ENVIRONMENTAL SURVEYS AND INDICATORS - CONCEPTUAL AND METHODOLOGICAL CHALLENGES

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ABSTRACT

Statistics Canada has recently embarked on an expansion of its environmental statistics program that will see more than a doubling of the number of surveys and an increase in the output of derived statistical products such as indicators and accounts. For the first time, the agency will begin regular collection of environmental information directly from households. It is also proposing a significant foray into the collection of pollution emissions data from businesses. New indicators of environmental sustainability are already being produced jointly with Environment Canada and Health Canada. All of this work requires new thinking about the concepts and methods that underpin environment statistics. This paper will explore some of the more novel aspects of this new thinking.

KEY WORDS: Environment, greenhouse gases, ground-level ozone, natural capital, particulate matter, water,

RÉSUMÉ

Statistique Canada a récemment entrepris une expansion de son programme de la statistique de l'environnement, qui fera plus que doubler le nombre d'enquêtes et entraînera une augmentation des produits statistiques dérivés, comme les indicateurs et les comptes. Pour la première fois, l'organisme commencera la collecte régulière de données environnementales directement auprès des ménages. Il propose également une importante incursion dans la collecte de données sur les émissions de polluants auprès des entreprises. De nouveaux indicateurs de durabilité de l'environnement sont déjà produits conjointement avec Environnement Canada et Santé Canada. Tous ces travaux nécessitent une nouvelle façon de voir les concepts et les méthodes qui sous-tendent les statistiques environnementales. Cet article portera sur certains des aspects plus novateurs de cette nouvelle façon de voir.

MOTS CLÉS : Environnement, ozone troposphérique, particules, eau, gaz à effet de serre, capital naturel

1. INTRODUCTION

Determining whether society is on a desired course requires a measurement system that supplies decision makers with the signals they need to make effective choices. While one of the main roles of statistical agencies is to provide these signals, there are several areas that do not receive a sufficient amount of attention. The relationship between the environment and the economy is one area where there are many such gaps.

This paper provides a brief synopsis of the Canadian Environmental Sustainability Indicators (CESI), a joint initiative of Statistics Canada, Environment Canada and Health Canada. The CESI initiative's indicators and surveys illustrate several challenges associated with linking environmental and socio-economic data and analysis.

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1.1 Original Mandate

In 2000, Canada's federal budget included funding for the development of a small set of national indicators of sustainability. These indicators would track the impact of current economic practices on the natural and human assets that will be needed by future generations of Canadians. Observing that "we must come to grips with the fact that the current means of measuring progress are inadequate," the Minister of Finance stated that the indicators requested in this budget "could well have a greater impact on public policy than any other single measure we might introduce."

Statistics Canada, Environment Canada and the National Round Table on the Environment and the Economy were jointly charged with developing a short list of national indicators on sustainability. The National Round Table on the Environment and the Economy is an independent federal agency that advises federal decision makers and others on the best way to integrate environmental and economic considerations into decision-making. The National Round Table's role in this case was to assist in the initial development of the indicators.

1.2 The Capital Approach to Indicators

Based on the mandate provided by the 2000 federal budget, the role of the indicators was to supplement existing macro-economic indicators such as the GDP. The goal, in other words, was not to change how GDP or other major economic indicators are calculated but to provide other signals to assess the overall state of the economy. The indicators would help people to not only ask "how is the economy doing?" but to help answer the question "are we living at the expense of future generations?"

In order to best examine the Minister's question regarding the impact of today's economy on future generations, it was decided to focus on economic sustainability, where the continuation of economic production is to be desired, not because production is inherently good but because it contributes to human welfare. To do this, we need to maintain the means of production—or capital—intact over time.

Capital embodies much of what is necessary to create the flows of services and materials necessary for economic production, today and for the future. If capital is maintained constant or growing over time, then economic production, too, can be sustained over time.

The reality, though, is that not all types of capital are equally accounted for (Smith, Simard and Sharpe 2001). In the mainstream of modern economic thought, economic production is defined as being a function of four "primary" inputs or factors: labour (or human capital), produced capital (machinery and other durable goods), natural resources and land. Of these four, natural resources are the least represented from a statistical and economic standpoint.

