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PERSPECTIVES

Innoversity in knowledge-for-action and adaptation to climate change: the first steps of an 'evidence-based climatic health' transfrontier training program

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Véronique Lapaige[1–3]
Hélène Essiembre[4]

[1]Department of Psychiatry, University of Montreal, Montreal, QC, Canada; [2]Fernand-Seguin Research Centre, Montreal, QC, Canada; [3]Quebec National Public Health Institute, [4]Industrial and Organizational Program, Department of Psychology, University of Montreal, Montreal, QC, Canada

Correspondence: Véronique Lapaige
Centre de recherche Fernand-Seguin de l'Hôpital Louis-H. Lafontaine (Fonds de recherche en santé du Québec), Université de Montréal and Institut national de santé publique du Québec (Unité Santé et Environnement, Québec), OURANOS-550 Sherbrooke Ouest, 19th Floor, Montreal, QC H3A 1B9, Canada
Tel +1 514 282 6464 ext 267; +1 514 366 9854
Fax +1 514 282 7131
Email veronique.lapaige@fsi.ulaval.ca; veronique.lapaige@inspq.qc.ca

Abstract: It has become increasingly clear to the international scientific community that climate change is real and has important consequences for human health. To meet these new challenges, the World Health Organization recommends reinforcing the adaptive capacity of health systems. One of the possible avenues in this respect is to promote awareness and knowledge translation in climatic health, at both the local and global scales. Within such perspective, two major themes have emerged in the field of public health research: 1) the development of advanced training adapted to 'global environment' change and to the specific needs of various groups of actors (doctors, nurses, public health practitioners, health care managers, public service managers, local communities, etc) and 2) the development of strategies for implementing research results and applying various types of evidence to the management of public health issues affected by climate change. Progress on these two fronts will depend on maximum innovation in transdisciplinary and transsectoral collaborations. The general purpose of this article is to present the program of a new research and learning chair designed for this double set of developmental objectives – a chair that emphasizes 'innoversity' (the dynamic relationship between innovation and diversity) and 'transfrontier ecolearning for adaptive actions'. The *Écoapprentissages, santé mentale et climat* collaborative research chair (University of Montreal and Quebec National Public Health Institute) based in Montreal is a center for 'transdisciplinary research' on the transfrontier knowledge-for-action that can aid adaptation of the public health sector, the public mental health sector, and the public service sector to climate change, as well as a center for complex collaborations on evidence-based climatic health 'training'. This program-focused article comprises two main sections. The first section presents the 'general' and 'specific contexts' in which the chair emerged. The 'general context' pertains to the health-related challenge of finding ways to integrate, transfer, and implement knowledge, a particularly pointed challenge in Canada. The 'specific context' refers to the emerging research field of adaptation of public health to climate change. In the second section, the characteristics of the research chair are more extensively detailed (the vision of 'innoversity' and 'transfrontier knowledge-for-action,' the approach of shared responsibility and complex collaboration, objectives, and major axes of research). We conclude with a call for complex collaboration toward knowledge-for-action in public health services/mental health services/public services' adaptation to climate change: this call is aimed at individual and institutional actors in the North and South/West and East concerned by these issues.

Keywords: global changing environment, climatic health, adaptation to climate change, adaptive capacity, innoversity, diversity, complex collaboration, transdisciplinary knowledge-for-action, transfrontier training, andragogy, continuing education, ecocompetency, public health, mental

health, health professional, public service manager, knowledge translation, implementation science, ecolearning, ecomanagement, eco-decision-making

Introduction

Globalization today constitutes a major challenge[1–4] for the public health sector and its involved professionals (Ciliska[5] defines 'public health professionals' as 'first-line' clinicians and workers, researchers, managers, and decision makers in public health). These professionals are collectively concerned with achieving an eco-socio-efficient public health as well as the steady growth of an equitable public health system.[1–3,6–10] The globalization challenge parcels out into several 'inherently global health issues,'[8] such as the struggle against climate change and drought, the establishment of international rules for migrant labor, the fight against poverty and for health equity, the management of fallout from natural catastrophes, and the fight against infectious disease (Figure 1). In the context of global social and environmental change, these globalization-related issues are all actively present and constitute meaningful targets for the efforts of professionals of the new 'globalized public health'.[4]

At another level, we find a second major challenge for globalized public health: knowledge-for-action or knowledge translation (KT).[11–13] This is a transversal challenge because it cuts across the issues raised by globalization mentioned previously (Figure 1).[4,14] In an era of hyperconnectivity and the global economy of knowledge,[15–17] this transversal challenge is inherent in the valorization of knowledge as well as the updating and transfer of knowledge for each contemporary public health issue.[14,18] This challenge is often referred to in public health circles as that of the 'integration'[13,18–29] of multilevel knowledge, of the 'transfer' of knowledge toward decision makers or again, of the knowledge-for-action (KT), ie, the 'practical implementations' or 'exemplary behaviors'.[11,12,30–35]

The 'big issue,' in the Quebec/Canadian context, is climate change (ie, local Agenda 21).[36,37] At a larger scale, as reported by the UCL-Lancet Commission, 'climate change is the biggest global health threat of the 21st century'.[38] Several considerations motivate this priority:

