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URBAN SUSTAINABILITY REPORTING

Urban sustainability reporting is a tool for informing local government, as well as individuals, businesses, and other organizations, about the progress that they are making towards achieving urban sustainability. The reporting process starts with the definition of sustainability goals for the community, followed by a scoping stage. Subsequent steps comprise choosing a conceptual framework for reporting, preparing a list of potential sustainability indicators, evaluating them by a variety of criteria, choosing a final set of indicators, analyzing their results, presenting the results to an intended target audience, and then periodically assessing indicator performance.

The concept of sustainability is starting to have a significant influence n planning and policy at the local level. Previous research has identified numerous examples of urban sustainability initiatives in North America.[1] A certain number of communities are starting to adopt sustainability as a goal in comprehensive plans and other planning activities (Maclaren 1993, Oullet 1993, Beatley 1995). Now, the important next step for sustainability initiatives at the local level is to determine whether or not these actions are leading a community to become more sustainable. A significant barrier to accomplishing this task is the absence of a clearly articulated methodology for reporting on urban sustainability. Urban sustainability reports include a range of information about environmental, economic, and social conditions and policies in the local community and use that information to make judgements about whether the community is making progress towards sustainability. Evidence of positive progress is important for justifying past expenditures on sustainability initiatives and building support for new initiatives. Evidence of a lack of sustainability can provide ammunition for community groups to demand more action from local government, other levels of government, or the private sector. Individuals in the community also can use sustainability reports to educate themselves about sustainability trends and evaluate how their own actions may improve sustainability.

The purpose of this paper is to present a structured process for urban sustainability reporting that improves upon the ad hoc reporting processes currently in use, and to explore some of the characteristics of urban sustainability indicators. In researching this paper, I examined some of the first efforts at urban sustainability reporting in North America and Europe and drew on local experiences with related types of reporting, namely state of the environment reporting, healthy city reporting and quality of life reporting. State of the environment (SOE) reports describe and analyze environmental conditions

and trends of significance. Social or economic conditions are discussed only insofar as they relate to the biophysical environment (Campbell and Maclaren 1995). Thus SOE reporting is not broad enough to be called sustainability reporting. In contrast, healthy city reporting has just as broad a focus as sustainability reporting, but with a much stronger emphasis on human health. (See, for example, Healthy City Toronto 1993.) Quality of life reporting has evolved to the point where it, too, has become very similar to sustainability reporting in that it examines economic, environmental, and social conditions and the linkages among them (e.g., Murdie et al. 1992); but quality of life reporting does not have the same concern for issues of intergenerational equity.

The examples of urban sustainability reports that are referred to in this paper come from three different levels of government: (1) the city of Seattle, Washington; (2) the Regional Municipality of Hamilton-Wentworth, Ontario; and (3) the province of British Columbia. Each of these cases is described briefly below.

Sustainable Seattle is the name of a multi-stakeholder group that was established in 1990 as a volunteer network and civic forum for the promotion of community sustainability. It is administered by the local YMCA and governed by an independent board of trustees. In 1993, the group released an urban sustainability report for Seattle containing 20 sustainability indicators and an evaluation of Seattle's progress towards sustainability (Sustainable Seattle 1993). An additional 20 indicators were released two years later. The target audience for the report was primarily individual members of the community and the media, with businesses and local government being a secondary target.

The Sustainable Community Indicators project in the Regional Municipality of Hamilton-Wentworth, Ontario, is a continuation of the region's Sustainable Community Initiative, which began in 1990. At that time, the Regional Council appointed a citizen's Task Force on Sustainable Development with a mandate to examine the concept of sustainable development as a basis for reviewing all regional policies. In 1992, after consultation with over 400 individuals and 50 community groups, the Task Force released a document entitled "Vision 2020," describing the type of community that Hamilton-Wentworth could be in the year 2020 if it followed the principles of sustainable development (Regional Municipality of Hamilton-Wentworth 1992). As a follow-up to this document, the Council launched the Sustainable Community Indicators project in 1994, with the goal of developing sustainability indicators for measuring the region's progress towards Vision 2020. The output of the project will be an annual report card that identifies the status of the indicators as well as the way in which they can be influenced by individuals, organizations,business, local government, and the community as a whole.

The British Columbia Round Table's State of Sustainability Report examines urban sustainability at the provincial level. The Round Table is a multi-stakeholder group, funded by the provincial government, and was responsible for developing the province's first sustainability strategy. For its urban sustainability report, the Round Table chose a sample of five cities, accounting for over 60 percent of the province's population, to represent the broad regions of the province as well as a variety of economic, environmental, and social conditions. The report, containing over 90 urban sustainability indicators, was released in 1994 (British Columbia Round Table 1994). Like the Hamilton-Wentworth initiative, the British Columbia report is meant to be a guide for both modifying personal behavior and informing planning and policy decisions.

The first two sections of this paper provide background material on urban sustainability reporting, with a brief discussion of the meaning of urban sustainability and an overview of the distinguishing characteristics of urban sustainability indicators. The remainder of the paper elaborates upon a proposed process for urban sustainability reporting.

Defining Urban Sustainability

What is the meaning of the term "urban sustainability"? It may help to first compare it to "sustainable urban development." The meanings of these two terms are very close and are often used interchangeably in the literature (cf. Richardson 1994). One way of distinguishing them, however, is to think of sustainability as describing a desirable state or set of conditions that persists over time. In contrast, the word "development" in the term "sustainable urban development" implies a process by which sustainability can be attained.

