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Demographics and social values as drivers of change in the Canadian boreal zone

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Abstract

The boreal zone, a vast region with abundant natural resources and related industries, has both provisioning and non-provisioning ecosystem services that draw some people, while warding off others. It is an area that arguably affects many Canadians in different ways and represents a wide range of tangible and intangible values. Changes in demographic patterns over time shed light on the development of the social-ecological landscape of the boreal zone, and elucidate potential changes in the future. Using past and current demographic data, we explore population size, immigration and emigration, and birth and death rates within and outside the boreal zone. We also explore links between demographics, social values, and important factors of change in the boreal zone, and present three contrasting scenarios predicting the state of this zone in 2050. We pay particular attention to the Indigenous population, generational differences, international immigration, and the urban-rural divide. Fertility rates and immigration influence population demographics within and outside the boreal zone, respectively, alluding to potential divergences in social values and between communities located within and outside the boreal zone. The boreal zone is currently comprised of many smaller towns and communities scattered across the landscape, yet it is equally important to consider the influences of larger cities located outside the boreal zone, particularly in terms of governance, population movements, and political power. Considered together, these factors provide insight on social cohesion and connectedness, demand for goods and services, and changes in boreal-centric activities.

Keywords: demographics, society, values, trends, boreal zone

1. Introduction

The Canadian boreal zone is characterized by plentiful natural resources, which have played an important role in shaping the culture and identities of Canadians living both within and outside the vast region. Iconic species such as beaver, caribou, moose, and loon are found here, and the forests and waterways of the boreal zone once teemed with opportunists and adventurers, *voyageurs* and *coureurs des bois*, who traded with Indigenous groups that braved the sometimes unforgiving climate for thousands of years previously. Indeed, the boreal zone is named after *Boreas*, the temperamental Greek god of the north wind, alluding to the harsh, cold environment of the region (Anielski & Wilson 2005).

Despite spanning seven provinces (British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, and Newfoundland and Labrador) and three territories (Northwest Territories, Yukon, and Nunavut), the boreal zone is sparsely populated compared to the rest of the country. Approximately 3.7 million people (10% of Canada's total population) live in the boreal zone, with approximately half of the population living in the region's urban areas. Today, industries such as oil and gas, mining, timber harvesting, hydroelectricity, and tourism have become integral components of the social-ecological landscape, serving as the primary economic focus for many boreal zone communities (Brandt et al. 2013).

This paper is part of a series called the Boreal 2050 Project (Creed and Serran 2018), which examines multiple drivers of change to the boreal zone including, in addition to demographics and social values, demand for provisioning ecosystem services (Erdozain et al. 2018), demand for non-provisioning ecosystem services (Lamothe et al. 2018), industrial innovation and infrastructure (Musetta-Lambert et al. 2018), governance and geopolitics (Fuss et al. 2018), and atmospheric change (Yeung et al. 2018). These driver papers were used to inform

a scenario and risk management analysis (Steenberg et al. 2018; Serran et al. 2018) for the boreal zone. Creed et al. 2018 provides an overview of the approach taken for the Boreal 2050 Project.

Using 2010 as a benchmark year, the goal of this paper is to highlight the major demographic changes that have occurred both within and outside the boreal zone over the past 35 years since 1985, and explore how these changes and related social patterns may shape the future of the region in the next 35 years until 2050. The boreal zone arguably affects many Canadians in different ways and represents a wide range of tangible and intangible social values shaped both directly and indirectly by demographics. Values are abstract, yet serve as guiding principles for making decisions, forming relationships, and evaluating situations, and can be expressed at both the individual and social level (De Groot & Steg 2007). Values are often at the forefront of discussions aimed at encouraging environmentally sustainable behaviour (Dietz et al. 2005) and are essential considerations when examining change in the boreal zone.

In the following sections, we discuss the relevance of Canadian demographics and social values as a major driver of change in the boreal zone. We begin by briefly outlining major findings about Canadian social and environmental values. Then, using census data, we analyze demographic trends and changes both within and outside the boreal zone since 1985, including population growth, fertility rates, immigration and emigration, generational differences, and the urban-rural divide. Using secondary data sources, we explore links between demographics, social values, and other important factors of change in the boreal zone, and use this information to present three contrasting scenarios predicting the state of the boreal zone in 2050.

2. Framework and approach

2.1 Analytical framework

Demographic change and associated social values are fundamental factors of change in the boreal zone, as values define motivations, behaviours, and actions (Stern & Dietz 1994; De Groot & Steg 2007). Rokeach (1968) defines a value as “an enduring belief that a specific mode of conduct or end-state of existence is personally and socially preferable to alternative modes of conduct or end-states of existence”. When values are expressed at the individual or social level, it could inform possible trends for decision-making, and such value-oriented decisions could be linked to environmentally sustainable behaviour (Dietz et al. 2005; De Groot & Steg 2007; Peattie 2010). Our understanding of how demographics and social values impact the boreal zone is represented in an analytical framework (Fig. 1) that incorporate the flows and feedbacks between demographics for specific subsets of the Canadian population and aggregates of social values. Specific aspects of the analytical framework are discussed below, with numbers directing the reader towards the associated element in the diagram.

The demographics affecting the boreal zone are represented by a cube (Fig. 1) that is broken down into four main categories, three of which are further differentiated into dichotomous subcategories. These categories include: Canadian citizens and non-Canadian citizens, urban and rural residents, people living inside and outside the Boreal zone, and Indigenous status. Growth or decline in the Canadian population can occur through international emigration and immigration as well as births and deaths within the population.

This cubic representation ([1] in Fig. 1) allows for the categorization of people in Canada in ways that we consider most relevant to understanding how demographics drive change in the boreal zone. Three dichotomous categories combine to produce eight explicit sub-populations. For example, one might consider a “Canadian”, living inside the boreal zone, and within an urban area. Within the same “Canadian” category lies the Indigenous population of Canada,

including First Nation, Métis, and Inuit living inside and outside the boreal zone, as well as those living in urban and rural locations. The possible demographic flows that can occur between the eight sub-populations is not explicitly shown in the diagram. For example, a flow between sub-populations occurs if an immigrant becomes naturalized as they would move from the foremost, bottom, right box to the foremost, bottom, left box (Fig. 1). The categorization of Canadian demographics in this manner makes certain sub-populations explicit, as these groups are assumed to bring different values, perspectives, and experiences that distinguish their interaction with the boreal zone landscape.

