

***Renforcement des capacités et sensibilisation face aux
changements climatiques pour la gestion publique locale et
la planification territoriale au Nunavik***

Projet 520005-120

Rapport final



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***Renforcement des capacités pour la gestion publique locale
et la planification territoriale au Nunavik et sensibilisation
face aux changements climatiques***



Les résultats et opinions présentés dans cette publication sont entièrement la responsabilité des auteurs et n'engagent pas Ouranos ni ses membres.



Table des matières

1. Introduction	3
2. Objectifs	4
3. Cadre théorique / compte-rendu de la revue de la littérature	5
4. Méthodologie	5
5. Résultats	7
6. Analyse et discussion	9
7. Conclusion et recommandations	9
8. Références	12
Annexes	13

1. Introduction

Les municipalités du Nunavik ont la responsabilité du développement et de la gestion de leur territoire de même que la construction et le maintien des infrastructures municipales. L'offre de services municipaux de qualité constitue un important défi pour les villages nordiques car ils doivent faire face à un bassin de population restreint pour trouver des employés, un niveau de scolarité relativement faible et un taux de roulement très important. Il est donc difficile de développer une expertise et aussi de transférer les connaissances acquises.

Dans le contexte où les régions nordiques subissent les effets des changements climatiques et que parmi les vulnérabilités, la manière de planifier, développer et gérer le territoire peut aggraver ou atténuer les impacts, les municipalités peuvent jouer un rôle important en matière d'adaptation aux changements climatiques. Cependant, les capacités liées à la gestion et au développement du territoire aux échelles locales et régionales doivent être renforcées afin que les employés municipaux puissent faire le lien entre leurs actions et les enjeux associés aux changements climatiques.

2. Contexte

Le Nunavik est la région du Québec située au nord du 55^e parallèle qui couvre un peu plus de 500 000 km². On y trouve 14 communautés inuites dispersées principalement le long de la côte. Elles ne sont ni reliées entre elles ni reliées avec la partie sud de la province par des voies terrestres. Elles sont seulement par avion à l'année ou par bateau durant la saison estivale. Le nombre d'habitants par village varie entre 200 et 2300, totalisant environ 12 000 pour l'ensemble du Nunavik. Compte tenu de l'immensité du territoire, le climat au Nunavik est variable. Ainsi, du sud vers le nord, on passe d'un climat subarctique à un climat arctique. La température moyenne annuelle varie entre -5°C et -10,8°C, ce qui crée des conditions favorables au développement de pergélisol.

Au moment de la création des villages nordiques, vers la fin des années 70, le développement était assuré par le gouvernement provincial qui s'occupait à la fois de planifier les villages, de subdiviser le territoire en lots et de gérer les infrastructures et les immeubles. Les municipalités du Nunavik se sont appropriées progressivement ces responsabilités et leur expertise en la matière se développe graduellement. Leur défi consiste à répondre adéquatement à la demande grandissante en services municipaux de qualité et durables pour une population en croissance rapide. Cette croissance se reflète non seulement par la construction de nouvelles maisons, mais aussi de nouvelles routes dans les villages.

Malgré le soutien apporté par l'Administration régionale Kativik aux villages nordiques, ces derniers font maintenant face à une nouvelle réalité : les changements climatiques. De nombreuses études ont fait part de l'augmentation des températures, notamment au Nunavik et plusieurs conséquences sont observées à l'heure actuelle. La dégradation du pergélisol par exemple, qui est un processus déjà bien amorcé dans les différents villages du Nunavik (Allard *et al.*, 2006; 2007; 2009; Calmel *et al.*, 2008). L'augmentation de l'épaisseur du couvert de neige et des volumes d'eaux de ruissellement contribuent également à la dégradation du pergélisol. Par conséquent, la façon de gérer la neige lors des activités de déneigement, le design et l'entretien du réseau de drainage peuvent contribuer à la dégradation du pergélisol. Cette dégradation cause actuellement de nombreux dommages aux infrastructures en place (dépressions du sol et tassements différentiels provoquant des problèmes aux bâtiments,

glissements de terrain en bordure des routes et fissures sur la chaussée, etc.), parfois au point de les rendre non fonctionnelles à moins de travaux de réfection majeurs. Il s'agit d'une problématique inquiétante considérant les projections de certains modèles climatiques qui indiquent que cette tendance se poursuivra (Sushama *et al.*, 2007; IPCC, 2007) alors que, à l'exception de Kuujuaapik qui est le plus méridional des villages, tous les villages sont situés en zone de pergélisol (Allard *et al.*, 2007).

Ce besoin réel de fournir les outils et les connaissances qui favoriseraient un développement et une gestion durable du territoire s'observe à partir de quelques exemples. La problématique de dégradation du pergélisol dans la communauté de Salluit en est un bon, où l'ampleur du problème semble accentuée par certains modes de déneigement ou de drainage des eaux, par l'utilisation de machinerie lourde dans des zones sensibles, par la construction de bâtiments chauffés placés directement sur le pergélisol, etc. La vulnérabilité de la municipalité face aux effets de la dégradation du pergélisol pourrait ainsi être grandement diminuée par une meilleure compréhension du phénomène et une amélioration des pratiques de gestion du territoire et d'entretien des infrastructures.

Les connaissances en matière d'impacts et d'adaptation aux changements climatiques sont récentes. De nombreuses études portent sur le sujet, notamment pour les milieux nordiques. Considérant l'urgence d'intervenir et de modifier certaines pratiques qui peuvent à terme influencer l'ampleur des impacts, il est essentiel que l'information disponible soit partagée afin d'améliorer la capacité des acteurs en place à mieux gérer le territoire et promouvoir un développement plus durable.

3. Objectifs

Le présent projet vise donc à combler le besoin de sensibilisation et de formation en apportant des outils et des connaissances aux différents acteurs municipaux concernés. Plus précisément, le projet permettra de sensibiliser les décideurs, gestionnaires et travailleurs municipaux face aux impacts des changements climatiques, de même que de leur fournir des outils pour améliorer la gestion du territoire et renforcer la capacité d'adaptation locale dans le but d'atténuer ces impacts. Un des objectifs du projet est de voir, entre autres, cette sensibilisation se propager à l'intérieur des municipalités via les gestionnaires et décideurs municipaux, une fois que ces derniers auront les connaissances et outils pour le faire. Les échanges entre les différents acteurs permettront également de valider l'information transmise, en plus d'approfondir les connaissances en lien avec les stratégies d'adaptation les plus pertinentes pour les municipalités de la région.

Les sous-objectifs du projet sont :

- 1) Résumer, sur la base d'une revue de documents et d'études existants, les impacts des changements climatiques pour les communautés du Nunavik qui ont un lien avec la planification territoriale et l'entretien des infrastructures municipales ainsi que les services municipaux pour lesquels l'adaptation de la gestion de ces activités et services permettrait de réduire la vulnérabilité des communautés face aux impacts attendus;

- 2) Identifier, sur la base de documents et d'études existants, des mesures d'adaptation qui permettront de réduire la vulnérabilité face aux impacts des changements climatiques sur les infrastructures et services municipaux;
- 3) Sensibiliser les décideurs et gestionnaires des municipalités aux changements climatiques et leur fournir des outils qui permettront d'accroître leur capacité à mieux orienter le développement et la gestion des services municipaux de façon à réduire les risques liés aux impacts des changements climatiques;
- 4) Sensibiliser les travailleurs aux changements climatiques et aux adaptations à prioriser dans les pratiques habituelles des services municipaux;
- 5) S'assurer de la pertinence et l'efficacité des adaptations retenues et de l'information transmise via les formations;

4. Cadre théorique / compte-rendu de la revue de la littérature

Ne s'applique pas au projet

5. Méthodologie

Les activités suivantes ont été réalisées dans le cadre du présent projet:

a) *Sondage auprès d'un échantillon de gérants municipaux ou autres représentants municipaux dans chaque communauté*

Le sondage a été mené en octobre 2010 auprès de représentants municipaux en personne ou par appel conférence. En tout, 18 personnes provenant de 11 communautés ont été interviewées. Pendant l'entrevue, les sujets suivants ont été abordés :

- Connaissances des changements climatiques et les impacts associés;
- Observations des impacts et modifications des pratiques;
- Enjeux spécifiques en lien avec les changements climatiques;
- Information et type de soutien requis.

b) *Revue de la littérature et production d'un document d'information vulgarisé sur les changements climatiques*

Ce document présente d'abord un état de situation sur les changements climatiques au Nunavik notamment sur l'habitation, les infrastructures municipales ainsi que l'accès au territoire et aux ressources. Il présente aussi l'importance de l'adaptation face aux changements climatiques en vue de réduire les impacts sur le milieu et les infrastructures municipales. Le document permettra aux travailleurs municipaux et à la population intéressée de saisir davantage la source des problématiques et d'ainsi mieux comprendre et intégrer les adaptations nécessaires.

c) *Rédaction d'un addenda au volume 5 (services municipaux) du Guide administratif – Villages nordique*

Le volume 5 *Guide administratif – Villages nordiques* traite principalement de l'entretien des bâtiments et des véhicules, ainsi que de la fourniture des services

municipaux. La version actuelle du guide ne prend pas en considération la vulnérabilité des municipalités face aux changements climatiques et ne prévoit donc pas les adaptations nécessaires pour réduire cette vulnérabilité. L'addenda proposé vise à combler cette lacune.

d) *Production d'outils d'aide*

Deux outils ont été produits afin d'aider les gérants municipaux et les employés municipaux pour leur travail quotidien. D'abord des fiches illustrées montrant des pratiques à adopter ou à éviter pour certaines opérations dont l'enlèvement de la neige ou l'entretien des ponceaux. Ensuite, des cartes ont été produites pour chaque village identifiant les sites propices à l'empilement de la neige de même que des endroits propices à l'accumulation d'eau.

e) *Formation dans les communautés avec les gérants et employés municipaux*

La formation a été donnée dans les villages entre le 22 janvier et le 27 avril 2012. Le formateur s'est déplacé dans chaque communauté. Le but de cette formation était d'aider les maires, gérants municipaux et employés de voirie à prendre en considération les impacts possibles des changements climatiques lors de la prise de décision et la gestion des travaux municipaux. Les travailleurs municipaux se sont vu offrir une formation pratique qui facilitera la transition vers les nouvelles méthodes de travail et façon de faire lorsque cela sera nécessaire.

Lors de la formation, différents représentants municipaux ont été rencontrés. La formation a été faite plus en profondeur avec les gérants municipaux et les employés de voirie. Le matériel de formation, c'est-à-dire les cartes de dépôts à neige et l'addenda au guide sur les services municipaux leurs ont été présentés. Les participants ont été invités à s'exprimer sur les différents effets des changements climatiques rencontrés dans leur village respectif.

f) *Atelier de fin de projet*

Cet atelier s'est déroulé le 11 septembre 2012 à Salluit. Le but de cet atelier était d'évaluer les outils développés de même que la formation qui a été offerte au début de l'année. L'atelier a mis l'accent sur deux points dont la gestion de l'enlèvement de la neige dans les municipalités et la construction des radiers, des routes et du drainage dans le cadre de la planification et la coordination du développement des nouvelles zones d'habitation.

Une partie de l'atelier s'est déroulée sous la forme d'une visite de site dans le village de Salluit afin de montrer aux participants différents enjeux auxquels le village fait actuellement face en lien avec les effets reliés aux changements climatiques. Les participants ont été en mesure de voir quelles sont les conséquences de la dégradation du pergélisol sur le paysage et les infrastructures, et aussi de voir des signes précurseurs d'événements causant des problèmes comme des glissements de terrain, des affaissements, de l'érosion, etc..

6. Résultats

Résultats du sondage :

Le sondage a permis de vérifier le niveau de connaissances concernant les changements climatiques dans les communautés. Ils ont d'ailleurs identifié les principaux changements observés dans les communautés :

- Changements dans les saisons (durée et calendrier);
- Changements dans la durée, la fréquence et l'intensité des événements;
- Difficulté croissante à prédire les conditions et patrons météorologiques.

Deux enjeux sont ressortis à la suite de ces sondages, à savoir :

- Les impacts sur l'accès au territoire et aux ressources;
- Les impacts sur l'environnement bâti.

Ce projet permet d'aborder le second enjeu, soit les impacts sur l'environnement bâti. D'autres initiatives avec l'ARK abordent le premier de ces enjeux. Le sondage a aussi permis de discuter des besoins en termes d'outils ou de formations, orientant ainsi la méthode et les livrables de ce projet. Le résumé de l'analyse de ces entrevues est présentée à l'annexe 1.

Document d'information sur les changements climatiques au Nunavik

Le document d'information complémentaire sur les répercussions des changements climatiques pour les communautés du Nunavik vise à expliquer aux travailleurs municipaux et à la population intéressée la source des problématiques et d'ainsi mieux comprendre et intégrer les adaptations nécessaires. Le document (annexe 2) a été distribué dans les bureaux municipaux des quatorze communautés.

Développement d'outils

- 1) L'addenda au volume 5 (services municipaux) du « Guide administratif – Villages nordiques » a été publié sous forme de fiches. Ce guide s'adresse principalement aux gestionnaires des villages nordiques. Il a été produit dans le but d'aider les gestionnaires dans leurs activités de planification, d'organisation, de direction et de contrôle des ressources de leur municipalité. Plus précisément, le volume 5 traite de l'entretien des bâtiments et des véhicules, ainsi que de la fourniture des services municipaux. Ce document est aussi accompagné de fiches présentant des pratiques à adopter ou à éviter lors de l'entretien de certains équipements municipaux. Cela favorisera la durabilité des infrastructures et services municipaux et contribuera à renforcer la capacité locale d'adaptation. Lors de la formation, les participants et principalement les opérateurs de machinerie lourde ont grandement appréciés

recevoir une copie personnelle du guide. Ils en ont tout de suite vu le côté pratique du fait que les pages de celui-ci soit plastifiées. Une copie est disponible à l'annexe 3 de ce rapport.

