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Introduction

- 1 There is no lack of adjectives to qualify the progress of the globalized world in the Arctic: 'last frontier', 'new frontier', 'ultimate frontier', etc. These locutions have given rise to a fierce global competition for its resources [Bloomfield, 1981 ; Macdonald, 1966], a 'first global battle of globalization' [Labévière and Thual, 2008] to integrate the boreal region [Pilyasov, 2016 ; Sommers, 1952]. Indeed, despite its harsh environment, difficult access, and scattered population, the boreal region provides the world with natural resources. This makes it possible to conceptualize it as a frontier where a battle is being waged for rapid expansion of the ecumene inducing fast population growth.
- 2 The Arctic has a population of just over four million [Larsen and Fondahl, 2014]. This number is often quoted while the boundary of the zone is rarely specified. In 2004, the Arctic Council reported this question quoting "*Some two to four million people live in the*

Arctic today, although the precise number depends on where the boundary is drawn.” [Arctic Council, 2004, p. 13]. Indeed, there are many limits, thus the circumpolar population varies greatly depending on the southern boundary of the Arctic zone. The question of its definition and its boundary has been one of the most debated issues due to its impacts on local development policies, particularly through the benefits that residents can claim [Brunelle, 1989 ; Burkhanov, 1970 ; Graham, 1990 ; Hamelin, 1968 ; Stammler-Gossmann, 2007 ; Tarakanov, 2010]. However, all of them are related to the perception of the Arctic as a frontier.

- 3 In this article, we propose to discuss this concept applied to the Arctic. We first examine its many facets and demonstrate that it is implicit in all the limits of the Arctic. We then present *Arcticapolis*, a new geohistorical database of standardized censuses of circumpolar countries, and we detail the challenges and methodological issues of its implementation. Based thereon, we continue by conducting an unprecedented assessment of population and density of the Arctic region depending on its various limits. Furthermore, we discuss the Arctic settlement dynamics over the last decade at the finest level.

1 The frontier and the Arctic

1.1 Conceptualize the Arctic as a frontier

- 4 The frontier consists, at the same time, in appropriating new resources, consolidating the national territory, establishing a national identity, expanding trade and redistributing the population [Bloomfield, 1981 ; De Koninck, 2000 ; Demangeon, 1932 ; Monbeig, 1952 ; Pilyasov, 2016]. It is thus multifaceted [Waechter, 2019]. First, it refers to a line separating the white civilization from the wilderness. According to the historian F.J. Turner [1920], *wherever the highest rate of penetration into the unexplored world is, there is a frontier*. He first developed the concept of the frontier applied to the conquest of the Far West of the USA. A few years later, the *Klondike* frontier opened, fueled by the gold rush.
- 5 Second, it refers to a region which is being shaped by colonization and civilization of the wilderness. Third, it also inevitably refers to the process of expansion itself. This leads to a transition from an economy of hunting and gathering, in balance with nature, towards an economy based on primary resources, destructive of nature [Raumolin, 1984]. The conquered space therefore becomes an exploited periphery serving a distant dominant center [Reynaud, 1981]. A.N. Pilyasov [2016] considers a frontier to be wherever more than 30% of the gross regional product (GRP) is due to mineral resource exploitation. The process involves two sides of the same coin; one is the advent of the wage-based and sedentary society, the other is the invisibilization of the natives [Hanrahan, 2017 ; Turner *et al.*, 2008] leading to terrible conflict between indigenous peoples and settlers [Argounova-Low, 2006 ; Slotkin, 1998].
- 6 The process of transforming wilderness into domesticated nature [Berque, 2011] goes hand in hand with large-scale transformations of landscapes linked to their new functionalities like residential ones (villages and towns) and production. Rapid expansion of the ecumene leads to fast population growth. The pipelines in the plain of the Ob river (Western Siberia, Russia) or the sawmills in Mato Grosso (Brazil) are the markers of landscape transformation from a wild environment into a space of

production [Hacquebord and Avango, 2009 ; Monbeig, 1952 ; Vaguet]-Marchand, 2005]. In the past, many States pushed the ecumene towards the forest considered as the antithesis of the city and civilization, as did temperate countries during their demographic and economic expansion (Ancient Greece, Europe of the Middle Ages, North America).

- 7 Finally, the frontier refers to a form of society and culture with its value and ideals as peculiar patterns of social organization arise under wilderness conditions [Waechter, 2019]. Turner's social evolutionist approach underlines that the European cultural heritage melted away when the American settlers were confronted with wilderness (see [Meyer, 2014]). Thus, the conquest of the Far West is an important part of national history especially because it produced the American pioneer. The geographer A. Demangeon [1932] underlines the hardships endured by all the pioneers of humanity on every continent, mentioning their obstinate battle to progress slowly. A frontier transforms people, the push generates new forms of civilization; it represents a new way of creating nations. For a nation, having a frontier is an exceptional fortune which involves a taste for novelty and a desire not to stick to the heritage of the past. It is a manifestation of a powerful vitality.
- 8 The Arctic as a frontier implicitly indicates some features that we will retain for this paper. First, it offers a harsh even implacable environment for human beings. Second, as a margin of the ecumene, its population is increasing rapidly, and the wage economy is spreading. Despite the fact that this is clearly a representation of the high latitudes by the South, more precisely the mid-latitudes, these characteristics somehow form the basis of the multiple Arctic boundaries.

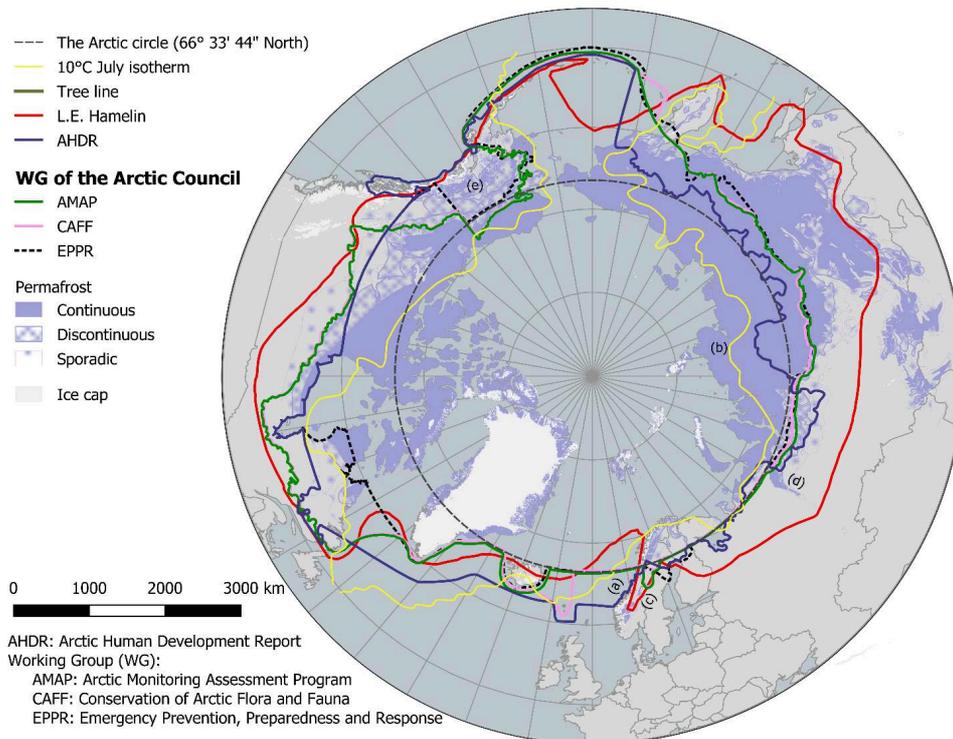
1.2 Limits of the Arctic as a *frontier*

