

## **Fresh water-related Indicators in Canada: An inventory and analysis**

### **Abstract:**

The number of fresh water-related assessment indicators in Canada has proliferated rapidly over the past decade. This article presents a systematic review and evaluation of existing fresh water-related indicators in Canada, and analyzes the extent to which these indicators can (and are) being used to guide effective water governance. Specifically, the article presents an inventory of over 300 fresh water-related indicators, the first of its kind in Canada. This inventory is analyzed with respect to jurisdictional scale (federal and provincial), method, and topic/issue of focus. We then present results drawn from a national-level survey and follow-up interviews regarding the effectiveness and utility of assessment indicators, and explore the key drivers and trends in indicator development. Our findings suggest that certain types of indicators and topics are under-represented, that important gaps and overlaps exist, and that indicators are not sufficiently adapted to the needs of decision-makers. We argue that this has resulted in systemic barriers to the effective use of indicators, and has thus reduced Canada's capacity to systematically assess water security.

### **Resume**

Au Canada, l'éventail d'indicateurs construits au cours de la dernière décennie pour l'évaluation de l'eau potable s'est considérablement élargi. Dans cet article, les indicateurs utilisés au Canada en matière d'eau potable font l'objet d'un examen systématique et d'un état des lieux. L'objectif de cette étude est de déterminer dans quelle mesure les indicateurs peuvent être (et sont) mobilisés pour orienter les efforts visant à améliorer la gouvernance de l'eau. En outre, les quelques 300 indicateurs relatifs à l'eau potable utilisés au Canada sont compilés dans un inventaire inédit au Canada. L'analyse de cet inventaire porte plus spécifiquement sur l'échelle des juridictions (fédérale et provinciale), la méthode et les sujets/enjeux en question. C'est sur la base des résultats obtenus d'un sondage d'envergure nationale et de ceux tirés des entretiens de suivi portant sur l'efficacité et le bien-fondé des indicateurs d'évaluation que notre étude se propose de mettre en lumière les principaux facteurs et tendances qui interviennent dans l'élaboration d'indicateurs. Il en ressort que certains types d'indicateurs et de sujets sont sous-représentés, que des failles et chevauchements majeurs peuvent être décelés, et qu'un écart subsiste entre les indicateurs proposés et les demandes des décideurs politiques. Il se dégage de ces résultats que des obstacles systémiques dans l'application efficace des indicateurs existent, ce qui suscite une remise en cause de la capacité du Canada d'évaluer de manière systématique la sécurité de l'approvisionnement en eau.

**Key Words:** Indicator, fresh water, inventory, water security, water management, policy

## Introduction

The number of environmental indicators has grown significantly over the past few decades, and the diversity of these indicators has also increased. Yet, in Canada, little attention has been given to characterizing and analyzing the types of environmental indicators currently available in the water sector. This paper fills this gap. We provide a systematic review and evaluation of existing fresh water-related indicators in Canada and analyze the capacity of these indices to aid decision-making. Specifically, we present our inventory of Canadian fresh water-related indicators, the first of its kind. The inventory is analyzed and the key gaps and overlaps between the types of indicators along with overall shortcomings are highlighted. We expand upon the core debates found in the academic literature in relation to findings from the inventory analysis. We examine jurisdictional fragmentation in federal and provincial/territorial government in relation to indicators. Focusing at the federal and provincial/territorial levels, we identify key drivers and trends in indicator development and identify major obstacles in Canada's capacity to assess water security. We then present recommendations designed to increase the effectiveness of water security assessments in Canada.

