CANADIAN APPROACHES TO ASSESSING WATER SECURITY:

AN INVENTORY OF INDICATORS

Policy Report

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CANADIAN APPROACHES TO ASSESSING WATER SECURITY: AN INVENTORY OF INDICATORS

POLICY REPORT, NOVEMBER 2009

AUTHOR:

Gemma Dunn
Research Associate,
Program on Water Governance,
University of British Columbia

with:

Karen Bakker
Director, Program on Water Governance, UBC
Associate Professor,
Department of Geography, UBC

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"Not everything that can be counted counts, and not everything that counts can be counted"
– Albert Einstein

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LIST OF ACRONYMS

AEIs	Agri-Environmental Indicators
CCME	Canadian Council of Ministers of the Environment
CCRM	Canadian Council of Resource Ministers
CESI	Canadian Environmental Sustainability Indicators
CISE	Canadian Information System for the Environment
CWSI	Canadian Water Sustainability Index
ESDI	Environment and Sustainable Development Indicators
GPI	Genuine Progress Index
GUDI	Groundwater Under the Direct Influence of surface water
NGO	Non-governmental organization
NRCan	Natural Resources Canada
NTREE	National Round Table on the Environment and the Economy
OECD	Organisation for Economic Co-operation and Development
PRI	Policy Research Initiative
SOE	State of the Environment
UN	United Nations
UNEP	United Nations Environment Program
US EPA	United States Environmental Protection Agency
WAI	Water Availability Index
WCED	World Commission on Environment and Development
WQI	Water Quality Index
WWT	Wastewater Treatment

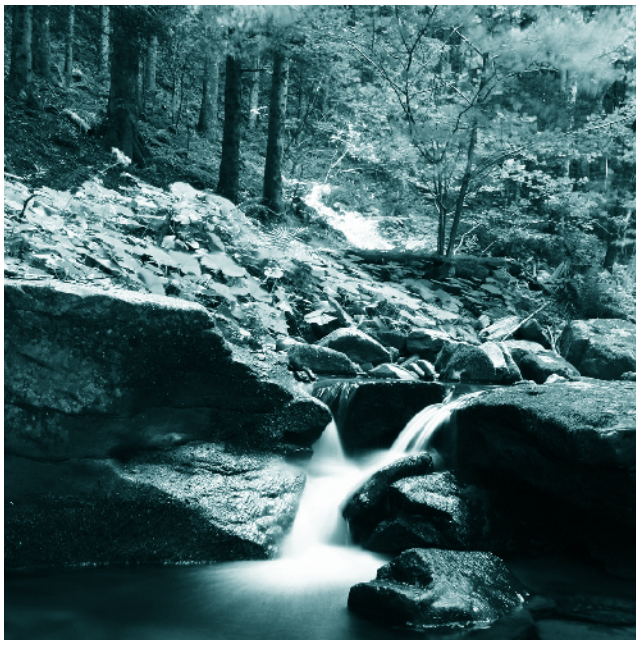
EXECUTIVE SUMMARY

What is water security? Water security may be defined as *sustainable access on a watershed basis to adequate quantities of water, of acceptable quality, to ensure human and ecosystem health*. The World Economic Forum has described water security as "the gossamer that links together the web of food, energy, climate, economic growth and human security challenges that the world economy faces over the next two decades" (World Economic Forum 2009, 5).

PURPOSE OF THE REPORT

This report, the first in a series, documents and assesses the strength of the indicators currently used in Canada to measure and assess water security, with a focus on both federal and provincial levels. Subsequent reports will describe current approaches to water security in Canada, examine the views of end users and policy-makers, and present recommendations for improving water security in Canadian communities.

This report documents current approaches to measuring and assessing water security in Canada based on our inventory of freshwater-related indicators, analysis of the inventory, a literature review, results from the 2008 Water Security Survey, and feedback from practitioners during a workshop on water security (September 2009). In addition, the report explores the impact of tiered levels of government on the uptake of indicators by various end users. (The inventory is available at www.watersecurity.ca).



STRUCTURE OF THE REPORT

The report is divided into five sections:

Section 1: Introduction: Approaches to water security

This section introduces the emerging concept of water security and explains why it is so important.

Section 2: Overview: Why use indicators?

This section provides an overview of the concept of environmental indicators: what they are, who uses them, why we use them, and what they enable us to achieve.

Section 3: An inventory of freshwater-related indicators in Canada

This section is based on a comprehensive inventory of freshwater-related indicators available in Canada, which was compiled in February 2009 and subsequently analyzed for this report. The indicators are grouped into the five water security dimensions identified by the research team. Analysis of these groups highlighted gaps and overlaps between the types of indicators along with overall shortcomings.

Section 4: Gaps and weaknesses in government approaches

This section is an overview of the current inventory of indicators in Canada, which examines jurisdictional fragmentation in three levels of government: federal, provincial/territorial, and municipal (community). Focusing at federal and provincial levels, we identify key drivers and trends in indicator development and identify major obstacles in Canada's capacity to assess water security.

Section 5: Recommendations

In the final section, we present recommendations toward the increased effectiveness of assessing water security in Canada.

KEY FINDINGS

The inventory identifies 365 Canadian freshwater-related indicators. Highlights of the systematic review of this indicator inventory include these findings:

- There are very few integrated (surface and groundwater) indicators.
- Water quality indicators are more prevalent than water quantity indicators.
- Ecosystem health indicators are more prevalent than human health indicators.
- Surface water indicators are more prevalent than groundwater indicators.
- Governance indicators are sparse and poorly developed.
- Infrastructure indicators are limited in number and in scope.

KEY IMPLEMENTATION GAPS

The major gaps in the current Canadian spectrum of indicators include the following:

- Absence of centralized, "one-stop shopping" source for water monitoring and reporting tools (which this inventory attempts to redress).
- Lack of a national framework or organizing structure to provide commonality and cohesion in government reporting efforts.
- Lack of coordination between government departments and agencies producing water monitoring and reporting tools, resulting in confusion for end users, along with duplication of efforts and gaps in the types of indicators being developed.
- Limited influence of environmental indicators on policy or change: current approaches to the development of indicators focus more on data availability rather than what decision-makers need to know. This results in limited uptake of indicators by end users.
- Lack of integrated knowledge and effective incorporation of freshwater-related decision-making at the community level.
- Indicators to measure water quantity (demand, supply, and infrastructure condition) are underdeveloped and overlooked.
- Integrated (surface and groundwater) indicators are underdeveloped.
- Governance indicators are underdeveloped.

KEY RECOMMENDATIONS

The report makes the following key recommendations:

1. Central repository for indicators and associated data

Currently, no central location or repository to find information on indicators or their associated data exists. Instead, a complicated web of federal and provincial initiatives has resulted in indicators being almost lost among a myriad of reports and various agency websites. Even if located, the indicators are time-consuming to retrieve and interpret. All levels of government (federal, provincial, and municipal), industry and non-governmental organisations (NGOs) are voicing concern about this lack of a centralized source.

2. Harmonization of indicator initiatives

The absence of a reporting framework or system has resulted in ad hoc environmental reporting that lacks credibility. As a result, environmental indicators currently have little or no impact on policy development. The 2008 Water Security Survey results and research analysis reiterate the call for indicator activities in Canada to be standardized with common reporting guidelines, as well as establishing a harmonized framework and a consistent set of indicators at the federal and provincial levels.

3. Greater collaboration

Greater communication and information sharing could take place between federal agencies, provinces, and community groups. This would avoid duplication

and overlaps. Ample opportunity exists to better share knowledge and exploit the wealth of indicators already developed.

4. Engagement of end users

Communication between the scientists who develop indicators and the policy-makers who could use them is limited. Also it is the *producers*' needs that still drive the development of indicators, rather than the needs of the *end users*. These two factors have limited end-user uptake of indicators and made for weak links between science and policy. The integration of policy-maker and community needs into indicator design could ensure applicability and uptake.

5. Timeliness

Good indicators should enable the release of statistics soon after the period they refer to. Currently, most federal-level environmental indicator reports are released two years after the reference year. If indicators are to influence policy, it is essential that policy-makers have easy access to up-to-date indicator information in a readily available and understandable form.

6. Addressing the gaps

The present inventory analysis and survey results reveal that, currently, few tools exist to measure water quantity issues (including infrastructure) or integrated (surface and ground) water and governance issues. In order to identify the priorities to achieve water security in Canada, it is essential that policy-makers give greater balance to water issues as a whole— particularly within a watershed.

Maintaining data collection and analysis requires a long-term commitment in terms of both financial and human resources from policy-makers. Monitoring networks have been dramatically cut back and, in many parts of Canada, they do not even exist.

7. Collaboration among key actors to develop a standard index of water security

Although several indices are being developed in Canada to support improved water security, no widely-accepted standard index of water security exists. Current water-related indices tend to focus more narrowly (e.g., solely on drinking water). They do not allow decision-makers to effectively assess and mediate between conflicting demands for water use, nor minimize the potential adverse impacts from land and water management practices. This creates significant risks to watershed integrity and thereby to public health—a situation that can, in turn, create significant costs.

8. Water security: A comprehensive approach

A lack of integrated knowledge and effective incorporation of water-related decision-making exists at the community level. Coordination among current efforts to develop comprehensive water-security indicators should be a priority. The involvement of end users in these indicators is crucial in order to ensure applicability and uptake. Adopting a comprehensive approach implies not only integrating water-related variables, but also taking an inclusive approach to indicator development, dissemination, and implementation.

RÉSUMÉ

Comme définir la sécurité de l'approvisionnement en eau? La sécurité de l'approvisionnement en eau se définit comme l'accès durable à l'échelle d'un bassin hydrographique à l'eau potable en quantité suffisante et en qualité acceptable et qui assure la protection de la santé humaine et des écosystèmes. Selon le Forum économique mondial (2009: 5), c'est autour de la question de la sécurité de l'eau potable que se cristallisent les défis actuels concernant l'alimentation, l'énergie, le climat, la croissance économique et la sécurité humaine et auxquels sera confrontée l'économie mondiale pendant les deux prochaines décennies.

BUT DU RAPPORT

Ce premier numéro d'une série de rapports vise à dégager les principaux points forts des indicateurs sur lesquels se fondent les études et évaluations canadiennes, tant au niveau fédéral que provincial, qui portent sur la sécurité de l'approvisionnement en eau. D'autres rapports suivront ayant pour objet les approches qui favorisent la sécurité de l'approvisionnement en eau du Canada, les positions prises par les utilisateurs finaux et les responsables politiques, et les recommandations pour l'amélioration de la sécurité de l'approvisionnement en eau dans les collectivités canadiennes.

Ce présent rapport propose une synthèse des approches permettant de prendre la mesure de la question de la sécurité de l'approvisionnement en eau du Canada. Cette évaluation repose sur l'inventaire des indicateurs relatifs à l'eau potable que nous avons dressé, une analyse de l'inventaire, un dépouillement de la littérature, les résultats tirés de l'enquête de 2008 sur la sécurité de l'approvisionnement en eau, ainsi que les commentaires recueillis auprès de professionnels lors d'un atelier sur la sécurité de l'approvisionnement en eau tenu en septembre 2009. De plus, le rapport examine dans quelle mesure les différents paliers de gouvernement peuvent influer sur l'utilisation de ces indicateurs par les divers utilisateurs finaux. L'inventaire est disponible à l'adresse web suivante : www.watersecurity.ca.

RAPPORT

Le rapport se divise en cinq parties:

Partie 1: Introduction: Les approches en matière de sécurité de l'approvisionnement en eau

Cette partie est un survol du concept nouveau de la sécurité de l'approvisionnement en eau et fournit des explications de sa montée en puissance.

PRÉSENTATION DE LA STRUCTURE DU

Partie 2: À quoi servent les indicateurs?

Cette partie propose une synthèse du concept d'indicateurs environnementaux. Les questions suivantes y sont notamment traitées : que sont-ils, qui s'en sert et pourquoi, et que permettent-ils d'accomplir.

