season during winter, for those who still practice this kind of activities, has largely decreased.

On the other hand, changes in winds and precipitation patterns were observed in each community: stronger winds but less consistent, more violent storms, precipitation falling mostly as rain rather than snow and some seasons (autumn and spring) drier than before. In general, residents in Nunavik are agree that it is increasingly difficult to predict the weather and thus to anticipate their travels for harvest activities. At the same time, several animal species already appear to suffer the effects of climate change since they have changed their migration routes.

Moreover, the risks associated with Inuit's travels on the land have strongly increased. In winter, the main dangers are the fissures and pile-up that can occur in certain sectors, sensitive to the tides or currents. During fall and spring, the growing instability of the ice has become a serious problem for residents of Nunavik, and forces them to change some of their roads and adapt their habits according to those new ones. However the changes in transportation have led inevitably a change in the perception of their environment by Quaqtamiut. And, they are less dependent today on nature for their livelihoods than they were fifty years ago. Therefore, they spend less time on the ice and also take fewer risks at the beginning and the end of ice cover period.

Regarding to the marine infrastructures, it is difficult to assess the proportion of people who use them and it differs among communities. Nevertheless, in the three villages of this study, the residents seem to be pleased by the construction of these infrastructures. Some recommendations were outlined during the consultation of each village.

To finish, these workshops have documented some of the local and traditional knowledge about the marine environment in Quaqtaq Peninsula, Guillaume-Delisle Lake (Umiujaq), and Koksoak River (Kuujjuaq). The weather and environmental changes observed by local experts corroborate the observations collected by Tremblay and Furgal (2008) in six other communities in Northern Quebec. At the same time, discussions on the construction, maintenance and future of the infrastructures have been made. Finally, some words from the vocabulary of each region have been identified, primarily associated to the marine environment, as to the type's conditions of ice.

To conclude, these three reports present only the validated observations and conclusions from the workshops conducted in the three communities. Although meetings and exchanges between, elders and between communities had occurred during the group meeting from November 22 to 26, 2010, no information on them will appear in this report. Another publication, dealing specifically with these exchanges, around security, transmission of traditional knowledge and adaptation to climate change is being prepared.

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Annexe 1 :

Final questionnaire used for Umiujaq workshop.

Some modifications were made compared to the first version used in February 2009 in Kuujjuaq. However, the course of the workshop and the questions remained similar.

KRG Marine Infrastructure and Environmental Change Workshop Package (Information Sheet, Consent Form, and Interview Guide)

and

INRS-ETE

PROJECT LEAD:

RENEWABLE RESOURCES DEPARTMENT

KATIVIK REGIONAL GOVERNMENT

1.1 Overview

This workshop is focused on changes Nunavik residents have noticed in the marine environment and key processes related to important environmental issues (.g. ice formation, break up, dynamics, tides, currents, high and low water levels etc). The workshop is particularly interested in changes that are important for existing marine infrastructure developments in Nunavik communities. The initiative involves the conduct of a workshop lasting approximately 2 days (4 hrs / day) which will be recorded using a digital audio recorder and mapping exercises. This project is being led by Kativik Regional Government, Renewable Resources Department, and is being done in cooperation with Institut national de recherche scientifique - Environnement Terre et Eau (INRS-ETE). The workshop will follow this order:

Day 1:
Opening of Workshop (Prayer or other opening at the choice of community participants)
Presentation of the team and the objective of the workshop
Discussion of changes in sea ice conditions

Day 2:
Trip in the community (facilitators and guide only) to photograph key infrastructures and issues raised on Day 1
Discussion of changes in sea ice conditions (cont'd)
Discussion of use of the area (hunting and harvesting practices and routes)
Payment of the honorarium
Close of Workshop

Honorarium
$165 per day

Consent Form

I am aware of the Environmental change and marine infrastructure workshops which are being conducted by Kativik Regional Government, in cooperation with INRS-ETE. I understand the intent of the workshop as explained to me by the researcher, _____. I have been informed and understand what it means to volunteer to be involved in the workshop discussions, and I consent to be involved in a workshop and mapping activity that will last approximately 4 hours for each of two days. I understand that I can withdraw from the workshop at any time, without prejudice, and if I withdraw no information I have provided will be used in any way.