While natural resources merit recognition in the production function because of their associated discovery and extraction costs, other uses of the environment for which there is no cost are not represented at all. For example, the free use of the environment as a sink for waste materials does not figure in the production function even though production clearly depends on the availability of this service. Without this type of ecosystem service (and many others provided at zero direct cost by the environment), producers would be forced to find other, more costly means of dealing with their wastes.

These indicators therefore, acknowledge the school of thought in which the environment is seen as comprising a variety of forms of capital that are just as important to the sustainability of the economy as are produced and human capital. These newly recognized forms of capital, which have come to be called collectively *natural capital*, are the source of the priced and unpriced environmental inputs upon which economic production depends. It is now increasingly recognized that natural capital must be maintained over time, along with produced and human capital, if the economy is to be sustainable.

Using this framework, Statistics Canada, Environment Canada and the National Round Table worked together to develop national indicators of capital focused on human and natural capital. Within the area of natural capital, there was a further emphasis on indicators related to the unpriced ecosystem services that are of value to the economy, but whose role is rarely acknowledged.

A suite of draft indicators was developed in six main areas of capital: renewable resources, non-renewable resources, ecosystem services related to air quality, ecosystem services related to water, land and ecosystems, and human capital. This work, which involved many governmental and non-governmental technical experts and stakeholders, resulted in the recommendation of six individual indicators in 2003, including five related to ecosystem services and one associated with human capital (NRTEE 2003):

Air quality: This indicator estimates the average Canadian exposure to ground-level ozone, and is more fully described in section 3.1.

Freshwater quality: This indicator reports on the suitability of a network of monitored bodies of water to support aquatic life, and is more fully described in section 3.1.

Greenhouse gas emissions: This indicator tracks the Canada's total greenhouse gas emissions, and is more fully described in section 3.1.

Forest cover: Canada's forests represent a valuable natural resource asset because of their production of wood and fibre, as well as their provision of wildlife habitat, recreational opportunities, and mechanisms to clean air and water and sequester carbon. This indicator would track changes in the extent of Canada's forests using a combination of satellite remote-sensing data and ground measurements.

Extent of wetlands: Wetlands provide many ecosystem services, including the filtration and purification of water, flood control, and the reduction of shoreline erosion. Like the forest cover indicator, this indicator would use satellite remote-sensing data to measure the extent of wetlands in Canada as well as the change in this area over time.

Educational attainment: This indicator was selected as a proxy for Canada's human capital. This indicator would measure the percentage of the population between the ages of 25 and 64 who have achieved post-secondary educational qualifications (e.g., vocational training, college or university degree).

2. OVERVIEW OF THE CANADIAN ENVIRONMENTAL SUSTAINABILITY INDICATORS INITIATIVE

As a result of the National Round Table's report, the 2004 federal budget announced funding for the reporting and development of three indicators – air quality, freshwater quality and greenhouse gas emissions. Forty-five million dollars were allocated over four years (from fiscal year 2005/2006 to fiscal year 2008/2009). This initiative eventually became known as the Canadian Environmental Sustainability Indicators (CESI).

Reflecting the collaboration that took place when the indicators were first developed, the CESI funds were divided between Statistics Canada, Environment Canada and Health Canada. These departments have jointly released two reports on the indicators, the first in December 2005 and the second in November 2006. The third report in the series will be released in fall 2007. All CESI documents can be found at www.statcan.ca/bsolc/english/bsolc?catno=16-251-X

Roughly consistent with the original mandate of the indicators, the stated intention of the CESI initiative is to provide Canadians with more regular and consistent information on the state of their environment and how it is linked with human activities. The term "human activities" is meant to include a variety of socio-economic issues.

CESI activities can be divided into three major categories:

i) Annual reporting and further development of the three indicators, which involves the participation of all three departments.

ii) Development and delivery of environmental surveys to gather data that will help interpret and analyse the three indicators, an activity conducted primarily by Statistics Canada with the input of Environment Canada, Health Canada and other relevant stakeholders.

iii) Improvements to relevant environmental monitoring systems; including, improved networks for monitoring fine particulates and water quality, and improved consistency in general environmental quality measurement and data processing across the country. This activity is conducted primarily by Environment Canada.

The four new CESI surveys (which are described in section 4.1) more than double the number of environmentally-related surveys conducted by Statistics Canada. These surveys have been designed to provide important contextual information to help interpret the trends of the three CESI. The surveys ask households, industries and farmers about behaviours that impact air pollution, water usage and pollution, and that lead to the emission of greenhouse gases.

