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ACADÉMIE  
DES SCIENCES  
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# *Comptes Rendus*

## *Géoscience*

### *Sciences de la Planète*

Fabienne Joliet, Laine Chanteloup, Thora Herrmann, Stéphane Gibout, Didier Haillot, Najat Bhiry, Véronique Coxam and Armelle Decaulne


**Urban emergence in inuit territory: impacts on the Nunavik socio-ecosystem**

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**Guest editors:** Robert Chenorkian (Professeur Émérite Aix-Marseille Université, Conseiller Scientifique CNRS-INEE pour les OHM), Corinne Pardo (CNRS FR3098 ECCOREV Aix-en-Provence (France), LabEx DRIIHM) and François-Michel Le Tourneau (UMR 8586 – PRODIG, Campus Condorcet, Aubervilliers)

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Review article

Human Environment Observatory

# Urban emergence in inuit territory: impacts on the Nunavik socio-ecosystem

Fabienne Joliet<sup>Ⓜ,a</sup>, Laine Chanteloup<sup>Ⓜ,b</sup>, Thora Herrmann<sup>Ⓜ,c</sup>, Stéphane Gibout<sup>Ⓜ,d</sup>,  
Didier Haillot<sup>Ⓜ,e</sup>, Najat Bhiry<sup>Ⓜ,f</sup>, Véronique Coxam<sup>Ⓜ,g</sup> and Armelle Decaulne<sup>Ⓜ,\*,h</sup>

<sup>a</sup> L'Institut Agro & laboratoire ESO, Angers, France

<sup>b</sup> Université de Lausanne, Switzerland

<sup>c</sup> University of Oulu, Finland

<sup>d</sup> Université de Pau et des Pays de l'Adour, France

<sup>e</sup> Ecole Technique Supérieure de Montreal, Canada

<sup>f</sup> Université Laval & Centre d'études nordiques, Québec, Canada

<sup>g</sup> INRAE, Clermont-Ferrand, France

<sup>h</sup> CNRS, laboratoire LETG, Nantes, France

*E-mails:* fabienne.joliet@institut-agro.fr (F. Joliet), laine.chanteloup@gmail.com (L. Chanteloup), thora.herrmann@oulu.fi (T. Herrmann), stephane.gibout@univ-pau.fr (S. Gibout), didier.haillot@etsmtl.ca (D. Haillot), najat.bhiry@cen.ulaval.ca (N. Bhiry), veronique.coxam@inrae.fr (V. Coxam), armelle.decaulne@cnrs.fr (A. Decaulne)

**Abstract.** Through the combination of interdisciplinary thematics studied on the territory of Nunavik by the OHMi Nunavik, the socio-ecosystem is considered with a focus on the urban context of northern Quebec. Since only a few decades, urbanity (in the geographical sense of the word) is a major change in Nunavik, impacting the traditional indigenous ways of life, geocultural images, food availability and sufficiency, opening new needs regarding energy self-sufficiency, and being impacted by hazards and vulnerability various situations. Therefore, we propose here a reflexive input on the recent urban development and complexity, based on the results of four research projects running since 2015–2017 within the framework of the OHMi Nunavik, Nuna, Niqiliriniq, Siqiniq and Kinngaq.

**Keywords.** Tradition, Indigenous peoples, Urban nuclei, Geoculture, Food, Energy, Hazards.

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## 1. Introduction

Although it is an oxymoron to speak of the urban Arctic, the question is very real today. Cities are multiplying on the northern edge of the ecumene, the Earth habitable by human. This is a real challenge for

arctic land-use planning, which, whatever the scale and scope of the process, has *de facto* led to a transformation of the traditional arctic socio-ecosystem in Nunavik (Northern Quebec) and other areas. This is a recent phenomenon for the Indigenous people of the Canadian Arctic who were still nomadic or semi-nomadic half a century ago, moving from camp to camp according to the season by dogsled or boat.

\*Corresponding author

Nunavik (“the great land” in Inuktitut, the Inuit language) is located in the northern part of the Quebec Province (north of the 55th parallel).

Within the traditional nomadic Inuit universe, colonial trading posts were the first fixed points along the coast. From this archipelago of anchor points, the Cold War generated two urban nuclei: Kuujuaq and Kuujuarapik, bridgeheads of the Distant Early Warning Line (DEW Line), a line of pre-warning radar stations laid out along the Canadian-American Arctic [Rousseau, 1968]. The last third of the twentieth century was a period of transition, imposing a sedentary lifestyle on the Inuit in fits and starts with the construction of villages, until 1986 with the creation of the last community, Umiujaq. Known as “New Quebec” (from 1912 to 1986), Umiujaq was the subject of successive proactive development policies. Between the beginning of the Cold War, when the first villages were established, and 1986, when the last village was created—in less than thirty years—fourteen “northern villages” were built *ex nihilo* along the coast and main rivers, sedentarizing Inuit (and Cree, and Naskapi) society in Nunavik.

The disruptive event that was selected for the creation of the International Human-Environment Observatory (in french Observatoire Hommes-Milieux, OHMi) Nunavik is the 2011 Northern Plan [Decaulne *et al.*, 2020], which represents a tipping point towards a real momentum of development and the growth of the Inuit population that is transforming the traditional socio-ecosystem. The urbanization that has been “built from scratch” as a result of the transfer of a model imported from the “south” is gradually being absorbed into the indigenous northern socio-ecosystem. Yet, if there is urbanization, having been imposed in just a few decades, can we speak of urbanity, i.e., of an Inuit urban experience? In her documentary “If Time Permits”, Inuit artist Élisapie Isaac recalls the desire to live in the city that led her to emigrate from Salluit to Montreal: “I took the risk of leaving, the immensity of the ice and land oppressed me” [Isaac, 2003, 15’42’]. Two years ago, a teenager from Kuujuaq [Huctin *et al.*, 2022] explained that, in her opinion, Kuujuaq—the Nunavik capital, population 2,700 in 2021—is not a city, because there is no constant Internet access and no traffic lights.

This paper focuses on the contributions of OHMi Nunavik to the study of the transformation of this traditional indigenous arctic socio-ecosystem by rapidly expanding urbanization. OHMi is an integrative

research program that studies the complex, systemic issues inherent in the emergence of urbanization in terms of territorial, energy, food and hazard mutations and adaptations. It proposes a global approach to be articulated with holistic Inuit thinking, which was faced with the urban fact and has since tried to take hold of it. This integrative perspective on the urbanization process in Nunavik revolves around the pivotal notions of urbanurbanity or “urban fact-urban effect” [Desbiens, 2017] in an indigenous context within the world system, as Nunavik has also entered what Chenorkian [2020a] calls the “Anthroposphere”.

The urban issue, as addressed within the interdisciplinary framework of OHMi Nunavik, will be presented first and Nunavik’s urban expressions (facts and effects) will be developed through a consideration of OHMi Nunavik’s research programs.

## **2. The interdisciplinary system of the human-environment observatory and the urban environment in Nunavik**

The Laboratoire d’Excellence (LabEx) framework on interdisciplinary research on Human-Environment Interactions (DRIIHM) includes thirteen Human-Environment Observatories as of 2023, eight in France and overseas (OHM) and five international observatories (OHMi). OHMi Nunavik includes various thematic research projects, selected by the OHMi Board of Directors and by regional government representatives from the Quebec Arctic. Although the socio-ecological framework of OHMi, the North Plan, confirmed the urbanization of Nunavik in 1986, the urbanization issue is not the subject of any specific research project within the OHMi Nunavik. This issue is addressed here as a cross-cutting research subject, which puts into perspective the complementary nature of the research results obtained within OHMi Nunavik’s integrative matrix. Several research projects conducted at this observatory since 2014 are remobilized here, insofar as they contribute, through their interdisciplinarity, to a reading of the urban phenomenon as a visible sign of the transformation of the traditional socio-ecosystem: resilience of indigenous territoriality (Nuna research project), food self-sufficiency and greenhouses (Niqiliriniq research project), energy self-sufficiency (Siqiniq), slopes and hazards (Kinngaq).

