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Development and Application of a Framework for Analyzing the Impacts of Urban Transportation

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Abstract: To adequately analyze the impacts associated with the rising use of automobiles, an assessment framework is needed that includes environment, health, economic, and sociocultural impacts. Such a framework was developed and applied to a proposed freeway-widening project in Edmonton, Canada. The assessment framework was developed using both Multi-Criteria Analysis and the Ecosystem Approach to Human Health (Ecohealth). Community participation was vital in the application of the assessment framework to this case study. Six stakeholder groups, including community members, City Councillors, and health, environment, and transportation experts, provided needed qualitative data for the assessment framework. Quantitative data were gathered from an ecological study design that associated traffic volumes with respiratory conditions in Edmonton. Community members' perceptions about the impacts of the freeway widening differed from those of the expert groups in a number of areas. Environmental and health degradation was more of an issue to community members than to expert groups. Though respiratory conditions were not projected to increase by a significant amount because of the freeway widening, further analysis is necessary on other biophysical and socioeconomic impacts listed in the assessment framework. The divergence in opinion between community members and experts suggests that more communication is needed between these groups in relation to transportation planning. The Ecohealth approach ensures that community concerns are addressed in transportation planning.

Key words: transportation, environment, automobiles, health, sustainability, policy

Introduction

The urban environment is one major ecosystem, where an increasing number of people worldwide are settling. By 2025, it is estimated that 59% of humans will live in urban settings, compared to 32% in 1955 (World Health Organization [WHO], 1998). Rapid urbanization has become a major issue for the WHO, as evidenced by their Healthy Cities Programme. The goal of that project is to ameliorate those aspects of the urban environment that adversely impact health, such as housing conditions, infrastructure, food, and urban transportation (WHO, 1996).

Transportation is defined as the movement of people and goods between places (British Medical Association, 1997). Transportation encompasses such modes as air,

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water, rail, and road travel, with most urban travel being done on land by automobiles. Further, the most prominent impacts of urban transportation involve roadways and the associated use of automobiles.

Worldwide, between 1970 and 1993, the number of automobiles has risen 150% (Giuliano, 1999). In the less-developed world, rates of automobile growth have increased dramatically. For example, in India, between 1990 and 1997, the number of vehicles increased from 19 million to almost 41 million; a total increase of 116% (Tata Energy Research Institute [TERI], 2001a). The concerns of increased motor vehicle usage are particularly acute in developing countries because of high lead concentrations in the fuels, older vehicles burning fuel more inefficiently than newer vehicles, and two-stroke engines producing more air pollution than four-stroke engines (TERI, 2001b).

In the more developed world, rates of automobile growth are also high. In the European Union, the number of cars per 1000 inhabitants increased from 390 in 1989, to 454 in 1998; a total increase of 16% (Eurostat, 2001). In North America, between 1980 and 1996, the annual growth rate in vehicle-miles traveled increased 3% annually, while population growth was only 1% (Environmental Protection Agency, 2001). In the Canadian province of Alberta, the number of registered vehicles increased over 300% between 1961 and 1999, and the average kilometers per vehicle has increased since 1990 (Pembina Institute, 2001).

Increasing automobile use and its environmental effects globally are drawing the attention of health, environmental, and transportation researchers. The issue of sustainability, that is, using resources and managing wastes that will allow future generations to meet their needs (The Centre for Sustainable Transportation, 1998), is pivotal. Sustainability addresses concerns that are long-term (several generations into the future), and equitable, in that it does not unfairly impact on one group more than another (Victoria Transportation Policy Institute, 2003). The increasing use of automobiles is seen as unsustainable from energy, environmental, and health perspectives (McCarthy, 1999). Fossil fuels needed to power automobiles are a nonrenewable resource, resulting in emissions that are detrimental to ecological integrity and human health.

Urban planners around the world struggle to contain increasing levels of automobile use. The framework developed in this article provides a conceptual basis upon which urban planners can understand the broad range of health, environmental, community, and economic consequences associated with different transportation options by identifying impacts, both measured and perceived. Thus, a basis for informed discourse on the topic of urban transportation is facilitated.

Review of Transportation Impacts

To appreciate the complexities involved in making transportation decisions, it is necessary to determine the full scope of how transportation impacts on society. Marko (2002) displayed a figure that identified factors (or pressures) that impact on transportation, and the impact that transportation has on society (see Fig. 1). The reader is referred to other publications that incorporate different lists of impacts (European Commission, 1996; Organization for Economic Cooperation and Development [OECD], 1997; Litman, 1999).