3. ENVIRONMENTAL INDICATORS – SOME CONCEPTUAL AND METHODOLOGICAL CHALLENGES

3.1 Description of the CESI Indicators

Air quality indicators: The national air quality indicator initially recommended in the National Round Table report was a population-weighted warm-season average for ground-level ozone. As monitoring instrumentation improved, a similar population-weighted indicator for fine particulate ($PM_{2.5}$) levels was added to the 2006 CESI report.

These indicators are measures of *average long-term exposure* to two pollutants that have well-documented health impacts. Even low ambient concentrations of both of these substances are known to have negative health repercussions for some segments of the population.

Both air quality indicators are measures of an important service provided by natural capital: the provision of air that is clean and does not negatively affect human health. An indicator that would directly relate to human health risk based on pollution exposure is currently under development.

Freshwater quality: The national freshwater quality indicator provides a measure of the suitability of selected water bodies in Canada to sustain aquatic life. Although still an imperfect measure (based on reasons described more fully in sections 3.2 and 3.3), this is the first indicator to provide anything resembling a national picture of freshwater quality.

Clean water is a crucial ecosystem service that supports natural habitats as well as many economic activities. In fact, all three departments are working to extend the freshwater indicator to track the suitability of water for other beneficial uses, including agriculture, recreational activities, and source water prior to treatment for human consumption.

Greenhouse gas emissions: This indicator, calculated by Environment Canada as part of Canada's national inventory report on greenhouse gas sources and sinks (Environment Canada 2006), tracks Canada's total annual emissions of greenhouse gases, including carbon dioxide, methane, nitrous oxide, sulphur hexafluoride, perfluorocarbons and hydro fluorocarbons. The indicator reports aggregate emissions of all these gases in megatonnes of carbon dioxide equivalent.

This is the only indicator of the three that does not monitor ambient conditions. It is therefore a less direct measure of an ecosystem service than the first two indicators. In fact, this indicator does not track the ecosystem service itself – in this case, the provision of a stable climate – but rather the pressure placed upon this service.

3.2 Challenge 1 – Availability of High-Quality National Time Series

Several of the challenges associated with the CESI initiative are related to the national scope of these indicators. The development and reporting of national indicators of natural capital and environmental issues often encounter two major difficulties: i) the lack of availability of reliable environmental time series existing on a national scale (which will be examined in this section); and, ii) how to best aggregate any existing environmental data into an indicator that reflects the national condition (examined in section 3.3). Two indicators – the ground-level ozone air quality indicator and the freshwater quality indicator – provide an interesting contrast with regard to these two issues.

The ground-level ozone air quality indicator is based on a well-established, representative and consistent air monitoring infrastructure that has been in place since the 1980s. Historical data are therefore readily available, allowing the ozone indicator to start in 1990.

The freshwater quality indicator, on the other hand, uses data that stem from a patchwork of existing provincial and federal water quality monitoring initiatives. Created for varying reasons and dealing with different levels of resources, these monitoring systems are inconsistent in how monitoring data are collected. For example, sites are not all sampled with the same frequency, and different substances are monitored. To further complicate the situation, there exist important variations in the natural characteristics of different monitoring sites. A particular level of one substance that might indicate a problem in one site, could in another site be considered a natural background level.

Because of the *ad-hoc* nature of the existing freshwater monitoring system, the network is not representative of Canada and all its watersheds. Monitoring sites included in the CESI water quality indicator analysis are almost all located in either populated areas, or in areas where land uses such as agriculture or forestry could affect water quality.

Although data quality issues will continue to be concerns for the next few years, it is important to emphasize the fact that the CESI initiative has instigated successful working partnerships between Statistics Canada, Environment Canada, Health Canada and provincial agencies.

It is also important to emphasize that a significant proportion of CESI funds will go towards improvements to the air and water quality monitoring networks. As these are implemented, the challenges described above should be significantly reduced.

3.2 Challenge 2 – Weighting and Aggregation

The national air quality indicators and the freshwater indicator provide very different aggregation challenges, despite the fact that all are exposure indicators measuring ambient conditions.

The first aggregation challenge is how, or whether, to combine into one index measurements associated with different substances. The second, and probably the most important challenge, is how to use localized ambient concentration measurements as the basis for a nationally representative indicator. Both the air quality indicators and the freshwater quality indicator provide practical examples of both challenges.

