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Local responses to regional mandates: assessing municipal greenhouse gas emissions reduction targets in British Columbia

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Local governments around the world face external and internal pressures to adopt climate change mitigation strategies. Provincial legislation in the Canadian province of British Columbia has recently mandated that all municipalities adopt targets for reducing greenhouse-gas emissions. Lack of specificity in the legislation gives rise to the possibility that even if compliance with the legislation is universal it could nonetheless result in minimal reductions in emissions releases. This article examines the response to the legislation of twenty municipalities in British Columbia's most populous regions. We hypothesized that noncompliance would be rampant and that cities with large populations, high residential densities, lower growth rates, and prior climate change planning work would set more ambitious targets. However, findings indicate that municipal targets vary widely in terms of intensity, target year, and type of reduction and have little or no relationship to population, residential density, or growth rate. We found 90% compliance and some correlation between prior planning activities related to climate change and target intensity. Findings also indicate that despite the wide range of emissions targets by each municipality, provincial per capita targets would be met if each municipality were to achieve the targets that they have set by the 2050 target year.

KEYWORDS: climatic change, mitigation, emission reduction, legislation, urban planning, government regulations

Introduction

Scholars increasingly emphasize the critical role that municipal governments can play in climate-change mitigation through the adoption and implementation of policies and actions aimed at reducing greenhouse-gas (GHG) emissions (Bulkeley & Betsill, 2003; Brody et al. 2008). While all levels of government can potentially make valuable contributions to mitigation (Collier, 1997; Betsill, 2001), untenable climate-change impacts are likely without the widespread involvement of municipal governments (Betsill, 2000; Lindseth, 2004). This work stresses the particular importance of municipal urban planning for climate-change mitigation, given the traditional role that such planning has played in managing public and private land-use and transportation decisions (Pitt & Randolph, 2009).

In British Columbia (BC), Canada, the provincial government has recently committed to reducing GHG emissions by 33% from 2007 levels by 2020 and 80% by 2050 (Parliament of the Government of British Columbia, 2007a). To help achieve these reductions, the province enacted Bill 27 (also known as "The Green Communities Act" and referred to here as GCA), which mandated that every municipal government in BC incorporate GHG emissions-reduction targets into their official community plans (OCPs) by the end of May 2010 (Parliament of the Government of British Columbia, 2007b). While this directive is unprecedented by North American standards in that it requires all municipalities in the province to set emissions-reduction targets, it does not specify target levels, target years, or base years to which municipalities should adhere; nor does it indicate whether targets should focus on aggregate or per capita emissions. This lack of specificity makes it possible that municipalities could comply with the letter of the law but not its intent. Conformance with GCA requires adopting targets that may ultimately entail such small reductions in GHG emissions that, even if met, would be insufficient to mitigate potentially harmful climate-change impacts. Even worse, the legislation allows the possibility that a municipality could reduce its per capita emissions while actually projecting and planning for an increase in aggregate emissions. Beyond a modest carbon tax rebate program, GCA provides little disincentive against token compliance.[1]

In this article, we examine the nature of GHG emissions-reduction targets adopted by a subset of BC municipalities in response to this legislation. In doing so, we address the following question: To what extent do municipal GHG emissions-reduction targets represent a cohesive response that might lead to regional achievement of provincial emissions targets in BC?

We first review the barriers that municipalities can expect in reducing local GHG emissions. The following section describes our variables, data-collection process, and the analytical techniques. We then present our findings and conclude with a discussion of the overall effectiveness of the local-government response to the provincial legislation.

Reducing GHG Emissions at the Municipal Level

Municipal governments are primarily responsible for overseeing a large number of activities that affect GHG-emissions levels, including controlling land use and development through zoning regulations and official plans; issuing building permits and approving major developments; controlling parking supply and rates, roads, and public transit; owning and/or regulating municipal power and natural gas utilities and district-heating systems; coordinating waste management; and managing parks and recreation services (DeAngelo & Harvey, 1998; Robinson & Gore, 2005). A number of scholars have shown that automobile emissions from low-density suburban developments are a particularly important source of GHG emissions (Brownstone, 2008; Ewing & Rong, 2008; Marshall, 2008) and that compact high-density development supported by reliable public transportation is a clear pathway to reduced emissions (Brown & Southworth, 2008; Ewing et al. 2008). We would therefore reasonably expect that cities that already have extensive high-density development would be leaders in both setting and implementing GHG reduction targets.

In the absence of federal or state/provincial mandates, municipal governments have generally been unwilling to voluntarily tackle climate change (Betsill, 2001). One reason for their initial reluctance has been a delay by cities in appreciating the climate-change problem, both in general and as a matter of local concern. Municipal officials often failed to understand how their community contributes to the problem or how they can be affected by it. Even when they have become aware that climate change was a problem at the global level, they have tended not to consider it a legitimate local concern (DeAngelo & Harvey, 1998; Wilbanks & Kates, 1999; Betsill, 2000; 2001; Bulkeley, 2000; Robinson & Gore, 2005). When cities have begun to adopt targets, their planning efforts have often been impeded by variable data, methodological uncertainty, political obstacles, and a general lack of resources (Pitt & Randolph, 2009).

Despite the aversion to climate-change planning and the refusal of the federal government in the United States to sign any climate-protection agreement, by October 2009, 1,000 mayors, representing more than a quarter of the country's population, had signed such a compact (USCM, 2009). By April 2011, 216 Canadian cities were participating in the Federation of Canadian Municipalities' Partners for Climate Protection Program (FCM, 2011). While Gore & Robinson (2009) point out that this constitutes only a small fraction of the over 85,000 local governments in the United States and approximately 5,000 in Canada, the numbers are significant, especially when we consider that American signatories grew from 152 in February 2007 (Gore & Robinson, 2009) to over 1,000 in October 2009. This clearly demonstrates a growing trend by cities and local communities to pay attention to the relationship between urban development and climate-change planning.

Numerous scholars have observed that, from a strategic planning perspective, it is difficult to justify municipal governments' expenditure of resources to control their own GHG emissions (Betsill, 2000; 2001; Engel, 2006; Brody et al. 2008). Any given municipality cannot know for certain that its expenditures will have a measurable impact on mitigating climate change, and even if its efforts did yield positive results, the benefits would not accrue exclusively (if at all) to the municipality that paid the costs. Under these conditions, each municipality has an incentive to "free ride" on the efforts of others.

