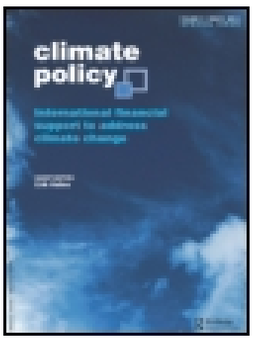

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Meeting the climate change challenge: local government climate action in British Columbia, Canada

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ABSTRACT

Local governments have a key role to play in implementing climate innovations as they have jurisdiction over a significant portion of greenhouse gas emissions. Meeting the Climate Change Challenge (MC^3) is the first longitudinal study exploring climate innovation in Canadian municipalities. A tri-university research collaborative, it focuses on British Columbia (BC), whose voluntary efforts to set and meet climate change goals were far more ambitious than those offered by the federal government (and almost any other province in North America at the time). These efforts included introducing a carbon tax and the Climate Action Charter voluntary agreement in 2007. Since then, 187 of the 190 local governments in BC have signed the Charter to take action on climate change. Research in the first phase of MC^3explored the dynamics of innovative local responses to the coordinated suite of government legislation, complimentary policy instruments, financial incentives and partnerships with quasi-institutional partners. In the second phase, the 11 original case studies were revisited to explore the nature of transformative change in development paths and indicators of change. Methods include sentiment analysis, decomposition analysis of regional/local emissions, and modelling relationships between climate action co-benefits and trade-offs. This paper provides a synthesis of research outcomes and their implications for environmental governance at multiple scales and the potential of policy innovations to accelerate transformation towards carbon neutral economies.

Key policy insights

- Local governments are on the front line of identifying indicators of change in current development paths and policy innovations to effect the necessary changes for transformation to carbon neutral economies.
- Barriers to transformational change include lack of coordination or concerted action across multiple scales of governance, electoral cycles and large swings in leadership, and lack of policy coherence across governance levels.
- Drivers of climate innovation include leadership at multiple levels of governance.
- Understanding the co-benefits (and trade-offs) of climate actions is important for integrated strategies that achieve broader sustainability goals, as well as accelerating more innovations on climate change.

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Climate change adaptation and mitigation; local government; development paths; local climate action

1. Introduction

Global climate change poses an immediate and serious threat to the ecological integrity of Earth's biosphere, the social and economic stability of society (Diffenbaugh & Field, 2013; IPCC, 2007; Stern, 2006), and continuing human prosperity (Dale, Herbert, Newell, & Foon, 2012). Success in addressing climate change internationally,

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however, has been mixed; and the Nationally Determined Contributions (NDCs) submitted under the 2015 Paris agreement fall far short of constraining warming to less than 2°C higher than the pre-industrial average global temperature, and even further short of the aspirational 1.5°C goal. Nevertheless, municipal, regional, territorial and provincial governments are working to address climate change within their jurisdictions, regardless of the lack of ambition of higher orders of government.

Local communities have a key role to play in climate mitigation and adaptation as they often have direct control over some critical sources of emissions (Betsill, 2001; Bulkeley & Betsill, 2005) and operate at the scale at which many of the potentially catastrophic impacts of climate change will be felt (Wilbanks & Sathaye, 2007). They also represent a scale that is most responsive and accessible to citizens through public participation in decision-making (e.g. town hall meetings, advisory sessions, civil society engagement, etc.), strengthening forms of governance and public buy-in (Beierle & Cayford, 2002). As hundreds of communities respond to climate change, analyses of the types of innovations occurring in local governments and communities are increasingly relevant to examine the sources of both climate innovation and inertia. Examining inter-related opportunities and challenges around adaptation, mitigation, community planning and public engagement provides insights into what constitutes a development path and the potential for change. The drivers and barriers to climate action represent (respectively) catalysis or hindrance to transformative change in underlying development paths. Identification of those drivers and barriers is critical for communicating best policy, technical and social practices needed to support decision-makers, domestically and internationally.

This article focuses on Canada, and specifically the province of British Columbia (BC) one of Canada's provincial government leaders in climate action. It summarizes the results of Meeting the Climate Change Challenge (MC^3) project, a seven-year climate research effort that brought together over 100 researchers, practitioners, civil society leaders and policy-makers to investigate 11 local communities characterized as climate innovators in BC. Building upon the results of the first phase of the research, the second phase then focused on unpacking development path change, testing indicators of transformative change, and investigating the role of multi-level governance in climate innovation. This paper summarizes and synthesizes the MC^3 research project, beginning with a discussion about development paths to provide the theoretical context for this exploration of local community climate action. It then summarizes the approach and objectives of the research project, followed by a detailed discussion of the methods and outcomes of phases I and II of the research. The paper concludes with main findings and lessons learned as well as policy implications for national and international transformative change.

2. Exploring development path change

A development path consists of a particular trajectory of social systems (formal and informal rules, habits, and norms), networks amongst actors, diverse technologies, and ecological systems, which drives the trajectory in certain directions. A low carbon development path would result in lower carbon emissions over time and would be characterized by those actions, technological developments, norms, institutional rules, practices, policies, and behaviours that lead to that outcome. Development paths are imbued with and defined by values, norms, rules, and habits rather than defined by a measurable set of conditions/characteristics. They exhibit a particular set of interlinking regime rules and behaviours, including inertia and cascading effects over time, and they are reinforced at multiple levels, with varied capacities and constraints on local agency occurring at each level (Burch, Shaw, Dale, & Robinson, 2014; Shaw, 2013). It is the underlying development path that yields current emissions trajectories and vulnerabilities (Cohen, Demeritt, Robinson, & Rothman, 1998; Robinson et al., 2006), and it is this path that must change in order to reach the ambitious goals of carbon neutrality and sustainable community development.