Partie 3: Un inventaire des indicateurs relatifs à l'eau potable au Canada

Cette partie du rapport fait état des résultats d'une analyse de l'inventaire exhaustif que nous avons dressé en février 2009 des indicateurs relatifs à l'eau potable utilisés au Canada. Pour les fins de l'analyse, les indicateurs ont été regroupés en fonction de cinq dimensions de la sécurité de l'approvisionnement en eau identifiées par l'équipe de chercheurs. Un tel regroupement a permis de constater des écarts et des chevauchements entre les types d'indicateurs et de découvrir également quelques points faibles.

Partie 4: Les failles et faiblesses des approches mises de l'avant par le gouvernement

Un tour d'horizon de l'inventaire des indicateurs utilisés au Canda est présenté dans cette partie. La fragmentation des compétences entre les trois paliers de gouvernement est abordée (fédéral, provincial/territorial et municipal ou communautaire). L'analyse porte sur les principaux facteurs et tendances dans l'élaboration d'indicateurs par les instances fédérales et provinciales et sur les obstacles de taille auxquels le Canada est confronté dans sa capacité d'évaluer la sécurité de l'approvisionnement en eau.

Partie 5: Les recommandations

Le rapport se termine par des recommandations sur les modalités d'intervention à privilégier pour évaluer efficacement la sécurité de l'approvisionnement en eau du Canada.

PRINCIPAUX RÉSULTATS

L'inventaire a permis d'établir un tableau de bord des 365 indicateurs relatifs à l'eau potable utilisés au Canada. Nous présentons dans le rapport les principaux résultats d'une étude systématique réalisée sur cet inventaire des indicateurs :

- Il existe très peu d'indicateurs intégrés de l'eau (de surface et souterraine).
- Les indicateurs de la qualité de l'eau sont plus largement répandus que ceux portant sur la quantité de l'eau.
- Les indicateurs de la santé des écosystèmes sont plus largement répandus que ceux portant sur la santé humaine.
- Les indicateurs de l'eau de surface sont plus largement répandus que ceux portant sur les eaux souterraines.
- Les indicateurs de la gouvernance sont à la fois rares et mal définis.
- Les indicateurs des infrastructures sont limités et insuffisants.

PRINCIPALES FAILLES DE MISE EN ŒUVRE

L'ensemble des indicateurs utilisés au Canada présentent de nombreuses failles :

- Absence d'un « guichet unique » centralisé pour obtenir des outils de diffusion de données sur la surveillance des eaux (l'inventaire vise à corriger cette lacune).
- Manque d'un cadre de référence national ou d'une structure organisatrice qui consiste à assurer une équivalence et une cohésion entre les différents travaux gouvernementaux.
- Manque de coordination entre les ministères et organismes gouvernementaux dont le mandat est de concevoir les outils de surveillance des eaux et de diffuser les données. Il en résulte une confusion chez les utilisateurs finaux, un dédoublement des efforts ainsi que des failles au niveau des types d'indicateurs mis au point.
- Une influence infime des indicateurs environnementaux sur les politiques publiques ou le changement : les méthodes d'élaboration des indicateurs mettent l'accent plutôt sur la disponibilité des données au lieu des informations utiles aux décideurs. Ceci se traduit par un faible niveau d'application des indicateurs par les utilisateurs finaux.
- Manque d'acquisition de connaissances et d'intégration des processus décisionnels liés à l'eau potable au niveau communautaire.
- Les indicateurs d'évaluation de la qualité de l'eau

(c'est-à-dire la demande, l'offre ainsi que la condition des infrastructures) sont mal définis et sous estimés.
- Les indicateurs intégrés de l'eau (de surface et souterraine) sont mal définis.
- Les indicateurs de la gouvernance sont mal définis.

PRINCIPALES RECOMMANDATIONS

Les recommandations suivantes sont formulées dans ce rapport :

1. Répertoire centralisé des indicateurs et des données connexes

Aucun site ou répertoire centralisé réunissant des informations sur les indicateurs et les données connexes n'a été constitué jusqu'à présent. Nous disposons plutôt de toute une panoplie d'initiatives fédérales et provinciales ayant servi de base pour établir des indicateurs qui se retrouvent éparpillés dans une myriade de rapports et de sites web d'organismes de toutes sortes. Une fois qu'ils sont repérés, la récupération et l'interprétation des indicateurs exigent un temps considérable. Le manque de sources centralisées rejoint les préoccupations de tous les paliers de gouvernement (fédéral, provincial, municipal), le secteur privé et les organisations non gouvernementales (ONG).

2. L'harmonisation des actions menées sur les indicateurs

L'absence de cadre de référence ou de système pour la diffusion de données a eu pour conséquence que la publication des rapports environnementaux s'effectue sur une base ad hoc qui nuit à leur crédibilité. Les indicateurs environnementaux ont alors peu ou pas d'effets mesurables sur les processus d'élaboration des politiques. Les conclusions tirées de l'enquête de 2008 sur la sécurité de l'approvisionnement en eau et les résultats de l'analyse montrent à quel point il est important d'établir des normes dans le cadre des initiatives canadiennes d'élaboration des indicateurs. Cela comprend la mise en place de lignes directrices en matière de diffusion d'informations, ainsi que la constitution d'un cadre de référence harmonisé et d'une série d'indicateurs cohérents entre les niveaux fédéral et provincial.

3. Une plus grande collaboration

Les organismes fédéraux, les provinces et les groupes communautaires pourraient communiquer davantage et mieux partager les informations. Les dédoublements et chevauchements seront alors éliminés. Il existe de nombreuses possibilités permettant de mieux faire circuler les connaissances et mettre en valeur les indicateurs opérationnels.

4. La mission investie par les utilisateurs finaux

Les liens qui unissent les chercheurs dont l'objectif est de définir des indicateurs et les décideurs politiques à qui ils sont destinés sont plutôt limités. Qui plus est, la demande des producteurs et non celle des utilisateurs finaux joue un rôle moteur dans l'élaboration des indicateurs. Ces deux facteurs combinés font en sorte que les utilisateurs finaux appliquent peu les indicateurs et que les liens établis entre la science et la politique demeurent faibles. Une meilleure intégration des demandes des décideurs politiques et de la communauté dans la conception d'indicateurs pourrait assurer l'applicabilité et l'utilisation des indicateurs.

5. Le respect des délais

Les indicateurs devraient être en mesure de produire des données statistiques peu de temps après la période à laquelle elles se rapportent. Présentement, la majorité des rapports fédéraux sur les indicateurs environnementaux sont publiés deux ans après l'année de référence. Si l'influence des indicateurs se faisait sentir dans le domaine politique, il est essentiel que les responsables politiques puissent obtenir facilement les indicateurs les plus récents qui sont accessibles dans un format utilisable et le plus compréhensible possible.

6. Résoudre les failles

L'analyse effectuée de l'inventaire et les résultats obtenus de l'enquête montrent que très peu d'outils sont disponibles aujourd'hui pour évaluer les enjeux concernant la quantité de l'eau (incluant les infrastructures) ou les enjeux de la gouvernance de l'eau (de surface et souterraine). En vue d'identifier les actions prioritaires favorables à la sécurité de l'approvisionnement en eau du Canada, il est essentiel que les responsables politiques tiennent compte davantage des enjeux globaux de l'eau, notamment à l'échelle du bassin hydrographique.

Un investissement en ressources financières et humaines de la part des responsables politiques est nécessaire à long terme pour recueillir et analyser les données au fil du temps. Les réseaux de surveillance ont souffert d'importantes coupures budgétaires et, dans plusieurs régions du Canada, ils n'en existent pas du tout.

7. La collaboration entre les principales parties prenantes en vue d'élaborer un indice général sur la sécurité de l'approvisionnement en eau
Si de nouveaux indices ont été définis au Canada afin d'accroître la sécurité de l'approvisionnement en eau, il n'existe à ce jour aucun indice uniforme et largement reconnu. Les indices relatifs à l'eau utilisés aujourd'hui mettent l'accent seulement sur l'eau potable. Ils n'offrent pas de possibilités aux décideurs politiques de mener à bien une évaluation et faire l'arbitrage entre les demandes conflictuelles en eau, ou de réduire les effets néfastes potentiels associés aux pratiques de gestion du sol et de l'eau. C'est dans ce contexte qu'émergent des risques importants à l'équilibre naturel des bassins hydrographiques et donc à la santé publique. Une telle situation peut générer des coûts considérables.

8. La sécurité de l'approvisionnement en eau : une approche intégrée
À défaut de disposer d'un ensemble cohérent de connaissances et d'une démarche décisionnelle efficace en matière d'eau au niveau communautaire, il importe de renforcer la coordination des travaux visant à définir des indicateurs globaux sur la sécurité de l'approvisionnement en eau. La participation des utilisateurs finaux dans ces travaux est essentielle afin d'assurer l'applicabilité et l'utilisation des indicateurs. Grâce à une approche intégrée, les variables associées à l'eau forment un tout cohérent et une place centrale est accordée à l'élaboration, la diffusion et la mise en œuvre des indicateurs.

RESEARCH APPROACH

This report is the product of the first phase of a four-year (2008–2012) research project funded by the Canadian Water Network. The project, *Developing a Canadian Water Security Framework as a Tool for Improved Governance for Watersheds*, will create a Water Security Framework (WSF) that includes decision-support tools for water managers. The overriding objective of this research project is to create tools to support the improvement of water security in Canada, specifically through improving governance for source protection and land use.

The report provides a systematic review and evaluation of existing water-related indicators and offers a critical insight into the capacity of these indices to aid decision-making.

OBJECTIVES OF THIS REPORT

The two objectives of this report are (1) To create and analyze an inventory of all freshwater-related indicators in Canada, and (2) to broadly review the spectrum of indicators in Canada.

1. Create and analyze an inventory of all freshwater-related indicators in Canada

Indicators are crucial measurement tools in the assessment of water security in Canada. If we do not measure where we are, how will we know where we are going, or when we will get there? Since no comprehensive list of freshwater indicators in Canada existed, the initial aim of this project was to compile an exhaustive inventory. The inventory includes all indicators developed at the federal and provincial levels and some of the indicators developed by community groups. In data collection, every effort has been made to be as extensive as possible, but it is still not exhaustive. Data collection ceased in February 2009, and any indicators released since then are unlikely to be included in the inventory.

Once compiled, the inventory was analyzed by applying the five core dimensions of water security identified by the project researchers:

- resources (water quantity)
- ecosystem health
- human health
- infrastructure
- governance

Applying the five water security dimensions, common themes were identified along with overlaps and omissions among the types of indicators already in place or (where possible) under development. The inventory was analysed using the following nine most common themes:

- water quality

- water quantity
- ecosystem health
- human health
- surface water
- ground water
- integrated (surface and groundwater)
- infrastructure
- governance

Where possible, comparison tables were compiled to examine the differences among these nine categories[1], for example:

- water quality vs. water quantity indicators (Appendix 2)
- ecosystem health vs. human health indicators (Appendix 3)
- surface water vs. groundwater vs. integrated indicators (Appendix 4)

The comparison tables were further analyzed to identify gaps and overlaps. Other possible comparison categories including agriculture, transboundary governance, valuation or water pricing, metering, and climate change were not addressed specifically in the inventory analysis.

2. Broadly review the spectrum of indicators in Canada

Through a review of the literature and the results of the survey, this second objective was to look at federal, provincial, and community actors and examine how they interact (or not) with each other in the development and use of indicators. This section of the report examines the key drivers and trends in indicator development and identifies the major obstacles in Canada's capacity to assess water security. Recommendations are put forward to address these key concerns.

DATA AND RESEARCH METHODS

The report draws on three sources: an inventory of water security-related indicators, a literature review, and a large-scale survey of water managers and policy-makers.

Inventory of Indicators

Indicator research for this report occurred between June 2008 and March 2009. An inventory of all Canadian freshwater-related federal, provincial, and community indicators was conducted through analysis of reports, Internet searches, and guidance from practitioners. Federal and provincial representatives were contacted to verify accuracy and comprehensiveness of the inventory. Approximately 75% of those contacted provided feedback on the accuracy of the inventory for their area.