I consent to be involved with the following activities:

Involvement (check all that apply)

I agree to take part in an:

___ Workshop / interview

Recording (check all that apply)

I agree to have my contributions to the project recorded using:

___ audio recording

___ audio & video recording

___ photographs

___ maps

Identification and Sharing of Information

I understand that my confidentiality will be respected. No personal identifiers such as my name will be utilized and the information I provide will be used in a collective sense. However, if there are circumstances where the researcher wishes to use a direct quote from my interview in any publication, I give them permission: **yes** ☐ **no** ☐

If ***yes***, I would like to have pseudonyms used instead of my name ☐

or I would prefer to be attributed by my real name ☐

Print name: _____ Verbal consent, check here: _____

Sign name: _____Witness: _____

Date: _____

If I have any questions or concerns about this project, or the consent that I have provided, I will contact the researchers involved or the Environment and Resources Department at KRG using the following information:

Michael Barrett or Melissa

Kativik Regional Government

Tel: (819) 964-2961 ext. 2322

Kuujjuaq, Nunavik

Yves Gauthier, Monique Bernier or Stephanie

INRS - ETE

Tel: (418) 654-3753

Quebec City, QC

– Protect this form when filled –

Interview/Participant Index

Participant information

Name: _____ Birthday: _____

Last First yyyy-mm-dd

Gender? M F Present community?

Years in present community? Where born?

What other communities lived in? When have you lived in other communities?

Interview information

Date of the interview: _____ Location of the interview_____

yy-mm-dd *(general description; address; coordinates)*

Translator:_____ Researcher/interviewer:_____

Last *First* *Last* *First*

Other people present (workshop participants/interviewer): _____

_____

_____

Consent form: ☐ Yes at interview ☐ Yes after interview

Other information: _____

_____

_____

– Protect this form when filled –

Workshop / Interview Guide

INTRUCTIONS TO FACILITATORS

PLEASE BE SURE TO ORGANIZE YOURSELVES WELL….IDEALLY THE WORKSHOP SHOULD BE CONDUCTED WITH ONE INDIVIDUAL LEADING THE DISCUSSION AND OTHER(S) IN SUPPORT RECORDING INFORMATION ON MAPS, TAKING PHOTOS AND VIDEO CLIPS OF THE WORKSHOP PROCESS ETC. WHEN SOMETHING IS SKIPPED OR ONE OF THE FACILITATION TEAM WOULD LIKE TO ASK FOR MORE DETAILS, BE SURE TO DO SO IN A WAY THAT DOES NOT INTERRUPT THE FLOW OF THE DISCUSSION…. TO PARTICIPANTS IT SHOULD BE CLEAR THAT THERE IS ONE PRIMARY PERSON LEADING THE DISCUSSION, NOT 2 OR MORE.

FOR ALL TOPICS AND QUESTIONS, PLEASE BE SURE TO RECORD INFORMATION ON THE MAPS ASKING ABOUT LOCATION AND TIMING OF CHANGE/IMPACT WITH AS MUCH DETAIL AS POSSIBLE. ALSO BE SURE TO ALLOW ALL PARTICIPANTS TO IDENTIFY THEIR OWN CHANGES AND OBSERVATIONS IF THEY HAVE SOMETHING ADDITIONAL TO ADD TO THE MAJORITY VIEW. THERE DOES NOT HAVE TO BE CONSENSUS AMONG THE GROUP TO RECORD THE INFORMATION.

ADDITIONALLY, PLEASE ASK PARTICIPANTS IF THEY HAVE ANY PICTURES OF THE CHANGES THEY HAVE NOTICED OR THEIR IMPACTS ON THEIR HUNTING / TRAVELING OR LIVELIHOOD ACTIVITIES OR PICTURES OF CHANGES IN THE ENVIRONMENT THAT ARE PARTICLARLY IMPORTANT FOR THE MARINE INFRASTRUCTURE IN THEIR COMMUNITY. PLEASE ASK IF PICTURES CAN BE USED FOR THE WORKSHOP REPORT AND PROJECT. ALL PHOTOS WILL BE SCANNED AND RETURNED TO THE OWNER AS SOON AS POSSIBLE.

1.2 INTRODUCTION TO WORKSHOP PURPOSE AND OBJECTIVES

This workshop is focused on changes you have noticed in the marine environment and key processes related to important environmental issues (e.g. ice formation, break up, dynamics, tides, currents, high and low water levels etc). The workshop is particularly interested in changes that are important from the perspective of marine infrastructure developments that already exist or are proposed to exist around your community. So, we will discuss, in general changes you have noticed in the seasonal patterns of events and formations in the marine environment but also ask you to specifically note those things that are important for the infrastructure projects in or around your community.