Municipal governments may also be reluctant to exercise control over their activities because an easy path to emissions reductions is not obvious. Unlike some other environmental problems (e.g., phasing out chlorofluorocarbons to halt depletion of the stratospheric ozone layer), there are no "silver bullet technological solutions" to solving global reliance on GHG-producing activities and scientists believe a wide array of changes is needed (Kosloff et al. 2004). The cities in the United States that are signatories to the climate-protection agreement are clustered in

[1] The Climate Action Revenue Incentive Program requires local governments to submit targets to receive financial incentives ranging from over CAN$400,000 for the largest municipalities to over CAN$8,000 for the smallest communities in the case study group. These sums, while not negligible, constitute a small fraction of the planning budgets for these jurisdictions.

areas of the country with the highest population concentrations (USCM, 2010) and there is a clear pattern of neighboring cities agreeing to reduce emissions to 7% below 1990 levels by 2012. Because land-use and transportation changes take years and sometimes decades to implement, it is too soon to determine whether cities are successfully executing their emissions-reduction targets, but much is to be learned from examining the potential regional impacts of clusters of cities reducing their emissions. This article attempts to fill this gap with respect to the area of concentrated population in southwestern BC.

For Canadian cities, budget constraints, along with both external and internal pressures, have limited capacity to act (Bradford, 2002; Slack, 2002; Robinson & Gore 2005). These circumstances have impaired municipal ability to handle new climate-related initiatives (i.e., by preventing municipalities from hiring new staff) (Robinson & Gore, 2005). Canadian municipalities, not unlike their counterparts in the United States, also face barriers of competing priorities, lack of information, and limited administrative capacity that have hindered their capacity to respond to climate change (Robinson & Gore, 2005). For some scholars, the existence of such obstacles (which can vary in nature and magnitude across municipalities) suggests that federal and provincial governments should avoid "one-size-fits-all" approaches to encouraging municipal climate-change responses. Instead, they should keep these barriers in mind and make allowances when designing programs to reduce emissions (Robinson & Gore, 2005).

The GCA in BC is a flexible and open-ended approach to bringing about province-wide reductions in GHG emissions (Parliament of Government of British Columbia, 2007b). The legislation requires all municipalities to set and achieve GHG emissions-reduction targets but does not prescribe specific levels. It appears to acknowledge that many municipalities may face significant barriers in both target setting and target achievement. One potential barrier to setting emissions-reduction targets at the local level is relative uncertainty about current emissions levels. Emissions estimates vary depending on the organization that produces them. For example, British Columbia's Ministry of Environment (2010) estimated that per capita emissions were 15.6 tonnes in 2008.[2] By contrast, the Pacific Institute for Climate Solutions, a research network funded by the same Ministry, calculates total emissions and population figures that indicate per capita emissions to have been 11.4 tonnes in 2008 (Nyboer & Kniewasser, 2012). This type of significant variation in emissions estimates is a source of ambiguity and confusion for municipalities and impedes the development of a climate protection planning agenda.

An additional barrier to setting targets is the relative uncertainty regarding what the ultimate emissions targets ought to be (Byrne et al. 2007). While absolute emissions values in terms of parts per million by volume of GHGs in the atmosphere are typically used to correspond to global temperature rise values (Metz et al. 2007), there is no consensus in the literature regarding the specific per capita emissions value that municipalities should target. On one hand, authors such as Höhne et al. (2007) estimate that global GHG targets must stabilize at between four and five tonnes per capita to limit temperature rises to two degrees Celsius. The Intergovernmental Panel on Climate Change (IPCC), on the other hand, calculates that per capita emissions must stabilize at approximately one tonne per capita to maintain a temperature rise of this magnitude (Metz et al. 2007). Allison et al. (2009) also state that "the required decline in emissions combined with a growing population will mean that by 2050, annual per capita CO_2 [carbon dioxide] emissions very likely will need to be below 1 ton." In 2005, the federal government of Canada briefly promoted a "One-Tonne Challenge Program," encouraging Canadians to reduce their annual per capita emissions to this amount (Environment Canada, 2006). In this context of uncertainty, it would be instructive to identify the range of per capita emissions that local governments in BC are likely to achieve if they are successful in meeting their targets. Knowing what would happen if they continue on the trajectories set by their own targets would help establish a preliminary assessment of the effectiveness of the provincial legislation and the regional response.

This review of the challenges to implementing targets suggests that for cities in BC the specific obstacles are likely to be all or some of the following: lack of power over regional emissions, reluctance to "pay" for the bad habits of "free riders," uncertainty about current emissions, insufficient information and resources, absence of obvious solutions, and uncertainty about desired target levels. By legislating that every city has to set targets, to take responsibility for its own emissions irrespective of neighbors' releases, the province has essentially made the *lack of power over regional emissions* obstacle irrelevant. The provincial legislation also encourages cities to overlook what other cities are doing, although the free-rider problem will persist if some cities choose to set modest targets to avoid high implementation costs with the hope that neighboring cities will shoulder the burden.

[2] One tonne is equal to 1,000 kilograms or 2,204.6 pounds.

In addition to the legislation, the provincial government of BC simultaneously developed a Community Energy and Emissions Inventory (CEEI) program that produces a tabulation of emissions for every municipality in the province. This inventory has provided municipalities with a reference point for both the absolute value of their 2007 baseline emissions, against which reductions can be measured, and the relative volumes contributed by each sector (i.e., buildings, on-road transportation, solid waste). This reduces the *uncertainty about current emissions* obstacle. While anecdotal evidence from planners' statements at regional conferences suggests some frustration with the CEEI methodology of calculating emissions, the mere presence of a baseline figure for each municipality alleviates some of the inertia experienced by cities that had not previously planned for climate change.