- 2) Des cartes pour chaque village nordique identifiant les sites propices à y disposer la neige provenant du déblaiement des routes et ceux où la disposition est à proscrire ont été réalisées. Ces cartes furent immédiatement adoptées par le personnel municipal et considérées comme un outil essentiel. La représentation par une vue aérienne fut appréciée par tous les participants car elle permettait d'y colliger toutes informations de façon très précise. Les sites d'empilement de la neige présentement utilisés par les autorités municipales ont été rapportés sur les cartes ainsi que celles où son accumulation est interdite. L'annexe 4 présente un exemple de carte réalisée.

Ces documents ont été colligés dans un cartable intitulé : *Adaptation to Climate Change in Northern Villages – Support documents for adapted municipal practices*. Ces documents ont été réalisés en prenant en compte les commentaires exprimés par les participants aux formations, favorisant ainsi l'appropriation des outils par les utilisateurs. Ces outils favoriseront le développement d'une expertise, où les impacts possibles des changements climatiques et les options d'adaptation les plus appropriées auront été identifiés grâce à des échanges entre les spécialistes et les intervenants locaux. Un cartable (avec versions en Anglais et Inuttitut) a été envoyé dans chacun des bureaux municipaux.

Formation dans les communautés

La formation a permis de rejoindre 59 personnes réparties dans toutes les communautés, soit en moyenne 4 personnes par communauté. Les maires, gérant municipaux et certains opérateurs de machinerie ont participé à cette formation. La formule de transfert de l'information qui fut retenue par l'ARK, c'est-à-dire de produire un guide explicatif d'usage pratique et d'en faire la promotion au moyen d'une visite dans chacun des villages par un représentant de l'ARK, fut très bien accueillie par les participants.

Le transfert de connaissances lors de cette formation ne s'est pas faite à sens unique, du formateur vers les participants, mais aussi des participants vers le formateur. Cette formule s'est avérée très bénéfique car elle a permis d'identifier certaines problématiques dans les villages dont l'enlèvement de la neige, l'entretien des ponceaux et aussi la planification des radiers pour la construction domiciliaire. Le transfert de connaissances de part et d'autre des intervenants est optimal lorsque les réunions se font dans les villages. Cette formule s'est avérée très bénéfique et devrait être reconduite si une seconde phase de formation devait avoir lieu.

Atelier de fin de projet

Cet atelier regroupait les gérants municipaux et quelques employés de voirie. L'atelier a permis de faire un retour sur ce qui a été réalisé dans le cadre de ce projet, notamment sur la pertinence des outils développés et leur validation, mais aussi sur la formation offerte. D'un côté, l'atelier a permis de créer des liens entre les gérants municipaux qui ont pu partager entre eux les problématiques qu'ils vivent dans leur communauté respective et les moyens pris pour faire face à ces problématiques. D'un autre côté, compte tenu de

l'endroit où s'est tenu l'atelier (Salluit), les gérants provenant de municipalités plus au sud du Nunavik, où les problématiques face aux changements climatiques sont moins prioritaires, ont pu en observer les conséquences et ainsi comprendre l'importance de l'adaptation. Ils ont aussi appris comment identifier des signes précurseurs de dégradation par observation du terrain. Enfin, lors de la portion plus théorique de l'atelier, la sensibilisation des différents acteurs s'est poursuivie et les spécialistes ont pu répondre à certaines interrogations. Le compte-rendu de cet atelier est disponible à l'annexe 5.

7. Analyse et discussion

Les outils développés dans le cadre du projet visent essentiellement les éléments les plus préoccupants de la gestion quotidienne auxquels font face les gérants municipaux des villages nordiques. Un des principaux effets des changements climatiques sera l'augmentation des précipitations sous forme de neige et de pluie, ce qui demandera une adaptation quant à la gestion de la neige et du drainage dans l'entretien des infrastructures municipales. Ces deux éléments sont intimement reliés entre eux et ont un point en commun : le maintien de l'intégrité du pergélisol. Les endroits où la neige et l'eau risquent de s'accumuler vont créer des conditions contribuant à la dégradation du pergélisol. Pour des sols riches en glace, la dégradation du pergélisol peut créer des conditions propices à l'instabilité, pouvant résulter en des glissements de terrain ou l'affaissement de portions de routes.

L'addenda au volume 5 (services municipaux) du « Guide administratif – Villages nordiques » a permis d'identifier les enjeux reliés aux travaux d'enlèvement de la neige sur le réseau de routes des villages nordiques pour assurer le maintien des services essentiels, dont l'approvisionnement en eau potable, et de produire des cartes localisant des aires propices pour l'empilement de la neige. Ces cartes visent principalement à éviter l'empilement de neige dans des endroits où le drainage est déficient et propices à l'accumulation d'eau, mais également sur des terrains en pentes où le sol est riche en glace. L'addenda fournit aussi des éléments à prendre en considération dans l'aménagement de nouveaux fossés, l'installation et l'entretien de ponceaux.

Ces deux outils permettront aux gérants municipaux d'adopter des méthodes de travail ayant moins d'impact sur les sols et ainsi réduire les effets liés aux changements climatiques. Ce n'est toutefois qu'un pas dans la bonne direction. Lors des formations, il a souvent été question de la planification des radiers pour la construction des nouvelles habitations. Avec l'augmentation de la population dans les villages et l'urgent besoin de nouvelles maisons, les travaux de construction sont planifiés et réalisés rapidement. La construction du radier, des routes et du drainage se fait donc présentement de façon approximative. Ceci a pour conséquence, dans certaines communautés, que les radiers ne sont pas prêts à recevoir les bâtiments car le sol ne s'est pas encore stabilisé, créant ainsi des mouvements sur les habitations. Cette problématique sera donc à considérer dans les prochaines années.

8. Conclusion et recommandations

Le bon accueil des outils de la part des communautés fait en sorte que la méthode utilisée pour la réalisation de ces outils, de même que le format de présentation seront maintenant considérés comme des modèles pour le développement d'outils par l'ARK dans le futur. Les villages nordiques font et auront à faire face à plusieurs enjeux reliés aux changements

climatiques. Le présent projet a permis d'aider les villages nordiques à prioriser certains enjeux majeurs et à commencer à mettre en place des stratégies pour y faire face. Une meilleure planification de l'aménagement du territoire jumelée avec une collaboration de tous les intervenants impliqués dans les activités de construction dans les villages nordiques sont requises pour s'assurer que ces communautés soient bien préparées pour réagir aux changements anticipés du climat.

Le présent projet permettra aux communautés du Nunavik d'adapter leur façon de faire en vue de réagir aux changements climatiques. Compte tenu des enjeux liés aux changements climatiques, d'autres actions devront être faites et les recommandations suivantes sont ressorties de ce projet:

1. Il faut incorporer dans les schémas d'aménagement présents et futurs les zones où il est souhaitable d'y déposer la neige provenant du nettoyage des rues. De cette façon, on s'assure d'éviter d'attribuer ces zones à d'autres fins et on s'assure d'identifier des zones d'empilement de neige dans les plans d'expansion des villages.
2. Il existe présentement des entrepreneurs qui offrent le service d'enlèvement de la neige. Ceux-ci devront être informés par la municipalité de la localisation des zones sensibles et celles choisies pour les dépôts à neige.
3. Il y aurait lieu d'améliorer la planification et la coordination nécessaire lors du développement des nouvelles zones d'habitation afin de produire des plans et devis de construction et de permettre la construction des radiers, des routes et du réseau de drainage suffisamment à l'avance. Idéalement, la construction du radier, des routes et du drainage s'étalerait sur deux saisons avant d'entreprendre la construction des habitations la troisième. Cette recommandation permet d'intégrer un ensemble de connaissances issues des travaux sur les changements climatiques permettant ainsi une viabilité et durabilité optimale des infrastructures.
4. Les gérants municipaux et les opérateurs de machineries lourdes se doivent de recevoir de la formation pratique plus technique sur la construction des chemins municipaux, du drainage, des radiers sur les diverses conditions de sols pouvant être rencontrées de même que sur l'importance de préserver autant que possible le couvert végétal pour préserver le pergélisol.
5. Les problèmes reliés au réseau routier et identifiés par les représentants des villages devraient faire l'objet d'une analyse conjointe par le département des travaux publics municipaux de l'ARK et les villages nordiques pour déterminer les moyens requis pour corriger les problèmes soulevés. On y retrouve principalement des problèmes de drainage inadéquat, de ponceaux gelés ou bloqués, de routes affaissées et d'accumulation excessive de neige sur les routes.

Des actions seront prises par l'ARK à court terme pour donner suite à ces recommandations. Ainsi, au cours des prochaines années, l'ARK entend poursuivre, dans le cadre du programme d'adaptation aux changements climatiques, la formation offerte aux adultes et aux jeunes afin de développer une expertise sur le pergélisol pour améliorer l'aménagement du territoire, les projets de construction, les infrastructures de transport et la protection de l'environnement. Aussi, des discussions ont été entreprises avec les différents intervenants

impliqués dans la construction résidentielle afin de mieux planifier la coordination des travaux et s'assurer d'avoir des fondations stables avant de commencer la construction des maisons. Ces discussions viendront baliser les étapes nécessaires lors du processus menant aux travaux de construction et identifieront les responsabilités de chacun.

9. Références

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Annexe 1

Analysis of interviews with Nunavik municipal representatives

ICAR PROJECT

Climate Change Adaptation

Analysis of interviews with Nunavik municipal representatives

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RESEARCH GROUP



INTRODUCTION

Climate warming and variability is projected to have a variety of impacts and challenges for Nunavik communities in the future (Allard et al., 2012). In fact a number of changes resulting in impacts have already been identified, however, at the same time significant adaptive capacity has been shown in the region at a variety of levels. The current report is provided in support of the Kativik Regional Government-led ICAR project on municipal adaptation to climate change in Nunavik. It provides a descriptive and thematic analysis of interviews conducted with municipal representatives from Nunavik villages on their views, needs and perspectives related to climate change and adaptation at the community scale.

METHODS

Semi-directive interviews and one meeting (Seidman, 2005) with municipal representatives in Nunavik were conducted by M Gagnon and M Griffiths (KRG) in October 2010. All interviews and discussions were conducted in person, or by telephone. Interviews and group discussions were guided by 8 primary questions related to municipal representatives' knowledge and perspectives on climate change and adaptation as outlined in Table 1.

Table 1. Interview questions on climate change and climate change adaptation posed to Nunavik municipal representatives in October 2010.

Interview Questions
1. In your opinion, what is climate change?
2. Do you have any questions regarding climate change?
3. Can you provide at least 2 impacts that you have noticed in your community, whether on the land within the municipality or on infrastructures?
4. Has the Municipality ever had to modify its practices regarding municipal services to deal with the impacts of climate change? Was it successful?
5. Do you feel prepared for such modifications? Is there any interest in doing so and are there tools available? Do you see any obstacles which would affect your ability to change your practices?
6. What kind of assistance would you expect and from who?
7. Do you expect to experience more impacts related to climate change in your community in the coming years? If so, what do you think these impacts will be?
8. What kind of information would be useful to you and to municipal workers regarding climate change in order to better adapt and help make the community less vulnerable to the effects of climate change?

Interviews and group discussions were transcribed and a synthesis of transcriptions were provided for thematic qualitative analysis. Transcripts were entered into NVivo 10 qualitative software (QSR International, 2012) and analysed using a process of thematic content analysis (Saldana, 2009). Responses to each question were reviewed and codes were developed based on common themes among individual responses. After all questions were reviewed, codes were then re-evaluated and codes in which only 1-2 responses were categorized were assessed for their contribution to the data gathered on that question (did they represent something truly unique?). If it was determined that the response was not truly unique to the dataset for that question those responses were re-categorized into an existing category or they were combined with an existing category and the category was expanded slightly to accommodate the new contribution. All codes were then reviewed by a second person experienced in qualitative analysis (inter-coder variability) in order to verify the clarity and interpretation of the coding used. This process was used to develop a descriptive analysis of the general themes associated with responses to each question. Data was then analyzed further to search for overarching themes from data across questions and responses (Saldana, 2009). Broader themes, not specific to any one question, were developed and interview responses were further coded into these categories as well. The results of the descriptive and thematic analysis are presented below.

RESULTS AND DISCUSSION

A total of 10 individual interviews were conducted with community representatives and one meeting attended by 8 participants took place in October 2010. A total of 18 representatives from 11 different Nunavik communities participated to the study. Participants included municipal mayors, senior village administrators and municipal managers. Responses to questions and discussion of topics have been grouped into three primary areas on which individuals provided perspectives:

1. Climate Change Awareness and Knowledge,

2. Current and Future Impacts, and
3. Adaptation and Adaptation Needs.

These headings are used in the presentation and discussion of results below.

Climate change awareness and knowledge

When discussing the general topic of what is climate change from their own view, participants responded with perspectives that group into three main categories. All responses referred to changes in aspects of the local environment that they could observe. Some referred to climate change in regards to its manifestation as **Land and resource changes**. They described climate change in terms of the changes it was creating in the land and bodies of water e.g. melting permafrost, as well in resource patterns and abundance e.g. no berries one year and many the next year. Several participants spoke of climate change in terms of **Thinning, changing ice**. They described how it was leading to thin and rough ice, making it more difficult to travel in the winter. As well, they reported that it was more difficult to predict whether or not the ice would be thick enough to travel on. Finally, when asked what climate change was, individuals spoke about **Unpredictable weather**. Many respondents referred to changes in the weather and its stability. It was reported that the weather was much more difficult to predict than it has been in the past, and that the seasons had shifted from their normal patterns. Winters were reported to be shorter than they used to, with snow coming later and melting earlier and more quickly. Also, participants spoke about how the wind is more extreme and comes from different directions than anticipated today.

When asked what their information needs or desires were related to the topic of climate change individuals reported one of two things. They either reported wanting to learn more about **Experiences in other communities**, to be informed of how climate change was impacting other communities in Nunavik and other Arctic regions, and whether these impacts were similar to their own experiences, or they reported wanting more information on **Regional and municipal impacts**.

Participants reported being concerned about the impacts of climate change on roads and infrastructure in their community and how the cost of these impacts would be met, as well as being concerned about the broader impacts of climate change on the region as a whole.

