Extending municipal water demand forecasting capacities

Steven Renzetti, Diane P. Dupont and James Price
Brock University

Canadian Water Network

1. Background

- 2008 AWWA survey: most North American water utilities forecast water demands by multiplying future population estimates by historical per capita water use

- Gleick (2000): almost all of the projections based on fixed-coefficient models of water-use significantly overstated actual water.

1. Background

- One solution: Large variety of forecasting tools and methods are available – rely on sophisticated numerical and statistical methods and large amounts of data
- Problem: many water suppliers lack **capacity** (data, HR, etc.) and **knowledge** of user characteristics to carry out simulations & forecasts

Objectives

Develop a user-friendly, spreadsheet-based demand forecasting and simulation tool that:

- provides water utilities with the capacity to project medium-term demands
- accounts for planned or expected changes in important demand drivers (e.g. price)
- supports community engagement

The simulation program

Key features:

- Residential water demands
- User inputs demand driver growth rates
- Price changes can be simple or complex; one-time or on-going
- Price and income elasticities can be input or chosen from default values

Here are some screen captures:

Introduction

Brock

Water Demand Forecasting Tool

About the Forecasting Tool

The program uses a variety of information in order to make predictions of future water demand levels. Initial information on a community's population, water demand and prices, and climate are forecasted using customizable growth equations. These 'drivers' are used to model future water demands.

The drivers are forecasted by average growth rates, which can be modified to vary year over year. A monte carlo algorithm iterates through a user specified number of iterations and creates a dataset and several charts outlining the forecasted data.

Guide

1. Click the button on the bottom of the page to begin forecasting.
You will be required to fill out a series of tables with information pertaining to your simulation.The beige coloured cells are those requiring user input, while yellow tabs display tooltips when the mouse hovers overtop of them.

User Input	More info (hover mouse)

2. Once the tables have been filled in, click the button located at the bottom of the worksheet to continue to the next step of the forecast. Follow the onscreen prompts and continue in this fashion to generate a customized forecast.

Start Forecasting: Initial Conditions

Guide | Initial Conditions | Price Adjustment (One Time) | Price Adjustment (Recurring) | Price Adjustment (C

User input: initial Conditions

1. Initial Conditions

1.1 Community Statistics

Fill in the fields of the following subsection using the community's current water demand, demographics, and available climate data.

i. Water Demand

	Residential
Annual WD (M³)	7,500,000
Daily WD (M³)	20,550
Average Daily WD (M³/h)	4,500
Peak Daily WD (M³/h)	8,200

ii. Initial Driver Values

	Value
Initial Population	50,000
Average Household Income ($)	72,240
Average Temperature (°C)	15
Average Precipitation (mm)	900

1.2 Pricing Structure

i. Residential

Volumetric

#	Proportion of Users	Max Usage (M³)	Price ($/M³)
1	1		0.45
2			
3			

User input: pricing

2. Price Adjustment

2.1 Constant Recurring Increase

Complete the table to simulate a recurring price increase (across all blocks). The increases are compounded, and can be applied for a finite duration, or for the entire simulation.

Proportional Increase (p)	0.05
Initial Effective Date (YYYY)	2020
Period (Years)	5
Duration (Years)	0

Next Step: Demand Side Management Policies

Guide | Initial Conditions | Price Adjustment (One Time) | **Price Adjustment (Recurring)** | Price Adjustment (C

User input: DSM polices

3. Demand Side Management Policies

Non-Price policies which affect demand can be accounted for in this section. The year the policy takes effect, the proportion of the population that would be affected, and an assumed proportion of reduction in demand are all user specified. Additional or unnecessary tables for DSMPs can be generated or deleted, using the buttons at the bottom of the sheet.

3.1 Citywide Education Program

Effective Year	2025
Target Population	0.8
Assumed Demand Reduction	0.01

3.2 Retrofits

Effective Year	2020
Target Population	0.1
Assumed Demand Reduction	0.05

New DSMP

Price Adjustment (Custom) | **Demand-side MGMT Policies** | Simulation Parameters

User input: sim parameters

4. Simulation Parameters

4.1 Horizon

Complete the initial year, duration of the simulation, and number of simulations to run. For a deterministic run, set the number of simulations equal to 1.