- Unequivocal recognition of the importance of this phenomenon by the international scientific community[39]
- Universal recognition of the unprecedented priority of this phenomenon by local,[40–48] regional, and worldwide[49–53] governmental and scientific bodies, given the intensive (rapid and severe) and extensive (present and projected) nature of the inherent risks
- Major health risks resulting from local,[37,54–58] regional, and worldwide[59–66] climate change, particularly with respect to certain vulnerable populations and regions
- Repeated calls at various levels[7,41,49,55,56,66–78] for reinforcement of the 'adaptive capacity' of the health systems that are faced with the challenges of climate change
- The necessity for collaborative and integrated intersectoral action that will reinforce transfer of knowledge toward health professionals and increase awareness in the general population of current challenges arising from climate change: these collaborative actions should aim at 'adaptive,' evidence-based, and effective risk management.[6,7,40,50,55,66,79–83]

The struggle against global warming and the efforts to 'adapt' to its inevitable escalation require a shared understanding of the problems society will be facing over the coming decades. However, this understanding must then lead to action in the form of ecobehaviors[84–88] (eco-decision-making, ecomanagement) adopted in a responsible and sustainable manner by a maximum of individuals and groups (ecocompetency). No one today can escape global warming and its challenges.[89] Public health,[66–68,74,80,90–93] along with other sectors,[94] must respond to these challenges by continually updating its database and professional competences, as well as developing new ways of thinking, communicating, and acting.[73]

Thus, at the dawn of the 21st century, public health professionals in Quebec, Canada, and elsewhere in the world are faced with a double challenge (Figure1):

- Part 1 – Transdisciplinary KT (the utilization/integration/transfer/implementation of knowledge)
- Part 2 – 'Adaptation' to climate change[36,37]

Before proposing a program to meet this crosscutting challenge, we will examine the specific demands associated with each of the aforementioned parts (Part 1 and Part 2), which will in turn allow us to set forth the research chair's vision and mission, as well as the objectives of its programmatic research axes. Again, our working hypothesis concerning KT is that there is a codependent relationship[95–97] between 'adaptation' measures (that seek to reduce the impact of climate change on nature and human society) and mitigation measures (that target the causes of climate change and seek to reduce the greenhouse gas anthropogenic emission).

Some sectors particularly concerned with 'adaptation' are health, the environment, and public security. Those sectors more particularly concerned with 'mitigation' are energy, transportation, municipal government, and agriculture. Although adaptation is a characteristic, even inevitable, option for public health, this sector must imperatively target effect reduction in order to tackle the problem at its root.