In total, an inventory of 365 freshwater-related indicators and indices was compiled. This survey of indicators and indices developed at the federal and provincial levels is, we believe, comprehensive. We have identified approximately 40 indices at the federal level, 143 at the provincial level, and 112 at the regional (large-scale watershed) level. In addition, at least 70 indicators have been developed at the community (small-scale watershed) level (including NGOs, municipalities, and industry). Due to time limitations, an exhaustive list of indicators developed at the community level was not feasible; instead, the 70 indices identified serve as a sample.[2]

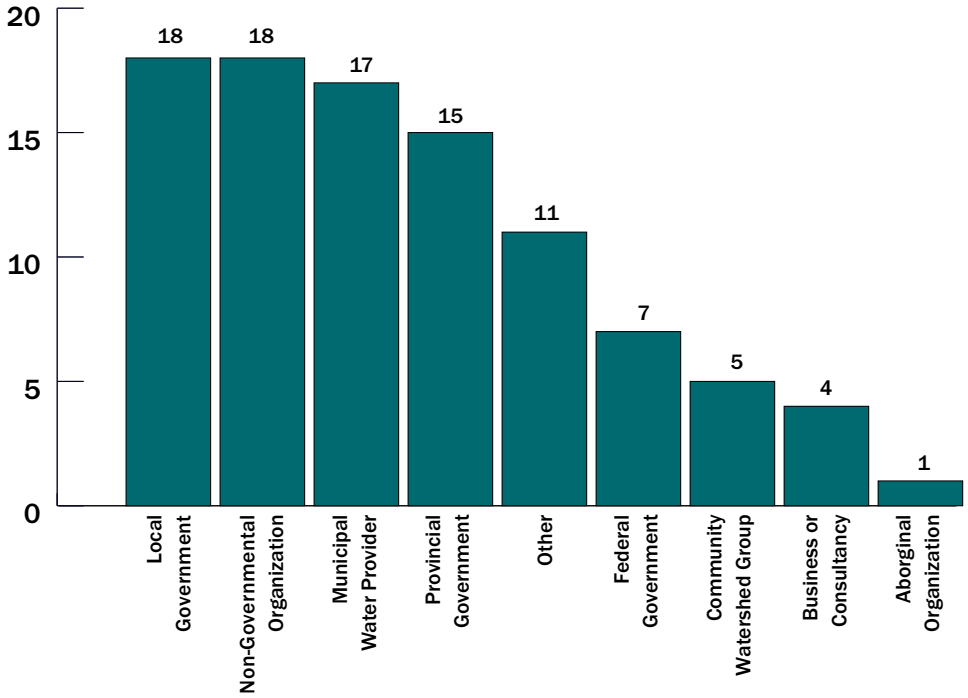
Although Canada, through more than 50 bilateral agreements, is committed to "sharing information" or "reporting on progress" in a particular area (Bond et al. 2005a,16), none of these or any other international indicators were within the scope of this project.

Literature review

The report includes supporting material from a range of papers on environmental indicators, which reinforce our findings.

1 These tables and others are listed in the Appendices to this report and are available on the project website www.watersecurity.ca.
2. Every waterway lies within a watershed. A watershed (also known as a "catchment" or "drainage basin") may be defined as a geographical area in which surface waters flow towards one destination. Watershed boundaries (or "divides") follow the highest ridgeline around the stream channels and meet at the lowest point of the land where water flows out of the watershed. Water flows in two different directions on either side of a divide. Watersheds can be subdivided into smaller watersheds, which collectively flow together to form larger watersheds. The scale at which the landscape is examined is relevant for identifying and defining watersheds. A watershed may be small, representing a single tributary within a larger system, or it can be quite large and cover thousands of kilometres. Watersheds can extend across municipal, provincial, and federal (international) borders.

Figure 1: Breakdown of 2008 Water Security Survey participants by organisation



Survey results

Between November and December 2008, we conducted a Web-based survey of 100 water practitioners across Canada (referred to as the 2008 Water Security Survey in this report). The survey was focused on data gathering, monitoring, and reporting tools[3], with an emphasis on water security-related indicators.

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.

Follow-up interviews were completed in the summer of 2009, and some of the comments, including aggregated opinions of practitioners, are included in this report. A separate policy report, to be available in early 2010, will provide detailed findings from survey and interviews.

Water Security Workshop

In September 2009, the University of British Columbia's Program on Water Governance hosted a workshop on water security at the Liu Institute for Global Issues in Vancouver (referred to here as the *2009 Water Security Workshop*). Sixty water practitioners from across Canada attended the workshop, representing a variety of different sectors including NGOs, consultants, municipalities, water utilities, and provincial and federal agencies. Plenary and small group discussions were supported by two background documents including a draft version of this policy report. Participants of the workshop expressed their view that the inventory was an extremely useful document.

3 In this policy report, the term "water monitoring and reporting tools" is an umbrella term to describe indicators, indices, benchmarks, and performance measures as well as report cards, sustainability checklists, and protocols.

1 INTRODUCTION: APPROACHES TO WATER SECURITY

Water security is an emerging concept. It may be defined as *sustainable access on a watershed basis to adequate quantities of water, of acceptable quality, to ensure human and ecosystem health*. This definition sets baseline requirements for water resources management in a watershed on a continuous basis; there must be access to adequate quantities of acceptable quality of water for both humans and the environment. In 2006, the United Nations Human Development Report described water security as

> ensuring that every person has reliable access to enough safe water at an affordable price to lead a healthy, dignified and productive life, while maintaining the ecological systems that provide water and also depend on water. When these conditions are not met, or when access to water is disrupted, people face acute human security risks transmitted through poor health and the disruption of livelihoods. (United Nations Human Development Report 2006, 3)

Interest in the concept continues to grow, as evidenced by the work of the World Economic Forum, which recently described water security as "the gossamer that links together the web of food, energy, climate, economic growth and human security challenges that the world economy faces over the next two decades" (World Economic Forum 2009, 5).

Water security takes a broad look at all demands placed upon a watershed, including quality, quantity (including climate change and allocation), ecosystem health, human health, infrastructure, and governance. Water security demands a greater priority for water. As such, it is a broad concept of holistic water management that balances resource protection and resource use. It is important to measure water security since this approach examines the watershed as a whole. Setting a goal of water security will enable decision-makers to effectively assess and mediate between conflicting demands for water use and minimize

potentially adverse impacts from land and water management practices.

Water-security related issues have been of growing concern in Canada over the past decade. Well-publicized water contamination incidents in Kashechewan (Ontario), Walkerton (Ontario), and North Battleford (Saskatchewan) have alerted Canadians to public health issues related to water quality (Butler 2008, O'Connor 2002, Parr 2005, Prudham 2004, Woo and Vicente 2003). At the federal level, reports from the National Water Resources Institute (Environment Canada) and the Senate on increased threats to water

have attracted renewed attention to water issues (Environment Canada 2001, 2004; Senate of Canada 2005).

Canada is not alone in dealing with water quality and water quantity concerns. Water, by its very nature, presents managers with three issues that are difficult to resolve: (1) competition between users of water resources; (2) vertical coordination of the multiple levels at which water is used and managed; and (3) the mismatch between geopolitical and administrative boundaries, on the one hand, and hydrological boundaries on the other.

These issues flow, in part, from the fact that water is a multi-purpose resource, which implies that multiple sets of users will operate at different scales. In turn, this creates competing uses and diverse views of stakeholders within the policy debate. For example, cities sit within watersheds, and the water within cities is often the subject of competing claims both upstream and downstream: industrial, tourism, amenity, residential, agricultural, and resource (e.g., hunting and fishing) uses. The debate over the Oak Ridges Moraine (north of Toronto) is one such example, of which there are many across the country.

Despite increased concern about water-related issues, no common definition of water security exists. Although several indices are being developed in Canada to support improved water security, no widely-accepted standard index of water security exists. Current water-related indices tend to focus more narrowly (e.g., solely on drinking water) and do not allow decision-makers to effectively assess and mediate between conflicting demands for water use, nor minimize the potential adverse impacts from land and water management practices. When examining a watershed, greater emphasis should be placed on the sum of all the parts: flow, use, quality, and biodiversity. Policy-makers, water resource managers, NGOs, industry, and agriculture, all need this information, despite their competing needs. If the complete picture is not available, then how can good decisions be made which can maintain a functioning ecosystem in the long term? This creates significant risks to watershed integrity and thereby to public health—a situation, which can in turn create significant costs.

How can indicators guide us along the path toward improved water security?

- First, indicators enable us to assess the state of Canada's water. Currently, little monitoring of this sort exists in Canada (in contrast to other countries), and this gap impedes our ability to adequately manage water resources.

- Second, indicators help us identify progress (or lack thereof) because they can be used to create baselines against which water-related variables can be measured over time.

- Third, indicators (under certain conditions) can be used to compare different locales and thus build a comparative picture of how well (or poorly) communities across Canada are faring in terms of water security. In short, indicators help us understand where we are, where we are going, and how well we are doing in relation to others.

2 OVERVIEW: WHY USE INDICATORS?

2.1 What is an indicator?

The term "indicator" describes a univariate or absolute number, a statistic, or a parameter. Tracked over time, an indicator can provide information, often related to trends, on the condition of a phenomenon and have significance extending beyond that associated with the properties of particular statistics (Bond et al. 2005b, Annex 3, 51). An example of a water-related indicator is the level of wastewater treatment: none, primary, secondary, or tertiary.

Conversely, an "index" is multivariate; an aggregate or complex number that incorporates a number of components. An index, in fact, is often comprised of a number of indicators. Expressed as a numerical scale, such as 1–100, it is a composite reflection that can enable, for example, two cities to be compared, or allow for a particular change over time to be described. Examples of indices include the Water Quality Index (WQI)[4], the Dow Jones Index of stock prices, or the UV Index of ultra-violet radiation.

Analysis of the inventory revealed that, generally in Canada, indices are more commonly used than indicators.

Despite their different meanings, the terms "indicator" and "index" are often used interchangeably. Frequently, "indicator" is used as a catch-all term that may include indices, performance measures, report cards, benchmarks, or objectives. The concept of indicator is loosely inferred when monitoring status, trends, and conditions. For example, both Saskatchewan Environment and the Saskatchewan Watershed Authority use a comprehensive suite of measures that are in essence indicators, but nevertheless are referred to as "performance measures." Alberta Environment clearly uses indicators as performance measures in its 2008–2011 Business Plan. In the Yukon, the terms "objective" and "monitoring programs" are used, and these can also be imprecisely interpreted as indicators. Manitoba uses "sustainability" indicators rather than "environmental" indicators. Environmental indicators are often used as a measure of the state of

the environment, whereas sustainability indicators are more often used in measuring progress towards a specific goal. (See Bond et al. 2005b, Annex 3 for a glossary of indicator and reporting terms.)

In this report, therefore, the term "indicator" will frequently be used as an umbrella term for both indicator and index.

The key characteristics of a good indicator are as follows:

- Easy to access
- Easy to understand

4 From the Canadian Council of Ministers of the Environment (CCME).

- Timely and relevant
- Reliable and consistent
- Credible, transparent, and accurate
- Developed with the end user in mind

Typically, environmental or sustainability indicators follow the Pressure-State-Response model, developed by the OECD (1997), meaning that they "focus on trends in the environment, the stresses that impact the ecosystem, the response of ecosystem change and societal actions to prevent or reduce stress" (Bond et al. 2005a, 6).

2.2 WHO DEVELOPS INDICATORS, AND HOW?

In Canada, various levels of government (federal, provincial, and municipal) develop indicators, as do industries and NGOs. Indicators are "intended to assist those in government who are responsible for developing policy and measuring performance, as well as to offer all Canadians information about environmental status and trends, and about the implications of the choices they make for the sustainability of the environment" (Government of Canada 2007, 2).