Current and future impacts of climate change

Interviews and group discussions included inquiry into the topic of current and future impacts on municipalities from climate change. When asked to provide at least 2 impacts that had been noticed in their community, individuals identified four common categories of impacts. They included:

- **Melting permafrost:** Many participants mentioned changes in permafrost; melting and sinking permafrost causing buildings and roads to shift, even necessitating the relocation of some homes in one community following a landslide;
- **Flooding, erosion, and drainage problems:** Participants reported concern about drainage problems caused by melting snow, as well as flooding and erosion problems in their community;
- **Water supply:** There was a concern about future water supply, as some participants mentioned that water levels in lakes were dropping with changes in precipitation in the region; and
- **Effects of warmer weather:** Many participants have noticed the weather becoming warmer over the years, and winter becoming shorter. This was reported to be causing earlier snow melt, disruptions in hunting due to thin ice, and melting permafrost. However, some suggested that this warming would allow for a longer construction season, and reduce fuel consumption.

A strong response indicating a belief that there will be future impacts from climate change in Nunavik communities among the participants was reported in interviews

and group discussions. Respondents identified four impact areas they felt would result from climate change in the future. These included:

- **Changes in hunting patterns:** Participants reported concern that changes in weather and ice patterns would make it necessary to change hunting patterns;
- **Flooding, erosion, and melting permafrost:** There was concern expressed about the possibility of flooding and subsequent erosion, as well as continued problems with landslides and shifting roads and houses due to melting permafrost;
- **Drinking water supply:** Participants were concerned about future impacts on drinking water quality due to flooding and heavy rains as well as decreased availability of drinking water due to low water levels in lakes associated with changes in precipitation regimes in the region; and
- **Earthquakes:** Two participants expressed concern that there would be earthquakes in the region in the future as a result of climate change.

Adaptation and Adaptation Needs

According to the representatives involved in these interviews and the meeting, some municipalities have already started adapting to climate changes and the impacts of climate change in the region. The changes enacted by municipalities are in response to melt and drainage problems and road construction and maintenance. In regards to ***Snow, ice, melting permafrost, and drainage*** several participants mentioned that there has been a need to change practices in order to cope with faster snow melt (necessitating quicker snow removal), icy roads in the winter, and problems with drainage from snow melt and heavier rains. In one community, it was necessary to move houses because of melting permafrost. Other individuals reported that adaptations have taken place in the construction of roads. It was mentioned that ***Road building*** had become more difficult, and that different materials were now required in order to have adequate compaction of the roadbed.

While participants identified these areas of adaptation in municipal activities thus far, they did not explicitly comment on their perception of the success of these adaptations in the face of climatic change.

When discussing whether or not municipalities felt prepared for the changes taking place and projected to take place in the future, there were mixed responses from participants. In response to this topic most participants identified a ***Need for funding, training, and equipment*** for adaptation at the local scale. Participants identified a lack of resources as an obstacle to changing practices, mentioning a need for training, financial assistance, as well as more and better equipment such as snow blowers adapted to the new snow conditions. Further, individuals reported a need for ***Training, research, and funding*** to further support municipalities in the face of climate change in the region. While most did not identify whom they would expect assistance from, some participants mentioned that they would expect KRG to provide this assistance in collaboration with the provincial and federal governments.

Finally, participants spoke of their information needs to be better informed and supported in their municipality in facing the climate related challenges that exist. Individuals identified the need for improved information on ***Changes in weather and ice conditions***, as well as information on how climate change affects communities and what actions can be taken to reduce the impacts, distributed via radio or pamphlets. Further, they reported a desire for ***Community and region specific studies*** to generate this information and that they be made accessible to the public.

Thematic Analysis

When reviewing the responses provided by participants from Nunavik municipalities on climate change, impacts and adaptations there is a clear distinction made by participants between climate change impacts that affect the municipality and impacts that affect the surrounding environment. Impacts of both

forms are of concern to municipal representatives. Participants commonly referred to impacts on infrastructure such as roads and buildings, as well as concerns about decreasing water levels that will impact community drinking water supplies. Many participants expressed concern about the deterioration of roads and the difficulty in maintaining them. As stated, *“Faster deterioration, roads for example. More rain and wet snow making it harder for road crews to maintain.”* There was also concern that reduced rain fall will create drinking water shortages, as one participant stated, *“This year we did not have enough rain so ponds and streams were drying up. What I’ve noticed is that the ancient snow, the snow that did not melt for years and years, is now gone. I do not know how this will affect our water supply.”*

As for impacts to the broader environment, many participants framed these concerns in the context of how they will impact hunting activities. For instance, *“This spring we had a lot of north winds. In the springtime, hunters are usually waiting for easterly winds but they didn’t catch many geese this spring because of the north winds.”* Similarly, for example, *“Hunters and thin ice. This year the river didn’t freeze. First time it ever happened...People had to be picked up by rescue boat and helicopter, 3 incidents—rescues have been needed.”* Several participants also referred to the unpredictability of the weather when stating *“In the past, it used to be very easy to read these things (thickness of the ice, read the weather) but in today’s weather it is very difficult to read...Inuit are more relying on the internet weather now because it is hard to read it in nature.”*

In general, participants were much more likely to discuss negative impacts of climate change rather than potential opportunities it might create. However, this may be partly due to the way in which questions were framed and posed in the interview guide. Potential benefits that were mentioned included a longer construction season, and reduced heating fuel consumption. As one participant noted, *“Positive aspects of climate change [include a] longer construction season which would allow people to finish their projects, less fuel consumption for buildings. “*

On the topic of support needed for adaptation in Nunavik municipalities into the future, representatives interviewed in this project equally identified the existing capacity for internal modification and change to help mitigate climate change impacts, as well as a need for external assistance, mainly in the form of training and financial support. Internal capabilities identified were primarily related to dealing with problems related to snow, as well as road maintenance and repair. As mentioned, *“In the winter, collecting it in some areas is not a problem but we have to take it away before it melts. When the snow just sits there it melts and creates problems.”* In regards to road construction one participant discussed the challenges of needing to use new materials... *“As to the compaction of it all [the road bed], having to mix different materials. Before we could just put down a natural material but now we have to mix it with a crushed material to get better compaction.”* The main external needs identified by participants were related to funding and training. As reported, *“The manpower and the budget are two things that we do not have, if we do need to make changes. Training also. I think the municipal workers, municipality, etc. would be interested in receiving training. The manpower is an issue because we don’t have the money to hire more people.”*

SUMMARY/CONCLUSIONS

Climate change is affecting Nunavik in a variety of ways (Allard et al., 2012). As reported here, municipalities are already adapting to some changes while greater support is needed to facilitate adaptation into the future. This project gathered perspectives from 18 individuals representing 11 different communities in Nunavik. Individuals reported primarily negative perceptions of the changes associated with climate change, made clear distinctions, yet reported concern about changes impacting both the physical and natural environment inside the municipality and that outside the community boundaries in the surrounding area. Both were reported to be of importance to municipalities as they affect municipal operations as well as such things as the ability of individuals to hunt, fish and travel safely and successfully. Concerns exist related to current impacts or the preoccupation of future impacts on roads and infrastructure, flooding and erosion, municipal

operations and maintenance (e.g. road clearing) and drinking water. Municipal representatives identified the need for greater information, training and financial support to help them maintain healthy, safe and viable Nunavik communities. This project highlights needs for adaptation support at the municipal scale in Nunavik and well as the current existing capacity to adapt to changes already taking place in the region.

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Annexe 2

Document d'information sur les changements climatiques

Climate Change & Adaptation in Nunavik

A support document
for municipal decision makers,
workers and residents

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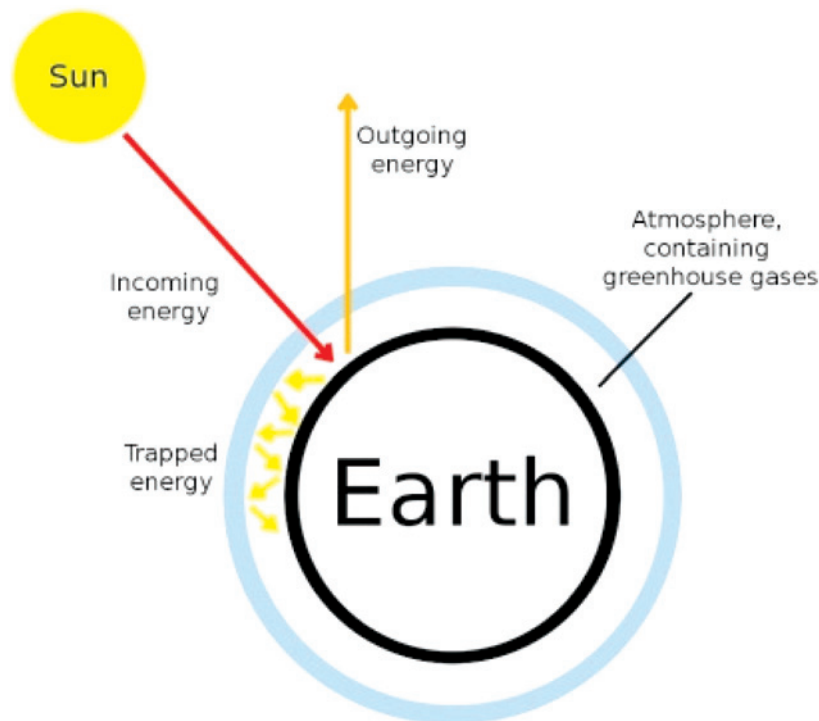
Table of Contents

1	Climate change: what is it ?	4
2	Climate change in Nunavik: what do we know ?	5
	Temperature	
	Precipitation	
	Wind	
	Ice	
	Water levels	
3	Let's Talk About Permafrost	6
4	Climate change in Nunavik: what does it mean for me and my community ?	9
	Housing	
	Roads and municipal infrastructure	
	Access to the land and resources	
	Country foods	
5	Climate change adaptation: what can we do ?	11
	What is adaptation to climate change ?	
	Why do we need to adapt ?	
	How does adaptation happen ?	
	How can we adapt: lessons from Inuit regions ?	
	What do we need to adapt ?	
	Additional Resources:	13
	list of resources for decision makers and community residents to learn more	
	Key Terms	14
	(Adapted from Government of Nunavut et al., 2005. Terminology on Climate Change)	

1

Climate change: What is it ?

The Earth's atmosphere is full of gases, some of which insulate the Earth. These gases trap the sun's heat close to the Earth, keeping our planet warm enough to live on. Greenhouse gases (these heat trapping gases) exist in the Earth's atmosphere naturally. However, humans have created large amounts of greenhouse gases by doing things such as burning coal, oil, gasoline and other fuels for heating buildings, for transportation and for other energy needs. These activities have (and continue to) increase the amount of greenhouse gases in the atmosphere trapping more heat close to the Earth and warming the planet. This is what is known as 'global warming'. Global warming is affecting weather patterns all over the world and changing normal climate conditions in many regions. This is known as climate change.



Simpleclimate.wordpress.com

Climate change can increase risks to people's health and safety, wildlife, water and food supplies. Aboriginal and especially northern communities face unique challenges from climate change as they live in close relationship with the land. It is expected that the earliest and most significant changes associated with climate change are expected in the Arctic and Antarctic.

2

Climate change in Nunavik: What do we know ?

Scientific research, monitoring, and observations as well as knowledge from residents of Nunavik are increasing awareness that changes are taking place. Changes are occurring in temperature, precipitation, winds, ice conditions and water levels. For example, a significant thinning of sea- and freshwater ice, a decrease in the extent of ice coverage, a shortening of the winter ice season, changes in snow cover (more or less snow depending on the area), changes in wildlife and plant species' distribution, melting permafrost, and increased coastal erosion of some shorelines has been observed and is expected to continue into the future. These changes are general trends that have been observed over many years. Therefore, there have been and will continue to be individual years that are quite different from this trend (e.g. a very cold winter may still occur) but overall the climate in Nunavik is warming.

A series of projected changes over the next 40 years are shown below.

Temperature ¹

Average winter air temperature is projected to increase between 3 and 5°C, with the strongest warming in northwestern Ungava Bay. Summer air temperature is predicted to increase by 1.5 – 2.0°C on average, with the greatest changes in temperature occurring in the far northern and southern parts of the region, and the least along the Hudson Bay coast. More extreme hot days are expected in the summer in the future. This increase in temperature will result in more thawing days (decrease in permafrost) and a much longer growing season in the region.

Total Precipitation ¹ (Snow and Rain)

Annual precipitation will increase by 12 to 25%, with the largest increases expected over the western Ungava Peninsula and along the Hudson Bay coasts. The smallest increases will happen in the southern parts of Nunavik.

Snow

An increase in snow is expected in the region in the future. Anywhere between 1 and 25% more snow is expected with greatest increases in snow occurring along the Hudson Strait. As snow acts as insulation over the ground, an increase in snow may add to thawing permafrost in the region over time. The start of the snow season is estimated to start 5 to 14 days later and end 3 to 11 days sooner, resulting in a much shorter snow season. Less snow and more freezing rain is expected.

Wind ²

Climate change can cause changes in atmospheric pressure, which can lead to changes in the wind direction and speed. These changes in wind direction and speed have a direct effect on sea ice formation and break up as well as the type of precipitation that occurs. While scientists are not confident in projecting changes in wind patterns in the region into the future, Elders and local residents have reported observing an overall increase in the number of days with strong winds in past years.

Ice³

The ice season is starting later and ending sooner, resulting in a much shorter sea ice season today. This trend will continue in the future. It is expected that the amount and thickness of ice will continue to decrease resulting in less safe and more unpredictable sea ice conditions in the future.

Water levels^{1,4}

Water levels are changing in Nunavik. It is predicted that freshwater levels will increase over time, resulting in a greater discharge into the ocean. This is a result of increases in temperature and precipitation. However, on a year to year basis, the amount of water seen in streams, lakes and rivers may still vary (be high or low in some years) as it is influenced by things such as annual precipitation levels and spring melt. Because of this, lower water levels could still be observed in some years even though, overall, water levels are increasing over time. This may be important for communities where rivers and streams run near or through the community or a river is an important community travel and access route. Also, the melting of multi-year sea ice will cause ocean levels to rise, affecting many low lying coastal areas.