Prior to the presentation of methods and results (below), it is important to (briefly) discuss why environmental indicators have proliferated over the past few decades. Although the use of environmental indicators dates back to the end of the 19<sup>th</sup> Century (Bouleau 2009), it was not until the late 1980s that their application become widespread, following the publication of *Our Common Future* by the Brundtland Commission, formally the World Commission on Environment and Development (WCED) in 1987 (Sagar and Najam 1997; Bell and Morse 2003; Pinter et al 2005; UN DESA 2007; UN DSD 2008). This report pushed the concept of sustainable development to the forefront of government policy, and was followed by a sustained increase in national and international environmental reporting initiatives, reinforced by subsequent international initiatives (notably, Agenda 21, the 1992 United Nations Conference on Environment and Development, and the subsequent 2002 Johannesburg Environmental Summit, Rio +10). The value of environmental information increased dramatically, and indicators were an important means of gathering this information, for two reasons. First, indicators enable the synthesis of large amounts of complex information to be presented in a simplified, accessible format that can be easily understood (OECD 1993; Hammond et al 1995; Molden et al 1997; Farrell and Hart 1998; Keating 2001; Niemeijer 2002; Gudmundsson 2003; UN DESA 2007; Barnett et al 2008). Second, indicators are useful in monitoring change and assessing performance; for example, by identifying progress (or lack thereof), usually as measured against a baseline against which related variables can be measured over time, and/or comparisons made between locales or organizations (Barnett et al 2008; Commonwealth Secretariat and the World Bank 2000, National Research Council 2000a; Niemeijer 2002; Villa and McLeod 2002). In short, indicators can help us understand where we are, where we are going and how well we are doing in relation to others.

A unifying concern in the academic literature is the exclusion of environmental considerations from conventional indicators (Hammond et al 1995; Sagar and Najam 1997; Niemeijer 2002; Clausen and Hafkesbrink 2005). The diversity of types and

methods of indicator application has also increased rapidly (Niemeijer 2002; Bell and Morse 2003; Rydin et al 2003; Hilden 2008). In the policy arena, consensus began growing in the 1970s that new indicators were required that would enable the measurement of the three pillars of sustainable development (economic, social and environmental). Consequently, environmental indicators proliferated rapidly, both in Canada and internationally (Clausen and Hafkesbrink 2005; OECD 1998; BMU 2000). Simultaneously, an increasingly diverse range of actors—governmental and non-governmental—at a variety of scales (from the local level to the international) has become involved in creating and applying environmental indicators.

Critiques of indicators have raised several important issues. One set of concerns pertains to the conceptual frameworks for, and design of indicators; for example, the use of composite/aggregate indices versus univariate indicators (Barnett 2008; Gudmundsson 2003; Pinter et al 2005; UN DSD 2008;). A second set of concerns pertains to the subjectivity, inherent bias, and associated limitations of indicators (Barnett 2008; Pinter et al 2005; Sagar and Najam 1997). A third set of concerns—and the focus of this article—relates to the role of indicators in assessment and policy (Lehtonen 2008; UNDSO 2008; Barnett 2008). As explored below, several systematic conditions seem to have prevented the widespread uptake of water security-related indicators in Canada, and to have inhibited their application in water policy and decision-making.

### **Method and Results: Canadian fresh water-related indicators analysis**

Currently in Canada, no central location or repository exists for fresh water-related indicators and their associated data. Instead, a complicated web of federal and provincial initiatives that has resulted in numerous indicators being housed in diverse formats, accessible via a myriad of reports and various agency websites.

#### ***Method***

Since no comprehensive list of fresh water indicators in Canada exists, an extensive inventory was compiled, derived from government reports, internet searches, a web-based survey of 100 water practitioners across Canada (referred to as the *2008 Water Security Survey* in this paper) and follow-up interviews with water managers and policy makers. The indicator research took occurred between June 2008 and March 2009.

The survey was focused on data gathering, monitoring, and reporting tools, with an emphasis on fresh water-related indicators. (In this paper, we use the term “water monitoring and reporting tools” as an umbrella term to describe indicators, indices, benchmarks, and performance measures as well as report cards, sustainability checklists, and protocols). The survey was administered to 512 individuals, and the response rate was 20%. The primary target participants for the survey were municipal water managers (including utility managers), water regulators, and community watershed groups. Federal provincial policy-makers were the secondary targets. All provinces and territories were

represented. 30 survey participants from federal, provincial/territorial and municipal government, NGOs, industry and consultants, from across Canada, took part in follow-up interviews conducted in Spring 2009.

