**STATISTICAL COMMISSION and**
**ECONOMIC COMMISSION FOR EUROPE**

**CONFERENCE OF EUROPEAN STATISTICIANS**

**Joint ECE/Eurostat Work Session on Methodological Issues of Environment Statistics**
**(Ottawa, Canada, 1-4 October 2001)**

**COMMISSION OF THE**
**EUROPEAN COMMUNITIES**

**EUROSTAT**

**WORKING PAPER No. 24**

**ORIGINAL: ENGLISH**

# DEVELOPING ENVIRONMENTAL PUBLIC HEALTH INDICATORS IN CANADA

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[1] This paper is draft only and has no official status.
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# 1. Introduction

## 1.1 Background

At the national level, economic performance has long been measured in terms of GDP, the inflation rate, the unemployment rate, etc. Such indicators continue to influence major decisions made by individuals, corporations and governments. Based on this success and the need for succinct information, indicators in other areas have proliferated in recent years. A number of social and environmental indicators projects have been led by United Nation agencies or other international organizations such as the OECD. Over the past decade, governments at various levels have at least initiated the development of various sets of indicators. Work continues on many fronts including various aspects of both environment and health.

As Trevor Hancock has noted, “in recent years there has been a growing interest in measuring health itself, as a state of complete physical, mental, emotional, spiritual and social wellbeing” (Hancock 2000: 3). The potential negative impact of the environment on human health has long been a policy concern, but medical research in recent years has sharpened and heightened debate. This has resulted in widespread agreement on the need to better understand and frame the relationship between environment and health by developing a set of indicators to help assess risks and negative impacts. However, the process involved in developing environment-health indicators is complex, as it involves multiple issues and interests.

In January 2000, a group of Environment Canada (EC) and Health Canada (HC) officials and the Canadian Institute for Health Information (CIHI), met to assess the need and potential for developing a framework and set of environmental public health indicators for use in Canada. That meeting decided to move forward on this work, beginning with collaboration between environment and health departments. A Steering Committee was created, chaired by the Policy Research Directorate, Environment Canada and the Environmental Health Directorate, Health Canada, to embark on a project to determine a set of core indicators that link environmental factors to health outcomes. A Working Group was created to prepare the present framework paper with a view to holding an expert workshop on this topic in October 2001.

## 1.2 Better environmental health information

Polls conducted for the Government of Canada showed that Canadians consistently reported a high degree of concern for hazards and exposures to their health from environmental causes. Canadians want more and better information — easily understood, readily available and widely disseminated — to help them make better decisions on things that affect their health.

*Environmental Health Reporting*

At a public policy level, there is a strong desire to improve understanding of the various relationships between human health and the environment, as well as to ensure that the data and information systems required to support our understanding are functioning well. Therefore, public policy managers, scientists and information users seek to further develop our capacity to understand, analyze and report on these issues to Canadians.

The development of environmental health indicators will enable:

- monitoring trends in the state of the environment, in order to identify potential risks to health;
- monitoring trends in human health resulting from exposures to environmental risk factors;
- determining potential links between environment risks and health effects as a basis for informing policy-makers;
- monitoring and assessing the effects of policies or other interventions on environmental health;
- comparisons across different regions;
- providing information to the public and help create a better informed public; and
- raising general and specific awareness about environmental health issues across different decision-maker and stake-holder groups.

*Accountability and transparency*

Federal departments and agencies have obligations to provide status reports and information to Parliament and to Canadians. Specifically, in 1995, the Government of Canada committed itself to implementing results-based management in all federal departments and agencies. Since 1998, annual *Departmental Performance Reports* and *Reports on Plans and Priorities* have been prepared by all federal departments and agencies. These are part of the new federal management framework, *Results for Canadians: A Management Framework for the Government of Canada* (TBS 2000). In the past, efforts for performance measurements were largely based on internal actions rather than on action impacts and outcomes. Indicators, where available, enable a level of transparency in environmental reporting not previously possible.

