forWater Research Snapshot

AUTHORS: Zehua Pan (PhD, UW), Roy Brouwer (UW), Monica Emelko (UW)

SUBJECT: **Correlating forested green infrastructure to water rates and adverse water quality incidents: A spatial instrumental variable regression model**

Key Messages

- The novel focus of the work is on the interrelationship between green infrastructure (proxied by forest cover), water treatment costs (proxied by drinking water rates) and drinking water-associated public health risks (proxied by adverse water quality incidents [AWQIs]) in Ontario, Canada
- Forest cover is shown to significantly reduce water and AWQI rates
- The estimated value of water treatment services by forested watersheds varies between $111–148 per ha ($11,100 to 14,800 per km^2) per year
- This study provides a starting point to this type of analysis, showing negative correlations. Further research needs to be done to capture all relevant costs and to identify causal interrelationships between forest coverage, water quality, AWQIs, treatment costs and water rates
- **Key words:** green infrastructure; ecosystem services; nature-based solutions; safe drinking water; water rates

Research Summary

Forested land plays a rather unique role in the provision of ecosystem services. Healthy forested watersheds provide natural filtration, retain and store nutrients/contaminants, regulate hydrology, and maintain or improve water quality. Given rising costs associated with the provision of safe drinking water, there is increasing interest in the cost-effectiveness and economic benefits of combining traditional engineering-based “grey” infrastructure with natural resource-based “green” infrastructure. As a result, it is increasingly important to describe the interrelationship between healthy forested watershed areas, water quality and the costs of drinking water treatment. This study builds on the emerging understanding in this field by exploring and describing the interrelationship between green infrastructure proxied by forest cover, water treatment costs proxied by drinking water rates, and drinking water-associated public health risks proxied by adverse water quality incidents (AWQIs).

Using data from Ontario, which is a water- and forest-abundant and densely populated Canadian province, the study assessed whether a relationship can be established using existing public data sources between the water rates households pay as a proxy for water treatment costs and the land cover surrounding drinking water intakes across 154 municipalities. The study showed that the fraction of forested land coverage is significantly correlated with water rates when potential spatial spillover effects—which must be considered in cumulative watershed effects assessment—are reflected. It also showed that the fraction of forested land coverage could be significantly correlated with AWQIs when possible endogeneity between AWQIs and water rates (i.e., reverse causality) is accounted for by including the latter as an instrumental variable, thereby enabling the model to account for possibly confounding effects between the variables.

Research Results

- While controlling for a limited number of treatment characteristics such as the size of the service area and the source of water supply, the share of forest cover systematically negatively influences both drinking water rates and AWQI rates. Hence, confirming a negative relationship between (i) the share of forest cover and drinking water rates and (ii) the share of forested land and AWQI rates.
- As the share of forest cover increases by 1% in a municipality with its own drinking water supply system, the average drinking water rate per household is reduced by around 0.4% per year. The same 1% increase in forest cover is furthermore associated with a similar 1% decrease in the likelihood of experiencing an AWQI. In this latter case, we detected furthermore a non-linear relationship, showing that the effect increases more than proportionally as the share of forest cover increases.
- The estimated total drinking water treatment costs in Ontario in 2007 were $304.3 million (Statistics Canada, 2021). About 20% of these total costs consist of material costs ($62.9 million), such as the chemicals needed in the drinking water treatment process, which are expected to go down as a result of improved source water quality.

Key Figure

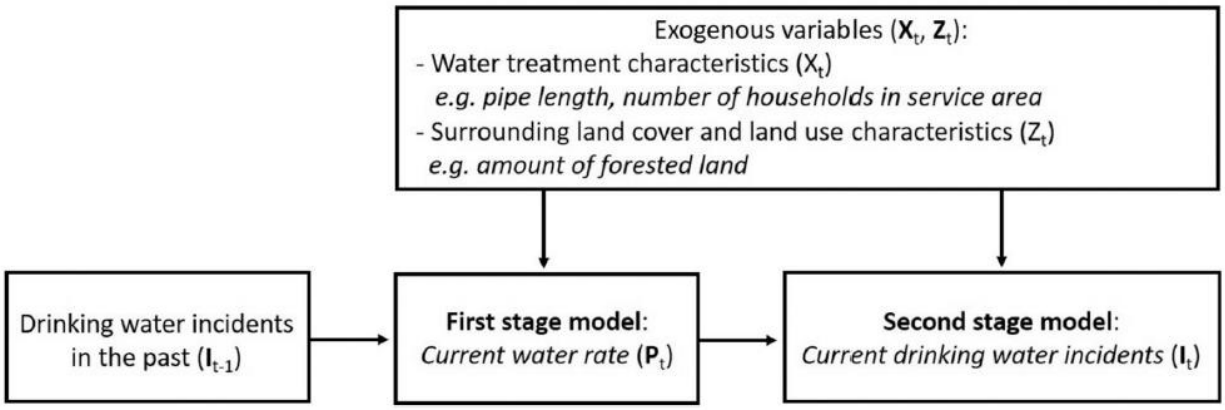

Fig. 1. Visualization of the econometric modelling framework.

Reference, featured publication: Pan Z, Brouwer R, Emelko MB. 2022. Correlating forested green infrastructure to water rates and adverse water quality incidents: A spatial instrumental variable regression model. *Forest Policy & Economics,* 140:102756. https://doi.org/10.1016/j.forpol.2022.102756

Contact Information
For more information on this research please contact:
Dr. Roy Brouwer – rbrouwer@uwaterloo.ca; Dr. Monica Emelko – mbemelko@uwaterloo.ca