### 2.1. OHMi Nunavik: an integrative research matrix for the study of indigenous urban complexity

In the Anthropocene era and during its acceleration [Steffen et al., 2015], understanding complexity in a “single EcoSystem – Single ES” [Chenorkian, 2020b, p. 280] such as Nunavik requires “joint and convergent approaches to ES that interact (Environmental Sciences, i.e., earth, life, human and social sciences) and [...] a systemic study process, i.e., one that takes into consideration the objects involved and their organization, and the nature and dynamics of the interactions they develop between them.” [Chenorkian, 2020b, p. 279].

The thirteen observatories constitute critical case studies, expressions of “anthropized sites hit by a ‘disrupting event’ which has upset the ecological, economic and social balances that have developed over decades in the local socio-ecological conditions” [Chenorkian, 2020a, p. 292]; “[...] a ‘social-ecological framework’, which is the socioecological context of the place, a ‘disrupting event’, which disrupts it, and a ‘focal object’, the product of the first two elements” [Chenorkian, 2020b, p. 280; Chenorkian, 2020a, p. 294] constitute the OHM ternary.

For OHMi Nunavik (Figure 1), the relevant disruptive event is the North Plan (2011), a mega-program for the economic development of Quebec’s far North over a 25-year period launched by the Jean Charest government in Quebec City in 2011. At the time of its launch, however, the 2011 North Plan aroused a great deal of emotion and opposition [Simard, 2017, p. 284] due to the postcolonial context in Nunavik, leaving little room for local indigenous consultation. The political tribulations of the 2011 North Plan prompted an immediate reaction, leading to the creation of an Inuit action plan in 2014: the Parnasimautik Plan [Administration Régionale Kativik (ARK), 2014]. Similarly, in 2020, the Quebec government scaled back some of its ambitions with a new, more measured northern action plan, proposed over a probationary period from 2020 to 2023. Although the 2011 referendum on self-determination proved to be a negative initiative, the “march towards Nunavik self-government” is the cornerstone of the new Makivik government and its President, whose “main interest is to help my Inuit family control its own development” [Pélouas, 2022, p. 8].



**Figure 1.** OHMi Nunavik ternary components related to the LabEx DRIHM vocabulary, together with the main issues targeted.

OHMi Nunavik aims to better understand the cumulative impacts of the 2011 North Plan and its successors, including the Parnasimautik Indigenous report [Decaulne et al., 2020]. However, it is important to emphasize that this disruptive event for OHMi Nunavik is the result of a more global process (Figure 1), linked to the joint acceleration of demography and sedentarization since the 1950s that has profoundly transformed the Inuit relationship to the territory and prefigured its urbanization.

To ensure that OHMi Nunavik resonates with indigenous communities, the name Tukisik (*Tukisigasuaqatigit*: Understanding together) was adopted by the local partners as a translation of its more complicated acronym. This “knowledge-sharing” name in Inuktitut—the Inuit language—highlights the research effort in partnership with Nunavik’s indigenous peoples; it counters the notion of unilateral observation, denied in this territory that massively rejects domination from the South. As a result, OHMi

Nunavik has been set up as part of a multilateral partnership that includes French (CNRS) and Quebec (Centre d'Études Nordiques, CEN) research institutions collaborating with Inuit scientific and political institutions (Kativik Regional Government, Makivik Corporation and its Research Centre). Through this goal of co-constructing research, OHMi Nunavik is engaged in the indigenization and decolonization of research in the Arctic environment [Smith, 2021, Radcliffe, 2017]. Scientific projects are evaluated by a Franco-Quebec-Inuit committee and approved by Nunavik authorities (Kativik Regional Government, Makivik Corporation), which “aims, in a process of reciprocal knowledge, to co-create and value local scientific knowledge and know-how in order to better understand and raise awareness of the Arctic socio-ecological system at different scales and for different audiences (Indigenous people, Euro-Canadians, scientists, political decision-makers and the general public).” [Decaulne et al., 2020, p. 3].

By integrating academic and indigenous approaches to the co-production of knowledge, OHMi Nunavik adopts the integrative “global ecology” approach [Chenorkian, 2020a, p. 294] in both senses of the term: on the one hand, the integration of diverse scientific disciplines around projects that respond to issues identified by Inuit communities [Decaulne et al., 2020]; and on the other hand, through the integration of different players from different cultures (researchers–inhabitants–political decision-makers, Western dualist culture and indigenous holistic culture). Beyond the scientific and applied research that meets the expectations of Inuit society, OHMi Nunavik aims to “advise political or economic decision-makers and social participants as fully as possible when they come to make their choices. In this way, the OHM position researchers within society” [Chenorkian, 2020a, p. 294], in synergy with the Inuit new health research framework (Inuit Tapiriit Katanami) signed with the Government of Canada in 2018, and the Memorandum of Understanding signed between OHMi and the Kativik Regional Government, the Makivik Research Centre in 2016.

## 2.2. *The urban in Nunavik, through the prism of some OHMi research projects*

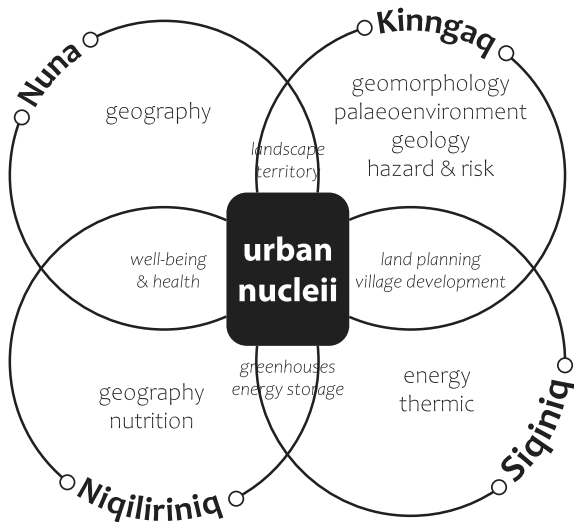
The various research projects carried out by OHMi Nunavik help create greater understanding and

unravel the complexity of socio-ecosystems disrupted by the founding event, the North Plan. This vast development plan helped to establish and develop the urban phenomenon at the forefront of the sedentarization process completed in 1986 (see above). OHMi Nunavik's research has been conceived within a panarchic model that considers the different temporalities that express themselves on a territory, as well as the multiscale nature of different processes that question both the local and the global [Decaulne et al., 2020].

In this sense, the urban phenomenon is part of a complex system that OHMi Nunavik can help to describe and interpret. Quoting Jacobs [1993], who saw the city as a complex but organized whole, Desbiens [2017, p. 152] states that: “even if they are much smaller in size (than American cities), the northern villages of Nunavik also present such complexity” (translated from French). This Arctic urban complexity is the product of colonial history, different settlement phases, mobilities including traditional nomadism, and is fundamentally marked by the cold [Vaguet, 2016, 2019]. Chartier [2020] adds that “Nordic cities are multicultural laboratories”, and refers to Zamyatin (2020), for whom the heterogeneous character of these Nordic cities is conducive to “the possibility of the emergence of new geocultural images that link experience, culture and climatic conditions [...]. The ‘insular’ character of northern cities thus makes it possible to define oneself in relation to the territory and in opposition to the rest of the world, which is more densely populated.” [Chartier, 2020, p. 28, translated from French].