Determining whether an indicator can combine different substances can be based on whether or not there exist any guidelines that provide a set threshold below which the substances in question no longer pose a threat. The existence of these types of guidelines can facilitate the aggregation of exposure data for these substances, in that an index can be devised that aggregates the difference between the measured concentration of a particular pollutant and its guideline.

However, this approach was not used with regard to air quality, where two separate indicators for ground-level ozone and for $PM_{2.5}$ are reported. The reason for separate indicators is due to the absence of guidelines indicating a threshold below which ground-level ozone and $PM_{2.5}$ do not affect human health. As noted above, current scientific thinking is that these lower thresholds simply do not exist, since some members of the population (such as those with respiratory conditions, the elderly and the young) are sensitive to very low concentrations of these substances.

On the other hand, the air quality data do lend themselves to methodologies that help aggregate the many measurements made at individual air monitoring stations into a useful national indicator.

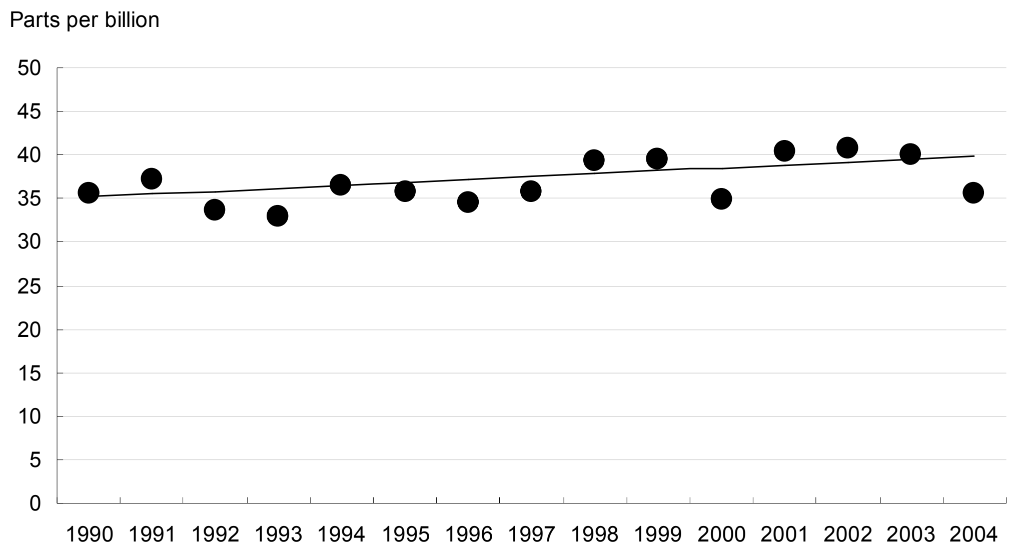
In order to better understand the national aggregation methodology associated with the CESI's air indicators, it is important to remember the role of these indicators. Unlike air quality advisories, which are designed to provide short-term warnings to the public about high-risk peak levels of air contaminants, the CESI air quality indicators reflect Canadians' day-to-day exposure to ground-level ozone and $PM_{2.5}$ over the long term.

For this reason, the CESI air quality indicators are based on average daily ground-level ozone and $PM_{2.5}$ concentrations measured during the warm season (April 1–September 30), which is also the time when Canadians are most active outdoors and when ground-level ozone concentrations are highest. It should be noted that while winter $PM_{2.5}$ is also a concern, current monitoring methods present challenges with instrument variability in cold weather. For this reason, warm-season $PM_{2.5}$ data only have been used in the CESI reports so far.

The question then becomes how to meaningfully aggregrate the average seasonal concentrations of ground-level ozone and $PM_{2.5}$ as measured at individual air monitoring stations. One problem stems from the fact that the number and distribution of network monitoring stations is not in direct proportion to the total population in each area. For this reason, the seasonal averages are weighted by population to provide a more relevant estimate of the potential human exposure to both types of air contaminant. The population-weighted concentration is calculated by estimating the number of people living within a 40-km radius of each monitoring station, and then using this population as a weight when determining the warm-season average of the ambient concentrations.

Figure 1 shows the ground-level ozone indicator as it appeared in the 2006 CESI report. It shows that, while average exposure to ozone fluctuates on a year-to-year basis, there has been a long-term increase of 0.9 percent a year based at a 90% confidence interval.