- 9 The Arctic presents the peculiarity of having a maritime center deserving of the expression "polar Mediterranean" [Dodds, 2010]. It can be bordered by various mono-criterion limits but in all cases, the cold plays a key role (Fig. 1). Latitude would seem an obvious criterion, however bioclimatic factors impacting landscapes are often preferred. The 10°C isotherm in July, the warmest month, is thus often suggested but it remains an average situation of only one month out of twelve. The *Koppen* line, known as the tree line, is already intended to be synthetic and has a strong intrinsic correlation with the previous one. Soil scientists would rather choose the southern limit of permafrost. These three boundaries migrate northward with the North Atlantic Current (Fig. 1.-a) or on peninsulas (Fig. 1.-b). Conversely, they migrate southward with the increasingly continental character, eastward and/or with the reliefs that block the oceanic air flows (Fig. 1.-c, d, e).
- 10 Furthermore, if each of these limits is reduced to a line on maps on the ground, they all extend over a wide band. Permafrost first appears sporadically before becoming continuous, and over great depths. Taiga trees first become stunted, then scattered shrubs before disappearing altogether.
- 11 In addition to these operating limits for natural sciences, the Arctic Human Development Report [Larsen and Fondahl, 2014] and the six Working Groups of the Arctic Council which have existed only since 1996, also have their own limit. For instance, the Conservation of Arctic Flora and Fauna (CAFF) considers a much broader definition than the *Koppen* limit, the Arctic Monitoring Assessment Program (AMAP)

favors the official administrative regions of each country, the Emergency Prevention, Preparedness and Response (EPPR) underlines the vulnerability and difficult recovery of the Arctic environment (Fig. 1).

- 12 An original contribution to this debate was proposed by L.E. Hamelin [1968]. To the hostility and vulnerability of the natural environment he added the human dimensions of the pioneer front, considering ten variables in total. One for positioning (latitude) that eliminates localities below 45°N. Five describe the harsh environment (annual cold, summer heat, precipitation, type of ice (permafrost) and vegetation cover). The last four indicators take into account the human desert (low human occupation, difficulty of access, absence of a so-called modern economy, i.e. wage-based). Thus, he highlights what Jean Corbel (1958) thought: the polar desert is the most deserted, inhuman of all deserts except Antarctica.
- 13 Each of the ten criteria is quantified between a minimum (=0) and a maximum (=100) of constraints. The sum accounts for the nordicity of a locality, its Polar Value (VAPO) which ranges from 0 (not polar at all) to 1,000 (North Pole). The southern limit of the circumpolar zone was proposed by the author as the isoline of nordicity, an isonorth, equal to 200 (VAPO=200). Similarly, on the basis of isonorths, the spatial categories advanced are: the Pre-North (VAPO < 200), the Middle North (200 < VAPO < 500), the Far North (500 < VAPO < 800), and the Extreme North (VAPO > 800). His contribution continues to inspire the Canadian administration [Graham, 1990 ; Simard, 2017]. This limit borders the 50°N parallel in the eastern parts of Canada and Russia, due to the continental character of these two regions.
- 14 For our purposes, we have chosen to take the southernmost limit which is that of Hamelin insofar as it allows us to examine all the localities mentioned in one limit or another. However, it excludes most of Iceland, the Faroe Islands, a few Aleutian Islands, and the southern Gulf of Alaska. These pockets of territory are, however, included in other limits. Thus, politically, it is undeniable that Iceland and the Faroe Islands are entirely Arctic. We have therefore integrated them into our area of interest which amounts to constituting a mix, taking in each part of the globe, the southernmost limit.

Fig. 1. Plurality of Arctic Boundaries



a- North Atlantic Current, b- Taymyr Peninsula, c- Fenno-Scandinavian Shield, d- Ural Mountain, e- Rocky Mountain

2 Arcticapolis database, a methodological challenge

2.1 Databases review, data collection, and applying a common administrative hierarchy

- 15 Worldwide urbanization has increased rapidly leading to over a half of the world's population living in urban areas since 2014 (UN, 2018). Cities play a key role as they are drivers of technological innovation, engines of economic growth, platforms of cultural development, and centers of decision making [Ni, Kamiya and Ding, 2017 ; Pacionne, 2009]. According to Malthusian theory, a community maintains itself and even develops as long as conditions are good enough. If not, a decline soon occurs. Therefore, in a large scale longitudinal study involving many localities of many states, the population is often the main, if not the only, indicator. This prevents the pitfall of incomparable or unevenly available data between countries while the number of inhabitants collected in censuses is widely disseminated with historical depth [Turok and Mykhnenko, 2007].
- 16 A major challenge is the construction of geohistorical databases which enable the study of the long-term evolution of the population and its spatial patterns [Bretagnolle and Franc, 2017 ; Claramunt and Thériault, 1995 ; Peuquet, 2001 ; Yuan, 2008]. Indeed, this requires an effort of data collection, matching and standardization of national censuses [Bretagnolle *et al.*, 2015 ; Chatel, 2012 ; Cottineau, 2014]. Recently, various international geohistorical population databases with different approaches and purposes have been developed (Tab. 1.).