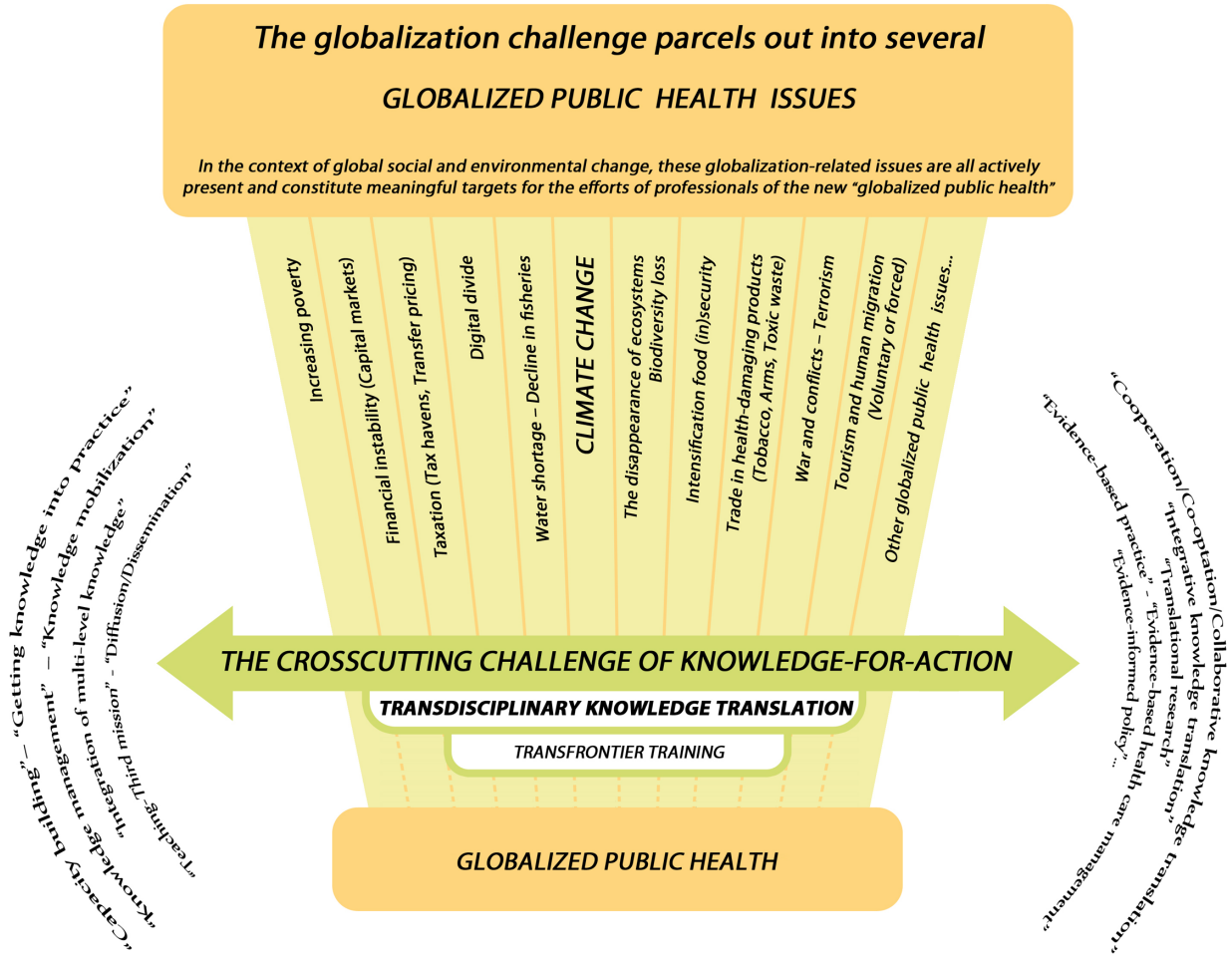

Figure 1 Transdisciplinary knowledge-for-action: A crosscutting challenge in globalized public health.

This program of KT in the face of climate change has, then, the global objective of supporting the action (ecodecision-making, ecointervention, and ecomanagement) of certain targeted groups (managers, deciders, clinicians, public health professionals, external partners, community workers, medias, and general public). As a function of each group's specific needs, this support could take many forms: communicating new knowledge, providing general information, increasing awareness of other cultural values, promoting change in the public's perception of climate change, modifying professional practice, enlightening decision making, and developing new professional competencies in climatic health.

Specific and general contextual determinants of the program

The challenge of KT in Quebec and Canada (general context)

The issue of the diffusion and utilization of research results as well as the more general question of knowledge transfer preoccupy both the international scientific community and the clinical and management professional community. Some consider themselves to be 'doing' knowledge transfer when they publish their studies or disseminate practical manuals. Other professionals such as clinicians or managers attempt to integrate concepts:

- Evidence-based medicine, concrete application of research results (getting research into practice), and 'best practice'[98–102]
- Clinical governance and improvement of health care[103–105]
- 'Integrated' patient care[106]
- 'Shared' care (shared decision making)[107–109]
- Knowledge management[110–114]
- Organizational learning and knowledge sharing within communities of practitioners[115–121]

Are all of these examples of 'knowledge transfer?' And do concepts such as 'transfer,' 'application,' 'diffusion,' 'dissemination,' 'utilization,' 'exchange,' and 'sharing' of knowledge mean the same thing? All of these concepts issue from the same culture of evidence-based decision making, but each has a precise meaning as well as a conceptual allegiance to one or another approach.[11–13,122–126] Faced with

this conceptual plurality, which concept should we chose and which should be the preferred approach in the chair's program?

Over the last decade, various actors within Quebec and Canada have promoted a professional culture of evidence-based decision making.[127]

- Since 1997–1998, the National Forum on Health has established the development of this culture as one of the main health sector objectives for the 21st century.
- At the same time, the Canadian Health Services Research Foundation (CHSRF) has made a priority of evidence-based decision making in the organization, management, and delivery of health services.
- The same importance was granted to evidence-based management within the Executive Training for Research Applications (EXTRA) program, created at the beginning of this century by the CHSRF in partnership with three institutions: the Canadian College of Health Services Directors, the Canadian Medical Association, and the Canadian Nurses Association. The goal of the EXTRA program is to acquaint deciders with research within a culture of evidence-based decision making.[128]
- Finally, many professional organizations (nurses, doctors, and other health professionals) at provincial and national levels have adopted an evidence-based approach during this same period.

This 'evidence-based' culture includes:

1. 'Evidence-based medicine,' appearing in the early 1990s, but rapidly expanding to 'evidence-based practice' across clinical health sciences (namely, evidence-based nursing, evidence-based social work, etc)[30,126,129–132]
2. 'Evidence-based public health,' including 'evidence-based health promotion' that particularly involves public health professionals confronted with the development of complex interventions, implementing, and evaluating new programs[133–139]
3. 'Evidence-based health care management' that involves clinical administrators and public health managers[140]
4. All of these evidence-based components call for an 'overall evidence-based health care organization'[141,142] that will be capable of formulating 'evidence-informed policies'[34,143,144]