Wildlife

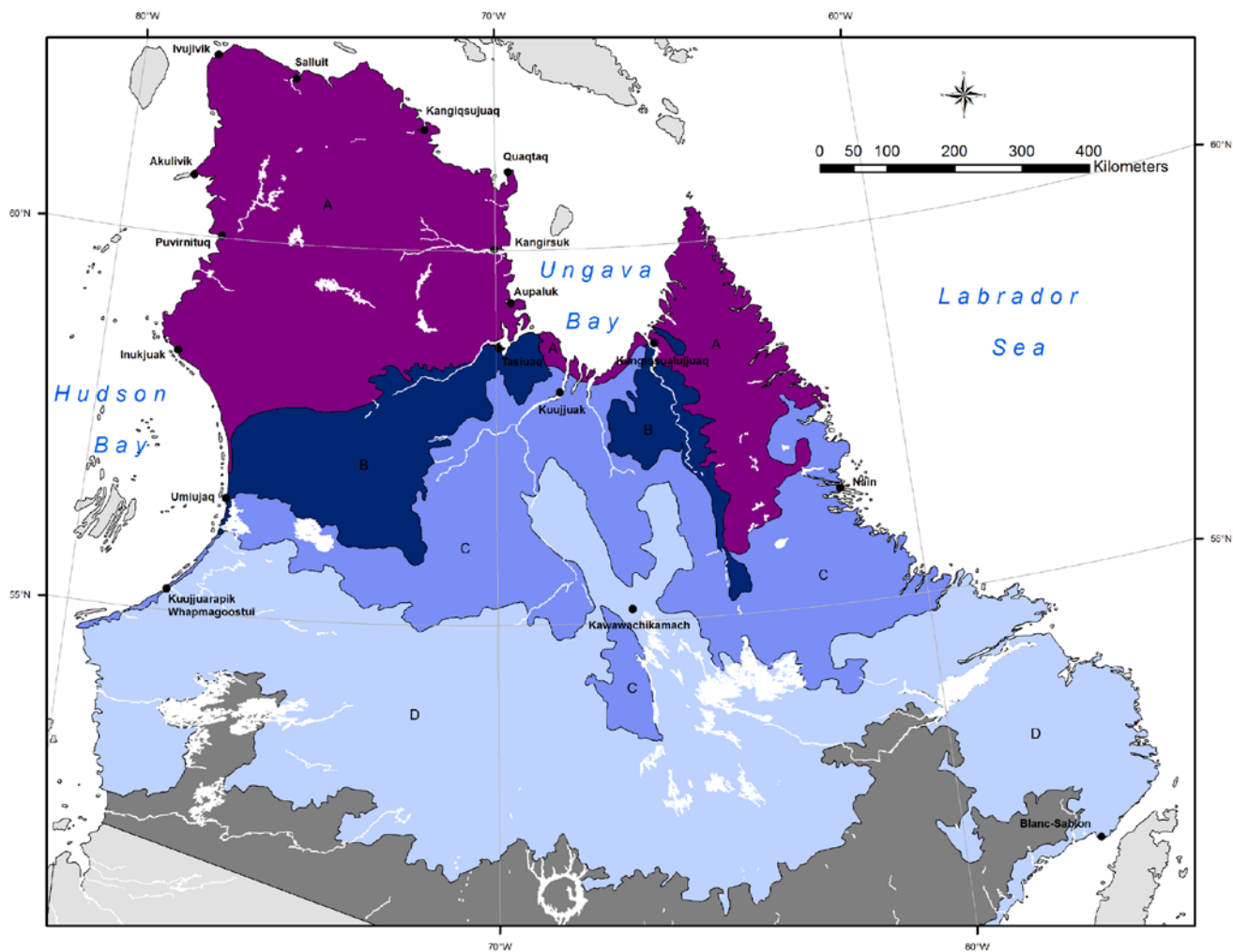
These changes in conditions in the environment are expected to change the food that some wildlife species eat, the habitat in which they live and the times and places where they migrate. Further, movement north of some species and the appearance of new species to the region is expected.

3

Let's Talk about Permafrost^{5,6}

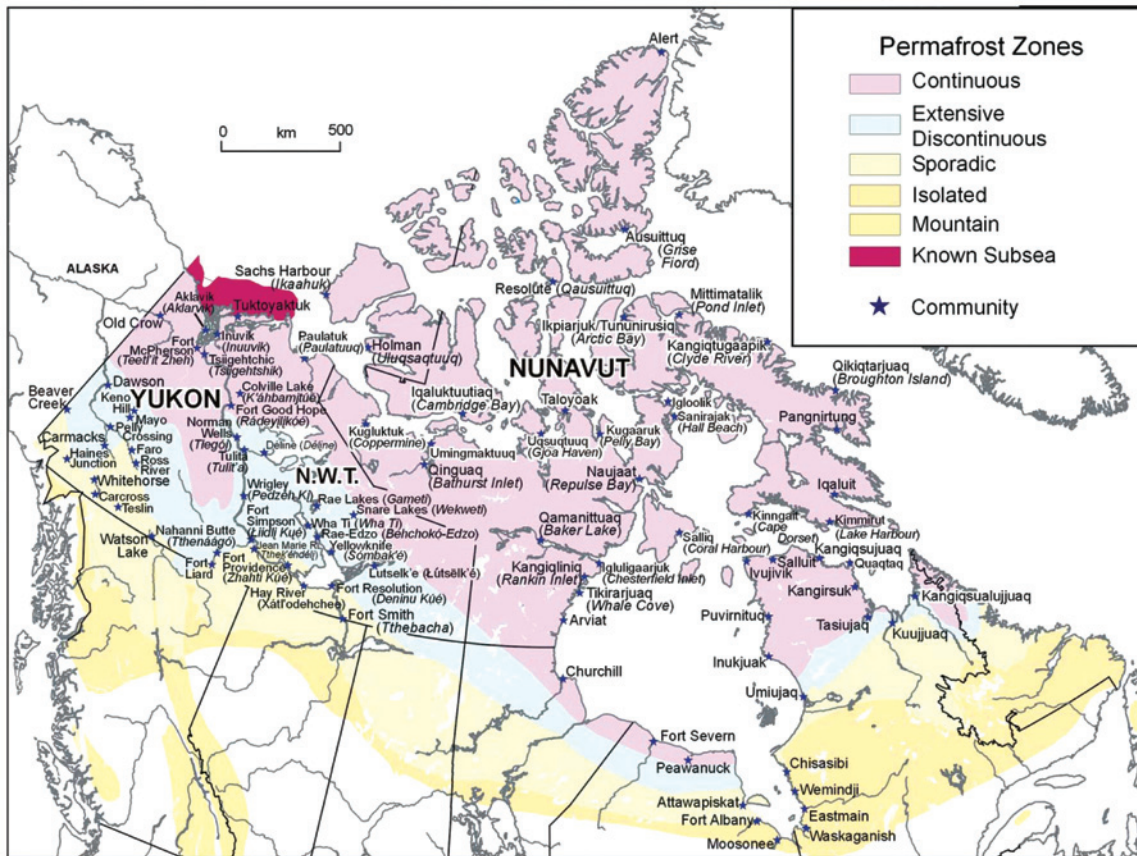
Frozen ground can either be seasonally frozen ground or permafrost. Seasonally frozen ground freezes in the winter and thaws in the summer each year. Seasonally frozen ground occurs in many locations in the world. Permafrost is a type of frozen ground that stays at or below 0° C for at least two years. It is considered to be permanently frozen ground. It doesn't need to contain water or ice, it just needs to stay frozen all year around. In some areas, the top part of the ground may freeze and thaw every year, this is called the active layer and is considered to be seasonally frozen ground. But it might have ground beneath it that stays frozen all year round, this is permafrost. Permafrost occurs in more northern and polar regions around the world, in the Arctic and Antarctic and in other permanently cold locations like very high mountain areas.

In regions where there is permafrost the ground can be frozen to depths of many many metres. Even though the top surface or active layer may thaw during the summer each year the ground below it remains frozen all year round. If the air and ground warm a lot, the stable permafrost can melt. With longer periods of warming more and more of the frozen ground beneath the surface can melt and loosen. With a great amount of



- A** Continuous permafrost, except under large lakes and rivers, with a transition to widespread permafrost at the southern margin of the zone. Thickness generally greater than 150 m, particularly in bedrock. The upper layers of permafrost have a cooling downward temperature profile and the active layer is currently increasing in thickness due to actual climate warming. Permafrost temperature between -3°C and -6°C.
- B** Discontinuous widespread permafrost (> 50% of land surface). Present under all types of surficial deposits. Absent under wet and shrubby ground and under forest stands. Active layer currently increasing in thickness. Permafrost temperature from 0°C to -3°C.
- C** Discontinuous scattered permafrost (< 50% of land surface) present under tundra terrain under exposed hills. Thick and increasing active layer in bedrock. Palsas currently disappearing in peatlands. Permafrost temperature at melting point in ice rich clay soils and in peat. Presence of residual thaw layer possible. Permafrost temperature between 0°C and -1°C.
- D** Sporadic permafrost (< 2% of the territory) located mostly as small residual patches in peatlands. Possible presence of residual thaw layer in bedrock and other surficial materials. Permafrost most often isothermal at thawing point.
- South of zone D, patches of high elevation permafrost.

warming this can cause the ground to settle, and even sink in some places. This can have significant effects on buildings and roads as it can cause 'slumps' in roads or airstrips or destabilization of building foundations if they are built on permafrost that is now changing. It is therefore important to know about permafrost in your community and how it is changing, because many buildings and roads and airports are built on permafrost in Nunavik. Local residents and scientists are already observing and reporting some problems in the region because of warming permafrost.



(From Furgal and Prowse, 2008)

Ground warming and thinning of permafrost as a result of climate change is projected to affect up to half of the permafrost in Canada over the next 50 years. Ground temperatures in Nunavik are quite variable normally but are now increasing. As a result, the condition of permafrost is changing and, in some places, degrading or becoming less stable.

4

Climate change in Nunavik: What does it mean for me and my community ?

It can be expected that the average temperature will increase in communities in Nunavik. Winters are already becoming milder and wetter, with fewer extreme cold days. This is resulting in a shorter ice season for both lake and sea ice, as well as thinner and more unpredictable ice conditions. Also, summers are generally warmer and there are more extreme hot days occurring. Both increased precipitation and warmer temperatures contribute to the thawing of permafrost, changes in growing seasons and the appearance of new species in the region never seen before. These changes in winter and summer are affecting migrations of animals such as birds, fish, caribou and beluga. These changes in animal movement affect people's ability to hunt these animals, and thinner, unpredictable ice makes hunting more difficult and dangerous. Climate changes will have many impacts in communities. It will impact some aspects of community life negatively (e.g. decrease in sea ice extent and stability and impacts on accessing country foods or increasing travel dangers). In some cases, the same change may provide new opportunities (e.g. increased length of shipping season).

A summary of some climate related changes and the most common reasons why they are important for communities and individuals is presented here:

Who does it effect ?			Why is it important ?				
Change in Aspects of Climate or Environment	Community Effect	Personal Effect	Housing	Roads and Infrastructure	Access to land and resources	Country Food Access	Human safety and security
Generally warmer winters and fewer extreme cold days	Less money spent on heat in homes and community buildings	Lower home heating costs Less chance of frost bite and other cold related injuries for individuals	X				X
Generally warmer summers and more extreme hot days	Increased growing season Possible to grow some types food previously not feasible (greenhouse gardening) More unstable and warming permafrost	Possible to consider local growing of some food items (vegetables) instead of buying from store Potential for heat stress among some individuals (e.g. elderly and those with respiratory challenges)	X	X	X	X	X
Shortening of the cold season and decrease in amount and thickness of sea and lake ice	More difficult to access some country food species and hunting/ice fishing locations : decrease in variety of foods in community freezer	Increased danger for winter travel and accessing resources (e.g. country food species) Difficult to travel and hunt on usual trails/routes/areas on the ice Increased concern / anxiety			X	X	X
Increase in winter rain (rain on snow) events and possible 'icing'	Increased danger for travel and community operations Potential loss of power, telephone, etc. Impacts to wildlife species that are key food resources (e.g. caribou) for community freezer	Increased danger for walking and increased damage to snowmobiles Challenges to accessing some country food resources for personal consumption	X	X	X	X	X
Changes to animal migration times and patterns	Less food in community freezer at regular times	Hard to find animals at typical times of year, increased costs for hunting or decreases in personal food availability			X	X	
Increased length of possible shipping season	More opportunities for food transportation at lower rates; possible reduction in food prices and resupply times	Save money and have access to greater variety of fresh store foods Increase chances for resupply frequency		X	X		
Decrease in permafrost extend and stability	Unstable foundations of buildings and roads Increased building and road maintenance and repair costs	Unstable houses, harder on vehicles	X	X	X		X

5

Climate change adaptation: What can you do ?

To minimize the chance of negative impacts and have the ability to take advantage of any opportunities that are created by these changes, communities, organizations, households and individuals need to be prepared. They need to be aware of what changes are taking place in their local environment and how they might respond.

What is adaptation to climate change ?

Learning to adjust as changes in the environment are happening is known as adapting. Finding different ways to maintain similar community operations and functions, and individuals' lives and ways of life, is needed to adapt to climate and environmental change. Adaptations are these alternate or different ways of getting the same things done as you have done before. A simple example is an individual taking a boat when going hunting at the end of winter to be able to cross over waterways that may break-up sooner than expected. That individual would be said to be adapting to changes in the environment in order to still go hunting.

Why do communities in Nunavik need to adapt ?

Climate change is continuing to happen and changes in local weather and sea ice conditions will happen now and in the future. Ice is getting thinner and less predictable, permafrost is degrading and animal migrations are changing. Therefore, it is important to adapt to minimize the chance of negative impacts on the community and individuals and to be able to live within the changes that are taking place. Adapting has always been an important part of life in the north, because of climate change it is even more important today.

How does adaptation happen ?