BC Hydro, the province's publicly owned electric utility, offers local governments a number of programs that help minimize the *lack of information and resources* and *absence of obvious solutions* obstacles. The company provides financial and technical support for the development of community energy and emission plans (CEEPs), funding for hiring a community-energy manager, and financial resources for feasibility studies for district-energy systems. The Power Smart Program, also operated by BC Hydro, offers many incentive programs for energy conservation, including a scoring system for local governments with points given for "enablement" and implementation of energy conservation. Additionally, the Federation of Canadian Municipalities maintains the Partners for Climate Protection program, which is the Canadian network of the Cities for Climate Protection program established by ICLEI—Local Governments for Sustainability.[3] This program helps connect and support cities that have committed to reducing their GHG emissions and tracks achievement of their corporate- and community-reduction milestones. Approximately 40% of BC's local governments currently participate in the program.

This combination of programs, incentives, and legislation in BC has served to diminish most obstacles to GHG target setting. However, neither the legislation nor any of the programs mentioned above address the *uncertainly about desired target levels* obstacle. Our research focuses on this final barrier and examines the targets that cities set in this context of uncertainty and whether their cumulative per capita targets would constitute a regional achievement toward the provincial government's per capita targets. We also explore the relationship between the targets that cities set and population, urban growth rates, density, and prior planning activity exemplified by the cities' participation in the various programs mentioned above.

Starting Assumptions and Hypotheses

As we began our exploration, we developed a few assumptions based on a reading of the literature and the unique nature of GCA, which, as discussed above, does not have a clear or binding requirement. Our review led to five general assumptions about what we might reasonably expect to find in this study.

Noncompliance Likely Rampant

Our first expectation, and the impetus for this research, was that the rate of compliance by municipalities with the provincial legislation would be low. We anticipated that the relative ambiguity of the law, and the absence of any mechanism for enforcing compliance, would mean that a considerable number of municipal governments would not prioritize expending resources on setting targets and would ignore the mandated deadline. Following the same logic, we expected that some municipalities would simply go through the motions of setting targets without undertaking any rigorous analysis or strategic planning to integrate the targets into their OCPs and other planning documents. The ultimate significance of compliance or noncompliance is that the cumulative effect of local government reduction targets would affect broader provincial goals and the general efficacy of GCA.

The Most Populous Cities Would Have the Most Ambitious Targets

From Robinson & Gore (2005), we know that limited administrative capacity and lack of data hinder climate-change planning. If we assume that the municipalities with the largest populations have more planning resources and the greatest amount of planning experience, then it seems reasonable to assume that these municipalities would be better equipped to tackle the complexity and uncertainty that might come with target setting. We might therefore expect that the most populous cities would have the most ambitious reduction targets.

The Fastest Growing Cities Would Have the Lowest Reduction Targets

Fast growing cities would likely have two constraints on target setting. Local leaders would be reluctant to slow the pace of development with any new

[3] ICLEI—Local Governments for Sustainability, an international organization established in 1990, was previously known as the International Council for Local Environmental Initiatives. See http://www.iclei.org.

policy constraints and planning staff would be too busy trying to keep up with the demands created by growth to concentrate on climate related land-use planning. We therefore expected some negative correlation between the rate of growth and the intensity of the reduction target.

The Densest Cities Would Have the Highest Reduction Targets

A fourth assumption was that cities that started off with higher-than-average densities would be most likely to proceed with confidence toward the prospect of more intensive densification. Those cities, such as Vancouver and the City of North Vancouver, are home to populations that have already experienced what it is like to live in more compact communities and would presumably be more amenable to continuing and expanding this development pattern. By contrast, low-density, sprawling cities, such as Abbotsford (located approximately 40 miles east of Vancouver), would have less access to transit infrastructure, be more heavily car dependent, and be least able to move toward ambitious emissions reductions.

Prior Planning Leads to Aggressive Target Setting

Our final assumption was that those municipalities that have actively participated in prior climate change planning programs, and have made use of the support provided by the various programs mentioned above, would comply with the law and set targets. We expected that these municipalities would be leaders in the province and set the most ambitious targets.

Variables, Data Collection, and Analytical Techniques

In this section, we describe our methods in terms of the variables examined, the kinds and sources of data collected, and the analytical techniques employed. We chose to focus our analysis on BC municipalities with a population greater than 25,000 and a location in one of the province's three most populous regional districts, Metro Vancouver, Fraser Valley, and the Capital Regional District. Table 1 shows the twenty municipalities that met both criteria and that in aggregate comprise the study group, maps each of the municipalities relative to one another, and provides their 2007 population estimates.

As this is an exploratory study we only review some general characteristics of the case-study municipalities and undertake descriptive analysis and some preliminary correlation analysis of a small set of variables described in Table 2. Our variables are broadly categorized as 1) municipal characteristics such as population and population growth; 2) prior planning activities such as completion of a CEEP, and 3) characteristics of municipal GHG emissions-reduction targets such as the target year and the percentage reduction. Table 2 describes the variables and shows the sources we used to retrieve or generate the data for the series of steps outlined below.

As mentioned above, our primary purpose here is to understand the general characteristics of GHG emissions-reduction targets and to determine the progress they have made toward achieving provincial GHG emissions-reductions targets. To address this question, we undertook the following six steps:

1. *Collected 2007 baseline GHG emissions data.* We used the Updated 2007 CEEI reports for each municipality in the study group, with the exception of Vancouver.[4] Since Vancouver was the only municipality to include emissions-reduction targets with a 1990 baseline, we used the City of Vancouver's (2009) self-reported 1990 emissions.
2. *Collected current GHG emission-reduction targets for study group.* We then collected data on GHG emissions-reduction targets for each municipality in the study group, many of which have incorporated the targets into their respective OCP (as mandated by Bill 27). However, a few municipalities are still in the process of updating their OCPs and have either included their targets in other documents or do not yet have targets at all. To help us determine the extent of prior climate protection planning work (if any) behind each municipality's selection of its GHG emissions-reduction target, we also examined corporate and municipal climate-action plans and related documents, including relevant council minutes and documents.[5]
3. *Normalized GHG targets to allow for cross-municipal comparisons.* Our initial review of municipal GHG targets revealed that a number of jurisdictions chose to adopt the province's emissions-reduction target of 33% of 2007 levels by 2020 and 80% by 2050. However, several municipalities formulated their own targets that vary in terms of the target year and target type. Of the twenty cities, sixteen set targets that specify a reduction amount and target "maturity" year. One specifies a reduction target without a deadline. The final three have not incorporated a target into their OCPs and did not file a target