Comprehensive Approaches for Transportation Planning

To integrate the impacts that were illustrated in Figure 1 into transportation planning, a framework is needed. In reviewing the literature on frameworks, two had potential relevance to transportation planning, the Ecosystem Approach to Human Health (Ecohealth), and Multi-criteria Analysis. A new assessment framework, based on these two approaches, is developed that will enable urban decision-makers to include the environmental, health, economic, and sociocultural impacts that transportation has on society.

Multi-criteria Analysis (MCA)

MCA is an approach where effects assigned a monetary value, as well as those using subjective criteria, are provided to decision-makers and analysts for comparison (OECD, 1997; European Conference of the Ministers of Transport [ECMT], 2001). MCA has been applied to transportation decision-making and is used in European countries and New Zealand, among others (European Commission, 1996; McDermott et al., 1997; ECMT, 2001). MCA is a synthesis of environmental, economic, and social assessments combined into one overall assessment. Double counting can be an issue in an MCA (Glaister, 1999), as can the fact that it tends to involve a large degree of subjective assessment and judgment (European Commission, 1996). However, the benefit of MCA is that it includes many impacts, and an ideal method for evaluating transportation planning.

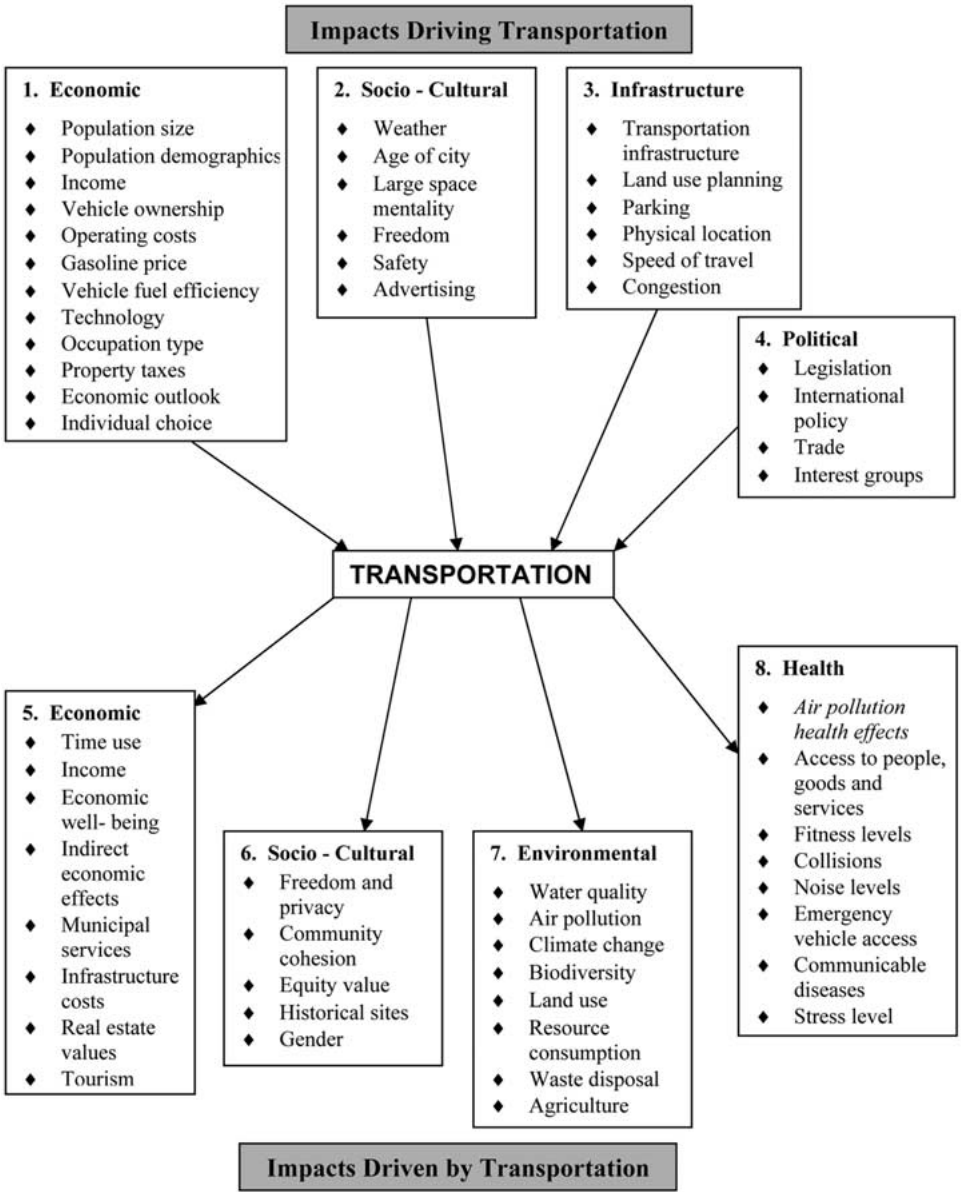

Figure 1. Transportation impact diagram (reproduced with permission from Marko, 2002).