Tab. 1. International geohistorical population databases covering the Arctic region

	¹ Geokhoris, ² E-geopolis	Megatrends	LandScan	GHSL	GRUMP- v1 GPW-v4
Format	Vector	Vector	Grid	Grid	Grid
Date	Max. range 800-2010 (10yrs interval)	1990, 2010	2000-2018 (every year)	1975, 1990, 2000, 2015	1990-2020 (5yrs interval)
Source of population	Census	Census	- Census - Ambience pop. calculated on the base of a complex and unknown algorithm	Pop. were disaggregated from census to grid cells	- Census - UN WPP- adjusted pop. count
Spatial unit	LAU ¹ + UA ² (>10,000 inhab. + 200m of c.b)	Settlement, cities, region	30 arcsec	250 m, 1km, {9, 30} arcsec	GRUMPv1: 30 arcsec GPW-4: 2.5 arcmin
Country coverage	Global	Arctic regions within the limit of AHDR	Global		
Limits for Arcticapolis	^{1,2} Completed in time and space only for European Nordic countries.	- Only 2 dates of census - Pop. available at different scales and dates by countries	- Estimation pop./pixel - Pixel resolution decreases with latitude - Weak in boreal regions with scattered pop.		
References	[Moriconi- Ebrard, 1993, 1994] [Chatel, 2012] http://e- geopolis.eu/	[Rasmussen and Nordic Council of Ministers, 2011]	https:// landscan.ornl.gov	https:// ghsl.jrc.ec.europa.eu/	a, b

Availability	On request	Not available	Paid	Free	Free
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UA: Urban Agglomeration, c.b.: Continuity of Building, LAU: Local Administrative Unit, pop: population, inhab.: inhabitant, UN-WPP: United Nation- World Population Prospect, arcsec: arc-second, arcmn: arc-minute, AHDR: Arctic Human Development Report

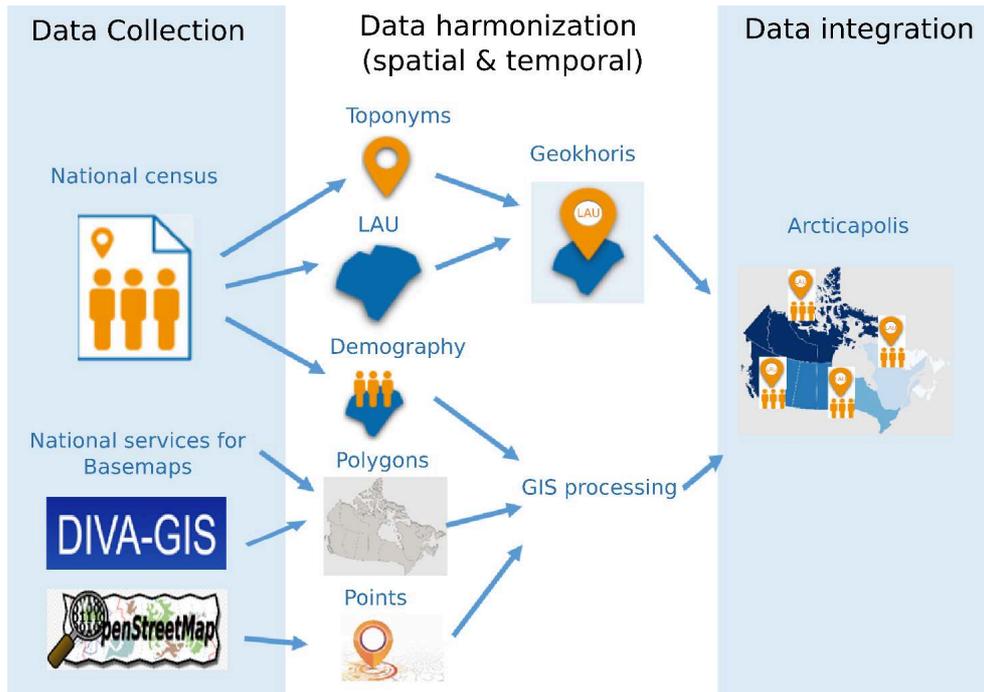
^a <https://sedac.ciesin.columbia.edu/data/collection/grump-v1>

^b <https://sedac.ciesin.columbia.edu/data/collection/gpw-v4>

- 17 The *Darius* database was also considered although it concerns only the former USSR. It contains all Soviet localities of over 10,000 inhabitants (+ 500m of c.b.) and their census population during the 1840-2010 period [Cottineau, 2014]. All the databases highlight the heterogeneity of data collection, the choice of data selection, the diversity of census dates, the definition and the historical changes of the administrative division units. The above-mentioned databases were evaluated because of their potential utility in the Arctic zone.
- 18 We notice a lack in terms of data coverage of the circumpolar regions and too high a threshold of the spatial units (*i.e.* *Darius* presents only 27 Russian localities within the AHDR limit). The latter criterion is a major issue as putting a high threshold makes the data collection easier as the data are widely spread for cities. Conversely, the lower the threshold, the more difficult it is to build the database due to the difficulty of obtaining data at the finest level however this is only what gives access to the settlement. The definition of what is 'urban' is somehow related to the size, ranging widely from one national context to another one. This makes conducting international comparisons difficult unless one applies the UN recommendation (10,000 inhab.) everywhere. However, the Arctic region is well known for its small communities over large territories and this is a difficult challenge for geographers to map. The threshold of urban definitions can be as low as 200 inhabitants for the members of the Nordic Council (Norway, Finland, Sweden, Iceland, Greenland and the Faroe Islands) and up to 12,000 in Russia.
- 19 We also notice a census and geo-localization incompleteness (*i.e.* *Geokhoris*), an unclear methodology (*i.e.* *Landscan*) or/and a roughly estimated population on the grid cell (*i.e.* *GHSL*, *GRUMP*, *GPW*). We decided, therefore, to develop the *Arcticapolis* and *Arcticakhoris* databases, the former being based on the latter giving details of the big localities (>10,000 inhab.) according to the model of the *Geopolis* and *Geokhoris* project because of its fine detail and uniqueness of the input data which make it easy to work with. This choice involves filling the gaps. For instance, for Russia, *Geokhoris* numbers 156,219 localities. The census data at LAU level had already been completed in 1811 for the largest settlements ($\geq 10,000$ people) while the smaller ones were available only for the 2010 census and that around 7% of the all the Russian settlements were localized [Chatel and Moriconi-Ebrard, 2007].
- 20 *Arcticapolis* is a standardized geospatial database on circumpolar settlements considering all different levels, from Local Administrative Units (LAU) up to national level. It has had an historical dimension with special focus since 1950. Over time, national censuses have been homogenized at 10-year intervals for the eight countries. The originality and breadth of this database were inherited from the *Geokhoris* database, which was initiated by F. Moriconi-Ébrard in 1980. This is relevant for *E-Geopolis* that aims to describe and compare the process of urban agglomeration (*Geopolis*) and settlement (*Geokhoris*) of the world over time [Moriconi-Ebrard, 1993].