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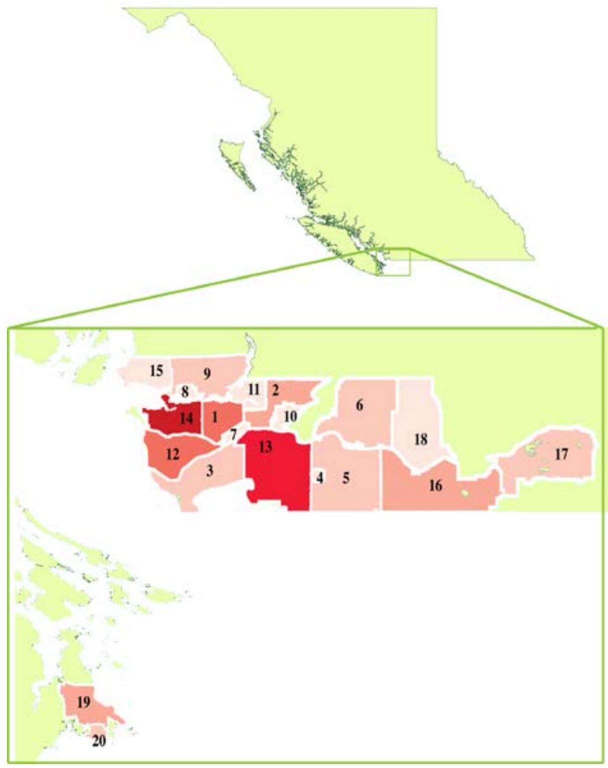
[4] Many municipalities used either their own baseline-emissions estimates or estimates from the 2007 Draft CEEI report produced by the Ministry of Community and Rural Development in BC.

[5] Corporate emissions here refer to the municipality's internal operations as opposed to policies it enforces through development permits and building permits.

Table 1 British Columbia Municipalities in Study Group.

Map legend	Municipality	Population in 2007	Municipalities in case group (dark red is highest population and light pink is lowest)
	Metro Vancouver Regional District		
1	Burnaby	214,919	
2	Coquitlam	120,249	
3	Delta	99,293	
4	Langley, City	25,167	
5	Langley, Township	99,012	
6	Maple Ridge	72,502	
7	New Westminster	61,778	
8	North Vancouver, City	47,277	
9	North Vancouver, District	85,966	
10	Port Coquitlam	54,971	
11	Port Moody	29,945	
12	Richmond	186,376	
13	Surrey	422,873	
14	Vancouver	610,136	
15	West Vancouver	42,973	
	Fraser Valley Regional District		
16	Abbotsford	131,239	
17	Chilliwack	73,294	
18	Mission	36,280	
	Capital Regional District		
19	Saanich	112,062	
20	Victoria	81,649	

with the BC Ministry of Rural and Community Development by the deadline. As a result of these discrepancies, we found it necessary to normalize the targets for comparability. We used the province's CEEI data to determine the 2007 emission and population values for all cities except Vancouver, for which we used its base year of 1990 and its self-reported emission and population data for that year. We determined each municipality's emissions-reduction goal from its OCP or council reports and used the emissions-reduction goals and baseline tonnes of carbon dioxide equivalents (tCO_2e) to calculate the city's target emissions by reduction-target year. We calculated the rate of total emissions reduction by plotting each city's emissions-reduction targets and used linear regression to calculate an emissions value for each city for the years 2020 and 2050. For steps 3 and 4 we estimate future emissions for each city based on the assumption that it will succeed in meeting its targets.

4. *Estimated per capita GHG emissions for each city in 2050.* The per capita emissions for 2020 and 2050 were calculated by dividing the estimated aggregate emissions by estimated population. In all cases, we used historical census data and linear regression of estimates from the years indicated below to approximate future populations for the years 2020 and 2050. For BC's population we employed provincial government estimates for 2012, 2016, and 2020 (BC Stats, 2011). For municipalities in the Metro Vancouver Regional District, we used population projections for 2021, 2031, and 2041 provided by the Regional District (Metro Vancouver, 2009). For municipalities in the Fraser Valley Regional District, we relied on population estimates made for the District by a consultant's report for the years 2013, 2016, 2019, 2022, 2025, 2028, and 2031 (Urban Futures, 2005). For municipalities in the Capital Regional District, we used population estimates reported in Victoria's OCP for 2020 (City of Victoria, 1995) and Saanich's OCP

Table 2 Variables.

Variable Type	Name	Description	Source
Municipal Characteristics Relevant to Emissions	Population	Municipal population in 2007	
	Population growth	Population growth from 2001 to 2006 expressed as a percentage of 2001	Calculated from census
	Density population	Number of people per square kilometer	Calculated from 2006 census
	Single-family homes	Percentage of homes that are single-family detached dwellings (this is a second indicator of density)	Calculated from 2006 census
	Drivers	Percentage of employed persons who drive to work	Calculated from 2006 Census
Prior Planning Related to Emissions Reductions	CEEP	Community Energy and Emissions Plan	Publicly accessible documents
	PSC-Score	BC Hydro's Power Smart Community Score	Publicly accessible documents
	PCP Milestone	Partners for Climate Protection sum of corporate and community milestones	Publicly accessible documents
Characteristics of Municipal Targets	2007 emissions	Municipal CO_2 emissions from buildings, on-road transportation, and solid-waste sectors in 2007, measured in tonnes of CO_2 equivalent (tCO_2e)	BC Community Energy Emissions Inventory
	Annual reduction	tCO_2e per capita per year	Calculated
	2020 emissions	Estimated 2020 emissions, both aggregate and per capita	Either adopted target or projected from nearest target date
	2050 emissions	Estimated 2050 emissions, both aggregate and per capita	Either adopted target or projected from nearest target date
	Target type*	Municipal GHG emissions-reduction target. • "Provincial" indicates that the municipality adopted the provincial target (i.e., a 33% reduction from 2007 levels by 2020, and an 80% reduction from 2007 levels by 2050). • Unless otherwise noted, "Modified Provincial" indicates that the municipality adopted only the Province's 2020 target.	Publicly accessible documents
	Reduction type	Whether the target reduction is expressed as an aggregate number for all emissions from the municipality or as a per capita value for each resident	Publicly accessible documents
	Date target adopted into OCP	Whether the target has been incorporated in the local governments' OCP as of September 2010	Publicly accessible documents
	Annual reduction in tCO2e/capita	The value of the annual reduction	Calculated using emissions targets and population projections
	Percentage annual reduction	Percentage reduction from 2007 per capita levels (with the exception of Vancouver which references 2000 levels) to either 2020 levels or 2050 levels	Calculated using emissions targets and population projections