*Setting and evaluating objectives*

Indicators can help set and evaluate goals. Once a goal has been clearly identified and an indicator, with available data, is attached to it, it can be evaluated over time. This allows for tracking of specific issues over time, and for goals to be re-evaluated, as needed. Careful attention to continuity is needed. As goals evolve, there is a need to ensure that corresponding measures and data keep pace. In this direction, Canada's Budget 2000 made explicit provision "to develop a set of indicators to measure environmental performance in conjunction with economic performance".

*Science-policy interface*

Indicators can help support an integrated management system (e.g., total quality management). The maxim: "You can't manage what you can't measure" is increasingly salient in the policy world and this requires tools to effectively communicate scientific data and assessments. Environmental science and monitoring can provide the raw material (ie., data). Transforming this data into indicators can effectively link this knowledge to policy. Indicators are one of the best ways to credibly and transparently connect science and policy.

### *1.3 Audience*

There are multiple intended audiences with needs for different types of indicators and each has particular uses. The development of a national set of environmental-health indicators seeks to address the requirement of various needs. The workshop discussed below will include this aspect as a central theme. Three major audiences include:

1. Policy-makers at various levels in government, including municipalities, who need this information to assess, compare and communicate priorities;
2. Canadian public, for whom the indicators should be useable as means to report on the general state of environmental health;
3. Producers and users of environment-health information, who generate and manage data through surveys, remote sensing or monitoring and those of transform, interpret and assess data to provide information to decision-makers. An information user is typically a senior policy maker, for example, business and industry leaders, senior officials of agencies and organizations, or economic and investment decision-makers (e.g., users of the Health Indicators Framework developed at the National Consensus Conference on Population Health Indicators by CIHI in May 1999). It is recognized that further work will be required to help this audience effectively use indicators as "early-warning" signals for management and implementation.
4. Government, business and industry, non-governmental organizations and academia for a variety of other uses.

### *1.4 Building on existing work and consultation*

The objective of this project is not to start from scratch but to review what has been done, learn from those experiences and tailor them to the Canadian setting.

Back in 1990, a workshop on Environmental Health Status was held in Ottawa and coordinated by the Institute of Risk Research, co-sponsored by the then Health and Welfare Canada and Statistics Canada. The federal government has continued and strengthened its interest in developing environmental health indicators. On May 4, 1999, CIHI), a federal organization responsible for the development of Canada's health information system, in cooperation with the Federal/Provincial/ Territorial Advisory Committees on Population Health and Health Services, Health Canada, and Statistics Canada, convened a *National Consensus Conference on Population Health Indicators* to identify measures for reporting in the health of Canadians and the health system (CIHI, 1999). The consensus conference confirmed a number of indicators related to health status, non-medical determinants of health, health service performance, and community and health system characteristics, primarily intended to support regional health authorities in monitoring progress in improving and maintaining the health of the population and the functioning of the health system for which they are responsible. However, a gap was identified for environmental factors of non-medical determinants of health. Additional technical information about the CIHI indicators is contained in a subsequent publication by Statistics Canada and CIHI (2000).

The development and use of various types of indicators has become widespread in many domains, including those of health and the environment. Recently, a number of efforts to develop indicators to focus on the intersection of these two domains –environmental health—have started. These efforts include work at the international and European levels through the World Health Organization (WHO 2000), the US level through the Centers for Disease Control and Prevention and partners (CDC *et al*. 2000), and the Canadian level through various research efforts, which culminated in the October 2000 Conference on Environmental Health Surveillance held in Quebec City. At the Provincial level, the Government of British Columbia has begun work to explore the potential for developing environmental health indicators. Work as has also been done at the municipal level, including that of the Canadian Federation of Municipalities and the Canadian Mortgage and Housing Corporation (FCM & CMHC 1995).

A subsequent workshop, coordinated by the International Joint Commission (IJC), was held in Quebec City in October, 2000. The conference brought together public health professionals, scientists, and policy makers to make progress towards developing consensus on minimal sets of indicators for public health and environmental surveillance and to prioritize indicators for future development. Many valuable think pieces were prepared for this workshop and are being used in the development of this framework paper.

