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Public Transit and the Kyoto Protocol: How Local Government in Canada Can Promote Greenhouse Gas Emission Reductions

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Once ratified on the world political stage, the Kyoto Protocol will require action by all levels of government. Local government in Canada has the potential to play an important role in this regard. This paper describes how local government in Canada can promote greenhouse gas emission reductions. At the present time there are few measures, or indicators, linking the built environment to the transportation system. Traditional public transit indicators such as transit ridership and cost recovery only measure the economic objectives of public transit and not the social or environmental objectives. This paper offers a methodology for developing sustainable transportation indicators based on access to public transit. A list of priority indicators is presented by indicator type, namely land use, community design, and transit policy. Current research in the field of sustainable development is poised to make a significant contribution to global greenhouse gas emission reductions. Local government, it is shown, has the potential to promote greenhouse gas emission reductions by integrating sustainable development practices with public transit service.

Keywords: Kyoto Protocol, sustainable transportation indicators, greenhouse gas emissions

The transportation sector, which includes the movement of people and goods, is responsible for 27% of the world's carbon dioxide emissions (Geerlings, 1999). Within Canada, carbon dioxide (CO^2) is the main gas associated with global warming (76%). Other contributing gases include methane, nitrous oxide and hydroflourocarbons. A range of CO^2 emission rates for several modes of transportation are presented in Table 1. After air transportation, the mode of transport

Table 1: Specific carbon dioxide emissions

Passenger transport	Carbon dioxide emissions(grams/pass. Km)
Bus	35 - 62
Train	39 - 78
Car	133 - 200
Air	160 - 465

Source: Geerlings, 1999

contributing the largest amount of CO^2 emissions into the atmosphere is the private automobile. Public transit offers a viable alternative to the private automobile. However, in many regions the potential of public transit is not complimented by transit friendly development. Since local governments in Canada have control over land use and community design, local government is well positioned to influence the mode of individual transport, thus affecting the emission rate of greenhouse gases.

Measuring Sustainability

Current research in the area of sustainable development has focused on the development of indicators (Sheltair Group, 1998; Litman, 1999a; Sarmento et al, 2000; MacDonald, 2000; Wilkinson and Baruah, 2001). Indicators provide a means of measuring progress toward, or away from, an intended goal. Existing public transit indicators consist of performance-based, economic measures such as ridership and cost recovery. Such indicators are outdated and offer no insight to the human-environmental condition. New indicators are needed that will integrate economic, social and environmental objectives. Geographers are making an important contribution to this effort and have become actively engaged in the development and use of sustainability indicators (Maclaren, 1996; Roseland, 1998; MacDonald, 2000; Wilkerson and Baruah, 2001, Patrick, 2002). New directions in geographic inquiry are expected to include continued interest in applied sustainability research (Slocombe, 2000).

Defining Sustainable Transportation

There is broad agreement within the literature as to the definition of sustainable transportation (Roseland, 1998; Geerlings, 1999; MacDonald, 2000). The Centre for Sustainable Transportation was established in Toronto in 1996 as a nationally chartered, non-profit corporation with a mission to provide leadership in achieving sustainable transportation in Canada. The Centre for Sustainable Transportation defines a sustainable transportation system as one that:

- allows the basic access needs of individuals and societies to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between generations;
- is affordable, operated efficiently, offers choice of transport mode, and supports a vibrant economy;
- limits emissions and waste within the planet's ability to absorb them, minimizes consumption of non-renewable resources, reuses and recycles its components, and minimizes the use of land and the production of noise.

Research Design

The research design for this paper centres on the development of sustainability indicators. This design borrows from similar sustainability research (Maclaren, 1996; The Sheltair Group 1998; Hart, 1999; MacDonald 2000; Wilkerson and Baruah, 2001) and is presented in Table 2.

Sources of Research Information (Step 1)

Data collection for this research makes use of four sources of research information, namely direct information, indirect information, document review, and a mail-out survey document. In addition to the four sources of information listed above, the research method for this paper includes the development of three distinct indicator types based on Blowers (1978), namely land use, community design, and transit policy. These indicator types will be described in Step 2. Indicator Type (Step 2)

Indicator Type (Step 2)

Based on Blowers (1978), Cervero (1989), and Alexander and Tomalty (2001), access to public transit is influenced by three factors: land use, community design and transit policy itself. Data collection and potential indicators have therefore been organized by these three factors, or indicator types, described as follows:

Land Use

Land use and transportation are inextricably linked. Land use patterns determine future transportation networks as well as the mode of future transport. Slaymaker (2001) illustrates the relationship between climate change and land use, calling for greater attention to the consequences of accelerated land use change. Based on the work of Sargeant et al (1991), Arendt (1994), and Alexander and Tomalty (2001), land-use indicators that facilitate access to public transit include the clustering of

residential and commercial activities along existing transit corridors. Examples of other indicators include local government official plan policies that support growth management, as well as land use activities that are mixed, or blended, within a community. (Litman, 1996)

Community Design

Beginning at the site scale, the design of our communities greatly effects public transit accessibility (Cervero and Radisch, 1995; Condon, 1996). Community design indicators will seek to identify those built-form features of the community that support access to public transit. Examples of transit friendly community design features include the presence of village or small town centres, improved subdivision design giving pedestrian priority over private cars, reduced roadway capacity expansion, street-front building locations in exchange of surface parking.

Transit Policy

Transit policy indicators will seek to identify institutional policies and procedures that serve to promote public transit accessibility. Examples of public transit indicators include timing of transit service, bus stop amenities, intermodal fare transfers, use of alternative fuels, and policies to promote the image of public transit.

Table 2: Research method and design

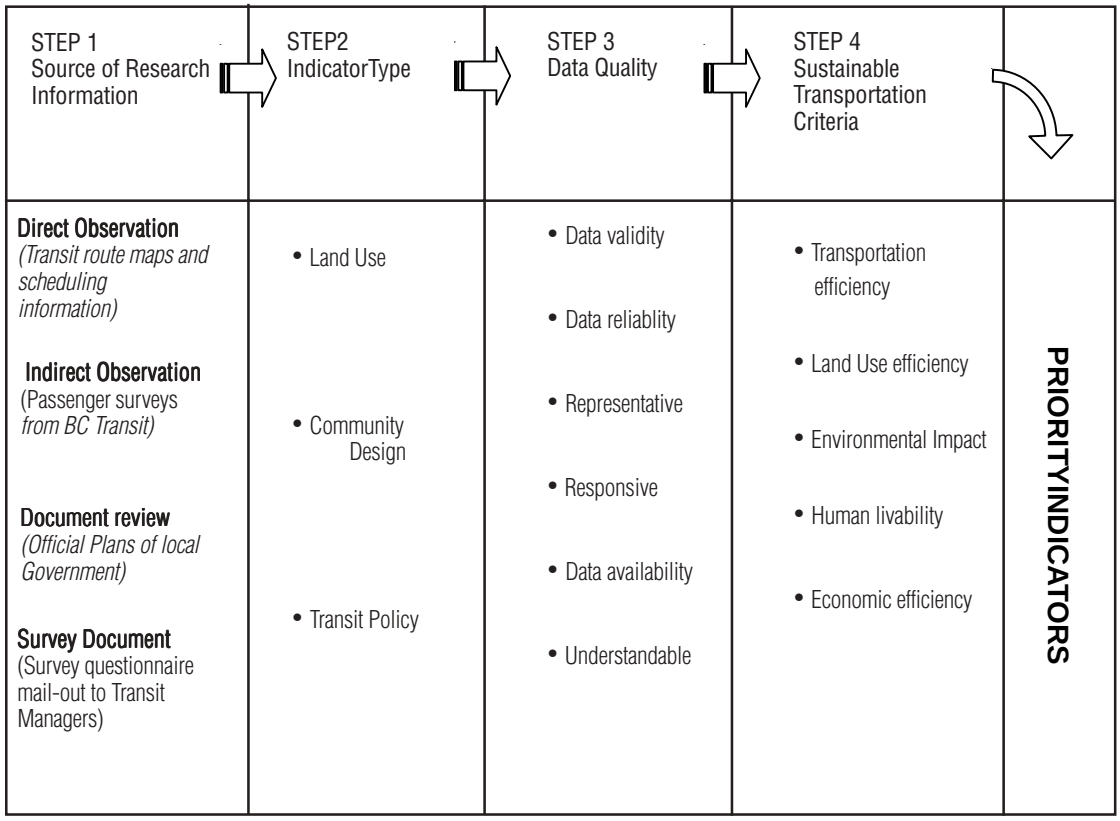

Table 3: Data Quality Criteria

Data Quality Criteria	Data Quality Criteria Charatceristics
Data Validity	The extent to which the indicator relates to the commonly accepted meaning of sustainable transportation
Data Reliability	Ensures that the data collected is independent of the researcher
Representative	Criteria necessary to ensure the potential indicator is representative of the issue of concern or sensitive to the three domains of sustainability
Responsiveness (sensitivity)	The ability of an indicator to respond to external stimuli such as policy intervention.
Data Availability	The extent to which data are accurate, available, and accessible
Understandability, knowledge of	The scientific content of the indicator must match the scientific the user

Source: after Maclaren ,1996

Data Quality Criteria (Step 3)

The use of data quality criteria allows for initial screening of potential indicators. This methodology is common place in sustainability research (Maclaren, 1996; Sheltair 1998; Hart, 1999). A total of six data quality criteria have been selected from the literature and are described in Table 3.