Canada's current position as one of the world leaders in research on KT is no accident.[18,127] From the end of the 20th century, the Canadian position has clearly been to apply research results at all levels of health care and health care management: micro (clinical), meso (management), and macro (political).[18,127] Since the end of the 1980s, the Canadian health system, along with many health systems around the developed world, has entered a deepening structural crisis involving aging populations, national budget limitations, an exponentially growing research literature, and the arrival of new, expensive medical technologies. In spite of this deepening crisis, Canada has remained faithful to its commitment to apply research results to decisional processes as a privileged means for providing equitable health care to her citizens.[145] In the context of a knowledge economy,[146,147] the adoption of a knowledge management strategy followed by research-informed decision making in clinical, management, and political environments has been placed at the heart of policies targeting the Canadian objectives of equity and effectiveness of the health system.[144,148–151] However, in spite of these efforts to promote utilization of evidence, there is a significant gap between knowledge produced and made public and expected changes in behavior and practice on the part of deciders (knowledge users) within the health system.[152–154] This 'know-do' gap has been held responsible for subperformance of health systems and growing disparities/inequities in health care.[124,150,155–158] These negative consequences are all the more regrettable because they could have been avoided if the available research results had been applied.[137,138]

Unfortunately, there appears to be nothing linear or automatic about the effective utilization of research results that become available to health system professionals. Instead, we see a complex, dynamic, and iterative process that involves various actors with their specific needs, interacting in an asymmetrical information context that includes the constraints inherent in the results themselves as well as the specific constraints characteristic of the targeted environments.[123,144,159] Because of this complexity, effective KT becomes a process involving a multitude of actors (producers and users of knowledge) interacting at several levels. We can begin to speak of an 'exchange' of knowledge and, consequently, of 'collaborative' strategies that can initiate or facilitate dynamic and multidirectional communications between knowledge producers and potential users. In recent years, these interactions and collaborative strategies have been successively structured in a series of knowledge use models (science push, demand, problem solving, enlightenment, strategic, and deliberative).[30,160–164] Depending on the model, research results could impact through 'instrumental' use (ie, the direct impact of research results on practice and policy), 'conceptual' use (ie, the impact of research results on thinking and understanding), and 'symbolic use' (ie, the use of research results as a political tool to legitimatize opposition or practice).[164–167] Development of these models has led to the progressive emergence of

an entire research area, which was first called 'transfer of research results' in Quebec, and later termed 'transfer of knowledge,' then 'KT' by the Canadian Institutes of Health Research (CIHR).[11,123,124,168] As for 'knowledge transfer,' the CIHR uses this term to refer to the transformation of tacit knowledge into explicit knowledge.[123,124]

Over recent years, KT has evolved from a field of study[151] into a dynamic research area with its own limits, subdivisions, and challenges.[11,30,38,123,126] Today, one speaks not only of a 'practice' of KT comprising the development of a fundamental knowledge-to-action process,[a] along with several typical knowledge application 'activities,' but also me speaks of a 'science' of KT, characteristic of a major research area.[123,168] KT research concentrates on the scientific study of the determinants, processes, and outcomes of KT. The overall goal is to foster the development of a theoretical foundation and empirical database that can be generalized to optimize the KT process and its knowledge application activities. As other worldwide scientists, many Canadian scientists have put KT research on the map as a new domain of interdisciplinary health research, at the junction of behavioral sciences (social psychology), clinical sciences (medicine and nursing), organizational and managerial sciences (health administration), and research on health services.[172]

This new domain now includes nine[b] subdivisions.[159,168] Each confronts specific challenges[38,168] (terminological, conceptual, methodological, and evaluation challenges), and can be viewed from two main perspectives.

The first perspective is a process-centered view on the transfer of technologies[173–178] and/or transfer of innovations.[179–184] It permits identification of the successive steps in the KT process as well as confirmation of its interactive character.[144,181,185–195] Among the various process-centered conceptual frameworks,[30,194–201] the Canadian school[c] generally favors Graham's knowledge-to-action process framework[124,201] (this model has been modified in our program to become transdisciplinary).

The second perspective is a determinants'-oriented perspective. Studies of organizational determinants have targeted either public organizations such as administrative institutions,[202,203] research centers, and universities,[144,204] or private organizations such as industries.[205] Studies of individual determinants have targeted actors up- or downstream from KT: deciders,[206–209] managers, professionals,[210,211] knowledge brokers,[212] researchers,[159,189,212,213] and the general population.[213] In our program, we study determinants related to the following: 1) actors, 2) knowledge, 3) organizational and contextual[159] characteristics, and 4) the 18-odd features that characterize complex collaborations and 'transdisciplinary' KT research and practice.[214]

The challenge of climate change in Quebec and Canada (specific context)

For Quebec, Canada, and other societies, today's indisputable global warming will bring not only an increase in average temperatures, but also a rise in sea level, and increased risk for extreme climatic and meteorological events.[39] Although climatic variability has always been part of our world, a major, qualitative change has occurred over the last 50 years. Human activity, notably in the increased use of fossil fuels and in new techniques of agricultural exploitation, has generated the major[50] contribution to the average temperature increase observed worldwide.[39,50,215,216] Along with other human-driven global environmental changes, climate change constitutes a menace for the entire ecosystem, and therefore for human health.[215–219]

