2009

How Do We Come to Know? Exploring Maple Syrup Production and Climate Change in Near North Ontario

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Abstract

This paper reports on a pilot project exploring the impacts of climate change on maple syrup production in understudied near north, Ontario spaces. Maple syrup is produced by settler, Métis and First Nations communities for commercial distribution and as part of a mixed subsistence economy. The focus on maple syrup is opportune, since syrup production and sugar maple trees (*Acer saccharum*) are extremely susceptible to climate change and the biophysical and social impacts of climate change on maple syrup production in the near north of Ontario have yet to be understood. Given that the process of developing research is under-reported and that this project has had the opportunity to undertake a funded development process, this paper describes and assesses our process of 'coming to know', which has been guided by the following objectives: 1) to undertake an exploratory investigation of the nature of available data about long-term syrup production and climate change in both settler and Indigenous communities, 2) to include and valorize marginalized Indigenous voices and ecologies, 3) to focus on collecting climate change data from understudied near north spaces, 4) to assess the availability and quality of ecological and quantitative data in order to enhance locally-relevant understandings of climate change, and 5) to work towards the development of a cross-cultural and transdisciplinary methodological framework within which to accomplish the first four objectives. We approach these objectives across disciplinary boundaries and cultural perspectives, and with growing relationships with community partners. We describe

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the rich sources of information found through the pilot study and discuss highlights of our on-going process of developing our research project.

Résumé

Cet article porte sur un projet pilote qui explore les répercussions du changement climatique sur la production de sirop d'érable dans les espaces du Nord proche de l'Ontario, très peu étudiés. Le sirop d'érable est produit par les communautés de colons, de Métis et de Premières nations pour la vente commerciale et dans le cadre d'une économie mixte de subsistance. L'attention que l'on porte au sirop d'érable est fort à propos, puisque la production du sirop et les érables à sucre (Acer saccharum) sont très sensibles au changement climatique et que les répercussions biophysiques et sociales du changement climatique sur la production de sirop d'érable dans le Nord proche de l'Ontario ne sont pas tout à fait comprises. Étant donné que le processus de la recherche en développement n'est pas encore documenté et que ce projet a été une occasion d'entreprendre un processus de développement financé, cet article permet de décrire et d'évaluer notre processus de « commencer à connaître », qui a été guidé par les objectifs suivants : 1) entreprendre une investigation exploratoire de la nature des données disponibles sur la production à long terme du sirop et le changement climatique, tant dans les communautés de colons que les communautés autochtones; 2) inclure et valoriser les voix et les écologies marginalisées des Autochtones; 3) porter une attention particulière à la cueillette de données sur le changement climatique dans les espaces peu étudiés du Nord proche; 4) évaluer la disponibilité et la qualité des données écologiques et quantitatives afin d'améliorer la compréhension localement pertinente du changement climatique; 5) travailler vers l'élaboration d'un cadre de travail méthodologique transculturel et interdisciplinaire dans lequel nous pourrons réaliser le premier de nos objectifs. Nous abordons ces objectifs au-delà des frontières des disciplines et des points de vue culturels et en établissant des relations plus étroites avec les partenaires communautaires. Nous décrivons les riches sources d'information que nous avons trouvées par le biais de l'étude pilote et analysons les points saillants de notre processus continu d'élaboration de notre projet de recherche.

Key Words:
Climate change, maple syrup, transdisciplinary, methodology, research development, Indigenous peoples, Ontario

Introduction

This paper reports on an exploratory pilot project that highlights the impacts of climate change on maple syrup production in understudied near north, Ontario spaces. The near north is a transition zone between southern deciduous and northern boreal forests. In Ontario, maple syrup production is centered in Lanark County and the Waterloo region, with many other areas throughout the province, including the near north, also involved in the industry. Although initially an Indigenous technology, maple syrup is now produced for commercial distribution and is also part of a mixed subsistence economy involving settler, Métis and First Nations communities.

The purpose of this paper is to report on the on-going process of developing our research project about maple syrup production and climate change. Whilst the importance of carefully thinking about methodology and methods has been highlighted among critical Indigenous and non-Indigenous scholars (e.g. Battiste and Henderson 2000, Krupnik and Jolly 2002, Lawrence and Despres 2004), research teams are often under resource pressure to move quickly towards 'doing' the research rather than thinking about the project approach. Further, final project manuscripts predominantly focus on outcomes, rather than on the process; the initial thinking, framing, and development of a research agenda tends to receive far less attention than the reporting of empirical results (although see Nielsen-Pincus and Wulfhurst 2004, Gough and McGregor 2007). Given that the process of developing research is under-reported and that our project has had the opportunity to undertake a funded development process, this paper describes and assesses our process of 'coming to know'. The paper focuses on outlining the insights, objectives and preliminary data collection exercises that underpin our on-going research.

The pilot project is guided by the following objectives. The first objective is to undertake an exploratory investigation of the nature of available data about long-term syrup production and climate change in both settler and Indigenous communities. We hypothesized that since maple syrup has been produced for centuries and production is closely tied to weather patterns, there may well be longitudinal local data (e.g. oral histories and diaries) about climate variability and climate change. The second objective is to include and valorize marginalized Indigenous voices and ecologies. Although maple syrup is an Indigenous technology, most accounts of modern syrup making focus on settler communities. Furthermore, this study explicitly includes Métis voices – voices that are often missing in climate change research and reporting.[1] The third objective is

[1] For instance in Pearson and Burton (2009), *Adapting to Climate Change in Ontario*, First Nations garnered their own section and the term 'First Nations' appeared 19 times in the text. The term Métis is completely absent.

to focus on collecting climate change data from understudied near north spaces. The literature review revealed that climate change research and its associated literature focus primarily on the Arctic and more southern locations, with very little research undertaken in near north spaces. The fourth objective is to assess the availability and quality of ecological and quantitative data in order to enhance locally-relevant understandings of climate change. As Pearson and Burton (2009: 67) assert, "Understanding of long-term climate change impacts on a local scale is still in its infancy." The focus on maple syrup is opportune, since maple syrup production and sugar maple trees (*Acer saccharum*) are extremely susceptible to climate change and the biophysical and social impacts of climate change on maple syrup production in Ontario have yet to be understood. The final objective is to work towards the development of a cross-cultural and transdisciplinary methodological framework within which to accomplish the first four objectives. We argue that there is a need to distinguish between multi-, inter-, and trans-disciplinary approaches (which, for simplicity, we call M-I-T approaches) and research that occurs in a cross-cultural setting.

The research reported on in this paper is part of a larger program of work that has involved a subsequent Research Development Initiative (Social Science and Humanities Research Council, SSHRC). We approach the question of climate change and maple syrup production from Indigenous and non-Indigenous ways of knowing. For the first two phases of the project the research team has been composed of a Métis Indigenous/Humanities-based scholar (Chrétien), a non-Indigenous social scientist in geography-resource management (Murphy) and a non-Indigenous physical scientist in geography-geomorphology (Brown), with involvement of several producers. As relationships and expertise have developed over the last three years we are beginning to involve a larger team of academics as well as explicit partnerships with producers and their communities. This opportunity to pilot and develop the project, we argue, is fundamental to undertaking research that cuts across academic disciplines and across cultural boundaries. This paper specifically focuses on reporting our processes of 'coming to know'; on the processes related to theory building, methodological development and the evolution of empirical knowledge. For this pilot study we have been collecting data since June 2008 and have found a rich source of information that has the potential, at the local scale, to detail the impacts of climate change on syrup production. In this paper we will first problematize and offer some initial insights associated with each of the objectives. We will then report on our initial empirical findings and outline some of the challenges and opportunities inherent to this type of research.

Context: Maple Syrup, Climate Change and Knowledge

This section lays out the five key objectives for the pilot study and explains and contextualizes the reasons for focusing on maple syrup, climate change, and the near north. Through the explanations associated with the first four objectives, we summarize the current knowledges (and gaps) about maple syrup and climate change. Through the fifth objective, we emphasize and delineate part of our process of 'coming to know'. Although in the subsequent section we report on data gathered from both settler and Indigenous communities, in this section we particularly emphasize Indigenous issues, since a coordinated study of Indigenous maple syrup production and the impacts of climate change has yet to be undertaken.