This complexity of the urban will be investigated here through the prism of various OHMi Nunavik research projects (Figure 2), which, as part of an interdisciplinary dialogue initiated by the various teams, aim to decompartmentalize the research conducted in “enlightened disciplinarity” [Chenorkian, 2020b] and articulate it around the urbanity issue.

Thus, the rapidly expanding Inuit urban phenomenon involves a combination of two processes inherent to sedentarization: fixity (in contrast to the seasonal mobility of nomadism) and population concentration (in contrast to the dispersal of camps). Cause and effect relations generate another process, that of adaptation to a new way of life and the upheaval of mobility. Itinerant mobility by dog sled or boat has been largely replaced over short distances



**Figure 2.** Interdisciplinary and thematic complementarity between four OHMi Nunavik projects to examine the impact of the urban in Nunavik's socio-ecosystem.

by snowmobiles, quads and 4 × 4 vehicles, and over long distances by airplanes between villages and connections with the South [Joliet and Chanteloup, 2020].

It is worth noting that in just over thirty years, an archipelago of fourteen coastal urban communities has been created from scratch (today numbering between 400 and 2700 inhabitants). They are connected by air travel, as arctic physical conditions make it impossible to build roads between them. Reciprocally, these new forms of mobility are transforming territoriality between generations, as well as between families, according to each individual's networks, standard of living or professional and family activities (Nuna project). This urban archipelago (as well as the extraction of natural resources) supports and is complemented by the protection of nature, with the development of a matrix of national parks anchored to the villages of Nunavik (Nuna project).

These renewed territorialities take place in an environment that is itself subject to major changes, such as climate changes that have led to increased avalanche risks threatening urban extensions (Kinngaq project). Finally, every urban core is based on energy dependence or autonomy (Siqiniq project) and food self-sufficiency (Niqiliriniq project).

To fully understand the complexity of the urban phenomenon in Nunavik, as studied in OHMi Nunavik's research projects, we approach the phenomenon through a diachronic analysis of urbanization (urban facts) and urbanity (urban effects).

### 3. Urban fact in Nunavik

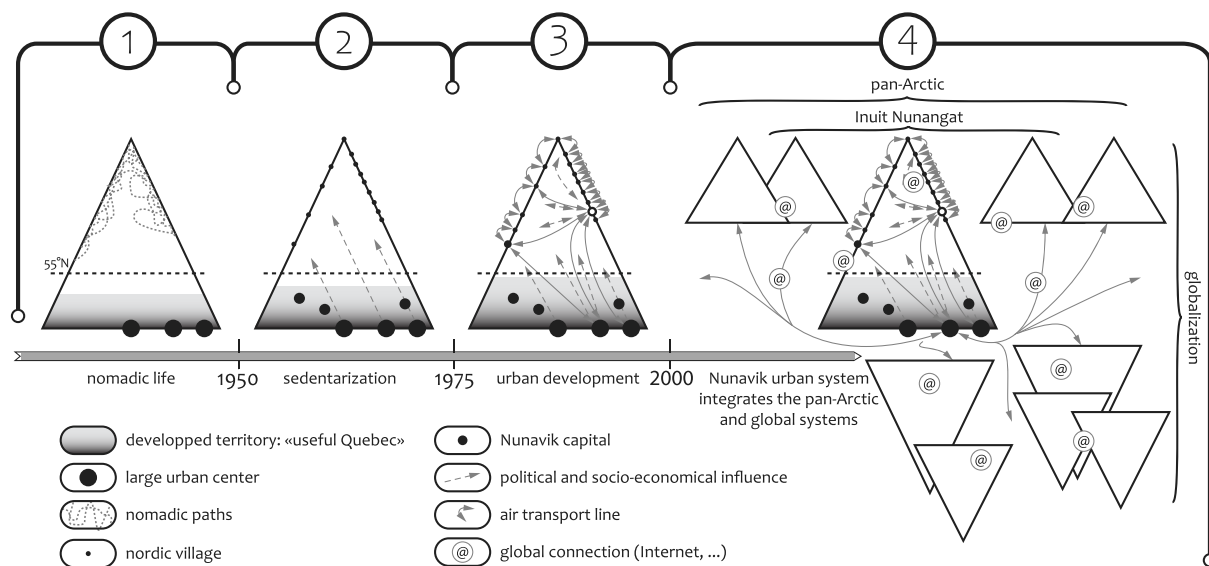
The urban phenomenon in Nunavik is presented on two scales of space and time: its diachronic constitution on the territory of Nunavik, and the current components of the northern village. It is then presented through two OHMi research programs focusing on the notion of risks faced by urban development, and the notion of energy and food sovereignty inherent in the development of urban greenhouse farming.

#### 3.1. Urban fact constitution in Nunavik

The urban process that has been developing in Nunavik since the mid-twentieth century is a recent phenomenon that has been co-constructed by combining external Euro-Canadian state impulses and Inuit adaptation (Figure 3). Inspired by Desbiens [2017], the urban fact is defined here as the morphological characterization of the urban archipelago and its typical urban core.

Breton and Cloutier [2017] identify three phases in the socio-spatial organization of urban development in Nunavik. Each of these phases saw the emergence of new facilities and services, shaping today's urban landscape. The first phase, from 1960 to 1975, accelerated the sedentarization of families residing near trading posts and certain services implemented by the federal and provincial governments. Semi-permanent infrastructures were created [Roy, 1971] by a federal program of one-room 'matchbox' housing, launched in 1959. The international context of the Cold War extended certain services in alignment with military resources such as airports and community radios [Brière and Laugrand, 2017].

The second phase, from 1975 to 2000, was marked by the James Bay and Northern Quebec Agreement (JBNQA). This phase led to the emergence of Inuit institutions such as the Makivik Corporation and the Kativik Regional Government. The JBNQA created fourteen municipalities and their municipal councils, with a land regime organized into three categories of land ownership and associated rights,



**Figure 3.** Rapid evolution of Nunavik's urbanization process since the 1950s, leading to globalization, as Nunavik Inuit are closely related to Inuit Nunangat (Canadian Inuit: from west to east Nunavut, Nunavik and Nunatsiavut) and pan-Arctic Inuit (aggregating Alaska and Greenland Inuit), and all other southern countries.

including Category 1 that was reserved for the urban location of new villages. In 1981, the federal government transferred the housing stock to the management of the Société d'Habitation du Québec. The latter then modernized housing with dedicated services. These developments extended the municipal model of southern Quebec into the north.

The third phase identified by Breton and Cloutier [2017] began in the 2000s, when development was taken over locally. The 2000s saw the creation of the Kativik Municipal Housing Bureau, which managed 93% of Nunavik's housing stock. At that time, housing consisted mainly of social housing. Parallel to this, the Makivik corporation set up a Construction Division to help develop the Inuit housing stock. The Land-Use Committees were established to promote local involvement in the development of municipalities and villages.

The work of OHMi Nunavik shows that a fourth phase could be added to the three previously identified: with the introduction of the North plan in 2011, the existing socio-system experienced a transformation that continues to this day. Its voluntarist development policy, the massive investments associated with it and the counter-plan proposed in re-

sponse to the Inuit (Parnassimautik) have generated strategies of adaptation, resilience and new aspirations. This current period suggests that the urban fact and the indigenous urban effect may be in sync or out of sync, thanks to self-determination based on a quest for cultural, food, energy and environmental sovereignty, to which the OHMi Nunavik has responded with a number of research projects.