The development of an indicator typically involves three core stages, with key steps in between. The three core stages are as illustrated in figure 2 below: "Indicator Development Cycle"

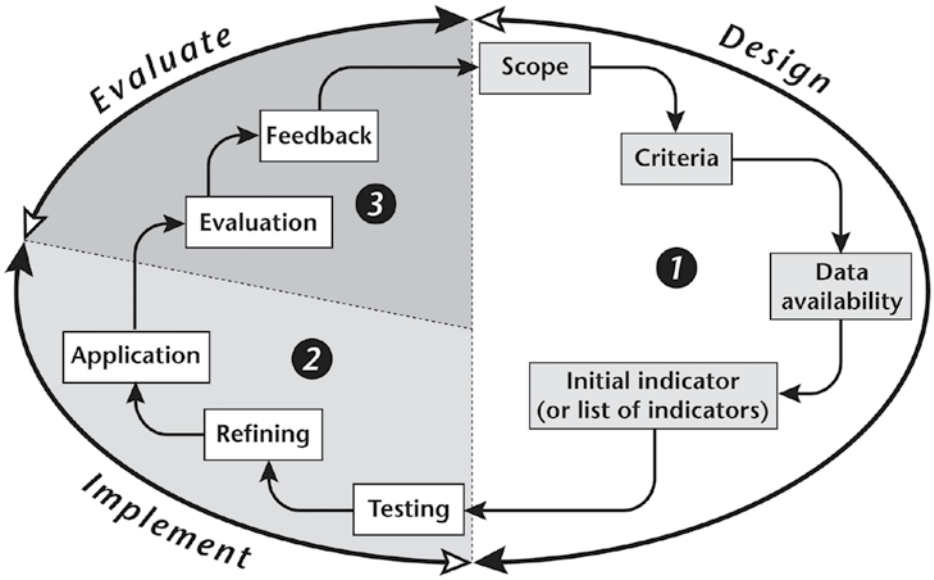
(1) Design: scoping to identify issues and problems and to set priorities; development of criteria; and review of data availability. At the end of the design stage, the goal is to have developed an indicator or a preliminary list of indicators.
(2) Implement: the indicator is tested and further refined before it is applied and the results published.
(3) Evaluate: the evaluation and feedback are critical stages in ensuring that the indicator continues to achieve its purpose.

This indicator development should continue as a cycle, further improving and refining the indicator. Currently, many indicator projects in Canada only complete one cycle, and there is no feedback to re-evaluate whether the scope, etc. has been met. Furthermore, in order to ensure applicability, buy-in, and uptake, stakeholders should be involved throughout the planning process. As Hilden states, "[t]his is critical for creating indicators that are salient, credible and legitimate to the key stakeholders" (Hildén and Rosenström, 2008).

2.3 WHO USES INDICATORS?

Table 1 shows the three typical audiences who use indicators, each with specific needs.

Figure 2: The Indicator Development Cycle



Each step should involve end-users where appropriate

Table 1: Target audiences and their indicator needs

Target audience	Indicator needs
Technical experts and science advisors	• raw data • highly detailed and complex indicators • emphasis on scientific validity and system complexity
Policy-makers, decision-makers and resource managers	Indicators directly related to: • policy objectives • evaluation criteria • target values
General public and media	• reduced set of indicators • easy-to-understand • represent issues of direct concern

Source: (adapted) Environment Canada and Canada Mortgage & Housing Corporation, Guidelines for the Development of Sustainability Indicators, August 2001.

Box 1: Examples of how end users apply water monitoring and reporting tools

- A municipality uses sustainability checklists to evaluate building permits, which include green building standards and water use.
- A provincial government uses water quality indices to identify poor water quality results, especially those exceeding management action thresholds, to trigger follow-up assessments and consideration of possible mitigation efforts and policy changes.
- A watershed authority uses a form of watershed report card to assess its progress on objectives outlined in the watershed management plan.

2008 Water Security Survey responses

In the 2008 Water Security Survey, 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. The survey respondents said they use water monitoring and assessment tools to

- 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;
- monitor and measure progress;
- compile reports; and
- make comparisons (either with other areas or past vs. current trends and future scenarios).

Box 1 provides some examples of usage by end users.

2.4 WHY USE INDICATORS?

In 1987, when the Brundtland Commission, formerly the World Commission on Environment and Development (WCED), published *Our Common Future*, the concept of sustainable development was pushed to the forefront of government policy, and the value of environmental information increased dramatically. Since then, the development of environmental indicators has proliferated, both in Canada and internationally. Government reporting initiatives, international reporting requirements (such as Chapter 40 of United Nations Agenda 21, which mandated the development of sustainability indicators by all countries) combined with the advances in information technology have triggered a flood of environmental indicators in Canada. The justification for new indicators was based, in part, on the need for analytical methods similar to economic indicators, but which would be more relevant to environmental systems (Environment Canada, 2005a). "[P]rogress is no longer seen through a purely economic lens, but one that encompasses the three pillars of sustainable development: social, environmental, and economic" (Brennin 2007, 4).

Indicators play an important role, enabling us "to take complex scientific and social data to provide a simplified, quantified and communicated expression that anyone can understand" (US EPA 2008). Keating states that, initially, "reporting focused on gathering together as much knowledge as possible. The result was books hundreds of pages long. While they formed valuable reference works, they were so complex as to be almost impenetrable to anyone wanting a quick synopsis of key issues and trends. Indicators are ways of aggregating complex information to make it understandable" (Keating 2001, 5).

The pressing need for quick snapshots of critical issues and trends driven by the information age resulted in development of an increasing number of indicators.

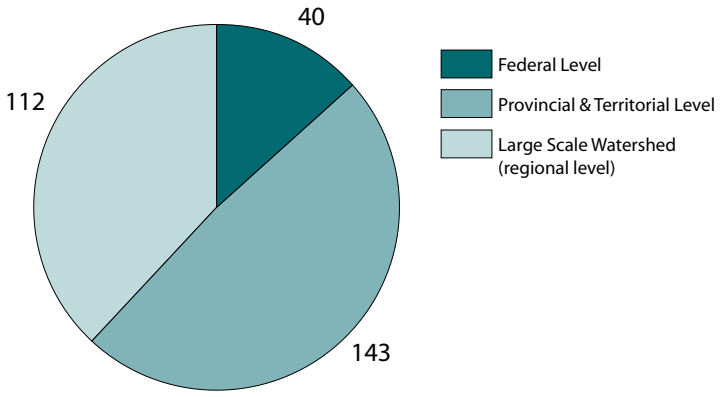
3 AN INVENTORY OF FRESHWATER-RELATED INDICATORS

Analysis of the inventory identified more than 300 freshwater-related indicators. The majority of these indicators were developed by governments: 295 freshwater-related indicators developed by federal and provincial agencies in Canada. A total of 40 indicators were developed at the federal level, 143 at the provincial level, 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)[5] organizations such as municipalities and NGOs. In sum, at least 365 indicators in Canada address water-related issues. This inventory does not include any of the 50 bilateral agreements Canada is committed to that require information sharing and progress reports; nor does it include any other international indicators.

Despite the flurry of environmental indicator development and the number of organizations producing them, the current trend is a "large number of indicators addressing a small number of issues" (Bond et al. 2005a, 4). For example, water quality indicators dominate the inventory, with emphasis on source water protection. Substantially fewer indicators exist to monitor water quantity or ailing infrastructure.

Appendix 1 of this report provides the inventory of Canadian freshwater-related indicators. This is a comprehensive list of all the federal and provincial/territorial indicators. It also includes examples of large-scale watershed (regional) indicator initiatives along with small-scale watershed or "community level" (i.e., municipal, industry, or NGO) indicator initiatives. The inventory also includes indicators currently under development (in grey text). Although indicators are the focus of the inventory, a few other types of water-related monitoring and reporting tools have been included, such as performance measures, benchmarks, or report cards.

Figure 3: Number of water-related indicators by government



This list has been further categorized using the core water security dimensions:

- Resources: water quantity[6]
- Ecosystem health: water quality and water quantity
- Human health: water quality
- Infrastructure (inc. water demand/use, condition, wastewater treatment)
- Governance

5 This inventory focuses on indicators developed at the federal and provincial scale. Although report cards, sustainability checklists, benchmarking tools etc. can be applied in a similar way to indicators as monitoring and reporting tools, they are not included in the inventory.
6 Demand and consumption indicators are included in both Appendix 2: Water Quality vs. Water Quantity and Appendix 5: Infrastructure Indicators (which includes consumption, wastewater treatment, and condition indicators).

The inventory was compiled through reports, Internet searches, and guidance from practitioners. To ensure that the list is exhaustive and comprehensive, federal and provincial/territorial representatives were requested to review the list. Of the 13 provinces and territories consulted, 75% gave feedback on the accuracy of the provincial/territorial indicator inventory.

Table 2 provides an overview of the key areas that Canadian freshwater-related indicators cover, using the five water security dimensions. Water-monitoring and reporting tools currently under development are not included in the tally in Table 2. Furthermore, all totals are approximate; it is possible that some indicators could be double-counted. Although this list was intended to be exhaustive, inevitably some indicators or initiatives may have been overlooked. To fully capture every single community indicator was beyond the scope of the project.[7] Instead, those listed represent only a handful of the many that have been developed by municipal governments, community groups, watershed authorities, and NGOs. As mentioned earlier, international indicators are not included either. It may be noted that the challenges encountered in compiling this list underlined how difficult and time-consuming it is for end users to navigate their way through the Canadian indicator landscape.

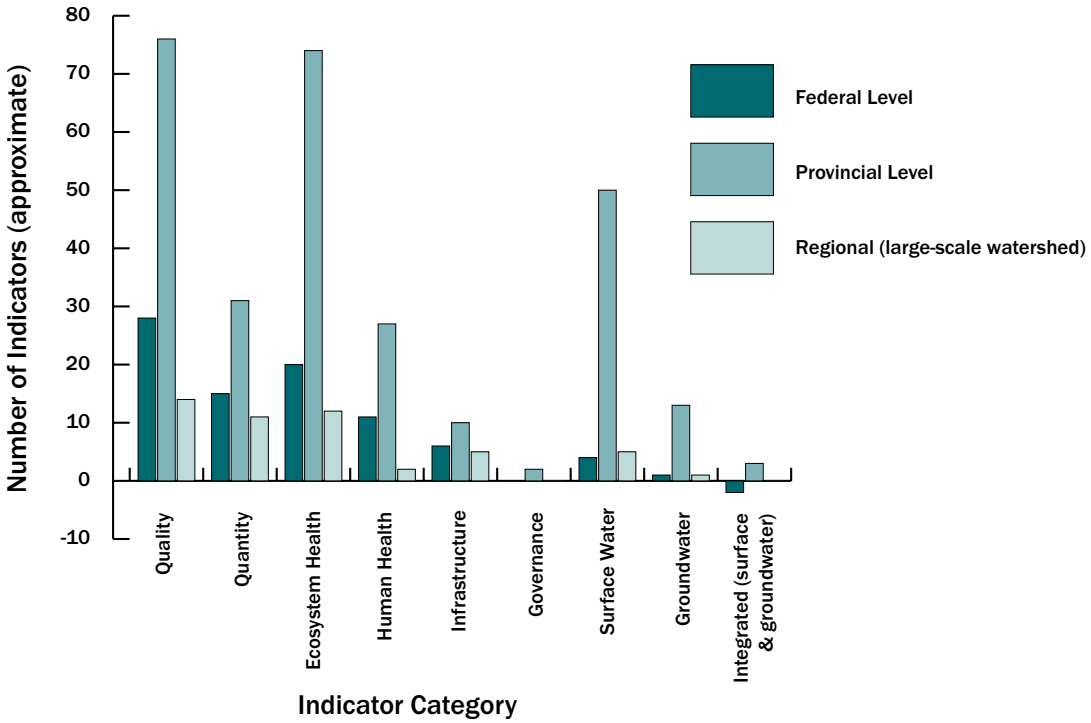
Table 2 demonstrates that currently in Canada, indicators focus mostly on measuring water quality (ecosystem health and human health), followed by resources (water quantity). Indicators measuring infrastructure and governance remain significantly underdeveloped.