At the international level, the World Health Organization's report *Environmental Health Indicators: Framework and Methodologies (1999),* establishes a set of indicators for monitoring trends in environment and health. At the European regional level, has applied this methodology to a range of environmental health issues (WHO 2000). Another international initiative, the Arctic Monitoring and Assessment Programme (AMAP) is carrying out important research and reporting on the status of and threats to the Arctic environment, which includes the health effects of pollutants in the Canadian and regional areas of the Arctic (AMAP 1997).

## 2. Human health and the biophysical environment

### *2.1 What is environmental-health?*

The World Health Organization has long defined environmental health in terms of the health consequences of interactions between human populations and the whole range of natural, and built and social environmental factors. The Federal, Provincial and Territorial Advisory Committee (1996) identified at least five key determinants of health:

- living and working conditions;
- physical environment;
- personal health practices and coping skills;
- health services; and
- biology and genetic endowment.

The Canadian Institute for Health Information (CIHI), developed a set of consensus-based Health Indicators (CIHI, 2000). This provides a set of indicators which measure the health of the Canadian population and the health care system. Environmental factors are identified within this indicator set as part of the "non-medical determinants" of health. Therefore, environmental factors are only one of a number of determinants of health within a much broader context (Table 1).

| Health Status | | | |
|---|---|---|---|
| **Well-Being** | **Health Conditions** | **Human Function** | **Deaths** |
| • Self-rated health<br>• Self-rated ‘excellent’ health for 2 consecutive survey cycles<br>• Self-esteem<br>• Mastery | • Low birth weight<br>• Overweight<br>• Arthritis<br>• Diabetes<br>• Asthma<br>• High blood pressure<br>• Cancer incidence<br>• Chronic pain<br>• Depression<br>• Injury hospitalizations<br>• Food and waterborne diseases | • Functional health<br>• Disability-days<br>• Activity limitation | • Infant mortality<br>• Perinatal deaths<br>• Life expectancy<br>• Total mortality<br>• Circulatory deaths<br>• Cancer deaths<br>• Respiratory deaths<br>• Suicide<br>• Unintentional injury deaths<br>• AIDS deaths<br>• Potential Years of Life Lost |

| Non-Medical Determinants of Health | | | |
|---|---|---|---|
| **Health Behaviours** | **Living and Working Conditions** | **Personal Resources** | **Environmental Factors** |
| • Smoking rate<br>• Youth smoking rate<br>• Smoking initiation (average age)<br>• Quitting smoking<br>• Regular heavy drinking<br>• Physical activity<br>• Breastfeeding | • High school and post-secondary graduation<br>• Unemployment rate<br>• Long-term and youth unemployment<br>• Low income rate<br>• Children in low income families<br>• Average personal income<br>• Income inequality<br>• Housing affordability<br>• Crime rate and youth crime rate<br>• Decision-latitude at work | • School readiness<br>• Social support<br>• Life stress | **(SEE LINK BELOW)** |

| Health System Performance | | | |
|---|---|---|---|
| **Acceptability** | **Accessibility** | **Appropriateness** | **Competence** |
| | • Influenza immunization, 65+<br>• Screening mammography, women age 50-69<br>• Pap smears, age 18-69<br>• Childhood immunizations | • Vaginal birth after caesarean<br>• Breast-conserving surgery<br>• Caesarian sections | |
| **Continuity** | **Effectiveness** | **Efficiency** | **Safety** |
| | • Pertussis<br>• Measles<br>• Tuberculosis<br>• HIV<br>• Chlamydia<br>• Pneumonia and influenza hospitalizations<br>• Deaths due to medically-treatable diseases<br>• Ambulatory care sensitive conditions | • Surgical day case rates<br>• May not require hospitalization<br>• % Alternate level of care days<br>• Expected compared to actual stay | • Hip fractures |

| Community and Health System Characteristics | |
|---|---|
| • Population<br>• Percent population age 65 or older<br>• Percent ‘urban’ population<br>• Percent aboriginal population<br>• Percent immigrant population<br>• Teen pregnancy/teen births | • CABG rates<br>• Hip replacement<br>• Knee replacement<br>• Hysterectomy<br>• Myringotomy |

| | |
|---|---|
| • Expenditures per capita<br>• Doctors (FP/GP and Specialists)<br>• Nurses per capita | |

