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CLIMATE CHANGE AND FORCE MOBILITY IN THE CANADIAN ARCTIC: IMPLICATIONS FOR OPERATIONAL PLANNERS

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Aim

1. The aim of this paper is to highlight the unique challenges to force mobility in the Arctic and how these challenges are likely to increase with climate change. Operational planners should reflect on the recommendations in this paper when reviewing contingency plans (CONPLANs) and operation orders (OPORDs) for activities in the Canadian North.

Introduction

2. The Canadian Armed Forces (CAF) routinely experiences culture shock when conducting exercises and operations in the Canadian Arctic. The military culture instilled in CAF members is one of precision and perseverance, attaining mission objectives within rigid timelines. Operational commanders that are not accustomed to operations in the Arctic often hold unrealistic expectations of timeliness when first presented with challenges in the North. Activities that are routine in other environments become impossible to achieve in the arctic within traditional timelines due to the impact of extreme weather, lack of infrastructure, and isolation on force mobility[1]. It could be argued that mobility is a critical aspect of any center of gravity for operations in the Arctic. The first Arctic initiative (106) in Strong Secure Engaged (SSE) highlights the importance of mobility to northern operations, specifically directing the CAF to "Enhance the mobility, reach and footprint of the Canadian Armed Forces in Canada's

[1] Adam Lajeunesse, P. Whitney Lackenbauer. *Canadian Arctic Operations, 1941-2015: Lessons Learned, Lost, and Relearned.* Fredericton: The Gregg Centre for the Study of War & Society, University of New Bruinswick, 2017. xxiv.

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North to support operations, exercises, and the Canadian Armed Forces' ability to project force into the region."[2] Each of the subsequent SSE initiatives for the Arctic are necessarily contingent on mobility and projection. The Inuit Circumpolar Council of Canada reinforces the importance of mobility in traditional knowledge, stating "Life in the Arctic is dependent on movement, and sea ice is integral to this movement."[3] Climate change will offer new challenges and opportunities for the CAF with respect to mobility in the Arctic, and CAF operational culture will have to evolve in order to remain effective in the future.

3. The effects of climate change on mobility in the arctic can be analyzed along the three traditional lines of operation: Land, maritime, and air. Land mobility may face the most significant challenges due to climate change. Changes in mean temperature will threaten the resilience and reliability of traditional highways due to changes in permafrost. Ice road seasons will become shorter and less predictable, and ground transportation off road will prove to be especially challenging during longer warm seasons. The effectiveness of land mobility will be dependent on the local sediment regime as well as weather and climate factors. Maritime access to the Arctic will gradually increase due to an overall reduction in sea ice, but the location and movement of ice will remain challenging and unpredictable for several decades. Air mobility will continue to be affected by volatile weather conditions, especially with respect to

[2] Department of National Defence. *Strong Secure Engaged.* Canada's Defence Policy, Ottawa: Government of Canada, 2017. 113.

[3] Inuit Circumpolar Council - Canada. *The Sea Ice is Our Highway: An Inuit Perspective on Transportation in the Arctic.* Ottawa: Inuit Circumpolar Council - Canada, 2008. 3.

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unpredictable visibility and wind conditions. Airfields are similar to highways in their susceptibility to damage due to changes in permafrost and sediment stability. The season for ice runways and ice roads is becoming shorter, and unexpected weather events may increase the risk of premature ice breakup.

Discussion

4. Land force mobility is critical to moving large quantities of equipment and personnel, especially given sparse airfield and marine infrastructure, unpredictable sea ice, and volatile weather conditions. Geophysical characteristics present unique risks between summer and winter months, with the former being predominantly more difficult. Existing roads and highways are relied upon for ground transportation during the non-winter months, but are subject to constant damage from freeze/thaw cycles, and the inherent instability of permafrost. Civil infrastructure is facing increased failure in the warming climate due to changes in the permafrost layer, and/or construction methods that did not adequately account for warming conditions[4]. CAF operations within the continuous permafrost zones of the North face increased risk of loss of mobility due to failure of existing roads. The impassability of off road terrain due to the poor integrity of the upper "active Layer" of permafrost will likely make alternative routes unviable for much of the year[5]. An increasing body of research is addressing road construction in the North, including

[4] Government of the Northwest Teritories. Environmental Impact Statement for the Construction on the Inuvik to Tutktoyaktuk Highway, NWT.Inuvik: Kiggiak - EBA Consulting Ltd. 2011. 58.