Some scholars claim that transformative change is all around us – the world is transforming as we speak. Ecologically, we have been transforming the Earth since our beginnings and the impacts are now visible at a global scale (Steffen et al., 2015). Rockström et al. (2009) argue that we have crossed at least three of the nine planetary boundaries within which we must operate to avoid catastrophic, system-wide changes that deeply affect human well-being: the rate of biodiversity loss, changes to the global nitrogen cycle, and (the primary focus of this research) climate change.

The pace and scale of change is profound; the world is being transformed in ways that are both intended and unintended; transformative change and disruptive innovation are happening all around us causing 'cascading regime shifts' and 'interacting critical transitions' in ecosystems (Rocha, Peterson, Bodin, & Levin, 2018). Climate change is only one manifestation of our capacity to fundamentally change both natural and human systems. Internet communications, artificial intelligence, nanotechnology, genetic modification, and even democracy are other examples of transformative change. Given the omni-presence of these significant changes, the challenge, from a climate change point of view, is not so much to create change but to steer ongoing changes in more sustainable directions. What is needed, then, is the widespread and rapid normalization of climate action and ultimately sustainability practices to shift development paths toward low carbon and sustainable futures.

3. Meeting the climate change challenge

The MC^3 project was a tri-university research effort involving researchers from Royal Roads University, University of British Columbia, and Simon Fraser University, as well as collaborators from public, private and not-for-profit sectors, using a mixed-methods, comparative case study (Stake, 1995; Yin, 2003) methodology. The first phase (2011–2013) examined the climate innovations of 11 local governments in the province of BC. The second phase (2014–2018), described in Section 4, uncovered development paths and the changes necessary for communities to transition toward more sustainable pathways. It also included a temporal dimension, and the 11 original case studies from MC^3's first phase were revisited in order to conduct longitudinal analysis to reveal the complexities of development path trajectories, and the nature of changes, if any, that had occurred since the onset of the project.

3.1 Phase I (2011–2013)

The first phase of the MC^3 research agenda investigated responses to climate change in local BC communities identified as climate change innovators, using a sample of 11 communities, diverse in scale, location and resources. BC was selected as it was seen as a 'living laboratory' given its proactive leadership in implementing Canada's first carbon tax, as well as a suite of other climate policies, programmes and incentives. We wanted to investigate the effects of provincial climate policy on community level climate action. Local government responses to provincial leadership were identified in adaptation and mitigation actions. Further policies and programmes needed to accelerate this learning throughout municipal governments in the province were identified in a policy action agenda finalized at the end of this first phase (Dale, Robinson, Herbert, & Shaw, 2013).

3.1.1 Case studies

The main research activity of MC^3 Phase I was the development of detailed case studies for 11 BC communities engaging in climate action and/or planning. Case study communities were selected based on two primary criteria – (1) communities demonstrating leadership in adaptation, mitigation, and sustainability, and (2) communities exhibiting evidence of multi-stakeholder involvement and social learning. We also identified secondary criteria to ensure we selected a diversity of different community types, to capture a mix of small, medium and large communities, rural and urban, communities with a long history of climate change action and emerging leaders, resource-based and diversified economies, as well as those with government led and grass-roots approaches. Based on these criteria, the cases selected for the research were Victoria, Vancouver, Prince George, Dawson Creek, T'Sou-ke First Nation, Eagle Island (a neighbourhood of West Vancouver), City of North Vancouver, Campbell River, The Kootenay Regional Districts (focusing on the Carbon Neutral Kootenays strategy), Revelstoke, and Surrey.

A case study interview protocol was developed to investigate the state of climate action planning and implementation in the communities. An interview script was designed to gain information about local climate action strategies and innovation, municipal groups and key organizations driving climate action/innovation, barriers to implementation, status and monitoring of implementation, public awareness and engagement, co-benefits and broader community development goals, and future plans. Using the interview protocol, a series of open-ended, semi-structured interviews were conducted with individuals from each case

community involved in local climate action. Due to conditions of the ethical review, interviewees cannot be identified by name and/or their specific position; however, each case study included some local government representation (elected officials and/or government staff) and other participants consisted of community leaders, non-governmental municipal partners, and researchers. Altogether, 83 people were interviewed and, in most communities, 7–10 interviews were conducted; however, fewer interviews were conducted for some of the smaller communities, such as the Eagle Island neighbourhood (four). Interviews were conducted either by phone or in-person, depending on the case study community (some communities were more accessible to researchers, geographically), and each interview lasted approximately an hour. Interview data were transcribed and thematically analysed to identify drivers, successes, barriers and benefits associated with local climate action. From this analysis, a detailed case study was prepared for each community. More information on the case study methodology can be found in Shaw, Burch, Kristensen, Robinson, and Dale (2014), and the case study descriptions are available here: http://mc-3.ca/case-studies.

