MOBILIZING FOR A SUSTAINABLE NORTH

RESEARCH ISSUES AND PRIORITIES

UNIVERSITÉ LAVAL

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STATEMENT

Whereas Université Laval

– has demonstrated its leadership and acknowledged expertise in northern research for over 50 years;

– has long asserted its desire to invest in interdisciplinarity and prioritize collaboration and partnership;

– carries out its research activities from a humanist perspective;

– and encourages the development of sustainable relationships with the people of northern Québec.

Recognizing

– the need to develop research priorities that allow communities and governments to better meet the challenges of northern Québec;

– the need to foster collaboration between the partners associated with northern development;

– the importance of respecting the culture, needs, and rights of aboriginal communities;

– the need for a multidisciplinary vision of human and social development in northern Québec;

– and the need for ethical and responsible behavior regarding the protection of the region and socioeconomic development.

Université Laval undertakes to

– mobilize its research resources and those of its partners to meet the challenges posed by northern development;

– develop and build its knowledge by conducting research that respects the needs, cultures, and environments of northern communities;

– transfer knowledge and technology so that present and future generations are better equipped to handle the challenges of the North;

– and promote the multidisciplinary aspect of northern research to support all the facets and complexities of sustainable northern development.

Denis Brière
June 18, 2012

A WORD FROM THE RECTOR

Over the past six months, professors from Université Laval and other universities enthusiastically joined forces to reflect on issues and priorities in university research on the development of northern Québec.

Along with community, business, and government experts, over fifty professors with an interest in the North took part in this collective endeavor—the first of its kind on a university campus—eager to help Québec rise to the challenge.

They are therefore proud to present this document, the fruits of their labor, to the university community and the general public. It is entitled “Mobilizing for a Sustainable North: Research Issues and Priorities.”

A leader in northern research and a Canadian pioneer in northern studies and Arctic research, Université Laval has garnered an enviable international reputation for itself over the years.

Its leadership in the field of northern research is in keeping with its status as a world-class university.

Northern studies are now very much on the public radar and Université Laval will continue in its efforts to mobilize stakeholders to ensure the sustainable development of the North and its communities.

Denis Brière, Rector, Université Laval

A WORD FROM THE HONORARY PRESIDENT

I feel very privileged to be closely involved with this initiative to mobilize for a sustainable North.

Building on fifty years of expertise and research in northern studies, in a leadership role that is acknowledged around the world, Université Laval is a leading force in scientific circles, with a legacy forged by its pioneering research professors.

The university’s ambitious research projects are internationally renowned, and Université Laval had no hesitations about committing to this innovative new collective effort.

In the face of the social, economic, and environmental challenges posed by the development of the North, numerous professors from a wide array of disciplines decided to get actively involved in this project. These researchers, with their wide-ranging complementary expertise, have teamed up with experts from outside the university to map out a research strategy that will ensure a brighter future for all Quebecers and establish effective partnerships to boost the province’s sustainable development.

We very much look forward to exploring their findings, concerns, and proposals in this brief— along with their passion for the North.

Edwin Bourget, Professor Emeritus, Université Laval

SUMMARY

Université Laval has been a world leader in northern and polar research for over 50 years.

Since the Québec government announced the Plan Nord in May 2011, our institution has mobilized some 50 scientists and experts who, together, have identified the main research issues and priorities that must underpin sustainable northern development. The research vision that resulted from this collaborative effort—which is unique at the campus-wide level—was built around four interdependent themes: community well-being, development, governance, and viability; environmental protection; development of economic potential; and accessibility via transportation and telecommunications.

For each of these themes, the experts targeted a series of research issues and priorities that were both strategic and tactical. Their discussions were guided by the fact that development of northern Québec is a true opportunity to translate the concept of sustainable development into concrete, concerted action. At the heart of these challenges, they also identified issues and parameters that must be rigorously considered in northern development, notably multifunctional land use, the full participation of aboriginal communities, the coordination and integration of development efforts, the adaptation of expertise, and the use of new technology.

Given the scope of the industrial projects envisaged in the Plan Nord, the size of the region and its vulnerability to climate change, the anticipated speed with which major infrastructure projects will be implemented, the logistical complexity, the transportation and telecommunication challenges, and the expected effects on local communities, there is an immediate need among public and corporate decision makers and the communities affected by these changes for ongoing support from experts, including scientists. That is why Université Laval wishes to mobilize Québec's northern research specialists in a broad and concerted multidisciplinary initiative. The goal is to structure a significant portion of the R&D efforts required to ensure the success of northern development initiatives. This proposal therefore serves as the starting point for a dynamic research action plan, a plan that involves all the key players in northern development, particularly aboriginal communities.

UNIVERSITÉ LAVAL'S LEADERSHIP ROLE IN NORTHERN RESEARCH: THE FOUNDATIONS

Université Laval has been a long-time leader in a number of fields related to the economic, social, and environmental development of northern Québec. Indeed the university has been a world leader in northern and polar research for over 50 years. It currently has more than 140 professors who are actively involved in various fields related to the North, with most of them coming from the university's faculties of Science and Engineering, Forestry, Geography and Geomatics, Social Sciences, Medicine, Agriculture and Food Sciences, Administration and Urban Planning, Architecture, and Visual Arts.

Based on these strenghts, Université Laval undertook in fall 2011 to draft a brief on research issues and priorities for a sustainable North. The first step was to set up a coordination working group of a dozen Université Laval representatives to oversee the process **(see Appendix 1)**.

Right from the outset, it was decided that this would be the starting point for a strategic thinking process that would quickly open up to include everyone involved in northern research in Québec as well as key players in northern development, particularly aboriginal communities. This document is the result of discussions held by four panels of experts **(see Appendix 2)** made up largely of researchers from Université Laval but also other institutions, as well as representatives from aboriginal communities and government. In all some 50 experts discussed research needs, issues, and priorities associated with northern development. Drawing on all these mechanisms, Université Laval has successfully put together a unique collaborative initiative in multidisciplinary research centered on a societal undertaking that will not only have an impact on northern communities, but on most Quebecers in the years to come.

WORLD-RENOWNED EXPERTISE A PARTNERSHIP APPROACH TO COLLABORATIVE RESEARCH

Université Laval is at the core of some ten university groups that devote much of their collaborative research efforts to northern and polar issues **(see Appendix 3)**. These groups include the Center for Northern Studies (CEN), the ArcticNet Network of Centers of Excellence, the Canada Excellence Research Chair in Remote Sensing of Canada's New Arctic Frontier, CIÉRA (Interuniversity Center for Aboriginal Studies and Research), Nasivvik, Québec-Océan, CFR (Center for Forest Research), and the Northern Sustainable Development Research Chair. In all, Laval is home to more than 15 northern research chairs along with the Takuvik program—the result of a partnership with CNRS-France. In conjunction with the Canadian Coast Guard, the university also manages the CCGS *Amundsen* research icebreaker. All these activities add up to some $35 million in annual R&D investment—some 10% of Université Laval's total research funding budget—covering a vast range of northern and polar issues.

INTRODUCTION

Northern development has always been a topic of major interest at Université Laval. Consequently, nearly 50 experts with extensive knowledge of northern environments have pooled their resources to identify the main economic, social, and environmental research issues and priorities they feel must be part of a concerted, multidisciplinary approach to development in the region.

Université Laval has therefore prepared this brief, entitled "Mobilizing for a Sustainable North: Research Issues and Priorities." The purpose of this proposed strategic action plan is to mobilize everyone involved in northern research in Québec in a broad and concerted multidisciplinary effort. The goal is to structure a significant portion of the R&D efforts required to ensure the overall success of northern development initiatives. However, Université Laval makes no claim to cover all research themes related to northern development in this brief.

On May 9, 2011, the Québec government officially launched the Plan Nord. One of the plan's main aims is to improve the living conditions of northern communities by generating economic benefits and social development and promoting environmental leadership.

In light of this, Université Laval has drafted a proposal emphasizing the importance and diversity of the research effort required to align northern development with the realities of northern Québec and the principles of sustainable development.

The Québec government's Plan Nord is based on four strategic areas:

1. Ensuring community well-being and development
2. Developing the immense economic potential of northern Québec
3. Access to the North: Transportation and communications
4. Protecting the environment

The government has identified a series of priorities for each area, several of which make reference to knowledge acquisition, innovation, and training needs. To facilitate discussion on strategic research issues and priorities, Université Laval has adopted the same thematic structure, which is reflected in this brief.

It is important to note that the experts who helped prepare this brief were guided in part by the positions on the Plan Nord set forth in documents submitted by various stakeholders, notably *Plan Nunavik, Position Paper Tabled by Nunavik Inuit in the Context of the Plan Nord, Nunavik Inuit and the Nunavik Region: Past, Present, Future 2011*[1] and *Cree Vision of Plan Nord*[2].

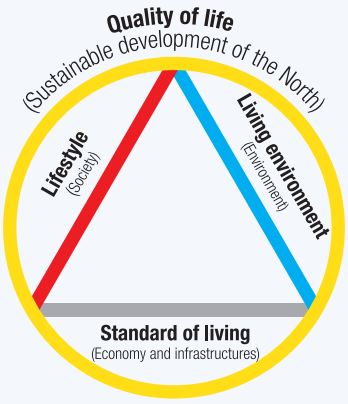
In this brief, Université Laval proposes a basis for further reflection and calls for a broad-based collaborative research initiative at Québec universities in close cooperation with northern Québec stakeholders, particularly the region's many aboriginal and non-aboriginal communities.

[1] *www.igfquebec.com/fileadmin/docu/prog/demi_jour_them/20111214/plan_nunavik.pdf*
[2] *www.gcc.ca/pdf/Cree-Vision-of-Plan-Nord.pdf*

THE BASIS OF SUSTAINABLE DEVELOPMENT: AN OPEN, COMPREHENSIVE APPROACH

Québec society is firmly committed to the concept of sustainable development. In 2006, the Québec National Assembly unanimously adopted a bill championing this commitment, an undertaking above and beyond that of most other nations.

The development of northern Québec is a unique opportunity to translate the concept of sustainable development into concrete, concerted action. For this proposal, the issue obviously had to be broken down into manageable components and subcomponents that are accessible to various experts. At the same time, the application of sustainable development principles calls for a broad vision acknowledging that economic, social, and environmental considerations can be reconciled in developing northern Québec. To do this, we need to be open to all stakeholders and experts, accept the limits of individual expertise, and most importantly, adjust to the realities of the North. Special attention, for example, must be paid to social and cultural values, because they are a priority for aboriginal communities. Implementing sustainable development in northern Québec therefore requires a comprehensive approach that is, by definition, multidisciplinary and collaborative, and open to new ways of thinking and doing. This approach is implicit in each avenue of research outlined in the following pages.



1 PREMISES

This brief is a dynamic and adaptive platform based on a concerted research approach appropriate for northern Québec

and aimed at meeting sustainable development principles, the expectations of local communities, wealth creation goals associated with northern development, and university objectives regarding the generation of knowledge and training. With this in mind, the following premises were formulated as premises for all the issues and research priorities we have identified.

Sustainable northern development must first and foremost be holistic and take into consideration the human, social, physical, natural, and financial capital that exists in northern Québec and within the stakeholder groups (communities, companies, governments, organizations, educational and research institutions) that will play a role in this development.