Some of the key characteristics of urban sustainability that are often mentioned in the literature and in policy documents are: intergenerational equity, intragenerational equity (including social equity, geographical equity,[2] and equity in governance), protection of the natural environment (and living within

its carrying capacity), minimal use of nonrenewable resources, economic vitality and diversity, community self-reliance, individual well-being, and satisfaction of basic human needs.[3] There is considerable debate within the academic community, planning agencies, and other organizations over the relative importance of each of these urban sustainability characteristics, and there is even disagreement on whether all of them should be included when developing sustainability goals. Almost everyone who has tried to define urban sustainability agrees, however, that the concept points to the necessity of introducing environmental considerations to the policy debate over the future of our cities. Some maintain that environmental considerations should now be paramount in this debate, while others call for a more holistic approach that balances environmental, economic, and social concerns.

For the purposes of urban sustainability reporting, I contend that there is no single "best" definition of urban sustainability, since different communities are likely to develop slightly, or even significantly, different conceptualizations of urban sustainability, depending on their current economic, environmental, and social circumstances and on community value judgements. As a consequence, a set of indicators designed to measure progress towards achievement of one community's sustainability goals may not necessarily be appropriate for measuring progress in another community. Nevertheless, there are certain fundamental properties of sustainability indicators that all communities will wish to consider. These are described in the next section.

What Is an Urban Sustainability Indicator?

One definition of urban sustainability indicators is that they are "bellwether tests of sustainability and reflect something basic and fundamental to the long term economic, social or environmental health of a community over generations" (Sustainable Seattle 1993, 4). This definition provides a good starting point, but it requires considerable elaboration. Looking first at the "indicator" component of "urban sustainability indicators," it is important to remember that most indicators are simplifications of complex phenomena. The term "indicator" should therefore be taken literally in the sense that it provides only an indication of conditions or problems (Whorton and Morgan 1975; Clarke and Wilson 1994). Since a single indicator will seldom be able to give the full picture, it is often useful to employ a wide range of indicators to characterize the different dimensions or aspects of a situation. Unfortunately, this requirement can conflict with the need to identify a fairly limited set of indicators for purposes of decision-making, and to minimize double-counting.

Urban sustainability indicators can be distinguished from simple environmental, economic, and social indicators by the fact that they are:

- integrating
- forward-looking
- distributional
- developed with input from multiple stakeholders in the community

All sustainability indicators should possess the last characteristic. It may not be possible to develop individual sustainability indicators that possess all of the first three characteristics, but they should possess at least one, and within a given set of sustainability indicators, all of these characteristics should be represented.

Integrating Indicators

Sustainability indicators are integrating in the sense that they attempt to portray linkages among the economic, environmental, and social dimensions of sustainability. One example of an integrating indicator might be the amount of "brownfield" land found in an urban area. This could be considered both as an indicator of industrial activity loss and as an indicator of environmental constraints on redevelopment (if the lands are contaminated). Still another integrating indicator would be the unemployment rate, since it is a measure of both economic stress and social stress. One of the integrating indicators used by Sustainable Seattle is the number of salmon returning to spawn in a representative sample of local salmon runs. This indicator is relevant for both an environmental condition (water quality) and an economic vitality condition (survival of one of the Seattle area's most important industries).

Composite indicators, which combine two or more individual indicators, can also be useful as integrative

indicators. For example, the cost of recycling per ton of waste recycled is a simple composite indicator that integrates economic and environmental considerations. Unfortunately, the construction of more complex composite indicators faces a number of methodological problems, including such issues as deciding how to weight the individual indicators, how to standardize different measurement units, and whether to choose a multiplicative or additive aggregation technique (Ott 1978; Innes 1990). Despite these problems, some composite indicators, such as the Human Development Index,[4] have gained considerable popularity because they reduce the information contained in several individual indicators down to a single number.

Forward-Looking Indicators

A second important characteristic of sustainability indicators is that they must be forward-looking if they are to be used in measuring progress towards achieving intergenerational equity. There are several different ways in which an indicator might be considered forward-looking. The simplest type of forward-looking indicator is a "trend indicator." A trend indicator describes historical trends and provides indirect information about future sustainability. For example, it is often obvious from examining historical trends that a development path followed in the past cannot possibly be sustainable into the future. However, because trend indicators provide only indirect information about the future, they are more useful for reactive than for proactive policy-making (Ruitenbeek 1991).

The forward-looking capabilities of trend indicators can be enhanced if they are linked to reference points that define intermediate or final steps in the move towards meeting sustainability goals. The two main types of reference points are targets and thresholds. Whereas targets are levels that must be met in the future if sustainability is to be achieved, thresholds are levels that should not be exceeded. Thresholds are scientifically determined and may possess regulatory status. Examples include air and water quality standards. Targets can be set in a fairly arbitrary manner either by using easily recognised numbers (e.g., reduce solid waste by 50 percent by the year 2000), by comparison to higher order jurisdictions (e.g., national or state means), or by comparison to social norms (e.g., the poverty level). A threshold, such as an air quality standard, also can be part of a target (e.g., zero exceedances of the standard by the year 2020).

The Oregon "benchmarks" are a well-known application of the use of targets for reviewing government accountability. In 1991, the Oregon Progress Board released its first benchmarks report, in which it identified 272 indicators of environmental, social, and economic well-being in that state (Oregon Progress Board 1991). The Board also specified a series of targets for each indicator, to be met at regular intervals up to the year 2010. They referred to these targets as benchmarks. The indicators in the report are primarily output indicators (e.g., number of households with drinking water that does not meet government standards) rather than input indicators (e.g., expenditures on water treatment facilities), and are being used to help set a broad range of program and budget priorities.

Both targets and thresholds are present in the Netherlands' national environmental policy indices. Each index has one or more policy targets set for specified future dates (e.g., the years 2000, 2010), and in some cases the index includes a longer-term "sustainability level" that is scientifically determined. For example, the Eutrophication Index, which measures releases of phosphates and nitrogen compounds to the environment, will reach a sustainable level when the excessive supply of phosphates and nutrients has been reduced enough that a balance has been achieved between supply and the removal from the environment of these two major contributors to eutrophication (Adriaanse 1993).