At the level of each urban entity, the typical urban pattern imported from the South is transposed to Arctic conditions and adapted to community lifestyles by the Inuit. This pattern is currently characterized by:

- coastal location and stilt architecture. The ground and climate do not allow running water to be incorporated into the dwellings. The fourteen villages were built on the coast or a few kilometres back along the larger coastal rivers close to Indigenous camps (as was also true of trading posts).
- dense settlement, consisting of a rental park of single-storey double dwellings, one or two churches (Protestant and sometimes Catholic), a town hall, a school, a dispensary, an oil tank, a community freezer, a general



store (Co-op), a hotel (Co-op), an airport (Air Inuit), a drinking water supply station, and a fire station. The typical village is often complemented by a second Northern chain general store (heir to the Hudson's Bay Company store).

Many more new facilities and services are being developed, such as a youth center [Blais and Vachon, 2020, Antomarchi, 2021] or intergenerational house, a gymnasium and skating rink (outdoor or indoor), school transportation and a greenhouse [Lamalice *et al.*, 2016]. In the immediate or relative periphery, each village has a harbor protected by riprap, one or two roads to the harbor, an airport, a waste disposal center, a wastewater treatment plant and basin, a cemetery, and even mining sites and the entrance to national parks.

The emergence of private services (grocery store, restaurant, bar, inn) and the purchase of homes by individuals are features of the two largest urban communities: Kuujuaq and Kuujurapik.

For the architecture, prefabricated wood construction prevails, clad in colored or varnished facades, with colored metal for the two general stores and the fire station. With regard to urban planning, the choice of the site and layout, as well as the orientation of the buildings, respond to an evolving functional logic. Openings have been enlarged, bay windows have been created, and buildings and openings are oriented towards the surrounding landscape.

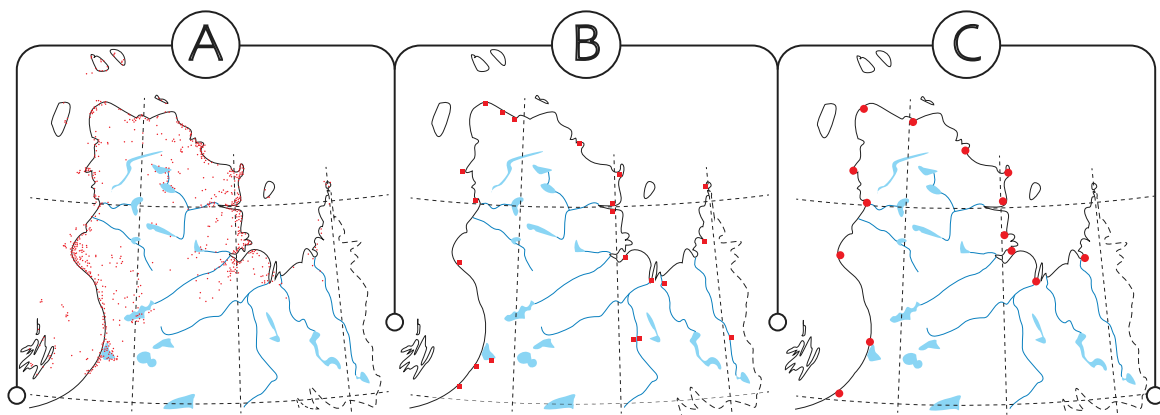
The exponential demographic growth of Nunavimmiut (Nunavik's inhabitants) has led to a major urban and peri-urban phenomenon: peripheral expansion and *de facto* exposure to hazards (landslides, permafrost subsidence, avalanches and landslides), studied by the Kinngaq research project. The deployment of a greenhouse network and an *ad hoc* energy resource in the villages is a second original urban fact that the Siqiniq and Niqiliriniq scientific projects are investigating.

### 3.2. *Assessing the vulnerability of urban development and deploying greenhouses*

#### 3.2.1. *Monitoring and anticipating arctic risks and urban vulnerability in Nunavik*

The emergence of urban development in Nunavik, and *a fortiori* its sprawl over an open territory, is

accompanied by its corollary, the emergence of the notion of risk in the face of the multiplication of fixed developments (Kinngaq project). This is an important bifurcation in Nunavik's socio-ecosystem. Risk is understood here in its general sense as the consequence of a natural hazard in a population, its infrastructure and its territory, depending on the vulnerability of the society and territory concerned [Léone and Vinet, 2006]. The appearance of fixed, perennial stakes, such as villages and all associated anthropogenic constructions, is an essential element of the new vulnerability of the Nunavik population, which has become urban even though it lives in "small" villages [from 209 to 2754 inhabitants according to Statistics Canada 2016, in Duhaime *et al.*, 2021]. Natural hazards are not new elements in the Inuit landscape; the work of Veilleux *et al.* [2020], Bhiry *et al.* [2019] and Decaulne *et al.* [2018] demonstrate that slope processes, for example, have been active on Nunavik's slopes since the start of the last major deglaciation, which began between 8500 and 6000 BP depending on the specific location in Nunavik. However, until the 1950s, the Inuit populations that had been living in the Arctic for around 6000 years, and in Nunavik for around 4500 years [Bhiry *et al.*, 2021], were nomadic. They moved in small family groups between summer camps that were located in the valleys drained by the small coastal rivers (up to around 40 km from the coast) and winter camps located on the coast or nearby islands, depending on their needs (Figure 4A) Each of the camps brought together only two to three families. From the 1800s onwards, Hudson's Bay Company trading posts were monopolies that established the fur trade (mainly in the form of bartering), and became general retail stores after 1870. The transition to Inuit sedentarization began through the dependence that developed between Indigenous peoples and the Euro-Canadians who offered manufactured goods (Figure 4B), which led to a contraction of the space covered by the Inuit populations [Heyes, 2007]. However, while the trading posts were attractive and tended to unite the population that settled nearby, the traditional way of life was maintained until the 1950s to 1970s. It was then that the various villages were successively created (Figure 4C) in a process that lasted until 1987 when Umiujaq, the fourteenth and last village, was assimilated as a "northern village" [Kativik Environmental Quality Commission, 2009].



**Figure 4.** The contraction of Nunavik's population over the past two centuries or so, from the dispersal of Inuit camps (A—wintering on the coast and summering in retrolittoral positions) to the growth of trading and commercial posts (B), then sedentarization in the 14 present-day villages along the coastline (C) [modified from Heyes, 2007; Archives of Manitoba].

The work of Grenier [2022] and Grenier *et al.* [2023] focuses on the weather conditions preceding the onset of avalanches at Umiujaq, pinpointing the periods of greatest potential danger for traffic on the portion of the trail most likely to present a hazard to winter or spring traffic at the foot of the slope. It is therefore the trail leading from the village to Lake Tasiujaq that represents a major concern for traffic around Umiujaq, which is used by local populations to access traditional activities on the territory (fishing, hunting, trapping on the shores of the lake and adjacent waterways). This road is all the more important for traffic and access to the “land”; it furthermore represents the gateway to Tursujuq National Park, created in 2013 and used by tourists on their way to “nature” activities.

The notion of risk, as it relates to slope processes and avalanches in particular, is even more visible in Kangiqsualujjuaq. In the early hours of 1999, the village was devastated by an avalanche that partially buried the gymnasium where villagers were celebrating the New Year [Decaulne *et al.*, 2021]. This event forced a spatial reorganization of the community, which had to retreat from the slope at the foot of which dwellings and activities had been established since the village's creation and initial expansion (Figure 5).