One of the major outcomes of the case study research was the identification of a series of important drivers of local climate action. A particularly important driver for climate action and innovation was leadership by multiple level of governance. The importance of municipal leadership for driving local climate action was an intuitive finding; however, the interviewees also emphasized the critical role of provincial leadership, particularly the 2007 Climate Action Charter, which provided a province-wide mandate for local governments to reduce greenhouse gas emissions (Shaw et al., 2014). Another driver of climate action was the extreme weather events and associated impacts experienced by the communities, for example, flooding and road damage due to freeze/thaw cycles in Prince George. These findings stress the social and economic importance of addressing climate issues (Newell & King, 2012). Additional drivers mentioned included access to funds through the province and organizations such as the Federation of Canadian Municipalities and BC Hydro, as well as access to skills and resources through partnerships. Quasi-institutional intermediaries were particularly important organizations associated with this driver, such as the Columbia Basin Trust in Revelstoke (Burch, 2013) and Fraser Basin Council in Prince George. Other drivers of climate action included mainstreaming of climate policies by treating them as a part of other policy areas (e.g. urban development), baseline GHG emissions inventories (e.g. BC Community Energy and Emissions Inventory), and the development of cost-effective infrastructure alternatives (e.g. district energy) (Robinson, 2018).

The case study analysis also illuminated four significant barriers to climate action. Although funding opportunities were identified as a driver, limited funds were also commonly expressed as a barrier by the communities. Similarly, human resource constraints were also identified as a barrier. Partnerships between communities could serve (in part) to overcome this barrier such as was the case with the Carbon Neutral Kootenays initiative; however, this was still noted to be a problem for many local governments, particularly smaller communities. In addition, electoral cycles and large swings in leadership were noted to be a challenge because newly elected governments may bring in a different mandate that does not align with climate action objectives and plans of the previous government. For example, in the first phase of the research, there was significant alignment between the provincial and municipal governments, referred to as policy congruence (within government) and policy coherence (between levels of government) (Dale, 2015). Interestingly, there was a major regime shift for the second phase of the research to a provincial government more aligned with traditional natural resource exploitation and neutral towards climate change adaptation and mitigation.

3.1.2 Peer-to-peer learning exchange

Phase I culminated in two peer-to-peer learning exchanges, involving face-to-face meetings with the researchers, collaborators, and interviewees from the different case study communities. Their purpose was to discuss research outcomes, further challenges and opportunities for local climate action and to develop recommendations to accelerate further local innovations. A policy document was developed following the first exchange that (based on both the case study research and learning exchange outcomes) identified 12 actions (discussed in further detail below in Section 4. Conclusions) that the BC Government could take to accelerate local efforts in mitigation and adaptation (Dale et al., 2013). This Action Agenda can be downloaded at http://mc3.royalroads.ca/sites/default/files/webfiles/MC3%20Climate%20Action%20Agenda.pdf.

3.2. Phase II research (2014–2018)

The second phase of MC^3 built on Phase 1, by investigating key recommendations in the Action Agenda to develop a deeper understanding about the challenges and opportunities in development path change. Investigating all 12 actions was outside the scope of this research; therefore, Phase II focused on actions we (and research participants) deemed had more potential for enabling communities to evaluate and make more meaningful progress towards climate change adaptation and mitigation. In particular, we explored the following.

- **Measure progress towards current development paths** – This action involves encouraging the transition to more sustainable community development that simultaneously restrains energy demand. The action is supported with methods for measuring progress away from unsustainable development toward more sustainable development paths.
- **Articulate the co-benefits** – This action emphasizes the importance of identifying co-benefits of climate change adaptation and mitigation, sustainable development and the green economy.
- **Government Incentives nationally and provincially**: This action calls for a new provincial Climate Action Charter that identifies more aggressive targets, goals and monitoring for the implementation of community GHG emissions, and more progressive systems of tracking progress towards achieving those goals.

3.2.1 Longitudinal analysis

The Action Agenda as it relates to development paths was a strong focus of Phase II due to our incomplete understanding of the complexities of change in development path analysis. To increase our understanding of development paths and change in the context of climate, we revisited the original case studies to engage in a longitudinal analysis. In-depth interviews were conducted with a subsample of interviewees from each of the original 11 cases. This was combined with an exhaustive comparative document analysis from 2012 to 2017, an examination of actual GHG emission changes, and an exploration of published or working descriptions of the progress of innovative responses to climate change and changes in development trajectories (for example in Official Community Plans, Integrated Sustainability Community Plans (ISCPs), Disaster Management Plans, etc).

Altogether, 36 people were interviewed in the second phase, and as in the first phase, the research employed open-ended, semi-structured interviews for data collection.

MC^3 Phase II builds on the findings of the first phase, and the interview protocol was designed to further explore insights on community climate action with respect to community development paths. However, as noted above, the second phase differed from the first in that it explicitly incorporated a temporal dimension and focused on changes in development paths. To this end, the development of the protocol was preceded by theory-based research and discussions among team members on ways of defining and investigating change in community development paths. It also built upon research findings from the first phase concerning policy harmonization and the role of multi-level governance (Bates, Green, Leonard, & Walker, 2013; Hooghe & Marks, 2003; Zeemering, 2016). From these discussions, three theoretical lenses were selected for the analysis:

- Social-ecological systems (SES);
- Multilevel perspective (MLP); and
- Social practice theories (SPT).

Using these frames allowed for an analysis of change that captured interactions between humans and their environment, relationships between levels of government and socioeconomic activities, and the role of both human behaviour and agency. Accordingly, the interview protocol was developed to include questions that interrogated change in each of these three areas. For more information on the relevance and use of these theoretical lens, see Moore, King, Dale, and Newell (2018).