The process of constructing an historical database within this project is organized in three steps: data collection, data harmonization both over space and time, and data integration as shown in Fig. 2.

Fig. 2. Arcticapolis construction model



- 21 *Arcticapolis* includes a cartographic dimension, unlike *Geokhoris*. All administrative unit boundaries at all levels are therefore collected either from official *Basemaps* of national services and/or from *DIVA-GIS* which has been extensively used in literature for mapping and geographical data analysis, and eventually compiled. Furthermore, the settlement coordinates, when missing, were extracted from *OpenStreetMap*, which gives quite an acceptable accuracy (70-80% depending on the area).
- 22 *Geokhoris* contains fields allowing one to track a settlement *i)* over the administrative hierarchy from local, regional, up to national levels, (often 5-7 different levels), *ii)* over time throughout events like (dis)appearing, splitting, merging, and changes in name or status and its name in several references (in native language, some alternatives, with and without diacritic) then, *iii)* its population in all censuses, and finally *iv)* the estimated population at the beginning of every decade. Indeed, because census dates for all countries are different, we proceed with a data harmonization in order to make them comparable - like *e-geopolis*, *Arcticapolis* considers the beginning of each decade. As an example, for Russia, in *Arcticapolis*, 14 fields precede those dedicated to the population out of the 39 fields in total. Table 2 describes the nesting of administrative levels in each Arctic country and their correspondence from one state to another based on *Geokhoris*.

Tab. 2. Common administrative hierarchy used in *Arcticapolis* database

	<p>Administrative hierarchy <i>Geokhoris</i> hierarchy base</p>
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Country

or

	c2	c3 several tens millions inhab.	c4 About 2.5 million inhab. / area of 25,000 sq.km	c5 About 750,000 inhab. / area of 5,000 - 10,000 sq.km	c6 About 20,000 to 50,000 inhab. / area of 30,000 sq.km	c7 >2,000 inhab. / area of about 100 sq. km	c8
Canada	Country	Territory/ province	-	Census division	-	LAU (Census sub- division)	-
United States of America	Country	State	-	-	Borough, County, Census area, City, Parish	-	LAU
Greenland	Autonomous territory	-	-	-	Kommun (municipality)	LAU (Kommun)	LAU
Faroe Islands	Autonomous territory	-	-	-	Landspørtum (region)	LAU (Kommuna)	-
Iceland	Country	-	-	Héraðsdóm (district)	-	Sveitarfélög	LAU
Finland	Country	-	-	Maakunta (region)	-	LAU (Kunta)	-
Norway	Country	-	-	Fylke (county)	-	LAU (Kommune)	-
Sweden	Country	-	-	Län (county)	Kommun (municipality)	LAU (församling, stad...)	-
Russia	Country	Federal'n- yj Okrug	oblast krai republic city of federal importance	autonomous okrug	rayon gorodskoyi okrug ...	-	LAU

LAU: Local Administrative Unit

2.2 Tracking settlement over time and space

- 23 Tracking the change in settlement in time and space is indeed a challenging task. In the first instance, because the Arctic, as a national frontier, often presents an ongoing process of change in administrative units. Canada provides an eloquent example of this

challenge. Expansion of the national territory and therefore changes in national population due to it, can be illustrated through the example of Northwest Territories (NWT) (Fig. 3. and Fig. 4.). Its name is stable and present in all censuses. However, its population refers to different areas over time. Its population increased sharply in the second half of the 19th century due to the Klondike gold rush. Yukon was created out of it in 1898 in order to administrate the massive in-migration flow. Meanwhile the gold rush was ending, other sites were taking over, such as Nome in Alaska. Consequently, in the early 20th century, the population of NWT declined sharply in census data, as did the population of the new Yukon. Nevertheless, altogether, the NWT of 1850 experienced a decrease but not as sharp as it looks if not for the creation of the Yukon. In 1905, the NWT population dropped only due to the creation of the two provinces of Alberta and Saskatchewan. The same experience occurred with the creation of Nunavut Territory in 1999. Since 1890, NWT's population could be misinterpreted as having decreased (98,967 inhab. to 41,462 in 2010) whereas considering the stable administrative unit (NWT of 1850), an increase can be noted (from 5,700 inhab. to 4,785,903 in 2010).

Fig. 3. Tracking boundary changes in territory over time - the example of Canada

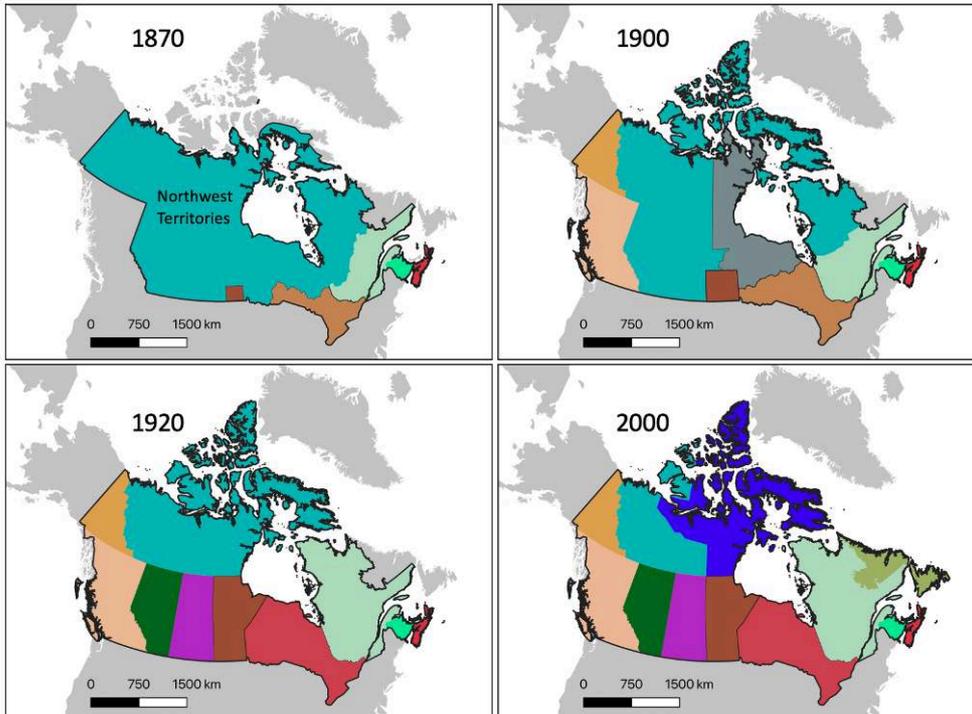
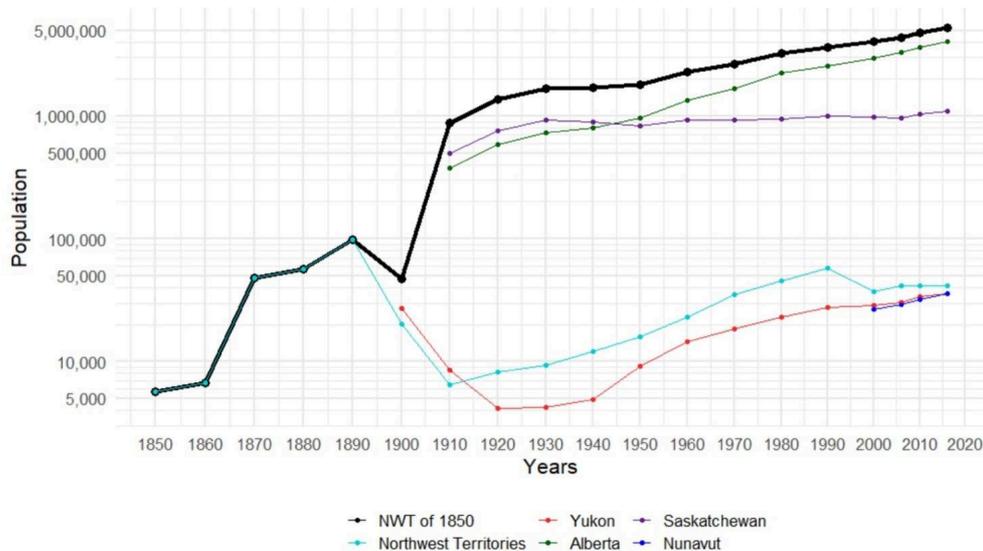