Geomorphological studies on the slopes of the central islands of Lake Wiyâshâkimî, in the southwestern part of Nunavik, highlight the importance

of evidence of avalanche activity on slopes corresponding to current dynamics [Decaulne *et al.*, 2018]. These findings are reinforced by the results of work by Veilleux [2019] and Veilleux *et al.* [2020], concluding similar avalanche dynamics from morphometric analyses of slope deposits near Umiujaq. Through the analysis of images from self-triggering cameras, Veilleux *et al.* [2021] revealed the frequency of avalanche processes during winter and spring, linked to the breakup of a summit snow cornice on the slopes near the village of Umiujaq. The avalanche deposition zone occasionally comes dangerously close to the road when avalanches have a long travel distance [Veilleux *et al.*, 2021].

### 3.2.2. Arctic experimentation with greenhouses and a specific local energy source

The aim of greenhouse farming is to enable Nunavik communities to grow their own food and strengthen their food self-sufficiency, while reducing their dependence on imported foods [Lamallice *et al.*, 2016]. In this remote and isolated region, fresh plants are indeed scarce and expensive, or even totally absent for part of the year. Greenhouse farming thus makes it possible to produce fresh vegetables locally that have a higher nutritional quality than processed or canned foods, while limiting greenhouse gas emissions linked to transport.

The greenhouse concept (Figure 6A) does have one drawback, however. It is a model “imported”



**Figure 5.** The development of Kangiqsualujuaq illustrated from the late 1950s to the present day; as the area grew during the 1960s and 70s, buildings, initially built on the riverbanks, multiplied at the foot of the slope; the avalanche of 1999 triggered a spatial reorganization that re-exploited the riverbanks and valley floor (original watercolor by Orsane Rousset, 2021).

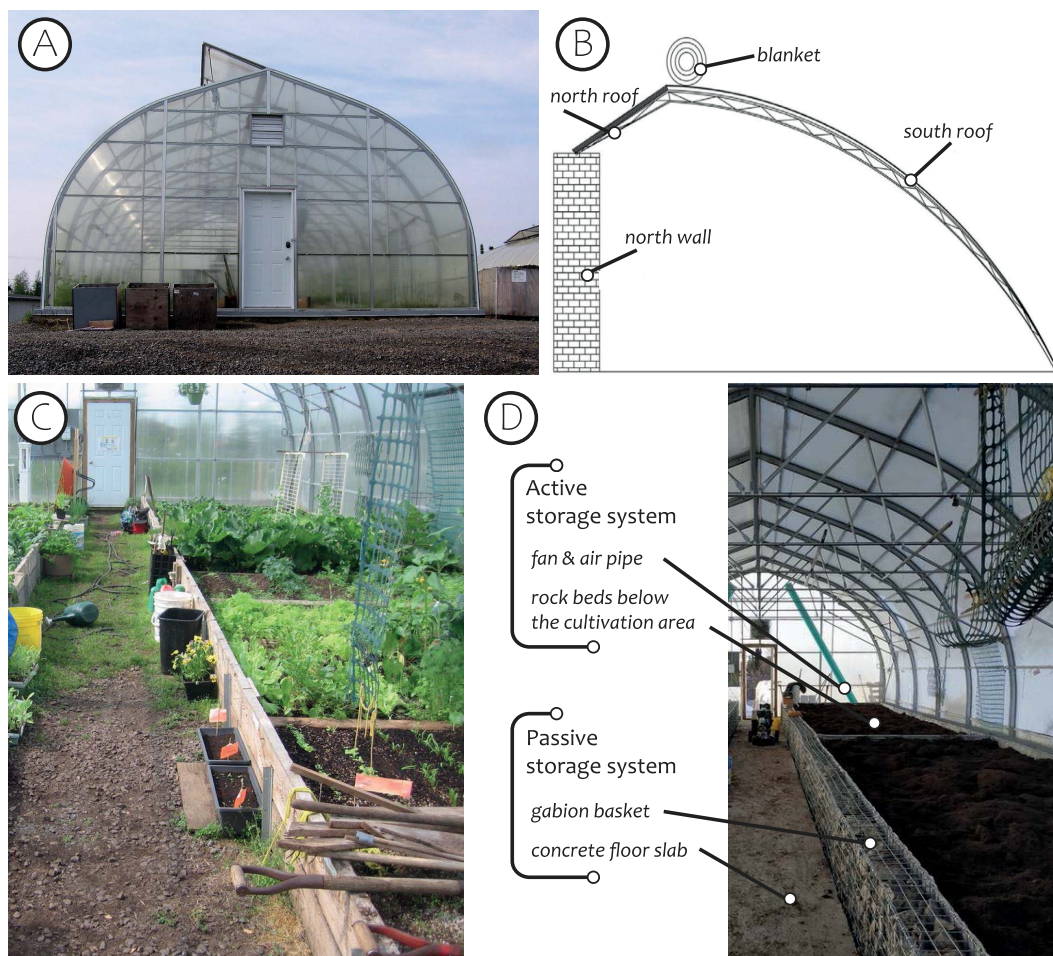
from the milder climate of the south, and therefore poorly suited to Nunavik, since the growing season is only about four months, from late May to late September.

The Siqiniq projects led by OHMi Nunavik were developed to study the thermal behavior of greenhouses and identify avenues for improvement. A measurement campaign (June 2016 to May 2018) initially showed that the growing season was reduced due to too low temperatures at night, while paradoxically daytime temperatures could be very high (even too high) and require ventilation [Piché, 2021]. This initial observation led to the design and installation of an energy storage system that is based on a unique low-tech approach using simple technologies, local material and human resources. The system is based on rock beds placed beneath the cultivated areas, which are elevated in a manner that facilitates the work of the gardeners, but also isolates the soil from the ground (Figure 6C,D).

A comparison of the growing seasons before and after the system was installed showed a reduction

in the temperature amplitude inside the greenhouse (i.e., a better decoupling between the greenhouse's internal and external climates), as well as an increase in the growing period [Piché *et al.*, 2020].

This work to adapt the greenhouse was constrained by the need to preserve the existing structure, i.e., a conventional temperate-zone greenhouse that is not optimal for cold climates. There are, however, structures that are much better adapted to these climates, such as Chinese greenhouses (Figure 6B), also known as “passive solar greenhouses”: these are structures specially designed for cold climates that can be an interesting alternative to greenhouses imported from the south, which are not adapted to Nunavik's climatic conditions. These greenhouses are designed to maximize the use of solar energy while minimizing heat loss. In particular, they have a sloping south face to enable better sunlight capture. The main advantage of Chinese greenhouses is their ability to store heat on sunny days, thanks to the thermal mass of the north wall, which acts as a heat accumulator. This heat is then redistributed at night



**Figure 6.** Energy adapted to greenhouses in Kuujjuaq. (A) Outside view of the community greenhouse, built in 2021; (B) principle of a Chinese greenhouse [from Cao et al., 2019]; (C) inside the greenhouse before and (D) after installation of the thermal storage system (photos from Paul Piché, 2020).

to maintain an optimum temperature inside the greenhouse, reducing the need for an additional heating source.

The integration of renewable resources (wind and solar) is also a way of extending the growing season and working toward energy autonomy, by enabling supplementary heating (solar thermal) or by providing the electrical consumption essential for ventilation, for example [Kumar, 2022]. It is also possible to implement longer-term (seasonal) storage strategies to store surplus summer energy and further extend the growing season [Giordano et al., 2021].

The Niqiliriniq project has demonstrated that greenhouse farming represents an opportunity to diversify the diet and produce fresh, high-quality

vegetables locally, while reducing dependence on imported food [Lamalice et al., 2018]. However, for this practice to be adapted to northern climatic conditions, it is necessary to develop greenhouses specially designed for these regions, that consider the constraints associated with cold, wind, snow and low winter light. The development of this type of northern greenhouse farming therefore requires specific research and technological development, as well as consideration of traditional knowledge and practices of local populations in terms of cultivation and natural resource management.

