CANADIAN WATER SECURITY ASSESSMENT FRAMEWORK:

TOOLS FOR ASSESSING WATER SECURITY AND IMPROVING WATERSHED GOVERNANCE

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Canadian Water Network

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RESEARCH BACKGROUND

Fresh water-related issues (both quality and quantity) are of growing concern in Canada:

- According to Environment Canada, one quarter of all Canadian communities have experienced water shortages since the mid-nineties. This is coupled with extreme flooding events. These issues will be further affected by global climate change.
- Water quality in rural communities is a concern. In 2007, there were 1766 boil water advisories across Canada in small communities, some for more than 5 years. A further 93 boil water advisories were in place in First Nations communities.
- Some ecosystems are showing signs of stress due to compromised water quality and declining water levels.

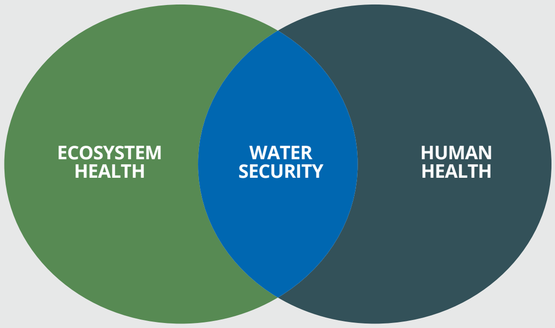
Water is a multi-purpose resource, with multiple users operating at different scales which creates competing uses and differing views of stakeholders. Often there is inadequate consideration and assessment of risks to water and comprehensive risk assessments are seldom applied to water-related issues. Such disparate water management challenges demand a broad, integrative approach that accounts for multiple stressors and cumulative effects. The concept of water security is one such promising approach.

Water security is an overarching concept of integrated water management that balances resource protection and resource use. It takes a broad look at all demands placed upon a watershed, including quality, quantity (including climate change and allocation), aquatic ecosystem health, human health, risk and adaptive governance. Water security examines the watershed as a whole and demands a greater priority for water.

Assessment and management of water security involves four core elements:

1. Evaluate ***current status*** of water quality and quantity
2. Determine ***thresholds*** above which water is insecure
3. Assess ***risk***, taking into account stressors like development and climate change
4. Integrate monitoring and assessment results in ***decision-making and policies***

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.



We define water security as "sustainable access on a watershed basis to adequate quantities of water, of acceptable quality, to ensure human and ecosystem health".

RESEARCH APPLICATION

Our team of researchers from eight Canadian universities worked together with twenty project partners (including two case-study communities), to develop six practical step-by-step tools that enable communities to assess water and manage water security. Four of these tools ***assess*** water security and risk while the other two tools ***manage*** water security. These tools can be used independently or applied in combination, depending on the needs and resources of the community.

WHO IS THIS INFORMATION RELEVANT FOR?

The ***Water Security Assessment Framework*** tools have been developed for small communities to assess and manage water security in their watershed, but many of the concepts and issues are applicable at larger scales. We have developed a broad range of information for both experts and non-experts in our ***Water Security Guidance Document***. Intended users include, but are not limited to:

- community watershed groups
- citizen environmental committees
- water managers
- municipal water policy and decision makers
- aggregate mining industry officials
- source water protection groups
- provincial water planners and watershed groups
- health authority officials
- water suppliers

ASSESSING WATER SECURITY

Assessing water security requires the evaluation of current water quality and quantity (through the use of indicators), their related thresholds, and an assessment of risks that may negatively impact water quality or quantity. Ideally, this should be an ongoing or long-term process of repeated evaluation, in order to track and assess changes over time. Estimating risk to groundwater and surface water (quality and quantity) represents a useful means to prioritize issues for municipal water management.

To access all the tools listed in this report, please visit the project website: www.watersecurity.ca

TOOL: WATER SECURITY STATUS INDICATORS (WSSI)

1. ASSESS CURRENT STATUS OF WATER QUALITY AND QUANTITY

The WSSI assessment method provides practitioners with a framework to select water quality and quantity indicators related to aquatic ecosystem and human health. Indicators are identified by a community, specific to their needs.