Ecosystem Approach to Human Health (Ecohealth)

The Ecohealth approach provides a comprehensive explanation of the relationship between humans and their life-supporting environment in a transdisciplinary way (Spiegel, 2001). The Canadian International Development Research Centre created the Ecohealth approach in 1996, and it has supported over 70 projects around the globe, mostly in developing countries. International organizations such as the National Institutes of Health, the United Nations Development Programme, the World Bank, the World Health Organization, and others, have supported its implementation in projects around the world (Lebel, 2003). The Ecohealth approach has three pillars (community participation, transdisciplinary methods, and gender as a source of inequity), and requires all stakeholders to be involved from the beginning of the study design process (Forget and Lebel, 2001).

Community participation and transdisciplinary methods guided the application of the newly developed assessment framework. Equity is an important consideration in urban transportation planning because communities closest to freeways are more adversely affected by air and noise pollution, cohesion, and real estate values compared to communities further away from freeways. In some instances, those that live closest to freeways are more socially

disadvantaged than others and are therefore more affected by roadway design (Dunt, 1991). This implies that extra consideration should be taken to comply with community needs when planning transportation infrastructure. In countries where the divide in gender roles is more pronounced (e.g., in developing countries), gender could be an equity issue, but was not seen as one by the stakeholders involved in this case study.

Methods

Impacts identified from previous literature are placed into a framework where each can be measured. Table 1 is a pictorial representation of the assessment framework, which has been adapted from other sources (Department of Environment, Transport, and the Regions, 2000), and also includes key indicators and probable data sources. Many impacts can be included in an assessment framework and the decisions about what impacts to include will vary depending on local context. The impacts in the assessment framework do not include all the impacts possible, but rather illustrates those that are important based on published literature and stakeholder opinion.

Categories Included in Assessment Framework

The four main categories in the assessment framework (Table 1) are listed in the left-hand column: (1) Health; (2) Environment; (3) Economic; (4) Socio-cultural. Within each of these categories are impacts. Within the Health category, air quality, collisions, noise, fitness, stress levels, and community cohesion are listed as impacts. Subsequently, quantitative and qualitative indicators are listed for each impact. Indicators represent or summarize a significant aspect of the state of the environment, and are useful in assessing health states (Health Canada, 2002). For example, in the collision impact, a quantitative indicator of the estimated number of collisions occurring in the network because of the project, and the cost of those injuries is listed. To supplement this, a qualitative indicator of the likely impact the project will have on collisions is also listed. Qualitative data are needed especially if quantitative estimates are not readily available. Common data sources for both quantitative and qualitative indicators are also shown. Risk of double counting exists with the health impact of air quality and the environmental impact of climate change because costs associated with carbon dioxide emissions frequently take health concerns into consideration. Therefore, in any attempt to quantify the impacts, the risk of double counting must be recognized.

To evaluate the usefulness of the assessment framework, a case study of a roadway-widening project in Edmonton is presented next. Information from various stakeholders is used to confirm the importance of the impacts included in the assessment framework and acts as a resource for qualitative indicators in the framework. The assessment framework is partially applied in this case to a roadway-widening project.

Case Study

The City of Edmonton produced a Transportation Master Plan that identified the need to balance private automobile use with improved public transit, bicycling, and pedestrian pathways. The impetus for this plan was the forecasted population growth for metropolitan Edmonton, expected to increase by one-third to 1.2 million in 2020 (City of Edmonton, 1998). In congruence with population growth, the city is predicted to continue its decentralized pattern of expansion into more suburbia.

Whitemud Drive was selected as a key component of the transportation system, linking south and west Edmonton (see Fig. 2). While most of Whitemud Drive has six lanes of through traffic, there is a section between 122nd street and 149th street that provides four lanes of through traffic, with congestion arising especially during the morning and evening peak hours. It is this section that the City of Edmonton plans to widen by one lane in each direction, including expanding the Quesnell Bridge to eight lanes from six lanes.