In this way, the Kinngaq, Siqiniq and Niqiliriniq projects have provided relevant data to meet the urgent needs of northern villages, particularly in terms

of exposure and vulnerability to natural hazards for more appropriate territorial planning, and also to promote energy security and food sovereignty.

#### 4. What is the inuit urban effect?

Living in an equipped prefabricated house, buying fruit and vegetables or sweets and soft drinks at the supermarket, consulting the town hall, playing Bingo, dropping by the municipal freezer, stopping at the Stop sign with your quad or pickup, taking the shuttle to the airport, ... are all practices and feelings that “make town” or “Urban Effect”, as described in Desbiens [2017, p. 152]: “to speak of an effect rather than an urban fact focuses the analysis on the geographical, historical and cultural specificity of Nordic communities which, after decades of external influence, are experiencing urbanization as another model of living. This makes it possible [...] to study the subjectivity of the Inuit, i.e., the active part they play in these urbanization processes” (translated from French). The urban fact being exogenous and imposed, the urban effect is a real question. A period of adaptation has been necessary, and, *de facto*, the urban fact and the urban effect have been out of sync.

Sedentarization has indeed led to a reorganization of community life within villages, hitherto mobile and scattered across the territory according to the feeding seasons. Once seen solely as “a point of service, [the village] has now become the main center of activity for a large part of the population” [Breton and Cloutier, 2017, p. 94, translated from French]. Even so, life in the territory and access to it remain an essential part of the Nunavimmiut way of life. In fact, to compensate for the loss of traditional seasonal nomadic camps and perpetuate their activities on the land over short periods of time, urban Inuit build handcrafted cabins on the land, using materials salvaged from dumps. The traditional activities of hunting, fishing and gathering in addition to new leisure practices organize a life outside the village or on its outskirts (Nuna project). Referring to Rémy et al. [1991], Breton and Cloutier [2017, p. 96] state that: “rather than opposing each other, the Inuit adopt a ‘transactional’ strategy”. In other words, “they integrate the allocation of fixed, concentrated housing, while allowing the traditional way of inhabiting the territory to express itself. Homemade

cabins built from [outside the village] correspond to the Inuit way of managing space.” [Breton and Cloutier, 2017, p. 96, translated from French]. The transition in Inuit ways of living that took place in the first half of the twentieth century, illustrated in some of publications titles such as “from the igloo to the council flat” [Duhaime, 1985] or “from the sea ice to the freezer” [Martin, 2003], had a major impact on the foundations of Inuit culture (modes of travel, pace of life, activities practiced). The fact remains, however, that the way of living in the city and the formation of the city remain quite hybrid for these northern communities, with Indigenous peoples playing “an active part (...) in the development of these new ways of appropriating the territory.” [Desbiens, 2017, p. 151, translated from French].

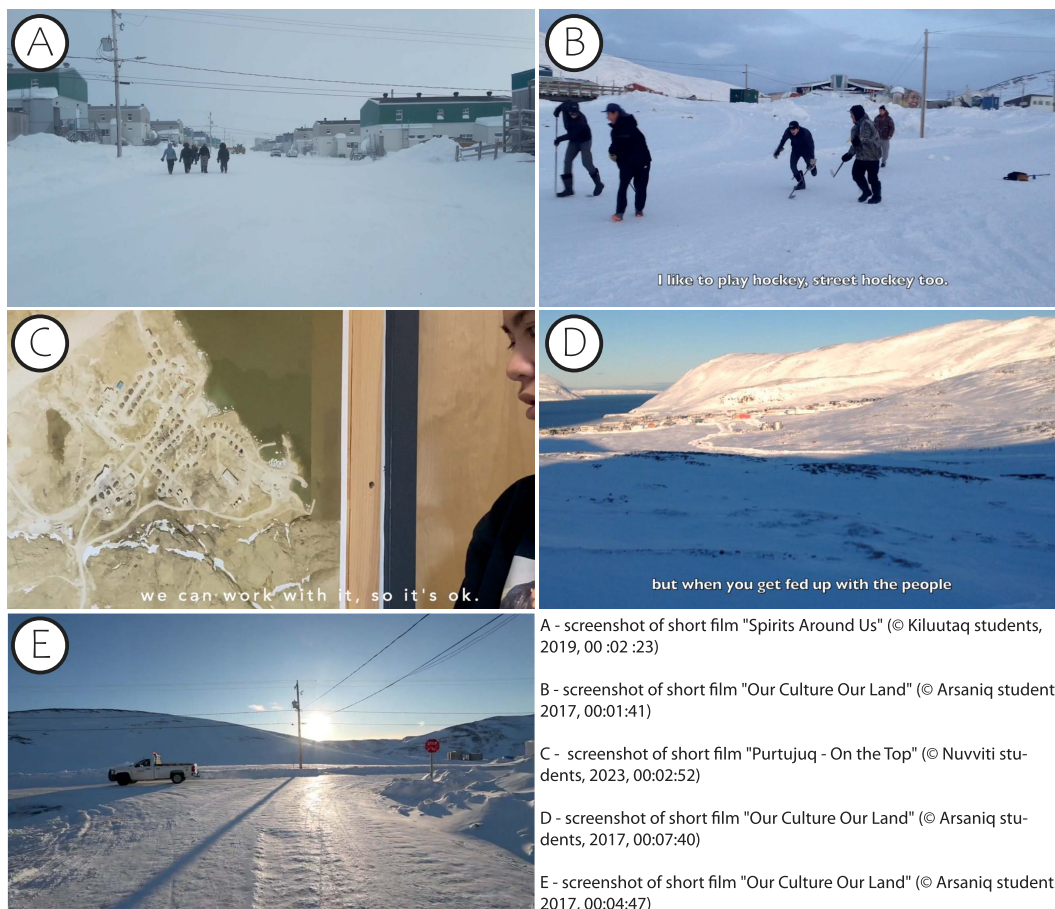
This reinvented urbanity is addressed through two examples from OHMi projects: the Nuna project dealing with the indigenous emic view of the territory [Herrmann et al., 2023, Joliet et al., 2021, Chanteloup et al., 2019] and the Niqiliriniq project addressing issues of food security and sovereignty in the city [Rapinski et al., 2023].

##### 4.1. *Urbanity, a reinvented territoriality?*

In Nunavik, traditional territoriality is being disrupted by urbanization. The holistic indigenous conception of Mother Earth endures, as a Kuujjuarapik elder testified: “So, I grew up in the camp for 10 years [...] we didn’t have TV, no iPad, no radio. Just pure Earth.” [Land is Home, 2016, Chanteloup et al., 2018, p. 375]. Similarly, all the generations of the village of Umiujaq evoke the presence of different types of spirits both in town and on traditional territory [Spirits Around Us, 2019]. Yet many adaptations attest to the reinvention of Inuit territoriality since the creation of the villages.

The five participatory videos (Nuna project) made by Nunavimmiut pupils show how the students and adults adopt strategies for appropriating urbanity (Figure 7A) [Herrmann et al., 2023, Joliet et al., 2021, Chanteloup et al., 2018].