Figure 1: Ground-level ozone indicator, Canada, 1990 to 2004

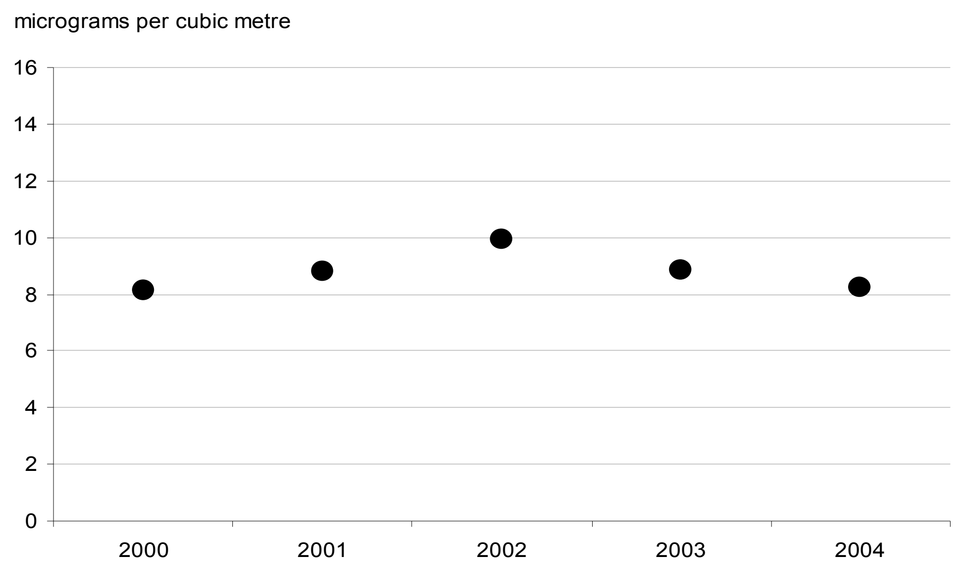


Notes: The indicator is a population-weighted estimate based on data from 76 monitoring stations. The trend line represents the average rate of change based on the Sen method. The average rate of change is 0.9% per year, with a 90% confidence interval between 0.1% and 1.6% per year.

Source: Government of Canada, 2006. *Canadian Environmental Sustainability Indicators 2006.* .

Figure 2 shows the $PM_{2.5}$ indicator as it appeared in the 2006 CESI report. Because extensive monitoring of $PM_{2.5}$ only started in 2000, the time series is much shorter. No trend is evident in the data.

Figure 2: Fine particulate ($PM_{2.5}$) indicator, Canada, 2000 to 2004



Notes: The indicator is a population-weighted estimate, based on data from 63 monitoring stations across Canada. The limited number of years that contributed to this indicator (2000 to 2004) does not permit trend analyses.
Sources: Government of Canada, 2006. *Canadian Environmental Sustainability Indicators 2006.*

The aggregation method for the freshwater quality indicator differs significantly from those of the air quality indicators. On the one hand, guidelines related to a variety of substances necessary for protecting aquatic life do exist. This allows for an aggregation method that tracks whether, and to what extent, measured substances fail to meet the set guidelines. This methodology, developed by the Canadian Council of Ministers of the Environment, is called the Water Quality Index (Environment Canada, Health Canada, and Statistics Canada 2006).

On the surface, the existence of the guidelines for the protection of aquatic life and the Water Quality Index methodology seem to solve the problem of how to combine the ambient measurements of many substances as measured in many different water monitoring stations throughout Canada. However, the situation is complicated by the fact that many experts in the field consider that guidelines should not be national in scope, but should be site-specific. In some areas of Canada, for instance, the background concentrations of some naturally-occurring substances (e.g. metals) exceed the national or provincial guidelines. Do these situations denote a problem or simply a natural characteristic of the site in question? While local experts can help assess the answer to this question, such a site-by-site assessment creates significant challenges with regard to the determining how consistently the aggregation methodology is applied.