[5] Isabelle De Grandpré, Daniel Fortier, Eva Stephani. "Impact of groundwater flow on permafrost degradation: implications for transportation infrastructures." *Proceedings, 63rd Canadian Geotechnical Conference and 6th Canadian Permafrost Conference.* Calgary: 2010.10-11. https://www.researchgate.net/publication/268513512_Impact_of_groundwater_flow_on_permafrost_degradation_implications_for_transportation_infrastructures,.

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extensive surveys of potential future highway routes[6]. New technologies and construction techniques are being introduced to maintain the integrity of the permafrost layer beneath the constructed road surface, but employment of climate-adaptive techniques is limited, and is often overlooked in the construction of municipal infrastructure[7]. The stability of permafrost and depth of the seasonal active layer is not uniform across the north, therefore understanding of local sediment and ground water is key to planning movements over land. Surface surveys tend to focus on areas of economic interest and population centers, around which the CAF also plans training activities, but there will inevitably be instances where access to more remote areas is necessary for CAF operations. It is therefore in the interest of the CAF to build an understanding of ground mobility risk areas based on regional surface conditions.

5. Remote sensing(RS) and geographic information systems (GIS) data are available for much of the Arctic, offering valuable information for planning CAF operations. Research should be considered an integral part of reconnaissance, and CAF planners should be encouraged to creatively employ RS/GIS early in their planning cycle. Figure 1 demonstrates a macro level map showing permafrost regions within Canada[8]. Geomatics products such as this are one should be integral to assessing the risks of local surface characteristics on mobility. Figure 1 specifically highlights areas of the arctic that have higher ice content, and are therefore at greater risk of

[6] Ibid. 6.

[7] Council of Canadian Academics. *Canada's Top Climate Change Risks: The Expert Panel on Climate Change Risks and Adaptation Potential.* Ottawa: Council of Canadian Academics. Ottawa. 2019. 30.

[8] Natural Resources Canada. *Canada Permafrost.* 2019. https://open.canada.ca/data/en/dataset/d1e2048b-ccff-5852-aaa5-b861bd55c367 (accessed October 21, 2019).

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infrastructure collapse from warmer than average temperatures. The Arctic continues to warm and change at a higher rate than the rest of Canada[9], which will warrant more creative

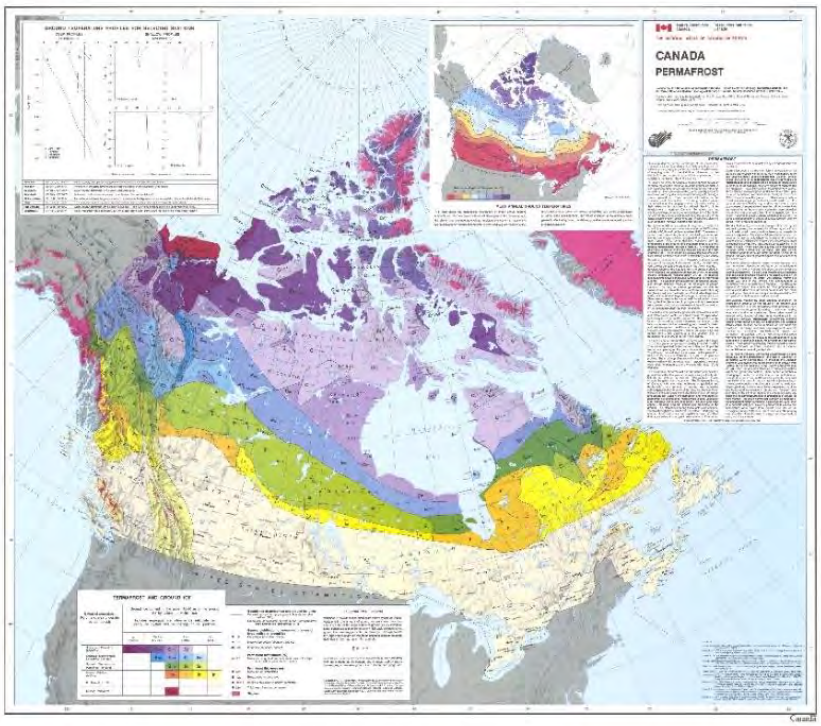

Figure 1 Canada Permafrost

Source: Natural Resources Canada 2019

use of research/reconnaissance tools to observe trends in the changing conditions of the North. An example of innovative use of remote sensing data could include association of Cariboo migration patterns with land mobility as illustrated in figure 2[10]. Routes used by migrating

[9] Council of Canadian Academics. *Canada's Top Climate Change Risks: The Expert Panel on Climate Change Risks and Adaptation Potential.* Ottawa: Council of Canadian Academics, Ottawa. 2019. 6-7.