Data Availability

Maple syrup was originally produced by North America's Indigenous peoples as part of their subsistence economy and was one of the early goods traded with European settlers (Pendergast 1982, Rekmans 2002). Today, maple syrup is only produced in two countries, Canada and the USA, with Canada accounting for 87% of that production (Agriculture and Agri-Food Canada 2006: 4). Within Canada, most syrup is produced commercially in Quebec (93%) followed by Ontario at 3.5% of the market. The Ontario market is valued at $10.9M, with production mostly centered in Lanark County and the Waterloo area (Agriculture and Agri-Food Canada 2006: 6). Currently, both settler communities and Indigenous groups continue to participate in the maple syrup market, many using modern management techniques and approaches (Rekmans 2002).[2] Others, including some Métis families and First Nations communities in Ontario's near north, use maple syrup as part of a mixed economy that includes subsistence activities and ongoing traditional relationships to the land. 'Wild' maple syrup, including that produced by one of the authors' (Chrétien) family, is harvested from mixed stand forests in a near north environment, produced through more traditional approaches and then distributed among the extended family and community. Given that maple syrup production is a vibrant component of the Canadian landscape and has such a long history, the study posited that many Indigenous and settler producers would have long-term oral and written histories documenting ecosystem change, climatic variability and long-term climate change. Hence, *the first objective of the study is to undertake an exploratory investigation of the nature of available data about long-term syrup production and climate change in both settler and Indigenous communities.*

Highlight Marginalized Indigenous Voices and Knowledges

The second objective of the research is to include and valorize marginalized Indigenous voices and ecologies. Despite ongoing Indigenous relationships with syrup production and maple forest ecosystems, there is virtually no research or publication that highlights current Indigenous production patterns, technologies and knowledges.[3] This is in sharp contrast to the vast array of information available about settler communities and commercial production. It is also important to note that much research dealing specifically with Indigenous Knowledge (IK) in assessing and understanding the impacts of climate change is focused on the Arctic and Inuit and other northern peoples (e.g. Cohen 1997, Fenge 200l, Krupnik and Jolly 2002, Laidler 2006, Thorpe 2000, Wolfe *et al*. 2007). In southern Canada, urban and agricultural landscapes have received significantly more attention than woodlot spaces (e.g. de Loe *et al*. 2001, Ivey *et al*. 2004). Some studies integrating IK in more southern regions do not specifically

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[2] See, for instance, Awazibi Maple Syrup, http://www.kza.qc.ca/awazibi.php

[3] Although most sources acknowledge the Indigenous origins of the technology; e.g. Eagleson and Hasner (2006).

deal with climate change (e.g. Davidson-Hunt and Berkes 2003), although the study of Walpole Island First Nation sponsored by NRCan (RFI 2004), the *Native Peoples-Native Homelands Climate Change Workshop* through the U.S. Global Change Research Program (Maynard 1998) and the *Climate Change Planning Tools For First Nations* (INAC 2006) are notable exceptions. Further, recent literature on landscape change (Mannion 2002) and climate change (Poelzer 2002) has begun to emphasize the importance of Indigenous voices and IK in scientific research (Bassett and Zueil 2003, Berkes 1999, Hanna and Slocombe 2007).

Existing research about IK also reveals other substantial gaps and challenges. As noted by Cruikshank (2001), difficulties facing environmental researchers attempting to integrate IK into their work often include a lack of knowledge about ethnographic methods in the field, and a lack of understanding of how to interpret oral narratives in scientific research. Methodological challenges can be further exacerbated by the tensions arising from outsiders conducting research in Indigenous communities. Finally, the need for researchers to be more transparent and respectful in using IK, and the intellectual property issues that arise in integrated research, have only recently been acknowledged in environmental research (INAC 2006, RFI 2004, Brascoupé and Mann 2001, Smith 1999, Battiste and Henderson 2000). Virtually none of the research mentioned above includes Métis voices.

Focus on Understudied Climate Change in Near North Spaces

The third objective is related to geography and the availability of climate change data and models. In Ontario, maple syrup production occurs across a significant part of the province. The Ontario Maple Syrup Producers Association[4] has divided the region south of Sault Ste Marie and Temagami into ‘locals’, for example the Algoma local includes Sault Ste Marie and the Algonquin local includes Temagami. These two northern locals as well as the locals of Lanark and Eastern Counties and the more northern parts of the Haliburton, Renfrew and Quinte locals, are all part of the ‘near north’; ecologically defined as the Great Lakes-St. Lawrence (GLSL) forest region (Figures 1 and 2). The more southern parts of these latter three locals, plus the remaining maple syrup production areas, are part of southern Ontario, within the Deciduous forest region. Southern Ontario is dominated by deciduous forests (e.g. non-conifer species including maples) and is characterized by the highest population densities in Canada, with the land base quite heavily urbanized. That said, significant parts of southern Ontario remain rural. For instance, in the Waterloo-Wellington maple syrup local, over 80% of the land is rural, including crop/animal based agriculture, woodlot production (e.g. logging and maple syrup production) and natural spaces (Nelson *et al*. 2004). In contrast, both ecologically and demographically, the near north region is a zone of transition between northern and southern Ontario. Ecologically, it is a transition zone between southern deciduous and northern boreal forests (Ontario Ministry of Natural Resources 2006). Demographically, the near north is characterized by smaller towns, often widely dispersed along transportation routes and the area is “frequently dependent on climate-sensitive economic

[4] See http://www.ontariomaple.com/

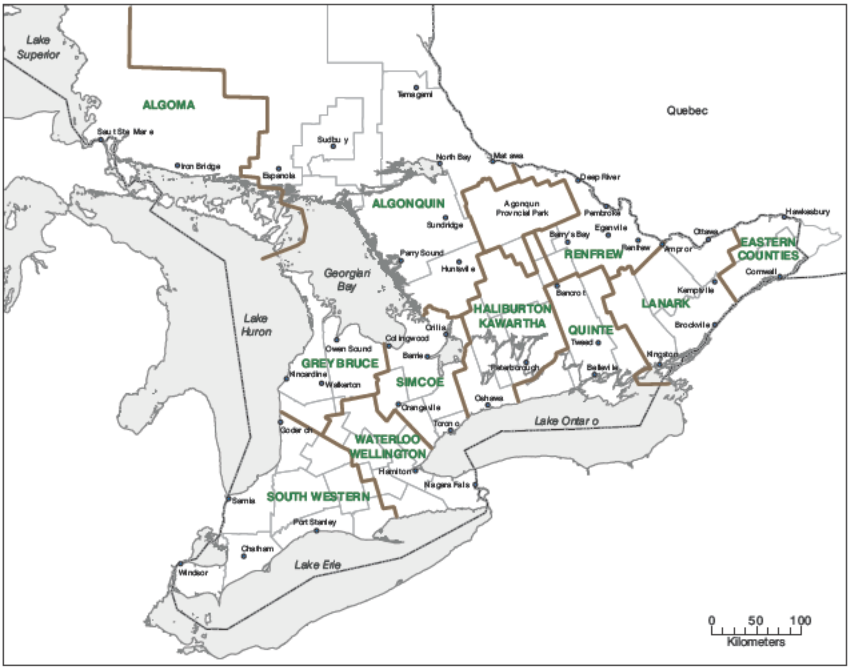
activities, especially forestry and tourism" (Pearson and Burton 2009: 65). Further, the majority of the northern population tends to cluster along the southern extremes of northern Ontario; that is within the Great Lakes-St. Lawrence Forest ecozone.

Globally, the IPCC (2007: 2) *Fourth Assessment Report* states that "warming of the climate is unequivocal". Since Ontario is a large province with diverse ecoregions and climates, the impacts of climate change will vary. On average, Ontario temperatures are expected to increase by 2.5 -3.7°C, with larger increases predicted across the North (Pearson and Burton 2009: 15). The potential for increased water stress in the summer (e.g. drought) is more likely in the southern Deciduous ecozone. In the near north, the temperatures are expected to increase by 3.0-3.3°C, with precipitation, both snow and rain, increasing in the

Figure 1: Forest Regions of Ontario

winter and spring seasons (Pearson and Burton 2009: 16). "If these predictions are realized, the summer temperature regime in Sudbury at the end of the next century would be similar to the current summer temperature regime in Windsor" (Flannigan 1998: 2.2). These trends will have mixed and uncertain results for Ontario's forests, including sugar maples. First, there is a strong possibility that increased warming will lead to increasing levels of evapotranspiration which will tend to reduce soil moisture and limit the distribution of some species (Papadopol 1998). Increasing temperatures will be particularly noticeable in the spring and fall seasons (Alpine 1998). These changes could affect freeze-thaw cycles and will lead to increased disturbance from extreme weather events, insects and forest fires (Agriculture and Agri-Food Canada 2006, Pearson and Burton 2009, Parker 1998). Second, an increase of even 3°- 4°C may result in a 300 km northern migration of some tree species, but this may be hindered by the lack of suitable soils, since acidic soils are not suitable for hardwoods, such as maples (Parker *et al*. 1998). Third, climate is expected to change at a faster rate than many trees species can migrate. However, in areas not subject to drought diebacks (and where suitable soils exist), sugar maples are thought to have a good potential to spread northward (Pearson and Burton 2009). Fourth, Karnosky *et al*. (2007) note that a nine year study assessing the direct effects of elevated carbon dioxide on forest productivity suggests that, unlike some species (e.g. paper birch and trembling aspen), sugar maples show no detectable stimulation in photosynthesis or growth when CO_2 levels are increased to simulate climate change conditions. They conclude that climate change could lead to an altered

Figure 2. Ontario Maple Syrup Producer Association Regions (Locals)



tree species composition, with other species out-competing sugar maples.

Thus, as exemplified by the myriad and often conflicting projections for the future of sugar maples under a changed climate, there is a tremendous amount of uncertainty regarding how climate change has or might affect specific tree species and ecosystems in the near north. In Canada, part of the problem is that global model projections do not easily capture such factors as lake effect snow and rain (Pearson and Burton 2009). For instance, Pearson and Burton (2009) assert that understanding the impacts of climate change on agricultural areas in Ontario, requires local-scale modeling, including the influence of the Great Lakes. They also maintain that the development of locally relevant climate change predictions and solutions requires local knowledge from farmers and the traditional knowledge of Indigenous elders. Given these contexts, *the third objective of this research is to collect climate change data from these understudied rural and near north spaces.* As we argue below, from an ecological perspective, focusing on maple syrup production and maple tree ecosystems is an opportune context for exploring climate change and its impacts.