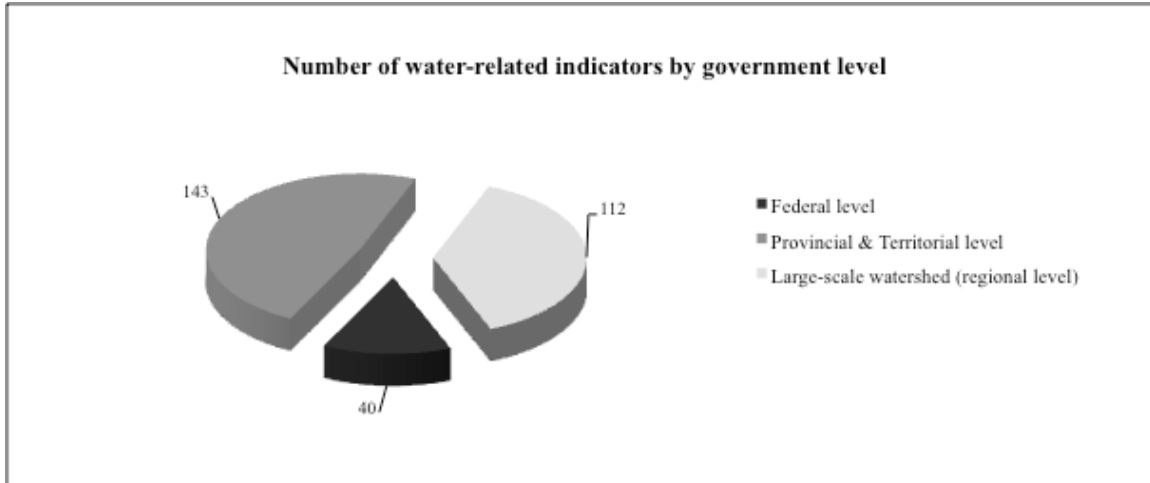
To ensure that the inventory is exhaustive and comprehensive, federal and provincial/territorial representatives were contacted to review the inventory. Approximately 75% of those contacted provided feedback on the accuracy and comprehensiveness of the inventory for their area. Finally, in September 2009, the inventory was presented and critiqued at a workshop on water security (referred to here as the *2009 Water Security Workshop*), attended by 60 water practitioners from across Canada, representing all provinces and territories. Participants represented a variety of sectors including NGOs, consultants, municipalities, water utilities, and provincial and federal agencies (Dunn and Bakker 2009).

The inventory focuses on indicators developed at the federal and provincial levels; in addition, it includes some examples of the indicators developed at the community level. Although report cards, sustainability checklists, benchmarking tools etc. can be applied in a similar way to indicators (as monitoring and reporting tools) they were not included in the inventory.

## ***Results***

The inventory contains 365 indicators developed in Canada that address fresh water-related issues (Figure 1). The majority, 295, of these indicators are developed by federal and provincial/territorial government agencies. A total of 40 indicators were at the federal level, 143 at the provincial level indicators, and 112 at the regional level (i.e. large-scale watershed). In addition to these, a further 70 indicators were developed by community level (i.e. small-scale watershed) organizations (such as municipalities and NGOs). This inventory does not include any of the 50 bilateral agreements Canada is committed to, many of which require information sharing, progress reports, and/or indicators (Bond et al 2005).

Figure 1: Canadian fresh water-related indicators (March 2009)