Table 2: Matrix of indicators – using the five core dimensions of water security

	Total	Resources (quantity)	Ecosystem Health	Human Health	Infra-structure (incl. wwt)	Governance
Federal Level	**40**	✔	✔	✔	✔	**x**
Provincial & Territorial Level	**143**					
Alberta	21	✔	✔	✔	✔	✔
B.C.	21	✔	✔	✔	**x**	**x**
Manitoba	8	✔	✔	✔	✔	**x**
New Brunswick	4	✔	✔	✔	**x**	**x**
Newfoundland & Labrador	10	✔	✔	✔	✔	**x**
Nova Scotia	3	✔	✔	✔	✔	**x**
Ontario	13	✔	✔	✔	**x**	**x**
Prince Edward Island	8	✔	✔	✔	**x**	**x**
Quebec	>18	✔	✔	✔	**x**	**x**
Saskatchewan	28	✔	✔	✔	✔	✔
Northwest Territories	>7	✔	✔	✔	**x**	**x**
Nunavut	0	**x**	**x**	**x**	**x**	**x**
Yukon	2	**x**	✔	**x**	**x**	**x**
Large-scale watershed (regional level)	**112**	✔	✔	✔	✔	**x**
Small-scale watershed (community level)	**>70**	✔	✔	✔	✔	**x**

✔ = One or more indicator found (developed or under development) **x** = No indicators found (developed or under development)

Figure 4: Freshwater-related indicators in Canada



Through a more detailed analysis, the following observations were made regarding federal and provincial/territorial freshwater-related indicators (the comparison tables are available at http://www.watergovernance.ca/security/index.htm):

- Water quality indicators dominate over water quantity indicators (Appendix 2).
- There are significantly more ecosystem health indicators than human health indicators (Appendix 3).
- Surface water indicators dominate over groundwater indicators (Appendix 4).
- There are only a few integrated (surface and groundwater) indicators (Appendix 4).
- There are a limited number of infrastructure indicators at the federal/provincial level (Appendix 5).
- 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 (Appendix 6).
- 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).

3.1 WATER QUALITY

Water quality indicators in this section are either single water quality indicators or indicators that include a water quality component. Water quality dominates the inventory. There are over 100, with approximately 28 at the federal level and 76 at the provincial level (Table 3). They span ecosystem health (for example, freshwater quality index ratings for lakes) and human health (for example, source and treated water quality).

Water quality indicators are prevalent at the federal and provincial levels, driven largely by the widely accepted CCME Water Quality Index (CCME WQI). The CCME WQI developed in 2001 provides a flexible method of assessing surface water quality: "water quality data to be compiled and reported in a consistent manner throughout Canadian jurisdictions" (CCME 2009). Its flexibility and adaptability have resulted in it being the only water-quality-related index accepted by all Canadian provinces and territories and adopted nationally.[8] However, there are not enough data available for this particular indicator to be reported as a national trend, and not all provinces and territories

Table 3: Tally of water quality indicators

	Approximate number of water quality indicators
Federal level	28
Provincial level	76
Large-scale watershed (regional level)	14
Small-scale watershed (community) level	28
Total	**146**

7 A detailed inventory of indicators developed at the community level, for example municipalities across Canada, could be another study.
8 As a useful tool.

actually report it (Government of Canada 2007, iii). While the CCME WQI provides the platform from which many other water-quality-related indicators have sprung, the index can only be applied to surface water bodies and does not examine drinking water quality.

Although a post-Walkerton drive for "greater emphasis on source water protection [and] higher water quality standards" exists, there are substantially fewer water quality indicators that address human health (i.e., drinking water quality) (Hill et al. 2008). The majority of the water quality indicators focus on ecosystem health.

Water quality indicators at the provincial level follow a similar pattern to federal level indicators; there are a greater number of ecosystem water quality indicators compared to drinking water quality indicators.

3.2 WATER QUANTITY

In total, there are approximately 46 federal and provincial indicators that measure water quantity in Canada (Table 4). This is less than half as the number of water quantity indicators that exist at the same scales (104). Although a number of new indicators under development do address quantity concerns (Appendix 2).

At the federal level, there are almost double the number of water quality indicators (28) than water quantity indicators (15) that are either in effect or under development. Similarly, at the provincial level, the number of water quality indicators (76) are more than double the number of water quantity indicators (30). However, at the large-scale and small-scale watershed level, the number of indicators measuring quality and quantity are more even.

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:

- Water intake as a share of stream flow (applies to major basins only)—by Statistics Canada (Human Activity and the Environment)
- The Canadian Water Sustainability Index (CWSI) by the Policy Research Initiative— looked at availability, supply and demand; now disbanded (PRI 2007)
- The Water Availability Index (WAI), currently under development by Environment Canada (will likely examine water demand and supply)

At the provincial level, Alberta Environment has an indicator that monitors water allocations compared to natural flows. Regionally, the Composite Index of Vulnerability of Prairie Resources accounts for demand and supply data in Alberta, Manitoba, and Saskatchewan (Box 2).

Participants in the 2008 Water Security Survey

Table 4: Tally of water quality and water quantity indicators

	Approximate number of water quality indicators	Approximate number of water quantity indicators
Federal Level	28	15
Provincial Level	76	31
Large-scale watershed (regional level)	14	11
Small-scale watershed (community) level	27	23
Total	**146**	**80**

Box 2: Example of an integrated water quality and quantity index

Composite Index of Vulnerability for Prairie Water Resources (2005): This regional initiative (Alberta, Saskatchewan, and Manitoba) looks at water availability stresses, water use stresses, water quality stresses, agricultural soil and water conservation practices, and water policy programs.

highlighted the general absence of water supply and demand data (both federally and provincially). The lack of data on water availability and water usage (supply and demand) in Canada has been acknowledged at the federal level. Statistics Canada is making some effort to address this data gap through the collation of new statistics. Consumption patterns appear to be tracked more actively at the community level (which includes municipalities) than at the provincial level.

3.3 ECOSYSTEM HEALTH

Ecosystem health indicators are the most common type of water quality indicator; they dominate over human health indicators. They have been developed at the federal, regional, provincial, and community levels (Appendix 3).

A wide selection of indicators measure ecosystem health. These range 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.

Table 5: Tally of ecosystem health indicators

	Approximate number of water quality indicators
Federal level	20
Provincial level	74
Large-scale watershed (regional level)	12
Small-scale watershed (community) level	22
Total	**128**

There are some overlaps, particularly in wastewater treatment, which can be used as an indicator of pollution into waterways or as an indicator of human health. Wastewater treatment indicators have also been included in Appendix 5: Infrastructure Indicators. There are approximately 20 federal level ecosystem indicators (or indicator components) and approximately 74 provincial level ecosystem indicators (Table 5).

3.4 HUMAN HEALTH

Monitoring water quality for basic human health is a long-established practice and, from a medical perspective at least, is one of the best instances of "common" indicators used for fresh water across Canada.

Human health indicators that are water-related are varied in scope. This category includes a range of indicators such as source water quality (for drinking water purposes), treated water quality, bathing water quality, as well as levels of wastewater treatment (Appendix 3).

In total, there are 94 ecosystem health indicators at the federal and provincial level, compared with 38 human health indicators (Table 6). 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 Guidelines for Canadian Drinking Water Quality have not been included in the inventory, it should be acknowledged that they include standardized indicators. Many (although not all) jurisdictions follow these guidelines and hence use these indicators. Not every jurisdiction follows or applies the guidelines in the same way. Currently, there are 10 different standards for drinking water quality across the 10 provinces and 3 territories. Three provinces, Manitoba, Alberta, and Nova Scotia, have adopted the national guidelines (Bakker 2007, 378).

Ontario is progressive in monitoring and reporting of water-related public health concerns, as well as protecting drinking water at the source. However, since most of the reporting initiatives are legislated, there are few human health "indicators" per se: "A key focus of the legislation is the production of locally-developed,

Table 6: Tally of ecosystem health and human health indicators

	Approximate number of ecosystem health indicators	Approximate number of human health indicators
Federal Level	20	11
Provincial Level	74	27
Large-scale watershed (regional level)	12	2
Small-scale watershed (community) level	22	17
Total	**128**	**57**

science-based source water assessment reports and protection plans" (Government of Ontario 2006, 4).

More than 1760 provincial boil-water advisories are in effect in communities and neighbourhoods across Canada (Canadian Medical Association 2008, 1261). To date, there appears to be no systematic monitoring or associated indicator for human health issues relating to water quality (Box 3). For example, the number of hospital visits attributed to gastrointestinal illnesses is monitored (Canadian Medical Association 2008, 1263). Some of these visits result from waterborne causes; however, they are not tracked.

Box 3: Provinces with boil-water advisory monitoring tools available to the public

- Ontario has two boil-water advisory indicators through the Association of Public Health Epidemiologists.
- Northwest Territories monitors boil-water advisories through its Drinking Water Quality Database.
- Nova Scotia has a dedicated boil-water advisory website, which is updated weekly.
- Newfoundland and Labrador, British Columbia, and Manitoba Water Stewardship have websites that list boil-water advisories currently in effect.

3.5 SURFACE, GROUNDWATER, AND INTEGRATED INDICATORS

As shown in Table 7, there are significantly more surface water indicators or indicator components (approximately 4 at the federal level compare to 50 at the provincial level) than groundwater indicators or indicator components (one 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.[9] Provincial efforts have not focused on groundwater sources to the extent that they have focused on surface water sources. At the community level, only those communities relying on groundwater would likely have groundwater indicators.

Significant variation exists across the provinces in groundwater data monitoring and reporting. Prince Edward Island, which relies heavily on groundwater, makes its groundwater data (including groundwater

Table 7: Tally of surface water, groundwater, and integrated indicators

	Approximate number of surface water indicators	Approximate number of groundwater indicators	Approximate number of integrated (surface and groundwater indicators)
Federal Level	4	1	-2
Provincial Level	50	13	2
Large-scale watershed (regional) level	5	1	0
Small-scale watershed (community) level	12	5	0
Total	**71**	**20**	**4**

9 Transboundary in this context meaning either across the borders between Canadian provinces or across Canada–U.S. state borders.

levels) available at http://web3.gov.pe.ca/waterdata/tool.php3), while Nova Scotia makes interactive groundwater maps available at http://gis4.natr.gov.ns.ca/website/nsgroundwater/viewer.htm).

There are two integrated (both surface and groundwater) indicators under development at the federal level and two under development at the provincial level (Appendix 4). The scarcity of integrated surface and groundwater indicators underscores how Canada has not moved fully toward the watershed approach. Since, these integrated approaches have been developed recently (or are still under development), only limited information is currently available.

Alberta, Nova Scotia, and Saskatchewan use the GUDI Protocol: Determining Groundwater under the Direct Influence of Surface Water. Although this is included in the inventory, since it is not technically an indicator it is not included in the inventory tally. The GUDI protocol applies to any groundwater source, where microbial pathogens can travel from nearby surface water sources into groundwater sources. In these provinces, water sourced from groundwater must meet treatment standards (usually filtration) applied to surface water. (Government of Nova Scotia 2002, Program on Water Governance 2008).

Similarly, tools for groundwater vulnerability and hazard and risk assessment are under development and, therefore, have not been widely applied. At the time of publication of this report, little information about them is available.

Table 8: Tally of infrastructure indicators

	Approximate number of water quality indicators
Federal level	6
Provincial level	10
Large-scale watershed (regional level)	5
Small-scale watershed (community) level	9
Total	**30**

3.6 INFRASTRUCTURE

Water infrastructure typically refers to the physical assets that are relied upon to store, treat and transport water: for example, reservoirs, pumps, treatment plants, sewers, and distribution systems.

Infrastructure indicators in Canada remain largely underdeveloped, limited in number and in scope (Appendix 5). Of the 183 freshwater-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 treatment. As shown in Table 8, at the provincial level, there are 10 infrastructure related indicators, of which only a handful monitor issues relating to aging water infrastructure (such as full-cost recovery pricing, infrastructure investment, and leakage levels). The only indicator that takes a broader view is the infrastructure component of the Policy Research Initiative (PRI) Canadian Water Sustainability Index (CWSI) (see Note 14), which assesses infrastructure in terms of demand, condition, and treatment.

There are three federal level indicator initiatives that examine infrastructure-related issues; among them are six infrastructure indicators or indicator components, two of which look at either water or wastewater treatment levels. The third initiative is the most comprehensive to date: the PRI CWSI.

Provinces that have developed infrastructure indicators include: Alberta, Saskatchewan and Newfoundland. Between them there are 8 infrastructure indicators or indicator components. Alberta has a facility design indicator that "indicates if continuous improvement and upgrading is occurring at regulated facilities" (Alberta Environment 2009). Saskatchewan is the only province to offer a suite of indicators addressing infrastructure investments:

- Waterworks systems and operations financially sustainable (Saskatchewan Environment)
- Risks associated with water management infrastructure (Saskatchewan Water Authority)
- Number of dams requiring upgrades to meet dam safety criteria (Saskatchewan Water Authority)

Indicators that explicitly report leakage levels or system losses are not used at the federal or provincial level. Newfoundland uses the Langelier Index, which is an approximate indicator of the degree of saturation of calcium carbonate in water. Water supply operators can use the Langelier Index as a tool to optimize their water supply systems and identify leakage potentials. No other province uses this index.