Multifunctional land use: Sustainable development must take into account the diversity of the North, the complexity of its living environments, production areas, and natural environments, and the multiple functions these areas fulfill currently and in the future.

Full participation of aboriginal communities: Implementation of a strategic research proposal for northern Québec could not be contemplated without the direct and ongoing participation of local communities (Inuit, Cree, Innu, Naskapi, Algonquin, Atikamekw) in defining specific needs and projects.

Dynamic nature of northern Québec: Northern Québec is currently undergoing high population growth and an industrial and socioeconomic boom. It is also experiencing one of the highest rates of global warming in the world, which is impacting the life of residents (safety, provision of services, infrastructures, etc.). This dynamic situation implies, among other things, that the issues are not fixed in time and it is essential to approach research from an evolutive perspective.

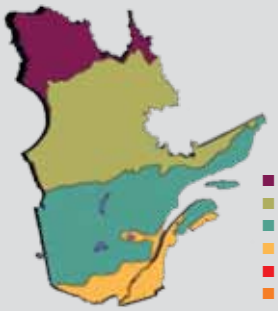
Distinctive character of northern Québec: In northern Québec, development models and relations between groups of people and institutions are different from those the business and academic communities are accustomed to. All development initiatives and knowledge and technology transfers in this region must take these differences into account.

CLIMATE CHANGE AND NORTHERN DEVELOPMENT

The Québec peninsula is characterized by a strong latitudinal climatic gradient that currently defines four ecoclimate regions. During this century, the boundaries of these ecoclimates are expected to rapidly shift to the north. All services provided by northern ecosystems will be affected by this major climate change, including biological productivity, permafrost stability, distribution of the taiga, caribou migrations, snow cover, and runoff.

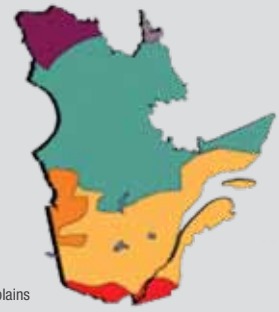
Most of the Plan Nord initiatives targeting economic development, transportation and telecommunication infrastructures, and environmental conservation will take place against this backdrop of rapid climate change. From a sustainable development perspective, each of these initiatives must therefore be examined and planned in keeping with specific climate change scenarios. Several areas of research and expertise need to be strengthened and directed as of now to meet the pressures associated with northern development, e.g., regional climate modeling, the response of marine, land, and freshwater ecosystems to climate change, and the stability of the geophysical environment in a context of warming.

ECOCLIMATE REGIONS IN QUÉBEC



Environment Canada

PROJECTED SHIFT OF THESE REGIONS IF CO_2 LEVELS DOUBLE



After Rizzo and Wiken, 1992

Coordination and integration challenges: One of the keys to the success of the Plan Nord, conceived as a model for the practical application of sustainable development principles, will lie in the willingness and ability of the players to coordinate activities in the region, avoid inefficiencies, and optimize development for the present and future benefit of local communities. Success will also rely on a collective awareness that northern and southern Québec cannot be approached as two separate realities and that close cooperation between stakeholders across Québec is required in this regard.

Multidisciplinary scientific support: Given the scope of the industrial projects envisaged in the Plan Nord, the size of the region and its vulnerability to climate change, the anticipated speed with which major infrastructure projects will be implemented, the logistical complexity, the transportation and telecommunication challenges, and the expected effects on local communities, there is an immediate need among public and corporate decision makers and the communities affected by these changes for ongoing support from experts, including scientists. For the vast majority of problems requiring solutions, scientific support must be coupled with transdisciplinary projects. This in itself will be a challenge for scientists as they face the obligation of adapting and converging their own paradigms to meet this multidisciplinary requirement.

Integration of indigenous knowledge: Indigenous knowledge varies in nature. It can relate to health, spirituality, settlement, or history, among other things. Generally transmitted orally, this knowledge is in no way static; it is adapted to the transmission context and can be expressed using technical or symbolic language. Knowledge of the land is generally very specialized because it has developed in particular contexts and in relation to specific needs. With regard to northern development, one of the challenges will be to perpetuate indigenous knowledge by considering it not solely as a supplement to scientific knowledge, but as an independent reference system specific to territories, resources, and communities. When included in decision-making processes, this knowledge will help maintain the integrity of aboriginal communities.

New collaborative research approaches: The development of the North offers an ideal opportunity to develop collaborative research methodologies. Although such approaches are already well established in a number of networks and research centers, we must consolidate these achievements, improve practices, and build closer collaborative ties with northern institutions. There are already a number of natural science research facilities in place, notably in Kuujjuaq, Kuujjuarapik/Whapmagoostui, Umiujaq, and Salluit, as well as climate and environment monitoring sites in most Nunavik communities. It is also essential to support the development or implementation of structures that help train northern researchers (aboriginals and non-aboriginals), notably in the field of social sciences.

Adapting know-how and harnessing new technology: Implementation of the Plan Nord is a unique opportunity to make maximum use of new technology (engineering, earth sciences, geographical information, telecommunications, development of intelligent systems, etc.) and adapt know-how to make a positive impact on human development. Northern development also offers an opportunity to develop a wealth of Québec expertise that can be exported elsewhere, particularly to circumpolar regions.

Rich field of ethics research: The development of northern Québec raises many specific ethical questions associated with issues such as social acceptability, the dependence of aboriginal communities versus exogenous economic development, the distribution of non-renewable resource rents to future generations (intergenerational ethics), north-south ethics, and decisions around integrating environmental, social, and economic considerations into northern development approaches. From the point of view of sustainable development, support for research on these issues will be essential.

2 RESEARCH ISSUES AND PRIORITIES

Like our four panels of contributing experts, this strategic research proposal for northern Québec was developed based on four interdependent themes:

1. **Community well-being, development, governance, and viability**
2. **Environmental protection**
3. **Development of economic potential**
4. **Access to the North: Transportation and telecommunications**

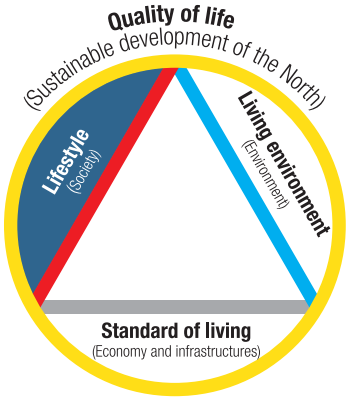
2.1 COMMUNITY WELL-BEING, DEVELOPMENT, GOVERNANCE, AND VIABILITY

The development of northern Québec is unfolding in a social, cultural, economic, and political context that has been no stranger to change or progress over the generations. However, the pace of change has significantly accelerated and northern communities are making considerable efforts to widen the range of strategies and innovations aimed at managing their own growth. One of the major challenges is to address this growth in a holistic manner. Education, housing, the economy, employment, culture, interculturalism, the environment, transportation, communication, and relationships between individuals and within communities are determinants that must be examined and managed with an integrated perspective. Furthermore, most aboriginal peoples living in northern Québec now live under agreements that give them some degree of regional decision-making control that permits the inclusion and sharing of long-sought benefits. On the other hand, although the material wealth of many has grown, some indicators show that this does not always mean social and individual conditions have improved.

Figure 1 presents the main issues associated with the well-being, development, governance, and viability of northern communities. Research priorities were identified for each of these issues.

Figure 1

COMMUNITY WELL-BEING, DEVELOPMENT, GOVERNANCE, AND VIABILITY



ISSUES

- Social and human indicators of concern
- Maintenance of languages, cultures, and identities
- Transmission of knowledge and preservation of cultural heritage
- Education and training
- Maintenance of health-friendly environments
- Access to communication technologies
- Housing challenges
- Household structure and home economics
- Governance models and social acceptability
- Exogenous economic development
- Aboriginal and treaty rights
- Dialogue among northern stakeholders

Social and human indicators of concern

A number of northern communities, particularly in Nunavik, are confronted with major social and human problems: a decrease in average life expectancy, high suicide rates, interpersonal violence, excessive alcohol consumption, drug use, gambling, and abuse. These symptoms are largely attributed to rapidly changing lifestyles, the loss of cultures and languages, adoption of a sedentary lifestyle, and housing shortages. For some communities, isolation can also be an aggravating factor.

RESEARCH PRIORITIES

Identify best practices that help ensure industrial projects contribute positively to the economic, social, and cultural development of northern communities and the quality of life of their members.

Analyze the role of the subsistence economy in the viability of northern communities and the quality of life of their residents.

Document the positive and negative effects of new land and sea links on northern communities and their social and human development.

Analyze factors that promote the resilience of northern communities so as to provide perspective on the conditions required for sustainable northern development.

Maintenance of languages, cultures, and identities

Many experts believe that accelerated northern development will have a definite and irreversible impact on the languages and cultures of aboriginal communities. Some communities will have to adapt to a mass influx of workers and their families, many of whom are from outside these communities. These changes will have a marked impact on the identities of aboriginal peoples, especially among youth. Various institutions (including Avataq, Institut Tshakapesh, and Aaischaaukamikw Cree Cultural Institute) are already working to prevent the erosion of cultural capital and should be seen as key players in the preservation of languages, cultures, and identities.

RESEARCH PRIORITIES

Identify avenues for improving efforts to develop and maintain northern Quebec's cultural capital and identity.

Transmission of knowledge and preservation of cultural heritage

The transmission of knowledge and the preservation of cultural heritage play a key role in maintaining the identity of northern communities. Development of a consistent approach to heritage preservation depends, among other things, on the ability of qualified personnel to act and develop a long term vision to preserve and promote these resources. In Québec the *Sustainable Development Act* (2006) and the new *Cultural Property Act* (2012) have established new heritage management principles. The enhanced powers granted to aboriginal managers may lead to assessments of their region's archeological potential and permit existing collections to be analyzed to promote the specific identity of communities.

RESEARCH PRIORITIES

Identify approaches that help preserve the heritage and identity of northern communities, including both traditional practices and archeological property.

Develop training programs in northern heritage and identity management that are adapted for aboriginal professionals.

Education and training

The realities of education, schooling, and vocational training are inseparable from identity building among individuals and capacity building at regional institutions. Despite significant human and financial investments over the past 40 years, northern high school and postsecondary graduation rates remain considerably lower than the Québec average. This is all the more significant given the important role that academic success plays in successful vocational training. Future training programs will have to take this chain of factors into account.

RESEARCH PRIORITIES

Develop approaches to ensure better access to education, especially at the postsecondary level, and improve academic and educational success. As a priority, research should focus on the following:

- The impact of using Cree and Inuktitut as languages of learning and teaching.
- The effect of bilingual, trilingual, and bicultural school curricula on the success rate of youth.
- Teacher training that helps teachers obtain the best results in various northern contexts.
- Access to postsecondary education (there are currently no postsecondary institutions in northern Québec).
- Distinctive features of aboriginal community education systems that could be used to adapt training approaches for jobs associated with northern development.

Develop new customized training approaches so that education programs not only target the most immediate needs of companies and organizations in northern Québec, but also offer the members of local communities the best opportunities to develop abilities for the long term.

Maintenance of health-friendly environments

Psychosocial health, chronic diseases (particularly cardiovascular disease), and risk behaviors (diet high in saturated fat, smoking, alcohol and drug use, gambling) are major public health issues for northern communities. It should be stressed that these issues affect both aboriginal and non-aboriginal populations. To deal with these challenges, the Plan Nord proposes to improve the availability of and access to healthcare (including telehealth) and social services.