Qualitative Methods

To adequately address the concerns of the citizens involved, an assessment framework has to include those impacts that the community, experts, and decision-makers feel are important. Stakeholder input from 36 individuals in six groups (two community groups, City of Edmonton transportation officials, Alberta Environment officials, Capital Health employees, and Edmonton City Councillors) was sought for this study to provide a balanced viewpoint on transportation in Edmonton and the Whitemud Drive widening in particular. One community group, the West Edmonton Transportation Coalition (WETC), contacted researchers at the University of Alberta to investigate the

Table 1. Assessment Framework

Category	Impact	Quantitative indicator	Qualitative indicator	Data source
Health	Air quality	Estimated no. of people experiencing respiratory degradation from alternative and cost	Likely impact on respiratory health outcomes	Air monitoring stations
		Estimated no. of air quality guidelines expected to be exceeded annually due to alternative		Epidemiologists
	Collisions	Estimated no. of collisions occurring in network and cost of injuries/fatalities resulting	Likely impact on collisions in the network	Transport Planning
				Police Dept.
	Noise	Estimated no. of people exposed to noise above city guidelines and cost	Likely impact on noise levels	Transport Planning
	Fitness	No. of nonvehicular trips made	Likely impact on pedestrian and bicycling	Transport Planning
				Stakeholders
	Stress levels		Likely impact on drivers stress levels	Stakeholders
	Community cohesion		Likely impact on community stress level and barrier effect	Stakeholders
Environment	Climate change	Estimated cost based on CO_2 emissions		Transport Planning
	Biodiversity	No. of wildlife road kills expected	Potential effect on displacement of plants, animals in area	Environment screening review
		Amount of habitat land area loss		
	Water quality		Potential for water contamination in area	Environment screening review
			Risk of spills from hazardous goods	
Economic	Traffic volume	Daily average volume for network		Transport Planning
	Journey times	Estimated no. of minutes saved on journeys through network		Transport Planning
	Real estate values		Likely impact on real estate values	Real Estate Board
Socio-cultural	Gender		Likely differential impact on both genders	Transport Planning
				Stakeholders
	Equity		Likely impact on public transit accessibility	Transport Planning
				Stakeholders

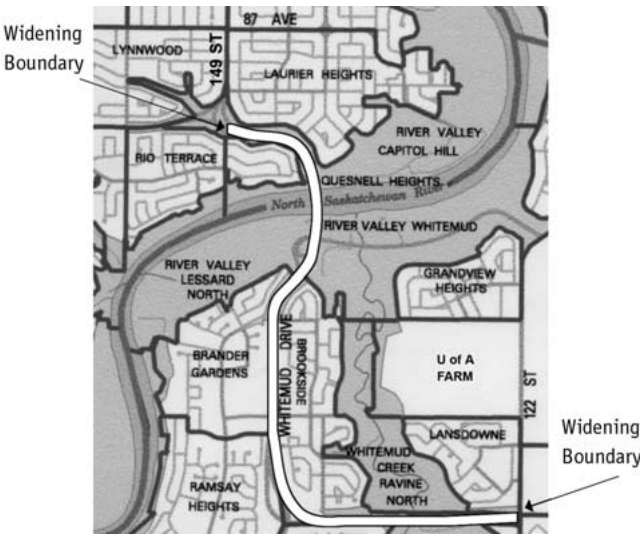

Figure 2. Freeway widening study area, Edmonton, 2000 (reproduced, in part, from the City of Edmonton's Standard Neighbourhood and Ward Map, 2003, with permission from the City of Edmonton, Alberta, Canada).

health and environmental impacts associated with the freeway and proposed widening. This group helped shape the research questions and was involved throughout the study.

A purposeful sampling strategy was used within each group, and all stakeholders were surveyed between February and March 2002. Individuals within each group were asked to fill out a questionnaire (with ethics approval from the University of Alberta), about their perceptions of Whitemud Drive and the impact of the proposed roadway widening.

Quantitative Methods

The assessment framework is partially applied in this case study because only one impact from the assessment framework, air pollution health effects, was empirically tested in the case study. It was decided that, because of generally good data availability, and established research findings showing associations between air pollution and respiratory conditions (Dockery et al., 1993; Brunekreef et al., 1997; Ciccone et al., 1998; Friedman et al., 2001), this impact would be tested. To ascertain air pollution health effects, an ecologic study design was used that associated traffic volume levels in the City of Edmonton to the number of respiratory conditions for this region.