This work was complemented by document analysis of official community documents between 2012 and 2016 to determine the degree and extent of change in development paths between the first and second

phases, as well as actual GHG emissions. These analyses were both used to better understand change in community development paths and support other complementary research activities. The latter is described in more detail in the sections below.

Findings from the Phase II research indicate that the pace of institutional change was too slow and the scale too small, yet there was a sense of urgency in the action needed (Dale, 2018). In addition, there was evidence that little transformative change had occurred in the case studies (Jost, Dale, & Schwebel, 2019), with only two of the case study communities demonstrating GHG emissions reductions in their municipal corporate operations (Jost, 2018). In light of these findings, there is a clear imperative for tools, techniques, policies and institutional arrangements that can spur shifts from incremental to transformative change, such as those described in the sections below.

In addition to gaining insight on development path change, case study data from Phase II confirmed our findings from Phase I in terms of the drivers of, and barriers to, climate action. For example, extreme weather events (forest fires, floods, droughts, heat waves, wild fires) that continued to increase throughout the second phase contributed to the sense of urgency to act by the public, and thus persisted as a driver of climate action. In some cases, a particular driver or barrier was observed in both phases; however, the nature of the driver/barrier differed. An example of this includes electoral cycles and change in leadership. In the first phase, this barrier was observed with changes in local government, whereas in Phase II, this was a barrier observed with a change in provincial leadership with weaker climate policies than the previous government that established the Climate Action Charter.

3.2.2 Sentiment analysis

This research is predicated on the conclusions from the Action Agenda that changing current development paths is imperative for climate change innovation domestically and to meet Canada's international obligations, recognizing that change in social and ecological systems is inevitable in the Anthropocene (Biermann, 2014). This position is supported by others who have argued that societal transformation is necessary for Canada to meet its emissions targets (Boothe & Boudreault, 2016; Heikkinen, Ylä-Anttila, & Juhola, 2019), and it has implications for both those who influence change as well as those who experience change. In order to determine interviewee perceptions around the concept of change itself, we engaged in text mining techniques, particularly sentiment analysis (see Aggarwal & Zhai, 2012; Liu & Zhang, 2012), to unpack positive and negative sentiments around the concept of change. Originating from Phase II interviews with local government officials, our objective was to interrogate views of climate researchers and policy-makers about the meaning of change, and to determine whether changes were actually occurring in the development paths of the case study communities.

Positive sentiments were generally linked to institutional changes regarding the integration of the climate change and sustainability agenda, as well as collaboration across local government departments, including changes in leadership and staff quality. This supports the findings of Phase I where leadership, policy alignment between departments and the institutionalization of sustainability goals were identified as enablers and were the main success factors. A unanimous positive sentiment was expressed for the changes stimulated by the Climate Action Charter, to take actions to become carbon neutral through the provincial government leadership. Described as critically important in Phase I, the support and guidance provided by the provincial government was deemed crucial for innovation while collaboration between local governments has been boosted by sharing common goals. However, the misalignment between the provincial and federal government goals and policies was identified as a barrier for change. As elected officials were reportedly likely to focus their efforts on concrete short-term priorities that were more closely aligned with their objectives during their term of office, local governments' initial steps focused on small achievements or 'easy wins', while measures that focused on co-benefits were the most praised.

Many interviewees expressed frustration over the scale and pace of change and expressed the belief that much deeper change was needed, particularly related to local growth challenges and the long path ahead to reach their GHG reduction goals. The continuation of local government climate innovation is strongly dependent on public acceptance of change. Outcomes of the analysis showed that the lowest rates of positive sentiments around change were related to the need for behavioural change and the perception of change by community members. These results reinforce two main drivers of innovation identified in Phase I, namely

people experiencing extreme weather events and mainstreaming of climate policies as urban development or sustainability. These outcomes demonstrate how crucial it is to raise awareness and gain public support on specific issues as well as the urgency of addressing climate change. On the other hand, elected officials described proactive leadership as crucial, in part because no amount of information can persuade some people to change, while others described enforced change with simple win-win measures as a positive opportunity to gradually encourage people to be more open to change. The results of our sentiment analysis lead us to optimism that local governments and key stakeholders are supportive of climate action and transformative change and frustrated by the slow and incremental changes they are seeing.

3.2.3 Assessment framework

The Action Agenda highlighted the need for augmenting methods for measuring progress toward more sustainable paths (Dale et al., 2013), and accordingly, we developed an assessment framework for analysing whether or not development path change had occurred. Document analysis was used to develop an initial assessment framework, based on a document review of reports from the 11 case study communities from two periods of time (2009–2012 and 2013–2016). Document analysis included reviews of annual reports, strategic plans, Official Community Plans (OCPs), Integrated Community Sustainability Plans (ICSPs), web pages and staff reports as well as reports from the Global City Indicators Facility, the Urban Climate Change Research Network, the Sustainable Prosperity Institute and the Fraser Basin Council's Report on Implementation of Community Sustainability Plans. After the initial framework was developed, it was iteratively reviewed by the research team. The resulting framework consisted of a set of 34 areas of community actions related to development path change, broken down into six categories – agenda setting, strategies, policy/plan formulation, implementation, feedback/evaluation, dissemination, and GHG emissions. Based on the criteria in the columns titled incremental, reformative and transformative actions, users designate which of the three kinds of actions are taking place at the local government level. The framework was further refined based on feedback given at a virtual peer-to-peer learning workshop involving researchers and local government staff from case study communities.