In aggregate, these populations have social values ([2] in Fig. 1) that shape Canada's demographic landscape ([3] in Fig. 1). For example, the current trend of Canadian women choosing to have children at later ages affects the growth of the population through births (Statistics Canada 2016). Aggregated social values also lead to decisions and actions that impact the boreal zone ([4] in Fig. 1). These might include consumer preferences or voting choices that affect land protection and land use practices.

Through this lens, we assess and analyze changes in the boreal zone driven by direct demographic effects, as well as the direct and indirect effects of decisions and actions produced from aggregate social values.

2.2 Approach

We explored demographic trends within and outside the boreal zone of Canada spanning from the level of census subdivisions to the province. The boreal zone was defined using the delineation of the boreal zone as defined by Brandt (2009). Census subdivisions that intersected or were fully located within the boundaries of this boundary were considered as being located

within the boreal zone. We assessed changes in demographics over space and time of three populations of interest: urban versus rural Canadians, immigrants versus non-immigrants, and Indigenous versus non-Indigenous Canadians. Finally, we also compared demographic changes between generations to capture potential changes in values over time as the population ages.

We defined populations within urban areas as a population centre that is defined by Statistics Canada (2011c) as an area of having a population of at least 1,000 people and a density greater than 400 people/km². Areas outside of these population centres were categorized as rural.

We also chose to focus on generational demographics, which generally fall within the following year ranges: Baby Boomers and older (born 1946-1964 and older), Generation X (born 1965-1976), Millennials (Generation Y; born 1977-1995), and Centennials (Generation Z; born 1996 to present). These generations have certain social values associated with them (Cennamo & Gardner 2008; Twenge et al. 2010), which have the potential to directly influence demographics by decisions to immigrate or emigrate from the boreal zone, or indirectly affect the socio-ecological landscape of the boreal zone.

Finally, we collected historical data on population, age, status as Canadian citizens, and status as Indigenous peoples. These data were obtained from Statistics Canada (1986, 1991, 1996, 2001, 2006, 2011b, and 2016a). To further distinguish Indigenous populations, we characterized the Indigenous languages spoken in the household using the National Household Survey (2011d).

2.3 Caveats

Many social, geographic, cultural, and linguistic groups reside within Canada. The objective of this paper was to identify and analyze major demographic trends that will likely drive change in the boreal zone. We found that some trends (or population groups) were more

relevant than others; however, it is worth acknowledging that many other distinct social and political identities exist within Canada and the boreal zone that will not be discussed at length in this paper, such as the Canadian francophone population, provincial entities, and various religious groups, among others. It is also worth noting that even within demographic groups, values, or manifestations of values will differ. Our aim was not to create caricatures of social groups and ascribe values to them, but rather to shed light on what is known about the values espoused by those living in Canada, and speculate on how these values play a role in shaping an important northern region.

The following sections detail the findings of our demographic analysis and exploration of social values in Canada. The first section represents emerging demographic trends, whose significant effects will likely be felt for decades to come. These include international immigration, primarily into urban centres, and the subsequent urban-rural divide that may contribute to conflicts related to governance and political power. The second section discusses social phenomena engendered by these trends that have been occurring over the last few decades, which include differences in generational values and the growth of Indigenous populations in the boreal zone.

3. Current status and emerging trends: international immigration and the urban-rural divide

3.1 Demographic trends

Given the sheer size of the boreal zone, it comes as no surprise that population changes across this zone vary (Fig. 2). Differences in population growth according to region highlight social and economic trends that both directly and indirectly shape demographics. For example,

certain boreal zones of Alberta underwent a large population growth over the last decade, while areas in northern Ontario, Quebec, and the territories show population decline. This pattern is likely explained by growth in resource-centric employment in Alberta due to the oil and gas industry. In contrast, northern Ontario and Quebec faced job losses in the forest industry that shaped the future of communities due to the declines (MacLean 2007; Puddister et al. 2011).

The majority of urban areas in Canada are found outside of the boreal zone, as two-thirds of Canadians live within 100 km of the Canadian-U.S.A. border (Fig. 3). Population centres within the boreal zone are scattered along its southern border and generally correspond to areas experiencing larger population growth, indicating that similar to the rest of the country, people within the boreal zone are gravitating towards urban centres. Trends in population growth mirror those related to immigration (Fig. 4). Within the boreal zone, the regions experiencing larger than average population growth are also those where immigrants choose to settle, emphasizing one of the main factors of population growth Canada as a whole as international immigration.

Since the 1990s, international immigration to Canada has remained relatively steady, at an average of approximately 235,000 landed immigrants per year (Statistics Canada 2016a). More than half of all immigrants (63.0%) settle in the three largest Canadian cities (Montreal, Toronto, and Vancouver) located outside the boreal zone. From 2011 to 2016, two-thirds of Canada's growth was due to immigration, and it is likely that total population growth in coming years will continue to be linked to migratory increases rather than natural growth (Statistics Canada 2016b). Indeed, as of 2011, approximately one in five people living in Canada were foreign-born, the highest proportion of all G8 countries (Statistics Canada 2016c). As urban areas continue to expand and become more diverse, governance systems and political spheres in

the same regions will likely become even more entrenched, highlighting further concentration in decision-making powers towards non-boreal zone urban centres.

3.2 Social values and perceptions

With the anniversary of Confederation's 150th year (1867-2017), many Canadians are no doubt reflecting on shared social values and the elusive "Canadian identity". In 2013, the General Social Survey (GSS) collected information on national symbolism, values, and pride, and found that the large majority of survey participants believed that Canadians collectively share core values of human rights (92%), gender equality (92%), and respect for the law (91%). To a slightly lesser extent (85%), participants also believed that Canadians value ethnic and cultural diversity. The lowest ranked value (68%) was found to be respect for Indigenous culture (Statistics Canada 2013).