2. DETERMINE THRESHOLDS

Security implies thresholds above which water is insecure. Target and baseline values play an important role in the use of indicators, as these help define changes in policy and action. With thresholds identified, stakeholders and regulators must ensure water meets the agreed upon minimum standard. Indicators need to be tracked over time (ideally through continuous assessment) to determine improvements or declines.

3. ASSESS FUTURE RISKS AND CONSEQUENCES OF THESE RISKS

Risks to water quality and quantity associated with current land use practices, changes in land use, climate change, or changes in water demand can be evaluated by considering these various stressors (and uncertain future events). Risk assessment must consider the probability or likelihood of occurrence; risk analysis also requires some estimate of loss.

For example, within a groundwater quality context, the intrinsic vulnerability of an aquifer can be mapped using information on the soils, geology, water table depth, etc. To assess risk, the threat of contamination (such as application of fertilizer or sudden release via a spill) and the associated uncertainty of occurrence must be taken into account, along with the consequence (financial or health related).

Our risk assessment encompasses several tools:

TOOL: WATER SECURITY RISK ASSESSMENT (WSRA)

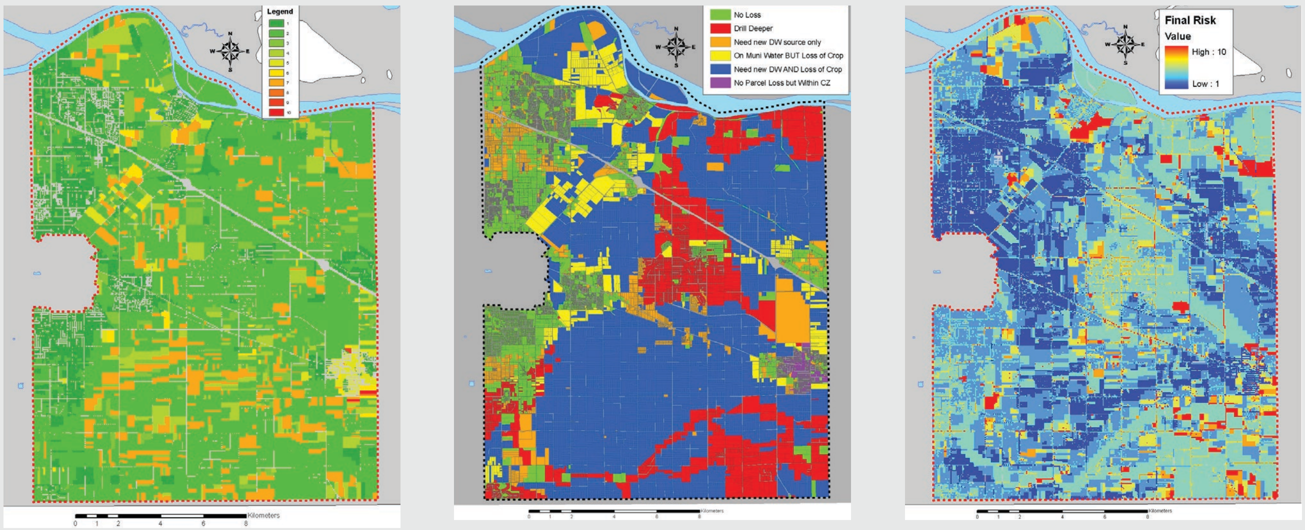
The WSRA framework provides spatial indicators of risk by mapping attributes of the built and natural environments at a watershed scale. It can be adapted to consider either or both groundwater and surface water, and either or both water quality or quantity, depending on the driving issues and practicalities like data availability:

To assess risk to groundwater ***quality*** due to chemical contaminants at land surface, one needs to know:

- the hazard posed by the chemicals present
- the likelihood that the chemicals would be released
- how easily those chemicals could enter the aquifer
- the potential consequences of the hazard should contamination occur

A similar type of analysis could be done for surface water sources. However, water ***quantity*** risk assessments are more difficult to tackle because information on current supply and demand is needed, as well as projections about how that ratio might change in the future. Supply assessment is difficult because of natural climate variability and climate change.

The level of detail possible in the risk assessment will be largely determined by the data that are available. The complexity of the analysis depend on the expertise and skills of the assessment team. For the approach described in our ***guidance document***, GIS was used to spatially map indicators of groundwater quality risk in the Township of Langley in British Columbia (Figure 1). Use of GIS is ideal; however, simple hard copy maps with annotations or overlays can also be used.