[a] Knowledge-to-action (KT) is an interactive, dynamic, and complex process.[123,168,169] It is *interactive* in the sense that it occurs within a system of exchanges among producers and users of knowledge, and oftentimes includes other actors. It is *dynamic* in the sense that it involves a range of actions such as adoption, integration, mobilization, and use of knowledge in order to transform or concretely apply knowledge toward better practice and exemplary actions. Finally, KT is *complex*, implying as it does: 1) identification of the know-do gap within each problem area, and identification of existing knowledge and knowledge needs for various targeted groups; 2) examination of knowledge in order to adapt it to local needs; 3) acquaintance with all actors involved, and an understanding of their interactions; 4) familiarity with the local context within which knowledge will be used, shared, or transformed; 5) identification of obstacles and facilitating factors to KT; 6) development of strategies as well as professional activities through which knowledge can be assimilated and integrated by concerned local actors, leading ultimately to modified perceptions and practices; and 7) evaluation of the results of the KT process: was the transferred knowledge accessible, understood, and used? Did the targeted group demonstrate changes in understanding, attitudes, and professional practice? Did the KT process demonstrate sustainability, innovation, and did it lead to complex collaboration?[170,171]

[b] 1) Knowledge synthesis (to identify the knowledge for KT); 2) Research into the evolution of and critical discourse around research evidence; 3) Research into knowledge retrieval, evaluation, and knowledge management infrastructure; 4) Identification of knowledge to action gaps; 5) Development of methods to assess barriers and facilitators to KT; 6) Development of methods for optimizing KT strategies; 7) Evaluations of the effectiveness and efficiency of KT strategies; 8) Development of KT theory; and 9) Development of KT research methods.[168]

[c] In Canada, today, existing theoretical models are classified into two general approaches: 1) the 'classical' models' approach often seen today as too descriptive and prescriptive, historically inspired by psychological theories of cognitive change, educational theories, organizational theories, and theories of 'quality improvement;' and 2) the 'planned action' approach, currently favored in Canada by authors such as Graham and Tetroe[201] and considered as an approach that 'causes change'.

In spite of geographical and demographic vulnerabilities, no region on earth escapes this environmental menace:[38,43,44,46,220–222] it is a planetary phenomenon with complex, cascaded impacts on human and ecological systems and whose effects can be direct and indirect, subtle, or sudden. These effects act simultaneously on three key elements: social groups and populations, the built and natural environment, and socioeconomic activities/sectors (and in particular, the health services/sector).[40]

For the public health field, global warming is creating a complex, critical, and worrisome situation that poses challenges to the fundamental mission of developing, promoting, and applying new knowledge and know-how.[37,38,66–68,74,80,83,90–93] It is important that public health providers begin to take on a leading role in the development of knowledge, in the transfer of learning, and in training and education not only for public health professionals (who must today begin to develop new competencies) but also for working people, social groups, and populations. Numerous studies have clearly demonstrated the negative repercussions of climate change at regional, national, and global levels.[54–56,61–67] Climate, as a macrodeterminant of health, is itself linked to other macrodeterminants of health.[223] Consequently, climate change influences health via complex, interrelated pathways that can be direct or indirect.[216]

In Quebec and in Canada, researchers have noted six health risks stemming from climate change; these risks impact public health through eight types of effects. The six risks are as follows:

1. Extreme temperatures (heat waves)
2. Extreme weather conditions with their concomitant socioeconomic consequences
3. Air quality (eg, smog)
4. Water and food contamination
5. Infectious disease transmission via insects, ticks, and rodents
6. Increased exposure to UV rays[37,55,56,224]

The eight correlated effects on health are as follows:

1. Heat-related mortality and morbidity
2. Consequences of extreme weather conditions (eg, post-traumatic stress disorder after exposure to climatic catastrophes)
3. Effects of atmospheric pollution (eg, asthma, cancer, and cardiovascular illnesses), particularly apparent in North America[49,216]
4. Consequences of food and water contamination (eg, diarrhea and food poisoning)
5. Zoonotic diseases and vector transmission (the first case of hantavirus-induced lung infection in Quebec was reported in 2005[225])
6. Consequences of increased UV (eg, skin cancer, cataracts, and weakening of immune systems)
7. Consequences for particularly vulnerable groups in cities and rural environments[226,227]
8. Socioeconomic consequences (eg, loss of productivity and revenue)[228]

All of these effects impact in a differential way, as individuals with limited resources, in poor health, seniors and young children are generally more at risk.[43,228,229] For example, Bélanger et al found that certain group vulnerabilities exacerbated the impact of heat waves (isolation of seniors, reduced mobility, poverty, presence of chronic neurological problems, residence in apartment blocks, and limited access to recreational facilities during a heat wave).[230] Vulnerabilities to climatic health risks that threaten different systems (individuals, populations, and institutions) induce complex and diversified impacts depending on: 1) the nature of the 'external factor' or exposure to climate change (ie, heat wave), 2) the 'internal sensitivity of the system' to this exposure's impacts, and 3) the internal 'system's adaptive capacity'. Although many studies have described interactions of these three variables, few have offered the possibility of a real integration,[231] because of the daunting challenge of dealing with a concept like 'vulnerability,' whose nature and conceptualization vary across contexts like climatology, ecology, social science, and public health.[232,233] As for 'adaptive capacity,' not only is it difficult to quantify, but the factors that can improve or diminish adaptive capacity also vary across time and geographical contexts.[234–236] For instance, 'adaptive capacity' is considerably affected by access to technologies, economic resources, renewed learning and professional ecocompetencies, the state of public health infrastructures, social networks, and general health status of the population.[237,238] At the individual level, 'adaptive capacity' is influenced by several determinants such as individual health, education (information, aptitudes, and learning), socioeconomic level, available social networks, and access to resources.