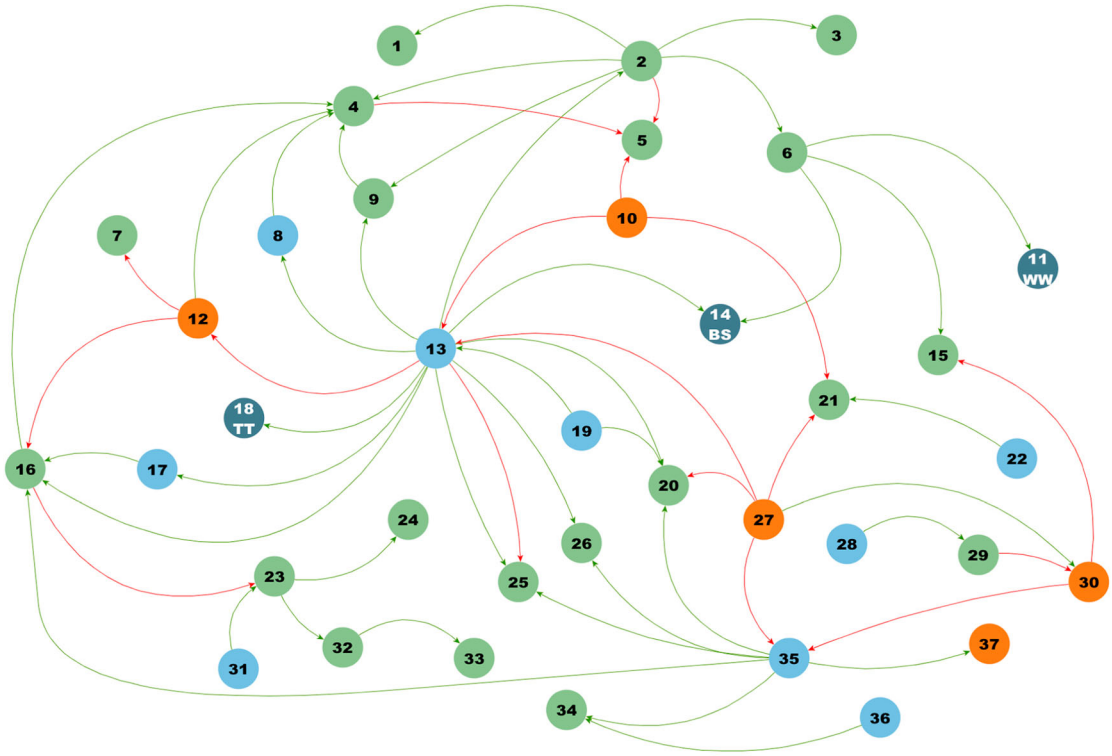
3.2.4 Co-benefits

The Action Agenda developed from the first phase recommended identifying and articulating co-benefits, that is, community benefits that occur from acting on climate change that extend beyond mitigation and adaptation, entering into other domains such as water quality, biodiversity, public health, or social equity. Accordingly, Phase II research involved delving deeper into the topic of co-benefits (Newell, Dale, & Roseland, 2018). Climate action that can be taken to achieve multiple social, economic and environmental objectives (Picketts, 2018; Romero-Lankao, 2012), and illuminate the multiple benefits that can result from integrated sustainability strategies and plans, strengthens the business case for even greater implementation. For example, creating a more walkable city can lead to reduced numbers of people driving (reducing emissions), but it can also lead to decreased obesity as more people walk or bike (increased health benefits), as well as enhanced community connectivity and social capital. In this way, climate action strategies and their co-benefits are 'win-win' situations; however, there are barriers, and some strategies may also have trade-offs. For instance, densifying a city leads to increased public transportation and building energy efficiencies, but it can also lead to taller buildings that impact views, the character of a community and people's sense of place. It is, therefore, important to demonstrate the relationships between strategies, co-benefits, barriers, and trade-offs, as this understanding can help decision-makers deliberatively optimize the benefits while also recognizing (and ideally addressing) the challenges.

Our co-benefits research involved coding the case study data from both phases to identify the range of co-benefits associated with climate action strategies. Data were aggregated for this study; thus, they represent co-benefits relationships occurring among all case study communities, and these relationships could differ somewhat in a specific place context. Barriers and trade-offs were also coded in order to understand challenges in implementing climate action and (more broadly) sustainable development. The relationships between codes were then identified through a coding matrix, and these were used to build a series of models that illustrate co-benefits, challenges and trade-offs associated with local climate action. Each model centred on a particular area of climate action, including energy innovation, urban densification, mixed-use and downtown revitalization,

building stock, ecological capital, trails and transportation, and waste and water. Figure 1 features the co-benefits model centred on energy innovation. A major strategy featured in this model is district energy (node 35), and co-benefits from this strategy include energy security (node 25) and employment (node 16) associated with building and operating the system. A potential trade-off with this strategy is that a district energy policy for a neighbourhood can 'scare away' some developers, who may wish to avoid the added requirements and specifications for their development.