Another type of forward-looking indicator is the "predictive indicator." Predictive sustainability indicators rely on mathematical models for the future state and development of variables describing the environment, the economy, and society, or the linkages among them. Population levels and population growth are commonly used predictive indicators found in planning reports. Bratt (1991) notes that since all predictions are inherently disputable, the best that predictive indicators can do is to provide plausible information about future conditions. Only trend indicators provide scientifically reliable information, assuming that the data collection methods themselves were reliable.

The uncertainty inherent in predictive indicators points to the need for a third type of forward-looking sustainability indicator known as the "conditional indicator." Conditional indicators depend on a form of scenario development; they answer the question: "If a given indicator achieves or is set at a certain level, what will the level of an associated indicator be in the future?" This type of indicator attempts to overcome the difficulty that predictive indicators have in forecasting, by developing a range of forecasts or predictions. Table 1, taken from the British Columbia Round Table's State of Sustainability Report

(1994), provides an example of a conditional indicator of urban form. The "if" indicator is future residential density. The "then" indicator is the total amount of land that will be needed to accommodate the expected urban population of British Columbia in 2021 at each of these density levels. Two different measures of the land-area indicator are presented: the amount of land in hectares and the equivalent amount of land currently occupied by the City of Vancouver. The former measure may be most useful for planners, and the latter measure is probably more meaningful to the general public.

Distributional Indicators

Sustainability indicators must be able to measure not only intergenerational equity but also intragenerational equity. They should be able to take into account the distribution of conditions (social, economic, environmental) within a population or across geographic regions. Typically, spatially aggregated indicators fail to account for distributive effects. An example is GNP, which may increase even though economic conditions for many groups or different regions in the country are declining (Liverman et al. 1988). Disaggregating certain indicators for a community by such factors as age, gender, and location can help to overcome this problem.

Sustainability indicators should also be able to distinguish between local and nonlocal sources of environmental degradation, and between local and nonlocal environmental effects. A downstream community may generate very little pollution and display all the characteristics of a sustainable community-except for the fact that it suffers from significant upstream water pollution or upwind air pollution. The development of indicators that can identify pollution sources outside the local community's control will facilitate the formulation of appropriate policy responses to geographical inequities. Similarly, sustainability indicators should also measure the extent to which a local community contributes to environmental degradation in other communities, regions, or the world at large.

Multi-Stakeholder Input

A final characteristic that distinguishes sustainability indicators from other types of indicators is the manner in which they are developed. The history of the social indicator movement suggests that the most influential, valid, and reliable indicators have been those that were developed with input from a broad range of participants in the policy process (Innes 1990). This lesson is especially applicable to the development of sustainability indicators, since sustainability is such a value-laden and context-sensitive concept. It therefore makes sense to seek input on sustainability concerns and priorities from a broad range of stakeholders. This can be accomplished by assigning significant responsibility for selecting sustainability indicators to a broadly-based, multi-stakeholder group or by consulting in some other way with multiple stakeholders from the earliest stages of indicator development.

Steps in Developing an Urban Sustainability Report

One way to develop and present urban sustainability indicators is in the context of the larger process of reporting on urban sustainability. This process should ultimately produce a report that describes the indicators and indicates how they were chosen. However, a sustainability report should not be simply a descriptive tool. It should also evaluate whether the indicator results are showing progress towards or away from sustainability and suggest how or whether the indicators could be improved. It may also present recommendations about the kinds of policies or programs that are needed to improve progress towards the community's sustainability goals.

An adaptation of the common plan-formulation process serves as a useful template for developing urban sustainability reports. This adaptation, which is illustrated in figure 1, consists of eight steps from goal formulation through evaluation of indicator performance. The process contains several feedback loops and has been portrayed as circular in nature, since indicators must be updated regularly. Each of the steps in the reporting process is described in more detail in the sections that follow.

Step 1: Define the Urban Sustainability Goals for which Indicators are Needed.

These goals may have been specified already in other planning documents, or they may have to be developed especially for the sustainability report. Some jurisdictions (e.g., Regional Municipality of

Hamilton-Wentworth 1992; Alberta Round Table on Environment and Economy 1994) have found that a community visioning exercise can be a useful technique for articulating sustainability goals. The visioning exercise typically uses a multi-stakeholder, consensus-based approach to identify how a community should appear at some specified future date in order to be regarded as a sustainable community.

Step 2: Scoping

The scoping stage attempts to define the scope of the report by identifying the target audience and the associated purpose for which the indicators will be used. It also gives preliminary consideration to the approximate number of indicators that will be needed, and sets temporal and spatial bounds for the report.

Both the format for presenting indicators and the number of indicators selected will vary according to whether the target audience consists of scientists, policymakers, or the general public. Professional analysts and scientists may be more interested in raw data and a highly detailed set of indicators that emphasize scientific validity and system complexity, but these may not be easily understood by the nonspecialist. Policymakers may prefer information that is directly related to policy objectives, evaluation criteria, and target values. The media and the public may be most interested in a reduced set of indicators that are easy to understand and representative of the issues of most direct concern to them. An example of how a report prepared for one type of audience may not be as useful for other audiences can be found in the Sustainable Seattle report. The main target audience for this report and the main participants in the indicator selection process were individuals in the community. The report was not found to be particularly useful for local government, because it did not include indicators that could be used to measure the progress or lack of progress being made in achieving specific municipal policy goals. On the other hand, it did contribute to increased awareness of sustainability issues within local government and consideration of those issues in ongoing planning.