* A related variable is "Reduction value," which is the manner in which the value of the municipal GHG emissions target is expressed. Because all municipalities used relative values that were expressed as a percentage reduction compared to a base year and only two used absolute values (Langley & Saanich), expressed as a specific number of tCO2e, in addition to the relative value, our analysis did not include this variable.

for 2026 (District of Saanich, 2008). Inconsistency in the years for which we have population estimates, as well as the potentially different methods used in arriving at the respective estimates, is a limitation of this per capita calculation. However, 75% of the cities studied are in Metro Vancouver for which we used a single source for estimates, and we have detailed estimates for three of the remaining five cities.

5. *Determined correlation between variables.* We conducted Pearson product moment correlation analyses to measure the linear dependence between each pair of variables. To better understand the overall response of the case-study group to the requirement of having to set targets, we measured associations between most of the variables in Table 1. For the target variables, we only used the baseline emissions, annual reductions, percent of annual reductions, and target

types and 2050 estimated emissions. Using OpenStat software (Miller, 2012) we ran the following product moment correlation calculation:

$$r_{x,y} = \frac{\sum_{i=1}^{N} z_{x_i} z_{y_i}}{N} \quad (1)$$

where Z_x and Z_y are the variables converted to z scores. To test the null hypothesis of zero correlation between variables we used:

$$t = \frac{r}{\sqrt{\frac{1-r^2}{n-2}}} \quad (2)$$

6. *Calculate cumulative effects of targets in 2050.* We used our estimates for 2050 population figures and per capita emissions for each city to calculate the total emissions across the region and divided by the sum of the population figures to determine what the regional per capita emissions would be if each city achieved its targets. In the case of cities with earlier targets, we assumed a constant linear (arithmetic) progression, with the exception of Victoria and Saanich. These two cities would achieve zero emissions if they continued along the trajectory of their 2020 targets. We therefore assumed that emissions reductions would stop when they reach 80% below the aggregate 2007 levels for Victoria and Saanich. We then compared the regional cumulative per capita emissions to the province's per capita target as well as the IPCC's one tonne CO_2e per capita per year recommendation. The CEEI methodology document warns against comparing community-level emission inventories to the province's GHG inventory by describing such a comparison as "inappropriate" (British Columbia Ministry of Environment, 2007). For example, some of the province's industrial- and resource-extraction emissions are not captured by any local government and therefore skew provincial per capita emissions relative to municipal ones. However, the Ministry of Community and Economic Development also expects that a certain share of municipal-emissions reductions would be the responsibility of the provincial and federal governments through their own emissions and energy-performance laws and infrastructure programs. Therefore, the "extra" resource-extraction emissions that the provincial per capita values include, which are not included in municipal-emissions values, might be cancelled out by the "extra" reduction that the provincial and federal governments would enable. Consequently, we judged that a comparison of per capita emissions would be instructive. It would at least reveal the general proximity of the municipal targets to the provincial targets and would help answer our question about the cumulative effectiveness of the targets.

Findings

In this section we report our findings in terms of each of the methodological steps outlined above. Table 3 shows the general response to GCA by each of the municipalities in the study group. Responses to the setting of targets range widely, with a number of cities choosing to adopt the province's own reduction target. Fifteen municipalities adopted emissions targets in their OCPs by the deadline of May 2010. Complete compliance with the legislation was therefore achieved by 75% of the local governments. Another municipality adopted a target one month late. Two more have set targets but have not yet adopted them officially into their OCPs. Only two of the twenty cities did not set any community targets, but one of these set corporate targets for the city's own operations. Therefore, only one city does not show any public record of any emissions-target planning of any sort. Burnaby stands out as having adopted a target without a target date.

In addition to the wide range of emissions-target setting displayed in Table 3, when we tabulated the baseline releases, calculated emission levels at target years, and normalized for the years 2020 and 2050, we found quite a range of responses. Table 4 shows the normalized values at the provincial target milestones. Comparing the per capita values, we can see that in 2007 emissions ranged from 3.65 tCO_2e in Saanich to more than twice that amount of 9.22 tCO_2e in Delta. The 2050 per capita values are also wide-ranging, with the standard deviation of 2.28 being larger than the mean value of 2.18. The annual per capita percentage drop in emissions, which represents the rate of change of emissions, ranges from 0.74% in the City of Langley to 2.92% in the Township of Langley (these are different municipalities, see Table 4). It is noteworthy that these two extremes in annual percentage reductions come from adjacent cities. As Table 1 shows, the City of Langley is nested within the much larger Township of Langley.

Table 3 Summary of GHG Targets by Municipality.

Municipality	GHG Target	Reduction Type	Date Target Adopted in OCP
British Columbia	33% by 2020 & 80% by 2050 below 2007	A	N/A
Metro Vancouver			
Burnaby	5% below 2007 with *no target date*	A	May 3 2010
Coquitlam	15% by 2031 & 30% per capita by 2021 below 2007	A & PC	May 10 2010
Delta	Provincial	A	May 10 2010
Langley	20,992 tCO_2e below 2017 forecast, 16% below 2007	A	May 31 2010
Langley, Township of	10% below 2007 by 2021	PC	May 3 2010
Maple Ridge	Provincial	A	May 11 2010
New Westminster	None (Corporate only)		N/A
North Vancouver, City	15% by 2020 and 50% by 2050 below 2007	A	May 17 2010
North Vancouver, District	8% by 2020, 13% by 2030, and 21% by 2050 below 2007	A	Not yet adopted
Port Coquitlam	8% below 2007 by 2017	A	May 25 2010
Port Moody	10% below 2007 by 2017	A	Not yet adopted
Richmond	Provincial	A	May 17 2010
Surrey	Modified Provincial[1]	PC	May 17 2010
Vancouver	Modified Provincial[2]	A	May 20 2010
West Vancouver	Provincial	A	June 21 2010
Fraser Valley			
Abbotsford	20% by 2025 and 45% by 2040 below 2007	PC	May 10 2010
Chilliwack	None		N/A
Mission	Modified Provincial[3]	A	May 17 2010
Capital			
Saanich	Modified Provincial	A	May 17 2010
Victoria	Modified Provincial	A	May 13 2010