The major outcome of the co-benefits work was that it provided a method for understanding synergies among different community strategies and policies and insight on how to engage in integrated planning. Phase I findings indicated that engaging in climate action through integrated strategies for sustainable community development can yield benefits in more effective ways than through compartmentalized approaches. As noted above, this is evidenced by the fact that over half of the 11 communities that we chose as examples of good practice on climate action chose to frame the issue more broadly as a question of sustainability. In addition, a major driver of climate action as per the Phase I findings was the mainstreaming of climate policies and including them as part of institutional policy areas. Although the need for climate adaptation and mitigation has gained widespread acceptance, the speed of implementation in many communities is slow and patchy. As a



Legend

1 Attract businesses	9 Tourism	17 Training and education	25 Energy security	33 Beauty
2 Branding and exposure	10 Inexpensive natural gas	18 Trail network	26 Wildfire management	34 Waste reduction
3 Tax base and labour	11 Recycling	19 Integrated design	27 Upfront expense	35 District energy
4 Economic development	12 Fossil fuel economy	20 Municipal account	28 Community engagement	36 Biofuel
5 Affordability	13 Renewable energy	21 Citizen accounts	29 Community support	37 Loss of developer interest
6 Pride and motivation	14 Green building	22 Energy conservation outreach	30 Community opposition	
7 Water conservation	15 Social capital	23 Air quality	31 Wood stove exchange	
8 Co-operative	16 Employment	24 Health	32 Viewshed	

Figure 1. Model of co-benefits and trade-offs associated with energy innovations (retrieved from Newell et al., 2018). Light blue nodes represent strategies, and dark blue nodes represent strategies that link to other models (BS – building stock; TT – trails and transportation; WW – waste and water). Green nodes represent benefits, and orange nodes represent trade-offs or challenges. Green connections refer to positive relationships, and red connections illustrate negative relationships.

result, it may be that important tools and techniques for climate action and planning are also those that support more general integrated planning and decision-making processes, which are already occurring.

The modelling of relationships between climate action strategies, co-benefits and challenges can result in a more comprehensive picture of the advantages and disadvantages associated with implementing certain plans and strategies in the local community, and allows climate action to be framed in terms of broader sustainability goals. As a result, these models can be used to support integrated planning efforts, whether by serving as the basis of an urban systems modelling exercise (e.g. Almeida et al., 2009; Sperling & Berke, 2017) or as tools for stimulating discussions in local government and stakeholder planning workshops. However, as mentioned above, the models were created from aggregate data, and relationships between strategies, co-benefits and challenges can differ from community to community. The models are thus made available online in editable format for local governments to adapt and use for their own community needs: https://www.changingtheconversation.ca/co-benefits.

3.2.5 Decomposition analysis

The recommendation for an updated climate action charter recommended 'identifying more aggressive targets, goals and monitoring for the implementation of community GHG emissions plans … with better systems of tracking progress towards achieving those goals' (Dale et al., 2013, p. 10). Setting targets and monitoring GHG emissions are relativity well-defined activities; however, methods for tracking progress and understanding drivers of emissions are less clear, leaving questions around what are the best ways for using data to understand emissions trends and inform policy and decision-making toward local climate action. The second phase therefore explored these questions by developing and applying a decomposition analysis to community emissions (Newell & Robinson, 2018). Decomposition analysis involves identifying and examining factors that influence the change in a variable, in this case, transportation and residential energy related factors that influenced changes in emissions on local and regional scales. Metro Vancouver served as the study site for the research, and emissions changes from 2007 to 2012 were examined. The results of this work were compared with findings from the case study research to develop a richer understanding of both local drivers of climate change and areas where progress is being made in reducing emissions.

The decomposition analysis indicated that inventorying and analysing GHG emissions can go beyond conventional monitoring approaches, which simply report on emissions changes in a given sector. For example, by decomposing transportation and residential related emissions, emissions changes can be understood in terms of factors such as how much people are driving and what type of vehicle, and how many people are living within a household. Such insights in turn can be used by local planners and decision-makers to develop policies and plans geared toward walkability and housing, in addition to mitigation.

Figure 2 provides an example of the output from a decomposition of Metro Vancouver's transportation emissions, and it demonstrates that the analysis can provide direction for policy. For example, 'the vehicle type effect' seen in Figure 2 indicates that the types of vehicles people bought/drove during the study period contributed to emissions increases, and the regional and local governments could respond to this challenge by devising ways to provide incentives for ownership of certain vehicle types. In other cases, the analysis elucidates challenges without direct policy solutions, but these are important to identify in order to understand problems and concerns for meeting mitigation targets. For example, population growth was the main contributor to emissions increases in Metro Vancouver, and considering that continual population growth is expected (Metro Vancouver, 2011), regional and local governments will need to implement more ambitious mitigation efforts to counteract these effects.

Decomposition analysis is a useful method for understanding challenges for and progress in climate action; however, the value and effectiveness of this method are very dependent on the available data (Jiang, 2015). In our analysis, the BC Community Energy Emissions Inventory (CEEI) provided a rich source of community data; however, data were only available for years between 2007 and 2012, thus creating challenges for applying these insights to current mitigation policy-making. This emphasizes the importance of monitoring and continually updating inventories, and provides support for climate action frameworks that call for this activity (e.g. Environmental Protection Agency, 2016; Federation of Canadian Municipalities, 2008).