A second scoping task is to determine how many indicators are enough, and how many are too many, for the intended audience to absorb. For example, the British Columbia urban sustainability report, with its 90-plus indicators, has been criticized by some policymakers as containing too much statistical detail and being too daunting to use (West 1995, personal communication). In Seattle, where the target audience was primarily individuals in the community and the media, the first Sustainable Seattle report contained only 20 indicators.

A key question that has yet to be resolved is whether or not it is possible to develop a "core" set of urban sustainability indicators that could be used by all municipalities in a state, a country, or even internationally. Since indicator choices are shaped by community-driven sustainability goals, and these in turn are influenced by local environmental, economic, and social conditions, there may be considerable discrepancies among communities in terms of their preferred indicators. The search for core indicators is a search for certain fundamental indicators that are of concern to all communities, regardless of differences in their situational context or their sustainability goals. The unemployment rate and the waste generated per capita may be possible examples of core indicators. On the other hand, the amount of contaminated land in the community is an indicator that may have considerable importance in larger communities where hazardous waste-producing industries have been or are currently present, but be of much less interest in smaller, rural communities that have had little industrial activity.

The final two scoping tasks are temporal and spatial bounding. Temporal bounding is the identification of the time frame over which indicators are to be measured. For historical trend indicators, this requires a decision about how far to look into the past; for predictive and conditional indicators, it means deciding how far to look into the future. Spatial bounding identifies the geographical context for the report. Typically, the spatial bounds are defined by the administrative boundaries of the reporting unit. If geographical equity is a concern, then indicators are needed not only of conditions within that reporting unit but also of the interaction between that unit and other communities (i.e., imports and exports). Both the spatial bounds and the temporal bounds may have to be modified for some individual indicators if, after the final set of indicators has been identified, it becomes apparent that data for them is not available at the desired spatial or temporal scale.

Step 3: Choose an Appropriate Indicator Framework.

A review of current practice in state of the environment reporting, quality of life reporting, healthy city reporting and urban sustainability reporting points to six general frameworks that can be used for

developing sustainability indicators. These are: do-main-based frameworks, goal-based frameworks, sectoral frameworks, issue frameworks, causal frameworks, and combination frameworks. Examples of the first five frameworks are given in figure 2.

Domain-Based Frameworks. A domain-based framework starts with the key dimensions of sustainability (environment, economy, and society) and then identifies indicators for each. Some domain-based frameworks define additional dimensions of sustainability, such as health or governance. One of the best known examples of a domain-based framework can be found in Seattle's sustainability report. The sustainability "report card" for Seattle, shown in figure 3, lists 20 sustainability indicators and, for each indicator, assesses whether Seattle is moving towards or away from sustainability. The Seattle report card actually presents four dimensions of sustainability, but most of the indicators in the "Population and Resources" category could just as easily have been classified under the heading of "Environment."

A domain-based framework is most effective for ensuring coverage of the dimensions of sustainability. It can be modified to add categories for linkages among the three domains (e.g., environment-economy, economy-society) and thereby accentuate the integrative aspect of sustainability.

Goal-Based Frameworks. An important weakness of the domain-based framework is that it does not directly link indicators with sustainability goals. These linkages can be more clearly defined by using a goal-based framework. As its name implies, this type of framework first requires the identification of sustainability goals for a community and then creates one or more indicators for each goal or combination of goals. For example, the total area of contaminated land in a community could be considered a negative indicator for the goals of economic vitality (since contamination constrains the redevelopment potential of the land), environmental health (since the land is polluted and may be contributing to the pollution of groundwater or adjacent lands), and intergenerational equity (since future generations may have to bear the burden of cleaning up the land).

The United Kingdom's Local Government Management Board (LGMB) is an example of an agency that favors a goal-based framework. This agency has been active in developing sustainability indicators for local jurisdictions in the United Kingdom; its most recent study (LGMB 1993) chose the sustainability goals of "carrying capacity" and "quality of life" as the building blocks for its framework. The Board had considered using a domain-based framework (with categories for environment, economy, and society), but rejected this approach because it felt that the categories were so familiar that they would not be useful for helping people move towards a new way of thinking. The goal-based framework was felt to be more suitable for dealing with the distinction between local and global environmental issues. Quality of life was felt to be primarily affected by local issues, and carrying capacity was interpreted as a concept with implications broader than just for the local community. Figure 4 shows how the LGMB's sustainability goals are broken down into themes, subthemes, and then indicators. This hierarchical arrangement is a useful way of showing the relationship between sustainability goals and indicators when the number of indicators is large. Although the LGMB identified a menu of over 100 sustainability indicators, only selected examples are shown in the figure. The strength of a goal-based framework is that it reduces the number of indicators that have to be considered to only those relating to specified sustainability goals. Use of a goal-based framework and its explicit characterization of sustainability also help in evaluating whether indicators are showing movement towards or away from sustainability. The weakness of this framework, however, is that it is still a fairly simple one that does not capture some of the complex interrelationships among the various dimensions of sustainability.

Sectoral Frameworks. A sectoral framework develops indicators of sustainability for each sector over which municipal government typically has responsibility, such as housing, transportation, waste management, land use, and police services. Such a framework may be most appropriate when the chief target audience for sustainability reporting is municipal government politicians or staff. The sectors can be tied to individual government departments, making it easier to determine accountability for particular problems or credit for positive results revealed by the indicators. A disadvantage of the sectoral approach is that, because it compartmentalizes the indicators into specific areas of government responsibility, it is not very effective for showing linkages across different areas.

Issue-Based Frameworks. An issues framework is organized around a listing of the key sustainability issues in the community, such as waste management, air pollution, education, employment, etc. An issues framework may have more popular appeal than the other types of frameworks do, because it is readily understandable and easy to construct. However, a weakness of this framework is that the issues are typically identified in a "shotgun" manner, with no attempt to match indicators with sustainability goals or ensure coverage of the three dimensions of sustainability. This approach to developing

indicators therefore lacks the structure found in some of the other frameworks.