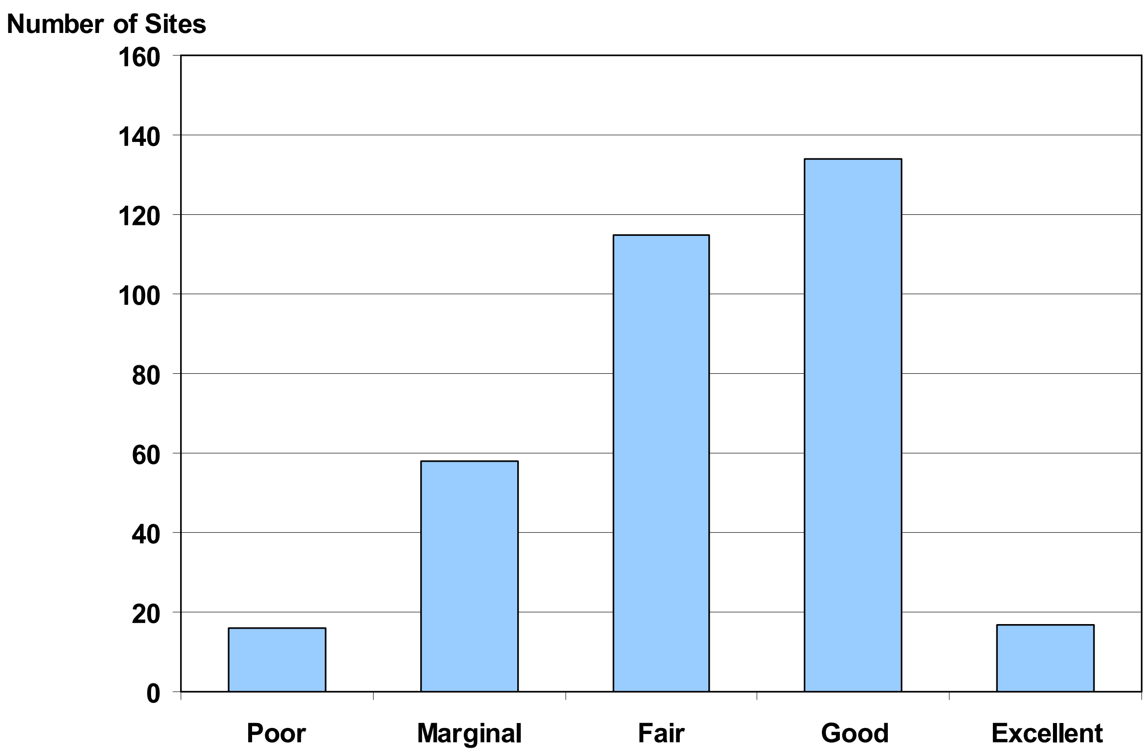
Since 2005, much effort has been aimed at working with representatives of the monitoring initiatives to enhance consistency of approach and replication of methods, all the while accommodating reasonable differences in the application of the Water Quality Index (Environment Canada and Statistics Canada 2007).

The second indicator challenge – that of providing a meaningful national picture – is one that will require further effort for the water quality indicator. As noted in section 3.2, this indicator is based on a national monitoring network that is made up of many different federal, provincial, and joint water quality monitoring initiatives. Available freshwater quality data from this network is not representative of all of Canada's major drainage basins, of its major types of land use, distribution of key species of aquatic life, or the distribution of the human population. The application of any weighting methodology is complicated by the fact that the indicator measures the suitability of water for aquatic life. Therefore, weighting by population (as with the air indicators) is not the obvious answer.

Figure 3 shows the indicator in its current form, which essentially provides a snapshot of the state of the water bodies monitored in a three year period (2002 to 2004). This rolling three-year period is necessary, since the number of monitoring samples taken in any given year is not great enough to provide good representation of the various monitoring stations. Also, annual fluctuations in weather can have a considerable impact on water quality, and consequently on the index findings when applied for individual years.

Although a similar graph appeared in the 2005 report (using data from 2001 to 2003), the changes in the location of the monitoring sites and the aforementioned data quality problems all make it impossible to compare the indicator from one period to the next. Statistics Canada is leading an effort to calculate the Water Quality Index using a set of common guidelines and data for a sub-set of water quality monitoring stations that have, over the years, maintained consistent sampling and monitoring practices. This would allow year-to-year comparisons for at least this sub-set of monitoring stations.