Sustainable Transportation Criteria (Step 4)

To facilitate the evaluation of potential indicators it is necessary to establish a set of criteria specific to sustainable transportation. MacDonald (2000) suggests the following five criteria for the selection of sustainable transportation indicators:

1. Transportation Efficiency
2. Land Use Efficiency
3. Environmental Impact
4. Economic Efficiency
5. Human Livability

Transportation Efficiency

Transportation efficiency contains two components. The first of these relates to the "people moving" capacity of any transport system (see Table 4). When the "people moving" capacity of a transportation system has been increased, so too has the transportation efficiency of that system (Litman 1999b). In this sense transportation efficiencies will be gained by trading automobile dependence for public transit accessibility. This first component of transportation efficiency will express itself through sustainability indicators that examine alternate modes to the private automobile.

The second component of transportation efficiency relates to the inter-relationship between transportation and land use. The most efficient transportation system will be provided through land use patterns that not only promote accessibility but also minimize the need for travel. Examples of sustainable transportation indicators relating to transportation efficiency

Table 4: Person moving capacity of a one lane roadway

Transport mode	Person moving capacity per hour (based on a single lane, 4 metre road)
Walk	7,200
Bicycle	6,000
Transit bus	4,000
Private automobile (occupancy = 1.2)	2,000

Source: after MacDonald, 2000

Table 5: Accessibility as related to land-use and transportation

		Transport Connection	
		Very poor	Very good
Land-use activities	Far apart	*Low accessibility*	*Medium accessibility*
	Close together	*Medium accessibility*	*High accessibility*

Source: after Ross, 1999

include local government policies in support of home occupations, mixed land uses, and nodal growth centres. Table 5 shows that even when transport connections are very poor, the proximity of diverse land use activities will provide medium accessibility. This information is significant where the level of public transport service may be infrequent or non-existent.

Land Use Efficiency

MacDonald (2000) defines land use efficiency as the optimization of spatial efficiencies through the minimization of land consumption. Clustering density through average parcel size provisions as opposed to minimum parcel size provisions will not only help retain natural features but will also enhance the viability of public transit. Examples of sustainable transportation indicators relating to land use efficiency include local government planning policies in favour of cluster development, subdivision design with pedestrian linkages to facilitate transit usage, commercial development nodes, and mixed use developments. (Roseland, 1998, Litman, 1999a).

Environmental Impact

A sustainable community, in the words of Elizabeth Kline (Roseland, 1997), is in harmony with natural systems by reducing and converting waste into non-harmful and beneficial products. To this extent, the private automobile stands in direct conflict with sustainability. After all, environmental impacts associated with the private automobile are wide ranging, including air, water and noise pollution all with significant human health implications. Other negative externalities associated with the automobile include natural resource consumption, mobility deprivation, road capacity expansion, and road construction subsidization. Examples of sustainable transportation indicators relating to environmental impact include the provision of bike rack equipped buses, provision for intermodal fare travel, percent of road system accessed by transit, percent of transit vehicles using alternate fuels and zero emission fuels. The term alternative fuel is sometimes interpreted as zero emission fuel. These two terms however are not synonymous as most alternate fuels are carbon based and therefore produce harmful emissions or the process required to make the alternative fuel produces harmful emissions, including hydrogen fuel cell technology (David Suzuki Foundation, 2001)

Economic Efficiency

In the right combination, transportation and land-use can have a positive impact on a local economy. Economic efficiency is an important criteria in that it aims to ensure all users of the transportation system are paying their fair share for the service they receive. Free parking, for example, provides an unfair subsidy to automobile users, encourages automobile use, and increases the cost of development for everyone, including those without access to an automobile (Shoup, 1999). Further, where employers pay for parking, by offering free employee parking a marked increase in commuter parking demand (26%) was noticed in a study of seven North American urban centres (Shoup, 1997b). State Law in California requires those employers that offer free

parking to employees to also offer a parking cashing-out program. This law was aimed at reducing traffic congestion and air pollution caused by employer paid parking. The practice of employer-paid parking raises equity issues between those who drive to work and those that choose to walk , ride, or take public transit.