In addition to these, Manitoba's public water treatment plants use four classes of treatment, depending on the quality of source waters. This classification will be used as an indicator and is currently under development. Nova Scotia uses a performance measure to report on the percentage of population served by municipal water supplies that meet the health-based criteria for bacteriological quality.

The Genuine Progress Index for Atlantic Canada (GPI*Atlantic*) has an infrastructure component. It takes a broader approach to water security by adding in economic valuation. Developed by a NGO, with support from Environment Canada (which is interested the GPI*Atlantic* being applied across Canada), the index has been tested in Nova Scotia. The GPI consists of two parts: (1) an indicator part—the development of indicators and measures of progress (trends)—and (2) an economic valuation—assessments of the economic value of non-market social and environmental assets not generally valued in conventional economic statistics (Box 5).

The GPI takes a markedly different approach to other indicator initiatives since it includes mechanisms to measure damage costs due to water quality decline, defensive expenditures (such as pollution abatement), restoration costs, and health impacts. The developers of this indicator advocate that price signals (full-cost accounting) are the major determinant of behaviour changes, rather than the actual indicators.

At the large-scale watershed (regional level) there are two monitoring and reporting initiatives that include infrastructure components, both of which are wastewater treatment.

At the small-scale watershed (community level), the range of infrastructure indicators also tends to focus on levels of wastewater treatment. Metro Vancouver's Infrastructure Leakage Index is an example of an infrastructure indicator. It examines the ratio of annual losses to unavoidable annual losses. However, Metro Vancouver has been unable to report on leakage levels and system losses using this index due to "limitations in the technology for measuring water losses in large buried pipes" (Metro Vancouver 2007, 8).

In 2005, the International Water Association applied its Infrastructure Leakage Index to a handful of selected municipalities across Canada. However, this index was not widely applied and does not appear to be reported on a regular basis (Eichenberger 2005).

3.7 GOVERNANCE

The role of good governance and the need for transparency and accountability is becoming increasingly central to debates over environmental indicators. Nevertheless, the development of indicators that monitor good governance in Canada or in the wider international community has been extremely limited.

No governance indicators exist at the federal level and few at the provincial level (see Appendix 6), 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 noted the absence of this type of indicator. This shortage 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).

Only two governance indicators were found in the entire inventory. These were developed at the provincial level and only scratch the surface of good governance:

- Alberta tracks the number of watershed stewardship organizations.

- Saskatchewan tracks whether citizens have meaningful access to information about the quality of their water.

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).

4 GAPS AND WEAKNESSES IN CANADA'S CAPACITY TO ASSESS WATER SECURITY

In Canada, the development and reporting of indicators is entirely voluntary and not regulated or enforced at any level. Despite rapid expansion in the number of indicators being developed by a diverse range of players, they cover only a narrow scope and lack both consolidation and commonality.

4.1 JURISDICTIONAL FRAGMENTATION

Numerous federal agencies, provincial/territorial governments, NGOs, and community groups develop environmental indicators, but there is little interaction among the developers. Tiered levels of government add complexity since there is no overarching body that manages or coordinates their use, resulting in a fragmented national scheme of indicators.

Approximately 40 federal level water-related indicators exist, 9 of which are under development (as of February 2009). Most of these indicators are applied nationally. The focus of these indicators is largely on water quality, particularly ecosystem health. A handful of indicators examine water quantity issues. Infrastructure indicators are limited in number and in scope. There are no governance indicators at the national/federal level.

At the provincial and territorial level, the inventory analysis identified 143 indicators. A broad range of these water-related indicators illustrate the state of water quantity and quality, with the primary focus tending to be ecosystem health. Infrastructure and governance indicators are limited in number and in scope.

At the large-scale watershed (regional level), the inventory revealed approximately 112 indicators. The types of regional indicators described in this report were developed for major watersheds that traverse provincial/territorial boundaries and/or international boundaries. Regional indicators are often applied to an entire ecosystem and consequently are broadly applied to the water-related issues of quantity and quality, although their primary focus tends to be ecosystem health.[10] Infrastructure and governance indicators do not typically feature in regional indicator initiatives.

The focus of this report has been federal and provincial level indicator initiatives. Only a small sample (70 in total) of community indicators are included in the inventory, although it is thought that many more indicators have been developed at this level. For an example, a study by Environment Canada and the Canada Mortgage and Housing Corporation in the mid-1990s "identified more than 900 indicators that had been developed at the community level. Of these, 214 were concerned with water …" (Bond et al. 2005a, 15).

10 Although this inventory focuses on freshwater-related indicators, some saltwater indicators are included.

At the community level, there is a broader interpretation of the concept of an "indicator." For example, monitoring and reporting tools include report cards, benchmarks, performance measures, water footprints, road maps, "plans,"[11] sustainability reporting, and progress reports. Many of these are in essence indicators, but different names are applied and different approaches taken. For example, some will measure and report on the state of an ecosystem, while others may also measure progress towards the achievement of environmental management or sustainability objectives. Water quantity indicators are seen more frequently at the community level than at the provincial or federal level.

4.1.1 Federal level

At the federal level, indicator development and reporting is dispersed across agencies resulting in fragmentation: "Unlike economic statistics, however, environmental statistics have up to now been collected in a largely ad hoc fashion. Statistical data collection and reporting have mostly been conducted to suit the needs of individual policy initiatives, following the ebb and flow of environmental concerns" (Statistics Canada 2009, 1).

Several waves of federal reporting/indicator initiatives have taken place since the 1980s, reflecting changes in environmental concerns. With senior decision-makers having acknowledged their confusion over linkages between federal initiatives (Bond et al. 2005b, Annex 2: 47), it is no surprise that practitioners find the current indicator scheme difficult to discern. A central information/data repository does not exist; instead there exists a complicated web of federal indicators buried amongst a myriad of reports, agency websites, and reporting initiatives. Information is difficult to access: both finding and deciphering it is a challenge.

Eleven different federal government environmental indicator and/or monitoring and reporting initiatives exist:

- National Indicator Series
- State of the Environment Reporting (SOE)
- State of the Debate
- Canadian Environmental Sustainability Indicators (CESI)
- Canadian Information System for the Environment (CISE)
- Environment and Sustainable Development Indicators (ESDI)
- Human Activity and the Environment
- Agri-Environmental Indicators (AEIs)
- Convention for Biological Diversity
- Natural Capital Accounts Initiative of Statistics Canada
- Children's Health and the Environment

Nine different federal agencies or federal level players are involved in the development of environmental indicators and/or monitoring and reporting initiatives:

- Environment Canada
- Health Canada
- Statistics Canada
- Natural Resources Canada
- Agriculture and Agri-foods Canada
- National Round Table on the Environmental and Economy (NTREE)
- Canadian Council Ministers of the Environment (CCME)
- Canadian Council of Resource Ministers (CCRM)
- Policy Research Initiative (PRI)

Furthermore, Canada is involved in a number of international initiatives. However, these were not included in the scope of this research.

Despite an increasing number of indicators being generated, few are widely integrated at the federal level or across agencies and departments (Bond et al. 2005a, 19). Consequently, the result is a "patchwork quilt of indicators and models, with too little consistency and too much potential for either overlap and duplication of effort, or gaps that need to be addressed" (Bond et al. 2005a, 24).

11 For example, the Okanagan Basin Water Board's Drought Management Plan contains four different indices used to measure drought intensity. Manitoba has many conservation districts that have developed 'Watershed Plans'. Other examples of "plans" include the Atlantic Coastal Action Plan (ACAP) and the City of Guelph's "Green Plan".

The lack of a national framework and the need for more integration is well known. In 1990, the CCME established the State of the Environment (SOE) Reporting Task Group. One of their objectives was to "establish common guidelines for SOE reporting; develop a common menu of environmental indicators…". However, the Task Group's advice went unheeded since "…various jurisdictions never employed either the common menu of indicators or the guidelines for SOE reporting" and by 1997, the Task Group was disbanded (Bond et al. 2005a, 21). In 2002, Environment Canada surveyed indicator practitioners, as did the 2008 Water Security Survey. Practitioners who participated in both surveys reiterated this call for a national framework of indicators (Box 4).

This diversity of indicators and lack of harmony is a symptom of fragmented water policy and legislation at both the federal and provincial/territorial levels. Responses to Environment Canada's 2002 water practitioner and decision-maker survey support this finding:

> There is a perception that while there is a great deal of activity on indicators, there has been too little communication and sharing of approaches among organizations. The tendency towards isolated activity, in turn, raises the prospect of duplication and overlap of efforts, and the loss of opportunities for progress towards a more fully integrated approach… (Bond et al. 2005b, Annex 2, 47).

The absence of a reporting framework or system has resulted in incomplete and inconsistent environmental reporting, lacking in credibility. Ultimately, environmental indicators have little to no impact on policy development: "As the need to pursue these [environmental] policies becomes more urgent, this situation will become increasingly problematic" (Statistics Canada 2009, 19).

In 2003, UNEP highlighted the importance of an "effort to promote multi-sectoral and multi-institutional collaboration on data and indicator work, especially among national statistics offices, ministries of environment and other technical institutes, to minimize overlaps and duplication of efforts" (UNEP 2003, 5).

Box 4: Practitioners across Canada highlight the lack of national harmonization

- "There is no centralized framework of indicators, either standards or guidelines at a federal / provincial level (aside from the CCME WQI)."
- "Each jurisdiction develops tools within their boundaries. No national framework."
- "There is no central place to access or locate information (web portal or database)."
- "There should be more integration across Canada."
- "It is difficult and time consuming to search the many disparate systems to gather information."
- "No centralized system."
- "Overlaps and inconsistency occur between various groups (industrial, NGO, and government) because different tools are used."

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4.1.2 Provincial and Territorial Level

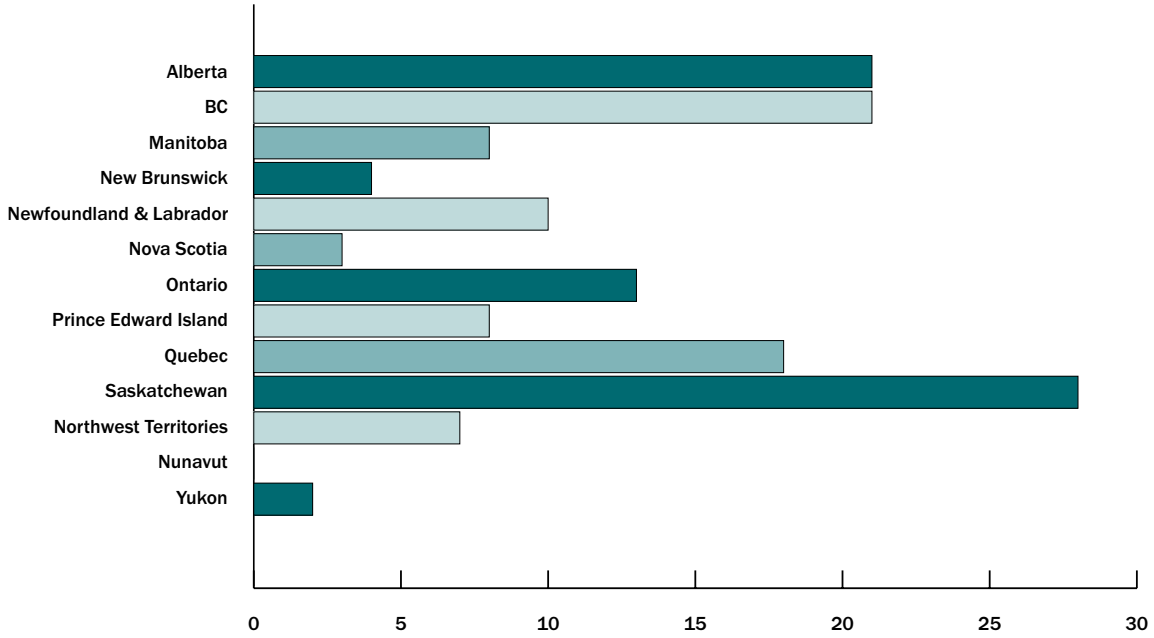
Under the Canadian constitution, territories have more constrained jurisdictional powers, in some instances, than provinces. As a result, the approach to water resource management is different. The territories tend to inherit the federal models (including indicators) and in most cases have not developed their own indicators. In the Yukon[12] and Northwest Territories, the reporting initiatives typically concentrate on ecosystem water quality or drinking water quality. Ecosystem health initiatives are usually undertaken in partnership with Environment Canada and the territory. Nunavut is unique in that it is the only part of Canada that appears to have no water-related indicators.