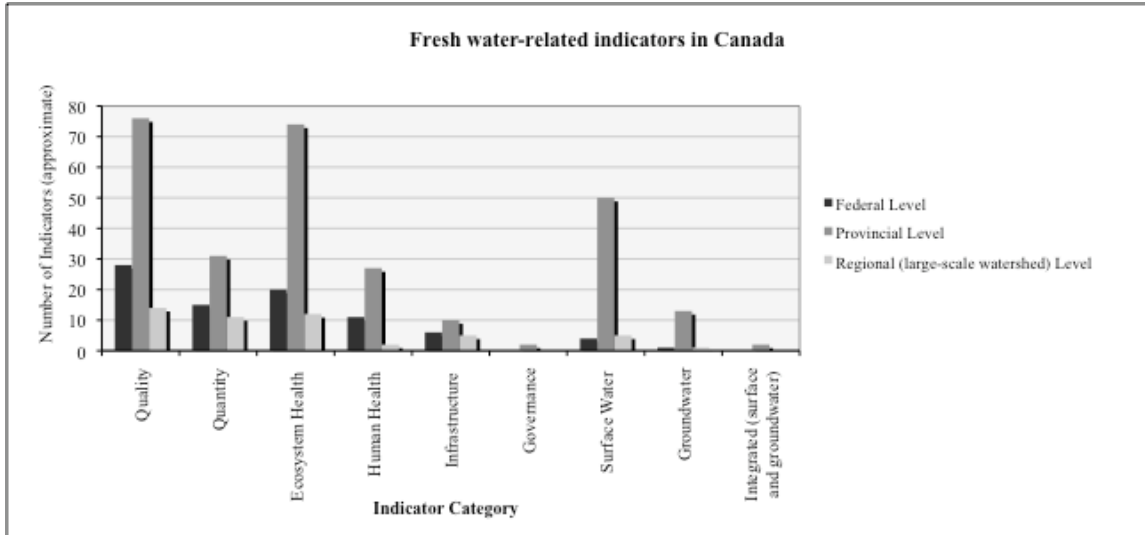


Once compiled, the inventory was analyzed with respect to five topics: resources (water quantity), ecosystem health, human health, infrastructure and governance (Figure 2). The following observations can be made regarding federal and provincial/territorial fresh water-related indicators:

- Water quality indicators dominate over water quantity indicators.
- There are significantly more ecosystem health indicators than human health indicators.
- Surface water indicators dominate over groundwater indicators.
- There are only a few integrated (surface and groundwater) indicators.
- Infrastructure indicators are limited in number and in scope (the main focus is level of wastewater treatment; few indicators reflect the condition of supply infrastructure)
- Governance indicators are sparse and poorly developed.
- Overall, indicators are narrowly focused (i.e. indicators do not enable decision-makers to assess the broader picture such as conflicting demands or land–water management practices).

Currently in Canada, there are a large number of indicators focusing on a narrow range of issues. For example the majority of indicators focus on measuring water quality (ecosystem health and human health), followed by resources (water quantity). Indicators measuring infrastructure and governance remain significantly underdeveloped.

Figure 2: Types of fresh water-related indicators in Canada (March 2009)



Note: There are overlaps between the categories and indicators will be double counted where this overlap occurs. All numbers are approximate.

We observe that at the federal and provincial level water quality indicators dominate the inventory, driven largely by the widely accepted Canadian Council of Ministers of the Environment (CCME) CCME Water Quality Index (CCME WQI). There are over 100 indicators for water quality, with approximately 28 at the federal level and 76 at the provincial level. Water quality indicators span ecosystem health (for example, fresh water quality index ratings for lakes) and human health (for example, source and treated water quality). Developed in 2001, the CCME WQI is perceived to be flexible and adaptable enough that it is the only water-quality-related index accepted by all Canadian provinces and territories and adopted nationally. However, there is insufficient data available for this particular indicator to be reported as a national trend, and not all provinces and territories actually report it (Government of Canada 2007). Whilst the CCME WQI has provided a platform from which many other water-quality-related indicators have sprung, the index is only applied to surface water bodies and does not examine drinking water quality.

In total, there are approximately 46 federal and provincial indicators that measure water quantity in Canada. This is less than half the number of water quality indicators (104) that exist at the same scales. Canadian water quantity indicators tend to look at either demand *or* supply. Only five indicators were identified that take a combined approach measuring demand *in relation to* supply. At the federal level, three water quantity indicators take into consideration the impacts of demand *and* supply (by Statistics Canada, Policy Research Initiative and a forthcoming index by Environment Canada). There is one provincial level (Alberta Environment has an indicator that monitors water allocations compared to natural flows) and one regional level (Composite Index of Vulnerability of Prairie Resources accounts for demand and supply data in Alberta, Manitoba, and Saskatchewan)

We observed that ecosystem health indicators are the most common type of water quality

indicator; they dominate over human health indicators. A wide selection of indicators measure ecosystem health, ranging from specific contaminant indicators (such as Agriculture and Agri-Food Canada's "Risk of Contamination by Nitrogen") to the broader "Quality of Major River Systems," an indicator developed by the New Brunswick Department of Environment. Contaminant-specific indicators appear to be more common. There are some overlaps between the categories used for the analysis, particularly wastewater treatment, which can be used as an indicator of pollution into waterways or as an indicator of human health. Wastewater treatment indicators were also included in Infrastructure Indicators category.