[10] Committee on the Status of Endangered Wildlife in Canada. *COSEWIC Assessment and Status Report on the Caribou: Eastern Migratory Population and Torngat Mountain Population.* Ottawa: 2017. https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/cosewic-assessments-status-reports/caribou-some-populations-2017.html

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Cariboo may highlight ground that is also more suitable for human traffic. Given further study, animal migration patterns could offer a more agile assessment of changing conditions given the accelerated trend of warming in the north. Macro and micro scale geomorphologic surveys are also available to assist planners with understanding conditions on the ground prior to execution of an operation.

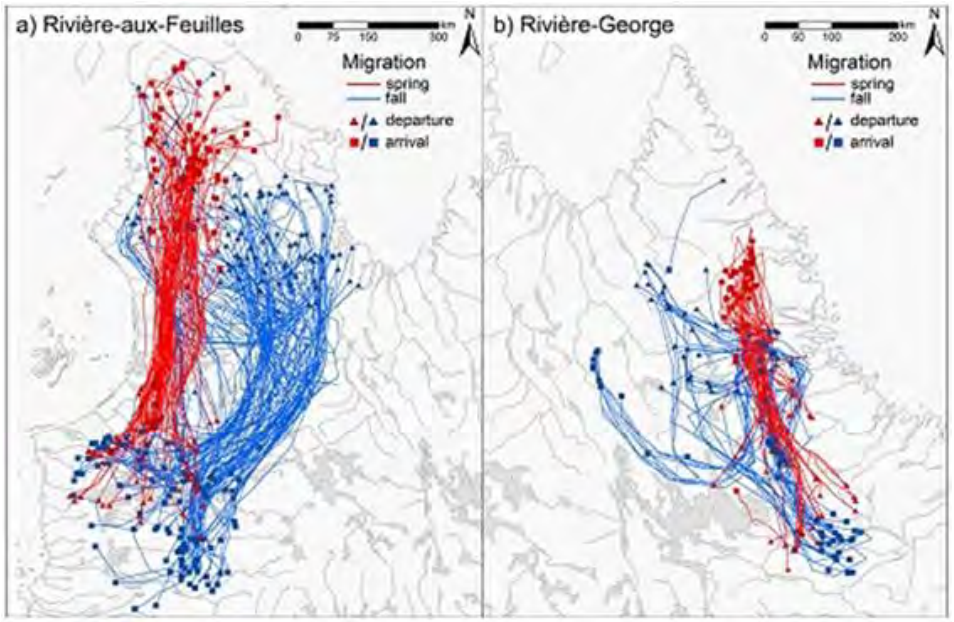

Figure 2- Cariboo Migration Routes –

Source: Committee on the Status of Endangered Wildlife Canada

6. Winter ground transportation is generally more reliable due to publically maintained ice roads, and stable off-road conditions across frozen ground[11]. Ice roads offer key access areas of the Arctic that are more difficult to reach during the summer, but ice roads are being threatened

[11] Council of Canadian Academics. *Canada's Top Climate Change Risks: The Expert Panel on Climate Change Risks and Adaptation Potential.* Ottawa: Council of Canadian Academics, 2019. 19.

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by shorter ice seasons and increased vehicle and maritime traffic in the Arctic[12]. Inuit hunters have become increasingly wary of ice routes that were traditionally safe. Icebreakers that offer increased service for commercial maritime traffic have been known to accidentally cut off traditionally reliable ice routes[13]. The Royal Canadian Navy (RCN) and Canadian Coast Guard(CCG) must increase their awareness of ice routes and work with local communities to eliminate risk to the livelihoods and safety of residents. CAF land forces must also be aware of the potential for ice crossings to be broken by natural or artificial occurrences, and be prepared to sustain themselves in place until alternate transportation can be activated. The risk of compromise to ice crossings will increase with additional RCN and CCG ice breaker traffic during northern exercises and operations, and must be a consideration for joint planners.