Fragmentation evident at the federal level is also visible at the provincial and territorial levels. This 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

12 The U.S. Geological Survey (USGS) considers the Yukon River to be an indicator basin, as it is one of the few largely uncontrolled rivers in North America.

Figure 5: Number of water related indicators by province or territory



provinces, a situation partly aggravated by the "silo structure" of government agencies (federal as well as provincial). Furthermore, "some jurisdictions or departments seek out comparisons, while others prefer to focus on their own progress without comparing themselves to how others are doing, have tended to hinder the application of a common menu of indicators and nationally consistent reporting" (Bond et al. 2005a, 25).

Although the CCME WQI has been adopted nationally, not all the provinces and territories report on this or any other water-related indicators. Ontario uses "standards" rather than indicators, as required under the *Clean Water Act, 2006*. Nunavut does not appear to use any freshwater-related indicators. Furthermore, there is variation across the country as to whether provinces report *specifically* on indicators or take a broader, more descriptive approach to sustainability reporting (Bond et al. 2005b, 18). If the more descriptive approach of sustainability reporting is taken, it becomes even more difficult and time-consuming to locate and tease out indicator information.

In terms of water monitoring and reporting tools, most initiatives in Ontario seems to focus on drinking water source protection through legislative instruments. At the provincial level, there are few indicators that address resources (i.e., water quantity), infrastructure condition, or governance. Quantity data are addressed more comprehensively through conservation authorities.

4.1.3 Large-scale watershed (regional level)

Although this report focuses on federal and provincial approaches to monitoring and reporting initiatives, it is important to acknowledge that there are extensive efforts to develop indicators in large-scale and small-scale watersheds. Large-scale watershed (regional) indicator initiatives include the following:

- Pacific and Yukon Region Environmental Indicators
- Atlantic Coastal Action Program
- Georgia Basin Action Plan
- Georgia Basin/Puget Sound Ecosystem Indicators Report
- St. Lawrence Action Plan
- Great Lakes Action Plan
- State of the Great Lakes
- Northern Ecosystem Initiative (including the Ashuki Project)
- Northern Rivers Ecosystem Initiative

- Atlantic Region Pilot Project (CCME WQI)
- Gulf of Maine Summit
- Mackenzie River Board

Despite the complex nature of regional collaboration and the comprehensive monitoring and reporting of the state of major ecosystems, many of these regional initiatives are successful at working together. For example, the Great Lakes are international waters shared with the U.S. federal government and eight Great Lakes states. "There are numerous pieces of legislation, treaties and agreements that govern how the many stakeholders address water quality and quantity impacts, as well as many established forums and partnerships to deal with Great Lakes issues" (Ontario Ministry of the Environment 2003). The Great Lakes region and the Atlantic region demonstrate how collaborative efforts between federal, provincial, community, and U.S. federal and state governments can be highly successful in developing and implementing monitoring and reporting programs.

4.1.4 Small-scale watershed (community level)

In this policy report, "community level" is used as a catchall term that includes indicator-reporting initiatives of organizations other than federal and provincial governments. For the purposes of this report, "community level" includes municipal and sectoral initiatives by NGOs, municipalities, conservation authorities, and industry as well as referring to small-scale watersheds. The following overview and analysis of the 70 community level indicators highlights current dilemmas faced by practitioners.

Ontario has 36 Conservation Authorities that monitor watersheds to "ensure safe drinking water, healthy fish to eat, clean beaches and enable us to adapt to climate change more easily" (Conservation Ontario 2005). Common reporting guidelines have been developed in the form of "watershed report cards" in order to "monitor three key environmental conditions that are important indicators of a watershed's health: forest conditions, surface water quality, and groundwater quality." The reporting style and frequency vary across the province. Although not explicitly measured as an "indicator" or included in the report card guidelines, many of the authorities (such as the Grand River Conservation Authority) measure quantity, including the relationship between demand and supply, as well as infrastructure-related issues. Governance indicators, as we have seen across the country, remain largely underdeveloped.

4.2 END-USER NEEDS NOT BEING MET

An important function of indicators is to inform and educate the public. It is an ongoing challenge to present indicator information that meets the needs of the local constituency, whilst maintaining scientific rigour.

In general, there is a disconnect between those that develop indicators and those that actually use them. There is a notable absence of local communities using indicators created by the federal government. By contrast, there has been a significant increase in the number of communities developing alternative indicators to suit their needs. This situation reinforces the thinking that federal reporting is driven more by internal requirements, rather than the needs of the end users.

There appears to be considerably more dialogue between some provincial governments (such as British Columbia, Manitoba, Alberta) and community groups in the development and implementation of indicators. Such collaboration recognizes that local knowledge has value and the direct involvement of local people "increases the likelihood that the resulting environmental information will be of value to public users" (Bond et al. 2005a, 25). Manitoba, for instance, is working with conservation districts, known as watershed groups, to develop indicators for use in upcoming watershed management planning initiative. A report from the Community Indicators Consortium comments on the potential for better linkages between community indicators and government performance measurement efforts:

> [I]f citizen-driven community indicators and government performance measurement were better linked, community indicators would have more influence on what government does to improve the community and government performance measures

> would become more relevant to the community conditions of greatest concerns to citizens (Community Indicators Consortium 2007, 4)

Another factor that contributes to the potential success of indicators is that they can produce information that is timely and relevant. Yet it is evident that, currently, there is a significant gap between the indicator information generated and its uptake and use by policy-makers. This is largely attributed to the fact that indicator development and reporting function was delegated to the scientists, those closest to the data collection and analysis. Yet few scientists have an understanding of the policy process, the needs of the policy-makers, and how best to communicate indicator information in a manner most understandable and useful to policy-makers (Brennin 2007, 7).

The result is that

> [e]nvironmental indicator information is often not presented in an understandable policy context that would make it clear why urgent action is required. It is frequently not made available in the most effective format for a policy audience, through the best channels, or at the right time in the policy cycle to be immediately useful to policy-makers (Brennin 2007, 2).

This poor communication between scientists and policy-makers, combined with the fact that the *producers*' needs drive the development of indicators, rather than the needs of the *end users* has limited end-user uptake and resulted in weak links between science and policy: "Current approaches have tended to rely too much on what data may be available and not enough on what decision-makers and the public need to know" (Bond et al. 2005a, 4).

4.3 DATA AND FUNDING ISSUES

Lack of long-term funding is a significant obstacle in terms of collaboration and data gathering, knowledge sharing and capacity building in the development of indicators (Bond et al. 2005a, 24). Collaboration between federal agencies has been impacted by budget cutbacks, which "resulted in the scaling back of both the federal SOE reporting program and the number of provincial programs" (Bond et al. 2005a, 24): Brennin comments:

> Changing governments, political priorities and bureaucratic leadership often result in sweeping reorganizations, reassignment of key personnel and funding reallocations, all of which further handicap progress (Brennin 2007, 2).

Financial and staff cutbacks have decreased the scope of monitoring networks, which in turn result in datasets that are either incomplete or inconsistent over time. Monitoring networks are often unevenly distributed and do not always offer fair representation of the environmental conditions. There is a "lack of consistent nation-wide monitoring for many environmental parameters that could serve as a base for a common menu of environmental indicators and more consistent national SOE reporting" (Bond et al. 2005a, 21).

Data form the foundation blocks on which indicators are built and therefore play a fundamental role in indicator development. Yet, there are substantial hurdles to overcome to improve gaps or inconsistencies in data. Current concerns include gaps in monitoring networks, limited data availability, or inconsistencies in existing data. Monitoring stations, for example, are "not statistically representative of Canada as a whole. Most were originally chosen for monitoring because they are in areas where there is concern about the effects of human activities on water quality. Saskatchewan, northern Ontario and northern Quebec are large areas that currently have little or no representation in the water quality indicator" (Government of Canada 2007, Appendix 3, 52).

Some federal indicators (such as CESI) may rely on data from surveys distributed to municipalities, farmers, and business. Completion of the surveys is not mandatory and at the discretion of end users.

The UNEP observes that "[e]ven in countries where the importance of having data and indicators is well recognized, it is still a challenge to maintain the levels of the interest and the funds required to collect primary data, establish useful indicators and use them

to monitor environmental and sustainable development trends" (UNEP 2003, 4).

Provincially, budgets and resources (surprisingly) do not always reflect output:

British Columbia, Alberta, Manitoba, and Quebec probably have the largest teams with indicators or state of the environment reporting on their work plans. In some cases, such as in Saskatchewan, only one person takes care of these files, with other tasks as well, and a relatively small budget (Bond et al. 2005b, 18).

Yet Saskatchewan, along with Alberta and British Columbia, has a broad suite of indicators; each of these provinces offers at least 20 water-related indicators. Most of the other provinces tend to have only a handful of indicators, which often focus more narrowly on ecosystem water quality.

4.4 EMERGING TRENDS IN INDICATOR DEVELOPMENT

Economic valuation of water is an emerging trend in indicator development. A handful of indicators are now being developed both at the federal and provincial/territorial level that will incorporate this concept. For example, the Agri-Environmental Indicator series will include economic valuation as an indicator. The Northwest Territories is developing a framework to track changes to natural capital accounts for water. Currently under development, this framework will include an accounting framework, water capital metrics, and processes for valuations of water (including goods and services). The GPI*Atlantic* also includes economic valuation (Box 5).

The GPI*Atlantic* is a good example of an indicator that takes a broader approach to water security by adding in economic valuation. Developed and applied in Nova Scotia, the GPI consists of two parts: (1) an indicator part—the development of indicators and measures of progress (trends); and (2) an economic valuation—assessments of the economic value of non-market social and environmental assets not generally valued in conventional economic statistics (Box 5).

The GPI*Atlantic* has five indicator components: time use, living standards, natural capital, human impact on the environment, and human and social capital.

The GPI takes a markedly different approach to other indicator initiatives, since it includes mechanisms to measure damage costs due to water quality decline, defensive expenditures (such as pollution abatement), restoration costs, and health impacts. The developers of this indicator advocate that *price signals* (full-cost accounting) are the major determinant of behaviour changes, rather than the actual indicators.

Some infrastructure components are included in this indicator and valuation, but water quantity and governance are not.

Box 5: GPI*Atlantic* – water components

The GPI indicator measures the following:

(1) Water quality, water pollution, drinking water quality, watershed protection, pesticides, groundwater quality, fish stocks, wastewater, contaminated sites.

(2) Defensive expenditures (incl. pollution abatement control, or PAC), water intake costs, damage costs due to water quality decline, restoration costs, and health impacts.

Source: www.gpiatlantic.org

Although most provinces and territories take advantage of the Internet to share information with the public, Alberta is the only province to offer all its indicator information in one website that is easy to find, navigate, and interpret. Most provincial and territorial agencies, like their federal counterparts, scatter the indicator information across their department websites or insert them in various reports—particularly those that approach reporting from a broader "sustainability" viewpoint.

4.5 WATER SECURITY: NARROW FOCUS OF CURRENT INDICATORS

Federal indicators focus largely on water quality, particularly ecosystem health. A handful of indicators examine water quantity issues. Infrastructure

indicators are limited in number and in scope. There are no governance indicators at the national/federal level. Provincial indicators illustrate the state of water quantity and quality, with the primary focus tending to be ecosystem health. Infrastructure and governance indicators are limited in number and in scope. Large-scale watershed (regional) indicators also focus primarily on ecosystem health. Infrastructure and governance indicators do not typically feature in regional indicator initiatives.