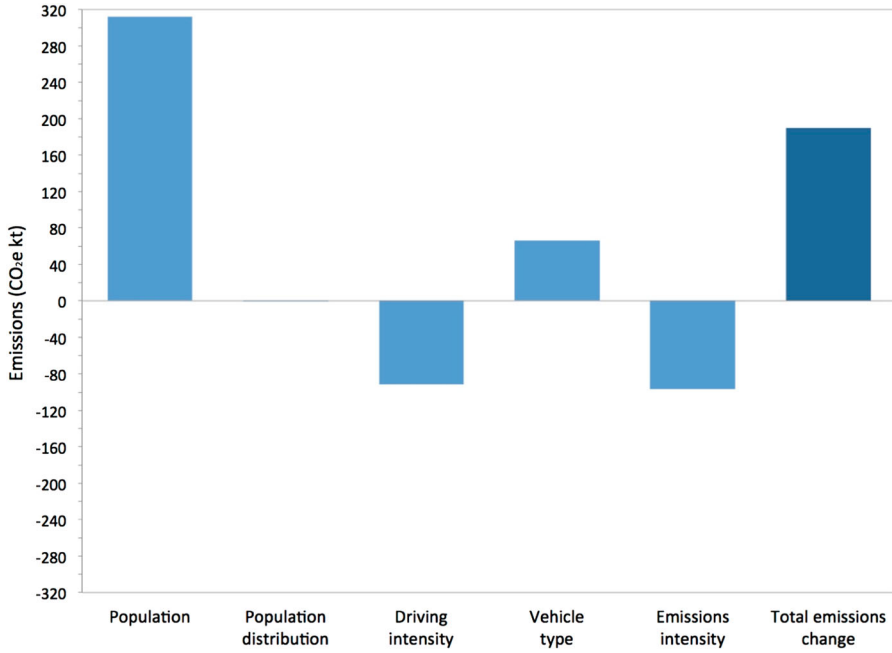


Figure 2. Factor effects for GHG emissions changes related to transportation in Metro Vancouver from 2007 to 2012 (retrieved from Newell & Robinson, 2018). Factor effects refer to number of potential vehicle drivers (i.e. 'population'), where people are residing in the region (i.e. 'population distribution'), the amount people are driving (i.e. 'driving intensity'), types of vehicles people are driving (i.e. 'vehicle type'), and emissions produced per distance travel (i.e. 'emissions intensity'). CO_2e kt refers to units of kilotonnes of carbon dioxide equivalent. 'Total emissions change' was calculated by summing all effects experienced in the transportation sector.

3.3 Knowledge mobilization

Knowledge mobilization was considered crucial from the beginning of Phase I and continued throughout phase two, to accelerate the take-up of climate innovations among communities. In addition, the 15 research partners were actively involved in case study selection, while the first peer-to-peer learning exchange included officials from the provincial government to ensure we were producing useful knowledge and policy relevant information. Both phases included diverse communication channels – a series of virtual real-time conversations (e-Dialogues), webinars, LiveChats, weekly blogging, videos, private virtual meetings with elected officials, and three peer-to-peer learning exchanges (two in Phase I and one in Phase II) to immediately begin research dissemination as soon as we began to obtain data and findings. Two e-Dialogues were held involving panels of MC^3 researchers and research partners, and the conversations (respectively) centred on the themes of sustainable development paths and climate action implementation. Each e-conversation was followed with a LiveChat, where the public could ask questions, engage in research topics and discuss findings. Six virtual meetings were also held between the research team and elected officials from different BC communities to share ideas and lessons about climate action strategies, and as a strategy to accelerate the take-up of climate innovations among local communities.

The effectiveness of the MC^3 knowledge mobilization strategies has not been assessed. However, we tried to address the role of knowledge in community transformation, in particular the dimensions of knowledge identified by Hjerpe, Glaas, and Fenton (2017), that is, the target of transformation, function of knowledge, and knowledge intermediaries. MC^3 focused on local climate action and the target of transformation was primarily local and provincial governance; however, this goes beyond local government because as evidenced through our case study research, climate action governance includes a multitude of different actors. We therefore employed a multipronged approach that included online strategies to engage the broader public, understanding this group to be 'community actors' and/or 'stakeholders' (Newell & Dale, 2015). The function of the knowledge dimension in MC^3 can be understood through our co-production approach. We continually engaged local government and community actors to develop findings, report back, gain feedback, and further develop findings.

This approach also speaks to the knowledge intermediaries in MC^3, as both researchers and participants served as channels for two-way information flows. The iterative process of collecting and presenting information to community partners allowed for an evolution of ideas and research outcomes that was grounded in real-world challenges and opportunities.

4. Conclusions

MC^3 research demonstrates the benefits that can result from a multi-level governance approach to climate action between two levels of government, in partnership with numerous civil society groups and researchers. As well, although many local innovations are happening, our case studies continued to place importance on other levels of government leadership to accelerate local innovation – proactive legislation; financial incentives; policy instruments; tools; and ongoing measurement and reporting. There are many lessons that are transferable to other levels of government that also highlight the efficacy of moving to a multi-level governance system for addressing implementation gaps and fast-tracking climate action locally. The greatest potential for accelerating shifts in current development paths occur when all levels of government are working congruently with one another, coupled with internal alignment within and across each level of government.

Our longitudinal research, however, also illuminates that very little transformative change has occurred in current development paths when strategies, plans and actions are compared to actual reductions in emissions. It is important to differentiate between the two research phases and the shifts that occurred in political regimes, again demonstrating the importance of multi-level governance for sustaining local climate innovation and accelerating the scale and degree of change in current development paths. In the first phase, which culminated in the action agenda for BC decision-makers, there was evidence of a diverse range of climate innovations. Climate action momentum and innovation, however, slowed significantly during the second phase with a provincial regime that was no longer interested in deliberately stimulating local climate action. Interviewees from the second phase reported that the pace and scale of change had been too slow, and in a few communities had actually stalled. Financial resources and leadership were identified during both phases to be a critical factor for implementing climate action by a local government, and barriers to climate action were varied, including a lack of broad community engagement and understanding about the need to change in some communities, and lack of horizontal institutional processes. In the second phase, institutional awareness had increased, although societal resistance was still cited as a major barrier.