7. In order to protect freedom of land mobility, CAF planners must incorporate optimal use of northern highways into contingency plans and collective training events. Most roads in the arctic were built to minimum standards, and are reaching the end of their design intent[14]. In order to prevent unnecessary wear to aging arctic highways by increased military vehicle traffic, CONPLANs should include awareness of permafrost engineering considerations for transportation infrastructure. The load bearing characteristics of permafrost roads, including

[12] Ibid 19

[13] Inuit Circumpolar Council - Canada. *The Sea Ice is Our Highway: An Inuit Perspective on Transportation in the Arctic.* Ottawa: Inuit Circumpolar Council - Canada, 2008. 25.

[14]Government of the Northwest Territories. "Connecting Us: Northwest Territories Transportation Strategy 2015-2040." *Government of the Northwest Territories*. Yellowknife: 2015. 27. https://www.inf.gov.nt.ca/sites/inf/files/resources/transportation_strat_final.pdf (accessed October 23, 2019).

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seasonal variability, should be included in all northern ground movement plans. A study should be commissioned on the load bearing of permafrost in the Canadian Arctic, to provide options to military planners for the employment of tracked and wheeled vehicles both on and off highway. The outcome of such a study should include guidelines for planners and operators on the movement of vehicles over both frozen, and active layer permafrost surfaces.

8. Maritime mobility should increase over time due to progressive reductions in sea ice coverage during the summer months, but the location and density of sea ice coverage is complex and chaotic, and is only partially related to rising temperatures. A younger ice pack associated with higher year to year temperatures can be more prone to influence by wind and current[15]. The unpredictable nature of sea ice distribution in the Arctic Archipelago may mean that a route which is safe and clear one year, may be completely inundated by ice the next. Ships without icebreaking capability must be mindful that ice can build up quickly with a shift in wind, cutting off a previously reliable waterway[16]. Sparse ice conditions linked to climate change may make new maritime routes more appealing, but rapid shifts in ice coverage have already created dangerous situations for mariners, evidenced by an increasing number of SAR events in recent years[17]. There is evidence that wind patterns may change, and storm systems may increase in intensity as the arctic becomes warmer, which presents additional problems for predicting when

[15] Fisheries and Oceans Canada. *State of the Oceans report 2012.* Ottawa: Communications Branch - Fisheries and Oceans, 2012. 21.

[16] Canadian Coast Guard. *Ice Navigation in Canadian Waters.* Ottawa: Icebreaking Program - Maritime Services - Canadian Coast Guard - Fisheries and Oceans Canada, 2012. 73.

[17] Leblanc, Pierre. "Hill Times." *Is The Canadian Coast Guard Underfunded.* March 4, 2019. https://www.hilltimes.com/2019/03/04/190222/190222 (accessed October 23, 2019).

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and where sea ice will concentrate[18]. Tuktoyaktuk experienced an unusual and crippling early shift of the sea ice in 2018, which resulted in the delay of a year's worth of supplies to 3 isolated northern communities[19]. Tuktoyaktuk is also a key hub through which to transport fuel and provisions in support of western Arctic CAF operations. The intersection of factors between land and sea transportation through Tuktoyaktuk to the western Arctic increases the risks to the mobility of CAF logistic chains. There is appetite from the government of the Northwest Territories to build a more robust four season highway from Inuvik to Tuktoyaktuk[20], which will also benefit CAF operations in the western Arctic. Increased traffic and commercial interests in the arctic due to climate change will produce increased demand for fuel services in the north, and over time should trigger increased commercial investment.

9. The role of maritime forces in the Arctic will steadily increase with the lengthening of the navigable season. Increased marine traffic will require several government departments to increase presence and response capabilities, and the RCN will be expected to provide resources and support to whole of government activities as a result. The RCN will soon be employing AOPVs during the navigable season, but will have to continue to develop expertise in ice

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[18] Government of the Northwest Territories. "Connecting Us: Northwest Territories Transportation Strategy 2015-2040." *Government of the Northwest Territories.* Yellowknife. 2015. 35. https://www.inf.gov.nt.ca/sites/inf/files/resources/transportation_strat_final.pdf (accessed October 23, 2019)

[19] Weber, Bob. "National Post." *After barge cancelled due to ice, three Arctic communities left without year's worth of supplies.* October 3, 2018. https://nationalpost.com/news/politics/cancelled-barge-cuts-off-arctic-hamlets-leaves-crucial-supplies-stranded (accessed October 27, 2019).

