CRC for
Water Sensitive Cities

What is the best mix for our urban water supply?

Industry Note
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Project A1.1

How much of our water supply should we source from reservoirs? How much should come from other sources such as treated stormwater or desalinated seawater? An economic model developed by researchers at the CRCWSC helps to determine the optimal mix of sources given the risks associated with availability and the costs of supplying water from these potential sources. They found that strategic investment in stormwater harvesting to lift its contribution to the water supply portfolio for Melbourne to around 14% would present an economic optimal mix.

Does Melbourne currently offer an optimal water supply portfolio?

Melbourne's water system in the 1990's relied primarily on reservoirs, like many other cities around the world, but the Millennium Drought placed the system under stress, leading to a $5.7billion investment in a desalination plant, among other initiatives. An important question is whether a supply mix comprising reservoirs and a desalination plant is the optimal portfolio.

This model takes into account risk aversion and yields closed-form solutions for a three asset portfolio water system. The model was trialed to determine the optimal consumption and individual contributions from three types of water supply assets (rural runoff into the Maroondah, O'Shannassy, Upper Yarra and Thomson Dams, urban stormwater harvesting in Melbourne and seawater desalination at Wonthaggi). The model was applied to three conditions of the water system to derive optimal water supply portfolios. The three conditions were:

1. System in crisis: the conditions that were experienced during the Millennium Drought
2. Average system: the long-term average water supply conditions
3. Vulnerable system: an intermediate, vulnerable water supply situation.

The model accounts for supply risks, dam levels and the supply costs associated with each source and can be used for any mix of water sources. The supply risks are estimated by observing historical volatility of rainfall and reservoir inflows deriving a robust statistical description of the risks*. These optimal portfolios were then compared with the observed portfolio supplying water to Melbourne for each of the three conditions.

**The model does not distinguish between potable and non-potable supply and assumes that reservoir water, desalinated water and stormwater are an undifferentiated product to aid the development of the closed-form solution algorithm.*

Acknowledging that government investment decisions are not solely based on financial considerations and that there are emerging uncertainties in meteorological conditions attributed to climate change not reflected in historical rainfall and reservoir inflow statistical analyses, the results presented in Figure 1, show that:

- Significant opportunities to hedge risks between the rainfall-dependent water sources are there for all three scenarios.
- A desalination plant of half the current capacity would be sufficient in periods of drought (based on current demands).
- Desalinated water is not required at all under the normal or intermediate scenarios.
- The optimal share of harvested stormwater is fairly constant across the three scenarios varying from 11% to 14% of the total water supply.

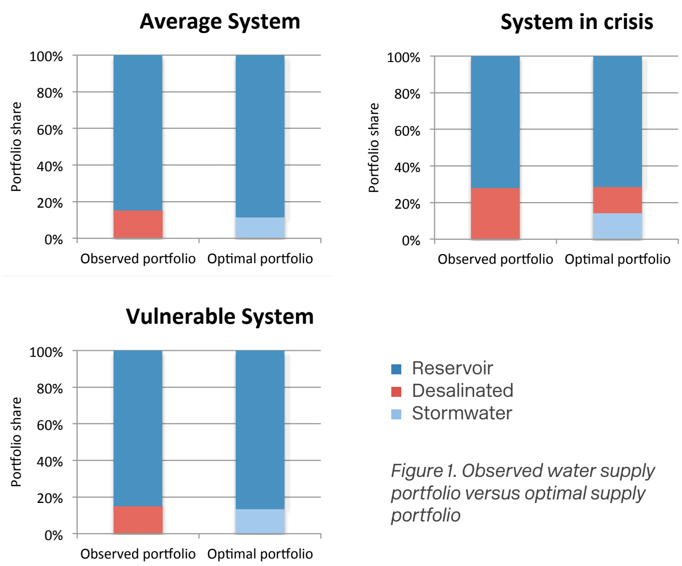

Figure 1. Observed water supply portfolio versus optimal supply portfolio

The model also showed potential cost savings of between $43 million and $463 million per year, depending on the scenario.

These findings suggest that priority in future investments in Melbourne's water supply should be directed at lifting the contribution of stormwater to around 14% to achieve a better balance in the water sources portfolio.

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Determining an optimal water supply portfolio

Table 1 provides an overview of various potential water sources: The two rainfall-dependent sources of water are reservoirs and treated stormwater. How much water is captured by reservoirs and stormwater harvesting systems depends largely on weather. The supply risks are not the same however, because of differences in scale, harvesting technique and location. This means that it is possible to hedge[2] the supply risks of these sources in the same way that the risks of different investment opportunities are assessed and hedged to design an optimal investment portfolio.

Why is this economic modelling important?

Providing water to meet the needs of a growing population and changing climate will become more challenging in the future. Water utilities and local governments are looking to invest in sources other than reservoirs to meet that growing demand. If future urban water supplies are to be reliable and affordable, it is important to account for the water availability risks and supply costs associated with all potential sources.

This economic modelling framework can be readily applied to analyse future supply-demand scenarios using rainfall and inflow projections from global climate change models. It can guide investment decisions by narrowing the suite of possible optimal infrastructure configurations, while explicitly allowing for water supply costs and different levels of risk aversion.

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Table 1. Risks and costs of different water sources

Rainfall-dependent sources	1. Reservoirs	Typically a primary source in an urban water supply system. **Supply risk:** Dependent on weather **Supply cost:** Low to moderate depending on how much capacity is used
	2. Treated stormwater	Collected from urban runoff. **Supply risk:** Dependent on weather **Supply cost:** Moderate to high depending on system efficiency
Rainfall-independent sources	3. Desalinated seawater 4. Treated wastewater	Used in some cities in Australia and internationally. **Supply risk:** Independent of weather. Assume no supply risk **Supply cost:** High

[2] Hedging is making an investment to reduce the risk of a supply shortfall from reservoirs.

Further reading:

[1]Leroux, A. D., & Martin, V. L. (2015). Hedging Supply Risks: An Optimal Water Portfolio. American Journal of Agricultural Economics. doi: 10.1093/ajae/aav014

About the research:

This research was conducted as part of CRCWSC project Cities as Water Supply Catchments: Economic Valuation (Project A1.1). This project's main objectives are to identify the willingness to pay for stormwater harvesting; to quantify the contribution of urban water amenities to property values and to determine the optimal portfolio of urban water supply sources.

Talk to:

Dr Anke Leroux
anke.leroux@monash.edu

Website:
http://watersensitivecities.org.au/programs-page/society-program-a/project-a1/project-a1-1-cities-as-water-supply-catchments-economic-valuation/

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