Adaptation happens as people find ways to continue to live similarly to the way they have in the past but in the new or changing conditions around them. People search for new ways of doing things and once they find one that is successful, they pass this knowledge on to others in the community. Adaptations can take place before changes in the environment impact the community or individuals, or they can take place afterwards, as a response. **Individual awareness, Inuit Knowledge, scientific research, regulations and policies can all be part of adaptation.** Learning more about changes in the environment can help residents be better prepared for new environmental conditions. Learning traditional skills and ways can help individuals adapt on the land to changing or more variable conditions and travel or hunt safely. Scientific research can help us understand how things are expected to change into the future. Policies and regulations (e.g. building codes and land use zoning) can inform us of the best way to do things in changing or new conditions.

How can we adapt: lessons from Inuit communities ?

Communities and individuals in the Arctic are adapting all the time. Many examples of adaptations taking place in response to climate change exist throughout the North. Some include:

- Extensive studies of changes in permafrost around the community of Salluit, Nunavik is informing municipal leaders of where to locate new buildings and development and warning individuals of repairs to infrastructure needed now or in the near future
- Inuit in Sachs Harbour report using ATVs more often in the spring to go to their camps instead of snowmobiles because of a decrease in snow in that region
- Inuit in many communities, including some Nunavik communities, are changing routes to hunting and fishing areas, to adapt to less predictable and stable ice conditions on lakes and rivers
- Tuktoyaktuk is adapting to its eroding shorelines by moving buildings and changing their community master plan. By planning ahead for climate change, Tuktoyaktuk is helping to minimize the future impacts of climate change on its infrastructure.
- Nain, Nunatsiavut is reviewing the management of their community freezer program to ensure they have enough and a variety of country foods available for key households in the community throughout the year. This is being done in response to climate change impacts on wildlife availability and access.
- Builders and contractors can adapt to climate change by changing the designs of foundations for buildings and other projects. These special designs need to account for warming permafrost. The Yellowknife airport is and the health centre in Inuvik are two examples of new designs of building in the north to consider climate change and warming permafrost.
- Other recommendations originating from work in Inuit communities include:
 - Improving land use planning practices for the location of roads and buildings (e.g.: planning further ahead);
 - Requiring better soil testing before construction;
 - Staging construction projects over time to allow concrete pads to settle before building;
 - Researching new building types and construction techniques where needed;
 - Adapting municipal practices (e.g. snow dumping) and maintaining municipal infrastructure (e.g. culverts) to respond to new average conditions and to be prepared for extreme or irregular weather or climate related events in the future.

What do we need to adapt ?

- Most importantly it is necessary to **identify that there is a need to adapt**. Making adaptation an important priority issue for a community is critical.
- **Knowledge and awareness of what changes are taking place** in your local environment and how these changes are impacting or may impact the community and individuals' ways of life, is needed to help plan effective adaptation actions.

- **Knowledge and awareness of what options exist** for adaptations is important. This knowledge may come from Inuit Knowledge, or other communities or experts outside the community.
- **Access to these options for adaptation is required.** Whether it is access to new equipment not typically sold in the community, or access to new technologies to help individuals remain safe while traveling on the land, communities and individuals need access to this equipment or these technologies.
- **Adaptations may require financial investment.** Whether it is money for buying new hunting equipment by an individual, or funds for the construction of a new breakwall by a community, adaptation may have costs associated with it. In most cases though, the costs of adapting are less than the long-term costs of the impacts of change if no adaptation takes place.
- For community adaptation to occur, it is important to **develop a plan or strategy for climate change adaptation.** This starts with open discussions and learning among members of the community, regional government and others. Successful community adaptations require input from many individuals, organizations and agencies.

Additional Resources:

List of resources for decision makers and community residents to learn more about climate change.

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ORGANIZATIONS:

The Intergovernmental Panel on Climate Change: <http://www.ipcc.ch/>

Ouranos: <http://www.ouranos.ca/en/>

Climate Change 101: <http://www.climatechange101.ca/>

Understanding the effects of climate change and global warming:

<http://www.dummies.com/how-to/content/understanding-the-effects-of-climate-change-and-gl.html>

Natural Resources Canada - Enhancing Resilience in a Changing Climate Program:

<http://www.nrcan.gc.ca/earth-sciences/about/current-program/enhancing-resilience/overview/5017>

Ministry of Sustainable development, Environment and Parks - Climate change:

http://www.mddep.gouv.qc.ca/air/inter_en.htm

Key Terms *(from Government of Nunavut et al., 2005. Terminology on Climate Change)*

Adaptation

The adjustments living things (like people) make in their behaviour and the actions they take to deal with the conditions that are changing around them. For example, a community decides to refer to maps describing permafrost characteristics to determine where and where not to build could be considered an adaptation.

Adaptive Capacity

The degree to which living things (like people) are capable of adjusting to changes in their surroundings by lessening damages, taking advantage of opportunities and dealing with the consequences. For example, a community where the level of awareness is high among citizens and municipal regulations explicitly account for climate change can be considered to have lots of adaptive capacity.

Climate

Climate is the usual temperature, rain or snow and wind conditions of an area over a very long number of seasons. For example, Nunavik has a cold dry climate in the winter months compared to the southern parts of Canada. This is a description of the winter climate in Nunavik even though some individual winter days that we experience may not fit this description.

Climate Change

A difference in the usual and extreme global temperatures that is not just a short term change, but lasts for a long time, such as decades. Climate change can then change what are normal weather conditions in a region over time as well.

Global Warming

The slow, continual increase of the Earth's air and oceans over the last few generations. Although there are still cold days and seasons, the usual temperature continues to get warmer. Global Warming is different from Climate Change because it only speaks to the increase in usual temperatures around the world.

Greenhouse gas

Natural and industrial gases that make up the one-way insulating layer trapping heat around the surface of the Earth. A common greenhouse gas that is talked about when speaking of climate change and global warming is carbon dioxide which can be put into the air by the burning of fuels and other activities.

Permafrost

Soil and ground that stays frozen all year-round.

Permafrost-Active layer

The soil at the surface of the land that thaws during the summer. This layer is on top of deeper ground that stays frozen all year-round.

Weather

Weather is the short term conditions in the air or sky over an area. It is described by the temperature, clouds, winds and rainfall or snowfall. For example, it is cold and raining today in Kuujjuaq is a description of the weather.

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4. Furgal C. and Prowse T. 2008. Northern Canada: *in* From Impacts to Adaptation: Canada in a Changing Climate 2007, *edited by* DS Lemmenm, FJ Warren, J Lacroix and E Bush; Government of Canada, Ottawa, ON, p. 57-118.
5. Hacham S, Allard M, Duguay C. 2009. Using the MODIS Land Surface Temperature Product for Mapping Permafrost: An Application to Northern Quebec and Labrador, Canada. Permafrost and Periglac. Process. 20:407-416.
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Annexe 3

Addenda au volume 5 (services municipaux) du Guide administratif – Villages nordique

Snow Removal and Sanding Operations

Expected climate and environmental changes for the region

- Increased snowfall in winter, with heavier snowfall over a short period of time, generating large amounts of snow accumulated at the head of drainage path (for example, at the mouth of a series of ditches & culverts) or over a zone of sensitive permafrost
- Change in the frequency and/or timing of rapid snowmelt events in the areas with a thick layer of packed snow/ice
- Changing patterns of freezing rain (frequency, intensity, duration and timing)

Associated impacts in the community and the practices that will help to reduce or prevent these impacts:

Blocked/impassable roads leading to difficulties in ensuring basic services:

- Perform frequent and systematic maintenance on snow removal equipment
- Have a snow removal intervention plan linked to the weather forecast (set thresholds of predicted snow accumulation that will trigger the implementation of the plan)
- Have enough properly trained employees ready to use the equipment in an efficient manner

Larger amount of water to be evacuated at springtime, which can create different problems (erosion of embankments, water accumulation or localized flooding, etc.):

- Conduct systematic culvert maintenance before the winter season
- Dispose of snow at the identified sites, preferably downstream of the drainage infrastructure (See Map provided)



Snow Removal and Sanding Operations *(cont.)*

Associated impacts in the community and the practices that will help to reduce or prevent these impacts:

Snowpack insulates the ground and prevents permafrost from freezing properly over the winter, which contributes to the thawing of permafrost and ground instability:

- Dispose of snow at the identified sites, preferably on bedrock or where the soil is proven to be stable (well drained sand and gravel soils) (See map provided)
- Remove (or avoid) obstacles that generate snow accumulation in sensitive areas

Dangerous road conditions leading to difficulties in delivering essential municipal services (water delivery, wastewater and garbage collection):

- Have a reserve of dry and covered sand prepared during summer time and have sand spreader equipment ready to work when there is a risk of freezing rain
- Have an intervention plan linked to the weather forecast (set thresholds of predicted freezing rain episodes that will trigger the implementation of the plan)

Soil erosion / permafrost degradation leading to bad road conditions and difficulties in ensuring basic services as well as damaging vehicles:

- Try to remove as much snow as possible on major roads during wintertime
- Remove layers of packed snow / ice as soon as they become softer
- Ensure snow removal is piled at the appropriate sites (See map provided)

Ditch Construction and Maintenance

Expected climate and environmental changes for the region

- Higher frequency /intensity /duration of rain events generating larger amount of surface water to manage in expanding communities, and a larger amount of water going to ditches

- Higher frequency /intensity /duration of rain events generating a large amount of water draining into ditches dug in poorly drained ground (silty or muddy types of soil)

Associated impacts in the community and the practices that will help to reduce or prevent these impacts:

Water accumulation can accelerate the thawing of permafrost under important infrastructures (roads, buildings) and create ground instabilities (erosion of soil, landslides):

- When planning and designing new drainage infrastructure, always consider surface water management. Try to direct the new ditches towards the outer limits of the new development, away from the village with no possibility of flowing towards the town

Expansion of the community combined with higher surface water flow peaks generate situations where existing drainage infrastructure is over solicited (receive more water than what they were initially designed for):

- Prevent water accumulation in ditches by ensuring proper initial design and by conducting frequent and systematic maintenance of the existing ditches (clean, repair damages from erosion, fill holes and low points) (See Appendix 1)



Ditch Construction and Maintenance *(cont.)*

Associated impacts in the community and the practices that will help to reduce or prevent these impacts:

Higher surface water flows can cause erosion of ditches and of nearby infrastructure foundations (roads, bridges, drainage, buildings):

- Design and build the ditches properly (See Appendix 1):
 - Add protection such as membrane and coarse rock to ditch sides
 - Make sure that the ditch slopes are appropriate
-

Surface runoff will carry the soil composed of sediments and fine particles, creating deep ditches or obstructing certain areas along the drainage system:

- Identify zones of well drained soils to build the ditches
 - If a ditch must be built in a zone of poorly drained soil, ensure the design includes a waterproof layer and protection of coarse rock (See Appendix 1)
-

Culvert Maintenance

Expected climate and environmental changes for the region

- Increase of freeze-thaw cycles or freeze-thaw episodes at different periods creating the formation of ice layers into culverts

- Increase in heavy snowfall or rain events creating excessive volumes of water to be drained in inappropriately sized culverts

- Increase in heavy snowfall or rain events increasing water accumulation into culverts

Associated impacts in the community and the practices that will help to reduce or prevent these impacts:

Ice layers obstruct the culverts during the melting period in springtime and prevent the culverts from functioning properly:

- Ensure frequent and systematic maintenance of the culverts before the winter season

- Make sure that the slope of the ditch where the culvert ends allows the water to flow out of it and in the ditch (prevent water accumulation into the culvert) (See Appendix 1)

- Make sure that both ends of the culvert are not crushed

Low point into the culvert that generate water accumulation that can transfer heat into the ground, transmitting heat to permafrost:

- Have a proper slope foundation when installing a new culvert and replace old collapsing culvert (See Appendix 1)



Culvert Maintenance *(cont.)*

Associated impacts in the community and the practices that will help to reduce or prevent these impacts:

Higher surface water flows can result in overflows and localized flooding where the culverts cannot drain enough water:

- Make sure that the culvert is at least as big as the ones upstream for the same ditch

- Consider the biggest volume of water that might have to be drained during the year when designing the culvert

- Keep in mind that part of the culvert might be unusable due to ice layers built in it, which would make the inside of it smaller

- When possible, install a second culvert at higher level that won't be affected by ice layers formation at the bottom

Bridge Maintenance

Expected climate and environmental changes for the region

- **Changing patterns of freezing rain (frequency, intensity, duration and timing) creating icy conditions on bridge surfaces**
- **Increase in snow accumulation and rapid snow melt events in springtime that can generate ice buildup and flooding near the bridges**

Associated impacts in the community and the practices that will help to reduce or prevent these impacts:

Bridges are more sensitive to freezing rain events and rapid temperature changes:

- Have a reserve of dry and covered sand prepared during summer time and have sand spreader equipment ready to work when there is a risk of freezing rain (fall, winter or spring time)
- Have an intervention plan linked to the weather forecast (set thresholds of predicted freezing rain events that will trigger the implementation of the plan)

Reducing the riverbed for the bridge construction can create ice buildup and/or flooding conditions:

- Make sure to keep riverbed and riverbanks areas under existing bridges free-flowing, make sure they stay clean (no obstruction)
- Avoid piling snow near a bridge
- Ensure that there is no ice buildup on the upper side of the bridge during springtime
- Design and construct bridges outside of the riverbed

Road Maintenance & Construction

Expected climate and environmental changes for the region

- Increasing temperatures in all seasons, which will affect permafrost zones and contribute to ground instability
- Increased frequency and intensity of rain events and rapid snow melt occurrences in spring generating more surface water runoff
- Increased precipitation in all seasons, which could result in water accumulation on the shoulders of the roads

Associated impacts in the community and the practices that will help to reduce or prevent these impacts:

Roads built in areas of sensitive permafrost will tend to be more subject to soil instability due to thawing permafrost:

- When designing and constructing roads, try to find alternate paths where the permafrost is the least sensitive (for example, bedrock or good sand and gravel soils that are well drained)
- When no other option than building on permafrost exists, consult with experts in permafrost soil and road design

The erosion of unmaintained roadside embankments eventually affects the paved parts of the road:

- Ensure frequent and systematic maintenance of road and roadsides
- Add material to the shoulder of the roads as soon as required (in holes or collapsing parts)
- Keep stockpiles of adequate material ready for roadside maintenance



Road Maintenance & Construction *(cont.)*

Associated impacts in the community and the practices that will help to reduce or prevent these impacts:

Water accumulated at the surface transmits heat to the ground which contributes to thawing permafrost and affects the integrity of the road structure:

- Ensure frequent and systematic maintenance of existing drainage along roads and any drainage in the community
-
- When designing and building a road, always consider proper drainage of surface water
-

Wastewater Collection and Drinking Water Delivery

Expected climate and environmental changes for the region

- Increased precipitation (snow, freezing rain, rain), which could affect the ability of the municipality to provide essential services
-

Associated impacts in the community and the practices that will help to reduce or prevent these impacts:

Difficult road conditions affect the delivery of essential municipal services like water delivery and sewage and solid waste collection:

- Have a snow removal and sanding intervention plan linked to the weather forecast
-
- Perform frequent and systematic maintenance on snow removal and sanding equipment
-
- Have enough properly trained employees ready to use the equipment in an efficient manner
-

General Recommendations for Snow Removal in Nunavik Communities

The study was based on primarily winter wind direction and snow drifting conditions, selecting large open areas, which provide good visibility and safe movements of equipment. The areas are usually away from schools, playgrounds and where young people may frequent. Areas were selected nearest to the streets to be cleaned to minimise haulage distances. Areas along the shorelines, dock areas, bedrock out crops were given priority as they will provide stable ground conditions during the thaw season.