Today, systems such as public health have made a priority of improving their adaptive capacity.[239] Numerous actors (individuals, organizations, industries, and governments) work toward improving adaptive capacity, even to the point of choosing and applying specific measures to this end.[d] Today, governments can significantly contribute by providing

information and tools, as well as by structuring interventions that can improve adaptive capacity.[240–242]

The United Nations Framework Convention on Climate Change[e] explicitly calls for an improvement of adaptive capacity. However, today in Canada,[44] as in other countries, attention granted to 'adaptive capacity' often takes the form of reactions to specific, urgent situations, given the socioeconomic burden[243–246] already present and anticipated in the future as well as increasing mortality and morbidity rates[f] (linked with heat waves, skin cancer, cardiovascular, respiratory, vectorial, renal, hepatic, neurological, and mental illnesses).[247–250] Recent extreme events in Europe (eg, heat wave of 2003),[251–253] the United States (eg, hurricane Katrina in 2005),[254] and Canada (eg, the ice storm of 1998) have all shown how even modern developed societies can be overwhelmed, thus emphasizing the critical importance of assessing vulnerabilities[g] as well as selecting effective adaptation measures. 'Adaptation' programs on climate change are codependent with 'mitigation' policies, and the two complement each other.

As noted in the last National Canadian Evaluation, Quebec has not been idle in responding to climate change. Since 1992, Quebec has respected the principles set forth in the United Nations Framework Convention on climate change, and has consequently carried out various initiatives, such as the application of the 2006–2012 Action Plan concerning climate change, as well as passing a law concerning sustainable development.[41,256] This same period has witnessed the development of the Ouranos Consortium, composed of more than 150 researchers.[36,37,77,257] This consortium is financed by several Canadian ministries, and is an integral part of Canada/Quebec's strategy of adaptation to climate change.[258–261] Ouranos participates in the elaboration of a Canadian climate model, high-resolution regional models to study the impacts of climate change.[37] In addition, Ouranos has developed public health programs in collaboration with Health Canada, the Ministry of Health and Social Services of Quebec, and the National Public Health Institute of Quebec.

Quebec, then, already acts proactively with respect to climate-related health risks, as shown by actions related to zoonoses, vector-borne illnesses, climatic catastrophes, heat waves, and air and water pollution.[230,262–270] However, despite Quebec's vigorous actions in implementing adaptation measures, Bourque has found the province lacking in the application of the strategic priority of "communicating and informing, in order to increase awareness and change behaviors" (p. 217, translated).[40] Gosselin also calls for efforts to increase awareness of climate change in the general population, as well as a more effective application of available knowledge – "it is time that research and development activities, until now confined to the Ouranos consortium, begin to be more available in the field" (p. 320, translated).[55]

Characteristics of the proposed program

Quebec, along with the rest of the planet, faces major challenges in terms of effectively managing climate-associated risks as well as strengthening the society's adaptive capacity.[36,37] These challenges are as immense as they are uncertain, but their complexity should not and cannot prevent the public health field from acting.[67–70,73–80,91–93,271,272] Continuing obstacles to 'adaptation to climate change' include lack of awareness of health risks, unequal access to protective measures, limited awareness of the best adaptive actions, lack of collaboration between levels of government, lack of integration of knowledge between sectors concerned by adaptation, and lack of a general program of preparation for natural catastrophes (for both primary and secondary health services). In addition, serious shortcomings have been identified in the education of the general public and of future health care professionals. Several authors have noted lack of efforts at national and international levels for education and awareness raising important issues pertaining to climate-related risk prevention or reduction.[43,55,66,71,264,265] Pointing out the multiple actors that must be reached (individuals, groups, as well as provincial, national, and international actors), public heath scientists have stressed the need to develop strategies of KT adapted to the levels and needs of targeted actors, taking into account the different levels of knowledge at stake.[71,72,272] Application of these strategies must not be 'security oriented,' but rather be 'public health oriented,' according to these authors.[272]

[d] These measures take many distinct forms, and can include behavioral changes, operational modifications, technological interventions, legislation, updating of professional practice, and investment planning.[233]

[e] In terms of the United Nations Framework Convention on Climate Change, participating nations must facilitate adaptation by attenuating ongoing impacts, reducing sensitivity and exposure to climate dangers, and increasing resistance to stressful climatic and nonclimatic factors (strengthening adaptive capacity).

[f] On the basis of the best-known available data, climate change is estimated to have caused 150,000 deaths and 5.5 million DALY (disability-adjusted life years) in the year 2000.