A report will be prepared and circulated to the communities by March 2010. You will receive a copy of this report, along with other decision makers and participants in your community and the other participating communities.

1.3 SECTION 1

1.4 Topic #1: Seasonal Sea Ice Patterns and Changes

1. When (month, week) does the sea ice typically start to form around the community? How long does it typically take to form ?

2. Where does ice typically start to form first? Where does ice typically form last?

3. Can you explain to me the processes and formations of ice freezing and formation (including Inutituut terminology or words to describe key processes or formations)?

4. What factors influence the formation ? speed up the formation / slow down the formation (e.g. wind, temperature, tides, currents, water level/depth)

5. During the time when the ice is forming can you point out areas where there are typically areas of (please emphasize areas associated with locations of marine infrastructure on the map):
    a. Multi year ice
    b. New ice
    c. Land fast ice
    d. Ice/open water edges
    e. Open water

6. Can you tell us the names of these features (listed in #5) in Inutituut? (write them down)

7. Has anything about the timing or process of sea ice formation changed from what you can remember? (please also indicate when you started noticing it changing)
    a. Timing? (Be as specific as possible, i.e. early, mid or late September)
    b. Length of time to freeze? (Be as specific as possible)
    c. Other ways? How? Approximately when did this element start to change?

8. When (month, week) is the ice typically safe and stable for travel and hunting?
    a. How can you tell ? (what cues do you use)
    b. Has this time changed from when you can remember? How? When?

9. During the time when the ice is stable and safe for travel and hunting is the location of the different ice formations or kinds of ice (first year, multi year etc) different from what you have already indicated during the time it is forming? (Please mark on the map; please emphasize areas associated with locations of marine infrastructure on the map)

10. When the sea ice is stable, has anything changed about the sea ice conditions around the community or region from what you can remember? (Please describe and where appropriate, mark on the map; please emphasize areas associated with locations of marine infrastructure on the map):
    a. Formations (e.g. pressure ridges, areas of major ice rafting/pile-up, open leads etc)
    b. Stability
    c. Dangerous areas
    d. Areas of open water
    e. Etc

11. What environmental factors influence the ice while it is formed and stable? (e.g. tides, currents, winds) and how do they influence ice stability and movements ?

12. When (month, week) does the ice typically start to break up? How long does it typically take to break up?
    a. Has this timing changed from when you can remember? How? When?

13. Can you explain to me the processes and formations of ice melting and break-up (including Inutituut terminology)?

14. Has anything changed about the process of break up of the sea ice around the community in your memory? (please also indicate when you started noticing it changing)
    a. Timing? (Be as specific as possible, i.e. early, mid or late May)
    b. Length of time to break-up? (Be as specific as possible)
    c. Other ways? How? Approximately when did this element start to change?

15. What factors influence the melt and break-up of sea ice ? speeding up or slowing down the melting or break-up (e.g. wind, temperature, tides, currents, water level/depth)

16. During the time when the ice is melting / breaking up is the location of different ice formations or kinds of ice (e.g. first year Vs multi year) different from what you have already indicated during the time it is forming or stable ?(Please mark on the map) (please emphasize areas associated with locations of marine infrastructure on the map)

17. When is it typically no longer safe for travel?
    a. How can you tell ? (what cues do you use)
    b. Has this time changed from when you can remember? How? When?

Topic #2: Tides, Currents, Water Levels and Shore Lines

18. Has anything changed about the tides and tidal fluctuations around the community since you can remember? If so, what has changed ? (height of high tide, level of low tide, average water level; frequency of tidal fluctuations etc.) Please identify where these changes have been noticed and be as specific as you can about the levels you mention

19. Has this had any impact on your transportation during the winter ? (If so, please explain and identify where this has been the case)

20. Has this had any impact on your transportation during the summer ? (If so, please explain and identify where this has been the case)

21. Are there areas where the current is much stronger than elsewhere around the community ? (please identify those locations on the map) Does the location of these currents have any impacts on your travel or hunting activities ?

22. Are there times when those currents are stronger than at other times ? (If so, please indicate when and where) Does the location or timing of the currents have any impacts on your travel or hunting ? (in summer or winter) If so please explain.

23. Has anything about the currents changed over time ? (if so, please explain and be specific as to when you noticed things change and how this change has impacted you, in any way)

24. Have you observed any change regarding the shoreline around your community ?
    a. Mobility of the ice? If yes, how has this changed, when and where?
    b. Accumulation of the ice? If yes, how has this changed, when and where?
    c. Erosion of the shoreline ? If yes, how has this changed, when and where?