Some conditions which should be respected, when clearing the streets are as follows:

- Push snow to downwind side of street

- Never push snow towards the predominant wind direction as this will create progressively higher barrier to drifting snow. These can reach 5 m height (Salluit road to airport)

- Cleaning of snow after storms should give priority to up. Wind side of road in an effort to not create snow banks which would encourage snow accumulation and drifting across roadways

- Before any dumping is a done, a close inspect of snow dumps for tunnels dug out by children must be carried out

- Compacting with a dozer is very important as they will help avoid collapsing of any tunnels which will trap children inside, as has occurred on recent occasions down south

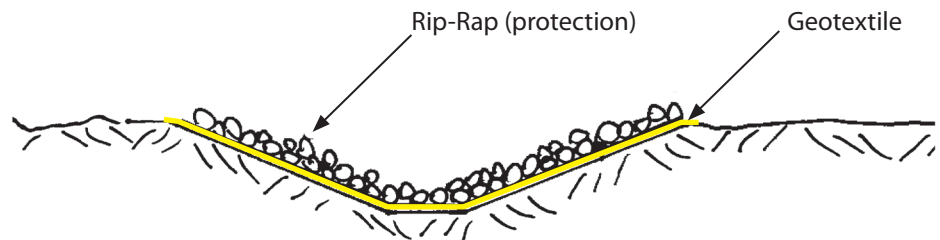
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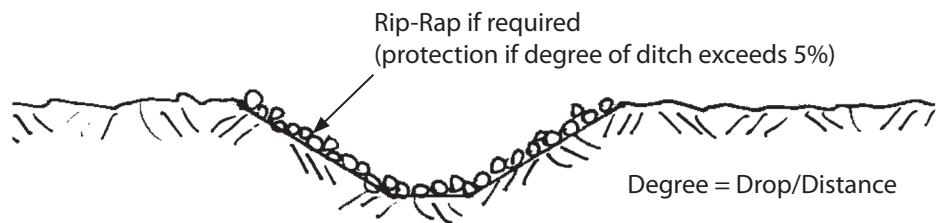


Appendix 1

Fine Sand / Silt material



Sand and Gravel



Coarse Gravel



NOTE:

These sketches are provided for information purposes only. Plans and specifications for this type of work must be adapted to each situation and validated by an expert.

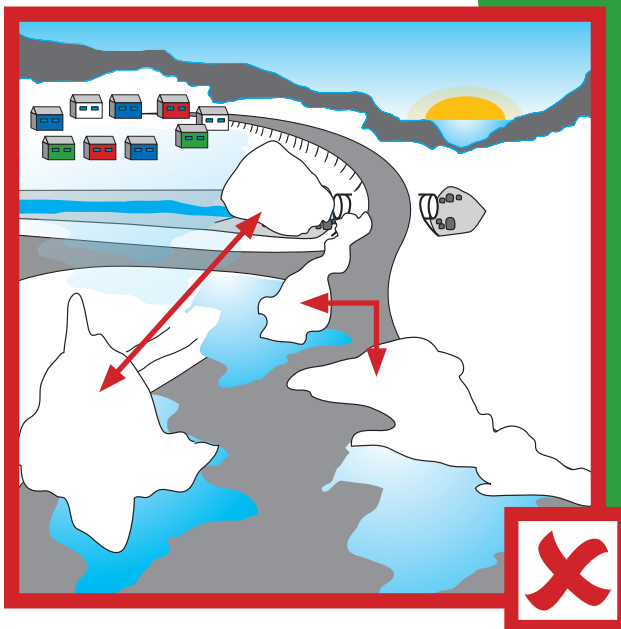
Snow Removal Operations

Bad Practice

- Piling snow at the head of a ditch crossing the village
- Leaving a large amount of packed snow on roads
- Waiting until the last minute to remove the melting ice
- Digging a ditch without conduction surveys beforehand (site, soil)
- To not maintain existing ditches

Good Practice

- ✓ Dispose of snow at the identified sites (See map provided)
- ✓ Try to remove as much snow as possible on major roads during wintertime
- ✓ Remove layers of packed snow / ice as soon as they become softer
- ✓ Ensure snow removal is piled at the appropriate sites (See map provided)
- ✓ Prevent water accumulation in ditches by ensuring proper initial design and by conducting frequent and systematic maintenance of the existing ditches (clean, repair damages from erosion, fill holes and low points) (See Appendix 1)



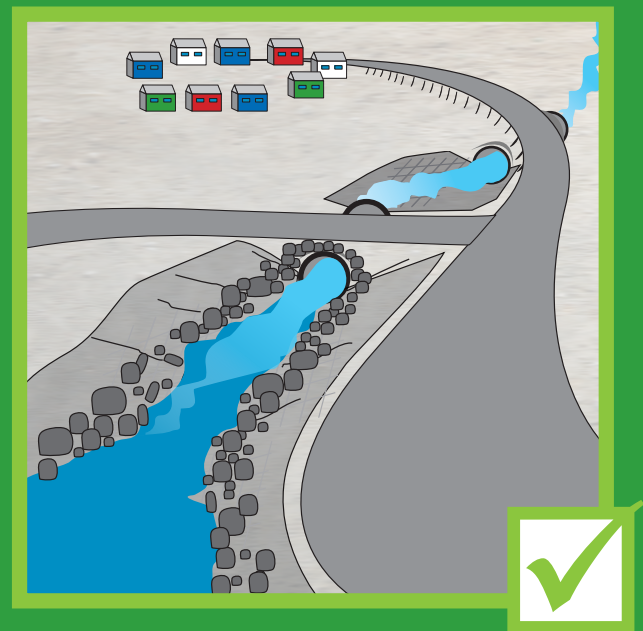
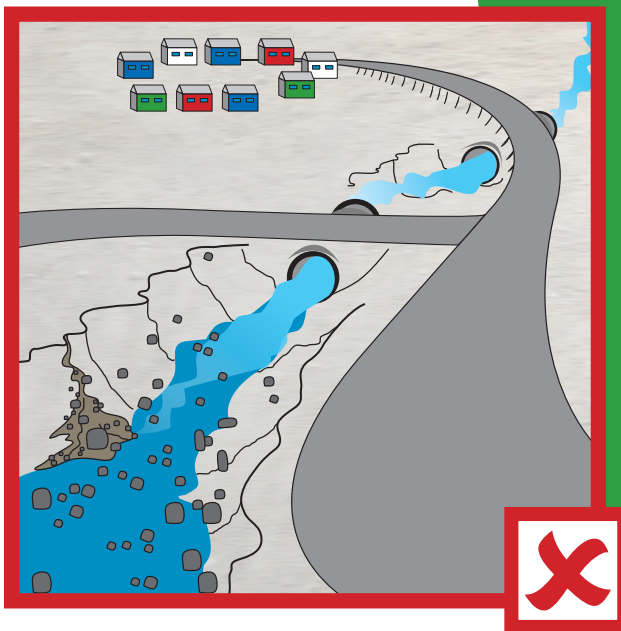
Ditch Construction & Maintenance

Bad Practice

- Digging ditches that have almost vertical sides, that are very steep and/or that are in fine material and unprotected

Good Practice

- ✓ Design and build the ditches properly (See Appendix 1):
 - Add protection such as membrane and coarse rock to ditch sides
 - Make sure that the ditch slopes are appropriate



Drainage & Water Management

Bad Practice

- Directing surface water towards town when unnecessary
- Not taking into account surface water drainage when developing new areas
- Connecting new ditches to existing ones that already have limited capacity

Good Practice

- ✓ When planning and designing new drainage infrastructure, always consider surface water management. Try to direct the new ditches towards the outer limits of the new development, away from the village with no possibility of the water flowing towards the town.



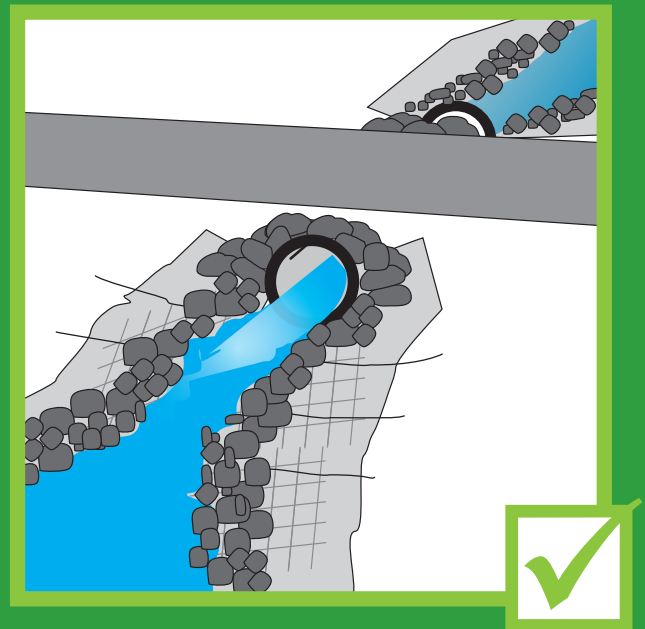
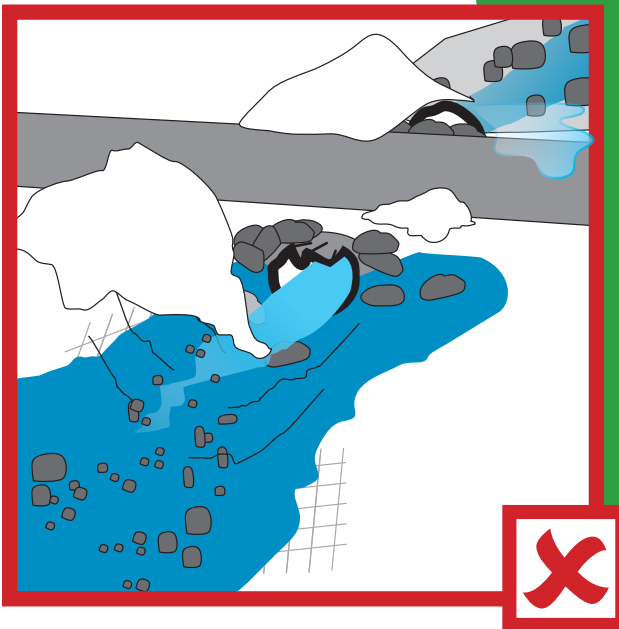
Culvert Maintenance

Bad Practice

- Have no inspection of the culverts to make sure they stay clean
- Choosing the wrong size of culverts
- Dumping snow at the entrance or exit of culverts
- Witnessing the deterioration of a culvert without taking action

Good Practice

- ✓ Ensure frequent and systematic maintenance of the culverts before the winter season
- ✓ Make sure that the slope of the ditch where the culvert ends allows the water to flow out of it and into the ditch (prevent water accumulation in the culvert (See Appendix 1))
- ✓ Make sure that both ends of the culvert are not crushed
- ✓ Design proper slopes and use proper foundation material when installing a new culvert
- ✓ Replace culverts that have collapsed or are damaged



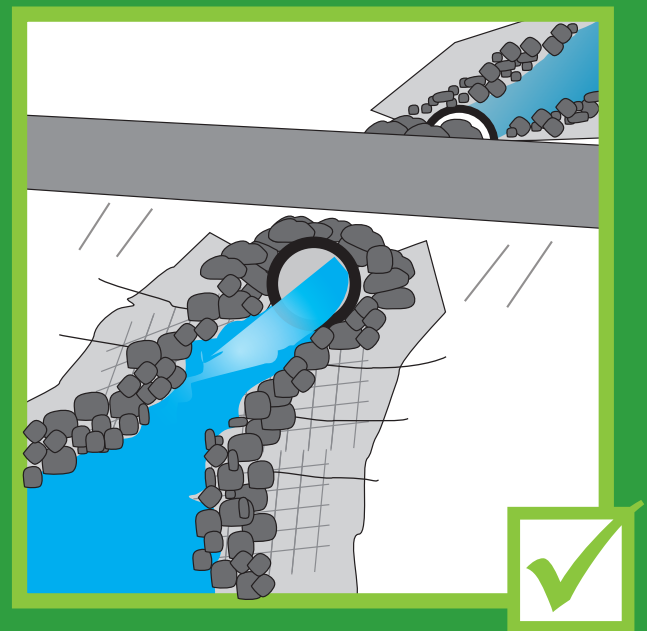
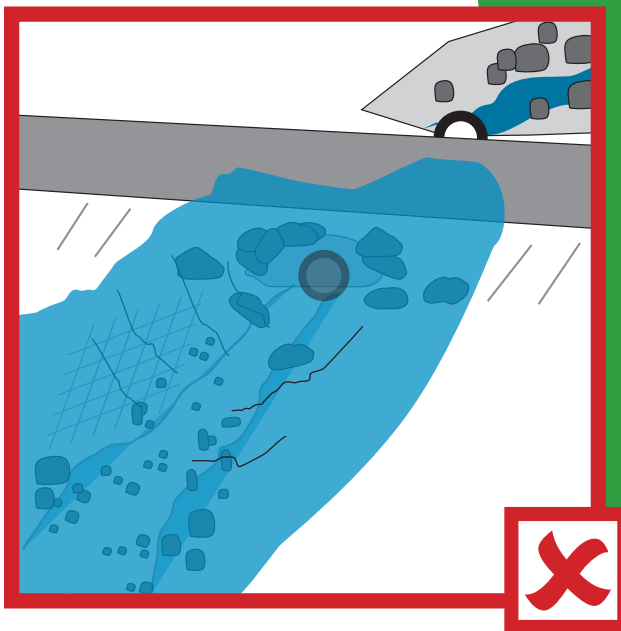
Culvert Design Specifications