Importantly, the GSS survey illustrated that demographic differences play a vital role in shaping perception of values. For example, older Canadians were less likely to greatly believe that Canadians shared the values mentioned above. Immigrants, on the other hand, were much more likely to believe that Canadians share common values (Statistics Canada 2013). These results reflect the diversity of opinions held by Canadians and emphasize the importance of considering social values exemplified by different regional and cultural groups (Toye 2007).

Multiculturalism has often been touted as a core Canadian value; our own settlement and colonization history is marked by the roles of Indigenous peoples, the French, and the British. Canadians are generally known to be supportive of a multicultural society, however many are wary about how this concept can be practically and widely applied in a liberal-democratic society (Dewing 2009). Most of Canada's current population is a direct result from immigration over the last hundred years, as the 20th century brought huge waves of groups from Europe and

Asia due to war, political upheavals, and opportunity seeking. The concept of embracing cultural, ethnic, and linguistic diversity is now embedded in federal legislation and public policy, exemplified by the explicit mention of multiculturalism in the *Canadian Charter of Rights and Freedoms* (1982), as well as the *Canadian Multiculturalism Act* (1988) – the first of its kind in world history. The goal of these policies is to ensure that through governance, cultural awareness is enhanced, discrimination is eliminated, and cultural differences are preserved.

The boreal zone has historically been settled and exploited for its abundant natural resources, emphasizing the importance of considering how and why Canadians value the country's natural capital. The ways in which humans value the environment will inevitably dictate demand for both provisioning (e.g. timber, water) and non-provisioning ecosystem services (e.g. recreational, spiritual), as well as governance and resource management strategies. Three value orientations representing divergent environmental attitudes, beliefs, and intentions have generally been identified: biospheric, where people base decisions to act proenvironmentally on the perceived costs and benefits for the environment and the biosphere; social-altruistic, where decisions are based on the costs and benefits for other people; and egoistic, where only personal costs and benefits matter in environmental decision-making (Stern & Dietz 1994; Stern 2000). While it has been suggested that biospheric and social-altruistic value orientations positively relate to proenvironmental behaviour (Stern & Dietz 1994), other scholars assert that a gap exists between environmental values and environmental behaviour, despite increases in environmental awareness worldwide (Kennedy et al. 2009). Environmental behaviours may also be influenced by external factors, such as resource availability and economic limitations, often outside a single individual's control (Dietz et al. 2005).

Approximately 80% of Canadians reside in urban areas, mostly located in the very southern portion of the country (Table 1). For this majority of Canadians, daily contact with nature occurs in back yards, in urban parks, and in other urban green spaces. Most urban Canadians generally do not directly depend on natural resources for their livelihood, compared to rural communities depending on forestry, mining, oil and gas, and other extraction activities. Some researchers postulate that post-materialist values are more present in urban communities, and urban dwellers are more likely to value environmental protection over economic output (Harshaw & Tindall 2005). In the case of Canadian forest management, Robson et al. (2000) found that local, forest-dependent communities tended to place a higher emphasis on economic value and clearcutting practices compared to provincial and national publics. Nevertheless, all publics surveyed supported an ecosystem-approach to forest management and rejected the idea of maximizing economic output at the expense of environmental conservation.

4. Past trends informing current change: generational differences and Indigenous legacy

4.1 Demographic trends

Proportion of generations found in urban and rural areas naturally fluctuate due to births and deaths as well as immigration and emigration. The generation of Baby Boomers (and older) will gradually decline from natural mortality (Fig. 5). The total population of Baby Boomers in non-boreal zone urban areas is increasing, which is likely due to immigration from other provinces and countries. Millennial (Generation Y) population changes differ based on geography, particularly between urban and rural areas. Within the boreal zone, Generation Y is the only generational group that is experiencing contrasting population changes in urban and rural areas, indicating that social values associated with this generational cohort are driving

movement within the region. Indeed, decreases in both total and proportional population in rural areas illustrate that many young people are consistently moving away from rural areas and into urban centres. Millennials are expected to reach the ages associated with political power and decision-making positions in this decade, therefore it is important to consider how this demographic trend will impact hubs of political, economic, and social influence. Within and outside of the boreal zone, Generation Z continually grows through births as the most recent generational cohort.

Approximately 4.3% of the population of Canada identified as Indigenous in 2011 (Statistics Canada 2011a). Indigenous groups are spread across the boreal zone, with many found in remote and rural areas (Fig. 6). Indigenous people were identified by the languages spoken in the household using the National Household Survey (2011). Thirteen Indigenous languages were identified within the boreal zone in 2010; these languages included Algonquin, Atikamekw, Blackfoot, Carrier, Cree, Dene, Inuktitut, Mi'kmaq, Ojibway, Oji-Cree, Slavey, Stoney, and Tlicho. Each of these languages was primarily concentrated within specific census divisions of Canada as distinct communities within the boreal zone (Fig. S.1).

Across Canada, Indigenous groups are dominated by younger generations, as 46.0% of the population was aged 0 to 26 years old in 2011 (Statistics Canada, 2011a). Fertility rates among Indigenous groups are higher than the national average, while life expectancy is lower (Statistics Canada, 2011a). Due to these demographic differences, between 2006 and 2011 the Indigenous population increased by 20.1%, or 232,385 people, compared to the non-Indigenous population, which increased by 5.2% (Fig. 7).

4.2 Social values and perceptions

Social values can shift and evolve over time, both over generations by historical events and periods of social upheaval, and over an individual's lifetime (Schwartz et al. 2001; Adams 2003; Williams & Page 2010). Younger generations, such as Generation X (born 1960s-1970s) and Y (born 1980s-1990s), are defined by more rapid technological advancements and social media exposure compared to their older counterparts. They are known to be civic-minded yet achievement-oriented and self-serving (Beutell & Wittig-Berman 2008). In a Canadian study comparing basic human values across generations, Lyons et al. (2007) found that, compared to older generations, younger ones scored higher on self-enhancement values, including power (social status and prestige), achievement (personal success), and hedonism (personal gratification). Similarly, self-transcendent values such as universalism (e.g., understanding, tolerance) and benevolence scored lower with younger generations, illustrating that these types of values might positively correlate with age (Schwartz et al. 2001; Lyons et al. 2007).