Figure 3: Status of freshwater quality at sites in southern Canada, 2002 to 2004

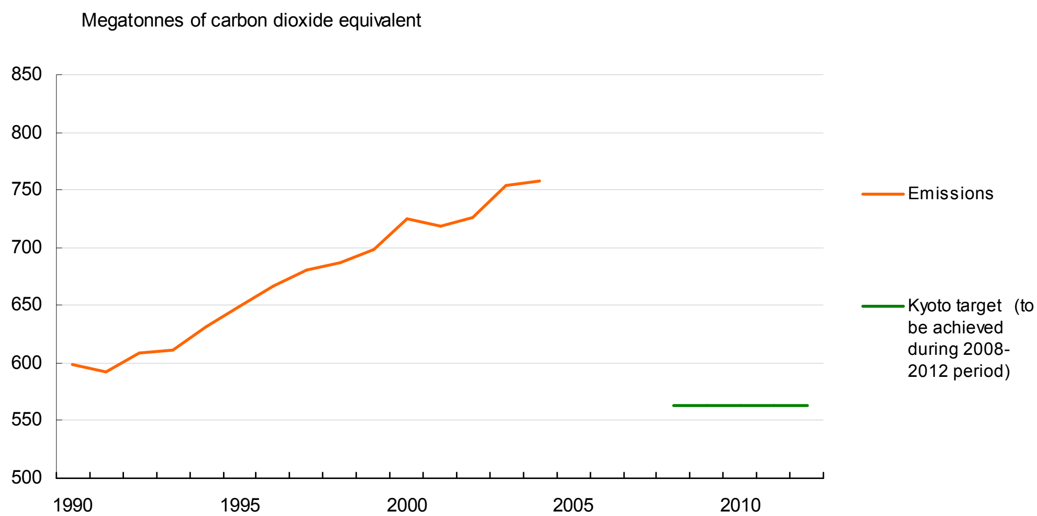


Notes: The results are for surface freshwater quality with respect to protecting aquatic life. They do not assess the quality of water for human consumption. Number of sites is 340.
Sources: Government of Canada, 2006. *Canadian Environmental Sustainability Indicators 2006.*

The third and final indicator, which tracks Canada's total greenhouse gas emissions, is associated with fewer aggregation problems since it simply tallies the total amount of relevant emissions. Furthermore, these emissions impact the environment on a global rather than a local scale.

Figure 4 shows the greenhouse gas indicator as it appeared in the 2006 CESI report.

Figure 4: Greenhouse gas emissions, Canada, 1990 to 2004



Source: Environment Canada. 2006. *National Inventory Report: Greenhouse Gas Sources and Sinks in Canada, 1990–2004.* Greenhouse Gas Division, Ottawa, Ontario quoted in Government of Canada. *Canadian Environmental Sustainability Indicators 2006.*

4. ENVIRONMENTAL SURVEYS – SOME CONCEPTUAL AND METHODOLOGICAL CHALLENGES

4.1 Description of the CESI Surveys

In addition to providing national indicators of environmental sustainability, the second feature of the CESI initiative is the collection of new socio-economic data to allow for better analysis of environment-human activity linkages. As described in Section 2, one of Statistics Canada's main contributions to the CESI initiative is the administration of four surveys to provide these new socio-economic data.

Three of the four new surveys are focused on water use and quality. The fourth, which surveys households, pertains to air quality, water quality and greenhouse gas emissions. The following provides a brief overview of each survey.

Drinking Water Treatment Plant Survey: This survey provides data on ambient and treated water quality from drinking water plants and sewage treatment plants. The first iteration of the survey will focus on drinking water plants. The data collected will provide an improved basis for a national indicator of drinking water source quality and for other statistical measures of the links between human activity and environmental quality. The methodology for the Source Water Quality Indicator is being developed by Health Canada as part of the CESI initiative. The survey will be administered for the first time in 2008.

Agricultural Water Use Survey: This survey supports the indicators initiative with estimates of agricultural water use for irrigation and other purposes. The survey will allow better understanding of the impact of irrigation on crop yields and improve the knowledge of the efficiency of the agricultural sector's water use. The survey will be administered for the first time in 2008.

Industrial Water Use Survey: This survey provides information about the quantities of water consumed in the mining, manufacturing and thermal power industries and the associated costs, treatment and discharge of water. Further information on the Industrial Water Survey can be found at www.statcan.ca/cgi-bin/imdb/p2SV.pl?Function=getSurvey&SDDS=5120&lang=en&db=IMDB&dbg=f&adm=8&dis=2 Additional industries will be surveyed in subsequent years. The survey was administered for the first time in 2006. It will be repeated in 2008 and every two years thereafter.