These videos reveal some striking urban effects: a divide between generations born before and after the creation of the villages; a shared sense of modernity and spatial confinement; the hijacking of certain “urban objects” (the kitchen, the dressing room, the



**Figure 7.** Screenshots from short films made by pupils and students from Nunavik schools as part of the Nuna project. (A) young people on the street in Umiujaq. [© Screenshot of *Spirits Around Us*, 2019]; (B) in front of the school, teenagers improvise a game of street field hockey. [© Screenshot of *Our Culture Our Land*, 2017]; (C) presentation of the village of Ivvujivik by a student [© Screenshot of *Purtujuq - On the Top*, 2022]; (D) a skidoo ride outside the village, view of Kangiqsujuaq [© Screenshot of *Our Culture Our Land*, 2017]; (E) pickup truck, electric wires and stop sign in Kangiqsujuaq [© Screenshot of *Our Culture Our Land*, 2017].

municipal freezer, the construction of cabins around the village).

#### 4.1.1. *The urban effect divided along generational lines*

The question of the urban effect now varies from generation to generation, depending on whether they were born before or after the establishment of the villages: "It's different today than it was thirty-five years ago. [...] It's the new generation, they grow up differently. Society is different." [interview 2022] (Figure 7B).

Elders and adults born before sedentarization, i.e., in camps, see the city or village as an extra-territorial parenthesis [Chanteloup *et al.*, 2018, Collignon, 1996]. In contrast, young people born in hospitals (mainly Puvirnituk, Montreal or Quebec City) and who grew up in the village see it as a given that they have made their own [Joliet and Chanteloup, 2021].

#### 4.1.2. *A shared feeling of modernity and confinement*

"I think young people rather be connected to the world now, if you put them in isolation they would

be bored. What am I doing here? Why am I hunting?” [interview 2022]: young people like to play field hockey in the frozen street, go out on quads or in pick-up trucks, revisit the design of their traditional clothing [Our Culture Our Land, 2017], go to the gym and the arena [Spirits Around Us, 2019], etc.

Although the communities average between 600 to 700 inhabitants, the inhabitants have basic modern equipment, as can be seen in Purtujuq - On the Top [2022] made by the pupils of the Nuvviti school in Ivujivik as part of the Nuna project: “This is our school, our only store, the airport. It’s pretty small, but we can work with it, so it’s ok.” (Figure 7C).

Conversely, some people testify to a feeling of urban oppression, for example in Our Culture Our Land [2017] in Kangiqsujuaq: “[...] you live in a small community, and you see the same people every day, but when you get fed up with the people, you can always go to the land [...] it’s very good to have a fresh air.” (Figure 7D).

#### 4.1.3. *Detour and adaptation of certain urban objects*

In the fullyequipped kitchen, meals are sometimes not eaten at the table but, as in the camp, on a cardboard box on the floor; the dressing room is used to dry skins progressively; studios are built for young couples—who used to live in a family community in the same camp and then in the same house; the windows of the houses are larger and oriented towards a preferred view. Traffic in the village is marked by a single road sign, the Stop sign, translated into Inuktitut (Figure 7E).

Instead of food caches in the camps, a municipal freezer has been created, set up by the Inuit in each village, to store country food and share it according to community tradition: “We have a community freezer, to share food we bring from the land, and to keep our culture alive.” [Land is Home, 2016].

Finally, the village model of the “solid” house is transposed to the traditional territory. Inuit salvage discarded materials from garbage dumps and build cabins that serve as fixed or sedentary camps instead of seasonal tents.

Through the short films made by young people in their communities, the Nuna research project demonstrates that the village and the territory are complementary, while for the elders, the village remains an imposed graft. The emergence of urban life is reflected in the videos by the appropriation of the

street in winter, an expression of modern services, sometimes confined, and outside a form of urban detour with the construction of “hard” huts in the territory, replacing seasonal camps. The Niqiliriniq research project looked at the disruption of food practices that are significant aspects of urban life.

#### 4.2. *The reinvention of a food landscape? Between food imbalance and food sovereignty complementary to country food*

The Inuit urban effect is also visible in the brutal nutritional transition that has taken place, with a kitchen equipped for cooking and a store for shopping, with major health repercussions for Inuit populations. As a result, the traditional Inuit diet from land and sea-based resources (“country food”) has evolved towards the integration of market food products imported from the South [which currently contributes up to 72% (elders) and 89% (youth) of energy intake in Inuit diet, according to Blanchet and Rochette, 2008, p. III]. These are typically ultra-processed foods: “I don’t want to be left behind, with my veils, my food, with my store-bought food, I rather eat store-bought food than country food now today. Because country food is mostly boiled, mostly fried, there is no mix, it’s always those three. No spice, no mixed, strict boiled, strict fries, so maybe I got tired of that” [Interview 2022].

This “westernization of the diet” [Counil *et al.*, 2011, p. 238] has led to a decline in the contribution of traditional foods to energy intake in favor of grocery-bought products, particularly among young people: “I rather go with store-bought food. But the further north you go, like in Sannikiluak, if you put a seal meal all the children will go there. But here, if I put it on at my grandkids, they said what’s the heck is that, I don’t want to see it, it looks terrible, that’s their attitude today, the kids” (op cit).

This context has prompted residents to look for solutions to regain food sovereignty in the village. Thus, the actionresearch carried out as part of the Niqiliriniq project addresses the major challenges of food security in the Nunavik communities of Kuujuaq, Umiujaq and Kangiqsujuaq, through the development of northern agriculture.

Gardening initiatives (Niqiliriniq project) in greenhouses, cold layers or even at home, aim to enable Nunavik communities to grow their own food

and strengthen their food self-sufficiency, while reducing their dependence on imported food [Lamallice *et al.*, 2018]. As noted above, fresh plants are scarce and expensive, or even totally absent for part of the year. Greenhouse farming and gardening thus make it possible to produce fresh vegetables locally, of higher nutritional quality than processed or canned foods, while limiting greenhouse gas emissions linked to transport [Lamallice, 2019].

This local cultivation, especially of green vegetables, enables residents to gather around an activity that promotes social cohesion and strengthens community ties [Lamallice *et al.*, 2016]. Two community greenhouses have been built in Kuujuaq to fulfil these various roles. Plots of land are allocated to village residents by lottery, and everyone is free to grow their own vegetables.

## 5. Discussion: the OHM device on the Nunavik territory

The work of OHMi Nunavik focuses on the socio-ecosystem of an Inuit territory, jointly and fundamentally environmental and human, in which indigenous ways of apprehending the world differ from those of Euro-Canadians, which are still dominant in the Arctic. Identifying these conceptions and understanding their complexity, while avoiding the cultural pitfalls of domination or competition, is essential [Decaulne *et al.*, 2020].

### 5.1. *Adapting the research methods to the Nunavik context*

One of OHMi Nunavik's challenges is to integrate the complexity of knowledges. Hybridizing Indigenous [Chilisa, 2012] and Western research methods to co-construct knowledge is one of OHMi Nunavik's aims. Members of the communities in which the projects take place are involved at various levels, with the dual aim of benefiting from the project implementation from an educational and societal point of view on the one hand, and ensuring adequate data acquisition on the other, the latter objective serving the former. Implementing hybrid methodologies between Western and indigenous knowledge is a complex and time-consuming process, requiring respect, listening and shared practice to build mutual trust and forge

more egalitarian collaborations between Nunavimmiut and non-native academics. This is clearly an effort redundant with the one building up interdisciplinarity, or "enlightened disciplinarity" within all OHM devices [Chenorkian, 2020a]. Ongoing communication between indigenous partners and non-indigenous researchers has opened up innovative avenues and new universes for concrete engagement in the co-construction of knowledge, with the researcher questioning the applied scope of his data (and its concrete use by communities), and the indigenous population being presented with the practical benefits of research findings by interacting with the researcher and questioning the investigations he hosts on his territory. In this way, learning is reciprocal and multidimensional: between disciplines within the same project, between different projects and between Nunavimmiut and French and Canadian researchers.