The regional health authority of Edmonton and surrounding area provided the number of respiratory conditions that occur in Edmonton (Capital Health Authority, 2000). Approximately 3% of all respiratory emergency department visits, hospital admissions, and deaths are attributable to traffic emissions (Kunzli et al., 2000; The Health of Londoners Programme [HOLP], 2001). Therefore, traffic emissions are estimated to cause 3% of respiratory health outcomes in Edmonton. Caution is noted when generalizing the 3% figure to Edmonton, because this value originally comes from studies conducted in Europe. However, both Canada and the countries in Europe where the studies were performed (Austria, Switzerland, France, and England) are developed nations and have similar population health indicators. These estimates have also been used to calculate traffic's contribution to health degradation in New Zealand and Australia (Woodward et al., 2002).

To calculate the estimated number of people experiencing respiratory degradation from traffic pollution, the scope of the analysis was first expanded to include all of Edmonton. Estimates of the total vehicle-kilometers traveled in Edmonton were taken from a travel survey (Applications Management Consulting Ltd, 1995). The total vehicle-kilometers traveled in Edmonton are linked to each respiratory health outcome to render a ratio of vehicle-kilometers-per-event. Estimates of respiratory degradation resulting from transportation alternatives at the local level (i.e., surrounding Whitemud Drive) were then calculated using figures from the Edmonton area estimates.

Results

Qualitative Results

The stakeholder groups and number of participants are shown in Table 2. Owing to time and resource considerations, these six groups comprising 36 individuals were the only stakeholders contacted for this case study. Most participants (58%) were between 46 and 65 years of age, with 69% of participants having a university degree or higher education level. The majority of participants were male (78%). Participants were asked if they had any environmental concerns with Whitemud Drive at the present time. Participants most often reported air pollution (35%) and noise pollution (31%). When asked what health concerns they had with Whitemud Drive (if any), air pollution (42%) was the most common response.

Table 3 displays the results of one question on the survey that asked stakeholders to estimate the effect a widened Whitemud Drive would have on a set of impacts

Table 2. Number of Participants in Each Stakeholder Group

Stakeholder group	Final no. of participants
City of Edmonton transportation planning branch	4
City of Edmonton councillors	8
Alberta environment	6
Capital health authority	5
Local citizens in WETC	7
Local citizens not in WETC	6
Total	36

WETC, West Edmonton Transportation Coalition.

20 years into the future. A score of 1 indicates an expected significant increase in the impact, and ranges to a 5, which is a significant decrease in the impact. The left-hand side of Table 3 lists transportation impacts with each of the six stakeholder groups listed across the top. Mean scores for each group are listed in the cells.

The answers reveal that there are wide discrepancies between some of the groups as to what they thought the impact of the freeway widening might be. The WETC group thought that air pollution was going to increase because of a widened Whitemud Drive (1.5), whereas Alberta Environment and Capital Health respondents thought it was going to decrease (3.8 and 4.0, respectively). All groups except WETC thought that community cohesion would be relatively unchanged (3.0–3.3), whereas WETC thought that there would be a moderate decrease in cohesion (4.3). The answers illustrate how far apart the stakeholder groups are in their perceptions of the expected impacts of a widened Whitemud Drive.

Quantitative Results

The results of the respiratory health outcomes are displayed in Table 4. The values in Table 4 should be viewed with caution because variables such as wind conditions, vehicle emissions, speed of travel, air temperature, and other sources of pollution are assumed to be constant. In the Edmonton area, it is estimated that traffic air pollution causes 685 emergency department visits, 72 hospital admissions, and five deaths each year. These estimates are considered conservative because air pollution particulate matter influences cardiac conditions (HOLP, 2001; Peters et al., 2001; Magari et al., 2002). For future analyses, the most useful values may be the vehicle-kilometers-per-event figures, because they show how many respiratory health effects are estimated for a given level of vehicle-kilometers traveled. This means that in a case where traffic is expected to increase because of a road widening, estimates of respiratory health effects can be made.

Scenario Analysis

The City of Edmonton has proposed to widen Whitemud Drive freeway to help alleviate traffic congestion. The community members involved in this study envisioned different transportation scenarios along this corridor. The results of the different scenarios and how they affected vehicle-kilometers in the year 2020 are shown in Table 5. These figures are then compared with the vehicle-kilometers-per-event statistics calculated in Table 4 to estimate the respiratory health effects from different transportation scenarios.