Hundreds of Indigenous communities reside within the boreal zone, highlighting the significance of their influence on the landscape and the importance of recognizing related social and ecological values. Descendants of the first inhabitants of North America, these groups are composed of First Nations, Métis, and Inuit, and represent substantial geographic, linguistic, social, and cultural diversity (Voyageur & Calliou 2001). Each group has a distinct belief system guiding values and attitudes, although commonalities exist between many groups. The value of reciprocity is central to many Indigenous belief systems, emphasizing the importance of respectful relationships between people and the land and its resources (Johnson 2000; Parsons & Prest 2003; Karst 2010). Harvesting in moderation and sharing among family and friends also dictate social norms in some groups, such as the Gwich'in in the Northwest Territories (Parlee et al. 2006). Oral traditions and cultural teachings play an important role in communicating these

values from generation to generation, and often incorporate stories about specific places, their names, and associated natural resources (Johnson 1992, 2000; Parsons & Prest 2003). Many Indigenous ecological values and subsequent land management activities are based on the idea that belief systems and worldviews evolved over time alongside a given ecosystem, highlighting the direct and intimate relationships held between people and their environment (Parsons & Prest 2003; Karst 2010).

Over the last few decades, land rights and self-governance have remained at the forefront of many management conflicts involving traditional Indigenous lands in the boreal zone (Parsons & Prest 2003). One famous example is the James Bay Cree hydroelectric conflict, which occurred when the Quebec government announced plans and started development for a hydroelectric project without consulting with the Cree, Inuit, and Naskapi people of the region, and without considering the environmental, social, and cultural impacts of the project. This conflict led to the *James Bay and Northern Quebec Agreement* in 1975, and the later modified *Northeastern Quebec Agreement* in 1978, which was the first Canadian modern treaty to approach issues regarding land rights, self-governance, and the issue of compensation (Indian and Northern Affairs Canada 1997). The agreement led to new practices of governance, which also benefitted health, education and economic development for the Cree, Inuit, and Naskapi Nations (Aboriginal Affairs and Northern Development 2014). However, there were issues with the agreement and implementation that led to further conflict between the Cree and the Quebec provincial government. Nearly 30 years after the project was announced and after many legal battles between government and the James Bay Cree, the *Paix des Braves Agreement* was signed in 2002, which clarified elements with the Cree for greater autonomy and forestry practices (Passelac-Ross & Smith 2013). Standards for consultation on development projects with First

Nations groups were also reinforced (Koutouki 2010). These types of conflict emphasize the importance of place-keeping, autonomy, and significant, equitable involvement in resource and land management for Indigenous groups in the boreal zone (Parsons & Prest 2003; McGregor 2009).

5. Driver interactions

Exploring the effects of demographics and associated social values is an important step in determining how the boreal zone might change in the next 35 years. Nevertheless, interactions exist between other drivers of change in the boreal zone. Table 2 provides a summary of the influence of other drivers on demographics and societal values, while the influence of demographics on other drivers is also discussed.

5.1 Demand for provisioning ecosystem services (PrES)

Extractive industries are integral components of the socio-ecological landscape of the boreal zone, and many communities depend on their economic output. As such, employment opportunities and industry profitability are important factors when considering why communities remain within or even move into the boreal zone (Brandt et al. 2013). For example, many Indigenous Canadians have historically been highly involved in boreal zone forest management; scholars assert that this likely influenced the current movement of forestry in Canada towards a more inclusive system that incorporates Indigenous values and considers local community sustainability (Merkel 2007; Wyatt 2007). Nevertheless, demand for forest products has also created social and political conflicts between industry, government, Indigenous groups, and other community groups (Canadian Boreal zone Forest Agreement 2010). Globalization, along with

the proliferation of Western values, and the demand for provisioning services may result in further encroachment onto traditional lands in the boreal zone (Merkel 2007). This demand could lead to the erosion of Indigenous culture, to the point where younger generations become less dependent on sustenance activities (Merkel 2007). However, increased demand may also result in better infrastructure in more remote locations, along with more accessible health and education services. Furthermore, the evolution of “aboriginal forestry” illustrates that social and ecological values upheld at local scales can influence governance systems and management practices in both industry and government at larger scales (Parsons & Prest 2003).

The creation of non-binding documents such as the United Nations Declaration of the Rights of Indigenous Peoples (UNDRIP) further outlines recent developments in acknowledging the rights of Indigenous peoples globally, both individually and collectively (UN General Assembly 2007). In 2010, the Canadian government endorsed the principles of the UNDRIP by issuing a Statement of Support and declared full support in 2016 (Indigenous and Northern Affairs Canada 2017). In doing so, consultations and accommodations are required with Indigenous peoples in Canada regarding decisions that may affect their interest. Previous Supreme Court cases, such as *Haida Nation v. British Columbia (Minister of Forests)* 2004 SCC 73, act as examples of rulings favouring Indigenous groups that must be consulted and accommodated if interests are affected by a specific claim. In this particular case, their interests were to harvest red cedar in the area where they held title. Overall, these developments illustrate steps forward towards acknowledging Indigenous rights and ensuring the protection and rightful use of traditional lands in the context of extraction activities.

5.2 Demand for non-provisioning ecosystem services (NPES)

Demand for cultural and recreational activities and for conservation areas may promote job growth, attracting some movement into the boreal zone. Demand for these services may also be driven by social values, particularly post-materialist ones, which are more pervasive in urban areas (Harshaw & Tindall 2005). The explicit involvement of Indigenous groups in the management of traditional lands permits the inclusion of traditional ecological knowledge in decision-making and, in some cases, strengthens social capital through economic opportunities such as tourism (Canadian Parks Council 2011). It would therefore prove important to consider social values both within and outside the boreal zone while developing and implementing conservation policies.