Bad Practice

- Not considering the amount of water to be drained when choosing the culvert size
- Not taking into account that there is much more water flowing in springtime

Good Practice

- ✓ Make sure that the culvert is at least as big as the ones upstream for the same ditch
- ✓ Consider the biggest volume of water that might have to be drained during the year when designing the culvert
- ✓ Keep in mind that part of the culvert might be unusable due to ice layers accumulated in it, which would make the inside of it smaller
- ✓ When possible, install a second culvert at higher level that won't be affected by ice layer formation at the bottom



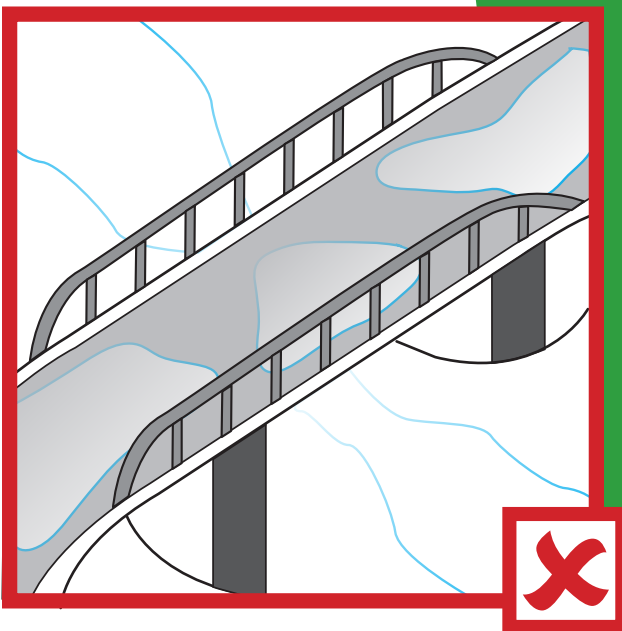
Bridge Maintenance

Bad Practice

- Maintaining the bridges the same way as the rest of the roads

Good Practice

- ✓ Have a reserve of dry and covered sand prepared during summer time and have sand spreader equipment ready to work when there is a risk of freezing rain (fall, winter or spring time)
- ✓ Have an intervention plan linked to the weather forecast (set thresholds of predicted freezing rain events that will trigger the implementation of the plan)



Bridge Maintenance

Bad Practice

- Dramatically reduce river path when building bridge abutment

Good Practice

- ✓ Make sure to keep riverbed and riverbank areas free-flowing, make sure they stay clean, especially when crossed by bridges
- ✓ Avoid piling snow near a bridge
- ✓ Ensure that there is no ice buildup on the upper side of the bridge during springtime
- ✓ Design and construct bridges outside of the riverbed



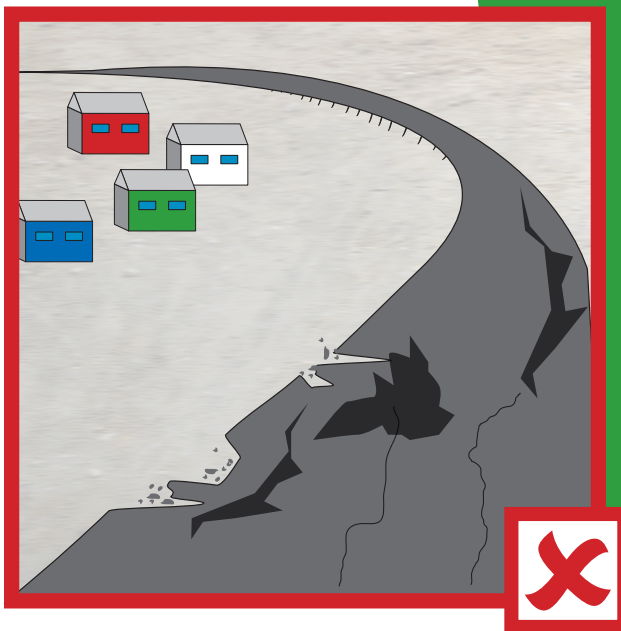
Road Maintenance

Bad Practice

- Witnessing erosion of the roadsides without taking any action

Good Practice

- ✓ Ensure frequent and systematic maintenance of road and roadsides
- ✓ Add material to the shoulder of the roads as soon as required (in holes or collapsing parts)
- ✓ Keep stockpiles of adequate material ready for roadside maintenance



Road Maintenance & Construction

Bad Practice

- Tolerate water accumulation along roads, especially on permafrost sensitive areas
- Allow creation of obstacles to proper drainage along the road (ex.: gravel stock piles, connecting small access roads without drainage)

Good Practice

- ✓ Ensure frequent and systematic maintenance of existing drainage along roads and any drainage in the community
- ✓ When designing and building a road, always consider proper drainage of surface water



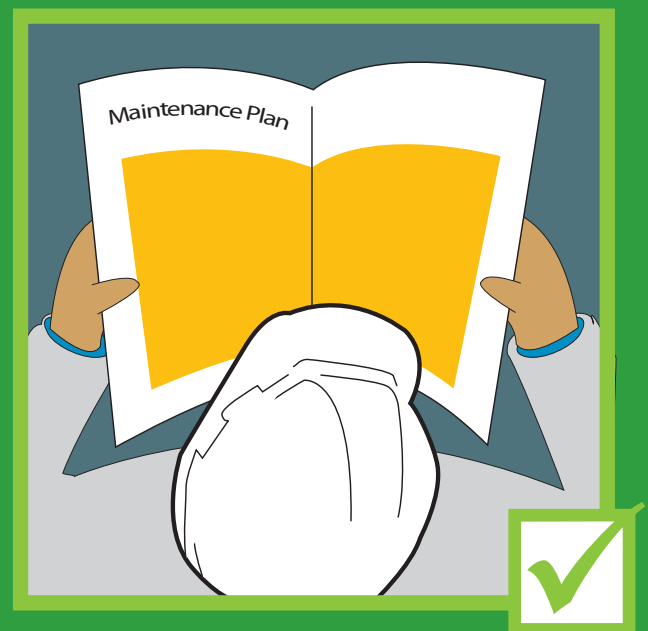
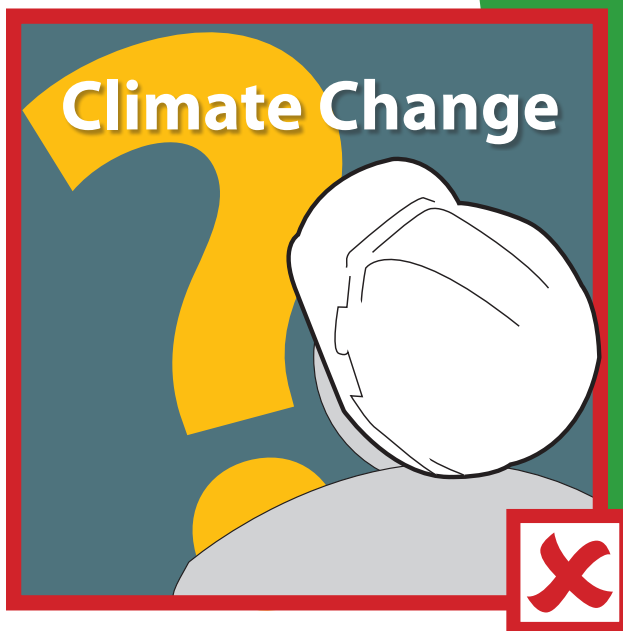
Maintenance Plan

Bad Practice

- Have no plan to face new conditions generated by climate change

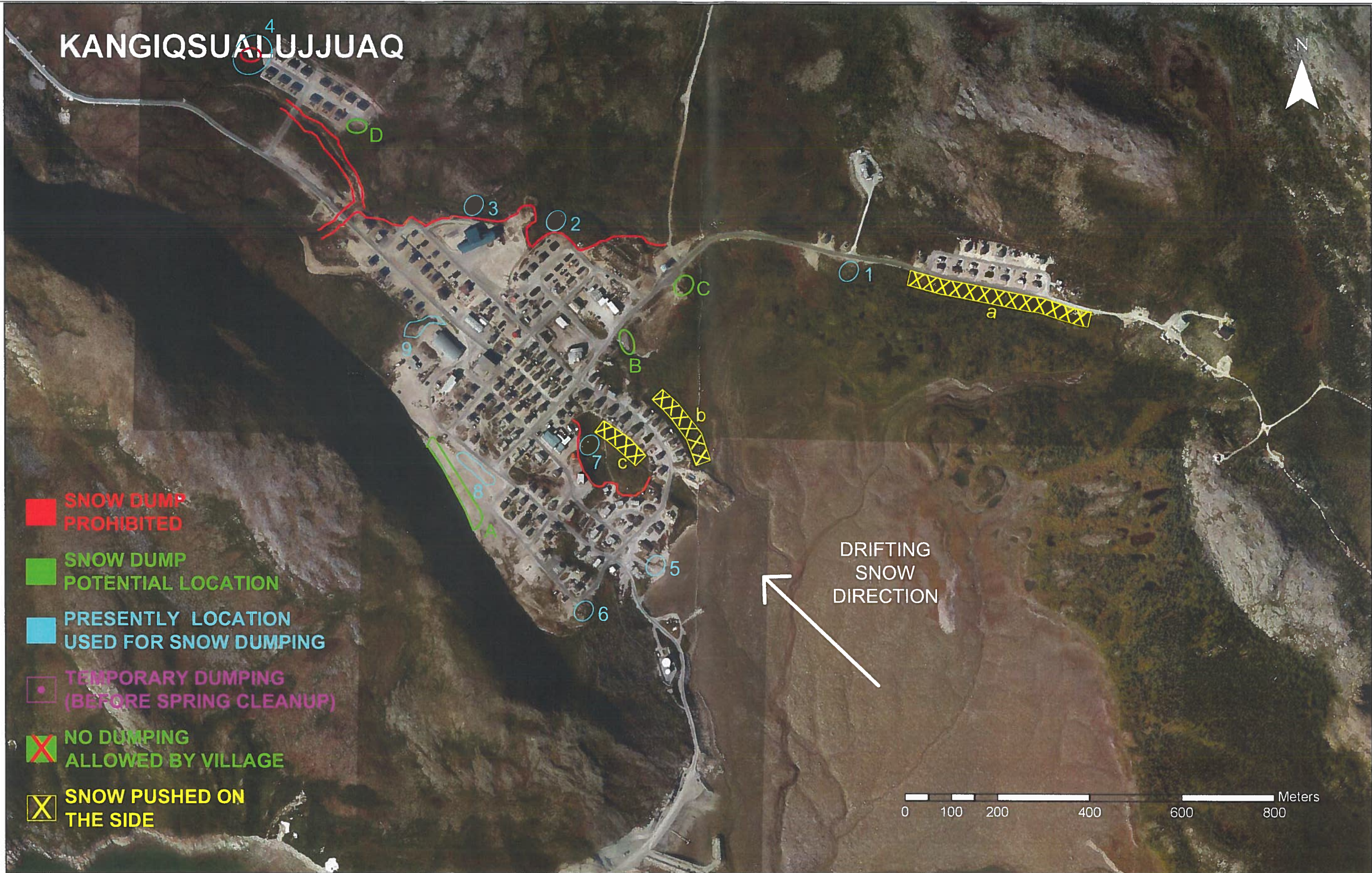
Good Practice

- ✓ Have a snow removal and sanding intervention plan linked to the weather forecast
- ✓ Perform frequent and systematic maintenance on snow removal and sanding equipment
- ✓ Have enough properly trained employees ready to use the equipment in an efficient manner



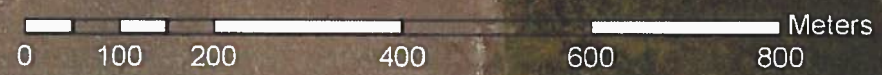
Annexe 4

Exemple de carte localisant les site d'empilement de la neige



- SNOW DUMP PROHIBITED
- SNOW DUMP POTENTIAL LOCATION
- PRESENTLY LOCATION USED FOR SNOW DUMPING
- TEMPORARY DUMPING (BEFORE SPRING CLEANUP)
- ✗ NO DUMPING ALLOWED BY VILLAGE
- ✗ SNOW PUSHED ON THE SIDE

DRIFTING SNOW DIRECTION



PRINTED DATE: 2012/08/27/09:41

CLIENT:		 KATIVIK
DATE:	PROJECT No.:	
22-08-2012	L-11-1446	

PROJECT:	KANGIQSUALUJJUAQ PROPOSED SNOW DUMPS NUNAVIK, QUEBEC
SCALE:	
DRAWN BY:	A.B.
PROJECTED BY:	N.J.
APPROVED BY:	N.J.