*Table 1: Health Indicators*

However, even when the focus is placed on environmental influences as determinants of human health, the range of factors remains very large. Environmental factors include a very broad range of biophysical and built (human-made) influences as determinants. This framework paper takes only a sub-set of these influences as a starting point for work on environmental health indicators, while clearly recognizing that these fit within the broader context outlined above. The focus here is on the biophysical world that we interact with, including air, water, land and plants and animals (the latter especially as sources of food in this context). Figure 1 below shows the focus. This approach is compatible with a vision of the whole, focuses development and analysis on its various components.[2]

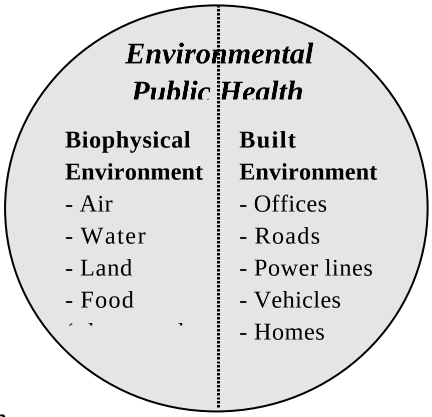


*Figure 1: Built versus non-built components of environmental health*

## 3. Getting the right indicators, and getting the indicators right

As Eyles and Furgal (2000: 5) have noted, to track all the relationships between environment and health would be an endless task: "Therefore, measurements that are indicative of the relationships and impacts we are concerned about, or interested in, are chosen as "indicators" of the status of these relationships and their impacts".

Dr. David Briggs, one of the main authors behind much of the WHO work, has summarized the basic characteristics of "good" environmental health indicators as follows:

[2] It should be noted that there can be significant overlap between biophysical and built environments, and between specific, direct human-environment relationships and broader or systemic ones. Examples of this include the close relationship between outdoor air quality (a non-built environment) and indoor air quality (a built environment) and the relationship between human health and ecosystem health as a whole.

> The fundamental assumption is that indicators are intended to serve a purpose. They must therefore be fit for their purpose. This implies that we know what purpose we want them for and who will use them in order to define and design them accordingly. To be useful indicators must relate to an issue of current or future interest or concern. Different issues raise different questions and different users have different interests and needs. To provide this information the indicator must be interpretable. This means that we must know what differences or changes is the indicator meant for. In addition, indicators should be accurate, so that they provide an undistorted picture of the condition of interest. At the same time they should be transparent – be readily understood and interpreted by the users. Crucial for the design of good indicators is the "denominator" (WHO 2000: 1.3).

### *3.1 Models for designing environmental health indicators*

In identifying environmental health indicators, it is important to be able to link the impact of the environment to affecting health status, ideally as a cause and effect relationship. However, information may exist on exposure or health status but not together. The links between exposure and health status may also be tenuous and must be couched in the context of the uncertainty of the information. To present indicators it is thus informative to use an analytical framework to classify indicators along the cause-effect continuum.

Rather than presenting indicators as one long, disconnected list, it is helpful to use analytical frameworks. Several frameworks have been proposed and are in use. The Organisation for Economic Co-operation and Development (OECD) and other institutions have used frameworks for sometime, largely based on the Pressure-State-Response (PSR) framework. For example, Environment Canada's indicators office uses an expanded version of the PSR to include environmental drivers and effects. The PSR framework has been used as the starting point for much on the international work on environmental health indicators, led by the WHO.

The WHO has expanded the scope of the PSR to accommodate the fact that assessing environmental health requires a complex framework to capture all the crucial linkages involved. The approach developed is the Driving Forces, Pressure, State, Exposure, Effects (DPSEEA) model (Corvalán *et al*. 1996). This framework is used here, but not discussed in detail in this paper, because it is dealt with through other discussions at this session.