A well-designed transit schedule will move people into commercial, entertainment, or recreational areas at optimal times. The economic potential of a commercial area and the success of public transit are co-dependent. For example, clustered commercial nodes will allow local shopping and opportunities for local economic development. Examples of sustainable transportation indicators relating to economic impact include proximity of residences to commercial shops, demand for expanded transit service, employer subsidized transit passes, local planning policies favouring nodal development over sprawl, and timing of transit service that is coordinated.

Human Livability

Sometimes referred to as the ubiquitous "quality of life", human livability reflects many of the qualitative aspects of a community. As such, human livability can be difficult to define, and even more difficult to measure. Kline (1997) defines human livability as something akin to human well-being, which includes sense of place, sense of self-worth, and sense of safety. The work of Appleyard (1981) in urban San Francisco illustrates that human livability is enhanced when citizens experience a sense of belonging and a sense of peace and safety with the streetscape. The automobile and its heavy road infrastructure operate in direct conflict with pedestrian movement and public transit accessibility. The introduction of public transit into rural and urban areas has a significant benefit in terms of transport safety. Annually the automobile claims the lives of some 30,000 Canadians and injures 300,000 more (Comeau, 1999). Where access to public transit is enhanced, there is a significant benefit to human safety. Examples of sustainable transportation indicators relating to human livability include percent of transit vehicles using alternate fuels, taxi passenger component as percent of total dial-a-ride custom service, and percent of workforce taking public transit to work.

High Priority Indicators

The following three tables represent the output of this research. Local Government is encouraged to make use of these indicators when making land use and community design decisions. Similarly, transit authorities are encouraged to consult these indicators when making transit policy decisions. The purpose of these indicators is to encourage and promote transit friendly development at the local level. The outcome of integrating sustainable development practices with public transit services will be a net reductionin private automobile useage with a subsequent reduction in greenhouse gas emissions.

Conclusion

Canada's commitment to the Kyoto protocol will require a concerted effort from all levels of government. Local government in Canada has an opportunity to play a major role in this regard. Transportation, and in particular our dependency on the private automobile, has proven to be a significant contributor to greenhouse gas emissions. One of the main responsibilities of local government includes the determination of land use and community design, key factors affecting the transportation system. In addition, many local governments either operate, or contract to operate, local transit service. This paper suggests that local governments in Canada should begin to integrate sustainable development practices with public transit service. Only through this integration will public transit emerge as a true alternative to the private automobile. Whether local governments have the courage to initiate such policy change has yet to be witnessed. However, given recent scientific discourse on global warming there is little time for further inaction.

Table 1: High priority land use indicators

1. Percent of housing within 450 metres of basic commercial shops
2. Percent of housing within 450 metres of a bus transit route
3. Percent of transit accessible housing stock per kilometre of transit road length
4. Percent of potential new lots within 450 metres of a bus transit route
5. Percent of OCP goals with specific reference to community accessibility versus automobile mobility
6. Percent of OCP residential land use objectives and policies with specific reference to nodal or clustered development versus sprawl development
7. Percent of OCP transportation objectives and policies with specific reference to public transit accessibility
8. Mandatory referral of subdivision and rezoning applications from local government to transit committee/staff (Yes/No)

Table 2: High priority community design indicators

1. Transit road length as a percent of total road length
2. Accident injuries and deaths resulting from public transit versus private automobile
3. Percent of OCP development permit guidelines with reference to design criteria for public transit
4. Percent of major local employers that offer employee incentives to ride transit as opposed to providing (free) on-site parking
5. Mandatory building permit referrals from local government building/eng. department to local transit authority for all development permits and non-residential building permits
6. Percent of community design features favouring access by public transit versus access by private automobile (store front transit access, centralized interchange, dedicated pull-outs)
7. Percent of commuting workforce population taking public transit to work

Table 3: High priority transit policy indicators

1. Percent of intermodal connections with less than 15 minute wait
2. Percent of journey to and from work/entertainment/recreation with less than 15 minute wait
3. Availability of handy DART custom service (Yes/No)
4. Taxi passenger component as a percent of total Dial-A-Ride custom service
5. Intermodal travel with transfer fares
6. Percentage of transit vehicles with low floor, wheelchair access
7. Percentage of transit vehicles equipped with bike racks
8. Percentage of transit stops with posted schedule, all weather cover, seating, telephone, regular maintenance
9. Percent of transit vehicles using alternate fuels

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