DRAWING No.:	FIGURE No.:	REV.:
L1446-01	----	D

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S:11-LAB2-Projet0114001446 - Administration Régionale Kativik - Snow dumps (13 commun.) (Desain/Rev D11) Aug 2012 [01-07]L1446-01 KANGIQSUALUJJUAQ rev D.dwg

Annexe 5

Compte-rendu de l'atelier de fin de projet



WORKSHOP ON ADAPTATION TO CLIMATE CHANGE
IN NORTHERN VILLAGES
By KRG

Salluit
Tuesday, September 11, 2012



GOAL: Assess the tools and training developed to help adapt municipal services and identify priority needs to better prepare communities in Nunavik to changing climate conditions

Summary notes of workshop

Participants:

Tommy Kudluk, Municipal manager – Kangirsuk
Saima Kanarjuak, Municipal manager – Ivujivik
Willia Nappatuk, Municipal manager – Akulivik
Jeffrey Fleming, Municipal manager – Kuujjuaraapik
Noah Inukpuk, Municipal manager – Umiujaq
Jimmy Angiyou, Assistant municipal manager – Puvirnituk
Stanley Aloupa, Municipal manager – Quaqtaq
Markusi Papigatuk, Municipal Manager - Salluit
Adamie Papigatuk, Heavy Equipment Operator - Salluit
Lucassie Grasser, Assistant Municipal Manager - Salluit
Keatainak Angutigirk, Garage Foreman - Salluit
Naina Keatainak, Qaqqalik Lanholding Corporation - Salluit

Meredith Griffiths, KRG
Christopher Chin, KRG
Stéphane Cossette, KRG
Jean Robitaille, Consultant for KRG (Trainer)
Caroline Larrivée, Ouranos
Noël Journeaux, Journeaux associés
Michel Allard, CEN
Tania Gibéryen, CEN



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P.O. Box 9 KUUJJUAQ (QUÉBEC) CANADA J0M 1C0

Summary of workshop:

C. Larrivée began with a brief description of how the day was going to unfold (see *Workshop Agenda* at the end of this document) before the participants quickly introduced themselves (providing their name and occupation).

She provided a very brief context to explain why and how the project developed. Results from a survey conducted with representatives from each northern village revealed that municipalities wished for more information on the impacts of climate change for the services they deliver and more generally for the communities. The respondents also expressed the need for tools to help cope with these impacts. This project was developed in response to these needs and the goal of the workshop was to assess the tools and training developed to help adapt municipal services and identify priority needs to better prepare communities in Nunavik to changing climate conditions.

The two first presentations of the day provided some information on how climate change could affect the Northern Villages and why it was important for municipal employees to be informed and concerned about these changes. Examples of how their own work could be affected served to illustrate this. A more detailed presentation concerning permafrost and specific issues related to permafrost degradation was given by M. Allard. Copies of these presentations can be made available upon request.

After the morning coffee break, the workshop focussed on snow management activities in the villages since snow cover insulates the ground and prevents it from freezing properly. Snow melt and drainage patterns also contribute to accelerating permafrost thaw by transferring heat more quickly to the ground.

Maps that were developed to identify sites to use or avoid as snow dumps are meant to help municipalities conduct snow clearing activities in ways that do not create problems for permafrost. N. Journeaux explained how these maps were created. Based on findings from M. Allard's work, he used aerial photos (showing topography, soil types, drainage patterns and use of the land in the villages) to identify sites and validated them through in-the-field visits during the training that was provided in each village during the Spring of 2012. The workshop was an opportunity to show the results of these maps and validate them with representatives from each village. Final versions of the maps will be printed in large and small format and be sent to the villages for their use.

Lunch was provided on site.

The afternoon began with a site visit to different locations in the village of Salluit to show the participants different issues that this village is already dealing with, that will likely worsen with climate change and that other northern villages may have to face in the coming years. The participants also got to see what permafrost with a high content in ice looks like and what kind of consequences thawing permafrost has on the landscape and the infrastructure (landslides,

riverbank erosion, shifting of the ground, etc.) and how to identify forewarning signs. They also went to see examples of areas to avoid as snow dumps.

After the visit on the field, a discussion period was held to verify whether the tools being developed through this project are helpful for the communities and allow for questions by the participants. A summary of the points raised is presented further in this document.

T. Gibéryen closed the workshop by presenting a new project that was recently approved for funding to transfer knowledge concerning climate change and permafrost issues in the villages to different groups of people, from secondary-school students to municipal employees and political decision-makers. She will be going around the communities in the winter to present the project more formally and begin developing, with the communities and the KRG, the tools necessary to ensure an effective transfer of information. The first training workshops in the communities are planned for winter/spring 2013.

Discussion:

The points discussed during the afternoon concerned:

- Preparing pads for construction of buildings

It is recommended to prepare the pads ideally two years in advance¹ (at the very least, one year ahead of time) before beginning construction to allow the ground to stabilize and prevent shifting once the structure is built. It is important to note that no snow should accumulate during this period on the pads, as this would prevent the ground from freezing properly.

Some villages are already doing this. However, it remains something difficult to do without longer term planning in the communities. This requires each community to have official land use plans that indicate the future zones for development with more detailed plans of the roads and pads to be built. It was agreed that surveyors should then visit the communities before the construction of the pads, as they could point out the exact location and dimensions of the planned pads and roads, namely to avoid wasting granular/backfill material, work-time and heavy equipment time. This could be one way to ensure pads are appropriate for the specific site where they are prepared. Currently, some efforts are made to coordinate on a yearly basis the survey needs for the construction projects in the communities to help reduce costs but more are needed to help plan longer ahead of time.

This strategy necessitates the collaboration between many partners involved in construction projects in the northern communities (northern villages, landholding corporations, land use planners, public works employees, project proponents, constructors, etc.). The KRG representative at the workshop mentioned that work towards putting this in place is on-going. It will also require efforts on the part of municipalities and landholding corporations to ensure that the land use plans are respected and that this way of preparing pads in advance is well observed. The communities need to be in a better position to impose their conditions and could improve the processing of requests for authorizations to build (“building permit”).

Another related aspect is that the communities would like to be more autonomous in preparing the pads themselves. The participants expressed the need for the communities to get equipped with basic surveying equipment to make the lots level. This would also help to avoid having to put too much granular material to prepare the pads. The availability of granular material appropriate for construction remains an issue in most communities.

The participants also pointed out that they would like to be trained in how to build a “good” pad. One of the engineers present provided some explanations on how to do this, for example by putting the better granular material right underneath the projected building/house combined with 2-3 layers of geotextiles to make sure that any shifting will happen more uniformly. The granular material of lesser quality could be used to fill up the remaining parts of the pad. The big blocks should be used as a first layer and can also be used to stabilize the edges of the pad. He

¹ The pad should be exposed for two winter seasons before beginning construction.

also suggested that heavier equipment (like the compactors that the northern villages have) are more appropriate for preparing and levelling the pads to prevent too much shifting. A thorough training that included this type of information along with in-the-field testing for preparing pads would be useful according to the participants.

The participants agreed however that while longer term planning is essential and will help to reduce future costs, there is also the need to balance that with the very urgent need for new housing to meet existing shortages. The support for building new houses must absolutely be accompanied with support for planning to ensure the houses are built correctly. It must also be recognized that the villages may need more resources to ensure services (more employees, more equipment). This issue of capacity of the villages must also be considered when planning future development.

- Snow management

The participants considered the maps that were developed to indicate areas for dumping snow (or areas to avoid) to be useful. For most villages, the areas identified on these maps are sufficient for snow management in the winter. This information should also appear on the official community land use plans and they should also be identified ahead of all new development areas to be more official like the waste disposal sites, water intake points, etc.

For some villages with very specific issues (such as Salluit), there is not enough space identified and the appropriate sites are not convenient or not accessible in the time required for the snow to be cleared off the streets. The current situation (lack of staff) makes it difficult in some cases to respect the areas identified on the maps as the ones to avoid for dumping snow. When there is a storm or heavy snowfall, the community usually expects the roads to be cleared quickly. It was suggested that an additional resource (human) would help to optimize the way snow clearing is done and ensure the snow is pushed into areas that will not cause problems for permafrost thaw. In some cases where there might be lacking space, it is suggested to at least wait until the ground has frozen deeply before beginning to store snow and to remove as much as possible before snow melt.

Many techniques were mentioned to help clear snow and remove it from the truck (using water to freeze the box; using the loader to help push the snow out of the box; etc.). The participants pointed out however that the snowblower isn't always the easiest tool to use, since roads have to be opened quickly. It would be useful in some cases to have additional heavy equipment. For example in Akulivik, an additional dump-truck could help reduce the time for snow clearing by two to three days for the roads that lead towards the water-intake and the sewage-dump. These roads can be covered with six to fourteen feet of snow accumulation after a snowstorm. There is also a need to make sure the equipment is functioning well and that there is someone on site with the ability to repair this type of equipment.

The participants also had some questions concerning snow fences to help manage snow and prevent it from blowing towards the houses. However, none of the communities are currently using this type of equipment so it was difficult to determine its effectiveness.

As pointed out by one participant, solutions will have to be worked out case by case, for each community, because local constraints/specificities require sometimes that snow has to be pushed into the red zones.

The participants suggested it would have been useful to have discussions with the KRG Transport representatives who are responsible for snow clearing on the airport road.

- Road pavement

It was suggested to try testing the use of more reflective material for paving to help keep the ground cold. Experience in other northern regions has shown that the use of lighter material can have a positive effect. It is suggested to test this on sites when the opportunity arises (repaving of sections, etc.). A pilot project is current on trial in Kuujjuaq on the airstrip. The results on how well this performs could be made available to the other communities.

- Culverts

The participants understood the importance of maintaining the culverts properly, especially at the beginning and end of the freezing season and didn't mention any specific problems. There seems to be the perception that this is something that is done quite systematically. Some villages work with the students in the Spring to help clean the culverts.

However, the shoulders of the roads in some areas in the villages are showing signs of erosion around the culverts. Proper maintenance is key for ensuring the culverts are fulfilling their role. This should be a very formally planned activity within the municipal public works services in the villages.

Experience in Kuujjuaraapik and Aupaluk suggests that there may be a need to revise how the open culverts are built. In some cases, they appear not to extend far enough at intersections and, with trucks and heavy vehicles passing over, cause problems such as erosion at the end of these culverts. This also causes the screens to become wobbly and not stay in place as well. This is something that could probably be avoided simply by extending them a little further. Since other villages are planning on installing this type of equipment next year and the following years, it could be helpful to use Kuujjuaraapik's experience regarding this.

It was also suggested to try using new equipment (for example, heavy equipment vehicle with a snow blade that lifts automatically) to avoid breaking culverts, etc.

Villages tend to know where the specific issues are. These should be located on a map and prioritize the work. This could be included within capital investment project planning.

- The workshop

The participants generally had positive comments regarding the project and this type of workshop which serves to inform different people in the communities about climate change, its impacts as well as adaptation strategies to help cope with the impacts. For example, some of the participants attending the workshop had not been able to attend the training given in the spring in each village. It was also pointed out that it would have been useful to invite other participants such as the KRG Transport workers (responsible for snow removal at the airport) to the workshops to make sure they also received this information.

The event also helped trigger the exchange of good practices and challenges between municipal public works employees, something that the participants also found to be quite useful. The field visit appeared to be a preferred activity, allowing the participants to actively engage in discussions and share their specific local knowledge with the others and providing an opportunity to question the scientists and engineers present.

There are many issues that municipalities have (or will have) to face with climate change. This type of project helps to prioritize some of the more pressing issues and begin to implement strategies to address them. Better land use planning along with improved collaboration on the part of all parties involved in construction activities in the Northern Villages are required to make sure the communities are well adapted/prepared to address the expected changes. This project and workshop make up initial steps in building the capacity in the communities to be able to deal with these issues.



WORKSHOP ON ADAPTATION TO CLIMATE CHANGE IN NORTHERN VILLAGES

By KRG

Salluit

Tuesday September 11, 2012



GOAL: Assess the tools and training developed to help adapt municipal services and identify priority needs to better prepare communities in Nunavik to changing climate conditions

WORKSHOP AGENDA

AM	9:00	- Introduction (<i>Caroline Larrivée – 15 min.</i>)
	9:15	- Climate change in Nunavik and its impacts on municipal services (<i>Presentations by: Caroline Larrivée – 20 min.; Michel Allard – 20 min.</i>)
	10:00	- Coffee break
	10:30	- Summary of the project to date - Training and tools that were developed, including the maps for snow removal activities (<i>Presentation by: Jean Robitaille – 40 min.; Noël Journeaux – 20 min.; Review of snow removal maps and questions – 30 min.</i>)
	12:00	- Lunch (provided)
PM	1:15	- On the field: observation of ice lenses in upper zone of the permafrost, examples of impacts in the community of Salluit as well as adaptation strategies and measures being put in place (<i>Field visit with experts</i>)
	3:15	- Discussions on what is happening in different communities in terms of impacts and adaptation to climate change (<i>discussions</i>)
	4:15	- The next steps: <ul style="list-style-type: none"> • Presentation on permafrost studies that were done in 5 communities in Nunavik (<i>by Tania Gybérien – 15 min.</i>); • Presentation concerning the next phase of the project – Training and workshop planned for 2013 (<i>by Michel Allard – 5 min.</i>); • Discussion with the participants on the expectations and needs in the communities for adaptation to climate change (<i>decision makers and managers – 45 min.</i>)



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Administration régionale KATIVIK Regional Government
P.O. Box 9 KUUJJUAQ (QUÉBEC) CANADA J0M 1C0

There will be time reserved for questions and answers throughout the workshop.

In order to prepare for the workshop, please review the information contained in the binder titled “Adaptation to climate change in Northern Villages”. Make sure to bring the binder and maps that were provided at the training with you. Also, please list all the climate change related issues you encountered in your community in the last year and of the measures you put in place to help resolve those problems. Bring with you any maps you have for snow removal operations, drainage, development options, etc.

Participants:

Tommy Kudluk, Municipal manager – Kangirsuk
Markusi Papigatuk, Municipal manager – Salluit
Saima Kanarjuak, Municipal manager – Ivujivik
Willia Nappatuk, Municipal manager – Akulivik
Jeffrey Fleming, Municipal manager – Kuujjuaraapik
Noah Inukpuk, Municipal manager – Umiujaq
Jimmy Angiyou, Assistant municipal manager – Puvirnituaq
Stanley Aloupa, Municipal manager – Quaqtaq (to be confirmed)

Meredith Griffiths, KRG
Christopher Chin, KRG
KRG representative from Municipal Public Work Department (1 person, to be confirmed)
Jean Robitaille, Consultant for KRG (Trainer)
Caroline Larrivée, Ouranos
Noël Journeaux, Journeaux associés
Michel Allard, CEN
Tania Gibérien, CEN