The widening of the freeway by one lane is expected to produce an additional 11 million vehicle kilometers above the baseline scenario of no widening. This would produce an estimated two respiratory related emergency department visits, and contribute to additional hospital admissions and mortality on an annual basis. Widening for public transport use is not expected to generate any more traffic than at baseline levels. In reducing the freeway by one lane in each direction, it is estimated that traffic volume decreases by 20%, even without concomitant investments in alternative means of transportation. This 20% reduction is based on a systematic review of observations around the world where roadways were reduced and changes in traffic patterns measured (Cairns et al., 1998). The reduction by one lane is estimated to reduce vehicle-kilometers per year by almost 60 million. This would result in a saving of 12 emergency department visits, one hospital admission, and contribute to savings in respiratory mortality.

Tables 4 and 5 represent an estimate of the quantification of respiratory conditions associated with traffic volumes in an urban area. The benefit of these estimates is to increase the awareness that transportation does have a measurable impact on population health. Future assessments will need to incorporate evidence for the other impacts incorporated into the assessment framework.

Discussion

This study is unique in that no other published studies where the Ecohealth approach was used specifically for

Table 3. Stakeholder Responses to Expected Impacts of Widened Freeway, Edmonton, 2020[a]

Categories	Alberta environment	Capital Health environment division	City of Edmonton transport planning	City of Edmonton Councillors	Non-WETC	WETC	Total
Trip time	3.6	4.0	2.5	3.8	3.5	3.4	3.5
Economic benefits	2.2	2.2	2.0	2.6	2.3	3.0	2.5
Real estate values	3.2	3.0	3.0	2.7	3.5	4.5	3.3
Motor vehicle collisions	3.8	3.3	3.8	3.4	2.7	2.3	3.1
Stress levels	4.2	3.6	3.5	3.3	3.3	2.1	3.3
Community cohesion	3.0	3.0	3.0	3.3	3.2	4.3	3.3
Air pollution	3.8	4.0	3.8	2.1	2.0	1.5	2.6
Noise levels	2.6	2.3	2.5	2.1	1.6	1.2	2.0
Water pollution	3.2	2.6	2.5	2.6	2.5	2.3	2.6
Physical fitness levels	2.8	3.0	2.8	3.1	3.0	3.1	3.0
Global climate change	3.4	3.5	3.3	2.6	2.7	2.3	2.9

[a]Scores are: 1 = significant increase in the impact; 2 = moderate increase in the impact; 3 = no change in the impact; 4 = moderate decrease in the impact; 5 = significant decrease in the impact.

Table 4. Estimated Traffic-attributable Respiratory Health Outcomes, Edmonton, 2000

Respiratory health outcomes	(1) No. of events per year[a]	(2) Traffic portion[b]	(3)=(1)*(2) No. attributable to traffic pollution	(4) Vehicle-kilometers per year (000s)[c]	(5)=(4)/(3) Vehicle-kilometers per event (000s)
Emergency department visits	22,841	0.03	685	3,613,500	5275
Hospital admissions	2,395	0.03	72	3,613,500	50,188
Deaths	168	0.03	5	3,613,500	722,700

Cell values in column (3) are calculated as the product of row values in columns (1) and (2); cell values in column (5) are calculated as the ratio of row values in columns (4) and (3).

[a]Source: Capital Health Authority (2000).

[b]Source: Kunzli et al. (2000).

[c]Source:Applications Management Consulting Ltd (1995).

Table 5. Vehicle-kilometers for Different Transportation Scenarios, Edmonton, 2020

Transportation scenario	Daily traffic volume per day on freeway[a]	Length of freeway expanse (km)[a]	Vehicle-kilometers per year (000s)	Difference in vehicle-kilometers per year from baseline (000s)
Without widening	135,000	6	295,650	0
With widening	140,000	6	306,600	+10,950
With widening for public transport	135,000	6	295,650	0
Reduction by one lane	108,000	6	236,520	−59,130

[a]Source: Stantec Consulting (2001).

urban transportation planning could be found. Spiegel et al. (2003) used the approach in developing ecosystem health indicators for an urban area in central Havana, Cuba. Though transportation was not the main focus of the Cuban project, roadway maintenance was one intervention that was used. Other frameworks, like Environmental Impact Assessment and Health Impact Assessment utilize similar goals for incorporating environmental and health concerns into transportation projects, though they are too often narrowly focused to integrate knowledge in a transdisciplinary fashion.