Although these priorities are justified, health is not just a matter of physiological processes that can be "fixed" by better access to care. Health is also the result of a concerted approach by societal actors to influence the social and environmental determinants that help maintain health-friendly environments, including diet, housing, the workplace, and working conditions.

RESEARCH PRIORITIES

Document the effects of increased industrial activity on the mental and social health of individuals and communities, especially youth.

Analyze the socioeconomic conditions of communities that promote or have a negative effect on the health of individuals.

Continue research on the links between a local diet and the health of northern community residents.

Determine the health risks and benefits of a traditional diet and traditional medicine.

Access to communication technologies

Access to communication technology is obviously central to the future of northern Québec communities and businesses. The Internet, in particular, has become a vital tool for social (networking, access to education and remote medical services, etc.) and economic development (communications, transactions, etc.). Despite the poor performance of the Internet network in Nunavik, Facebook clearly played an important role during the recent referendum on the Nunavik regional government.

RESEARCH PRIORITIES

Analyze the effect of access to communications technology on the social, cultural, and economic development of northern communities.

Note: See also Section 2.4.

Housing challenges

The relative improvement in housing conditions since the 1950s has certainly helped improve health in northern communities. However, more than ever, overpopulation and inadequate housing (deterioration, designs unsuited to traditional lifestyles, excessively high rent in some cases) pose risks to the physical and mental health and well-being of individuals, families, and communities. These often lamentable conditions draw attention to the cultural and ontological challenges that come with the profound economic and social changes affecting members of various communities within the course a single generation. These problems, which defy simple causal explanations, are very difficult to solve.

RESEARCH PRIORITIES

Using a transdisciplinary approach, document and interpret the development of the built environment and cultural landscapes to account for the complexity of these changing environments and develop solutions to the housing problems in communities.

Identify how housing design and construction practices and expertise influence the transformation of environments and landscapes as well as individual and collective representations.

Household structure and home economics

Many grey areas still exist in understanding the household structure and contemporary home economics in northern communities as well as their ties to health and housing. In every society, for example, fluctuations in access to resources and the organization of work—viewed in the broad sense as the range of traditional, domestic, or paid tasks—lead to changes in relationships between men and women. This situation can be explained by the complementarity of the tasks performed by each of the sexes. However, strategic research underpinning aboriginal policy development often ignores these gender dynamics (a tendency termed “gender blindness” by some). In the context of northern development, most prospective jobs are likely to be concentrated in fields traditionally reserved for men (mining, construction, engineering). At the same time, it is reasonable to suppose that women will be represented in less specialized and less well-paid fields (housekeeping, food services, tourism-related services, etc.). The Plan Nord will result in many changes in local economies that will most definitely be felt in home economics.

RESEARCH PRIORITIES

Study the effect that northern development will have on gender equality in employment and family organization, notably in the following areas:

- The effects on the family (women, children, grandparents) and home economics, given that most men could be called upon to work outside the community on a regular basis. In this context, study the role of assistance from the extended family, the diversity of parenting models, and couple dynamics.
- The needs and aspirations of women in northern communities as well as their participation in the economic and industrial development of northern Québec, especially young women.
- The core principles of job equality and pay equity policies that could apply to the context of northern communities.

Governance models and social acceptability

The issue of governance is often a determining factor in successful regional development, notably to avoid the "resource curse" that affects many resource-rich countries. Governance includes the ability of local populations to define and implement development objectives, share the benefits, and monitor the situation so as to adapt to unexpected circumstances. These mechanisms, which become important vectors of social acceptability, must convey values of openness, inclusion, adaptive management, transparency, and rigor.

Northern Québec has immense economic, cultural, and symbolic potential and its development has been one of the engines of Québec's economy since the 1950s. While southern Québec has clearly benefitted from northern resources, the benefits for the members of northern communities have been less obvious. Northern residents have criticized their lack of input into the resource development decisions. Their dependence on government transfers has often been cited as an obstacle to their development. However, the situation is changing. Initiatives to decentralize resource management and establish aboriginal and regional governments have multiplied over the past 30 to 40 years. However, these initiatives need support and the transfer of expertise to effectively take shape, develop their own specific approach, and meet the social, cultural, economic, and environmental challenges of local communities.

The growing complexity of management mechanisms and relationships between institutions, northern communities, and their members should also be examined. For example, the James Bay and Northern Québec Agreement (JBNQA), which created a specific administrative regime covering one-third of Québec's land mass, has been amended over 30 times since it was adopted in 1975. Agreements have also been signed with the governments of Nunavut and Canada to manage coastal islands. Other special situations further add to this complexity, for example, that of a Naskapi community that is party to the Northeastern Québec Agreement while its neighboring Innu community is not.

RESEARCH PRIORITIES

Contribute to the development of new approaches concerning the main parameters of governance and the renewal of the relationship between the government and the aboriginal peoples in northern Québec. These issues include a number of aspects, particularly territory and territoriality, aboriginal and treaty rights, and access to justice.

Develop tools to identify and assess the parameters of social acceptability and the dynamics of governance mechanisms in northern communities.

Better understand the interrelations between regional and local governance models emerging in northern Québec as well as regional decentralization experiments.

Analyze the portrait and nature of the institutional arrangements specific to each northern community, taking into account the diversity of governance models.

Propose innovative models for governance capacity building within northern communities.

Exogenous economic development

In most northern aboriginal communities, the economy is heavily dependent on government transfers. It also depends, though to a lesser degree, on benefits—particularly jobs—associated with natural resource development, mainly by companies from outside the region, many of which may only be in the region for a short period of time. This largely exogenous economic development model has an effect on the approaches that local communities wish to adopt to manage their future.

RESEARCH PRIORITIES

Analyze the social and economic consequences of outside resource–dependent (exogenous) development for northern aboriginal communities.

Aboriginal and treaty rights

First Nations and Inuit ancestral and treaty rights are enshrined in the Canadian Constitution. The Taku River and Haida Nation rulings as well as the Mikisew Cree First Nation ruling extended this recognition and its implementation further by clarifying the duty to consult in cases where aboriginal communities will be affected by actions taken on lands to which they hold rights and title. Despite this step forward, the consultation obligation does not provide for all the mechanisms required to ensure concrete action, often because local communities lack the resources needed to analyze and prepare briefs on projects submitted by non-local stakeholders.

RESEARCH PRIORITIES

Analyze the needs and priorities of aboriginal communities regarding the creation of management mechanisms for projects submitted to local authorities for consultation.

Study the effects of development projects in northern Québec on the changing interpretation of aboriginal rights.

Dialogue among northern stakeholders

Dialogue among northern stakeholders should seek a balance between the political and economic clout of southern Québec and the perspectives and priorities of northern populations. The Plan Nord proposes a multi-channel dialogue, but the winning strategies for maintaining such a vision require in-depth examination.

RESEARCH PRIORITIES

Identify the most proven cooperation and pluralist land management models in Québec, the rest of Canada, and elsewhere around the globe.

Profile and evaluate similar initiatives in other aboriginal communities and make recommendations applicable to the northern Québec context.

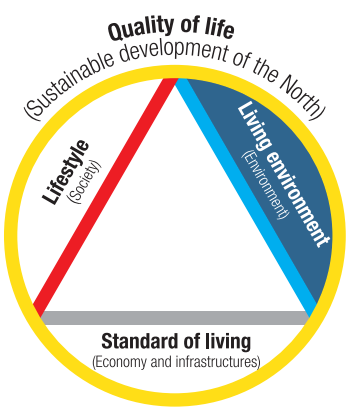
2.2 ENVIRONMENTAL PROTECTION

The development of northern Québec is a formidable endeavor that combines development and conservation goals. It is an opportunity to think differently about development from a green economy standpoint. The green economy—the theme of the Rio+20 Summit held in June 2012—consists of configuring businesses so that their environmental impact is reduced, conservation is an explicit consideration, and financial returns remain. In other words it involves organizing, by means of a concerted approach, the industrial value creation chain so as to reduce energy requirements, minimize the carbon footprint, and maintain profitability while limiting biodiversity loss and protecting water, air, and soil quality. It also involves constantly monitoring the impact of climate change on ecosystems.

Figure 2 presents the main issues associated with environmental protection in northern Québec. Research priorities have been identified for each of these issues.

Figure 2

ENVIRONMENTAL PROTECTION



ISSUES

- **Importance of establishing baselines and understanding the dynamic of change**
- **Identification of protection, adaptation, restoration, and conservation measures**
- **Project environmental assessment**
- **Measurement and mitigation of environmental impacts**
  - > Mining development
  - > Forestry development
  - > Energy development
  - > Wildlife, recreation, and tourism development
  - > Transportation and telecommunications development
- **Reduction of greenhouse gas emissions**
- **Environmental service flow accounting**
- **Analysis of cumulative effects**

Importance of establishing baselines and understanding the dynamic of change

Better knowledge of the reference state of the region and its resources is important for assessing the impact of new activities, their cumulative effects, and the potential for successful restoration work, particularly in mining. Furthermore, ongoing environmental monitoring is essential for understanding the rate of change of these baselines in the dual context of global warming and socioeconomic development.

RESEARCH PRIORITIES

Continue to document the reference state of northern environments and resources. This research should include the following:

- Detailed mapping of environments, subsoil, and surface.
- A status report on water quality.
- In-depth knowledge of the climate and its regulatory role in regional processes (geomorphological processes and ecosystem dynamics).
- Exhaustive characterization of the biodiversity (including endangered and migratory species) and environmental conditions of various northern ecosystems (terrestrial, aquatic, and maritime).
- Determination of the zones of influence of the various development activities planned.

Develop environmental monitoring approaches adapted to the northern context.

Improve dynamic feedback processes for documenting the evolution of northern terrestrial, aquatic, and marine ecosystems.

Identification of protection, adaptation, restoration, and conservation measures

Knowing the reference state of the environment and its resources (water, air, soil, habitats, etc.) is essential for guiding environmental protection measures and identifying restoration targets. For the purpose of identifying adaptation measures, it is also important to determine whether such protection and restoration measures are flexible in the face of environmental changes. Climate change, for example, could force a revaluation of appropriate protection and restoration measures because of new local conditions and their effects on the ecological niches of terrestrial, aquatic, and marine animal and plant species.

In terms of conservation, the Québec government announced in February 2012 its desire to expand its network of protected areas to cover 20% of the Plan Nord territory by 2020. Furthermore, under the Plan, 50% of the territory will be set aside by 2035 for non-industrial purposes and environmental and biodiversity protection. The management approaches for fulfilling this commitment have yet to be determined.

RESEARCH PRIORITIES

Develop and analyze protection, adaptation, and restoration strategies based on ecosystem dynamics, activities in the region, and risks related to environmental changes.

Propose new ecosystem observation and monitoring methods adapted to the northern context.

Identify effective compensation solutions adapted for northern Québec for environmental impacts resulting from development and infrastructure implementation.

Analyze indicators and monitoring methods that help ensure the network of protected areas effectively contributes to maintaining a representative sampling of ecosystems and species in northern Québec.

Examine the use of conservation and development plans established by aboriginal authorities.

Study the specific rules of governance for northern protected lands.