5.3 Atmospheric change

Atmospheric and climate change may result in permanent changes in the ecological landscape of the boreal zone, due to the spread of forest fires, pests and disease, shifting climate envelopes, and environmental catastrophes (Gauthier et al. 2015). Adaptive capacity will determine demographic movement into and out of the region due to changing environments, as well as changes in social values. Food security for communities in the boreal zone may become a more pressing issue. For example, the amount of traditional food of the Inuit is predicted to decline due to pollution contamination from melting permafrost (Downing and Cuerrier, 2011). These drastic changes could potentially lead to societal value shifts associated with decreased reliance on the land for sustenance; knowledge about native food sources and associated cultural teachings may be lost completely (Downing and Cuerrier, 2011). Furthermore, the continued growth of the global population will contribute in some way to anthropogenic climate change. In Canada, land development and urban sprawl occurring to accommodate influxes of urban

413 dwellers may indirectly increase greenhouse gas emissions through increased vehicular transport
414 and the removal of natural habitats. Climate refugees around the world will likely grow in
415 numbers and may place pressure on countries like Canada to expand immigration programs
416 (Méthot et al. 2015).

418 5.4 Governance and geopolitics

419 Governance systems must reflect the population being governed. Governance over the
420 boreal zone based in urban areas may alienate smaller communities whose livelihood depends
421 heavily on natural resources and their surrounding environment. As globalization continues and
422 as international trade increases, communities in the boreal zone may not be able to keep up with
423 social and economic changes, and many may end up relocating to urban areas. As economic
424 migrants and refugees continue to settle in Canadian cities and as resources are allocated to
425 address their societal needs, political power may strengthen in urban hubs while weakening in
426 more remote, rural areas.

428 5.5 Industry and innovation

429 Increased infrastructure investments and modernization of communities in the boreal
430 zone could open access to the region and precipitate growth. Part of this growth could be driven
431 by investment into the boreal zone, which would both influence and be influenced by
432 immigration to the region. Modernization, however, may shift social values of local communities
433 away from traditional knowledge and values, as globalization and trade bring new social and
434 economic opportunities. Remote rural communities would become more physically and socially
435 connected and develop greater ties outside of the boreal zone through partnerships between

Indigenous groups, forest communities, government, industry, and academia. For example, communities off of the electrical grid would become connected where there is currently a reliance on unreliable diesel generators (Arriaga et al. 2013). However, the rise of the digital economy through globalization and modernization may result in job losses in the boreal zone due to automation and labour export (Johal & Thirgood 2016), illustrating the importance of effective job transition programs reflecting new and emerging industries. Indeed, the rise of big data and artificial intelligence in the global marketplace is predicted to significantly alter the Canadian workforce; the concentration of artificial intelligence institutes and research centres in large cities illustrates a growing innovation disparity between large urban centres and smaller communities (Canadian Institute for Advanced Research, 2017).

Virtual infrastructure relevant to changes in social identity and values can occur due to increased exposure to telecommunication networks, such as the Internet (Bargh & McKenna 2004). Social media has been shown to build connections between groups of people who might otherwise not have connected, increase access to information worldwide, fuel grassroots support for large-scale causes, and create entirely new, web-based communities based on interest instead of geography (Haythornthwaite 2005). The Internet can also be used as a medium for knowledge transmission through forums, research databases, and online courses and degree programs, emphasizing the potential for expanding social, professional, and technical ties between people and communities. Unfortunately, research has shown that millions of Canadians living in northern and remote areas do not have broadband Internet access (Sawada et al. 2006). For those who do not have ready access to virtual and social networks, learning processes and access to technological advancements may be harder to come by, particularly in an economy shifting towards the digital realm.

6. Looking forward (2015 – 2050)

The scenarios described below are based on Canadian population projections over the next 35 years (Fig. 8). Between now and 2050, the total population is projected to grow to about 42 million, with the population growth driven mostly by immigration. Foreign-born Canadians are expected to account for more than one in four Canadians by 2050, indicating that the population will become more diverse than ever. The overall population growth rate will also continue to slow in the coming years, due to an aging population and low average fertility rates (Statistics Canada 2016b).

The following predictive scenarios describe three contrasting demographic shifts that could occur in boreal zone over the next 35 years: (1) “Status quo”, where the region experiences a slow, gradual population decline consistent with current trends; (2) “Boreal zone Renaissance”, where the region experiences a population boom; and (3) “Fortress World”, where the region experiences relatively rapid population decline.

It is worth noting that by the very nature of the exercise, these scenarios act as brief narrative snapshots. As mentioned in section 2.3, our aim is not to create caricatures or generalize social groups, but rather to present ideas about potentially disparate futures based on current (and projected) data and evidence. We recognize, for example, that Indigenous communities in the boreal zone will likely face different challenges and opportunities due to unique governance regimes and modern treaties and land rights.

6.1 Status quo

Given the consistent movement of youth and immigrants toward urban areas, cities both within and outside the boreal zone continued to increase in size and density over the last 35 years. As younger generations moved into urban areas, rural areas of the boreal zone gradually depopulated. Population centres located within the boreal zone, such as St. John's, NL, Edmonton, AB, and Yellowknife, NWT, have continued to directly affect the region's landscape through demand for provisioning ecosystem services (e.g., resource extraction. Cities outside the boreal zone are now highly influential due to population size and political influence.

Rural areas are still predominantly inhabited by Indigenous groups, although youth continue to gravitate towards population centres. Social values may differ among those who remain in rural areas in comparison to those who reside in urban areas. Remote communities have become more and more disenchanted by the isolationism of urban politics, and local *ad hoc* governance systems have consequently developed to manage large expanses of land. These groups have difficulty managing landscapes that are continuously changing due to environmental catastrophes such as drought, forest fires, pests, and other extreme weather events. Many young remote and rural dwellers, frustrated by lack of social and economic opportunities, continue to move to urban centres both within and outside the boreal zone.

International immigrants have predominantly settled in urban areas outside of the boreal zone in Canada's three largest cities – Toronto, ON, Vancouver, BC, and Montréal, QC (Statistics Canada, 2011). Many of these newcomers are not familiar with the boreal zone landscape, nor its many communities and land use history. Demand for physical and virtual infrastructure between southern and northern portions of the country has remained weak and its construction haphazard, as politicians and decision-makers choose to focus resources on newcomers and urbanites. Some immigrants will settle in smaller urban centres in the boreal

zone, driven by the prospect of job opportunities related to resource-centric industries. However, these job opportunities are often uncertain and insecure, as “boom and bust” cycles continue to plague the local economy of many boreal zones.