Focus on the Development of Locally-Relevant Climate Change Data

The fourth objective of this research is to assess the availability and quality of ecological and quantitative data in order to develop locally-relevant understandings of climate change. Ecologically, despite the uncertainty described above, maple syrup production is a good indicator of the changes in climate because sugar maple trees (*Acer saccharum*) are extremely susceptible to mid-winter thaws and summer droughts and a successful maple syrup season is dependant upon the right combination of weather conditions for sap to run. Sap collection is limited to a few weeks each spring season when the night temperatures are approximately -4 to -6°C and day time temperatures hover above freezing within a range of 2 to 7°C. Although sap may continue to run beyond this narrow temperature range, the quality of the syrup declines. The sugar maple trees thrive where summers are cool and moist and soils are slightly acidic. They are not tolerant of hot drought-like summers and can suffer dieback due to moisture deficiency. Weather events such as late spring frosts, and midwinter thaw/freeze cycles can also affect tree vigor and lead to mortality (Horsley *et al*. 2002).

In some preliminary research from the American Vermont Proctor Maple Research Center, Tim Perkins (2007) suggests that climate change over the next 50-100 years will affect maple syrup production in New England and New York in three key ways. First, an earlier season start is predicted (an 8.2 day earlier season start is evident, compared to 40 years ago), second, climate change may reduce season duration (a 3.2 day shorter season is evident, compared to 40 years ago; this is a 10% loss), and third, increased uncertainty regarding season timing is likely. These first two trends are significant, even when accounting for climatic variation, changing technologies, etc. The third trend is important since it increases the uncertainty associated with the timing of inserting the taps; these were traditionally inserted using historical patterns and dates. Taps must be inserted early enough to catch the first sap flow, but not too early or the tap holes 'dry out'. Perkins notes that beyond more efficient technologies that have helped to maintain production levels, there has been little investigation of potential adaptive strategies to reduce the impacts of climate change.

Ultimately, his predictions for the New England and New York maple syrup industry and maple ecosystems are dire: maples, along with other more northern species, are likely to be extirpated from the region over the next 100 years, supplanted by an oak-hickory-pine dominated forest. "In the long-term, the migration of the maple resource will render even hobby maple production impossible in the U.S." (Perkins 2007: 9). In Canada, similar studies have not yet been undertaken; however, data from one farm in Lanark County did demonstrate a long-term trend towards an earlier production season (Mcleman and Gilbert 2008). Our research program is positioned to address these various research gaps and questions.

Multi-Inter-Trans-Disciplinary and Cross-Cultural Approaches

The final objective of the research is to work towards the development of a transdisciplinary and cross-cultural methodological framework within which to accomplish the first four objectives. We argue that there is a need to distinguish between multi-, inter-, and trans-disciplinary (which we are referring to generically as M-I-T) approaches and research that occur in a cross-cultural setting.

There is a growing body of research about climate change that integrates western perspectives and Indigenous ways of knowing. For instance, in addition to those listed above, Dolan and Walker (2003) assess the effects of climate change on First Nations on British Columbia's west coast and Ford *et al*. (2006) and Laidler (2006) both integrate Inuit and western science perspectives on climate change within Arctic environments. We argue that bridging the divide between these different 'ways of knowing' is an opportunity for an inter-cultural evaluation of climate change; this requires attention to issues that are not necessarily addressed by a methodology based on M-I-T approaches (Murphy, in press). In other words, M-I-T approaches cannot, and should not, be conflated with working in a cross-cultural context. Further, as demonstrated in recent Arctic research (e.g. Krupnik and Jolly 2002), IK is not 'pan-Aboriginal' (Chrétien and Murphy, in press); there are differences amongst Indigenous ways of knowing, for instance, between First Nations, Inuit and Métis perspectives and within each of these groups. These two specific assertions are explored below.

First, the literature on the various aspects of M-I-T approaches is focused primarily on understanding the nature of academic disciplines and the extent to which disciplines can, or should, engage in integrated research (Horlick-Jones and Sime 2004, Lawrence and Despres 2004, Nielsen-Pincus *et al*. 2007). Generally speaking, complex problem foci, such as climate change, are considered key areas where M-I-T perspectives are most useful in developing a more complete understanding of the issues at hand. M-I-T approaches range from multidisciplinary through to transdisciplinary. Multidisciplinary approaches are additive (Vance *et al*. 1997, Farnell *et al*. 2004), interdisciplinarity looks for synchronization (Kruse *et al*. 2004, Wolfe *et al*. 2007) whereas transdisciplinary research attempts to transcend disciplinary boundaries (Despres *et al*. 2004, Cruikshank 2001) (see Table 1). Overall, research approaches that move away from the multi-disciplinary perspective have greater capacities to meaningfully incorporate other stakeholders and other ways of knowing from outside the academy including all levels of government, private industry, non-government organizations, local communities and Indigenous peoples.

Table 1. Comparison of M-I-T Approaches

Disciplinary Approach	Style of Interaction	M-I-T-Disciplinary Engagement	Nature of Results	Outside Stakeholder Engagement*
Multi-disciplinary	May or may not be interaction amongst disciplines	Work within own knowledge framework	Coordinated, but separate results for each discipline	If involved, support disciplinary requirements
Inter-disciplinary	Collaborative	Develop integrated concepts that include all disciplines involved	Synchronization across disciplines	Could be significant, but academic perspectives predominate
Trans-disciplinary	Transgressive	Develop new models, beyond any of the disciplines involved	Results evolve from new models, transcend disciplinary boundaries	Where involved, valued partners, contr bute to new models and results

*Not necessarily part of any M-I-T research

Adapted from Despres *et al*. (2004), Horlick-Jones and Sime (2004), Lawrence and Despres (2004) and Nielsen-Pincus *et al*. (2007).

The key point is that the literature on M-I-T has been very much focused on understanding the relationships among and between disciplines, rather than on inter-cultural research per se. In the M-I-T literature the academic lens is focused, reflexively, on the scholars themselves, rather than being primarily concerned with 'other' ways of knowing beyond western frameworks. To date, however, climate change studies do not always make this distinction and conflate M-I-T with research in a cross-cultural context (see for instance Wolfe *et al*. 2007, Hanna and Slocombe 2007). Many climate change studies tend to adopt the nomenclature of multi-inter-trans-disciplinarity when undertaking research involving cross-cultural contexts, such as combining Indigenous and non-Indigenous ways of knowing (Murphy, in press). This can be problematic because it may not specifically require the scholarly team to acknowledge and reflect upon their own knowledge frameworks,[5] assumptions and biases (Smith 1999). To begin the process of understanding the underlying knowledge frameworks that underpin this project, the research team undertook a self-reflective exercise (see below).

The conflation between M-I-T and cross-cultural approaches may also result in the requirement that 'other' knowledge frameworks (e.g. IK), defacto, must be validated and justified against the dominant western scientific paradigm and that research questions and results are designed to meet the needs of the scientific team (Battiste and Henderson 2000).[6] Further, while climate change

[5] Knowledge is defined as a set of ideas, accepted by a social group, pertaining to what they accept as real.

[6] Although there are some notable exceptions e.g. Krupnik and Jolly (2002).

studies may integrate Indigenous peoples and knowledges, it has been difficult to fully capture their perspectives since Indigenous ways of knowing have typically been inserted into a western paradigm (Dei and Johal 2005, Wolfe *et al*. 2007). Houde (2007) suggests that IK consists of six interconnected faces: factual observations, management systems, past and current uses, ethics and values, culture and identity, and cosmology. The first three faces are more easily integrated into the predominant western research agendas, including climate change, since these are focused on scientific or instrumental knowledges. The latter three, reflecting ethical and aesthetic knowledges are less likely to be easily integrated into mainstream studies (Houde 2007, Murphy, in press). As outlined below, our team became quite cognizant of this academic tendency to focus on instrumental knowledges as we began to undertake pilot interviews. We went in (initially) to talk about climate change, whilst respondents proceeded to share with us a range of knowledges about their sugar bushes. Thus, we argue that research projects involving multiple scholars *and* multiple ways of knowing must be actively aware of the knowledges being highlighted or marginalized through their research.

The second assertion we make revolves around cross-cultural differences as well as differences between and within IK frameworks. A mainstream definition of IK is

> *…a cumulative body of knowledge and beliefs, handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environments (Berkes 1999: 8).*

Battiste and Henderson (2000) emphasize that IK is a complete knowledge system focused on processes and relationships, rather than objects (which is a western tendency). This is reflected in Indigenous languages, which are typically verb-based (action, process), rather than rooted in nouns (things). The continued insistence on this point – on this emphasis about the process and relationships of ‘coming to know’ – by the Indigenous scholar on our team (Chrétien) has influenced this research program away from objectifying knowledge outcomes and towards ac*knowledging* the research process as a fundamental component of ‘doing’ research.

Despite the general similarities amongst Indigenous knowledge systems, the specifics regarding the nature of IK varies by perspective and by the Indigenous group involved. Houde (2007: 36) asserts that because IK “connects such varied dimensions as the type of knowledge, the identity of knowledge holders, and the process of knowledge acquisition” there are a great variety of definitions and an extensive nomenclature associated with IK. For instance, a broad typology of IK includes Traditional Ecological Knowledge (TEK), Aboriginal Traditional Knowledge (ATK), Traditional Knowledge (TK), and more recently, *Inuit Qaujimajatuganquit* (IQ) and Métis Indigenous Knowledge (MIK) (Chrétien and Murphy, in press). In terms of IK, we argue that climate change research must carefully differentiate among IK knowledge systems. This has been acknowledged in the IK and climate change literature (e.g. Jolly and Krupnik 2002), and will be an important dimension of future phases of this research program.