Fig. 4. Monitoring the population over time, despite changes in the delimitation of census units - the example of Northwest Territories (Canada) 1850-2016



Source: Arcticapolis

- 24 A similar example could be developed in Russia. For instance, at the local scale in Western Siberia, when a new oil-gas settlement was created, its population was counted as part of its southern rear base until it obtained the status of town and therefore its municipal territory. Noyabrsk took into account the population of Muravlenko before it split up. The first census where Muravlenko is mentioned shows that the population of Noyabrsk declined by about the same number of inhabitants.
- 25 Thus, it is of utmost importance before any analysis to take such events into account. Although adjustment and reconstitution of the spatial units are difficult and time consuming, they are compulsory in order to rebuild the population of a stable territory in order to build the territorial demographic trajectory throughout history and to avoid a misinterpretation.
- 26 Among other challenges to be mentioned is the historical research to collect all the censuses. For instance, Russian censuses are easily available for urban settlement in the past. For rural ones, censuses are available in Moscow at the State Library but not the oldest ones. For those, the research advises fieldwork in every regional capital city. This part is under construction and the following section discusses our first analysis for the last decade. Another point is the different census dates for all countries.

3 Arctic frontier, first reflections from *Arcticapolis*

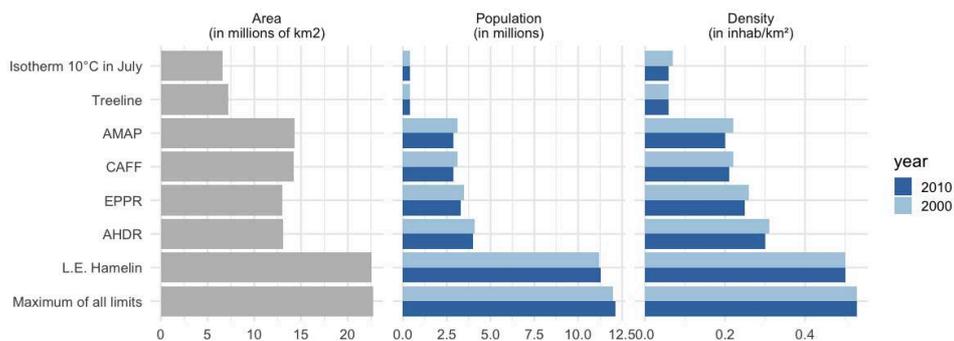
3.1 Population, density and limits

- 27 The *Arcticapolis* database allows one to discuss the Arctic as a frontier defined as a low-density area showing a rapid population growth. The figure of 4 million people for the Arctic is often mentioned without being systematically recalled that it is within the limits of the AHDR (i.e. Arctic Council website). However, there are ten times fewer polar residents than the above-mentioned figure when the limit is strictly based on biophysical factors, while the space under consideration is only divided by two.

Moreover, the number exceeds 15 million within the southernmost boundary, three times more than in the AHDR region, while the area concerned barely doubles (Fig. 5).

- 28 However, small numbers and tiny changes in numbers of inhabitants should be considered accurately for several reasons. L.E. Hamelin [1980] noted variations in northern populations of Saskatchewan province of between 17 and 22 thousand inhabitants depending on the sources. One reason is the—difficulty of counting accurately in those remote areas a fortiori at an early stage of Arctic colonization when censuses were poor. Another reason is an overlap between the boundaries of the North and the administrative units of censuses which creates difficulty in separating the northern inhabitants from the whole population. Nevertheless, it is clear that the northern population is concentrated in the southern fringe of the North. In other words, the southernmost edge of the polar region appears to offer the best compromise between the harshness of the environment and the benefits allocated to the northern inhabitants, since almost all the countries conduct a proactive policy.
- 29 Overall, the Arctic zone, whatever its limit, shows no significant ecumene progress over the recent period (2000-2010). Moreover, the total boreal population has slightly declined according to the AHDR [Larsen and Fondahl, 2014]. Furthermore, the Arcticapolis database shows that this decrease is more pronounced in the northernmost boundaries (Fig. 5). This is mainly due to the Russian part where out-migration has continued since the collapse of the USSR. Indeed, the brutal decline of the 1990s marked a radical change in the occupation model of the Russian Arctic by spontaneous departures of non-indigenous peoples [Heleniak, 2009]. This led to an indigenization of the Russian Arctic including the Russian Arctic towns.