Causal Frameworks. Causal frameworks go beyond the taxonomic approaches of the preceding frameworks by introducing the notion of cause and effect relationships. State of the environment (SOE) reporting offers a good example of a causal framework. This framework, known as the condition-stress-response framework, provides a vehicle for answering the following four simple questions that lie at the heart of SOE reporting (Environment Canada 1991b):

- What is happening in the environment?
- Why is it happening?
- Why is it significant?
- What are we doing about it?

Within this framework, human activities are seen to act as stressors that affect environmental conditions, which in turn affect economic, health, and social conditions. Policy responses can alleviate the stressors or modify environmental conditions directly through restoration or clean-up programs. These relationships are illustrated in figure 5, and some examples of the types of linkages that can occur between human activity stressors and urban environmental conditions are shown in table 2.

The condition-stress-response framework has been used for international SOE reporting by the OECD (1985), for national SOE reporting by Environment Canada (1991b), and, most recently, at the local level by the Municipality of Metropolitan Toronto (1995). A causal framework such as this one has the significant advantages of being able to suggest why certain indicators are rising or falling and to show whether or not policy interventions are having an impact. The main difficulty with transferring the condition-stress-response causal framework found in SOE reporting to sustainability reporting is that the distinction between economic/social stressors and economic/social conditions is not always clear. In addition, the connection between these types of stressors and conditions may be considerably more complex than that between human activity stressors and environmental conditions.

Combination Frameworks. Many of the disadvantages of the individual frameworks described above can be overcome by using a combination framework. This type of framework brings together two or more of the individual frameworks and can therefore consolidate the advantages of several individual frameworks while simultaneously overcoming some of their weaknesses.

An example of a combination framework can be found in figure 6, which illustrates a model taken from the literature on quality of life reporting, known as the Community Oriented Model of the Lived Environment (COMLE). This model, developed by Murdie et al. (1992), contains three major segments, one for sectoral policies or programs, one for what they refer to as "components of livability" or the key dimensions of sustainability, and one for "indicators of livability" or subcategories of the sustainability dimensions. For the social well-being component of the housing sector, recommended subcomponents are affordability, suitability, adequacy, and accessibility. Each of these can be measured by one or more indicators. For example, a proposed indicator of accessibility is the waiting time for those applying for social housing, and for adequacy, it is the percentage of the housing stock requiring major repairs. Some sectors, particularly the natural environment, do not have linkages with all components of the livability segment.

Step 4: Define Indicator Selection Criteria.

In addition to a conceptual framework, the indicator selection process relies on a set of general selection criteria against which indicators can be evaluated. Unlike the guidance for indicator selection provided by a conceptual framework, general selection criteria have nothing to do with the sustainability properties of the indicators, but rather are related to their overall viability and validity. Commonly accepted indicator selection criteria can be found in the literature on social indicators (Hatrey et al. 1977), urban indicators (Schulman and Bond 1978; OECD 1978; UNCHS 1994), environmental indicators (Pocock 1981; Australian Government Publishing Service 1983; Council of Great Lakes Managers 1991; Forrest and Morrison 1991; Carruthers 1994; Environment Canada 1991a),healthy city indicators (Healthy City Toronto 1994; Flynn 1992), and sustainability indicators (Liverman et al. 1988; Bratt 1991; Gosselin et al. 1991; Hodge 1995). An examination of these criteria suggests that good sustainability indicators are those that are: scientifically valid, representative of a broad range of conditions, responsive to change, relevant to the needs of potential users, based on accurate and accessible data, based on data that are available over time, understandable by potential users, comparable with indicators developed in other

jurisdictions, cost-effective to collect and use, attractive to the media, and unambiguous. These criteria are not necessarily exhaustive, but simply the ones that have been most frequently used in the past and appear to be most appropriate for sustainability reporting. Additional criteria or modified criteria may be deemed appropriate for the needs of a particular municipality.

Step 5: Identify a Set of Potential Indicators.

Potential indicators can be identified by referring to sustainability or environmental reports produced by other jurisdictions. Experts should be involved at this stage because of their specialized knowledge. They can provide support to the nonexpert stakeholder participants, who will have their own suggestions for indicators and can also guide the experts to look for indicators that are easily understandable. Brainstorming sessions in a workshop format or questionnaire surveys of stakeholders in the community are useful ways to identify potential indicators at this stage.

Step 6: Evaluate the Indicators and Select a Final Set.

This step assesses each of the potential indicators against the selection criteria identified in Step 4 and in the context of the conceptual framework chosen in Step 3. The result is a subset of the final indicators that best meet the criteria and satisfy the requirements of the framework. Several approaches can be used to evaluate the indicators, ranging from the fairly simple to the more complex. A good example of a simple evaluation methodology is found in Carruthers' (1994) evaluation of proposed urban green-space indicators against a set of nine selection criteria.[5] His evaluation resulted in the identification of 22 indicators, out of an original set of 58, that met seven of nine selection criteria. All of the selection criteria were given equal weight in the evaluation, and all indicators were evaluated on a simple two-point scale ("present"-"absent"). More complex evaluation systems might weight the relative importance of selection criteria and measure indicator performance on three-point ("high"-"medium"-"low") or five-point scales.

Environment Canada (1991a) follows an iterative process for evaluating indicators, in which some selection criteria assume more importance than others at different stages of the selection process. During the early stages of the indicator selection process, evaluation is largely internal and the criteria of concern tend to be scientific validity, representativeness, responsiveness, data accuracy and availability. In the final stages of indicator selection, when external comments are invited from interested stakeholders, selection focuses more on user-related criteria, such as relevance to sustainability goals, comparability, relationship to thresholds/targets, and ease of understanding.