Methodological Opportunities

In summary, in this paper we argue that the focus on maple syrup production provides the following methodological opportunities. Historically, since maple syrup production is an important part of our Canadian heritage, dating back to the pre-colonial landscape, we suggest that the available oral narratives and recorded documentation potentially provide a rich source of data with which to evaluate climatic changes in this environment. From the perspective of justice, the study highlights maple syrup as an Indigenous technology and features marginalized Indigenous voices. Spatially, the impacts of climate change on near north and some rural spaces have received less attention; this paper focuses on these spaces. Next, since maple syrup production and maple tree ecosystems are good indicators of climate change and these ecosystems and practices occur throughout much of the understudied near north spaces in Ontario, this problem focus provides an excellent opportunity to evaluate local impacts of climate change and develop locally relevant data. Finally, from an epistemological perspective, the M-I-T-disciplinary and cross-cultural nature of maple syrup production provides an opportunity to access multiple 'ways of knowing' about climate change including humanities/social science/physical science knowledges, Indigenous knowledges and local knowledges. Since this type of problem focus demands data from a wide range of sources, we argue that the theoretical approach underpinning the research should adopt an explicitly M-I-T-disciplinary and cross-cultural approach in order to equitably incorporate all relevant knowledges from across the disciplines and ways of knowing.

Pilot Project Data

Within the context of the objectives and arguments developed above, this section is a summary of the pilot project to evaluate the potential of utilizing maple syrup production and maple tree ecosystems to assess the impacts of local and regional climate change in Ontario. The purpose of this section is to outline our initial process of exploring the nature and richness of available knowledges. Notice that from a much wider range of potential scholarly knowledges about climate change and maple syrup, the data collected and the methods used reflect the training of the three researchers. Although it makes sense to start with what we know best, the partiality of the produced knowledge must also be recognized. Thus, even a whole-hearted embrace of an M-I-T approach can leave many knowledges marginalized – even among scholarly disciplines. Being aware of both the strengths and gaps in our research process will ultimately impact the direction and team composition of our future research program.

The pilot project reported on here is exploratory in nature; it is less focused on final results. Instead, the study seeks to identify, develop and evaluate the methods, approaches, data availability and quality, partnerships, knowledges, etc. that have been/will be used in past and subsequent studies. In future studies we will also move beyond impact assessment to investigate opportunities for the development of adaptation and resiliency. In this paper we report on the findings of the initial pilot study.

To meet the objective of developing an M-I-T-disciplinary and cross-cultural approach, an extensive review of the IK and cross disciplinary literatures has been undertaken. Some of this broader conceptual development is reported in two new papers: Chrétien and Murphy (in press) and in a second manuscript currently under review. The initial research team (Murphy, Chrétien and Brown) has been mindful of the differences between multi-, inter-, and trans-disciplinary approaches and is striving for an approach that moves towards the latter pole. Towards that end, the literature on M-I-T-disciplinarity suggests that awareness of personal knowledge frameworks and opportunities to develop transcendent approaches benefits from prolonged and frequent face-to-face interaction of the project team in which key ideas and terms as well as taken-for-granted understandings can be discussed, challenged and reflexively negotiated. Academic reflexivity requires the team to reflect critically on its relationships and its approaches to undertaking research (Bevan 2007). Thus, the team has had several meetings in which it became quite clear that even among three academics who are long-time friends, the understandings of the key components of a maple syrup production system and the impacts of climate change on such a system can be quite divergent. For instance, during one exercise, the geomorphologist on the team (Brown) was more focused on the physical aspects of 'what makes the sap run' (e.g. temperature), the humanities-based Indigenous scholar (Chrétien) was more interested in the relationship of Indigenous peoples to the land base, and the environmental geography scholar's focus (Murphy) was on such issues as land management and tenure. This latter member took the lead on translating comments made during the session about the relationship between maple syrup and climate change into a mental map[7] (Figure 3). Interestingly, on viewing the final product the Indigenous scholar, Chrétien, did not feel that it fully captured her ideas, whilst it lined up far more closely with that of Brown and Murphy. In fact, in retrospect, it seems quite clear that for Murphy, her 'academic roots' (systems theory perhaps?!) undermined her ability to fully understand Chrétien's perspective.

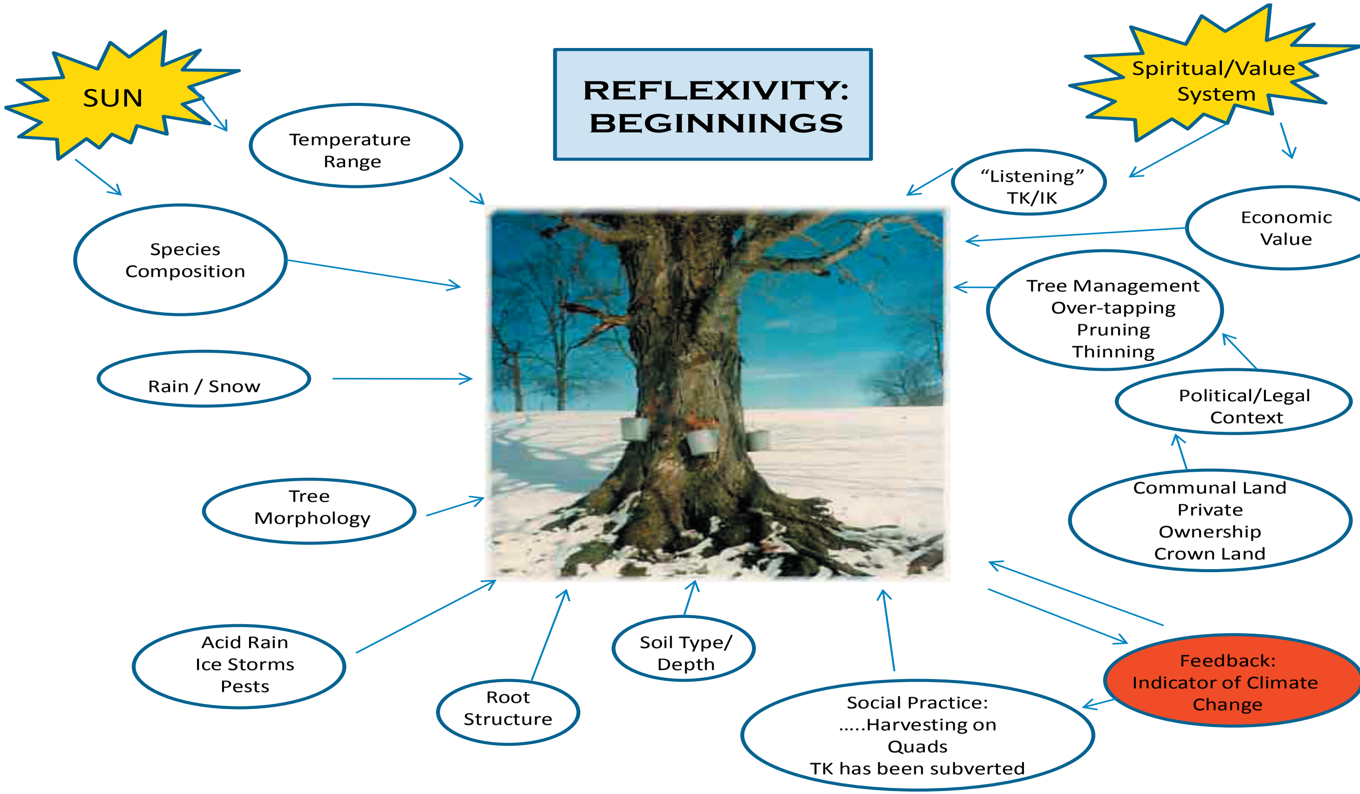
To date, although we have not fully resolved these tensions, we are convinced that turning the research focus onto ourselves is a key first step in an M-I-T-disciplinary, cross-cultural research process. We note that participating in this exercise has made the team much more open and humble when considering each other's ideas; it has moved us towards the nascent development of a more integrated research approach. Exercises in academic reflexivity also sensitized us to be open to the knowledge frameworks we eventually encountered (and will encounter) in the field. For instance, in our most recent work, funded through a SSHRC Research Development Initiative grant, attention to these issues has contributed to a more explicit embracing of anti-racist and decolonizing methodologies and methods (e.g. Smith 1999, Dei and Johal 2005) and to the active involvement of Indigenous and non-Indigenous communities (including the Métis and First Nations producers mentioned below).

Data Availability, Local and Indigenous Voices, and Near North Spaces

To begin the process of testing our nascent approach to the issue of maple syrup

[7] A mental map, or cognitive map is a person's personal perception of the world. In this case, we were trying to develop a composite map that blended our 'ways of knowing' about maple syrup production and climate change.