Fig. 5. Populations and Densities of the Arctic depending on its boundary 2000-2010



Sources: Arcticapolis based on national censuses; boundaries from Arctic Portal and L.E. Hamelin [1968]

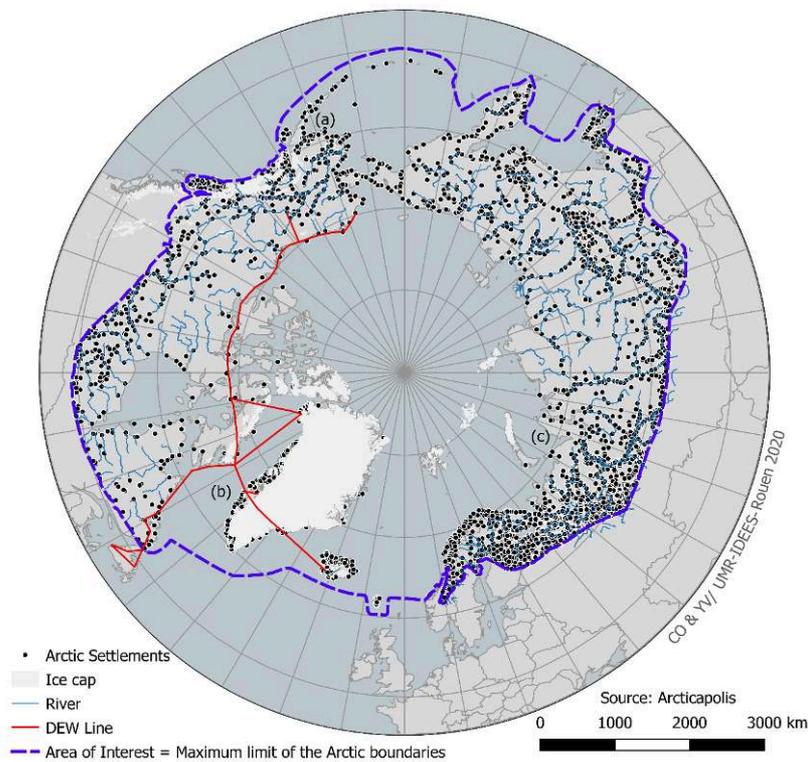
- 30 In terms of density, a threshold limit of 0.8 inhab./km² was considered by F.J. Turner [1920] to qualify a pioneer front in the United States of America. This author stated that by the end of the 19th century, this value was exceeded in the West making the whole territory colonized. Thus, the West was no longer a frontier although thousands of km² of land continued to be gained from wilderness [Juricek, 1966]. For all the limits of the Arctic zone, densities are well below 0.8 inhab./km² according to the Arcticapolis database (Fig. 5). Therefore, the conquest of the circumpolar zone remains incomplete. This is particularly clear for the northernmost limits which take into account the hostility of the environment alone (*isotherm 10°C in July* and the *tree line*).

- 31 The paramount importance of a frontier is considered in terms of low population and rapid growth. The boreal region can be considered as such for its low population and density. However, it cannot be considered as such when looking at its dynamic despite the on-going process of globalization. The ecumene and its complement, the anecumene, form 88% and 12% of the land area respectively. The Arctic still forms the outer part of the latter (2%), beside the absolute deserts and very high mountains (10%) [Baudelle, 2016]. Nevertheless, L.E. Hamelin [1980] considers the whole North as part of the ecumene making two categories out of it: active or passive ecumene. The former is the only one that is (barely) profitable, combines the functions of residence, exploitation, and connection. The latter is a costly burden on the nation.
- 32 However, in detail, there are large differences within the Arctic. For instance, looking at densities, Iceland, the Faroe Islands, and the three European Nordic countries have exceeded the threshold of 0.8 inhab./km². Moreover, differences are greater within countries than between them. Urbanization is a process that illustrates the integration and globalization of the Arctic regions.

3.2 Urban *versus* rural settlements

- 33 One of the interests of *Arcticapolis* linked to *Arcticakhoris* as a geohistorical database is the ability to examine the spatial distribution of the boreal population at the finest level regardless of the population of the localities, even if it is only a few inhabitants, as long as the censuses record them. Thus, we can discuss the distribution of settlements regardless of their size.
- 34 It would be wrong to think that small communities belong to the past while towns represent the present, resulting from white colonization. Everywhere and all the time, the presence of water for fishing and transportation is a fundamental factor in order to understand human occupation. Indeed, human occupation emphasizes rivers and Alaskan and Western Greenland coasts that offer a relatively mild climate with longer-lasting ice-free seas than elsewhere (Fig. 6 a & b). In Canada, during the Cold War, the Distant Early Warning line (DEW) was created as a network of radar stations along the 69°N parallel. The DEW stimulated local settlement, 300 kilometers north of the Arctic Circle, either by relocating First Nation communities, though sometimes at a high human cost [Weetaltuk, Martin and Perreault, 2009], or by the attractiveness of the resulting economic activity, however relative (e.g. Cambridge Bay). In Western Siberia (Fig. 6 c), the economic transition towards an economy based on hydrocarbon extraction, which occurred in the 1960s, is emblematic of the 'white' invasion from the South [Vaguet]-Marchand, 2005]. There, a number of small settlements was created at the frontier time, either for a gas compressor station, or for road or railway maintenance. They stand next to larger colonies, some of which turned into towns.

Fig. 6. Spatial distribution of Arctic settlements



a- West Alaskan Riviera, b- West Greenland Riviera, c- Western Siberia

- 35 The Arctic's biggest settlements are mainly the result of either mineral resource exploitation (e.g. Fairbanks, Fort Mc Murray, Kirkeness, Novy Urengoy, Norilsk...) or to territorial administrative control (Iqaluit, Salekhard, Yakutsk...) [Vaguet, 2016]. The majority of non-natives choose to settle in towns, in connection with their professional activity, which implies a wage economy that is more in line with the urban lifestyle. However, the long-standing trend is that both groups, indigenous and non-indigenous, have a shared preference for living in cities for economic and service reasons [Dybbroe, 2008 ; Dybbroe, Dahl and Müller-Wille, 2010 ; Larsen and Fondahl, 2014 ; Rasmussen, 2013]. Although the choice is not always in line with deep feelings [Sejersen, 2010].
- 36 Russia presents the highest urbanization rate in its northern part due to its historical legacy rooted in the times of empire and extending beyond the abolition of the Soviet gulag system [Laruelle, 2019 ; Vaguet, 2016]. Thus, of the 16 biggest Arctic cities (>100,000 people), 13 are Russian (Tab. 3.). However, Russia also predominates when looking at small settlements (200-1,000 inhabitants). Indeed, it owns 78% of them, on 51% of the Arctic lands. This reflects the long history of the native settlement of the Russian north. Nevertheless, the density of small settlements is far higher in Scandinavia.
- 37 European Nordic countries stand out in particular; with some 40 cities larger than 10,000 residents, they hold 22% of the Arctic urban units of this size, while they occupy just over 2% of Arctic land. This advantage persists down to the smallest units of 200 inhabitants, which matches the threshold of the urban criterion of the Nordics (Scandinavia, Iceland, Greenland and Faroe Islands). The long history of European colonization, including the northern parts, has resulted in truly urban systems.