Project environmental assessment

Project environmental assessment is at the heart of governance issues in the North. Over 20 years ago, a special environmental assessment regime was set up for lands covered under the *James Bay and Northern Québec Agreement*. The foundations and benefits of this approach should be evaluated, given that it will be used extensively in new developments planned for northern Québec.

RESEARCH PRIORITIES

Propose preferred approaches to project environmental assessments in northern Québec.

Analyze the ability of communities to take part in environmental assessment processes.

Propose approaches for upgrading technical and professional expertise in northern communities so that they can effectively intervene in such processes.

Measurement and mitigation of environmental impacts

Sustainable management of the North requires the development and implementation of environmental impact assessment and mitigation mechanisms adapted to northern conditions. Maintaining open and collaborative approaches is also essential so that project proponents can "learn from the past" with a view to continuous improvement.

• Mining development

Development of mineral resources in the North will have an impact on the environment, particularly terrestrial and freshwater ecosystems. In addition to the electrical infrastructure required to service mining operations, mineral exploration and mining involves the release of heavy metals, tailings, and wastewater as well as soil compaction, peat extraction, and noise and visual pollution for both animals and humans. In addition to the application of various environmental protection regulations, these impacts can be measured and mitigated through an open and concerted approach.

RESEARCH PRIORITIES

Continue building knowledge about mining project impacts on ecosystems and their components. As a priority, research work should concentrate on the following:

- Changes in mine site physical chemistry, hydrology (groundwater flow dynamics and contamination), and hydrogeology.
- Dispersion of contaminants into the water and air.
- Biodiversity, particularly effects on community structures and functioning, genetic diversity, and biotic aspects.
- Toxicity and bioaccumulation in animal and plant species and the effects on species physiology (adaptation and tolerance).

Other fields of knowledge are also considered important, including effects on sedimentation, displacement, population dynamics and migration, habitat loss (e.g., peat bogs), microbial hydrology, and the visual changes in the landscape (e.g., open pit mines).

• Forestry development

The remarkable biodiversity of the boreal forest is unique yet fragile. The forest acts as a natural filter that helps purify the large bodies of water in the North. Forestry development impacts the environment, particularly terrestrial and freshwater ecosystems. In addition to the roads required to access and transport timber, forest management involves activities that can affect the environment, including the harvest of timber and nontimber resources, bridge construction, use of heavy machinery, soil scarification, and restoration of forest barrens. It is important to note that various environmental protection and forestry industry regulations already regulate forest management practices in the region.

RESEARCH PRIORITIES

Continue building knowledge about the impact of forestry management operations on ecosystems and their components. As a priority, research work should concentrate on the following:

- Changes to the physical chemistry of aquatic ecosystems.
- Effects on wildlife movement, migration, population dynamics, and habitats.
- Impact on biodiversity, particularly community structures and functioning, genetic diversity, and species diversity.
- Regeneration of northern areas and the impact on the carbon balance.
- Other fields of knowledge are also considered important, including effects on soil hydrology, erosion, sedimentation, and compaction, thermal regime changes, the strength and direction of winds near the ground, disturbance regimes, problems associated with defoliating insects and tree diseases, the visual aspects associated with changes in the landscape, and the impact of wildlife habitat maintenance on the allowable cut.

• Energy development

Although hydroelectricity and wind energy use renewable resources and are among the least polluting forms of energy, their development nevertheless affects the environment, particularly terrestrial, marine, and freshwater ecosystems. In addition to the transportation infrastructure required to carry electricity, the construction of hydroelectric plants involves river diversion, the construction of dams and retention basins, reservoir impoundment, and flooding—all activities that inevitably lead to changes in natural water levels and flow. Wind park construction also involves some smaller, local disturbances.

RESEARCH PRIORITIES

Continue building knowledge about the effects of hydroelectric projects on ecosystems and their components. As a priority, research work should concentrate on the following:

- Changes to the physical chemistry of ecosystems, hydrology, and hydrogeology.
- Wildlife movement, migration, population dynamics, and habitat loss.
- Biodiversity, particularly the effects on community structures and functioning, genetic diversity, and species diversity.
- Other fields of knowledge are also considered important, including effects on microbial hydrology, bioaccumulation, the landscape, the use of waterways by humans, and carbon storage.

Better understand the environmental impacts associated with the development of wind energy potential in northern Québec. As a priority, research work should concentrate on the following:

- Bat and bird movement, migration, and population dynamics.
- Other research is required, particularly on soil disturbances, summit occupation, atmospheric dispersion and ambient contamination, habitat loss, and noise disturbances.

• Wildlife, recreation, and tourism development

In addition to the construction of access roads to the region, the development of wildlife resources, recreation and tourism involves wildlife observation and harvesting, use of watercraft and recreational vehicles, terrestrial and aquatic habitat management, potential seeding of aquatic habitats, likely introduction of non-native species to local ecosystems, the construction of outfitter camps and cottages, the erection of sometimes illegal facilities (hunting or fishing camps, etc.), garbage dumping, and the trampling and picking of plants. Although the increased access that accompanies development can be beneficial in some ways, development of wildlife resources, recreation, and tourism will definitely impact the environment, particularly terrestrial, freshwater, and marine ecosystems.

RESEARCH PRIORITIES

Continue building knowledge about the effects of hunting, fishing, and other recreation and tourism activities on ecosystems and their components. As a priority, research work should concentrate on the following:

- Impact of human disturbances (boats, cars, etc.) on ecosystems, including animal species.
- Impact of harvesting on population dynamics.
- Potential propagation of invasive species and diseases.
- Determination of harvest potential based on demographic and genetic studies.
- Impact on subsistence hunting and fishing for aboriginal communities.
- Other fields of knowledge are also considered important, including the quality of the visitor experience, effects on soil erosion, sedimentation, and compaction, disturbance regimes, the likely increase of fires caused by humans, and biodiversity.

• Transportation and communications development

Development of new transportation and communication infrastructures will have an impact on the environment, particularly terrestrial, freshwater, and marine ecosystems. Effects associated with land infrastructures include the use of salt and sand, soil compaction, human and vehicular traffic, and a higher risk of pollution. With regard to maritime infrastructures, construction and operation of such facilities may involve the use of heavy machinery and construction materials, increased maritime traffic, and more pollution.

RESEARCH PRIORITIES

For land infrastructures, study environmental impacts and develop mitigation approaches, with a priority on the following:

- Hydrological changes, e.g., water tables and surface water.
- Impacts on terrestrial and aquatic habitats, particularly fragmentation, edge effects, species displacement, and the creation of new habitats.
- Ecological corridor planning.
- Propagation of invasive species and wildlife and plant diseases.
- Impacts of contaminants (oil, salt, etc.) on ecosystems.
- It is also important to develop knowledge and solutions associated with impacts on the permafrost, including changes in the thermal regime, freeze-thaw effects, road maintenance and contaminants, the transportation of waterborne sediments, restoration of degraded sites, changes in species ranges, increased intraspecies interaction, maintenance of population dynamics and genetic integrity, impacts on subsistence hunting and fishing, and noise pollution.

- Transportation and communications development (cont.)

RESEARCH PRIORITIES

For maritime infrastructures, study environmental impacts and develop mitigation approaches, with a priority on the following:

- Bathymetry, ocean currents, and the transport of sediments.
- Characterization of the coastal ecosystem (map of aquatic habitats) and the impact of the construction of deep water ports (study on the resilience of Arctic marine ecosystems).
- Pollution caused by ship traffic.
- Ballast water discharge with potential arrival of contaminants and invasive species on coastlines.
- It is also important to develop knowledge and solutions associated with sea ice dynamics, the impact of noise pollution on animal species and humans, and the impact on fishing activities.

Reduction of greenhouse gas emissions

Northern development is an opportunity to plan various activities with a view to reducing greenhouse gas emissions. Whether it is a matter of northern infrastructure design, specific activities associated with industrial and commercial development, or life in local communities, all avenues should be explored to reduce Québec's carbon footprint.

RESEARCH PRIORITIES

Develop practices aimed at minimizing greenhouse gas emissions, taking into account the realities of the North.

Environmental service flow accounting

The environmental aspect of sustainable development recalls the importance of calculating the flow of environmental services derived from the natural capital of the North. Determining the economic value of the environmental services that maintain and improve human well-being will improve regional planning processes. Environmental services include things like the water cycle, carbon sequestration, pollutant filtering, and pollination, all of which are functions vital to life, but whose existence is not explicitly acknowledged by the market. Although there is a conceptual apparatus for recognizing, measuring, and capturing these values, its robustness in concrete situations specific to northern development has yet to be assessed.

RESEARCH PRIORITIES

Improve and adapt environmental flow service accounting mechanisms in the specific context of Northern Québec.

Analysis of cumulative effects

In addition to assessing the potential impact of specific activities on the environment, it is also important to be able to measure the cumulative effects of anthropogenic activities on cold region ecosystems, including habitat loss and its consequences on animal and plant species.

RESEARCH PRIORITIES

Analyze current approaches to assessing cumulative effects on the environment and resources and adapt new ones adapted to the northern Québec context

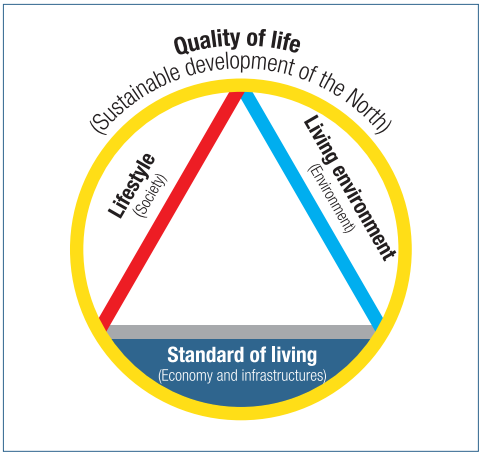
2.3 DEVELOPMENT OF ECONOMIC POTENTIAL

Although specific discussion of economic development in sectors such as mining, energy, forests, wildlife, recreational tourism, and biofood is essential in the context of Plan Nord implementation, this brief deals first with broader considerations that affect all economic contribution processes associated with the North, its resources, and its occupants.

Figure 3 presents the main issues associated with the development of the North's economic potential. Research priorities were identified for each of these issues.

Figure 3

DEVELOPMENT OF ECONOMIC POTENTIAL



ISSUES

- **Multifunctional land use**
- **Application of an adapted, collaborative approach to wealth creation**
- **Economic efficiency and economic rent**
- **Intergenerational equity**
- **Attraction, recruitment, and retention of a skilled workforce**
- **Mining development**
  - > Geological and geotechnical knowledge
  - > Project design and technological challenges
  - > Infrastructure synergy
  - > Mine lifespan
- **Energy development**
  - > Cost internalization and sharing
  - > Reduced energy consumption
- **Forestry development**
  - > Knowledge of forest resources
  - > Reforestation of forest barrens
  - > Forestry industry competitiveness and profitability
  - > Green economy
- **Development of wildlife resources and recreational tourism**
  - > Knowledge of wildlife habitats and populations
  - > Development of distinctive signature ecotourism products
  - > Social impact
- **Biofood development**
  - > Local food production
  - > Development of aboriginal knowledge

Multifunctional land use

In a context where the Plan Nord is meant as a model for sustainable development, northern Québec must be viewed as much more than just a source of resources. A multifunctional approach allows for planning and management processes that acknowledge the diversity of the region and its complexity as a living space, production space, and natural environment. It also allows the various functions of the region and their multiple interactions to be considered. By breaking with a sector-based approach, the multifunctional approach fosters better integration of market and non-market functions, a coexistence of uses based on local consensus, and more effective management of externalities at an appropriate level. Lastly it requires balanced participation by all regional stakeholders. In the context of northern development, it is important to master the concepts that underpin this approach, both with respect to the activities that will be implemented in the North in the coming years and the footprint and legacy they leave for future generations.