Topic #3: Use of Existing Marine Infrastructure

25. On a weekly basis, how often (# times / wk) do you use the (insert community name) marine infrastructures during the :

    Summer ?

    Fall ?

    Winter ?

    Spring ?

26. Have you observed any problems with the use of the marine infrastructures in (insert

community name)? If yes, what problem(s) and when did you first notice this / these? (ie. stability, upkeep, maintenance, utility. design, damage, etc)

27. Have you observed any specific changes regarding the marine infrastructure and its suitability for use in your community (e.g. water depth, rock positioning, obstacles, etc.). Please identify what the changes are, the cause of these changes and when you noticed it, if possible.

1.5 SECTION 2

1.6 Topic #4: Harvesting History and Sea Ice/Marine Environment Use

1.6.1 For this section go through all questions by 'season': A. Fall - as the ice is forming and when it is just formed, B. Winter - while the ice is well formed and stable, C. Spring - while the ice is breaking up, and D. Summer – during the nearly or completely ice free season). For all questions, focus on marine environment use only and any use that is specifically adjacent to the existing marine infrastructure in the community.

FOR SPECIES IDENTIFICATION PLEASE USE THE FOLLOWING CODES ON THE MAP (create new codes where required for common species available to the community) or other notation so that purpose of route use can be identified on workshop report maps:

Polar Bear = PB Fish = F Seal = S Goose = G

1.6.2 *Beluga = BL Fox = FX Walrus = W Others = O (specify)*
Bowhead = BO Muskox = MU Caribou = CR

1. During _____(fall/winter/spring/summer) how often do you go hunting or fishing on the sea ice or water or via a route using the sea ice or water ?: (Example: twice a week, on weekends, once every 2 weeks)

2. Can you please mark on the map the places you typically / usually go during this season (or period of the year) to go hunting / fishing? (cycle through the 4 seasons)

3. Can you identify for each route the mode of transportation you use to travel that route ? (If possible, use colour coding for mode of transportation OR develop coding (e.g. Skidoo = SK) and write on map the mode of transportation so that it can be identified in workshop report)

Ski-doo	**Blue**	**Dogteam**	**Purple**
Honda	**Orange**	**Kayak**	**Green**
Walking	**Black**	**Canoe**	**Yellow**
Speedboat	**Red**	**Peterhead**	**Brown**

4. Are there any difficulties or hazards (dangerous areas) associated with these routes? (Dangerous places? dangerous times to use them? etc.)

5. Have you had any accidents or unexpected happenings while using any of these routes? (If yes, please identify where, and what happened, when did it happen, where did it happen, what was the result/damage or other of the event?)

6. Are these difficulties/hazards things that have always been there or is this something recent (e.g. much more stormy and therefore dangerous to travel a certain route ? much more dangerous to take a certain route because the ice is now much less stable than it used to be at a particular time of the year ? etc)

7. In your opinion, what caused these changes? What are they related to?

8. Which routes do you use most often during the year? Which are most common or important for all seasons ?

9. Have you stopped going to or abandoned any harvesting sites (not used any more)? When? Why? What was it used for before? (Please mark these on the map)

10. Have you stopped going or abandoned any routes (not used any more)? When? Why? What was it used for before? (Please mark these on the map)

11. Can you please mark on the map the areas/location of other species that you see or hunt in the marine environment or near the marine infrastructure in your community that have not been mentioned? (Use codes above)

12. In general, has anything else changed about your hunting/fishing during (insert season) that we have not talked about? (changes in animals, environment, travel routes, equipment, opportunities to hunt etc). (Please explain and mark on the map if appropriate).

1.7 CLOSING

Is there anything else you think we should know about but have not discussed in order to learn about changes in the marine environment (sea and sea ice conditions etc) around your community that you think are important for understanding the safety and security of marine infrastructure developments? Or are there others things you would like to add?

1.8 THANK YOU

Thank you for your time and sharing your information in this workshop.

The workshop team held a workshop in (name previous communities and times) and will also be holding a workshop in (name next communities and times). In all workshops, experts, like yourself, are being asked to discuss similar issues in relation to their communities. A report will then be prepared and returned to you in March 2010.

If you have any questions about the project or the information you shared please contact any of the people listed on the Consent Form to get more information.

Thank you!