## 4. Selection: choosing themes, issues and indicators/variables

### *4.1 Choosing the broad themes and issues for the framework*

Indicator selection needs to be built around clear, specific goals. Selection must take into account the physical and social environment in which indicators are constructed and used. This paper develops a framework for environmental public health indicators in full recognition that these are embedded within the broader context of sustainable development and sustainability. While environmental public health indicators are very useful to look at on their own, they are ultimately only one crucial part of the broader picture of sustainable development / sustainability. Take the example of ecosystem health whose state overall underpins human health. Without full recognition of the broader picture, individual indicators are without context. Therefore, it is acknowledged that this work on environmental public health indicators must be part of the much broader work on sustainable development and sustainability.

| Theme | Issue | Indicators | Description / variables | DPSEEA model | Data sources |
|---|---|---|---|---|---|
| | | | | | |
| ***Air and atmosphere*** | Outdoor air quality | | | | |
| | Indoor air quality | | | | |
| | UV radiation | | | | |
| | Climate change | | | | |
| ***Water and aquatic systems*** | Drinking water | | | | |
| | Recreational water | | | | |
| ***Land and land-cover*** | Contamination of land / soil | | | | |
| | Waste disposal | | | | |
| ***Food and food products*** | Contamination of food sources | | | | |

*Table 2: Environmental Public Health Themes*

### *4.2 Criteria for indicator and component variable selection*

Much has been written on criteria for indicator selection, including much foundation work by the OECD (1993). Most of this literature includes discussion of both technical/scientific and user/policy elements as criteria. It is generally accepted that a good indicator should be scientifically sound, robust, easily understood, sensitive to the change it is meant to represent, measurable and capable of being updated regularly. Information should be readily available or it should be easily collected. Eyles, *et al*. propose criteria that can usefully be divided into scientific-based and use-based (Eyles et al. 1996 & Eyles and Furgal 2000 13-14). The following list is based on that work:

Scientific-based

1. **Data availability and suitability**
   Accessibility and regularity of data are real issues given time and cost restraints. However, gaps in identified important data should provide an impetus for efforts to improve that data.
2. **Indicator validity**
   Validity should be established both theoretically and empirically.
3. **Indicator representativeness**
   A measure of the indicators appropriateness to represent a specific dimension of concern within the phenomenon of interest.
4. **Reliability**
   Measured by consistency over a number of repetitions, to ensure the measurement is the same, or very close to (minimal error variance), over a variety of measurements and under a variety of conditions.
5. **Ability to disaggregate**
   They can be broken down into other variables.

Use-based

1. **Feasibility**
Data is already collected. If not, how feasible is access and for how long?
2. **Resonance**
Importance of the indicator measurement to those affected. Relevance to policy-makers or goals, targets, objectives, etc.
3. **Manageability**
Manageable number to reach goals. Must not be too cumbersome to understand

An essential part of the indicator selection process is the identification of scientific or use *gaps*. For example, in some cases validity, significance and resonance criteria could be meet but the required data is not consistently available.

### *4.3 Core versus optional or local indicators*

WHO work has emphasized the fact that differences in data collection practices as well as the lack of harmonized criteria on how to address environmental health issues and setting priorities makes the selection of a single, universally applicable set of indicators undesirable. The WHO has therefore proposed to use the approach of "core" indicators with the addition of "optional" ones to fit local and particular user needs. This approach allows greater flexibility in using the indicators: it allows for comparisons as well as for customized reporting. It has been adopted here.

## 5. Considerations for the implementation and utilization of the indicators

### *5.1 Aggregation of the indicators*

Issues of aggregation are at the heart of indicators work since such work, by its very nature, points toward reductionism. A common approach is to use a composite index (e.g., the TSE composite index). Composite indexes are also used for a number of environmental issues such levels of "heavy metals" as a sum of the individual components in question (e.g., Mercury, Cadmium, Lead, Nickel, etc.). This applies equally to other issue-areas such as persistent organic pollutants (POPS). Of course, like indicators themselves, composites are not exactly the same as the sum of all their parts, but have added power of parsimony to succinctly explain a "big picture" snapshot of a complex phenomenon. However, such composite indexes have their drawbacks has they may not fit the criteria of being easily understandable (e.g., by the general public) or on the contrary they may oversimplify the reality. In addition, the choice of components, or the weight assigned may be very subjective. For example, a different choice of components or of weight, may portray entirely different results. Moreover, the significant trend in one component may be hidden by other elements.