RESEARCH PRIORITIES

In a context of multifunctional land use:

- Study the benefits of better coordination between mining, forestry, environmental, and energy policies in the North.
- Study possible synergies between the various aspects of northern development in accordance with the needs of local communities and all Quebecers.

Identify internalization and cost-sharing rules for multiple land uses in the North.

Develop monitoring frameworks so that practices can be adapted to multifunctional approaches in the North.

Application of an adapted, collaborative approach to wealth creation

The development of the North provides an opportunity to build new wealth creation models through natural resource development, particularly from a knowledge economy perspective. It encourages us to rethink the cluster concept around a network of economic stakeholders and imagine a wealth creation strategy based on the collaboration of local, regional, and international actors. This strategic approach must, for example, take into account the central role that contracting organizations play through tendering processes and contract allocation rules in distributing wealth and developing infrastructure, skills, and sustainable capacities for local businesses and communities. Furthermore, the economic and social impact of the Plan Nord in Québec will largely depend on the ability of communities to identify development projects in keeping with local potential, develop strategic plans, coordinate efforts with research institutes, and take an equity share in the companies involved. To date, large communities have organized their development systems around diagonal networks and, to build on this legacy, it will be important to have a clear understanding of its levers.

Given the scope of many of the projects planned in the region—particularly transportation infrastructure (roads, energy links, telecommunications, etc.)—it will also be necessary to propose new private funding options (Québec and foreign capital markets), analyze selected approaches, and identify lessons relevant to sustainable northern development.

RESEARCH PRIORITIES

Study northern value chains (strengths and weaknesses) and propose mechanisms that promote the development of sustainable capacities, particularly in local communities.

Propose new cluster models derived from Québec's natural, physical, financial, social, and cultural capital to develop the North.

Study the social capital of northern communities and the strategies that can help make these communities more conducive to entrepreneurship, innovation, and skill development.

Study the various private funding models (Québec and foreign capital markets) for major northern development projects, including benefits, pitfalls, and risk sharing.

Economic efficiency and economic rent

Rapid development of the North requires an efficient value chain system. Projects developed in the North should therefore be submitted to a cost-benefit analysis that takes into account multifunctional land use. This kind of analysis serves to identify the economic players involved and quantify all costs and benefits, including those associated with non-monetary values such as the environment, quality of life, health, and community vitality, so as to validate true price accuracy.

Given the government's desire to implement the Plan Nord in a context of sustainable development, it is also vital to understand how new projects in northern Québec will generate positive economic rents. In general, economic rent represents the difference between the value of a resource and the cost of extracting it. This analysis could include a study of government royalty mechanisms.

RESEARCH PRIORITIES

Propose cost-benefit analysis methodologies adapted to the realities of northern Québec, notably by including externalities in decision-making processes.

Examine how economic efficiency and economic rents associated with northern projects would be affected by renunciation (i.e., redirection of public funds for other purposes).

Propose new rent calculation models that take into account all benefits, including those associated with environmental and social services.

Interpret performance using an integrated assessment model that encompasses both monetary and non-monetary values generated by development projects.

Analyze various methodologies that would allow businesses to report on how they fulfill their corporate responsibilities regarding sustainable northern development.

Assess government royalty mechanisms and analyze their synergy effects in terms of efficiency and equity. Examine the issues of tax redistribution and redistribution to northern communities.

Develop benchmarking strategies and accurate and methodical data interpretation to compare economic parameters governing northern development, wealth sharing, and social acceptability with those in other regions of the world.

Intergenerational equity

Implementation of the Plan Nord involves mobilizing private and public funds to put in place new social (including the workforce) and physical (infrastructure) capital required to develop the North's natural and cultural capital. This new influx of capital and the economic rents collected from development projects raise the issue of intergenerational equity. To the extent that new physical capital has a limited lifespan (e.g., mines) or may not be used elsewhere, this equity analysis must above all take into account the development of social capital and its ability to generate more wealth in the future.

RESEARCH PRIORITIES

Study a set of basic principles, indicators, and mechanisms that, through analysis of natural, physical, and social capital, would help ensure intergenerational equity in connection with projects associated with northern development.

Attraction, recruitment, and retention of a skilled workforce

It is increasingly evident that development of the North will pose serious human resource challenges. For example, the labor shortage already affecting the mining industry will likely be exacerbated by new projects in the region. Repercussions are already being felt in other economic sectors throughout Québec.

Developing a specialized workforce in local communities is among the solutions. The green economy approach dovetails particularly well with the identity-building efforts of the aboriginal peoples who inhabit the North and intend to continue to do so in a contemporary manner marked by disciplined economic progress. Certain types of training should also be reviewed to ensure that more professionals and technicians in Québec have the skills applicable to the realities of the North.

RESEARCH PRIORITIES

Develop a better understanding of the factors affecting workforce attraction, recruitment, and retention in the special context of northern Québec.

Mining development

The northern development model proposed by the Québec government will be largely based on mineral resource development. Northern Québec already numbers five operating mines. More than ten new mines are planned in Nunavik and nearly as many on Cree territory (Eeyou Istchee) and in the Côte-Nord region. To ensure responsible development of these resources, it is particularly important to enhance our knowledge of the mines already in operation and learn from circumpolar experiences in this field with a view to optimizing benefits and minimizing negative impacts. The technological challenges remain considerable, both in terms of mine operations and environmental protection. And since mining is by definition based on non-renewable resources, it is also necessary to think about how to convert mining development into sustainable development for communities.

• Geological and geotechnical knowledge

As indicated in the Plan Nord, the mineral resource potential of northern Québec is far from being fully documented. In fact, only 40% of the mineral potential has been identified. Furthermore, the geotechnical properties of the rock masses at potential mining sites remain little known. A better understanding of the geomechanical and hydrogeological behavior of rock masses in northern environments is also essential to maximizing the economic potential of these deposits and minimizing the risk of premature closure.

RESEARCH PRIORITIES

Increase knowledge on the mining potential of northern Québec.

Further knowledge of the geomechanical and hydrogeological behavior of rock masses in northern environments, particularly around mining excavations or between permafrost zones.

• Project design and technological challenges

In the context of the Plan Nord, mining projects must be designed in keeping with sustainable development principles. Mineral resource development in northern Québec poses numerous technological challenges, particularly due to the extreme climate conditions, fragile natural environments, and permafrost.

Northern development also offers an opportunity to position Québec as a world leader in geology and northern mining engineering. This niche remains underdeveloped, and training of professionals in these fields would provide a definite comparative advantage.

RESEARCH PRIORITIES

Develop mining design approaches that integrate sustainable development concepts and are adapted to northern realities.

Develop and adapt mining expertise and technology for extreme climate conditions and permafrost and subpermafrost environments.

Assess mining project energy requirements and develop approaches that help reduce energy consumption and the carbon footprint of such projects.

Establish guides to good practice and indicators for responsible mining.

Develop specific training approaches to increase the level of northern expertise among professionals (engineers, biologists, etc.) responsible for designing and implementing mining projects and conducting related environmental studies.

• Infrastructure synergy

New mining projects in the North will require more new infrastructure than any other industry, notably in the form of roads, railways, energy production and distribution infrastructure, etc. Efficiencies from these projects will largely depend on the synergy that will be implemented.

RESEARCH PRIORITIES

Study the potential synergy between various mining projects in order to optimize transportation and energy infrastructure for industrial projects and communities.

Analyze the best approaches for integrating and optimizing mining infrastructure (mines, plants, etc.) in association with service infrastructure.

• Mine lifespan

In view of the fact that mining projects have a relatively short lifespan, it is essential to set up models that integrate post-mining development in local communities.

Ensuring adequate restoration of sites once mining has been suspended or completed is also crucial. Restoration may take a number of forms based on the type of mine and on regulatory and non-regulatory environmental requirements.

RESEARCH PRIORITIES

Develop post-mining economic development approaches for the region, paying particular attention to the needs of local communities.

Develop knowledge on the environmental restoration of mine sites.

Energy development

The Québec government is continuing to develop the energy potential of northern Québec by focusing on clean, renewable energy. The lion's share of the 4500 MW announced in Québec's 2006–2015 Energy Strategy will be produced in the North. An additional 3500 MW is planned under the Plan Nord through construction of hydro-electric plants (3000 MW), wind farms (300 MW), and other sources of renewable energy (not identified, 200 MW). Policy and the commitment to sustainable solutions are at the very heart of the challenge that northern development poses. Given that Québec energy development has so far been guided primarily by the anticipated needs of communities and businesses located further south, changes to this approach should be considered that might better integrate the reality, energy security, and development of northern communities.

• Cost internalization and sharing

Development of the North and its communities runs the risk of being two tiered, with priority going to major industrial sites whose energy needs require fast solutions and high energy capacities, while local communities see development happen more slowly using specific solutions adapted to each. Given these two realities, it is vital to develop a specific vision for the North in order to propose one or more strategies allowing for the creation of a "northern green energy road." Furthermore the carbon economy offers the government new opportunities to increase its ability to fund and develop new energy sources, including in the North.

RESEARCH PRIORITIES

Evaluate, on a regional level, the implementation of energy solutions based on available resources (water, wind, biomass, etc.), the maturity of technologies and their ability to function in a northern environment, and development goals and characteristics.

Document the fair cost of energy solutions for large projects and communities by internalizing the social and environmental costs.

Establish appropriate funding models for the various issues and types of development.

Propose cost- and risk-sharing models for energy production and distribution to major energy consumers, notably by studying European models promoting the use of green energy and greenhouse gas reduction.

Study the carbon economy and understand its impact on rent, industry competitiveness, and greenhouse gas reduction.

Propose financial mechanisms to accelerate the deployment of green energy in the North, particularly through the use of specific carbon credits.

• Reduced energy consumption

Energy solutions for the North must be accompanied by a comprehensive analysis of the most suitable building infrastructure, building methods, and transportation systems. Choices made with regard to construction and modes of transportation could significantly reduce energy consumption for major industrial projects.

RESEARCH PRIORITIES

Analyze various northern construction options that might reduce energy consumption and measure the financial, environmental, and social contributions associated with each.

Analyze the implementation of transportation solutions by considering combined use (people and merchandise) and user/client groupings to reduce transportation energy needs.

Forestry development

Under the Plan Nord and the new forestry regime coming into force in 2013, the Québec government wishes to develop boreal forests, notably by means of a sustainable forest management strategy adapted to the environmental characteristics of the North. It should be noted that the timber harvested in the area covered by the Plan Nord represents 53% of Québec's total annual harvest. Over 30 wood processing plants are currently supplied by northern forests, over one-third of which are located north of the 49th parallel.

• Knowledge of forest resources

Implementation of ecosystem management requires more historical research on pre-industrial conditions in northern forests. This knowledge helps to develop forest management strategies that minimize gaps with nature. It is also important to better understand forest inventories and carbon stocks as well as their development over time. Furthermore, better knowledge of the properties of timber from northern forests will aid in designing better industrial strategies for creating added value.