[1] Provincial targets on per capita basis: 3.29 tCO_2e per capita by 2020 and less than 0.98 tCO_2e by 2050.
[2] Reduce community emissions by 33% below 2007 levels by the end of 2020 and 80% below 1990 levels by the end of 2050.
[3] Reduce community emissions by 20% below 2007 levels by the end of 2020 and 80% below 2007 levels by the end of 2050.

The correlation analysis revealed a number of strong associations with low probability of error. The strongest correlations occur within the variable groupings. For example, as one might expect, there is a strong correlation between annual reductions in emissions, percentage reductions in emissions, and ultimate emissions in 2050 (see bottom right portion of Table 5 segments). There is also a strong negative correlation between the percentage of workers who drive to work in a municipality and the density of that municipality, both in terms of people per square kilometer and the percentage of detached houses (see top left segments of Table 5). This confirms expectations from the literature. Similarly, the strong correlation between 2007 emissions and the percentage of workers who drive to work supports general findings that automobile emissions are a significant component of overall community emissions. A strong correlation that confirms our expectations is that if a municipality completes a CEEP it will likely set its own targets and not merely adopt the provincial targets. If communities set and manage to achieve their own targets, they have larger annual reductions and ultimately lower 2050 emissions.

If all the targets set by all the municipalities were met then the cumulative effect would result in regional per capita emissions of 2.15 tCO_2e even if we include no reductions by those municipalities that have not yet set targets. If we exclude those municipalities and only calculate for those that have already set targets, then the cumulative per capita emissions are 1.36 tCO_2e (see Table 6). This number is useful for understanding the regional response in the event that the municipalities without targets eventually set targets in line with those already adopted by others.

Discussion and Conclusion

We found no clear pattern linking the characteristics of communities in BC with levels of target setting. More specifically, there is no correlation between baseline emissions, population, rate of growth, density, and the types or intensities of targets. There is therefore no evidence that the relationships we hypothesized exist with the exception of prior planning activity. Those municipalities that completed CEEPs tended to set their own targets. Additionally, there is a significant and high correlation between setting

Table 4 Estimated Emissions in 2020 and 2050 in tCO_2e.

Municipality	*2007 Emissions* Aggregate	*2007 Emissions* Per Capita	*2020 Emissions* Aggregate	*2020 Emissions* Per Capita	*2050 Emissions* Aggregate	*2050 Emissions* Per Capita	Annual Reduction	% Annual Reduction from 2007 Emissions
British Columbia			45,091,000	8.76	13,460,000	1.94	0.31	
Metro Vancouver								
Burnaby	1,298,362	6.04	*No target year*					
Coquitlam*	650,213	5.41	621,778	3.64	509,888	1.78	0.12	2.22
Delta	915,158	9.22	613,156	5.63	183,032	1.41	0.17	1.84
City of Langley*	172,441	6.85	136,573	4.42	53,802	1.22	0.20	2.92
Langley, Township of*	805,271	8.13	1,049,869	7.36	1,614,327	6.63	0.06	0.74
Maple Ridge	362,616	5.00	242,953	2.57	72,523	0.49	0.10	2.00
New Westminster	285,135	4.62	*No set targets*					
North Vancouver, City of	228,982	4.84	194,635	3.91	114,491	1.56	0.08	1.65
North Vancouver, District of	411,908	4.79	378,955	3.92	325,409	2.68	0.05	1.04
Port Coquitlam*	315,797	5.74	282,954	4.23	207,163	2.19	0.12	2.09
Port Moody*	130,587	4.36	113,611	3.03	74,435	1.00	0.11	2.52
Richmond	1,153,658	6.19	772,951	3.50	230,732	0.77	0.12	1.94
Surrey	2,399,002	5.67	1,826,221	3.29	820,450	0.98	0.10	1.76
Vancouver	2,943,222	4.82	1,971,959	2.98	547,000	0.70	0.08	1.66
West Vancouver	275,405	6.41	192,784	3.77	55,081	0.86	0.12	1.87
Fraser Valley								
Abbotsford*	1,028,472	7.84	861,392	4.70	443,222	1.00	0.17	2.17
Chilliwack	534,085	7.29	*No set targets*					
Mission	239,687	6.61	191,750	3.35	47,937	0.49	0.13	1.97
Capital								
Saanich**	409,027	3.65	274,048	2.37	0	0.00	0.10	2.74
Victoria**	382,412	4.68	256,216	2.95	0	0.00	0.13	2.78

Note: Average rate of emissions reduction for entire study group is 0.12 tCO2e per capita per year.

* Linear trend calculated for 2020 and 2050 emissions and population. Per capita 2020 and 2050 emissions calculated by dividing estimated emissions amount by estimated future population.

** Victoria and Saanich each set targets of 33% below 2007 by 2020. They did not set additional targets, but if they continued this percentage reduction trend then their 2050 emissions would be zero.

independent targets and setting aggressive reduction targets. If those cities that established their own targets manage to achieve those objectives, they are estimated to ultimately have lower emissions in 2050 than cities that adopted the province's targets. This is somewhat supported by the weak direct correlation of 0.32 at 83% significance between CEEPs and the percentage of 2007 emissions reduced annually (see Table 5).