For the Regional Municipality of Hamilton-Wentworth, the indicator identification and evaluation process was heavily community-driven (Bekkring 1995, personal communication), with the aim of selecting indicators that were acceptable and understandable by the community. For example, the biotic health of fish in Hamilton Harbour was thought to be of less interest to the community or less interpretable by an individual in the community than was the number of sport fish there.

A key issue in performing evaluations of urban sustainability indicators is the possible existence of conflicts among the general selection criteria. It may not be possible to find an indicator that fulfills all of the general selection criteria simultaneously. For example, it is possible that some indicators found to be scientifically valid may not be as easily understandable or as relevant to the needs of potential users as some that are more intuitive and for which there is less scientific support. In such a case, decisions have to be made about the relative importance of the criteria. Because of the nature of the value judgements involved, these decisions are probably best undertaken by means of a consensual multi-stakeholder consultation process.

Once such decisions have been made, one of two general approaches can be taken to identify the preferred set of indicators. The evaluation performed by Carruthers (1994) is an example of a one-step procedure in which all the indicators were evaluated against all of the selection criteria simultaneously. The evaluation performed by Environment Canada (1994) is an example of a sequential procedure. With a sequential procedure, the most critical criteria or, sometimes, the more objective criteria are used during the first step of the evaluation, and different sets are used during later steps. Each step of the evaluation reduces the number of indicators requiring further analysis. The advantage of this approach is that stakeholder groups can be asked to review only the criteria that are of interest to them. For example, as discovered during the indicator selection process for the Regional Municipality of Hamilton-Wentworth, the general public is not knowledgeable about such criteria as data availability or accuracy and tend to be most likely to judge indicators on the basis of their ability to understand them.

The evaluation phase of the indicator selection process used by the Alberta Round Table on Environment and Economy in reducing its initial list of 850 suggested provincial sustainability indicators to a final list of 59 offers another approach: a hybrid sequential procedure. The distinguishing characteristic of this approach is that it allows for the introduction of new indicators at later phases of the evaluation if it becomes apparent that certain criteria are not being met by any of those in the initial set.

In the first phase of their evaluation, the Alberta Round Table used seven general criteria that had to be met by all indicators; there followed a second phase in which the indicators were rated according to attainment of the Round Table's vision principles (Alberta Round Table on Environment and Economy 1994). At that point, several new indicators were introduced, because it was discovered that some vision elements were not well covered by any of the indicators. The third and final phase of their evaluation was the most subjective: Round Table members had to determine whether the selected indicators were capable of adequately measuring progress towards the Round Table's vision.

Regardless of the complexity of the evaluation system chosen or the relative importance assigned to different selection criteria, an evaluation matrix is a useful way of organizing the information needed to evaluate urban sustainability indicators. Table 3 gives an example of an integrated matrix that structures the evaluation so it ensures that the demands of the general selection criteria and the indicator framework are met. This particular matrix has been designed for use with a domain-based, goal-based, and causal combination framework. The rows of the matrix cover key sustainability domains; the first set of columns determines whether the indicators meet sustainability goals; and the last set of columns checks to see that the indicators selected represent a balance of conditions, stressors, and responses. The middle set of columns contains the general evaluation criteria.

Step 7: Collect Data and Analyze the Indicator Results.

Once the data have been collected for each of the indicators, the next step is to determine whether or not the indicator results show that progress is being made towards achieving sustainability. This part of the sustainability reporting process can often be the most difficult, because not everyone may agree on the interpretation of a particular indicator. For example, to some people, rapid rates of economic growth in a community are good because they imply a healthy economy. To others, rapid growth can be undesirable because it may be accompanied by environmental degradation that outpaces the assimilative capacity of the natural environment. The value judgements that are made when evaluating indicator results should be clearly explained in the sustainability report.

Step 8: Prepare and Present the Urban Sustainability Report.

At the very minimum, the report should contain a description of the meaning of each indicator, why it is important, historical trends or anticipated changes, and an evaluation of whether the indicator is showing movement towards or away from sustainability. In order to emphasize the integrative aspects of sustainability reporting, it is also useful to have a discussion of the linkages among indicators. By way of illustration of the form that these descriptions can take, table 4 presents a description of two indicators (vehicle miles traveled and fuel consumption per capita) found in the Sustainable Seattle report.

Recommendations for improving data collection programs are an important output of the reporting process. Policy recommendations may also be included in the report. However, such recommendations may not be needed or even desired if the purpose of the report is to provide background material for a broader policy formulation process or a plan revision exercise. The policy recommendations are likely to come out of these activities rather than from the report itself.

The presentation format for an urban sustainability report can vary depending on the target audience. If the media and the general public are the main target audience, then a very effective communications tool can be a "report card," of the type used by Sustainable Seattle and also by the British Columbia State of Sustainability report. A short summary document can also be an important supplement to the report card to explain the rationale behind its conclusions. Finally, those requiring more detailed information can be referred to a technical report that contains all of the information called for in the preceding paragraphs.

Step 9: Assess Indicator Performance.

The purpose of this step is to determine whether the indicators are performing adequately in measuring what they were meant to measure. Assessment of indicator performance can be carried out periodically, as the indicator data become available. Since some of the data may be collected daily or monthly (e.g., water quality data) while other data may be collected only every few years (e.g., transportation surveys), assessment of the indicators may not be simultaneous.

Several questions can be asked about the indicators at this stage that, depending on their answers, may lead to the modification or elimination of existing indicators or to the selection of new indicators. For example, have data collection problems been encountered which have affected the quality of measurement of certain indicators? Is there improved scientific knowledge available that suggests some of the indicators are no longer valid? Do the indicators appear to be responsive to changing environmental, economic or social conditions? Does feedback from the target audience indicate that the indicators are clearly understandable? Has there been a change in the sustainability goals that the indicators are meant to measure? A positive answer to this last question could stimulate a new round of reporting. Requirements for periodic policy or plan reviews also may stimulate a new round of reporting.