RESEARCH PRIORITIES

Enhance knowledge of pre-industrial conditions in northern forests through the use of methods such as palynology and dendochronology.

Promote the use of technology such as laser telemetry (airborne lidar) coupled with satellite imagery to more effectively measure timber inventories and carbon stocks in the region.

Study ways in which the management of forest landscape units could help reduce greenhouse gas emissions.

Compare the chemical, physical, mechanical, and anatomical properties of northern wood species from natural and managed sites. Predict these properties based on stands, stems, or sawlogs in order to develop high value-added processing strategies.

• Reforestation of forest barrens

The Plan Nord calls for reforestation activities in certain forest barrens in the northern commercial forest zone. It is important to document the economic and environmental logic underpinning these silvicultural investments. For example, the role barrens play in providing specific wildlife habitats should be known and the impact of possible reforestation activities on habitats and species should be assessed.

RESEARCH PRIORITIES

Analyze the impact and benefits associated with the reforestation of forest barrens in northern Québec.

• Forestry industry competitiveness and profitability

Ongoing development of a viable forest industry requires knowledge of the economic potential of such development in the North. Certain questions arise regarding viability, particularly in terms of transportation logistics and business network integration between northern and southern Québec. We need to examine the new forestry regime's capacity to create the economic conditions operators need to be competitive and profitable, along with the limits of these conditions.

RESEARCH PRIORITIES

Continue developing value-added products based on the knowledge of the properties of wood from northern forests.

Acquire further knowledge on the logistical and business networks required to keep the forestry industry competitive in the specific context of northern Québec.

Document best practices in business partnerships between aboriginal and non-aboriginal businesses in the development of the northern forestry industry.

Study the provisions of the new Québec forestry regime with a view to fostering the emergence of integrated suppliers of forest products that can guarantee supply to plants at a competitive cost and promote the production of high quality products.

• Green economy

The forestry industry is increasingly being viewed as a key vector of the green economy. To validate this assertion, it is important to conduct a carbon assessment of the northern forestry value chain. The role of forest biomass–based bioenergy production should also be validated in this assessment. In addition, more effort should go into developing new green products that can contribute to the competitiveness and sustainable nature of the northern forestry industry (eco-responsible wood-based buildings and construction systems, biorefinery products, extractable products, etc.).

RESEARCH PRIORITIES

Conduct a carbon and environmental assessment of the northern forestry sector using forest carbon inventories and a lifecycle analysis of carbon processes and products.

Develop eco-responsible wood building concepts that are energy efficient, have a small environmental footprint, and are highly adapted to the needs of northern communities. Accelerate the transfer of these technologies.

Examine various aspects associated with bioenergy:

– Evaluate how sustainable it is for northern businesses to integrate bioenergy production into timber harvesting and processing operations.

– Analyze the effects of forestry biomass harvesting on the integrity of forest soils.

– Study the contribution of bioenergy production to the profitability of the entire northern forestry industry.

Evaluate the potential and constraints of developing green chemistry (biorefining) associated with northern forestry industries.

Measure the potential and the constraints of developing extractables derived from northern tree species.

Development of wildlife resources and recreational tourism

Under the Plan Nord, the Québec government wishes to ensure responsible and sustainable development of wildlife resources and recreational tourism. There are already 186 outfitters, 12 controlled harvest zones (ZECs), and 4 wildlife reserves in the North. In addition, adventure excursions and non-consumptive wildlife activities such as ecotourism have grown rapidly in recent years. With its spectacular landscapes and characteristic wildlife, northern Québec offers enormous potential for developing such activities.

• Knowledge of wildlife habitats and populations

To develop and diversify wildlife-related services and activities adapted to the northern context, the Plan Nord acknowledges the importance of investing in knowledge acquisition. Such knowledge is essential to ensuring the sustainability of wildlife resources living in environments known to be fragile. It is also essential to have a better understanding of aboriginal consumption of terrestrial, aquatic, and marine wildlife and determine measures to maintain this harvest capacity, which is the basis of aboriginal culture and quality of life in the North.

RESEARCH PRIORITIES

Pursue specific research on various species and natural environments to better understand their evolution, needs, and contribution to ecosystems, particularly in a context of climate change.

Develop approaches to integrating aboriginal knowledge with a view to improving knowledge of key wildlife species, identifying potential, and developing enhancement infrastructure.

Study the population dynamics and habitat productivity of key wildlife species likely to be harvested in greater numbers: fish (Arctic char, lake trout, brook trout, Atlantic salmon), mammals (moose, caribou, bear, fur-bearing animals), and others.

Identify the desirable characteristics of sites with strong wildlife observation and recreation potential.

Identify possible invasive species and diseases that could be associated with northern development and perform a risk assessment.

• Development of signature ecotourism products

The development potential for ecotourism in northern Québec is enormous. Many sites boast major scenic appeal. Aboriginal communities possess a wealth of ancestral and traditional knowledge offering great potential for the development of recreational tourism products of interest to local and international clienteles. To support the development of ecotourism, which is of interest economically, socially, and culturally, requirements for transportation and logistical links between northern and southern Québec must be assessed. Most airlines, for example, are owned by northern communities, and it is important to know how increased development can be integrated and contribute to the viability of existing operations.

RESEARCH PRIORITIES

Support research in aboriginal entrepreneurship to evaluate organizational approaches that allow northern communities to take charge of ecotourism development.

Improve approaches for marketing potential signature ecotourism products and northern cultural heritage. Doing so involves gaining a better understanding of target clienteles and their geographical origin and socioeconomic stratification in order to develop appropriate tourism infrastructure.

Characterize logistics and transportation constraints so that distinctive tourism products can be offered at competitive terms and prices.

• Social impact

The social impact of recreational tourism development in and by northern communities must also be assessed. It is necessary to ensure that this industry provides a means of maintaining and modernizing the lifestyle of northern communities on their own terms. The economic viability and social impact of recreational tourism development must be assessed for its endogenous development potential and as a tool for fighting unemployment and marginalization. Its impact on the modernization and preservation of the traditional lifestyle of northern communities should also be examined.

RESEARCH PRIORITIES

Better understand the impact of recreational tourism development on northern communities. For example:

– Compare endogenous tourism development by aboriginal businesses to exogenous tourism development by southern Québec businesses.

– Measure the effect of this development on the maintenance of traditional activities and lifestyles in northern communities.

Biofood development

To date, a number of promising biofood development avenues have been identified for northern Québec, including fish-farming, certain forms of livestock production, use of native plants for ornamental, nutraceutical, or restaurant purposes, and greenhouse production of berries and vegetables. Priorities should first focus on promoting good nutrition among residents, improving the quality of life in communities, and developing certain species for specific purposes.

• Local food production

A number of experts believe that local production of certain fruits and vegetables in kitchen gardens in the summer or under greenhouse conditions in the off-season could improve the nutritional habits and quality of life of northern residents. New fish farming techniques are another form of controlled environment production that can provide additional sources of quality protein. Such production is also more closely linked to the dietary habits of aboriginal peoples. The addition of fresh, local, quality products would also enhance regional tourist products.

RESEARCH PRIORITIES

Develop plant crops adapted to the needs of northern communities.

Improve approaches to fish farming in a controlled environment so that they are better adapted to northern conditions.

Contribute to habitat enhancement work to maintain Arctic char populations.

• Development of aboriginal knowledge

Over time, aboriginal peoples have identified many plant species of medicinal or nutraceutical interest. The study and development of such plants could lead to local applications for natural health products and commercial development for exportation. The promotion of native plant species could also lead to applications in ornamental horticulture, the revegetation of infrastructure areas, and the restoration of mining or industrial sites.

RESEARCH PRIORITIES

Acquire new knowledge about the nutraceutical development of native plant species, particularly berries.

Identify strategies for intergenerational transmission of aboriginal knowledge about food and traditional medicine to maintain and develop expertise in this field.

2.4 ACCESS TO THE NORTH: TRANSPORTATION AND TELECOMMUNICATIONS

Access by means of transportation and telecommunications is doubtless one of the biggest challenges surrounding the development of Québec's North. Needless to say, accessibility must respect the environment and the cultures of the people who live there. Planning will have to take the following elements into account:

– Physical and ecological constraints for the construction, maintenance, and impact mitigation of all urban, industrial, and tourism infrastructure required for both transportation and telecommunications.

– Geography, i.e., the distribution of communities and current, emerging, and future industrial infrastructure, particularly in relation to natural resource potential, the protected area network, and the need for connectivity between ecosystems.

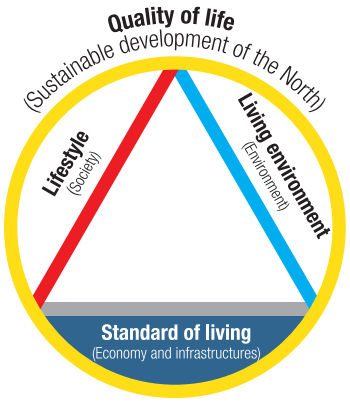
– The need to reduce infrastructure investment costs and exploit infrastructure to its full potential for the good of companies and society as a whole.

In an area as vast and varied as the North, installation and construction of network infrastructure, especially for transportation and telecommunications projects, will require careful planning to ensure these three key elements are taken into account. Network infrastructure in the region will allow for the free movement of extracted materials, consumer goods, knowledge, and information. Installation and construction aside, the ability of this infrastructure to provide efficient interconnections and sufficient capacity to meet the growing needs of the economy and the public is a matter of logistical planning and assessment of public services to be provided. All experts, including those from the Québec government, the Cree nation, and the Kativik Regional Government, believe it would be inefficient and costly to continue developing transportation and telecommunications infrastructure in northern Québec without first having a clear and concerted long term vision.

Figure 4 shows the main access issues for northern Québec, especially for transportation and telecommunications. Research priorities have been identified for each issue.

Figure 4

ACCESS TO THE NORTH: TRANSPORTATION AND TELECOMMUNICATIONS



ISSUES

– Basic environment knowledge
– Sustainable infrastructure construction
– Integration and logistical challenges
– Unconnected infrastructures
– Telecommunications infrastructure performance
– Telecommunications infrastructure coordination and sharing
– Access to telecommunications services
– Smart systems installation
– Data center installation

Basic environment knowledge

Until now, plans for transportation infrastructure such as roads, railways, and power and communication lines have been based on geotechnical studies that, although professional, were not necessarily supported by in-depth knowledge of basic environments. By basic environment, we mean the substrate (rock, soil, sea floor, lakes, shorelines, forest, and tundra) and the environment (atmosphere and climate). A telling example is the network of Nunavik community airports built on permafrost from 1984 to 1992, before the latest scientific findings on global warming became available. To produce a climate change adaptation plan for these airports after the fact, surveys and analyses that were neglected at the time have since had to be carried out since it was presumed that "surface engineering"—i.e., a construction method that did not take the properties of the permafrost into account—would be sufficient to ensure infrastructure stability. It is vital that professionals and industries use the very latest methods to characterize permafrost and tailor projects to suit the northern environment.

RESEARCH PRIORITIES

Increase knowledge of surface deposits in northern Québec, including their distribution, nature, geotechnical properties, depth (peat bogs, for example), and the volumes that can be exploited in an environmentally sustainable manner, starting with the most likely transportation and communications corridors.