We found a similar correlation of –0.315 at 82% significance between BC Hydro's PowerSmart Community Score (PSC-Score) and estimated 2050 emissions. Participation in the Partners for Climate Protection Program (PCP participation) had no impact on the targets that cities set in our analysis. However, our hypothesis that prior climate protection planning activity results in more ambitious targets is somewhat supported by our findings for two of the three programs. This suggests that at least the CEEPs and the PowerSmart Community Score not only helped municipalities overcome initial barriers to target setting, but they may have in fact led to more ambitious objectives. We assume this direction of causality because, while all cities amended their OCPs to include GHG reduction-target amendments in 2010, almost all participation in climate-protection planning occurred prior to the enactment of GCA in 2007. It is therefore more likely that climate-protection planning prompted the setting of more ambitious targets and not the other way around. However, given our small sample size, further research with a larger number of communities is required to test the validity of this correlation.

While we did not test for the quality of prior planning activity, one indication of quality is third-party acknowledgement. The City of North Vancouver has won at least two awards for its climate change planning work (CIP, 2010; CEA, 2010) and, perhaps because of its small geographical area and limited opportunities for low-density growth, has undertaken more emissions-reduction planning than other cities in the region. Nevertheless, we see from Table 4 that the City of North Vancouver has the thirteenth highest 2050 per capita target which, out of

Table 5 Correlation Matrix.

Correlation (shading: > 0.5 / < -0.5; > 0.3 / < -0.3)	Population	% Population growth	People per square kilometer	% detached homes	% drivers to work	Completed CEEP	PSC-Score	PCP participation	Provincial or own target	Per capita or aggregate	2007 estimated emissions	Annual reduction in emissions	% of 2007 Emissions reduced annually	2050 estimated emissions
Population	1	0.177	0.402	-0.283	-0.341	-0.052	0.748	0.468	0.044	0.092	-0.12	-0.136	-0.094	-0.119
% population growth		1	-0.163	0.101	0.184	-0.357	-0.029	-0.085	-0.069	-0.475	-0.133	-0.246	-0.123	0.029
People per square kilometer			1	-0.912	-0.893	0.068	0.455	0.567	0.192	0.197	-0.465	-0.171	-0.022	-0.134
% detached homes				1	0.809	-0.078	-0.471	-0.435	-0.222	-0.241	0.471	0.109	-0.039	0.133
% drivers to work					1	0.014	-0.426	-0.528	-0.095	-0.315	0.582	0.245	0.006	0.171
Completed CEEP						1	-0.131	0.410	0.572	0.419	-0.23	0.183	0.32	-0.075
PSC-Score							1	0.293	0.187	0.289	-0.038	0.162	0.157	-0.315
PCP participation								1	0.377	0.300	-0.313	-0.14	0.012	-0.142
Provincial or own target									1	0.380	-0.091	0.632	0.751	-0.559
Per capita or aggregate										1	-0.258	0.356	0.497	-0.418
2007estimated emissions											1	0.279	-0.181	0.279
Annual reduction in emissions												1	0.871	-0.751
% of 2007 reduced annually													1	-0.873
2050 estimated emissions														1
t test values for probability of correlation > 0 (shading tracks significance from above)														
Population	0	0.765	1.863		1.54	0.22	4.789	2.25	0.188	0.394	0.513	0.58	0.4	0.509
% population growth		0	0.702	0.432	0.793	1.623	0.124	0.364	0.296	2.287	0.569	1.079	0.526	0.123
People per square kilometer			0	9.46	8.44	0.291	2.17	2.919	0.832	0.854	2.231	0.738	0.092	0.572
% detached homes				0	5.847	0.334	2.264	2.052	0.964	1.052	2.264	0.465	0.165	0.571
% drivers to work					0	0.061	1.997	2.639	0.404	1.407	3.037	1.073	0.027	0.735
Completed CEEP						0	0.561	1.907	2.96	1.957	1.003	0.790	1.435	0.318
PSC-Score							0	1.299	0.807	1.279	0.16	0.698	0.673	1.406
PCP participation								0	1.724	1.332	1.399	0.601	0.051	0.608
Provincial or own target									0	1.743	0.386	3.458	4.823	2.863
Per capita or aggregate										0	1.133	1.615	2.433	1.955
2007 estimated emissions											0	1.233	0.78	1.234
Annual reduction in emissions												0	7.521	4.832
% of 2007 reduced annually													0	7.61
2050 estimated emissions														0
Probability of greater t (shading tracks significance from above) (bold border is 99% confidence and light border is 95%)														
Population	0	0.454	0.079	0.227	0.141	0.828	0	0.037	0.853	0.699	0.614	0.569	0.694	0.617
% population growth		0	0.492	0.671	0.438	0.122	0.903	0.72	0.771	0.035	0.576	0.295	0.605	0.903
People per square kilometer			0	0	0	0.774	0.044	0.009	0.417	0.405	0.039	0.47	0.927	0.575
% detached homes				0	0	0.742	0.036	0.055	0.348	0.307	0.036	0.647	0.871	0.575
% drivers to work					0	0.952	0.061	0.017	0.691	0.176	0.007	0.297	0.978	0.472
Completed CEEP						0	0.581	0.073	0.008	0.066	0.329	0.44	0.169	0.754
PSC-Score							0	0.21	0.43	0.217	0.874	0.494	0.509	0.177
PCP participation								0	0.102	0.199	0.179	0.555	0.96	0.551
Provincial or own target									0	0.098	0.704	0.003	0	0.01
Per capita or aggregate										0	0.272	0.124	0.026	0.066
2007 estimated emissions											0	0.233	0.446	0.233
Annual reduction in emissions												0	0	0
% of 2007 reduced annually													0	0
050 estimated emissions														0

twenty cities, is arguably not very effective for having invested so much in climate-change planning. This finding suggests that while some prior climate-change planning work may lead to strong target setting, detailed climate-action planning leads to a more conservative and perhaps a more realistic approach to target setting. Future research is needed to test this hypothesis. In addition, since our study did not test the quality of the plans and policies that are intended to help achieve the targets, the relationship between prior planning activity and the ultimate robustness and feasibility of the targets is unknown.