Figure 3. Team Member Mental Mapping Exercise



and climate change – including hypotheses, data collection techniques, knowledge synthesis, etc. – the research team has been gathering data from a number of sources including interviews, producer documentation, climate data and a survey. In the pilot project we have undertaken five interviews, four with producers and one with a government specialist in maple syrup production. In this section we report some of the initial insights from these interviews; full ethnographic analysis has yet to be undertaken. The four producer interviews consisted of two from the Algonquin maple syrup local, (one Métis, one First Nations – on reserve) one near Barrie in the Simcoe local (farmer) and one near Kingston in the Lanark local (woodlot owners) (Figure 2). Although all four producers are located in the Great-Lakes-St. Lawrence Forest (near north) region, our research highlights the variability among the four locations. The Métis site is located in a remote, boat-in only location that utilizes more small scale, traditional techniques, tapping trees on both owned and crown land with produced syrup distributed throughout the family. The First Nations producers are located some distance from the main road and use a mix of modern and traditional methods such as a sap collection system using horses and an evaporator. These producers tap on the reservation's communal land, and tend to make syrup mostly for the community[8] (although some farm-gate sales do occur). Both of the Algonquin sites reflect a Canadian Shield location and a forest with a more prominent complement of coniferous trees (among other things this contributes to more acidic soils, poorer drainage, and less soil development).

The remaining two locations are easily accessible, privately owned properties, underlain by sedimentary rock formations. The Barrie producer uses technology similar to the First Nations producer, while the Kingston location is the only one that uses lines strung from tree to tree to gather sap, rather than the older bucket method. Of the four sites, the longest oral history is available from the First Nations producers whose ancestors had been producing syrup prior to first contact with European settlers. This was followed by the Barrie producer whose family had farmed the land for seven generations. Finally the Métis and Kingston producers both started producing syrup in the early eighties. These differences amongst the producers, their knowledges, production sites and technologies highlight the complexities of translating data between scales and locations. Broader scale climate change impacts will be influenced by local ecological conditions as well as resource management choices, relationships with the land-base, and land tenure systems. Differences in the available knowledges also require specific attention: knowledge is tied to the knowledge holder and their experiences and contexts. From a scientific perspective, these multiple producer contexts also point to some of the difficulties involved with extrapolating individual, producer-level data to the broader scale, generalized conclusions that tend to be valued within western paradigms. This became obvious in the pilot study as we tried to interconnect local-scale understandings and contexts with broader scale climatologic data (see below).

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[8] In a First Nation context, the relationship with the maple sugar bush is more about a fiduciary responsibility rather than ownership; the producers are the 'keepers of the bush' and they produce syrup with permission of the Band Council.

Interview Data

It was quite clear in the interviews that maple syrup production and 'the sugar bush' are valued for many different reasons and that aesthetic and ethical sensibilities are an integral part of producers' knowledges; while we came in with questions about climate change, producers had a much more nuanced story to tell us. We walked the sugar bush used by three of the four producers and their intimate relationship with these landscapes and ethic of care was immediately apparent. For instance, the Métis producer pointed out the trees, most located on crown land, that were healthy, stressed, needed pruning, etc. He said that he walked the bush regularly over the summer to assess the trees in anticipation of the following spring's tapping – only healthy trees are tapped. The First Nations producers talked about the importance of the sugar bush for their family and the community and how this practice connected them with their historical landscape and traditions. Yearly celebrations were common among three of the four producers. The First Nations producers have a yearly event especially for the elders as well as other 'get togethers' and both the farmer and woodlot owner have large family/community oriented events to participate in, and celebrate, maple syrup and its connection to Canadian heritage. These comments made in the pilot study have contributed substantially to the re-orientation of our subsequent research approach towards a more holistic understanding of the value of maple syrup production and maple ecosystems. As a direct result of these interviews we are currently involved in a project that is assessing the environmental, social and economic value of maple syrup to a small town in southern Ontario. Thus, as the study has moved forward, these initial interviews have led to on-going relationships wherein the 'interviewees' are being transformed into active partners who are influencing the direction of the research program.

In terms of the initial impetus for interviewing producers – e.g. the impacts of climate change on maple syrup production – all four producers were quite adamant that adverse effects were being felt. For instance, all maintained that the production season was more variable and less predictable. The Barrie producer asserted that his grandfather used to be able to count on a steady flow of sap that started at approximately the same time each year. Now, he says, producers have to be ready for constantly changing conditions and uneven sap flow. The unpredictability has become so severe that he has stopped producing commercially and now makes syrup simply for the enjoyment of his family and friends. Both the Métis and First Nations producers suggested that the season seems to be starting later, rather than earlier and that the snow and ice are less predictable. The Métis producer used to snowmobile into the site over the lake. Now the ice is often unsafe, making access difficult. This producer now usually uses a 'quad' (four-wheeled vehicle) to collect the sap. We surmise that it could be the case for the Métis producer that the later time frame for syrup production might be related to access, rather than sap availability. On the other hand, since both Canadian Shield producers report the same trend, and data about the effects of climate change on syrup production in near north spaces has never been collected, it could be the case that other factors are at play which indeed lead to a later season start. Information from two producers is not enough to generalize; this will be an interesting point of investigation in our subsequent research.

Compounding the complexity of sorting out the effects of climate change on maple syrup production are a range of other factors. The producers mentioned a variety of concerns regarding the health of their sugar bush that may, in turn, affect season timing as well as sap quality and quantity. For the Barrie producer, recent wind events have damaged and toppled trees. The Kingston producer's woodlot is still recovering from the 1998 ice storm that hit eastern Ontario. (Was this natural variability or was it the effect of climate change?) The First Nations and Métis producers both believe that their sugar bush is being damaged by acid rain. All producers felt that the uneven weather patterns, including droughts, unusually heavy precipitation (both rain and snow) and storm events were negatively impacting their trees and production levels. Further, as outlined by Perkins (2007), maple syrup production can also be affected by changing levels of technology. For instance, both the First Nations and Kingston producers had upgraded their evaporators and the Kingston producers have been increasing the number of taps being drilled. For both producers, recent syrup quantities have been steady or increasing. Thus, while it is clear that all four producers feel that they have been experiencing some effects from climate change, these various other factors complicate their observations. In our future work, we will need to sort out the potential impact of these types of influences on our capacity to understand the impact of climate change. Among other things, this will mean that we will need to engage a wider range of scholarly knowledges (e.g. biology, ecology) as we move forward with the research program.

Producer Documentation

Producers typically have a range of records associated with their yearly activities. This includes oral history and stories, diaries and formal records. As is common among producers, the Kingston producers keep an extensive diary for each production season that details first and last boil dates, weather observations, sap quality and quantity, and other information. For this paper we extracted some of this information and graphed the length of the maple syrup season, as well as first and last boil dates to look for evidence of climate change. Further, the maple syrup production association has being keeping records of first and last boil dates since 2001. One caveat to note with boiling date data is that it does not reveal the full range of variability associated with maple syrup production. For instance, first boil dates do not typically correspond exactly with the first sap run, since it may be the case that producers miss the first run or that the run is not sufficient to start boiling. Further, the Kingston diary notes that one year sap ran in December and then in another it ran in early February, but boiling in both of those years did not start until late February. Also, as noted in the diary, there are often many days within the boiling season where the sap does not run because it is too hot, too cold, too much rain, snow, etc. The government specialist we interviewed maintained that last boil dates are probably the most accurate since syrup can no longer be produced once 'bud break' occurs; the new growth taints the taste of the syrup.

Since the maple syrup season is, on average, about three to four weeks long, and climate change is associated with increased variability and increasing temperatures we were looking for changes in the patterns of variability and a shift in the boiling dates. However, we hypothesized that weather data beginning from the 1980s, as available from the Kingston producer, may not provide a long enough record to see any noticeable patterns (and certainly not from the eight years of data available from the producer association!) and that weather data from the 1980s might already exhibit the effects of climate change, such as variability. In a study completed for a farm in the Lanark region, Mcleman and Gilbert (2008) demonstrated a long-term shift of boil dates towards an earlier production season for one farm where data was available from the 1950s to the present.

Figures 4 and 5 demonstrate the variability in the production seasons for the Kingston location. Boil seasons vary in length from 9 to 34 days, typically extending from mid-March to mid-April (February 28th – earliest first boil, April 20th – latest last boil). Since no earlier production data is available for this location, the extent to which this pattern might be different from an earlier time frame when greenhouse gases were at lower levels cannot be surmised. Since it may very well be the case that the typical producer does not have written records extending back more than 20-30 years (see below), this highlights the importance of