Conclusion

Among certain communities in North America and the United Kingdom there is considerable interest in the development of urban sustainability reporting. Drawing on the limited experience of urban sustainability reporting activities in these jurisdictions, and on related types of environmental and social reporting theory and practice, this paper has proposed a process for developing urban sustainability indicators and preparing sustainability reports. Sustainability indicators and reports give communities an opportunity to evaluate whether local and nonlocal sustainability initiatives are having beneficial effects. Is sustainability reporting an effective tool for accomplishing this task? Unfortunately, it is too early to determine either the effectiveness of such reports in detecting progress towards sustainability or the influence that they are having on government and individual decision-making. However, the development of a structured process for sustainability reporting may encourage wider local adoption of such reporting and, eventually, the emergence of a more extensive track record for answering this question.

Although substantial progress has been made over the past few years in defining the concept of urban sustainability and in measuring it, several key methodological, theoretical, and practical questions still need to be answered in order to assist the growth of sustainability reporting and the development of useful sustainability indicators. For example, how many indicators does a community need to report effectively on sustainability issues? Of related interest is whether or not a core set of indicators is needed for sustainability reporting, so that municipalities can compare their progress with others'. Perhaps most importantly, a key area of future research will be the development of examples of "good," theoretically sound, sustainability indicators that meet as many general selection criteria as possible while satisfying the needs of a chosen conceptual framework and measuring sustainability goals.

The creation of a widely accepted set of sustainability indicators cannot be accomplished overnight. Economic, social, and environmental indicators have been in existence for many years and are still evolving. The development of sustainability indicators is an even greater challenge because of the complexity of the economic-environmental-social relationships involved and because of the absence of a commonly understood measurement unit comparable to the monetary units employed in economic indicators. Since sustainability reporting is still in its infancy, it is too early to say whether the phenomenon is likely to spread, particularly if local governments are afflicted by significant fiscal constraints. Although much work remains to be done, urban sustainability reporting has the potential to be an important new tool in planning for sustainability.

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NOTES

1. See, for example, Roseland 1992; Maclaren 1993; Oullet 1993; Tomalty and Pell 1994; Ontario Round Table on Environment and Economy 1995.

2. Geographical equity is a term coined by Haughton and Hunter (1995) to emphasize the undesirability of achieving economic growth or a higher quality of life in one community at the expense of environmental degradation in another. They assert that this form of development is inequitable unless some form of reparation or compensation takes place between the communities.

3. See, for example, Alberta Round Table 1991; Jacobs 1991; Hardoy et al. 1992; Richardson 1992; British Columbia Round Table 1994; Haughton and Hunter 1994; Beatley 1995.

4. The Human Development Index was developed by the United Nations Development Program (UNDP) for comparing human welfare levels in different countries. The index is an aggregation of four indicators: life expectancy at birth, adult literacy, average years of schooling, and GDP per capita. The UNDP publishes the index for all members of the United Nations in its annual "Human Development Report."

5. The selection criteria were: (1) scientifically valid, (2) having data availability over time, (3) responsive to changes in the environment, (4) representative, (5) understandable, (6) relevant to stated goals, objectives and issues of concern, (7) comparable to a target or threshold, (8) national in scope or applicable to regional environmental issues of national significance, (9) flexible enough to incorporate new scientific information and changing public perception.

TABLE 1. Land area needed for cities to serve additional British Columbia residents in the year 2021 at various residential densities

Legend for Chart:

A - Housing Density[1] (units per hectare)
B - Area Needed for Housing (hectares)
C - Area Needed for Other Urban Functions
D - Total Area Needed (hectares)
E - City of Vancouver Equivalents

A	B	C	D	E
1.4	479,000	240,000	719,000	64
2.3	290,000	145,000	435,000	38
6.5	103,000	52,000	155,000	14
9.5	70,000	35,000	105,000	9
18	37,000	19,000	56,000	5

Source: B.C. Round Table on Environment and Economy (1994)

1. From lowest to highest, these are the current densities, respectively, for the City of Kelowna, the City of Cranbrook, Greater Victoria, Greater Vancouver Regional District, and the City of Vancouver.

TABLE 2. Selected linkages between human activity stresses and environmental conditions

Legend for Chart:

A - CONDITIONS
B - STRESSES, Land Use Change
C - STRESSES, Contaminant Loadings to the Land
D - STRESSES, Contaminant Loadings to the Air
E - STRESSES, Contaminant Loadings to the Water

A
B
C
D
E

Soil Quality

Land-use change modifies the landscape, changing topography and removing topsoil. Urban development displaces the soil's potential as a renewable resource (e.g., agriculture, gardening).

Contaminant loadings to the land pollute the soil from activities such as landfilling, hazardous materials use, transport and storage.

Contaminant loadings to the air pollute the soil from atmospheric deposition of pollutant-laden suspended particulates.

Contaminant loadings to the water pollute ground water resources and impair soil quality.

Air Quality

Land-use change influences surrounding meteorological conditions, contributing to the urban heat-island effect. Land-use change influences local microclimate conditions, which can intensify air quality concerns (e.g., the canyon effect along streets).

Contaminant loadings to the land pollute the air from methane gas emissions released from waste disposal sites. Contaminant loadings to the land in the form of waste generation can contribute to degraded air quality conditions as wastes are incinerated.

Contaminant loadings to the air contribute to urban smog conditions, stratospheric ozone layer depletion, and global warming.

Contaminant loadings to the water contribute pollutants to the atmosphere from the incineration of sewage sludge Following waste water treatment.

Water Quality

Land-use change alters natural drainage patterns and interferes with the natural hydrological cycle.