The strengths of the assessment framework developed in this article are varied. First, it comprehensively identifies the health, environmental, economic, and sociocultural impacts that are affected by transportation infrastructure. Using Multi-criteria Analysis, quantitative indicators of each impact, along with probable data sources are utilized. Where the impacts cannot be feasibly measured, qualitative indicators are used. The Ecohealth approach was crucial in the application of the assessment framework because it attempted to incorporate community participation to solve problems in a transdisciplinary fashion while taking equity issues into account. Many of the stakeholders involved in this case study had not worked together or been consulted on a transportation project before. WETC community members concern over this freeway widening was the catalyst for this study.

Challenges existed in integrating all three of the Ecohealth pillars—transdisciplinary methods, community participation, and equity—in this case study. First, acquisition of data from environmental agencies proved problematic. Various inputs are essential to applying the assessment framework as one that transcends traditional reductionist approaches to solving community concerns.

Second, all stakeholder groups had been consulted independently by the researchers. It was only at the end of the study that the various stakeholders, including community members, met face-to-face with technical experts. It is noted that the community groups had occasion to meet with the technical experts prior to this study. Indeed, a more complete participatory approach would have brought all stakeholders together at the start of this study. The authors feel it would have contributed to a shared understanding of the issues involved. Shared understanding of an integrated ecosystem approach has produced measurable benefits at the local level (see Spiegel et al., 2003).

Third, while equity in developing regions of the world relates more to questions of gender, in this Canadian case study, equity relates first and foremost to the question of residential proximity to the proposed highway changes. While the community groups sampled were not representative of all community members residing near the freeway, it is assumed that those living most closely to a freeway feel more concerned about potential impacts than those who live distant from a freeway. A small proportion of freeway users live close to the freeway and hence stand to be negatively impacted. Those deriving the benefits of freeway expansion tend to reside far from the freeway and thus, while a majority of the population may be less directly concerned about negative impacts from freeway expansion, the concerns of those who live in proximity, a minority of the larger community, need to be acknowledged and respected. A secondary aspect of equity in this case study relates to differential freeway use between men and woman. Because women tend to drive more at off-peak hours than men, freeway expansion could serve to relieve congestion during peak hours, producing more benefit to men (i.e., less time commuting).

The final summary related to the widening of Whitemud Drive is presented in Table 6. Two additional respiratory emergency department visits per year are likely from the widening, along with contributions to respiratory hospital admissions and deaths. For the qualitative indicators, aside from moderate increases expected in noise and economic benefits to the city, no changes in the impacts listed are expected from the roadway widening according to the stakeholders involved. These six groups were not representative of all stakeholder interests in this case study, and therefore caution is advised in generalizing these findings.

More detailed quantitative analysis is needed for a complete application of the assessment framework. The only impact empirically tested in the case study was air pollution health effects, and estimates show that these are not substantially elevated. However, other impacts need to be evaluated that are of concern to stakeholders, such as noise pollution, community cohesion, real estate values, and motor vehicle injuries. A complete application of the assessment framework is needed for decision-makers when deciding on transportation options. Therefore, drawing inferences from Table 6 would be premature. Owing to time and resource considerations, such a comprehensive analysis was beyond the scope of the present study. Only a partial application of the framework was completed, setting the groundwork for researchers to fully apply the framework to other case studies.

Table 6. Summary of Expected Impacts of Freeway Widening, Edmonton, 2020[a]

Category	Impact	Quantitative indicator	Qualitative indicator
Health	Air quality	Two emergency room visits annually expected; contribution to hospital admissions and mortality	No change expected
	Collisions		No change expected
	Noise		Moderate increase expected
	Fitness		No change in fitness levels expected
	Stress levels		No change expected
	Community cohesion		No change expected
Environment	Climate change		No change expected
	Water quality		No change expected
Economic	Traffic volume	140,000 vehicles per day	Moderate increase in economic benefits expected
	Journey times		Moderate decrease in trip time expected
	Real estate values		No change expected
Socio-cultural	Gender		No change expected

[a]Widening of Whitemud Drive by one lane, primarily for private vehicle use.

Qualitative results from the case study demonstrate that community members and expert groups differ in their perceptions about the impact of a widened Whitemud Drive. Although all stakeholder groups identified air pollution as an issue, community members perceived that a widening of Whitemud Drive would increase air pollution, while expert groups perceived little or no change. Evidence suggests that community group (especially the WETC group) concerns are justified because widened roadways tend to encourage more traffic, which in turn exacerbate air pollution (The Standing Advisory Committee on Trunk Road Assessment, 1994; Goodwin, 1996; Cairns, 1998; Hansen, 1998). WETC members were more worried than the expert groups about stress levels, noise pollution, real estate values, injuries, and community cohesion because of a widened Whitemud Drive.