Initial Date (YYYY)	2015
Simulation Years	100
Number of Simulations	100

4.2 Growth Rates

Complete the following subsection with the growth rates for the water demand drivers, and (optionally) the coefficient of variation of the growth rate.

Demand Driver	Growth Rate	Coefficient of Variation
Population	1.009	0.01
Income	1.00198	0.01
Temperature	1.0025	0.01
Precipitation	0.9992	0.005

4.3 Elasticities of Demand

Complete the following subsection with the drivers' elasticities of water demand.

Driver	Elasticity of Annual WD	Reccomended Values
Price	-0.86	-0.86
Income	0.87	0.87
Temperature	0.75	0.75
Precipitation	0.25	0.25

Price Adjustment (Custom) | Demand-side MGMT Policies | Simulation Parameters

User input: elasticities

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Next Step: Run Simulation

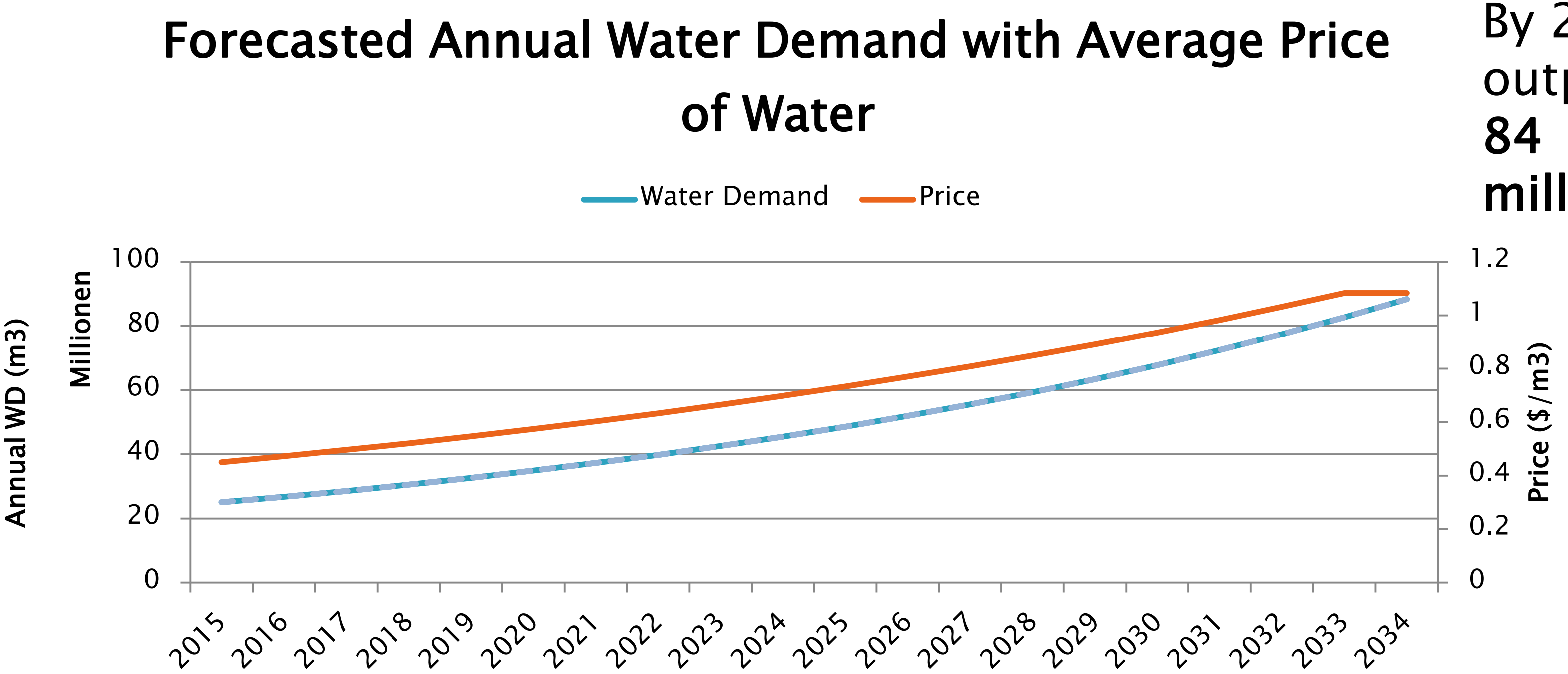
Price Adjustment (Custom) | Demand-side MGMT Policies | **Simulation Parameters**