Are there critical policy lessons for different levels of social organization, from local to international? The data reveal that leadership at multiple scales of government is critical for continuing and accelerating innovation and is a key driver for climate change adaptation and mitigation. Leadership that builds a level playing field, creates incentives and provides support for local governments in their implementation of climate strategies is critical for leveraging and accelerating current momentum and advancement on climate change (Dale, Burch, Robinson, & Strashok, 2017). A key factor for continuing innovation was the reporting requirements under the Charter and Climate Action Revenue Incentive Program (CARIP) that changed the way organizations made decisions and managed risks, most notably by facilitating inter-departmental and inter-sectoral cooperation and integrating climate change initiatives into broader sustainability-related strategies, observations that persisted into the second phase. This broader sustainability framework is directly linked to more integrated strategies for landscape, land use, transportation and energy infrastructure planning at multiple scales.

An important structural factor emerged from the second phase data. Electoral swings were identified as a major barrier in the first phase, and a success strategy for continuing climate action momentum in some of the case study communities involved embedding and institutionalizing climate innovations in departmental mandates, policies and programmes. Similarly, because the carbon tax was revenue neutral, the new provincial Premier was unable to eliminate it, although the planned phased increases were no longer implemented. Another key finding from the first phase was the sheer number of local and regional governments and organizations working together on the climate change challenge, and this collaboration and experimentation occurring on the ground was a metric of success in and of itself (Dale et al., 2013). Partnerships and networks of climate actors that promoted policy coherence within systematic policy frameworks were also reported as critical elements of successful climate action in both phases of the research.

Several key recommendations from the action agenda have implications for all levels of governance. First, the critical role that ongoing legislation can play in reducing GHG emissions. Second, recognition of the importance of synergy and coordination of local and provincial efforts with national and international initiatives engaging municipalities, quasi-institutional intermediaries and organizational networks to increase the density and centrality of the multiplicity of actors working in this domain. And third, encouraging the transition to more sustainable community development that simultaneously restrains energy demand (despite population growth), drives the production of low carbon energy sources, and designs complete and compact neighbourhoods and communities that create alternative forms of transport, and encourages multi-use development.

Last, operationalizing development path change is challenging. In order to test some of our assumptions about change, we applied our assessment framework in three of the largest cities – Vancouver, Victoria and Surrey. Here, we concluded that transformative change has occurred in some areas – but the changes have been primarily incremental or reformative. Any assessment of development path change, however, is problematic as there are historical trajectories that affect the scale and time frame of any evaluation. The dynamics have been occurring over a longer period of time for some communities, for example, in their response to the 1987 Brundtland Commission in Canada. The direction and degree of change are important, whether progressive or regressive, and whether it contributes to climate action and broader sustainability objectives or maintains the status quo.

The recent IPCC report on Global Warming of 1.5 degrees clearly states that the scale and pace of change must dramatically accelerate, as well as the uptake of climate innovations worldwide (IPCC, 2018). Drawing upon our MC^3 findings about the pace and scale of change, it would appear that governments at all levels must now intentionally intervene in current development paths if we are to realize transformative change. Critical questions must be addressed such as what is the nature and scale of change that is necessary – is it merely incremental shifts in current development paths or a more dramatic transformation to fundamentally new paths?

If policy interventions are to be effective, our data confirm the importance of integrating outcomes frbom research on multi-level perspective (MLP) and multi-level governance (MLG) (Armitage, Berkes, & Doubleday, 2008; Betsill & Bulkeley, 2006; Bulkeley & Betsill, 2005; Bulkeley & Kern, 2006) connecting the local, to regional, to national and international regimes. There is a decided lack of co-ordination across places and governance scales that can only be addressed through MLG to side step existing traditional power and conflict dynamics. MLP evidence illustrates the importance of various scales of interactivity for change (Geels, 2005a, 2005b, 2010, 2011, Geels & Schot, 2007). Although there is some evidence of smaller or 'niche' scales changing the larger regime scale (Rocha et al., 2018), we argue that rapid and timely deliberate government interventions for transformation will not be effective without policy coherence (within governments) and policy congruence (between government levels); as our evidence shows in BC, there is often a dampening down effect by one or two of the higher levels. This is in spite of unprecedented consensus among Canadian scientists on a detailed roadmap for achieving a renewable resource energy system by 2050 (Potvin, 2014; Potvin et al., 2017).

Our research also shows that the pace, scale and urgency of change are very dependent upon broad-scale public engagement. Public perceptions around 'change' are highly normative and evoke intersecting personal and cultural determinants about the urgency, and the scale and pace of change needed, which in turn can also be ideological.

Our research clearly demonstrates ways in which government policies and incentives can accelerate the take-up of climate innovations (Dale, 2015). These innovations need to be scaled up and adapted to different place contexts. Breaking down the barriers that existing institutions present is also required, barriers such as path dependencies, structural rigidities, age old power and conflict relationships, and ecologically damaging and economically perverse incentives. Transition strategies to move away from current development paths to a carbon neutral economy will allow communities to 'see' the co-benefits of climate action, the new employment opportunities that climate innovation can realize and the costs of not acting now. These transition strategies will not happen without political agency, and not just multi-level, but multiple levels interacting in vertical and horizontal interplay (Young, King, & Schroeder, 2008) – a new ecosystem of novel nested institutional arrangements.

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