Households and Environment Survey: This survey provides context to the indicators through data on household behaviour and practices with respect to the environment. It examines a variety of environmental practices, including:

- consumption and conservation of water
- energy use and home heating
- gasoline powered equipment use
- pesticide and fertilizer use
- recycling, composting and waste disposal practices
- air and water quality
- transportation decisions

For the survey results of the 2006 survey and other information, see www.statcan.ca/bsolc/english/bsolc?catno=11-526-XIE. The survey was administered for the first time in 2006. It will be run again in 2007 and every two years thereafter.

4.2 Challenge 1 – Estimating Physical Measurements

All four CESI surveys aim to examine how respondents either use key types of natural capital (such as water) or how their behaviour affects natural capital (such as burning fossil fuels).

In many cases, these surveys attempt to collect data on actual consumption of resources. However, survey respondents often do not keep close track of the amounts or the value of the resources they use.

Measuring water use is a particular challenge. The Agricultural Water Survey, for instance, is confronted with a situation where water-use permits are granted to farmers, but where actual use is not always monitored. Questionnaire development and testing of the Industrial Water Survey found that in most cases where businesses were paying for their water supply they were able to report on their level of use. In cases where water was self supplied or supplied at a flat rate there was less likelihood that flow rates were tracked.

Innovative techniques are being used in the surveys to help respondents estimate their resource use . The Household and the Environment Survey, for example, uses pictures to help respondents determine how much wood their wood stove uses and to help navigate the distinctions between different types of windows. The survey also seeks permission from the respondents to obtain information on energy use from utility companies in cases where the respondent cannot provide these data directly.

4.3 Challenge 2 – Use of Non-Standard Geographic Units

To support analysis of water use and other environmental issues, Statistics Canada, Natural Resources Canada and Environment Canada developed the Canadian Digital Drainage Area Framework, a geographic database of the drainage areas, river networks, lakes and islands in Canada. Drainage areas describe where surface water naturally collects. They are well-defined by physical geography and constant over time, which makes them useful for analyzing trends.

The framework defines a hierarchy of drainage areas that begins with Canada's five major ocean drainage areas and descends to about 1,000 smaller sub-sub-drainage areas.

The drainage area framework can be used to illustrate not only the availability of water resources, but also where and how human activity may impact water supplies and quality. Many watersheds contain dams, diversions and water intakes that provide water for agriculture, industry, hydro-electricity and drinking. Pressures on the water supply are further increased by municipal wastewater, industrial effluent, fertilizers, pesticides and other pollutants.

In order to capitalize on the analytical potential of the drainage area framework, data must be collected so that they may be aggregated according to basin boundaries. A challenge with regard to the new surveys is to create a cost-effective sampling strategy using existing survey methods and infrastructure (e.g., the business register), that will provide data at this level of geographic detail without encountering problems of data confidentiality.

5. MESHING ENVIRONMENTAL AND SOCIO-ECONOMIC DATA

The final challenge discussed here is how to best integrate the CESI indicators with Statistics Canada's rich array of socio-economic data. One way to do this is to build upon the existing System of National Accounts to include broader measures of natural capital. This is what is termed a "system of environmental and economic accounts" (United Nations et al. 2003). While such a system provides an internationally agreed-upon approach to linking environmental data with the national accounts, there remain many challenges in actually putting these accounts into place. Once again, the case of water provides a concrete example.

Ideally, a full system of environmental and economic accounts for water would contain the following:

- stocks and flows of water resources and emissions within the environment;
- the supply of water and the use of water as input in the production process and by households;
- the costs of collection, purification, distribution and treatment of water as well as the service charges paid by the users and the identification of who is paying for these services;
- the payments of permits for access for abstraction or use it as sink for discharging of wastewater;
- the hydraulic stock in place as well as investments in hydraulic infrastructure during the accounting period.
- accounts that present water resources in terms of quality
- accounts that present water resources in terms of its monetary value

The CESI indicators and surveys discussed in this paper could all contribute to assembling such a system and some of this work is already underway at Statistics Canada. Progress has been made, for example, with regard to creating accounts that link greenhouse gas emissions with economic activity through the framework of the input-output tables.

But while much work has been completed in this area, incorporating water quality data into the environment-economy accounting framework remains a challenge. On the other hand, the example of water quality can also be seen from a positive perspective. At the start of the millennium, there existed no national information of any kind relating to freshwater quality. Through the CESI initiative, much has been done to improve upon this situation by building relationships with other departments and jurisdictions and by collecting new data.

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