Document thermal conditions and the hydrologic and surface regimes in the discontinuous permafrost zone where temperatures are not as cold.

Increase knowledge of the bathometry, sedimentary regime, and natural ecology of bays, fjords, and estuaries likely to house marine infrastructure.

Study the characteristics of the marine storm regime and the dynamics of coastal ice that could influence maritime transportation.

Study hertzian propagation north of the 49th parallel, taking climate change into account.

Analyze the potential impact of electromagnetic storms in northern Québec.

Study the geotechnical properties of glacial, maritime, and shoreline deposits in the sublittoral and intertidal zone to shed light on the possibility, for example, of running cables and fiber optics from the sea floor to land.

Sustainable infrastructure construction

The development of northern Québec will be challenging in terms of new transportation and communications infrastructure, and it will be essential to ensure infrastructure design is as sustainable as possible. Experts note a consistent lack of preparation when building infrastructure. There is also room for improvement when it comes to gauging its long term resistance and future maintenance requirements. The ability to plan ahead depends on having proper knowledge of basic environments and climate influences from the project planning stage. Given the speed with which new infrastructure could be built under the Plan Nord, there is also a need to reexamine the consultation and decision-making mechanisms at the project planning stage.

RESEARCH PRIORITIES

Develop innovative approaches so that people building infrastructure on permafrost will be able to assess its geotechnical and thermal properties. Evaluate the cost of these new approaches in relation to subsequent maintenance and repair costs, with a view to sustainability.

Pursue climate and geomorphological research, not only to acquire basic knowledge (temperature, precipitation, etc.), but to be able to evaluate the risks posed by extreme events (destructive floods, avalanches, landslides, etc.).

Integration and logistical challenges

Accessing northern Québec's resources and communities will require installing a significant amount of infrastructure, including roads, culverts, bridges, borrow pits, pipelines, rail lines, landing strips, ports, and power and telecommunications lines. Work on these is already under way in many locales. But in actuality, there is still no overall plan and requirements have yet to be fully identified, meaning that possible synergies have not been completely explored and channels for cooperation between the various stakeholders are not yet clearly defined.

Ideally, areas with development potential should be identified before any investments are made in major land, marine, energy, telecommunications, or other infrastructure. It is also essential to step up research into the design and implementation of logistics for development activities, especially industrial ones, in order to maximize effectiveness and optimize the spinoffs that come with massive investment in multiservice infrastructure.

RESEARCH PRIORITIES

Develop new models for designing and installing transportation and telecommunications logistics. Research priorities should focus on:

- Designing new approaches to the organization, management, and virtual modeling of manufacturing, technology, and logistics organizations, networks, and processes in northern Québec.
- Using a "physical Internet" model to rethink how transportation, telecommunications, and logistics are handled in the North. It might include creation of one website devoted to mobility logistics, distribution, and procurement, and another dedicated to northern services such as health, education, culture, transportation, etc.
- Developing new models for the integration of industrial products and the various human communities already established in the region.
- Assessing the costs and risks of diversifying the North's energy portfolio.

Unconnected infrastructure

North of the 55th parallel, land-based access infrastructure, power grids, and fiber optic networks are currently few and far between. Web communication in this part of the region is handled primarily via satellite, which means that capacity is inherently limited. Moreover, since electricity is produced using diesel generators, costs are volatile and sky-high.

Without making assumptions about the pros and cons of bringing infrastructure to isolated communities, we note simply that without it, economic development and the ability to innovate are slowed in many respects, impacting residents' safety and quality of life. The technical and integration challenges surrounding these issues are all the greater given that deployment of new infrastructure for northern development will require different timelines depending on the community and its needs.

RESEARCH PRIORITIES

Study various approaches tailored to northern conditions so as to best meet the needs of communities and industries that currently lack infrastructure. Research priorities should focus on:

- Developing affordable sources of renewable energy (wind, solar, fuel, biomass, osmotic and tidal power), especially in light of climate change.
- Designing integrated systems capable of storing and distributing energy and electricity from multiple sources.
- Recovering industrial waste heat.
- Improving telecommunications over the Internet.
- Developing solutions for a potential transition to land-based or undersea power and communications links.

Telecommunications infrastructure performance

Although wireless communications are available in various forms in northern Québec, performance standards lag far behind those enjoyed by residents and businesses in southern Québec. The lack of modern telecommunications not only has an obvious effect on northern communities' quality of life, it can also be a major deterrent to economic development and innovation.

Access to modern telecommunications is also a critical to the health and physical safety of those living and working in the North. Moreover, such infrastructure is key to implementing systems that perform remote monitoring of environmental changes or infrastructure development, especially against the backdrop of climate change.

RESEARCH PRIORITIES

In view of the current region-wide lack of fiber optics, explore multiple wireless communications solutions, including microwave, high-speed geosynchronous satellite, tethered balloons, low earth-orbiting satellites, and more. Research priorities should focus on:

- Identifying solutions to meet the needs of small communities whose isolation is a major economic obstacle to fiber optic installation .
- Analyzing options for deploying fiber optic telecommunications networks in northern settings (for example, laying fiber when building land-based infrastructure such as roadways, rail lines, pipelines, power lines), as well as business models for these options, to see how they might be tailored to northern community economies and governance models.

Study the physical constraints for installing fiber optic networks underwater (depth, tide level fluctuations, presence of surface ice, etc.) or on land (effects on wildlife; running cable over long, uninhabited distances; cold temperatures).

Telecommunications infrastructure coordination and sharing

The deployment of new northern infrastructure (roads, rail lines, pipelines, power lines, etc.) must be carried out with an eye to modern telecommunications needs. It would be particularly helpful to take advantage of the scientific, technical, and operational expertise that Hydro-Québec has gained through its infrastructure projects for installing and managing large, high-tech telecom systems throughout northern Québec.

RESEARCH PRIORITIES

Study the issues, constraints, and opportunities involved in sharing fiber optic infrastructure between the private and public sectors for the purpose of reducing costs, improving regional coverage, and providing more timely access to communities and businesses.

Study new business and governance models that might facilitate more timely deployment of shared telecom infrastructure throughout northern Québec.

Access to telecommunications services (distance learning, telemedecine, virtual collaboration, etc.)

To provide northern communities and businesses with access to the services and expertise they need, and to meet the Plan Nord's ambitious goals, rapid steps are needed to overcome current limitations on communications network infrastructure and develop fast and effective methods for compressing data.

To meet the demand for services in a region marked by vast physical expanses and low population density, it will also be helpful to develop immersive community environments that rely on virtual and augmented reality (that is, environments allowing many people to participate simultaneously), notably for collaborative initiatives in engineering, telemedecine, group strategizing, or post-secondary education. With these technologies groups in different locations can share the same virtual environment and actively work together as if they were in the same room.

RESEARCH PRIORITIES

Develop data compression technologies to offset current reliance on less efficient satellite telecommunications systems.

Identify technologies that, in view of current northern telecommunications, could be used to maximize telemedecine, distance learning, and virtual collaboration services.

Identify virtual environment features that would best meet the needs of aboriginal communities, in a context where future telecommunications infrastructure will have superior capacities.

Analyze the socioeconomic effects that Internet access has had in Nunavik since it became available in 2004. This analysis could include a study of how technology has been used and what obstacles individual and business users have encountered.

Smart systems installation (sensors, remote security, etc.)

Various technologies could be implemented to improve security and allow online management of land-based infrastructure—large and small—throughout the North. For example, it is entirely plausible to envision a vast network of smart sensors arrayed over broad sections of uninhabited territory and capable of providing real-time continuous monitoring of the physical condition, operation, and utilization of existing infrastructure. Such a vision would require the use of the latest sensor and smart system technologies, which would need to be adapted to withstand northern Québec's extreme climate conditions.

RESEARCH PRIORITIES

Develop ways to operate smart networks of remote cameras and sensors for monitoring infrastructure or large tracts of land (construction sites, for instance) or automatically analyzing human activities (counting persons or vehicles, identifying individuals or objects, etc.). Topics to examine include:

- Deployment of smart systems to perform real-time analysis in various situations (e.g.,, road train driver behavior, to improve highway safety).
- Use of digital smart systems to monitor infrastructure (e.g., deformation, wear, energy consumption, ground movement, abnormal use, etc.).
- Implementation of non-destructive inspection technologies that use infrared or 3D vision (e.g., inspecting manufactured parts or premises).
- Investments required to use machine intelligence for remote analysis of continuous data acquisition systems already utilized in northern Québec to study climate change.

Data center installation

With the world clamoring for more and more mobile technologies, data centers are springing up all over to reduce costs and enhance computer application performance. Until recently, only high-demand data could justify the need for these data repositories, but the advent of cloud computing has accelerated the call for more—and more powerful—data centers. Given the amount of energy these facilities use, especially for cooling purposes, northern Québec offers particularly compelling advantages, not only because of its cold temperatures but also its plentiful supply of renewable energy, which has a smaller carbon footprint. While these advantages have been known for many years, no data center project has yet come to the North.

RESEARCH PRIORITIES

Develop a concerted research approach to promote northern Québec as an attractive location for data center installation. Research efforts should give priority to:

- The physical and logistical infrastructure required to transport equipment to data centers (volume, reliability, costs).
- Logistics models that can be used to reduce the costs of building, operating, and maintaining data centers .
- New, fiber-optic-based technologies for deployment in data centers and in conjunction with Internet telecommunication networks.
- Approaches for facilitating the dynamic exchange of data between different centers in order to optimize operations (load balancing, energy cost reduction, carbon footprint reduction, etc.).
- The latest information on heat transfer mechanisms used at data center facilities throughout the world.

3 CONCLUSION

According to government estimates, the Plan Nord will engender investments in excess of $80 billion over a 25 year period.

The government also anticipates that this vast endeavor will be responsible for creating or consolidating an average of 20,000 jobs per year, generating $14 billion for Québec and its citizenry. Given the plan's scope, it would seem reasonable to expect that at least 1.5% of this investment—or $1.2 billion—will go to R&D.

Developing the North gives Québec the opportunity to cement its reputation as a leader in sustainable development. It also gives Université Laval and its partners and research centers a chance to look anew at research methodologies by asking new questions, forming new collaborations, and adopting new ways of thinking and doing that reflect the specific needs of the changing North.

The proposal presented by Université Laval is a catalyst project predicated on research excellence; structured, strategic support for the recognized teams already in place in Québec and elsewhere around the world; and a vision of unlimited innovation. To that end, we need transdisciplinary perspectives to decompartmentalize knowledge and take a holistic approach to northern research. We must therefore draw on all available scientific competencies and elicit full cooperation from institutions of higher learning. We must also cast aside the traditional view that held researchers should be separated from the subjects they study, ensuring that each phase of northern research receives the unequivocal support of local communities and institutions. One key objective must be to train a new generation of aboriginal northern researchers. This also entails putting information to work at the local level by disseminating results in a manner that respects the ways in which northern communities produce and transmit knowledge.

ACKNOWLEDGEMENTS

This examination of research issues and priorities for a sustainable North was developed with input from over 50 experts and researchers, mostly from Université Laval, but also representing other universities, aboriginal communities, businesses, and the Government of Québec. These contributors pooled their expertise —to identify research priorities relating to the development of northern Québec. The ideas and time they contributed attest to their commitment to ensuring that Québec can deal with the many challenges that lie ahead in developing the North. Université Laval extends its appreciation to each of them.