Figure 4. Length of Boiling Season, Kingston

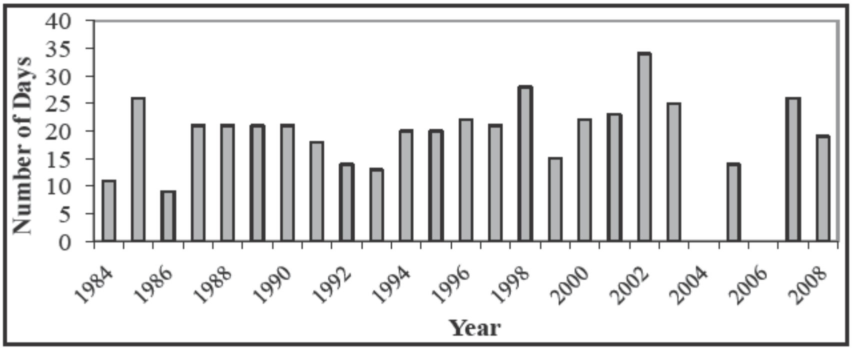
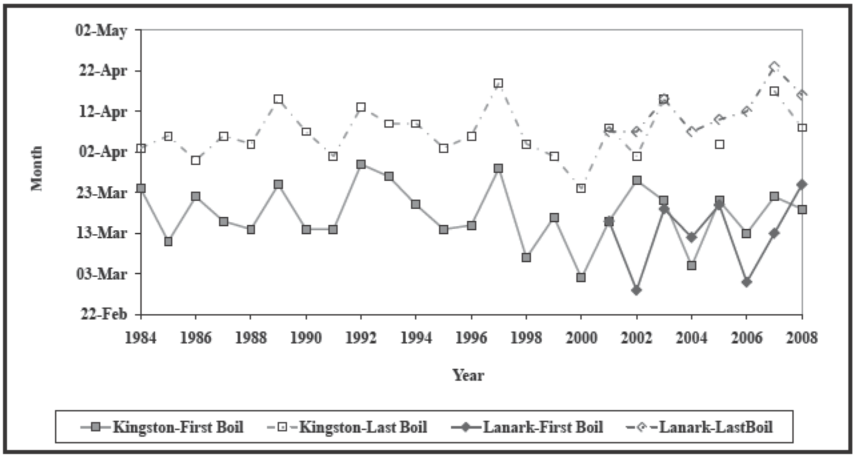


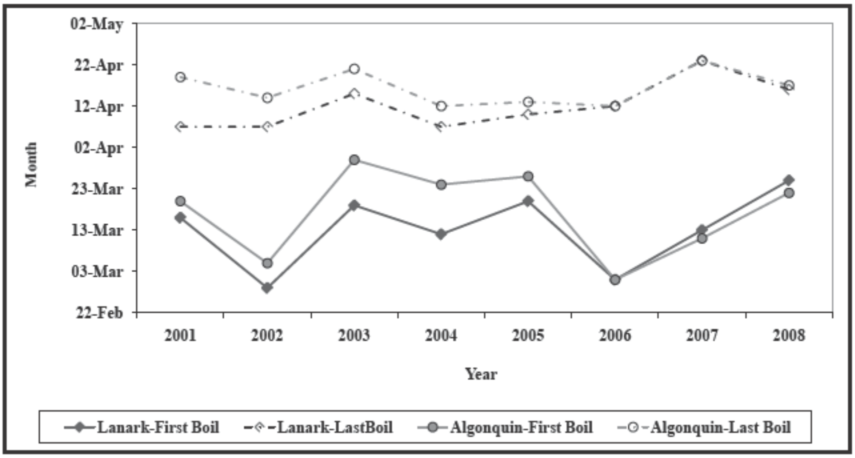
Figure 5. Kingston and Lanark Region Syrup Production



other types of data (e.g. oral) to understand the effects of climate change.

In Figure 5 the data for the entire Lanark production region (2001-2008) is compared with that of the Kingston producer. Notice that the two data sets do not always trend together (e.g. last boil dates 2002 and 2006). This suggests the difficulty of scaling up from the individual location level. Figure 6 compares the production data for the Lanark and Algonquin regions. Since the Algonquin region encompasses more northern territory, we would expect first and last boil dates to be typically later than that of Lanark's. This pattern is only partly evident in the data series. That being said, the short time series does demonstrate that the annual pattern is remarkably similar between these two regions although the exact 'boil' dates vary.

Figure 6. Production Data Compared Across Regions



Climate Data

Historical climatic data can be downloaded from the Environment Canada website[9] with data sets for some locations dating back to the mid-1800s. To explore the data sets pertaining to climatic change for our study the minimum and maximum temperatures associated with two locations where we had obtained interviews were selected, Kingston in the Lanark 'local' and near French River in the Algonquin 'local'. For each location the meteorological data for the months representing the first boil (March) and the last boil (April) dates were collected. The city of Kingston, ON, has climate records dating back to 1872; however the time period of record for that particular meteorological station does not extend to the present and ends in 1957. Therefore, in order to collect a long term temperature record, data from several different stations in Kingston are combined and none has monthly data up to 2008 (Table 2). The French River location does not have an Environment Canada meteorological station and the closest station is North Bay, ON. Therefore, North Bay's climate data is used to represent the temperature regime for the

[9] http://www.climate.weatheroffice.ec.gc.ca/climateData/canada_e.html

French River site. Once again data from more than one North Bay meteorological station were combined into a single data set to produce a long-term temperature record for the two months of interest (Table 2). Once the data records for these two locations were compiled the data were plotted to illustrate the change in temperature records for the time period for which we had the diary data (1984 to 2006 for Kingston and 2008 for North Bay) and also for the full period of record.

Table 2. Climate Data Sources

Station name	Climate record	
	Start Date	End date
Kingston Queens University	1872	1957
Kingston Ontario Hydro	1945	1971
Kingston Pump station	1960	2006
North Bay	1887	1982
North Bay A	1939	2008

For the period from 1984 to 2006/2008 the mean minimum temperature and the mean maximum temperature along with the trends lines associated with each data set for both Kingston and North Bay are plotted in Figures 7-10. The trend lines associated with the March months show a very slight increase in temperature over this time period for North Bay (Figure 7), with the Kingston data set for March (Figure 9) showing a stronger increasing temperature trend. However, the April data sets for both locations (Figures 8 and 10) do not show an increase in mean temperature over this time period. This lack of an increasing trend in both the mean minimum and mean maximum temperatures for April and slight increasing trends in these temperature regimes for March seem to support that climate change trends need a longer term record.

To consider the longer trends, the entire data set for each location is depicted in Figures 11-14. The long term data set for Kingston shows an approximate 2°C increase in both the mean minimum and maximum temperatures in March (Figure 13) and close to a one degree increase in April's temperatures as well (Figure 14). While for North Bay there is a 3°C increase in mean minimum temperatures in March (Figure 11) and a 2°C increase in minimum temperatures in April (Figure 12) with no significant increase in mean maximum temperatures for either month over this longer time period. The long term record in Figures 11-14 also shows less of a range in temperatures during the month of April and a greater range of temperatures during March. Therefore, the longer temperature record does show an increase in mean minimum temperatures in the first boil month of March. This suggests that evaluating the effects of climate change on sap run and the timing of sap collection will require the acquisition of a longer term producer data set. It will also be important to understand if and how these temperature changes translate into noticeable impacts on syrup production and tree health.

Although we have been able to build a long term climatic record of temperature for these two locations, there are several weaknesses in these data sets.

Figure 7. Short-term mean maximum and minimum temperatures for March (first boil), North Bay

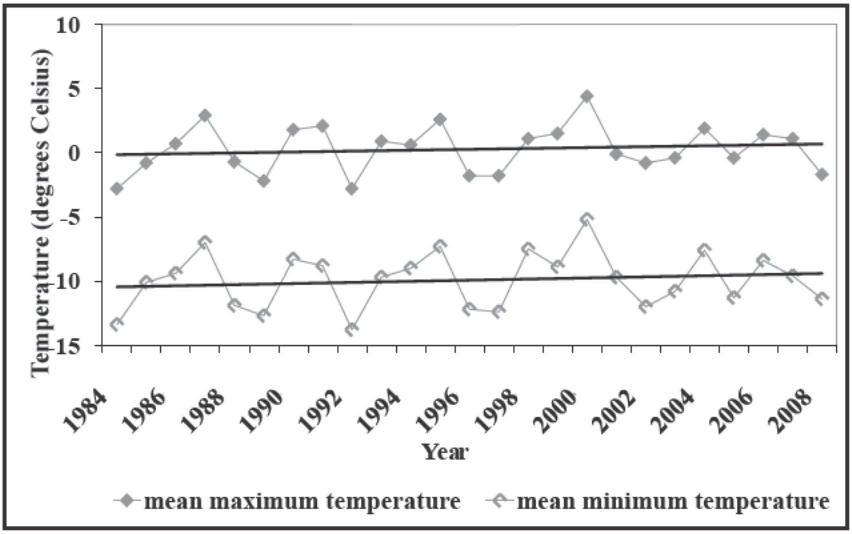


Figure 8. Short-term mean maximum and minimum temperatures for April (last boil), North Bay

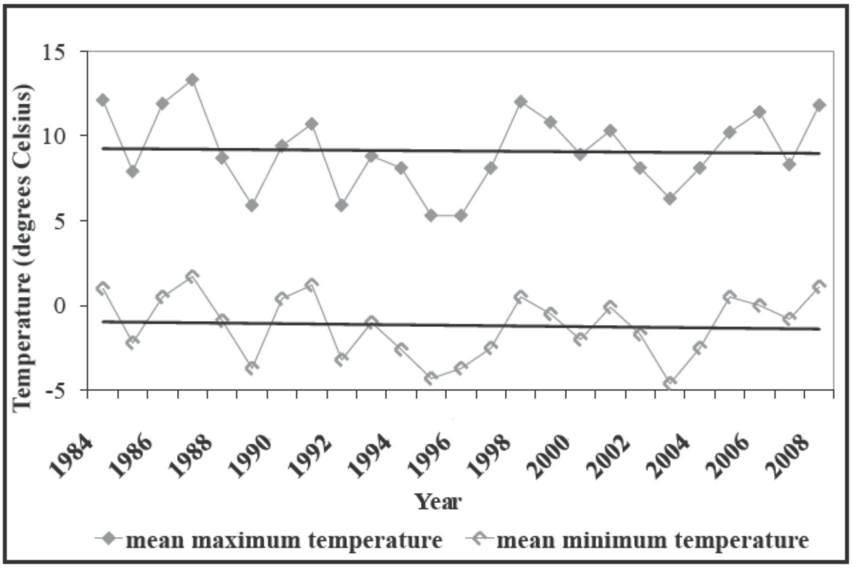


Figure 9. Short-term mean maximum and minimum temperatures for March (first boil), Kingston

