VALUING WATER QUALITY CHANGES

WITHIN A WATER QUALITY LADDER FRAMEWORK

DIANE DUPONT, BROCK UNIVERSITY

Published January 2016

Canadian Water Network

VALUING WATER QUALITY CHANGES
WITHIN A WATER QUALITY LADDER FRAMEWORK

DIANE DUPONT, BROCK UNIVERSITY

Published January 2016

WHY DID WE DO THIS RESEARCH?

Most governments conduct environmental assessments of large-scale proposals like pipeline construction and/or mine siting to examine potential environmental impacts. Some government agencies, like Environment Canada, are also required to assess whether these proposals will make positive economic contributions.

This project looked at how to convert a proposal's expected impacts on water quality into information about changes in economic values. Academic researchers in the fields of biology and economics were brought together with government staff to co-create new forms of knowledge. The goal was to develop a flexible, computer-based model that could be used by government and/or policy analysts to put a dollar value on the potential impacts of changes to surface water quality in Canada.

ABOUT THE WATER QUALITY VALUATION MODEL

Following a workshop at Environment Canada's offices in Gatineau, the project team created a white board roadmap, which led to the development of the Water Quality Valuation Model (WQVM). The model was written using MS ACCESS, and drew on features of Environment Canada's existing Air Quality Valuation Model and the National Sanitation Foundation's Water Quality Index used by the United States Environmental Protection Agency.

The model includes baseline water quality and sociodemographic data for 25 drainage regions across Canada, as shown in Figure 1.

Figure 1: Drainage Regions in Canada

The Water Quality Ladder (see Figure 2) maps a collection of water quality parameters like nitrogen, phosphorus and turbidity onto an index of water quality levels that range from poor (e.g. non-boatable) to excellent (e.g. drinkable) water quality. The ladder associates different levels of water quality with changes in how water of that quality can be used. Movements along the ladder represent either potential increases in benefits to members of society from higher water quality, or potential increases in costs to members of society from lower water quality.

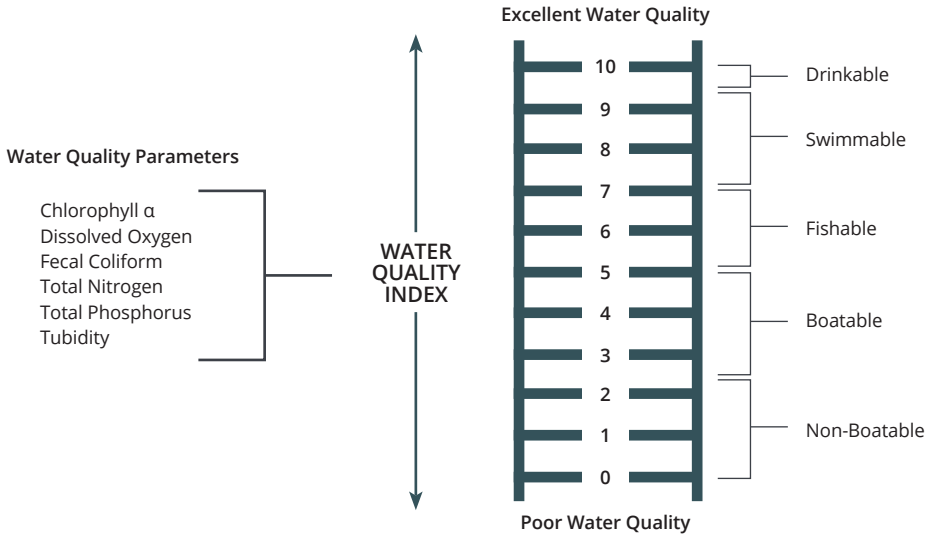

Figure 2: The Water Quality Ladder

MODULE 1: WATER QUALITY LADDER

The model compares the historical baseline water quality index for each drainage region with the index that is expected based on a specified policy change. It uses specified biological thresholds to indicate whether there has been an improvement or deterioration in water quality based on movement along the Water Quality Ladder. As an example, if water quality moves from boatable to swimmable, there is a clear economic value to society in terms of improved recreational opportunities, ecosystem health, and aesthetics.