- 38 In the opposite situation stands Canada showing a deficit in human settlements in its northern part. Indeed, the country does not have a large urban unit there (>100,000 inhab.). Moreover, its share of settlements has increased timidly inversely to their size, going from 3% (>10,000 inhab.) to 10% (200 -1,000 inhab.) while it covers 31% of the land concerned (Tab. 3.).

Tab. 1. Number of Arctic localities depending on their size by country

Arctic part of	100 000	10 000	5 000	1 000	200
USA	1	6	22	65	194
CAN		5	18	104	274
GRL		1	2	13	33
ISL	1	6	9	33	63
FRO		1	1	12	22
NOR		15	36	110	124
SWE		11	26	50	55
FIN	1	17	39	71	71
RUS	13	133	224	709	2065
Total	16	195	377	1167	2901

Source: *Arcticapolis database*

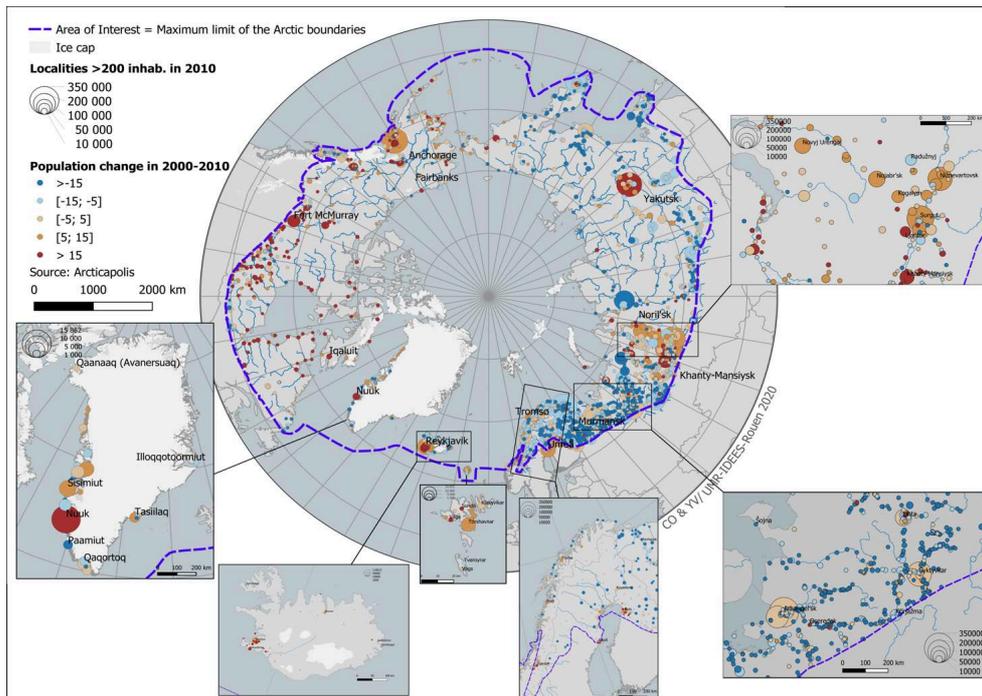
3.3. Global demographic decline and heterogeneous local dynamics

- 39 As mentioned above, the Arctic shows a population decline at all boundaries except at its southernmost edge (Hamelin limit). One of the interests of our geohistorical database, *Arcticapolis* linked to *Arcticakhoris*, is the ability to examine the spatial modalities of this process of decline at the finest level. Over the past decade, the evolution map shows a strong dichotomy between the two sides of the Arctic Ocean (Fig. 7). In North America, growth has been positive for the vast majority of communities, regardless of their size. Meanwhile from Europe to the Pacific, the population has declined overall, as shown by the general statistics [Larsen and Fondahl, 2014]. However, in detail, the situation is slightly more contrasted and it is difficult to make clear categories in terms of winning and losing places.
- 40 Over the course of history, policies for the integration of the pioneer fringes into the ecumene have been expressed by the creation of permanent settlements, often military forts, that can potentially become urban. The word 'boomtowns' illustrates the speed of the urbanization process and its emergence in the middle of nowhere. Towns play an important role being the rear bases of the front line [De Koninck, 2000 ; Engel, 2007 ;

Gavrilova, 1997 ; Vaguet, 2008]. Nevertheless, some of these embryonic towns do not survive the end of the cycle.

- 41 The Klondike region is dotted with ghost towns illustrating the boom and bust cycle of gold (e.g. Dyea, Bennett...). Others survive thanks to tourism in the old gold mines (e.g. Dawson) or to the emergence of a new cycle (e.g. Yellowknife with diamonds after gold). In the same way, West Siberian towns remain at risk of closure if oil market prices become too low to make it worth extracting oil in their harsh environment. This illustrates the issue of economic diversification of the young mono-activity towns.

Fig. 7. Population dynamic of Arctic settlements 2000-2010



- 42 The Russian Arctic shows a two-speed change globally. The old Russian Arctic inherited from the end of the Empire and early Soviet times, possibly based on the gulag economy, has experienced a decline with shrinking cities as a result of the weakening of the proactive policies. The decline was sharp during the black decade after the collapse of the USSR. Anadyr, the regional center of Chukotka, the region furthest from Moscow, lost 35% of its population over the 1989-2010 period (from 17 down to 11 thous. inhab.). Since then, it has shown a welcome reversal of the trend. Nevertheless, the gain (up to 13 thous. inhab. in 2010) is far from sufficient to bring its population back to its level prior to the collapse of the USSR. All of the Arctic's largest shrinking cities are Russian. Murmansk and Arkhangelsk are the biggest shrinking cities (respectively in thous. inhab., from 468 and 416, down 307 and 349). The Great Noril'sk that includes the main town and its satellite settlements has lost about a quarter of its population (from 232 in 1989 to 175 thous. inhab.). Vorkuta is also a shrinking city (from 116 in 1989 to 85 thous. inhab. in 2010).
- 43 The highest growth rates ($> + 15\%$) are found in Alaska, Canada, Nuuk, and Reykjavik. Yet, some Russian places are concerned too, illustrating the 'new' Russian Arctic. Indeed, Western Siberia is stimulated by gas development (LNG) in the Yamal peninsula. In this region, all the towns continue to grow and its regional capital,

Khanty-Mansiysk, shows rapid growth (> +40%). Moreover, a few coastal establishments benefit from their position on the Northern Sea Route, upstream of Yamal LNG (e.g. Naryan-Mar). In addition, Arctic regions have experienced a metropolization trend in the biggest regional localities. Anchorage and Fairbanks, the two biggest Alaskan cities, are two poles of growth [Vaguet, 2018]. In Canada, the municipality of Wood Buffalo with Fort McMurray, a well-known oil sands development center, has developed. The European Nordic countries show strong signs of coastal development. In Finland, Oulu on the coast of the Gulf of Bothnia, is developing into a technopole supported by regional development policies [Gløersen *et al.*, 2006 ; Gløersen, 2012]. The capitals have taken advantage of their status. Reykjavik (Iceland) is the unique entry point into the country for its 1.8 million tourists and it has the largest Icelandic university. Consequently, it has the highest concentration of jobs. Iqaluit, the capital of Nunavut, a territory created in 1999, already has over 7,000 inhabitants. In the Russian Far East, the capital of Sakha Republic, Yakutsk, and its close surroundings, are showing rapid growth as well.