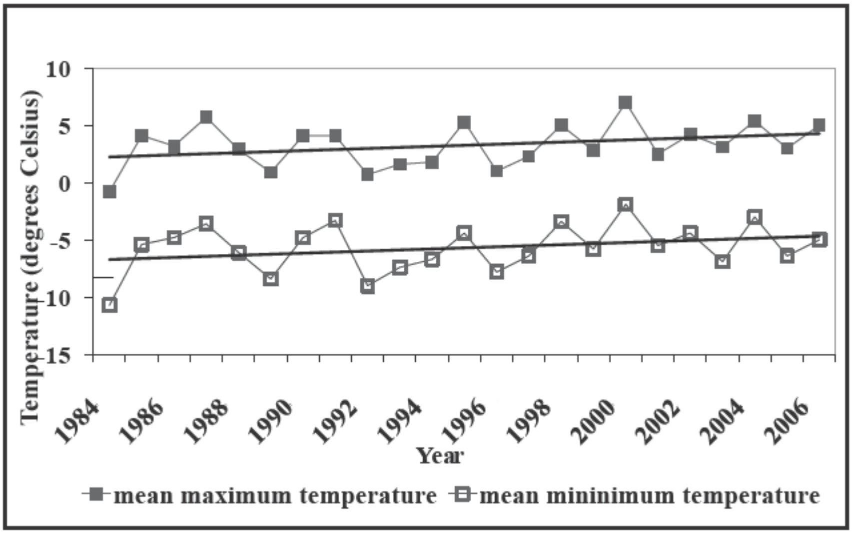


Figure 10. Short-term mean maximum and minimum temperatures for April (last boil), Kingston

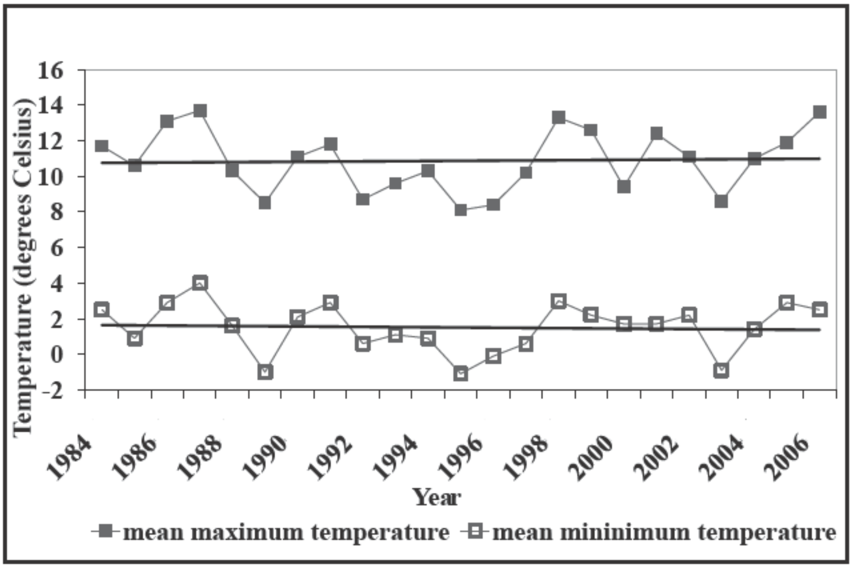


Figure 11. The long-term mean minimum and mean maximum temperature records for March (first boil) for North Bay

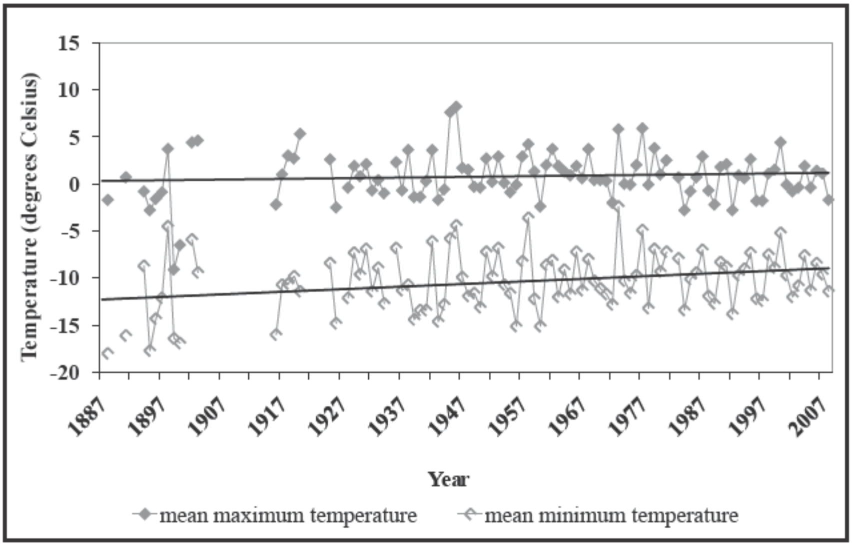


Figure 12. The long-term mean minimum and mean maximum temperature records for April (last boil) for North Bay

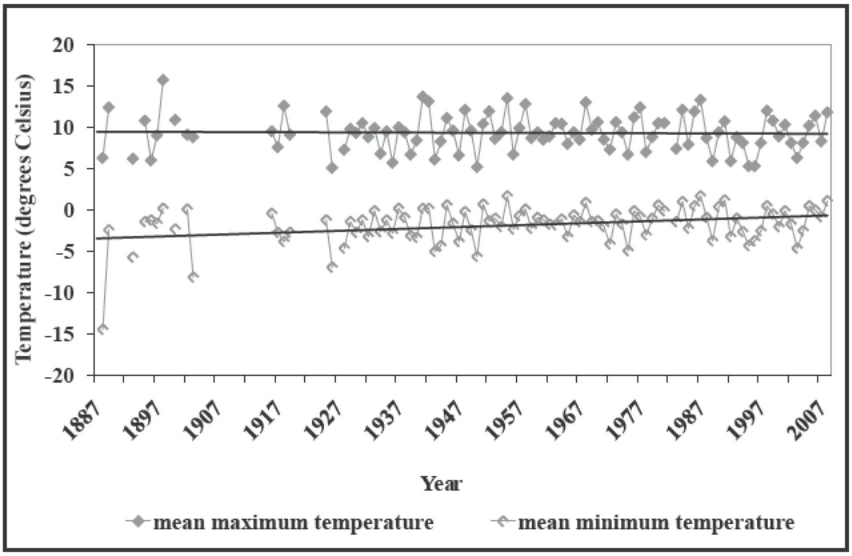


Figure 13. The long-term mean minimum and mean maximum temperature records for March (first boil) for Kingston

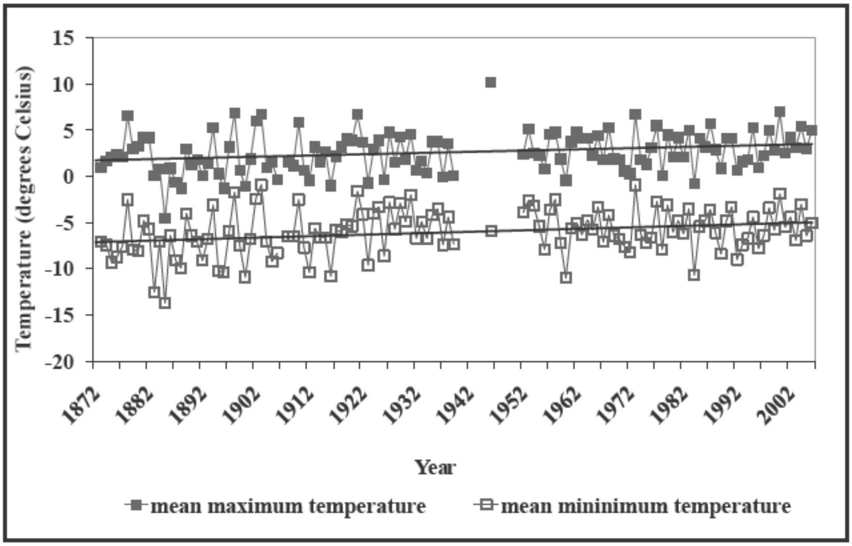
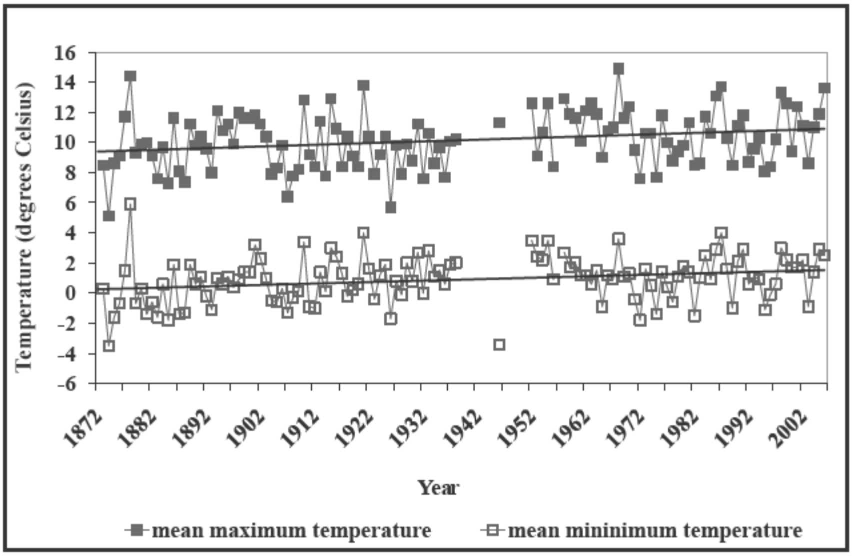