Cities and towns driven by the demand for provisioning ecosystem services will continue to experience population growth, particularly in northern Alberta. The oil and gas industries will continue to be an integral part of the economy in these areas, where the amount of temporary foreign work is dependent on the demand to fulfill positions in these sectors (Statistics Canada, 2012). Grant and incentive programs launched by the federal government have been, for the most part, unsuccessful in diversifying the region’s economy. These failures can be attributed to some degree to the lack of adequate investment in technological and transportation infrastructure throughout the boreal zone, as well as the lack of community and political readiness to fully embrace low-carbon initiatives. Population centres in the boreal zone find themselves left behind as southern cities become more resilient to environmental change due to smart grids, large innovation hubs, private sector investments, and integrated and inclusive governance systems.

6.2 Boreal zone Renaissance

Feedbacks between local and global scale processes have become stronger as the effects of climate change are felt, and as information and transportation technologies grow and strengthen social networks. Problems that were once distant and abstract are now localized, and many Canadians are dealing with the severe and often unpredictable effects of storms, flooding events, heat waves, and drought. Diversity and collaboration have been increasingly valued as solutions to “wicked” or complex problems. A greater awareness of environmental issues has

526 been engendered through local and grassroots initiatives and calls to action have been taken
527 seriously to promote sustainable development in the short, medium, and long term.

528 During this period, Canadians have increasingly internalized the need for transformative
529 change in society towards a more sustainable relationship with the environment. This sentiment
530 has engendered a shift towards a lower carbon economy, with renewable energy solutions taking
531 centre stage. This shift, along with automation in the work force, has eliminated many traditional
532 forms of employment in the boreal zone. Although the effects of climate change are still being
533 felt, investments in climate adaptation measures (such as mandatory “FireSmart” assessments for
534 every home and business) and new technologies (such as artificial intelligence and machine
535 learning for more accurate modeling and forecasting) have prevented widespread damages in
536 boreal zone towns. Policies implemented at the municipal level in many regions across the boreal
537 zone discourage private developers from constructing in “high risk” areas like floodplains.

538 In the first decades of the 21st century, wealth inequality in urban areas rose sharply as
539 major cities along the southern Canadian border, such as Vancouver, BC, Toronto, ON, and
540 Montréal, QC, grew and as the high housing prices became unsustainable (Fong 2017). As a
541 result, many young professionals and families chose to live in more affordable and less densely
542 populated areas, incentivized by joint government and private sector programs geared towards
543 attracting an educated and skilled labour force to small- and mid-sized communities both within
544 and outside the boreal zone. Attracting those with a love for the outdoors and a longing for that
545 “small-town feeling”, these programs focused on creating local economic opportunities in the
546 renewable energy and technology sectors, creating small yet significant innovation hubs across
547 Canada. Renewed interest in the boreal zone and its lifestyle is emphasized when, in 2025, the

largest Canadian marijuana producer chose to move its headquarters from Toronto, ON to Saskatoon, SK.

Migration away from large urban centres sparked demand for more reliable physical and virtual infrastructure and transportation networks, increasing telecommuting, and remote employment opportunities. Changes in traditional employment, corporate organizational structure, and technological innovation enabled workers to collaborate without requiring the same spatial proximity. Private and public investments in renewable energy, transportation, and information technologies supported the movement to smaller, independent, dispersed, family- and community-oriented towns and cities in the boreal zone. Local and regional stewardship of the boreal zone landscape has become a priority, as population centres scattered across the boreal zone grow steadily and are transforming into spheres of political and social influence. Urban expansion into the boreal zone forest has occurred, as infrastructure is built to accommodate a growing population.

In this scenario, international instabilities and increased incidences of climate-related catastrophes elsewhere continued to drive immigration into Canada, contributing to the majority of its population growth. The value of multiculturalism and support for immigration remained strong during this period, with an understanding of the need for diversity to drive social, technological, and economic innovation. A surprising population shift is noticed as skilled immigrants, incentivized by opportunity, supportive government programs, and lower real-estate costs, settled in population centres in the boreal zone. Northern cities have become more and more attractive as social and economic hubs.

6.3 Fortress World

In this scenario, extractive industries such as mining, oil and gas, and coal have become less profitable and less efficient in the face of alternatives, and as a result these activities have slowed considerably within the boreal zone. Due to economic and environmental factors including market competition, drops in worldwide lumber prices, and widespread outbreaks of invasive insects and diseases that have ravaged softwood species in Canadian boreal zone forests, the country's timber industry has declined considerably. Wind power, biomass, solar and tidal energy, and hydroelectricity shares have increased in the energy market. However, with few exceptions, the development, construction, and management of renewable energy infrastructure is done remotely, either in urban hubs or abroad.

Despite efforts to transition jobs and people from non-renewable to renewable industries, automation and technological advancements that emerged within the new digital economy resulted in many permanent job losses in transportation, manufacturing, equipment operation, and resource extraction across the boreal zone (Johal & Thirgood 2016). Job transition and training programs proved to be underfunded and underdeveloped, and frustrated, unemployed, skilled workers moved away from small- and mid-sized communities in the boreal zone. Growing technology companies chose to headquarter in towns and cities along the Canadian border, where previously established virtual and physical infrastructure granted them ready access to larger markets.

Rapid depopulation occurred in the boreal zone over the last 35 years, as people either flocked to the few population centres located within the region, or moved to more distant metropolitan areas found along the southern Canadian border. Limited infrastructure built between the southern and northern parts of the country in the last few decades resulted in fractured virtual and transportation networks, made worse by the continued exodus of local

boreal zone populations. Lack of infrastructure investment in the boreal zone has been compounded by the fact that the majority of immigrants, who generally have limited knowledge about and interest in the boreal zone landscape, chose to settle in cities outside the region due to social and economic opportunities.

Incidences of environmental catastrophes related to climate change such as massive forest fires and invasive species increased in frequency and severity over the years (Gauthier et al. 2015). As devastating effects were felt in more remote and rural communities with few resources, many were left with little choice but to move to urban areas. Younger generations, such as Millennials and Centennials, uninspired by the lack of economic stability and the increasing social detachment between small boreal zone towns and the rest of Canada, have been steadily moving away from their communities, seeking opportunity in urban centres (Johal & Thirgood 2016). As boreal dwellers struggle to withstand and the effects of a changing climate, unsuccessful and underfunded climate adaptation strategies are highlighted further; the exodus of younger generations is only exacerbated.