We observe that human health indicators relating to water are varied in scope. This category includes a range of indicators such as source water quality (for drinking water purposes), treated (drinking) water quality, bathing water quality, as well as levels of wastewater treatment. In total, there are 94 ecosystem health indicators at the federal and provincial level, compared with 38 human health indicators. There are approximately 11 human health indicators (or indicator components) at the federal level and approximately 27 at the provincial level. The limited number of human health related indicators may be attributed to the fact that national drinking water quality guidelines already exist. Although the national Guidelines for Canadian Drinking Water Quality have not been included in the inventory, it should be acknowledged that these guidelines include standardized indicators. Many (although not all) jurisdictions follow these guidelines and hence use these indicators. However, not every jurisdiction follows or applies these guidelines in the same way. Currently, there are 10 different standards for drinking water quality across the 10 provinces and 3 territories. Only two provinces, Alberta and Nova Scotia, have fully adopted the national guidelines (Bakker 2007, 377).

We suggest that infrastructure indicators in Canada remain largely underdeveloped, limited in number and in scope. Of the 183 fresh water-related indicators developed at the federal and provincial level, 16 assess infrastructure. Most of these 'infrastructure' indicators focus narrowly on population served by wastewater treatment plants or the level of water or wastewater treatment. Only a handful of the infrastructure indicators monitor issues relating to aging water infrastructure (such as full-cost recovery pricing or infrastructure investment). Indicators that explicitly report leakage levels or system losses are not used at the federal or provincial level.

There are significantly more surface water indicators (or indicator components) (approximately 4 at the federal level compared to 50 at the provincial level) than groundwater indicators or indicator components (1 at the federal level and 13 at the provincial level). This difference may be attributed largely to the lack of availability of groundwater data compared to surface water data. The lack of indicators at the federal level is likely a reflection of the fact that groundwater is a provincial resource, except for transboundary areas (whether inter-provincial or Canada-U.S.). Provincial efforts have not focused on groundwater sources to the extent that they have focused on surface water sources, unless they rely on groundwater. There are two integrated (both surface and groundwater) indicators under development at the federal level and two under development at the provincial level. The scarcity of integrated surface and groundwater

indicators underscores how Canada has not moved fully toward the watershed approach.

The role of good governance and the need for transparency and accountability is becoming increasingly central to debates over environmental indicators (Kaufmann and Kraay 2008; Pinter et al 2005). Nevertheless, the development of indicators that monitor good governance in Canada or in the wider international community has been extremely limited (UN DESA 2007 1:10).

No governance indicators exist at the federal level, although the inclusion of ‘capacity’ as a variable in the PRI Canadian Water Sustainability Index is a notable exception. Participants in the 2008 Water Security Survey mentioned the absence of this type of indicator. This dearth is largely due to the complexity surrounding the measurement of governance through indicators. What should be measured? Specific “governance rules” such as legal, constitutional, or regulatory environment? Or general “governance outcomes” such as the existence or absence of specific agencies? How should these be measured? And whose opinion should be relied upon? As Kaufmann notes, “...virtually all measures of governance involve a degree of subjective judgment” (Kaufmann and Kraay 2008, 3). There are only few governance indicators in the inventory, developed at the provincial level. These indicators measure governance outcomes, the most common type of governance indicator, but do not offer a holistic view of governance practices (Kaufmann and Kraay 2008).

We observe two trends in environmental indicators: economic valuation and target setting. Assessment of the full cost of non-market social and environmental assets is not generally included in conventional economic statistics. The incorporation of economic valuation is an emerging trend in fresh water-related indicators under development at the federal, provincial and community level. Pinter (2005) states that since early 2000, there has been a trend towards using goals or targets in tandem with indicators, we do not observe this approach in federal and provincial indicators. Dube, Duinker and Munkittrick (2009) and participants in the 2009 Water Security Workshop note that indicators with associated thresholds are more meaningful.

In our 2008 Water Security Survey, we asked water practitioners why and how they use indicators. 60% of the water practitioners surveyed said they use water monitoring and assessment tools, with 43% using indicators. These indicator users include utility managers, industry associations, municipalities, water boards, conservation authorities, and NGOs, as well as federal and provincial governments. Survey respondents said they use water monitoring and assessment tools to:

- monitor and measure progress;
- identify priorities and budgets (planning);
- raise / improve awareness (particularly in communicating with the public);
- improve knowledge and education;
- enable informed decision-making;
- comprise part of evaluation and approval (decision-making) processes;
- compile reports; and

- make comparisons (either with other areas or past vs. current trends and future scenarios).