(A) (B) (C)

Figure 1. Map series showing (A) Potential hazards affecting groundwater (B) Potential economic loss associated with hazards, and (C) Overall Risk (from Simpson et al. 2014)

TOOL: WATER SECURITY VULNERABILITY SCORING METHOD

Land use activities within a watershed (e.g. infrastructure and aggregate quarries) may increase the susceptibility of an aquifer by modifying contaminant migration pathways. The purpose of this vulnerability scoring method is to assess the impacts of land use changes that may influence pathways of a contaminant source to impact the water supply system. This tool can be used in both urban and rural settings. The tool is intended to supplement decision-making on projects that may alter the natural landscape in all levels of government, particularly at the watershed and municipal scale.

The example provided in our ***guidance document*** is the application of the tool in an aggregate extraction site in the Grand River Watershed in Ontario (a highly contentious issue within this watershed), and presents an example of how changing land use may change pathways. This tool can be applied to other uses including the assessment of hazardous contaminant sites for example, in communities dealing with old landfills that need remediation. The tool can also be adapted for use in wellhead protection planning where a site vulnerability assessment is needed.

TOOL: MAPPING THE LIKELIHOOD OF GROUNDWATER CONTAMINATION

Maps are a valuable tool for displaying water quality information in a format that allow the visualization of spatial patterns of concentrations of water constituents and areas of concern. This tool consists of a series of steps for generating maps that highlight different groundwater chemical environments in a study area; geochemical interpretation for likelihood of occurrence of a particular constituent; confidence of interpretation, and raw concentration data. These maps are then superimposed to produce a map showing the likelihood of occurrence of a constituent of interest for each aquifer of a study area. The tool is primarily aimed at hydrogeologists who may be working with communities to map groundwater quality data. Figure 2 shows one such map of the likelihood of arsenic occurrence in groundwater; arsenic is hazardous to human health when present at elevated concentrations in water.

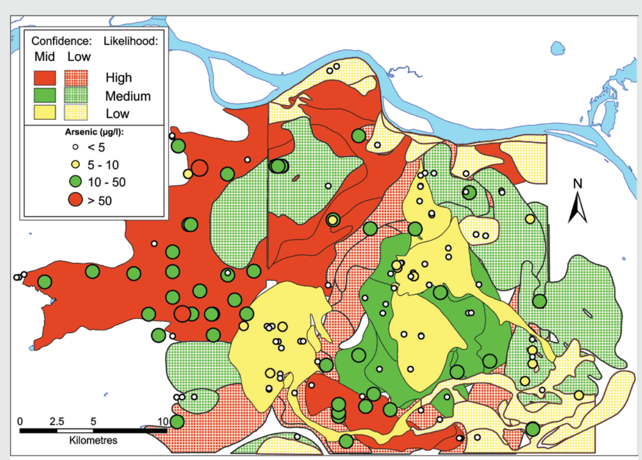


Figure 2. Map showing likelihood of arsenic occurrence in groundwater (from Cavalcanti de Albuquerque et al. 2013)

The approach can be adapted to map other chemical water quality parameters of concern, which may be natural (e.g., arsenic) or anthropogenic (e.g., nitrate from fertilizer application or septic system sources) or a combination of both; for example, chloride from road salt application versus naturally saline groundwater. The method's use for mapping biological contaminants, such as pathogens, has not been tested here, but in principle, such contaminants could also be mapped. The method could also be adapted to map water quality indicators, such as the CCME Water Quality Index.

MANAGING WATER SECURITY

4. INTEGRATING RESULTS INTO DECISION-MAKING PROCESSES AND POLICIES

A critical element of water security is ***adaptation***: having plans in place to link the results from monitoring and assessments back to policies and decision-making processes. These changes would aim to strategically reduce a community's overall exposure to risk over time.