The natural landscape of the boreal zone has been left to its own devices in many areas. In the face of climate change, biodiversity loss, and worldwide wildlife habitat destruction, urban dwellers and policy-makers have been calling for environmental preservation in large swathes of mostly uninhabited forest not yet severely affected by fire, insects, and pests. Forest management strategies geared towards mitigating climate change, such as maintaining and enhancing carbon sequestration, have taken precedence over timber extraction (Gauthier et al. 2015). Post-materialist values have been gradually superseding materialist ones, at the expense of local ecological knowledge and traditions that continue to erode and might eventually disappear. As Indigenous governance and sense of place within local communities weakened due to declines in

capacity, services, and resource accessibility, many traditional lands were left uninhabited. Population centres turned into fortresses of innovation and policy-making, while smaller communities in the boreal zone transformed into ghost towns.

7. Synergies and trade-offs

As illustrated by these scenarios, factors such as birth and death rates, immigration, emigration, and social and cultural norms influencing social and demographic patterns do not exert influence in isolation. A synergy occurs when two or more independent factors exert a greater influence combined compared to the sum of each effect considered separately, while a trade-off occurs when an action or driver of change results in a positive (or increase) in one aspect and a negative (or decrease) in another. Major synergies and trade-offs corresponding to the effects of demographics and social values in the Canadian boreal zone are shown in Table 3.

One of the major risks uncovered from current (and future) demographic trends relates to value divergence. Many values associated with urban dwellers necessarily differ from rural dwellers, just as boreal zone communities may experience environmental, social, and economic upheaval differently from non-boreal zone communities. International immigration, one of the major factors influencing population growth in Canada, may only compound the effects of dissociated value systems, as immigrants with limited or no knowledge about the boreal zone find themselves in cities entirely geographically, socially, and politically disconnected from northern areas. Remote and rural communities, who likely already feel isolated from political and decision-making hubs, will continue to feel the brunt of politicians and elected officials prioritizing urban areas and their growing population.

8. Conclusion and recommendations

The boreal zone is a fragile region that is vulnerable to ecological, social, and economic change. For so long, its population has depended on its abundant natural resources, yet we are moving towards a modern, digital economy where innovation and automation will permanently alter this social-ecological landscape. Furthermore, increased international and interprovincial immigration towards urban centres may result in the further concentration of power and governance structures away from the boreal zone. This trend may deepen the urban-rural divide and engender disconnect between boreal zone and non-boreal zone communities. To minimize these risks, we propose the following recommendations for policy- and decision-makers:

1. Increase adaptive capacity of smaller boreal zone communities to environmental and economic change without compromising social and cultural values. Local communities need to be empowered by ensuring local economic opportunities as well as strong social capital through effective forms of local and regional governance systems. These governance systems should continue to recognize and strengthen Indigenous rights and relationships with Indigenous communities. Job transition and training programs, along with an emphasis on social entrepreneurship, should be developed, strengthened, and implemented in anticipation of resource-centric job loss and the transition towards a digital and data-driven economy.

2. Encourage and facilitate cooperation and collaboration between boreal zone communities, as well as communities outside the boreal zone. Greater investment in transportation networks, virtual infrastructure, and health and educational facilities will generate economic and social opportunities in more remote areas, and create connections between southern and northern communities. Further reducing the isolation and enhancing the connectivity of Indigenous communities would facilitate more equal access to resources.

663 3. Ensure adequate representation of boreal zone communities in decision-making
664 organizations, most importantly without resorting to tokenism. Public participation and
665 consultation with local stakeholders should be carried out appropriately and effectively, and local
666 governance systems, especially those representing Indigenous communities, should be a given a
667 place within the political sphere.

668 Our socio-ecological landscapes are changing at a rapid and unprecedented pace, and it is
669 essential to consider past and present demographic and social trends in policy- and decision-
670 making. The risks outlined in this paper must be addressed and minimized in order to ensure
671 sustainable development both within and outside the boreal zone. Canada is poised to address
672 these challenges, but it will require us to clearly understand and articulate our vision of the future
673 of the boreal zone – a daunting and potentially divisive endeavour.

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Fig. 1. Analytical framework of the demographic and social value driver system in Canada as it relates to the boreal zone. Note: the analytical framework does not consider the impacts of changes in demographics and the social values of the international community.

Fig. 2. Population change in the boreal zone from 2011 to 2016 within census divisions of Canada. Population categories are derived using Jenks natural breaks.

Fig. 3. Location of population centres (PCs) of Canada. A population centre is defined by Statistics Canada (2011) as an area of having a population of at least 1,000 people and a density greater than 400 people/km².

Fig. 4. Distribution of non-Canadian citizens in the boreal zone in 2006 within census divisions of Canada.

Fig. 5. Total population and proportion of populations for generations in rural and urban areas located (A) outside the boreal zone and (B) within the boreal zone.

Fig. 6. Distribution of people identified as Indigenous in the boreal zone in 2006 for census divisions of Canada.

Fig. 7. Distribution of Indigenous population change in the boreal zone from 2001 to 2006 for census divisions of Canada.

Fig. 8. Projection population by generation (thousands) in Canada from 2015 to 2050 (Statistics Canada 2015).

Table 1. Total population within the boreal zone and non-boreal zone of Canada from 1986 to 2016.

Table 2. Impacts of boreal zone drivers on demographics and societal values

Table 3. Examples of synergies and trade-offs corresponding to the effects of demographics and social values in the Canadian boreal zone.

Fig. S.1. Populations of indigenous languages spoken in households within the Boreal region. Population categories are derived from Jenks natural breaks. Summary across the region is based on the census divisions of Statistics Canada in 2011.

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Table 1. Total population within the boreal zone and non-boreal zone of Canada from 1986 to 2016.