Other issues of aggregation are relevant to the construction of the indicators themselves. For example, it is widely accepted that particulate matter (PM) is an important indicator component variable for ambient air pollution—but how should it be measured, in its entirety (TSP), only at certain sizes ($PM_{10}$ & $PM_{2.5}$) or both? In this case TSP (total suspended particulates) is an aggregation, but it may not be the relevant measure for PM exposure and health outcomes. Theses are also important issues of aggregation which must be resolved with the context of the selection criteria in section 5.2.

Aggregation is a key issue for any set of indicators. In addition to technical considerations, the intended audience for the indicator in question is crucial in determining goals for aggregation. For example, if the intended audience is a daily newspaper, the level of aggregation sought might be the maximum possible. It may be to strive for aggregation as much as feasible (essentially following the same rules for indicator selection), but do so only when it is possible to show disaggregated variables and methodologies in their entirety.

Active debate continues as to the most appropriate use of composites for the environment on a variety of issues from air quality to land contamination. Each issue will need proper treatment in the context of this framework.

### *5.2 Indicators should evolve as knowledge and expertise change*

Good, consistent information and data are essential to develop indicators. In the case of environmental health indicators, this applies to both the environmental and health domains. Indicators are mere representations of phenomena and are inherently limited and representational, but they may be an effective form of interface between science and policy. There is a constant challenge for indicators to be complex enough to be powerful in explaining the key issues and simple enough for effective communication to their intended audiences. There are also numerous issues relating to aggregation (e.g., individual variables versus and index) and weighting that have not been detailed in this paper (Hunt 2000).

Indicators are unlikely to be the single or final word on an issue. As many analysts of such processes have concluded, no single assessment, or even assessment methodology, will universally prompt policy-makers into action (Parris *et al*., 1998: 11). Similarly, each set of indicators needs to be tailored to the specificity of the issue at hand. In other words, while general indicators may apply across related issues, what is key in one case may not matter at all in another. Finally, indicators must continue to evolve as knowledge and expertise change. As the science underpinning the indicators improves (e.g., a new substance in the air is found to be harmful to human health), the corresponding indicator for outdoor air quality can be appropriately revised. Similarly, if pollution and exposure drop to insignificant levels for a particular substance then the corresponding indicator would need to be modified.

### *5.3 Problems with information/data should be identified, prioritized, resolved*

The existence of quality information is a prerequisite for constructing environmental health indicators. In particular, quality ongoing monitoring and surveillance data is required as the basis of the indicators. Consistent, nationally available sources of such data may not be available for indicators identified on a priority basis.

Some existing inventories of data which may be useful. In the early 1990's the Canadian Council of Environment Ministers (CCME) sponsored a collection of databases for environmental analysis from FPT jurisdictions, not necessarily monitoring data. This was updated in 1998. The meta data is available on CD ROM. The National Environmental Indicators Program and the National Environmental Indicator Series have produced indicators for issues of national significance for more than a decade. In 1998, the Committee on Environmental and Occupational Health identified environmental and occupational health surveillance as one of its five strategic priorities. In response, a Working Group was struck to determine gaps and directions. All of these data sources need to be systematically tapped into.

Recommendations on developing a Canadian Information System for Environment (CISE), are being developed. Decisions taken in this direction will be crucial to ensuring the provision of adequate, timely and consistent data needed to support indicators.

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# ANNEXES

The following annexes to the present paper are available separately (document WP.24/Add.1):

**ANNEX I: DRAFT INDICATOR SETS**

1 AIR AND ATMOSPHERE
- *1.1 Outdoor air quality*
- *1.2 Indoor air quality*
- *1.3 UV Radiation*
- *1.4 Climate Change*

2. WATER AND AQUATIC SYSTEMS
- *2.1 Drinking water*
- *2.2 Recreational water*

3. LAND AND LAND-COVER
- *3.1 Toxic contamination of land / soil*
- *3.2 Waste disposal*

4 FOOD AND FOOD PRODUCTS
- *4.1 Contamination of food sources*

**ANNEX II: INDICATOR DEFINITION TEMPLATE**

**ANNEX III: EXISTING WORK**