[20] Government of the Northwest Teritories. *Environmental Impact Statement for the Construction of the Inuvik to Tuktoyaktuk Highway, NWT.* Inuvik: Kiggiak - EBA Consulting Ltd . 2011. 4.

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navigation in cooperation with the Canadian Coast Guard (CCG). Weather and Climate will continue to pose challenges in predicting ice conditions, and the RCN must continue to evolve SOPs for the safety of personnel working in AOPVs, boats, or on shorelines where ice floes can create hazardous conditions. Severe storms may become more common in some areas[21], threatening damage to vessels, increasing SAR events, and diverting or delaying planned and contingency operations. The Arctic remains uncharted in many areas, preventing ships from finding safe havens from severe weather, and making anchoring more difficult in remote areas. The RCN should continue to assist CHS with surveying on an opportunity basis, as areas of the arctic become more accessible. New safe haven anchorages should be explored to specifically address the risk of extreme weather events when HMC ships are out of the Nanisivik Naval Facility(NNF) area.

10. Air transportation in the Arctic can be unreliable due to extreme weather patterns and lack of reliable forecasting in the north[22]. Visibility and wind conditions can change rapidly making it unsafe to operate aircraft, therefore air component planners must be particularly vigilant, and have ample contingency plans for changing conditions. Land and Maritime elements must also consider the unreliability of air support in the Arctic, and ensure that no one

[21] Council of Canadian Academics. *Canada's Top Climate Change Risks: The Expert Panel on Climate Change Risks and Adaptation Potential.* Ottawa: Council of Canadian Academics, 2019. 16.

[22] Nathan S. Debortoli, Dylan G. Clark, James D. Ford, Jesse S. Sayles & Emilia P. Diaconescu. "Nature." *An integrative climate change vulnerability index for Arctic Aviation and Marine Transportation.* June 13, 2019. 9. https://doi.org/10.1038/s41467-019-10347-1 (accessed October 23, 2019).

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plan is contingent on timely arrival of an aircraft. Ships and ground forces must have built-in self-sufficiency to deal with cancellation and delays of air mobility as they arise. Air mobility is the key element to rapid response in the Arctic, deployment of the CAF for SAR or major disasters can only be achieved quickly by the use of air power.

11. Air component planners would benefit from awareness of climate modeling products that specifically reference changing conditions in the north. For example, Debortoli, et al. observed a lack of integrative approaches to climate change vulnerability, and authored a report titled *An integrative climate change vulnerability index for Arctic aviation and marine transportation* [23]. From publications such as this, trends could be established for the probability of delay or denial of air support to forces by region, so as to make better informed assessment of risk and allow planners to establish robust contingency plans when warranted.

12. Airfields are increasingly more available in the Arctic, with public and private sector organizations investing upgrades and new construction of airfields to support economic interests. The CAF should continue partnerships such as the Iqaluit airport upgrade[24]and informal arrangements with local industry. As northern ice conditions become more permissive, alternatives to air transportation by sea will become increasingly available. Arctic/Offshore

[23] Ibid.

[24] Government of Canada. "Government of Canada." *National Defence to contribute funding for upgrades at Inuvik Airport.* September 4, 2019. https://www.canada.ca/en/department-national-defence/news/2019/09/national-defence-to-contribute-funding-for-upgrades-at-inuvik-airport.html (accessed October 25, 2019).

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Patrol Vessels (AOPV) may be able to provide a limited alternative to CAF air mobility, but will only be able to operate in the Arctic during the 4-month navigable season. Air Forces have been operating effectively in the Arctic for decades, but climate change will continue to impact the availability of airfields, shorten the season for viable ice runways, and introduce more severe weather conditions in some areas. The CAF should continue to partner with other levels of government and industry to enhance the capabilities of airfields to support national defense objectives. CJOC planners should be cognizant of changing conditions in the arctic, especially with respect to the availability of airfields due to failing infrastructure.

Conclusion

13. The CAF must be ready to execute operations at short notice, which require access to an isolated area of the Canadian North, and operations planners must be prepared to assess and mitigate risks to force mobility. The CAF does not have the luxury of assuming conditions will remain static from year to year in a changing climate, or that existing infrastructure will be reliable when needed. Operational planners must be aware of the tools available to assess risks to force mobility in the Arctic, and incorporate research from OGDs, municipalities, and private sources, into contingency plans and annual training events. Appreciation of mobility in the changing Arctic environment will ensure the CAF remains agile, flexible, and effective when executing operations in the North.

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