Of course, the various projects in which OHMi Nunavik researchers are involved consider multiple space and time scales, and, in some way, all inform the implications of urbanization on the socio-ecological system under study, from instant (*i.e.*, thermic values in a greenhouse) and seasonal observation (*i.e.*, vegetable yield informing nutrition facts in a community) to that spanning over several centuries (*i.e.*, geomorphic impact of snow avalanches on a slope segment). Similarly, approaches can be highly naturalistic, or on the contrary based on narrative and iconographic sovereignty. Participatory methods are thus a strength of the researches carried out in Nunavik, paralleling all the disciplinary methods deployed. Research in the social sciences and humanities allows for the involvement of indigenous communities, and is in line with their choice of sovereignty; on the other hand, it allows for the precision, adaptability and acceptability of research in the natural sciences. Participatory methods have been specifically developed in the context of Nunavik communities (*e.g.*, participatory videos, researcher-inhabitant interviews based on personal snapshots).

### 5.2. *Conducting scientific researches in Nunavik context*

One of the strengths of OHMi Nunavik's research lies in the interdisciplinary nature of its French-Canadian



scientific expertise (engineering sciences, nutritional sciences, geomorphology and human sciences). Priority research themes are defined with local partners, making it clear that not all research topics can be developed outside the agreed framework. Unlike many disciplinary research projects on urbanization in Inuit territory following sedentarization, results are cross-disciplinary.

At the end of the 20th century, the establishment of research protocols and frameworks encouraged, then made mandatory, fairness, reciprocity and transparency in research with the communities involved [Regan, 2010, Inuit Tapiriit Kanatami, 2018, First Nations Information Governance Centre, 2014]. This recent ethic has emerged as a reaction to the scientific behavior of previous decades: for much of the 20th century, most research in arctic regions was carried out without the agreement or cooperation of the indigenous populations; the results of the research carried out were disseminated without the clear and informed consent of the holders of the knowledge intended for Western societies. The abusive repetition of this unilateral Western research was experienced as an usurpation or dispossession by Inuit, a clear colonial domination [Inuit Tapiriit Kanatami, 2018]. Since then, the decolonization of research is a recognition of indigenous knowledge and its modes of production as heuristic potential equivalent to that of Western science [Wilson, 2008, Tuhiwai-Smith, 2012, Inuit Tapiriit Kanatami, 2018].

OHM's scientific dynamic is increasingly interdisciplinary: after eight years of funding targeted programs, the development of intra-OHM cross-disciplinary research projects and inter-OHM programs reinforces this reflexive dynamism. The visibility and invisibility of flows (HYDECO cross-disciplinary program), nutrition (SASI cross-disciplinary program) and contaminants (collective work by LabEx DRIIHM on contaminations), for example, enable multi-disciplinary teams to target specific issues. For instance, "rivers", or "urban nutritional patterns" in a Nunavik village, are currently research themes in development, enabling a focus supported by prior research, combined and compared with the results of research carried out in other OHM.

The development of such interdisciplinary research in an indigenous environment presents challenges. The confrontation of different scien-

tific cultures reflects divergent interests in developing research in the arctic environment: academic institutional holders, political partners, inhabitants, researchers and students. Solutions, such as the development of Memoranda of Understanding, agreements between regional and academic partners, are a slow process in which power relations must be balanced and multiple levels of recognition intertwined. Another challenge is the complex reconciliation of knowledge. Finally, a number of challenges are intrinsic to the Nunavik system, such as the history of research carried out in this area, which has not yet been appeased: even if OHMi Nunavik researchers are trying to proceed differently, the indigenous perception is not necessarily so, as they are once again non-indigenous researchers involved in the study of this area. That is a process experienced by some as another form of colonization by research. The actual relationships in the field are often more personal than institutional; however, these good individual agreements and their durability are essential, and are facilitated by the long-term nature of the OHM system ["multi-year projects", as underlined in Chenorkian, 2020a], which represents a uniquely active research device in the Nunavik territory. At the local and regional institutional level, the very high staff turnover rate in this isolated environment complicates the coherence of research conducted over the long term, as much as the relationships of trust between partners. This is counterbalanced by the bi-national nature of the research teams, with Canadian experience in indigenous research, facilitating French inclusion in this context.

Unfortunately, the small scale of Nunavik's communities makes it difficult to conduct an interdisciplinary field campaign involving all OHMi Nunavik members. This is certainly a hindrance, which, over and above questions of the researchers' schedules, poses logistical problems: it is impossible to accommodate a large number of people in most communities, which would exert an undesirable form of pressure on the population, and create a climate of oversolicitation unfavourable to data acquisition. On the other hand, the organization of multiple data acquisition campaigns is organized upstream between the research teams, and the interpretation of cross-referenced results *a posteriori* provides interesting perspective and hindsight.

## 6. Conclusion

This paper provides an insight into the social, cultural and ecological transformations linked to the urban development of villages in Nunavik and their effects on Nunavimmiut and the surrounding ecosystem, based on a reflection led by the OHMi Nunavik collective, and illustrated by the various research projects carried out within OHMi.

Each of these research projects sheds light on different elements of the urban system, enabling us to gain a better understanding of village construction. Currently, there is an ongoing process of reflection to ensure more sustainable development and to avoid natural hazards and related risks and to ensure the population's energy and food security and sovereignty. The article also looks at contemporary Nunavik Inuit urbanity, which is taking shape as a reorganization of lifestyles within villages. However, it has a complementary and still fundamental dimension in terms of territorial travel. The research projects mobilized here to illustrate diverse aspects of the urban socio-ecological system were co-constructed with Nunavik authorities and local populations. The results from the research projects will help guide future political decisions and aid in the implementation of concrete solutions in the villages. The scope of possible action differs depending on the project. At the village level, the Siqiniq and Kingaq projects have introduced more sustainable energy models for greenhouse farming or have provided village authorities and northern organizations such as Nunavik Parks with recommendations for future land-use planning to avoid the risks of instabilities on slopes. At the local level, the Niqiliriniq project provides support in gardening and the creation of vegetable gardens, nutrient courses and greenhouse installation, while the Nuna project promotes the visual sovereignty of young Inuit, while developing teaching materials that can be used by classes to work on participatory videos.

As well as making a significant contribution to support decision-making and to stimulate positive change in communities, the projects have also spawned other community-led projects or participatory action research; in some cases, these have spread throughout the Nunavik region. For example, the experiences and lessons learned from the Niqiliriniq project were recently replicated in the

village of Inukjuak, where a community gardening project was launched with the construction and installation of cold beds; or in Kangiqsujuaq, where a seaweed composting project was launched by the local Niqiliriniq project coordinator. In Kuujuaq, a collaboration with the company Kuujuaq Inc. has been initiated to extend the lessons learned from the Siqiniq project about energy optimization from greenhouses to the municipal swimming pool, with a view to possibly extending the growing season within the greenhouse using an additional geothermal system. Finally, Kativik Ilisarniliriniq (the Nunavik School Board) has expressed interest in having one of their pedagogical advisors participate in a future video workshop, with a view to eventually integrating participatory video-making into their curriculum.

The OHMi Nunavik framework contributes to the sustainability of the northern urban socio-ecological system by combining approaches from different academic fields (geography, energy, nutrition), while producing knowledge that will enhance public policy decision-making and research-intervention. These efforts echo recent calls from indigenous organizations for transformative, locally-rooted arctic research.

## Declaration of interests

The authors do not work for, advise, own shares in, or receive funds from any organization that could benefit from this article, and have declared no affiliations other than their research organizations.

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