Frequency of use varies from once a year (26%) to daily (22%).

In summary, our analysis suggests that currently in Canada, indicator development has focused largely on water quality (ecosystem and human health), whilst quantity, infrastructure and governance indicators are inchoate. Accordingly, in the next section, we examine the drivers behind the development of indicators in Canada, taking a closer look at the factors and mechanisms that could account for these gaps and overlaps.

### **Discussion: Fresh water governance and water indicators in Canada**

Water security is an emerging concept in Canada and internationally (Cook and Bakker, forthcoming). It can be defined as *sustainable access on a watershed basis to adequate quantities of water, of acceptable quality, to ensure human and ecosystem health*, implying the need to assess all demands placed upon a watershed including quality, quantity (including climate change, allocation), ecosystem health, human health, infrastructure, and governance. We suggest that it is important to measure water security since this approach examines the watershed as a whole, placing emphasis on the sum of the parts; flow, use, quality and biodiversity. Policy-makers, water resource managers, NGOs, industry and agriculture all need this information. If a complete picture is not available, then how can good decisions be made that maintain a functioning ecosystem in the long term?

2008 Water Security Survey respondents identified the following issues that are limiting the application and use of indicators: the absence of a national framework; the lack of standards or consistency and integration (at the community, provincial and national level); the absence of a central data and / indicator repository; data issues (including access to data, availability, and consistency); and the narrowness of indicators. Limited human and financial resources were also identified as a concern. Two further issues are the narrow scope of indicators, limiting their utility; and the lack of commonality, limiting utility and comparability across jurisdictions. Both of these latter issues are compounded by Canada's incomplete and inconsistent environmental monitoring and reporting, related to the absence of a national reporting framework or system.

In short, although the inventory confirms our hypothesis of a proliferation in the number of indicators being developed by a diverse range of players, our analysis suggests that these indicators are not being widely or consistently used by water managers. Some of the reasons are technical, related to data availability, the design of indicators, and the approach taken to disseminating indicators.

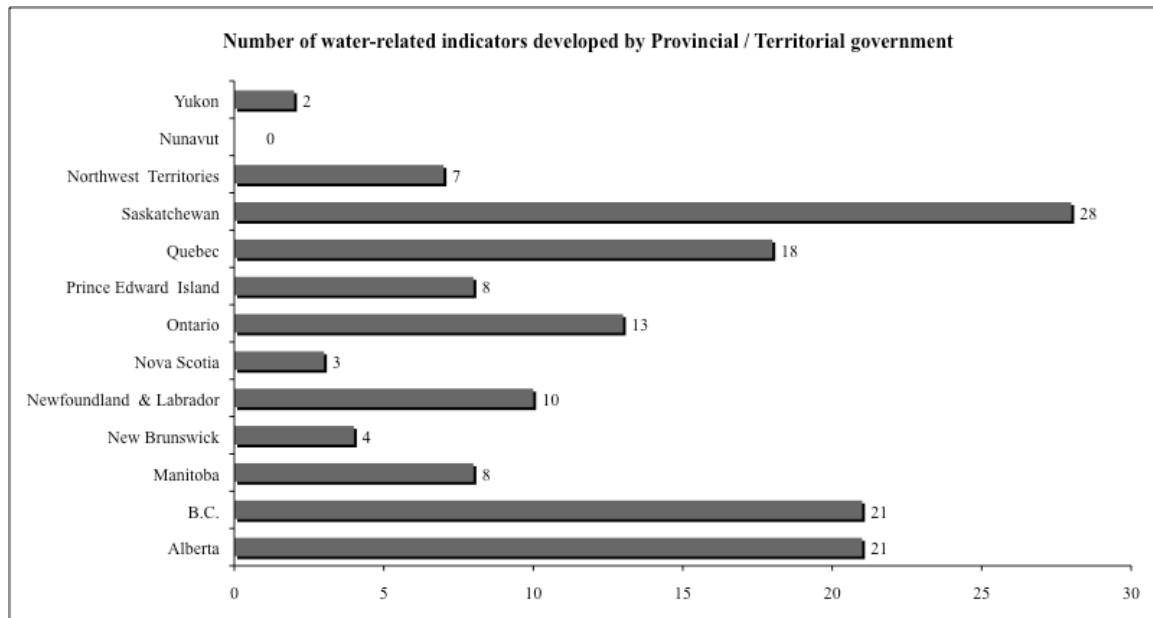
Another set of issues relates to governance, specifically the poor link between the development of indicators and decision-making, in two senses: the limited or absent interaction between indicator designers and decision-makers when indicators are