Contaminant loadings to the land pollute the water through leachate migration into ground water and surface waters.

Contaminant loadings to the air pollute the water from atmospheric deposition of pollutant-laden suspended particulates.

Contaminant loadings to the water pollute the water from storm and waste water discharges.

Natural Resources

Land-use change consumes natural resources and decreases plant and animal habitat.

Contaminant loadings to the land bioaccumulate in species (e.g. pesticides) and degrade habitat.

Contaminant loadings to the air contribute to global warming and stratospheric ozone layer depletion, with their associated effects impairing habitat and species.

Contaminant loadings to the water degrade aquatic habitat and present opportunities for pollutant bioaccumulation.

Human Well-Being

Land-use change modifies the landscape and consumes resources, interfering with ability to enjoy and appreciate the environment.

Contaminant loadings to the land affect human well-being through contact with polluted soils and ingestion of pollutants through food.

Contaminant loadings to the air affect human well-being through inhalation of pollutants.

Contaminant loadings to the water affect human well-being through contact with and ingestion of food and water.

Source: Metropolitan Toronto Planning Department (1995)

TABLE 3. Urban sustainability indicator evaluation matrix

Legend for Chart:

A - Type of Indicator
B - Proposed Indicators
C - Sustainability Criteria, A
D - Sustainability Criteria, B
E - Sustainability Criteria, . . .
F - General Criteria, A
G - General Criteria, B
H - General Criteria, . . .
I - Condition
J - Stress
K - Response

A	B	C	D	E	F	G	H	I	K
Environmental	1								

	2
	. . .
Social	1
	2
	. . .
Economic	1
	2
	. . .
Environmental-Social	1
	2
	. . .
Environmental-Economic	1
	2
	. . .
Social-Economic	1
	2
	. . .
Environmental-Social-Economic	1
	2
	. . .

TABLE 4. Example of an indicator description from Sustainable Seattle

Indicator: Vehicle Miles Traveled and Feel Consumption per Capita in King County

Interpretation. Vehicle miles traveled have increased from 5,763 per capita in 1970 to 9,344 in 1991. Growth averaged about 150 miles per year from 1970 to 1985, and more than 200 miles per year between 1985 and 1991. Some change has taken place in the last three years, with growth leveling off and perhaps decreasing. Adding in the effect of population growth, total miles traveled almost doubled between 1970 and 1991. Increased fuel efficiency and improved emissions controls have helped to reduce some of the impact of this growth on air quality. Gasoline consumption per capita was about the same in 1991 as in 1980, and is slowly turning downward.

Evaluation. There are encouraging signs that we are beginning to level off and perhaps make small improvements in transportation use. If this pattern continues, we may be able to balance the effects of population growth. In the long run, however, more major changes in land use, vehicle technology, employment patterns, and vehicle-use habits are required in order to achieve sustainability.

Linkages. Vehicle use and gasoline consumption are links to excessive use of nonrenewable resources, pollution, loss of open space and wildlife habitat, decreased social health as a result of stress and pollution, and a declining sense of community. Many of these can be improved by switching transportation modes to more use of mass transit, walking and bicycling, as well as by increasing energy efficiency. Others may require action on land use and other social factors. An increase in the availability of affordable housing near work would make vehicle use less necessary. A stable population would also reduce sprawl and help make increases in vehicle use less likely.

Source: Sustainable Seattle (1993,19)

FIGURE 2. A typology of frameworks for sustainability indicators development

Domain Based

- Environment
- Economy
- Society

Goal Based

- Carrying Capacity
- Basic Human Needs
- Social Well-Being
- Economic Prosperity
- Participation in Governance
- . . .

Sectoral

- Housing
- Welfare
- Recreation
- Transportation
- Environment
- Economic Development
- . . .

Issue Based

- Urban Sprawl
- Solid Waste Management
- Crime and Safety
- Job Creation
- Industrial Pollution
- . . .

Causal

Conditions

- Air Quality
- Unemployment
- Human Health
- . . .

Stresses

- Automobile Use
- Inadequate Education
- Air Quality
- . . .

Responses

- High Occupancy Vehicle Lanes
- Special Training Programs
- Pollution Warnings
- . . .

FIGURE 3. Sustainable Seattle report card

Source: Sustainable Seattle (1993)

ENVIRONMENT

[a] Wild salmon runs through local streams

[b] Number of good air quality days per year

[c] Percentage of Seattle streets meeting "Pedestrian-Friendly" criteria

POPULATION AND RESOURCES

[a] Total population of King County

[b] Gallons of water consumed per capita in King County

[a] Tons of solid waste generated and recycled per capita per year in King County

[a] Vehicle miles traveled per capita and gasoline consumption per capita

[a] Renewable and nonrenewable energy (in BTUs) consumed per capita

ECONOMY

[b] Percentage of employment concentrated in the top ten employers

[c] Hours of paid work at the average wage required to support basic needs

[a] Percentage of children living in poverty

[a] Housing affordability for median- and low-income households

[a] Per capita health expenditures

CULTURE AND SOCIETY

[a] Percentage of infants born with low birthweight

[a] Juvenile crime rate

[c] Percent of youth participating in some form of community service

[a] Percent of population voting in odd-year (local) primary elections

[c] Adult literacy rate

[b] Library and community center usage rates

[c] Participation in the arts

[a] Moving away from sustainability

[b] Toward sustainability

[c] Neither toward nor away

CHART: FIGURE 1. Steps in the urban sustainability reporting process

CHART: FIGURE 4. Example of a goal-based framework: The United Kingdom's LGMB model

Source: Local Government Management Board 1994

CHART: FIGURE 5. Example of a causal framework: the condition-stress-response model

Source: Campbell and Maclaren (1995)

CHART: FIGURE 6. Example of a combination framework: the COMLE model

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