MODULE 2: VALUATION MODULE

The valuation module assigns economic values to changes in the predicted uses of the impacted water bodies. The economic values are drawn from existing research studies, many of which were identified using Environment Canada's Environmental Valuation Reference Inventory. A method called Benefit Transfer was used to modify or adapt values from the literature to the Canadian context. Since many of the values available come from studies done in the United States, values are adapted for different incomes, population size, exchange rates and time period in which the study was done. Benefit Transfer is a common practice that has been employed by the United Nations, World Bank, and European Environment Agency. Figure 3 provides an example of the annual dollar value of benefits gained per household from improvements of water quality between steps on the ladder. Values represent the maximum amount of money the typical household is willing-to-pay in exchange for a water quality improvement.

In order to calculate the total willingness-to-pay for an entire drainage region, the model uses population and income information from census sub-divisions within that region. The same procedure is used to calculate total willingness-to-pay for each province.

	Average	Minimum	Maximum
Non-Boatable to Boatable	$117.41	$47.40	$234.96
Boatable to Fishable	$75.57	$14.40	$194.43
Fishable to Swimmable	$149.23	$2.34	$300.94

Figure 3: Household Willingness-to-Pay (2014 CAD dollars)

As an example, suppose a policy proposal is expected to reduce phosphorus, nitrogen, and turbidity levels in a northwestern drainage region by 10%. The WQVM calculates that the drainage region has an initial water quality index value of 4.8 and an index value of 5.1 under proposed policy. This change represents an improvement along the Water Quality Ladder from boatable to fishable water quality. On average, households are willing-to-pay $75 annually for this type water quality improvement. Based on the characteristics of the population, the WQVM estimates a total willingness-to-pay of $2,250,000.

WHAT ARE THE IMPLICATIONS FOR DECISION MAKERS?

The WQVM enhances Environment Canada's capacity to assess the environmental and economic impacts of large-scale proposals by using the latest Canadian data on water quality and drawing on leading research on the economic value of water quality changes. It can also be used to evaluate the costs and benefits of alternative regulatory proposals that may have an impact upon water quality.

A variety of methods of analysis are provided in the model. There is built-in flexibility in the method used to combine individual water quality parameters into a single index that can identify steps on the water quality ladder. There is also flexibility in the values used to determine a household's willingness-to-pay. This ensures that the analyst can examine results for sensitivity to choices.

The WQVM can be expanded by updating the data libraries (water quality parameters, socio-demographic information, and valuation studies). The framework also expands to incorporate additional water quality parameters of interest, and a set of future expansions is already planned.

Although the current version of WQVM is designed to reflect water quality changes and associated benefits/costs on regional and national scale, it could be easily expanded for evaluation of the impact of water quality changes on local scale.

TO CONTACT THE RESEARCHER, EMAIL RESEARCHSPOTLIGHT@CWN-RCE.CA.
VISIT OUR REPORT LIBRARY AT WWW.CWN-RCE.CA

REPORT AUTHORED BY DIANE DUPONT AND JAMES PRICE, BROCK UNIVERSITY

RESEARCH TEAM

DIANE DUPONT, Brock University
STEVEN RENZETTI, Brock University
JAMES PRICE, Brock University
STEVE PUGLIA, Brock University
AZIT MAZUMDER, University of Victoria
JOHN ZHU, University of Victoria
YVES BOURASSA, Regulatory Analysis and Valuation Division, Environment Canada
ANN CAVLOVIC, Regulatory Analysis and Valuation Division, Environment Canada
YANG YANG, Regulatory Analysis and Valuation Division, Environment Canada
VALERIE SEXTON, Regulatory Analysis and Valuation Division, Environment Canada
MARTHA GUY, Information and Indicators Division, Environment Canada

PARTNERS

REGULATORY ANALYSIS AND VALUATION DIVISION, ENVIRONMENT CANADA

REFERENCES

DUPONT, D. P. (2013) "Water Use Restrictions or Wastewater Recycling? A Canadian Willingness to Pay Study For Reclaimed Wastewater" Water Resources & Economics. 1(1): 61-74.

DUPONT, D. P., S. RENZETTI, J. PRICE, A. MAZUMDER, J. ZHU, AND S. PUGLIA (2015) "Valuing water quality changes within a water quality ladder framework" Poster presentation at World Water Congress XV. International Water Resources Association (IWRA), Edinburgh, Scotland, May 25-29.

ZHANG, J., W. ADAMOWICZ, D.P. DUPONT, AND A. KRUPNICK (2013) "Assessing the Extent of Altruism in the Valuation of Community Drinking Water Quality Improvements" Water Resources Research.