developed; and the limited availability and utility of indicators to decision-makers once the indicators have been created. Currently in Canada, unlike other federal institutions such as the United States and the European Union, there is no national framework or organizing structure that provides commonality and cohesion in government reporting efforts. Tiered levels of government add complexity, since there is no overarching body that manages or coordinates their use, resulting in a fragmented scheme of indicators across the country.

At the federal level, indicator development and reporting is dispersed across nine different federal agencies and eleven different federal government environmental indicator and/or monitoring and reporting initiatives, not including the 50 bilateral reporting commitments. Several waves of federal reporting/indicator initiatives have taken place since the 1980s, reflecting changes in environmental concerns. The result has been that even senior decision-makers acknowledge their confusion over linkages between various federal initiatives (Bond et al. 2005b, Annex 2: 47). Therefore, it is no surprise that practitioners find the current indicator scheme difficult to understand.

Similarly, fragmentation is also evident at the provincial and territorial levels. Here fragmentation is largely attributed to each province or territory being responsible for water (except transboundary) and limited coordination occurring between provinces and territories. On the whole, there appears to be limited dialogue, collaboration, or information sharing among the provinces, a situation partly aggravated by the “silo structure” of government agencies (federal as well as provincial). The effect of this fragmented approach is illustrated in Figure 3, which shows the variation in number of indicators across the provinces and territories. Nunavut for example, has no fresh water related indicators, whereas Saskatchewan has 28. The application and use of fresh water-related indicators across the provinces or territories is inconsistent.

Figure 3: Water-related indicators developed by provincial and territorial governments (March 2009)



The impacts of jurisdictional fragmentation we suggest, have presented systemic barriers to the effective use of indicators, and have thus reduced Canada’s capacity to assess water security. One issue is the absence of a national reporting framework, which has resulted in ad hoc environmental reporting and environmental statistic collection. Practitioners across Canada highlighted a need for a common framework of indicators. Similarly, academic literature supports the need for a system of indicators (Gudmundsson 2003; Hilden 2009).

A second issue is the lack of a comprehensive approach to data collection. Data form the foundation blocks upon which indicators are built and therefore play a fundamental role in developing indicators (UNEP 2003; Fitzgibbon 2006; PRI 2007; Bouleau 2009). Yet, there are concerns regarding gaps in monitoring networks, limited data availability and inconsistencies in existing data (Bond 2005; Brennin 2007). Monitoring stations, for example, are “not statistically representative of Canada as a whole” (Government of Canada 2007, Appendix 3, 52). Statistics Canada suggests that environmental statistics are a poor relation to their economic cousins. Currently, environmental statistical data collection and reporting are mainly conducted “to suit the needs of individual policy initiatives, following the ebb and flow of environmental concerns” and that this approach will become increasingly problematic in the future (Statistics Canada 2009, 1). We suggest that many of the gaps and narrow scope of indicators in the inventory reflect limited data. Bouleau (2009) suggests that most effective way to improve data monitoring for environmental indicators is through legal enforcement. Referencing to the historical development of environmental indicators in France, culminating in the European Union Water Framework Directive (WFD), Bouleau states that binding legislation has been critical in systematic environmental monitoring in France.

A third issue is the lack of influence of indicators on policy. This is particularly relevant given that a frequent justification for indicators is the ability to inform policy-makers

(Hammond 1995; Gudmundsson 2003). There was agreement amongst the 2008 Water Security Survey follow-up interview candidates, that whilst indicators in general are influential (to both public and government), environmental indicators are not having any visible influence on policy. This was attributed to a number of factors: a lack of communication between the creators of indices and end-users (whereas the literature suggests that end-users should be engaged from the early stages of indicator development in order to achieve buy-in and success (Bond 2005; Brenin 2007; Community Indicators Consortium 2007; Bouleau 2009)); the slow pace with which indicators are released is inhibiting their influence on policy cycles (currently in Canada, federal environmental indicators are typically released two years after the data has been collected (Brenin 2007; Statistics Canada 2009)); and accessibility of indicators (the current indicator landscape is too complex and indicator information is exceedingly hard to locate, compare, and apply—particularly between jurisdictions).