- 44 The reverse of this trend is the significant decline in small communities (below -15%) with Canada as an exception as mentioned above. In this sense, the Arctic follows a global trend. The depopulation of the European Nordic hinterlands is fueling the coastal metropolization. Greenland is a good example of the 20th century transformation occurring in the Arctic from traditional economies to wage-based economies, from scattered settlements based on hunting and fishing towards an urbanized system with a service-based economy [Hamilton and Rasmussen, 2010]. As a consequence, localities have died: more than 100 no longer have residents.

4 Conclusion

- 45 The Arctic is a fuzzy region having different boundaries created by international organizations or working groups, depending on their interest. National limits also exist which rarely match with the previous ones. In most cases, the cold is the direct or indirect key factor in defining the Arctic. However, the North is a more complex reality; the boreal world is cold as well as not being easily accessible and is based on rather traditional economies. Thus, national governments use multi-scalar aspects to delineate the northern part of the country as the area for application of regional development policy. Consequently, drawing the line is an eminently political exercise which affects the daily-life of residents since they get some benefits (*i.e.* multiplicative factor of the salary, longer annual holidays, and early retirement). Both, the growing regional metropolis of Oulu and the shrinking Russian cities are examples of the impacts of these policies.
- 46 It has been reported that the circumpolar region has four million residents but it is safe to say that this number varies depending on the boundary. Yet, due to climate change and globalization, the limits are likely to retract. The *Arcticapolis* database aims at *i*) collecting and georeferencing censuses in space (8 circumpolar countries) and over time at all levels including the finest one, *ii*) over time, delineating spatial units at all levels of the administrative hierarchy, and *iii*) harmonizing in time. Although, it is still under construction, *Arcticapolis* already makes it possible to picture today's Arctic population at the finest level. It allows one to engage a longitudinal study of the Arctic demographic trends whatever the Arctic limit is.

- 47 The traditional scheme involving small communities living in large territories, mainly based along rivers or coasts, seems to lose its attractiveness. Meanwhile, urban settlements, which are easier to supply in goods and energy, concentrate jobs and bring people together, as Arctic populations are less and less self-sufficient. Does it really make the Arctic a *frontier*? It is certain that it does for extractive industries [Pilyasov, 2016 ; Sejersen, 2010]. However, from a demographic perspective, the last decade has shown that this concept cannot be applied to the entire region. Indeed, it does not give a clear sign of a frontier that involves rapid growth and not only qualitative change. This was the case in Russia during Soviet times. Perhaps, nowadays, the Arctic southern fringe of L.E. Hamelin can be seen as a frontier but definitely not its northernmost part, which is in slight decline.
- 48 The conquest of the far north is not homogeneous and it is difficult to define clear rules. Cities are winners, but not all of them. Small communities seem to have lost their populations, but not in Canada and there are many other exceptions elsewhere. Northern Russia is declining but with many exceptions and not only cities. Currently, there is a need to update the index of nordicity for localities across the entire Arctic basin. This would clarify systemic trends, i.e., in terms of both physical and human environments. In this respect, L.E. Hamelin referred to processes of *de-nordification* or *re-nordification*.

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RÉSUMÉS

En dépit d'un environnement extrême, d'un accès souvent très difficile et d'une population dispersée, l'Arctique fournit des ressources naturelles pour le marché mondial. Sur une superficie immense, entre écoumène et ère vivent 4 millions d'habitants. Toutefois, ce total nécessite une première clarification compte tenu de la myriade de limites de l'Arctique qui font mécaniquement varier la population boréale.

Par ailleurs, le réchauffement climatique semble offrir de nouveaux potentiels de développements en arctique et sa médiatisation suscite une certaine effervescence, multipliant les références au terme de *frontier*, dans son acception de front pionnier. Ce concept appliqué aux hautes latitudes est ici mis à l'épreuve avec l'appui de la nouvelle base géohistorique de peuplement des pays circumpolaires, *Arcticapolis* dont les enjeux méthodologiques sont importants.

Globalement, la population boréale diminue légèrement, quasiment dans toutes les limites proposées. Ceci s'oppose à la conceptualisation de la zone boréale comme front pionnier ce qui

requiert un changement quantitatif rapide. Finalement, *Arcticapolis* autorise un bilan du peuplement boréal à un niveau fin. La conquête du Nord reste sujette à caution et spatialement hétérogène. Ainsi, la tendance générale à l'urbanisation n'implique pas pour autant que toutes les villes gagnent des résidents ni que tous les villages en perdent. Cette recherche met en perspective des pôles de croissance et de déclin, ainsi que des phénomènes de littoralisation. Au total, il existe une grande variété des dynamiques de peuplements des marges boréales.

Despite its extreme environment, often difficult of access and with a scattered population, the Arctic provides natural resources for the global market. Covering a vast area, somewhere between an ecumene and a wilderness, it has a population of four million people. However, there is a myriad of Arctic limits making the boreal population mechanically variable.

Moreover, global warming appears to offer new potential development in the Arctic and its media coverage has been generating a certain excitement, multiplying references to the term *frontier*. This concept applied to the high latitudes is tested here with the help of the new geohistorical database of settlement of the circumpolar countries, *Arcticapolis*. This work presents important methodological challenges.

Overall, the boreal population is declining slightly, almost within all of the Arctic region's limits. This fact is in contrast to its widespread portrayal of a pioneering front. Indeed, it requires an increase in settlement. Finally, *Arcticapolis* allows the highest level of assessment of the boreal population. The conquest of the North remains complex and spatially heterogeneous. The general trend of urbanization, therefore, does not imply that all cities are expanding or that all villages are losing residents. This research puts into perspective many of the places of growth and decline, as well as the phenomena of coastal development. Therefore, it shows the range of variety in settlement dynamics within the boreal margins.

INDEX

Keywords : North, Arctic limit, frontier, settlement, population dynamics, Arcticapolis

Mots-clés : Nord, limite de l'Arctique, front pionnier, peuplement, évolution démographique, Arcticapolis

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