[g] There are several types of adaptation.[234] Adaptive capacity includes *anticipatory* or preventive measures (before observed impacts) and *reactive* or corrective measures (after impacts). Both can be *planned* (products of political decision), but reactive measures can also be unplanned, *spontaneous*, after-the-fact. *Planned adaptation* consists of four phases: 1) information gathering and awareness raising; 2) conception and planning; 3) putting into practice; and 4) surveillance and evaluation.[255]

Quebec does not yet have a structured, coherent program for public health professionals and practitioners addressing the prevention and/or treatment of the physical, psychosocial, and psychological effects of climate change. Furthermore, Quebec does not have a clearly defined process for the application/implementation of available knowledge pertinent to climate change attenuation and the public health system's adaptation to climate change (it must be said that no model for such a 'knowledge-for-adaptive-action' process exists anywhere today in the international scientific literature).

Returning now to our challenges concerning KT on climate change, and taking into account what has been mentioned above, we can now set forth key elements of the research chair's program:

- This program's major theme will be the 'science' and the 'practice' of KT, KT being conceived in the double perspective of process and determinants; this program will touch directly or indirectly five of the nine subdivisions of KT research, and will attempt to respond to three of the four challenges faced by this emerging field today.
- This program will respond to the need to promote scientific and traditional climatic health-related knowledge and to the need to apply this knowledge in an integrated, cohesive manner outside the milieu in which this knowledge was generated, all the while favoring interactions between producers and users of this knowledge.
- This program will respond to the need to train, educate, and increase awareness in several targeted groups, to develop their individual and collective competencies concerning climatic health or to develop the application of these competencies, while keeping in mind the possible need to renew public health knowledge in the context of global climate change.
- The chair is thus primarily oriented toward the training of potential key actors in climate change adaptation as well as to public education, and secondly oriented toward research on the implementation of knowledge pertinent to public health systems' adaptation to climate change.

The chair will be a Quebec partnership/collaborative[h] chair of advanced training, dedicated to the integration and implementation of knowledge relevant to helping health services adapt to climate change. The chair will offer strategic support to Ouranos. In addition, its interventions will be in conformity with Article 6 of the United Nations Framework Convention on Climate Change, and also conform with 'Theme 6' of Quebec's 2006–2012 Action Plan for climate changes (local Agenda 21).

With a continuing relevance perspective, the chair's activities will abide, at both national and global levels, by the overall framework of the United Nations convention, and will aim to promote a strong and fair post-Kyoto agreement that would foster an objectively equitable and durable healthy climate. The scientific activities of the chair can be summarized under the following three headings:

1. Training and education of professionals and practitioners of public health/mental health, as well as of public service managers
2. Increasing awareness of the general public (and working population)
3. Research on the processes and determinants of KT and on knowledge-integration programs: their results, sustainability, and functional optimization.

A partnership/collaborative research chair as a leader in training and communication, and a laboratory for studying climatic health KT

A 'transfrontier' vision

The chair is 'transfrontier,' promoting the innoversity[273] (the dynamic relationship between innovation and diversity) and complex collaboration[170,171] essential for establishing 'transfrontier KT' for an evidence-based, equitable, and sustainable climatic health.

The 'transfrontier' aspect of this vision[259] refers to a KT that would ideally be:

- Transsectoral – the program seeks to transcend hermetic sectoral compartmentalization of knowledge among key actors for adaptation.
- Transdisciplinary[i] – the program seeks to break down disciplinary barriers (eg, clinical sciences, public health science, social sciences (eg, communication sciences, anthropology, and ecology), cognitive engineering, and climate science) and exclusionary schools of thought between key actors.
- Transnational – the program seeks to transcend spatial boundaries between agents as well as spatiotemporal boundaries between their knowledge bases.
- Transinstitutional – the program seeks to transcend institutional boundaries between agents, in terms of institutional cultures, silos, practices, as well as divergent stakes, interests, and programs.

[h] *Université de Montréal (Département de psychiatrie; Centre de recherche Fernand-Seguin de l'Hôpital Louis-H Lafontaine) and Institut national de santé publique du Québec* (Canada).

- Transcognitive – the program seeks to transcend the cognitive forms that characterize various disciplines, which may facilitate work and communication within a discipline but render it less accessible to other specialists, as well as to transcend the various supports, media, and practices related to these disciplines.
- Trans-knowledge level – the program seeks to integrate the various levels of knowledge ('micro' level or individual level, 'meso' level or team level/unit level, 'macro' level or organization level/policy level).
- Transcultural – the program seeks to transcend cultural and ethnic boundaries by promoting local cultures of contributing agents (eg, traditional knowledge and practices), mobilizing, and integrating them without excluding their particularities.