In part, the diversity of indicators and lack of cohesion is a symptom of fragmented water policy and legislation at both the federal and provincial/territorial levels (Hill et al 2008; de Loe 2008). UNEP highlighted the importance leadership amongst national statistics offices and ministries of environment in order “to minimize overlaps and duplication of efforts” (UNEP 2003, 5). In Canada, there is a strong appetite for indicator activities to be harmonized, with common reporting guidelines or framework established. For example, in February 2009, Statistics Canada, recognizing that current approaches to environmental reporting are ad hoc, put forward a document calling for a national framework for developing environmental statistics (Statistics Canada 2009). Environment Canada has also identified the strong need for a national strategy calling for a “national set of environmental indicators providing a framework for regional and local indicators, and urged the adoption of nationally consistent and comparative approaches” (Bond 2005, 26). This appears to be supported by public opinion: 2009 Nanos Research Poll, sponsored by the Walter and Duncan Gordon Foundation for *Policy Options*, showed that 28.9% of Canadians regard the adoption of a national water strategy as a top priority for government to address Canada’s water challenges (Nanos, 2009). These views are borne out by the responses to our 2008 Water Security Survey, where participants highlighted the need for a coordinated set of indicators developed federally and provincially.

## **Conclusion**

Indicators play a significant role in the implementation and assessment of progress towards sustainable development. This paper has documented the increased development and use of water-related indicators, which have proliferated dramatically over the past twenty years, and by all accounts will continue to do so for the foreseeable future. Canada is no exception. However, the absence of a coordinated pan-Canadian approach in the development and application of indicators has resulted in certain indicators being duplicated, whilst other important issues are not being fully addressed. Simply put, a lack of coordination and systematization, together with a weak national policy structure, has inhibited systematic assessments of water security across Canada.

There are numerous federal agencies, provincial/territorial governments, NGOs, and community groups developing fresh water-related indicators, yet the interaction between them appears limited. This lack of coordination between government departments and agencies producing water monitoring and reporting tools, has resulted in not only the duplication of efforts and gaps in the types of indicators being developed, but also confusion amongst end users. We suggest that a coordinated approach is necessary to increase Canada's capacity to fully assess and improve water security.

As this paper has documented, current water-related indices tend to have a narrow focus (e.g., solely on drinking water) and segmented approach, and do not consider the broader balance of ecosystem health and human health. Multiple orders of government add complexity to the array of indicators currently available. To recap, federal indicators focus largely on water quality, particularly ecosystem health. A handful of federal indicators examine water quantity issues. Provincial indicators illustrate the state of water quantity and quality, with the primary focus tending to be ecosystem health. Large-scale watershed (regional) indicators also focus primarily on ecosystem health. Infrastructure and governance indicators are limited in number and in scope federally, provincially and regionally (the main focus is level of wastewater treatment; few indicators reflect the condition of supply infrastructure). There are no governance indicators at the national/federal level or regional level and only a few provincially.

We suggest that it is important to measure water security since it is a broad concept of holistic water management that balances resource protection and resource use. Although several indices are being developed in Canada to support improved water security, no widely accepted standard index of water security exists. This absence of a widely-accepted standard index of water security is potentially negative, for three reasons. First, it reinforces the fragmentation of focus typical of water management in Canada (and elsewhere), in which government departments focus on specific aspects of water (e.g., public health or aquatic organisms), without making holistic assessments. Second, and related to the previous point, managers and policy-makers do not share common points of reference when assessing the state of water security, impeding decision-making over cross-cutting issues. Third, a reliance on narrowly-focused indices may hinder the ability of decision-makers to effectively assess and mediate between conflicting demands for water use. Simply put, narrowly-focused indices limit the ability of managers and policy-makers to develop a complete, comprehensive assessment of water security, jeopardizing the long-term effectiveness of decision-making.

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*Water Security Framework as a Tool for Improved Governance for Watersheds*” that will create a Water Security Framework (WSF), which includes decision-support tools for water managers.

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