Example

- Pop ↑ (5% p.a.), income ↑ (2% p.a.)
- Modest DSM measure in place
- Price ↑ (5% p.a.) for 20 years

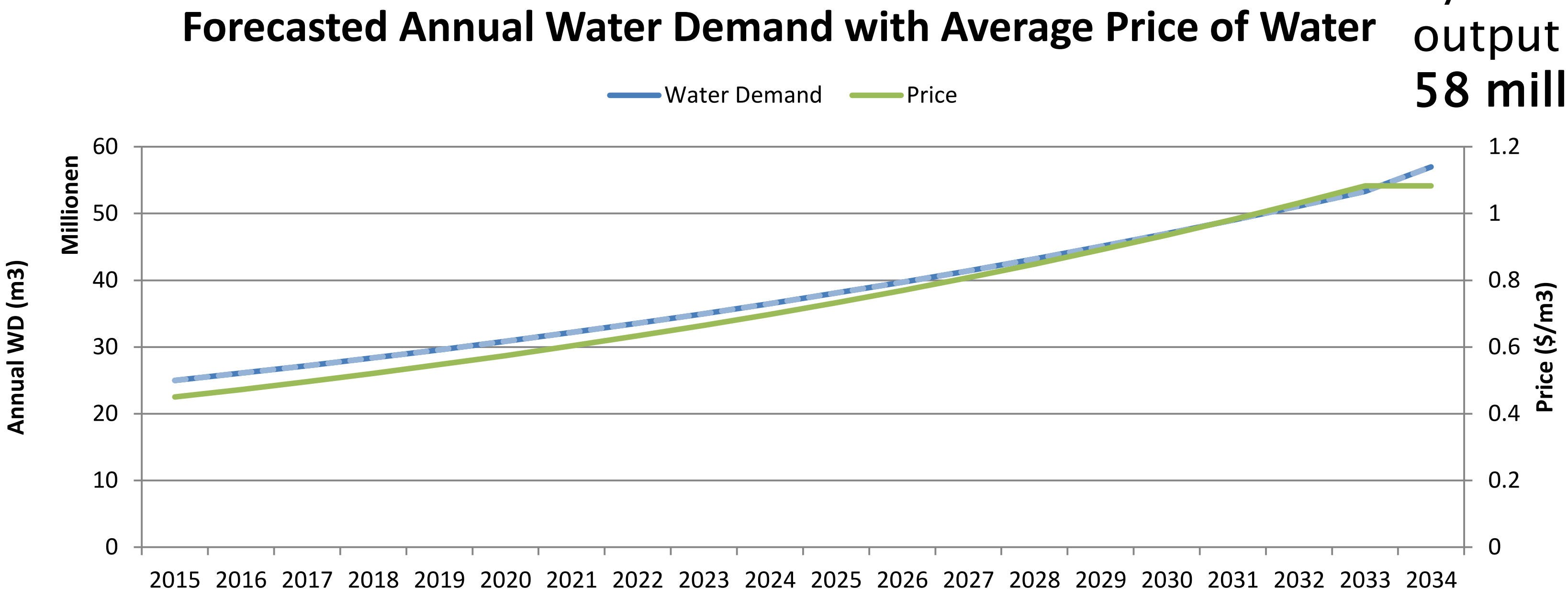
- Case 1: price elasticity of demand =−0.5
- Case 2: price elasticity of demand =0.0

Case 1: no price response



By 2034, output is **84 million**

Case 2: price responsive



By 2034 output is **58 million**

Benefits to water agencies

(1) produce more accurate water demand projections
(2) assess potential impacts of pricing and other policy measures,
(3) integrate capital investment planning and demand-side management
(4) engage stakeholders

Next steps

- Add more examples to user manual (apparently “price elasticity of demand” isn’t as obvious as we thought…)

- Add ICI sector’s demands

Want more information?

Contact Steven Renzetti

srenzetti@brocku.ca

A copy of the program will soon be available from:

www.brocku.ca/wepgn