APPENDIX 1 | Members of the Coordination Working Group

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The coordination working group also included the expert panel co-chairs (see Appendix 2).

DESBIENS, CAROLINE
Panel Co-chair
Community well-being and development

RODON, THIERRY
Panel Co-chair
Community well-being and development

DEBAILLEUL, GUY
Panel Co-chair
Economic potential of the North

GRENON, MARTIN
Panel Co-chair
Economic potential of the North

ALLARD, MICHEL
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Transportation and telecommunications

RUSCH, LESLIE
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Transportation and telecommunications

BOUDREAU, STÉPHANE
Panel Co-chair
Environmental protection

FORTIN, DANIEL
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APPENDIX 2 | Members of the Expert Panels

Panel 1
Community well-being and development

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Environmental Protection

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APPENDIX 3

Principal northern and polar research initiatives associated with Université Laval (networks, chairs, research centers, etc.)

Université Laval–based research centers and networks linked to the development of northern Québec

ARCTICNET

Scientific Director: Louis Fortier, Université Laval

ArcticNet, a network center of excellence (NCE), is a world-class Canadian initiative involving some 12 countries. It also represents the federal government's largest NCE program investment to date, $67.3 million for a seven year period. Mandated to help the Canadian Arctic adapt to climate changes and modernization, ArcticNet consists of 135 researchers from 30 Canadian universities and involves both the provincial and federal governments, including 11 provincial departments and 8 federal ministries.

CEN

Director: Warwick F. Vincent, Université Laval
Co-director: Monique Bernier, INRS

The Center for Northern Research, or CEN, is a Québec research consortium made up of centers of excellence at three universities, Université Laval, Université du Québec à Rimouski, and Institut national de la recherché scientifique (INRS). CEN also has members from six other Québec universities and works closely with governmental, aboriginal communities, and industry. It strives to contribute to the sustainable development of northern regions while improving our understanding of environmental change and the issues at stake. CEN brings together over 50 researchers and some 160 students, fellows, and professionals from various disciplines (biology, microbiology, geography, geology, engineering, archeology, land-use planning). CEN members and alumni are highly qualified, having undergone rigorous training in the analysis and management of cold climate ecosystems and geosystems.

NASIVVIK

Co-director: Éric Dewailly, Université Laval
Co-director: Christopher Furgal, Trent University

The Nasivvik Centre for Inuit Health and Changing Environments is funded by a $1.475 million research subsidy from the Institute of Aboriginal Peoples Health, part of the Canadian Institutes of Health Research (CIHR-IAPH). The center relies on the expertise of some ten researchers from Canadian universities who focus on training, education, and research in Inuit health and environmental change. Nasivvik, which is based at the public health research unit of Centre hospitalier de l'Université Laval (CHUQ), is part of a network of centers established across the country by ISA/IAPH under the Aboriginal Capacity and Developmental Research Environment program (ACADRE) to address the need for aboriginal health training and research. Center partners include the Inuit Circumpolar Council of Canada, Inuit Tuttarvingat, Nanatsiavut Government, Inuit Tapiriit Kanatami (ITK), Nanavut Tunngavik Inc., Inuvialuit Regional Corporation, and Makivik Corporation.

CIÉRA

Director: Martin Hébert, Université Laval

The Interuniversity Centre For Aboriginal Studies and Research (CIÉRA) is heir to a long tradition of research and teaching on the North and indigenous peoples that started at Université Laval in the early 1960s with the establishment of the Center for Northern Research (CEN) by Louis-Edmond Hamelin. When CEN narrowed its focus to natural sciences in the early 1980s, Université Laval researchers in social sciences and the humanities working on the North and indigenous peoples, founded the Groupe d'études inuit et circumpolaires (GÉTIC) in 1987, affiliating with the Faculty of Social Sciences. In 2004, GÉTIC became CIÉRA, which was then officially recognized as a research center by the University Council. CIÉRA'S mission is to conduct interdisciplinary and multidisciplinary research from a global perspective in collaboration with aboriginal communities and other universities to promote the full participation of aboriginal peoples in the social, economic, and political activities of civil society. Since its creation, CIÉRA has considerably broadened the scope of its research activities, focusing not only on indigenous issues in Québec and Canada, but also on other regions of the world. Its members include professors from some 15 universities in Québec, Canada, Europe, and South America. In total, CIÉRA includes 25 regular researchers, nearly 30 associates, and some 50 students.

ARUC – Inuit Leadership and Governance in Nunavut and Nunavik: Life Stories, Analytical Perspectives and Training

Director: Frédéric Laugrand, Université Laval

This research partnership, financed primarily by the Social Sciences and Humanities Research Council of Canada (2010–2015), seeks to develop knowledge of leadership and governance in Inuit communities and to expand the social sciences competencies of those working alongside northern communities (researchers, teachers, managers). The research program was developed in close collaboration with Nunavut and Nunavik residents and nonprofit organizations. The network includes approximately 10 researchers, 18 students, and over 15 or so partner organizations and institutions.

TAKUVIK

Director: Marcel Babin, Université Laval
Co-director: Jean Carignan, Université Laval
Scientific Director: Louis Fortier, Université Laval

Takuvik was established in January 2011 as a partnership between Université Laval and France's Centre national de la recherche scientifique (CNRS) for the purpose of studying the impact of climate change and anthropic pressure on Arctic ecosystems. Marcel Babin, the Canada Excellence Research Chair in Remote Sensing of Canada's New Arctic Frontier, is closely affiliated with Takuvik.

QUÉBEC-OCÉAN

President: Michel Gosselin, UQAR
Executive Director: Maurice Levasseur, Université Laval

Québec-Océan supports oceanographic research initiatives undertaken at four Québec universities (Université Laval, UQAR, McGill, and UQAC) and by partners from the government and private sectors. It is one of the strategic groups recognized by Fonds de recherché du Québec – Nature et technologies. Through its work, Québec-Océan brings together high-caliber researchers specialized in various disciplines of oceanography: physics, geology, chemistry, and biology. This interdisciplinary approach facilitates ambitious research projects, the training of students, and the transfer of acquired knowledge to managers, decision-makers, and the general public. The organization's mission is to mobilize Québec researchers and train students to ensure excellence in oceanographic research and the dissemination of knowledge. Initiatives in a number of these areas specifically address Arctic research issues. Québec-Océan has 33 regular researchers, 32 associate researchers, and 100 or so students.

CEF

Co-director: Louis Bernier, Université Laval
Co-director: Pierre Drapeau, Université du Québec à Montréal

The Centre for Forest Research (CEF) is a university group financed by FQRNT (Fonds québécois de la recherche sur la nature et les technologies). Unique in Québec, it pools the expertise of 53 regular researchers (from 10 institutions of higher learning) dedicated to forest research to work toward an overarching vision that draws on the functional role of organisms and dynamic processes in forest ecosystems processes to design innovative solutions for forest management managers. Responding to these challenges, the scientific mission of CEF is to better understand forest ecosystem functions and dynamics and component biology and interactions with a view to embracing biodiversity conservation and increased productivity of commercial species. A great deal of CEF research is carried out in the contiguous boreal forest, 60% of which is located south of the northern limit for timber allocations. Forestry in Québec's northern regions produces 11.7 million cubic meters of wood that account for 53% of the province's total production. In addition to 53 regular researchers, CEF has some 50 associate researchers and 360 students.

INSTITUT EDS

Director: François Anctil, Université Laval

IHQEDS, or Institut Hydro-Québec en environnement, développement et société, was founded to elevate the status of environmental issues in society and to engage in or promote activities aimed at furthering and disseminating knowledge in the fields of the environment and sustainable development. Five institutional members comprise the institute, which draws on numerous Université Laval resources in a host of fields and areas of expertise as well as ten faculties that span the social, natural, and applied sciences. The organization has established an ongoing dialog by developing collaborative research initiatives focusing on shared challenges. In addition to its 57 regular members, the institute has 7 associate members and some 300 students.

Université Laval–based Chairs of Excellence in Canadian Research and Canada Research Chairs linked to the North

1. Canada Excellence Research Chair in Remote Sensing of Canada's New Arctic Frontier (Marcel Babin)
2. Canada Research Chair in Boreal Ecosystems Modelling (Steven Cumming)
3. Canada Research Chair in Historical Geography of the North (Caroline Desbiens)
4. Canada Research Chair in Comparative Aboriginal Conditions (Gérard Duhaime)
5. Canada Research Chair in Planning Sustainable Forest Value Networks (Sophie D'Amours)
6. Canada Research Chair on Sustainable Energy Processes and Materials (Faïçal Larachi)
7. Canada Research Chair on the Response of Arctic Marine Ecosystems to Climate Change (Louis Fortier)
8. Canada Research Chair in Aquatic Ecosystem Studies (Warwick F. Vincent)
9. C.D. Howe Chair on Environmental Law And Arctic Development (Paule Halley)
10. Research Chair on Northern Sustainable Development (Thierry Rodon)
11. Louis-Edmond-Hamelin Chair for Northern Research in the Social Sciences (Gérard Duhaime)
12. NSERC-Université Laval Industrial Research Chair in Boreal Forest Silviculture and Wildlife (Daniel Fortin)
13. NSERC Industrial Research Chair in Peatland Management (Line Rochefort)
14. NSERC Industrial Research Chair in Collaborative Integration and Synchronization of the Forest Products Supply Chain (Sophie D'Amours)
15. NSERC Industrial Research Chair in Heavy Load, Climate and Pavement Interaction (i3c) (Guy Doré)
16. NSERC Northern Research Chair on Disturbance Ecology (Serge Payette)

Examples of large multi-institutional projects related to the North funded by NSERC or FQRNT and directed by Université Laval researchers

- ADAPT: Arctic Development and Adaptation to Permafrost in Transition (Warwick F. Vincent)
- Adaptation of northern transportation infrastructure to climate change (Guy Doré)
- Boreal forest growth and production: long-term patterns and process (David Pothier)
- Opening the Northwest Passage: navigational developments and impacts (Frédéric Lasserre)
- Caribou Ungava: Ecology and dynamics of caribou populations migrating between Québec and Labrador in the context of climate change (Steeve Côté)
- And others

Major northern research resources managed by Université Laval

- CCGS *Amundsen* icebreaker
- Qaujisarvik northern research station network
- SILA network of automated weather observatories
- Databases including ArcticStat, Nunivaat, Polar Data Catalogue, and CEN-SILA
- Louis-Marie Herbarium

Research centers in development at Université Laval

Center for mining industry value chain research

A dozen or so professors, with industry support, have joined forces to develop a research initiative addressing all aspects of mining activity, from resource assessment, exploration, deposit appraisal, and mining complex construction to mine operation closure, and site restoration. In partnership with COREM, a consortium of applied research for the mineral processing and transformation of mineral substances, this group aims to develop a critical mass of researchers specialized in the socioeconomic, technological, and environmental aspects of mining.

Center for renewable energy research

Upwards of 20 researchers from the Faculty of Science and Engineering are working on one or more forms of renewable energy: geothermal, wind, tidal power, hydroelectricity, biofuel, solar. Together they are attempting to better understand the challenges in producing and distributing these types of energy. They plan to pool their collective skills in order to better serve communities, industry, and public utilities.

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