Water security implies the need to assess all demands placed upon a watershed including quality, quantity (including climate change, allocation), ecosystem health, human health, infrastructure, and governance. As such, it is a broad concept of holistic water management that balances resource protection and resource use.

Despite increasing references to water security internationally and in Canada,[13] the concept is still emerging and has not yet entered the vocabulary of most practitioners, as substantiated by our 2008 Water Security Survey. During the follow-up phase, many interviewees reported little to no exposure to this term prior to participating in this study. No common definition of water security currently exists. Although several indices are being developed in Canada to support improved water security, no widely accepted standard index of water security exists.[14]

As this report has documented, current water-related indices tend to have a narrow focus (e.g., solely on drinking water) and do not consider both groundwater and surface water. The 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.

13 Governments in Canada (federal and provincial) use the term "secure water" more frequently than "water security." Usually, "secure water" is used in relation to water supply. For example, Environment Canada's 2007–2009 sustainable development goals include "clean and secure water for people, marine and freshwater ecosystems." Several provinces use this language as well. In British Columbia, the Ministry of Environment uses the term "security" in its Living Water Smart plan. The overall goal of the plan is to "secure stream health" and provide farmers secure access to water (BC MOE Living Water Smart 2008). In Alberta, the term appears in the renewed Water for Life strategy. This strategy is based on three outcomes: safe, secure drinking water supply; healthy aquatic ecosystems; and reliable, quality water supplies for a sustainable economy (Alberta MOE 2008). The Canadian Council of Environment Ministers (CCME) is launching an initiative on water security.
14 The Canadian Water Sustainability Index (CWSI) is the first and only attempt at a national composite index. It addresses five key components: resource, ecosystem health, infrastructure, human health and well-being, and capacity. Developed in 2006 and pilot tested on six First Nations communities by the Policy Research Initiative, this project has since been discontinued. The CWSI includes community capacity indicators as well as the standard physical measures of water availability, supply, and demand but does not accommodate the unique characteristics of the Arctic or focus specifically on vulnerability because it emphasizes sustainability of agricultural areas of southern and central Canada (PRI 2007). Other approaches to water security include source water protection and land use planning initiatives, which have come into being since the Walkerton (Ontario), Kashechewan (Ontario), and North Battleford (Saskatchewan) threats to public health.

5 RECOMMENDATIONS

Indicators play a significant role in the implementation and assessment of progress towards sustainable development. Their proliferation and prominence has increased dramatically over the past twenty years and by all accounts will continue to do so for the foreseeable future. Canada is no exception, and this report has documented the increased development and use of water-related indicators in recent years.

The preceding analysis identified strengths, weaknesses, and gaps in Canada's current approach to water security-related indicators. In this section, we make recommendations to achieve a more integrated spectrum of indicators and more effective tools for assessing water security for Canadian governments and communities.[15]

5.1 CENTRAL REPOSITORY FOR INDICATORS AND ASSOCIATED DATA

Currently, no central location or repository to find information on indicators or their associated data exists. Instead, a complicated web of federal and provincial initiatives has resulted in indicators being almost lost among a myriad of reports and various agency websites. Even if located, the indicators are time-consuming to retrieve and interpret.

Although data are the stock-in-trade of any type of indicator, a commonly voiced concern in the 2008 Water Security Survey was that this information was not easy to find or readily available. The difficulties experienced whilst compiling the inventory emphasized just how time-consuming indicators and associated data are to locate. Many organizations simply do not have the resources to dedicate to this quest. Likewise, policy-makers need to know where to find this information, which should be timely and presented in a format that it is easily understood and accessible:

> Information is the foundation of sustainable development and is a basic and essential ingredient for successful planning and decision-making. If decisions are made without sound data and information, they will be little better than best guesses and are likely to be wrong (UNEP 2003, 6).

The 2008 Water Security Survey participants called for a central repository to house data and indicator-related resources. Greater emphasis could be placed on communicating the data in a clear, concise, and understandable format that reflects what decision-makers and the public need to know.

5.2 HARMONIZATION OF INDICATOR INITIATIVES

In Canada, there is a strong appetite for indicator activities to be harmonized, with common reporting

15 The recommendations are based on the findings of the literature review, the 2008 Water Security Survey, and interviews with federal, provincial, and community level groups (including municipalities, NGOs, and consultants).

guidelines or framework established. For example:

- 2008 Water Security Survey participants stated they would like to see a consistent set of indicators developed at both the federal and provincial levels.

- 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. This would be a framework that would provide "guidance on what should be collected and how to ensure quality: quality of the datasets and quality in the execution of statistical activities" (Statistics Canada 2009, 1).

- 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 et al. 2005a, 26).

Multiple orders of government add complexity to the array of indicators currently available. Defining each role the federal and provincial agencies play would be helpful to all parties involved: "At the national level, the main focus of the future initiatives should be on capacity building, sectoral integration, and awareness raising" (UNEP 2003, 4).

5.3 GREATER COLLABORATION

Greater communication and information sharing could take place between federal agencies, provinces, and community groups. This would avoid duplication and overlaps.

More emphasis could be placed on knowledge sharing: many indicators are developed ab initio even when there is ample opportunity to exploit the wealth of indicators already developed. Public and professional scrutiny along with scholarly peer review could further strengthen the credibility of indicators (Kaufmann and Kraay 2008).

5.4 ENGAGEMENT OF END USERS

In recent years, it has been widely acknowledged that too little attention is paid to the needs of end users (especially policy-makers) and decision-makers when developing indicators. Communication between the scientists who develop indicators and the policy-makers who could use them is at a low level. Also it is the producers' needs that still drive the development of indicators, rather than the needs of the end users. These two factors have limited end-user uptake of indicators and made for weak links between science and policy: "Current approaches have tended to rely too much on what data may be available and not enough on what decision makers and the public need to know" (Bond et al. 2005a, 4). The integration of community needs into indicator design could ensure applicability and uptake.

Future endeavours should make greater efforts to address the needs of end users by engaging policy-makers in the development process and framing relevant policy questions in the design stage: "Posing the right policy questions must precede the development of indicators" (Brennin 2007: 3).

Participants in the 2008 Water Security Survey voiced concerns that current indicators do not adequately meet the needs of end users (Box 6).

Box 6: Views of end users: Indicators do not meet the needs of end users

- "They are too vague and 'high level'. They seem to be designed and promoted by academics and never come with worked examples."
- "One-size-fits-all approach"
- "None of the reporting tools (e.g., WQI) are perfect. They either lose important detail in the final presentation or are too complex for the final user to quickly understand."

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5.5 TIMELINESS

Good indicators should have statistics available soon after the period they refer to. In Canada however, "[e]nvironmental statistics are, generally speaking, not as timely as their economic and social cousins" (Statistics Canada 2009, 4). Currently, most federal level environmental indicator reports are being released two years after the year they refer to. Consequently,

along with a number of other factors, environmental indicators are having little or no influence on policy.

5.6 ADDRESSING THE GAPS

In Canada, many indicators appear to be developed and used once, reported infrequently, or disbanded in pursuit of a new initiative. This reflects the current ad hoc approach to environmental reporting.

Indicator development is complex and takes time. The process should be approached as a continuous loop, rather than a completing the cycle only once. "Indicators must be developed in a dynamic feedback process involving policy-makers, indicator specialists, and the stakeholders who will be affected by the policies in question" (Brennin 2007, 14). Good indicators should be flexible and adaptable.

The UN Commission on Sustainable Development reviews its sustainability indicators every five years. Knowledge and experience increases with each cycle through testing and application, and as more information and data becomes available or as environmental needs unfold, indicators are adapted to reflect these changes.

5.7 COLLABORATION AMONG KEY ACTORS TO DEVELOP A STANDARD INDEX OF WATER SECURITY

Insufficient funding, human resources, and training were obstacles frequently highlighted in the 2008 Water Security Survey (Box 7).

A long-term commitment (both financial and human resources) is needed for data collection and analysis. Monitoring networks have been (dramatically) cut back and in many parts of the country do not exist. "A critical success factor for any indicator-driven policy process is its integration into the annual budgetary cycle" (Brennin 2007).

5.8 WATER SECURITY: A COMPREHENSIVE APPROACH

Current water-related indicators tend to be narrowly focused (e.g., solely on drinking water). Water security requires broad consideration of all demands placed upon a watershed: quality, quantity (including climate change and allocation), ecosystem health, human health, infrastructure, and governance. Water security requires a greater priority for water. As such, it is a broad concept of holistic water management that balances resource protection and resource use. It is important to measure water security since this approach examines the watershed as a whole.

A lack of integrated knowledge and effective incorporation of water-related decision-making exists at the community level. Coordination among current efforts to develop comprehensive water security indicators should be a priority. The involvement of end users in these indicators is crucial in order to ensure applicability and uptake. Adopting a comprehensive approach implies not only integrating water-related variables, but also taking an inclusive approach to indicator development, dissemination, and implementation.

Setting a goal of water security could enable decision-makers to effectively assess and mediate between conflicting demands for water use and minimize potentially adverse impacts from land and water management practices.

Box 7: Resource issues highlighted by practitioners across Canada

- "There is a lack of funding and manpower."
- "We do not have the financial resources to do the job the way it should be done."
- "Cost is prohibitive, including the cost of staffing."
- "Costs are associated with collecting and testing."
- "Lack of ongoing resources make it difficult to provide data from year to year."
- "Resources are not available to allocate sufficient time to develop and utilize tools."

2008 Water Security Survey responses

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7 APPENDICES

7.1 Appendix 1: Inventory Of Canadian freshwater-related indicators

A comprehensive list of federal, regional and provincial water-related Indicators (through February 2009) is available at: http://www.watergovernance.ca/PDF/security/Append1_Complete_List_of_Indicators.pdf

7.2 Appendix 2: Comparison table of water quality vs water quantity indicators

A table comparing the number of water quality indicators with the number of water quantity indicators is available at: http://www.watergovernance.ca/PDF/security/Append2_Quality_vs_Quantity.pdf

7.3 Appendix 3: Comparison table of ecosystem health vs human health indicators

A table comparing the number of ecosystem health indicators with the number of human health indicators is available at: http://www.watergovernance.ca/PDF/security/Append3_Ecosystem_vs_Human_Health.pdf

7.4 Appendix 4: Comparison table of surface water vs groundwater vs integrated (surface and ground) water indicators

A table comparing the number of surface water indicators, with groundwater and integrated indicators is available at: http://www.watergovernance.ca/PDF/security/Append4_Surface_vs_Ground.pdf

7.5 Appendix 5: Infrastructure indicators

A table listing all the infrastructure indicators is available at: http://www.watergovernance.ca/PDF/security/Append5_Infratructure.pdf

7.6 Appendix 6: Governance indicators

A table listing all the governance indicators is available at: http://www.watergovernance.ca/PDF/security/Append6_Governance.pdf

7.7 Appendix 7: Project description

This report is the product of the first phase of a research project funded by the Canadian Water Network. The project "Developing A Canadian Water Security Framework as a Tool for Improved Governance for Watersheds" aims to provide a systematic review and evaluation of existing water-related indices and provide a critical insight into the capacity of these indices to aid decision-making.

PROJECT SUMMARY

Water security is emerging as a paradigm for cumulative impact assessment and watershed management. Funded by the Canadian Water Network (CWN), this project focuses on developing a framework to improve water security in Canada, by improving governance for source water protection and land use. The Water Security Framework (WSF) will be a "toolkit," which will comprise a Water Security Index (WSI) and decision-making tools and protocols. The framework is intended to enable decision-makers to effectively assess and mediate between conflicting demands for water use, and minimize the potential adverse impacts from land and water management practices.[16]

16 UBC Ethics Review Board has approved the Water Security research project. The reference number for this project is H08-01157.

Fostering Water Security in Canada Project

The Program on Water Governance at UBC

conducts basic research on water management, engages the wider community in outreach and education on water issues, and facilitates dialogue on water governance among universities, communities, government, NGOs, and the private sector.

Contact

Program on Water Governance
439-2202 Main Mall
University of British Columbia
Vancouver, BC
V6T 1Z4
Email: water.security@ubc.ca
Tel: 604 822 6474

www.watergovernance.ca
www.watersecurity.ca