Year	Non-boreal zone		Boreal zone	
	Urban	Rural	Urban	Rural
1986	12871890	1495490	1495490	995435
1991	14793280	1641520	1641520	1162595
1996	16359750	1631450	1631450	1320400
2001	20744900	1669250	1669250	1383800
2006	25859260	1802560	1802560	1619945
2011	27613040	1929295	1929295	1734260
2016	28625095	2633865	2257585	1644450

Table 2. Impacts of boreal zone drivers on demographics and societal values

	Demographics	Societal values
Demand for provisioning ecosystem services (PrES)	<p>Economic opportunities and subsequent job creation affect the demand for PrES in the boreal zone, influencing the number and types of jobs available. These may also result in a population influx into the boreal zone.</p> <p>Demand for products influences management and governance systems, as well as relationships between communities and stakeholders (e.g., industry, government) within and outside the boreal zone.</p>	<p>Globalization fosters shifts in social values that may replace traditional values, particularly at local scales.</p> <p>The involvement of local communities in extractive activities may allow for the incorporation of local values.</p>
Demand for non-provisioning ecosystem services (NPES)	<p>Demand for services like tourism, recreation, and protected areas will dictate job growth in these fields and subsequent demographic movement.</p>	<p>Demand for services within the boreal zone may stem from values outside the boreal zone, generating conflict due to differing societal values.</p> <p>The protection and/or inclusive management of traditional lands ensure the preservation of ecological and social knowledge and values.</p>
Atmospheric Change	<p>Climate change will affect capacity for demographic growth and precipitate immigration/emigration depending on geographic and regional changes (e.g., agricultural output, sustenance activities).</p>	<p>Loss of cultural and traditional values may occur due to biophysical and ecological changes in the boreal zone.</p> <p>Environmental refugees from other countries will bring their own social and cultural values to Canada.</p>
Governance & Geopolitics	<p>Governance empowering local communities and favouring growth of the boreal zone will attract immigration and discourage emigration.</p> <p>Governance systems concentrated in urban centres may fail to consider rural issues, isolating more remote communities.</p>	<p>Loss of local values and autonomy may occur due to political power concentration in urban hubs.</p>
Industry & Innovation	<p>Access to innovation and better infrastructure promotes growth in boreal zone by encouraging immigration and discouraging emigration.</p> <p>Automation and the emergence of the digital economy may render many boreal zone-centric jobs obsolete, encouraging emigration.</p>	<p>Globalization and the continued modernization of industry and natural resource management may result in shifts away from traditional knowledge and local values.</p>

Synergies	Trade-offs
Indigenous populations	
<p>The movement of rural and Indigenous youth to cities with increasingly less affordable housing and high unemployment may compound risks of poverty and homelessness, especially for those coming from backgrounds of poverty, substance abuse, substandard housing, and lack of educational opportunities, in addition to being prone to high mobility (Hick 2007; Peters & Robillard 2009).</p> <p>Many of these factors together place these youth at a disadvantage in securing stable employment and related health and social services (Patrick 2014).</p>	<p>Indigenous youth searching for educational and economic opportunities in cities may end up in research and decision-making positions, with greater capacity to enact positive change in regions both inside and outside the boreal zone through policy. However, the movement into cities may in turn contribute to losses in traditional social values and local, place-specific knowledge.</p> <p>According to the Environics Institute (2010), approximately half of surveyed Indigenous Canadians living in Toronto are at least somewhat concerned about loss of cultural identity, while 40% expressed a lack of knowledge about their family history.</p>
Immigrant populations	
<p>Today, most immigrants originate from Asia and the Middle East, and overwhelmingly settle in large urban centres, attracted by economic opportunities, other family members, and the sense of community created by other immigrants settling in the same cities (King 2009). Similar to other urban dwellers, immigrants are less affected by the social-ecological landscape of the boreal zone, and may generally feel less attached to the region.</p> <p>As immigrants settle with other immigrants in large cities, connections between regions within and outside the boreal zone may weaken further as social and local ecological values between boreal and non-boreal communities become more and more disparate.</p>	<p>Immigrants who choose to settle in communities within the boreal zone will necessarily develop greater connections to its socio-ecological landscape, but may feel more isolated from other immigrants who settled in southern areas of Canada.</p>
Rural and urban populations	
<p>As immigrants settle in predominantly urban areas along with rural youth, rural communities may continue to feel the brunt of politicians and elected officials prioritizing</p>	<p>The movement of younger generations away from rural communities may lessen the local environmental impact associated with the demand for provisioning and non-provisioning</p>

urban areas and their growing populations.	services. However, these impacts may be felt in urban areas instead, particularly as suburban sprawl and demand for residential housing in larger cities replaces and/or fragments natural habitats.
Investment in physical and virtual infrastructure between southern and northern portions of the country, as well as between rural communities, will further influence population flow from rural into urban areas.	

Table 3. Examples of synergies and trade-offs corresponding to the effects of demographics and social values in the Canadian boreal zone.

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Fig. 1. Analytical framework of the demographic and social value driver system in Canada as it relates to the boreal zone. Note: the analytical framework does not consider the impacts of changes in demographics and the social values of the international community.

233x166mm (144 x 144 DPI)

Fig. 2. Population change in the boreal zone from 2011 to 2016 within census divisions of Canada. Population categories are derived using Jenks natural breaks.

762x542mm (100 x 100 DPI)

Fig. 3. Location of population centres (PCs) of Canada. A population centre is defined by Statistics Canada (2011) as an area of having a population of at least 1,000 people and a density greater than 400 people/km2.

762x544mm (100 x 100 DPI)

Fig. 4. Distribution of non-Canadian citizens in the boreal zone in 2006 within census divisions of Canada.

762x544mm (100 x 100 DPI)

Fig. 5. Total population and proportion of populations for generations in rural and urban areas located (A) outside the boreal zone and (B) within the boreal zone.

643x762mm (100 x 100 DPI)

Fig. 6. Distribution of people identified as Indigenous in the boreal zone in 2006 for census divisions of Canada.

762x544mm (100 x 100 DPI)

Fig. 7. Distribution of Indigenous population change in the boreal zone from 2001 to 2006 for census divisions of Canada.

762x542mm (100 x 100 DPI)

Fig. 8. Projection population by generation (thousands) in Canada from 2015 to 2050 (Statistics Canada 2015).

762x398mm (100 x 100 DPI)