Mission, general objectives, and programmatic axes

In collaboration with its partners, the research chair's mission is to accomplish the following:

- Contribute to scientific progress of 'knowledge-for-adaptive actions,' and to the practice/science of KT related to the adaptation of public health and the public sector to climate change, by developing a 'transfrontier KT' approach, which implies studying KT determinants and KT programs optimization in order to strengthen the public health systems' adaptive capacities to climate change
- Support a deeper understanding of the challenges of adaptive management of climate change by:
  - Contributing to the development of competencies in climate-influenced health sciences and/or the communication of knowledge to public health practitioners and to public sector managers
  - Contributing to public awareness of the importance of climate change for health
  - Contributing to the updating of existing training programs in public health and public administration, in the context of globalization, of changes in the public health sector, and in the changing learning approach[275]
- Innovate conceptually in studying, developing, and communicating the concepts of 'evidence-based climatic health' (*santé climatique factuelle* in French), 'climatic stress,' 'climatic trauma,' and 'climatic mental health' (*santé mentale climatique* in French), at a national and international level
- Facilitate individual and collective partnerships that cross geographic, disciplinary, sectoral, and even cognitive boundaries, in order to favor more effective responses to climate change and to KT related to the major contemporary issues (globalization, sustainable development, and transfrontier education; ecolearning and ecocompetencies in public health; and transdisciplinarity in KT research)

The general objectives of this transfrontier knowledge-for-adaptive-action program in climatic health are presented in Table 1.

The chair's program includes five major themes in training and programmatic research axes in climatic health, which are as follows:

1. Extreme weather conditions, biopsychosocial vulnerabilities, and mental health (in French: *Aléas hydrométéorologiques, vulnérabilités biopsychosociales et santé mentale* axis)
2. Transfrontier education, collaborative ecolearning, and collective competences in climatic health (in French: *Éducation transfrontières, écoapprentissages collaboratifs, compétences collectives en santé climatique* axis)
3. North-South/West-East French-speaking world and Web-hypermedia learning tools in climatic health (in French: *Francophonie Nord-Sud/Est-Ouest, technopégagogies et autoformation Web-hypermédia pour la globalisation des apprentissages* axis)
4. Climate, working people, and mental health (in French: *Climats, travail et santé mentale* axis)
5. Innovations, technologies, theories, and models in evidence-based climatic health (in French: *Innovations, technologies, théories et modèles interactifs en application transfrontières des savoirs* axis)

Conclusion

This article has presented the transfrontier vision of a training and research program stressing innoversity and complex collaboration. Any reader interested in discussing these issues, or in collaborating in their study, is invited to communicate with the first author. Whether you be North or South/West

[i] Transdisciplinarity as a form of knowledge translation research is driven by the need to solve problems of the lifeworld. By transcending disciplinary paradigms, transdisciplinary knowledge translation research is challenged by the following requirements: to grasp the complexity of the problems, to take into account the diversity of scientific and societal views of these problems, to link abstract and case-specific knowledge, and to constitute knowledge with a focus on problem solving for what is perceived to be the common good. (p. 19)[274]

Table 1 General objectives of the transfrontier knowledge-for-adaptive-action training and research program

Objective 1	Communicate to public health practitioners and public service managers the urgency and high priority of combating the negative effects of climate change, help make them ready and able to assume their complex role in the face of the challenge of understanding and fighting climate change armed with the latest pertinent knowledge
Objective 2	Increase awareness among the general public, public health practitioners, and public service managers, regarding the health-related impacts of climate change at the local, national, and global levels, by means of informative and knowledge-application activities
Objective 3	Develop and reinforce, among the general public, mental health professionals, public health practitioners, and public service managers, the capacity to identify, understand, define priorities, and apply adaptive measures
Objective 4	Develop an andragogy program of in-service training to provide basic, factual information on climate change to public health practitioners and public service managers
Objective 5	Develop and suggest addendums to existing university and college programs that are related to public health and health sciences, to add pertinent elements concerning the challenges of climate change and knowledge translation
Objective 6	Promote fruitful exchanges among students, researchers (in public health sciences, clinical sciences, social sciences, public administration, climate science, and knowledge translation sciences), public health practitioners, and public service managers, as well as the general public, on subjects related to the application of knowledge to climate-change-related challenges, namely by: • Collaborating and partnering with other chairs, research centers, and external partners; • Organizing 'transfrontier' events pertaining to climate health and adaptive management of climate-change-related risks; • Offering research scholarships to master's and doctoral students; • Welcoming sabbatical professors in health, social sciences, and public administration.
Objective 7	Participate in public discussions and debates on the application of knowledge to climate change challenges in public health, ecotraining in public health, and new evidence-based training programs in climatic health
Objective 8	Develop a research program on the application of knowledge to climatic health, so as to • Better understand the concepts, theories, and practices that underlie an effective knowledge translation, as well as a transfrontier integration of knowledge pertinent to the adaptation of public health and the public sector to climate change; • Better understand possible interrelations between the determinants of knowledge translation, and the determinants of the public sector's adaptive capacity.
Objective 9	Participate in complex collaborative research on the transfrontier application of knowledge related to public sector adaptations to climate change, for example: • Synthesis of knowledge and development of a theoretical model of the application of climate-change-related knowledge; • Development of a technological infrastructure to facilitate the translation of climatic health knowledge; • Optimization of strategies for the translation of climatic health knowledge; • Evaluation of the effectiveness of climate-change-related knowledge translation strategies; • Delineation and analysis of the know-do gap in climatic health; • Study of the micro/macro interrelations between the determinants of knowledge translation and the vulnerabilities and behavioral changes in vulnerable populations.

or East, an individual or an institutional actor, and regardless of your disciplinary affiliation, we hope to share with you this new vision of a transfrontier KT and education for an evidence-based, equitable, and sustainable climatic health.

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