The contradictory perceptions of community members and expert groups found in this study are not unique. Perceptions of environmental and health issues by the local community are often discounted by scientific experts. Dunt et al. (1991) reported a case study of a freeway planned in Melbourne, Australia, that community members opposed, based on environmental and health considerations. Subsequent analysis suggested that these concerns were of little significance. Similarly, Gorman et al. (2003) reported community and expert assessments of health issues associated with Edinburgh's transport policy. Cole et al. (1999) reported on a study that brought together four communities in Ontario, along with an expert panel, that worked towards developing environmental health indicators for air quality. Cole et al. (1999) suggested that government and university scientists are best equipped to apply scientific approaches to assess adverse health impacts of air pollution, and the community is needed to ensure that scientific information is used in the public domain and also to make local observations regarding emission sources.

The two contradictory viewpoints found in this case study suggest that formalized mechanisms of communication are needed between community members and expert groups. Increasing the opportunities for citizens to be involved in transportation issues from the outset, and communicating with planners and engineers is essential to promoting healthy sustainable cities.

This study was undertaken as part of a graduate degree. Because graduate research at the Masters level is normally completed in about 1 year, the multidimensionality of the Ecohealth approach is more demanding than what is accommodated in the time allowed for graduate studies. While such research could be accomplished at the PhD

level, adequate resources would need to be committed by the granting agencies/sponsors.

Conclusions

What is the added value of a transportation planning framework that utilizes MCA and Ecohealth methods? First, the fastest growing proportion of the world's, population is the urban population in the poorest countries (Northridge and Sclar, 2003). If these countries are to effectively deliver transportation infrastructure and land use planning, an approach that is broad enough to take into consideration the environmental, health, economic, and sociocultural impacts of transportation is needed. Ecosystem approaches to urban planning and policy development have been advocated for cities in all stages of development (Marcotullio and Boyle, 2003). An approach for so doing is provided in the assessment framework presented here.

The need exists for different approaches to urban planning that take into account sustainability at the local level (von Schirnding, 1997). Improvements in ecosystem and human health depend on coordinated action by all levels of government, social institutions and, importantly, citizens themselves. Such participatory approaches are key to major health initiatives such as the WHO's Healthy Cities Programme. There have been increasing calls for public health professionals to work with urban planners, community members, and decision-makers on transportation issues (Jackson and Kochtitzky, 2001). The framework developed here, using the Ecohealth approach, provides an example of how participation at the local level can be included in transportation planning.

This study is unique because the Ecohealth approach, developed by IDRC, is tailored primarily for countries of the "south." The Ecohealth approach used in this case study is in a "northern" setting, in Edmonton, one of the materially wealthiest regions in Canada. The possibility of developing countries mimicking automobile ownership and low-density urban design philosophies typical of developed nations underscore the importance that the Ecohealth approach can bring.

The assessment framework included impacts derived from published literature and stakeholder input combined with both quantitative and qualitative indicators. The inclusion of many impacts is necessary for urban planners to make informed transportation decisions, especially because health and environmental issues have tended not to receive much attention in traditional transportation planning. The need for a framework like this to be applied in a transdisciplinary fashion, with community participation and recognition of equity (the Ecohealth principles), is essential to more inclusive and sound transportation planning. Anything less than this comprehensive an analysis would be unjust, resulting in inequity for those deriving benefit of, and those carrying the increased risks from, any transportation infrastructure expansion decisions. The partial application of the assessment framework presented here demonstrates the utility of this framework for future transportation planning.

The results of this research show that there is a measurable impact associated with emissions from motor vehicles, and that transportation infrastructure that encourages more vehicle-kilometers traveled will lead to increased adverse health effects. While additional analyses concerning other impacts included in the assessment framework are needed to support or negate the conclusions reached, this case study provides a starting point for recognizing the diversity of impacts from roadways.

Increasing roadway capacity is associated with increased automobile traffic volume, which increases air pollution regionally and globally, and affects levels of injuries, noise pollution, and contributes to sedentary lifestyles. Therefore, the policy of continually expanding roadways to manage congestion needs to be critically examined. Community members in this case study indicated a desire for alternative mechanisms of moving people (such as through public transit and provision for bicycling and walking) that could lead to less adverse health and environmental effects. The shift away from roadways may help make public transit, bicycling, and walking more desirable when compared to the private automobile, contributing to healthy public policy. Public policy that supports ecosystem integrity will ultimately support public health.

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