Our finding about compliance with GCA challenges our starting assumptions and disproves our first hypothesis, that noncompliance would be rampant. With 75% of municipalities having complied completely by setting and adopting targets and 90% having complied by setting targets, we can reasonably declare that BC's legislation has effectively prompted the widespread adoption of targets among the municipal governments in our case-study group. For legislation that has no built-in mechanism of enforcement, this level of compliance is a positive signal for other jurisdictions that might seek to enact flexible legislation that is likely to be politically feasible. However, not all targets set by municipalities in the study group would result in sufficiently low per capita emission levels to help regional targets. For example, the Township of Langley has set per capita targets that would result in only slightly lower per capita emission in 2050 and aggregate emissions that are higher than in 2007. This type of compliance with GCA does nothing to advance provincial emissions reductions and, if it occurred with greater frequency, would call into question the effectiveness of this kind of flexible legislation.

Table 6 Cumulative effect on regional per capita emissions.

	Targeted 2050 Emissions	Estimated 2050 Population[a]
Metro Vancouver		
Burnaby[b]	2,582,100	427,500
Coquitlam*	509,888	286,454
Delta	183,032	129,810
Langley*	53,802	44,100
Langley, Township of*	1,614,327	243,488
Maple Ridge	72,523	148,006
New Westminster[b]	589,050	127,500
North Vancouver, City of	114,491	73,392
North Vancouver, District of	325409	121,421
Port Coquitlam*	207,163	94,595
Port Moody*	74,435	74,435
Richmond	230,732	299,652
Surrey	820,450	837,194
Vancouver	547,000	781,429
West Vancouver	55,081	64,048
Fraser Valley		
Abbotsford*	443,222	443,222
Chilliwack[b]	1,703,891	233,730
Mission	47,937	97,831
Capital Regional District		
Saanich**	81,805	115,587
Victoria**	76,482	156,365
Total excluding "No-Target Cities"[c]	5,457,779	4,011,028
Total assuming "No-Target Cities" maintain 2007 emissions	10,332,821	4,799,758
Cumulative per capita emissions for 2050 excluding "No-Target Cities"		5,457,779/4,011,028 = **1.36** tCO_2e/capita
Cumulative per capita emissions for 2050 including all cities assuming "No-Target Cities" maintain 2007 Emissions levels		10,332,821/4,799,758 = **2.15** tCO_2e/capita

[a] Population projections calculated using mean annual growth rates for years included in Metro Vancouver and British Columbia projections.

[b] Did not set targets by December 2010. Emissions for 2050 were calculated as a product of 2007 per capita emissions and calculated 2050 population projections.

[c] Comprises Burnaby, Chilliwack and New Westminister.

* 2050 population and emissions were projected from earlier target dates.

** Set 2020 projections only, which, if extended would lead to zero emissions by 2050. Instead, we assumed emissions reduction would stop after reaching 80% below 2007 levels.

Most municipalities set targets that would result in 2050 emissions lower than two tCO_2e. As Figure 1 shows, fourteen of the twenty municipalities in the case-study group set targets that would result in per capita emissions lower than the province's 2050 per capita target. While the cumulative effect if each municipality achieved its target does not place the region within the IPCC's recommendation of one tCO2e per capita, it would in fact lead to the desired regional goals. The cumulative 2050 emissions of all cities that did set targets is 1.36 tCO_2e, well below the province's per capita 2050 target of 1.94 tCO_2e.

One of the challenges to the regional response is the disparity of target emissions between adjacent municipalities. As cities attempt to implement emissions reductions through land-use and transportation changes, if adjacent cities are not engaged in similar activities then the effectiveness

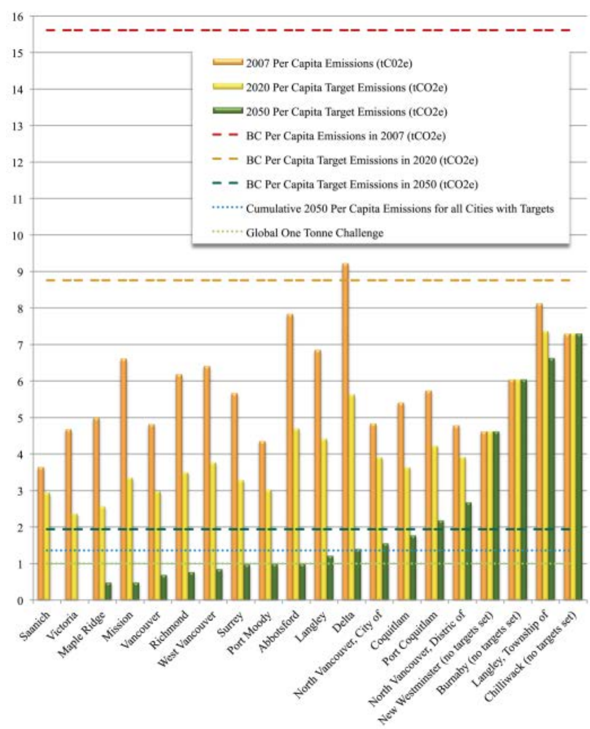


Figure 1 Estimated 2007, 2020, and 2050 per capita emissions for studied cities in British Columbia.

and feasibility of transforming transportation patterns is likely to be undermined. This impediment is exemplified by the divergent planning trajectories of the City of Langley and the Township of Langley. This situation also calls for an important next stage in this research; a closer examination of specific implementation strategies by each city and of the regional planning efforts that might facilitate local emissions reductions.

Future research might also address the institutional and political context within which target setting takes place. Why is it that some municipalities chose not to comply with the legislation? Are they simply on a different schedule and taking advantage of the legislation's flexibility? Do they deliberately ignore it to assert their independence? Or do they disagree with it? What caused the others to set the targets that they did? Was it political expediency or strategic planning? Our initial and informal conversations with planners suggest that all of these factors may have been at work. To answer these questions rigorously would require undertaking qualitative research involving interviews of planning staff and decision makers. Additional investigations could also include a larger sample of cities in BC to enable better statistical analysis.

Upon examining the normalized GHG targets for the twenty municipalities in terms of annual per capita emissions, this research finds that GCA in BC has resulted in discernible progress in climate-change planning. Analyzing the general characteristics of the targets reveals that the flexibility of the legislation is both a strength and a weakness. Its major weakness is that it is so flexible that a number of high-emitting municipalities have made little or no serious effort toward emissions reductions. The strength of this approach is that a majority of local governments have already incorporated language about climate-change mitigation into their OCPs. It appears that the first step toward reduced emissions, that of altering the culture of planning, may have been achieved.

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