Figure 14. The long-term mean minimum and mean maximum temperature records for April (last boil) for Kingston



First, neither city has a continuous record of temperature for the same station for the long term record and the microclimate surrounding each meteorological station's location adds some uncertainty to the data. Second, for the French River location, the climate data from a station approximately 50 kilometers away at North Bay had to be used. Therefore, these temperatures may not be representative of local conditions. Finally, the temperature data sets for both the cities of Kingston and North Bay may not be representative of the conditions within the rural sugar bush regions. Despite these drawbacks these data do provide an initial starting point and are indicative of the general climatic patterns and trends for these regions. Further, beyond min-max temperatures, producers also note that other factors such as wind speed and direction and snow pack depth impact syrup production. Assessing the possibility of examining data related to these types of factors will be important for our future research.

Survey Data

In addition to the above data, we undertook a small survey that was sent out to some of the membership (those with an email address) of the Ontario Maple Syrup Producers Association. Although only nineteen producers participated, their responses have helped us identify some potentially useful avenues of research and point to some interesting insights about climate change and maple syrup production. Building from insights gained from our interviews, our future study would like to include more explicitly aesthetic and ethical knowledge. Thus, the survey first asked respondents why they produced maple syrup. Choosing from a list, respondents selected as many answers as appropriate, covering a range of values. Notice that economic value is not necessarily the main impetus for producing syrup (Table 3); connection to the environment was followed by economic value and family/community relationships. Following Houde (2007) and the producer interviews, even among non-Indigenous producers, knowledge of maple syrup production is tied integrally not only to its utilitarian value, but also to its ethical value as an opportunity to maintain and strengthen relationships both with people and the environment.

In order to assess the type of data that might be available, the survey asked a series of questions about the type of record, the information in the record, and the length of record (See Tables 4-7). For Tables 4, 6 and 7 multiple answers were again possible. The most common type of data available appears to be personal diaries and formal records. This is a bit surprising, since we would surmise that all producers would have their own perceptions and stories about past production (e.g. oral histories). We suspect that the under-reporting in this category might be a function of producers discounting the value of their personal stories (e.g. that this information is anecdotal and not 'scientific'). Yet, as revealed by our interviews, oral

Table 3. Reasons for Producing Maple Syrup

Reasons	# responses
Connection to Environment	16
Economic Value	14
Family/community Relationships	12
Connection to History/ancestors	7
Part of Canadian Heritage	6
Other	5

histories are a key source of data to further explore the value of syrup production and to understand the impact climate change could have on the producers. Nevertheless, the fact that formal records exist for 14 of the 19 producers (Table 4) and that production records were available throughout the province (Table 5) suggests that there are potential data sources available to assess climate change. The type of information that is available, e.g. boiling dates, is also potentially useful for our study (Table 6).

The ultimate value of this data, however, is tempered by its temporal length. As demonstrated in Table 7, fully half of the respondents have been making maple syrup at the same location for 50+ years, but only 3 indicated that they had formal records over that same time period. Given that there may also be oral histories for some of these other long-term producers, it will be important to follow up with these individuals to explore exactly what kinds of data they have, and if they would be willing to share it. The one respondent with the 50 years of data is of particular interest, since this data would pre-date some of the later climate change effects.

Finally, the survey asked respondents if they had noticed any changes in their production patterns or woodlots and then asked if they thought those changes might be related to climate change. Of the 14 respondents who had noticed changes, 9 believed that climate change might be involved (Table 8). When asked about the impact of climate change, their responses suggest that producers have a fairly good understanding of the problem. Similarly to our interviewees, some survey respondents stated that seasonal variability has increasingly affected the predictability of their production and that they have noticed some dieback among the sugar maples. One producer was very clear about the impacts of climate change and succinctly identified the type of information that is available:

Table 4. Type of Records

Type of Record	# responses
Formal Records	14
Personal Diaries	10
Oral history/family stories	3

Table 5. Regions with Records Available

	Yearly Records
Production Region	**# responses**
A. Southwestern	1
B. Waterloo/ Wellington	1
C. Simcoe	2
D. Haliburton/ Kawartha	4
E. Quinte	2
F. Lanark	3
H. Renfrew	2
I. Algonquin	2
K. Grey-Bruce	2
Total	19

Table 6. Information in Records

Infomation in Records	# responses
First/last boil	17
Quantity of syrup	17
Costs/sales	14
Grade of syrup	13
Sap sugar content	9
Air temperature	8
Rain/snow/ice/ frost	8
Other	7

> *Comparing our ten year history to local oral history it appears that we have greater variations in first and last boiling dates and that the average boiling dates are earlier.*
>
> *Oral history suggests that the syrup season was more continuous between first and last boil – our documented experience shows abrupt changes in temperatures during the season i.e. stretches of too cold or too warm for sap runs in the middle of the season resulting in fewer sap runs. Again, comparing our recent records with local oral history, the winter weather has greater variability (Survey respondent, 2009).*

Table 7. Length of Records

Length of Production / Record-Length	< 10 years	10-20 years	20-50 years	50-100 years	> 100 years	Total # responses
< 10 years	3	2	3		1	9
10-20 years		4	1	1	1	7
20-50 years			2	1		3
Total Respondents	3	6	6	2	2	19

Table 8. Perceived Role of Climate Change

Changes Noticed?	Climate Change Responsible?	# responses
No		4
	total	**4**
Yes	No	2
	Yes	9
	Not sure	3
	total	**14**
Grand Total	(1 blank)	**18**

Final Thoughts

Throughout this paper we have reported on the progress we have made in our ongoing project about maple syrup production and climate change. We have outlined our methodology and objectives, including the development of an approach that attempts to incorporate both cross-cultural and M-I-T-disciplinary contexts. Through careful attention and valorization of both the cross-cultural context and our own knowledge frameworks, our unfolding process of ‘coming to know’ has been outlined. Having experienced first-hand the benefits of taking M-I-T-disciplinarity and academic reflexivity seriously, we encourage other researchers who are attempting a team-based project to take the time to think about their own knowledge frameworks and those of their team members. We also encourage research teams to access 'seed' money funding or research development grants. These are excellent opportunities to take the time to explicitly develop the theoretical and methodological approach and to develop the disciplinary, cross-cultural and community relationships necessary when undertaking a complex research program.

Our intention is to build on this initial work, particularly as it relates to the integration of multiple ways of knowing. In the time-pressed environment of many research projects, the tendency is often to get to the 'doing', without much reflection about the range of knowledges that may underpin the study. Yet, attention to knowledge frameworks can be a source of innovation to develop exciting new approaches and hypotheses. In our case, we have used the pilot project and the SSHRC research development phase of the research to develop an approach that is more explicitly self-reflective and inclusive of community partners. As research subjects have become active community partners, their knowledges have already influenced the research direction and will continue to do so in the future.

This research approach does present some unique challenges. In undertaking such an endeavor we, and other researchers, should be cognizant of the many pitfalls: 1) such research inevitably requires more resources (time, money, personnel), 2) it will likely lead to uncomfortable moments of tension among the scholars and between the scholars and community partners as we bump up against biases and differences of opinion, and 3) regardless of our intentions to level the playing field, a power dynamic always remains wherein the scholars on the team have the dominant position (there may also be a hierarchy amongst scholars).

This paper has presented the four types of data we have gathered to date and has reported on data availability, challenges of data acquisition and data quality issues. Despite the limitations, we argue that triangulation across different types of data about maple syrup and maple ecosystems offers the potential to develop a nuanced understanding of climate change in understudied near north and rural spaces. Gaps in our current approach suggest the need to incorporate other scholarly knowledges, such as biology and ecology, to continue developing a broader conceptualization of the value of maple syrup production, and to focus more specifically on Indigenous knowledges and production locations. Beyond the small town study mentioned above, as part of the work funded by the SSHRC grant, we are investigating the possibility of using the spectral signature of maple leaves, particularly during the fall season, to map the migration of maple trees, and, following input from one of our Indigenous partners, we are instigating an opportunity to bring youth into the bush both to learn about maple syrup production and to provide much needed help for the heavy work and long hours associated with maple syrup production.

We hope our initial foray into team-based research and our explicit reporting of the process of 'coming to know', rather than focusing primarily on the knowledge produced, will be enlightening for other teams also struggling not only with complex problems but also with complex teams and research agendas.

Acknowledgements

The authors gratefully acknowledge that financial support for this research was received from a grant partly funded by Wilfrid Laurier University Operating funds and partly by the SSHRC Institutional Grant awarded to WLU. The research was also supported by a subsequent grant funded by a SSHRC Research Development Initiative. The authors gratefully acknowledge the insightful feedback received from anonymous reviews and from Beth Dempster on earlier versions of this paper.

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