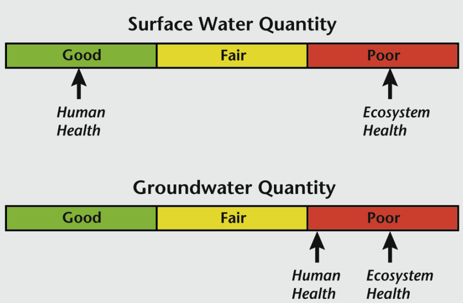
TOOL: GOVERNANCE PRACTICES THROUGH ADAPTIVE MANAGEMENT

The integration of the results from monitoring and assessment into the decision-making process could ultimately help move communities closer to water security. Adaptive governance formalizes a "learning by doing" approach that can link science and policy. It entails three overlapping activities:

- participation of stakeholders
- policy-development
- monitoring and enforcement

An adaptive governance approach focuses on the process by which the information from water security status and risk assessment is absorbed, decisions are made and implemented, and decision makers are held accountable.

Engagement of stakeholders is an essential component of good governance and this assessment framework. Stakeholders provide valuable local knowledge and access to data sources. Civic engagement and general awareness of water-related issues by the public and policy-makers is critical for linking assessment to change. Visualization tools can be a valuable way of communicating results to communities, helping them update and refine on-the-ground practices as conditions change. There are many ways to present the status of water, for example, a slider bar (Figure 3) or geospatial maps (Figure 4). These can be developed to communicate risk so that more informed choices can be made in terms of land use planning, water allocation, etc.



- Ecosystem habitat is poor as preferred egg-laying sites are at groundwater discharge areas, which are declining.
- Surface water quantity for human health is good with drinking water available from Greater Vancouver Water District (although at a hugh price)
- Groundwater quantity for human health (drinking water) is poor/fair with growing demands and declining well levels

Figure 3. Water Security Status Indicators Slider Bar

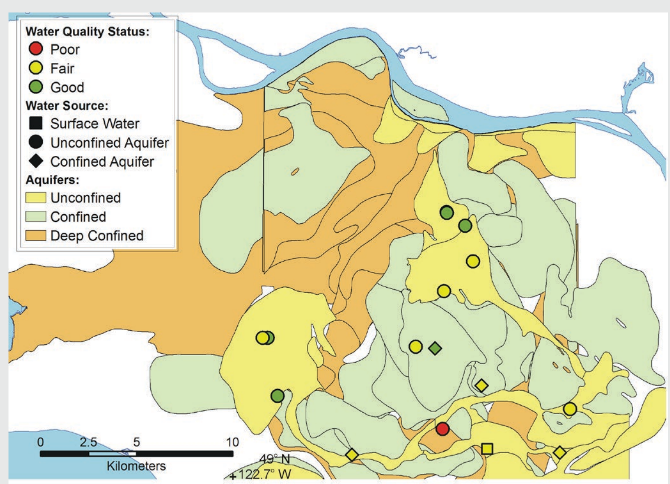


Figure 4. Map of Drinking Water Quality

TOOL: BOIL WATER ADVISORY PROTOCOL

Boil Water Advisories (BWAs) are public notifications of drinking water quality and are used as temporary, precautionary measures to protect the public from possible waterborne illnesses. In many Canadian jurisdictions, BWAs have been in place for months to years. With lengthy or on-again-off-again BWAs, there is concern that the public will not comply.

The BWA protocol defines and describes the three main types of public notifications ***(Water Quality Advisory, Boil Water Notice and Do Not Use Notice)***, and the circumstances in which each should be issued. It also recommends steps for regulatory officials and water suppliers to take for issuing and removing BWAs. The protocol may be used together with other related and jurisdiction-specific policies, regulations and guidance material; however, this protocol is subsidiary to any provincial/territorial and federal laws, directives, policies or regulations based on the management of BWAs.

IMPLICATIONS FOR DECISION MAKERS

> "Water security is 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).*

Water security demands a greater priority for water. Together, the ***Water Security Assessment Framework*** tools can assist communities in planning and decision-making on land use projects that may impact watersheds. Our research highlights the need for a broad and integrative approach to water quality and quantity. It is important to examine the watershed as a whole, incorporating both human and aquatic ecosystem health.

The assessment of current water security status (through indicators) needs to be combined with the assessment of future risks and tracked over time (ideally through continuous assessment) to determine improvements, or declines against baselines or thresholds. We recommend a "learning by doing" approach; integrating the results from monitoring and assessment into the decision-making process using an adaptive management approach.

The engagement of stakeholders is also an essential component of the ***Water Security Assessment Framework*** as general awareness of water-related issues is critical for linking assessment to change.

REPORT AUTHORED BY GEMMA DUNN, ISHKA CONSULTING

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