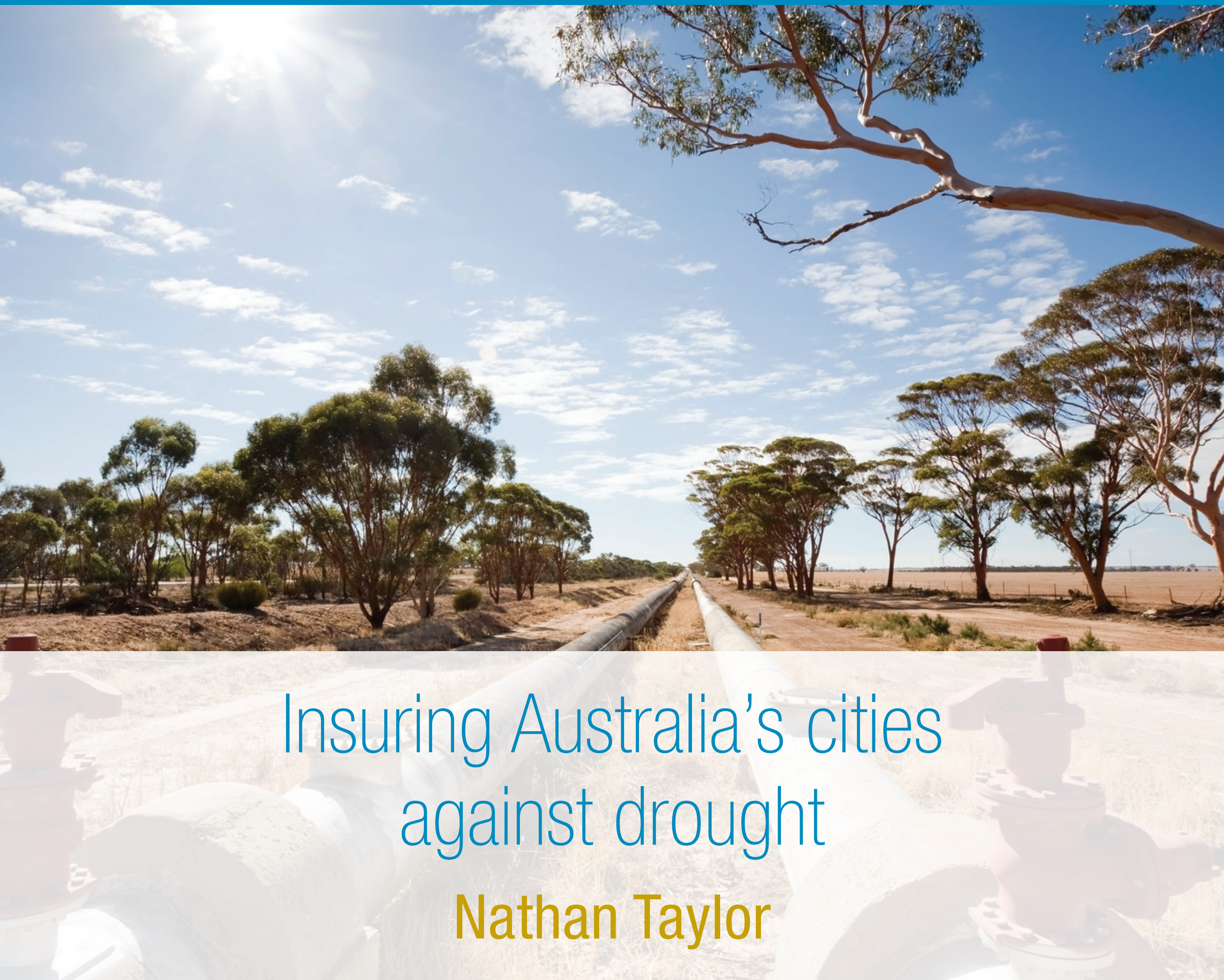


Insuring Australia's cities against drought

Nathan Taylor

Nathan Taylor is the Chief Economist at CEDA and a behavioural economist. He is responsible for the CEDA Research and Policy agenda which is undertaking an extensive series of reports into water, energy and population issues in 2012. He has been responsible for the projects *Crisis and Opportunity: Lessons from Australian Water Reform* and *A Greater Australia: Population, policies and governance*. He has also edited *Australia's Nuclear Options, Renewables and efficiency* and *Australia's Unconventional Energy Options*. He has authored the paper *Water Security: Water for the farm and the city*. Nathan has held policy roles at the Reserve Bank of Australia, the Chamber of Commerce and Industry WA, WALGA and others. He is the author of a book on corporate governance and cultural change and the blog *The Writings of a Naked Ape*.

Introduction

Australia has historically embodied an unquantified insurance premium associated with ensuring continuing water security for urban centres in physical infrastructure. This has been inefficient, resulting in suboptimal augmentation decisions, and unequitable in that a homogenous security preference is imposed on all customers. Furthermore growing populations and changing water supply variability is exacerbating the failings of this approach. To ensure Australia's urban centres have sufficient access to secure water supplies the desired insurance premium should be quantified and water utilities should have the responsibility to make suitable provision for ensuring their customers' preferred level of security. Such an approach would enhance the flexibility and adaptiveness in providing water to Australia's urban centres.

Water can be considered to have two key component services, delivery and security.[1] This discussion focuses on the security component embodied in various sources of bulk water supply, the so called head works and not the distribution of urban water. Unless the security component of a bulk water supply can be quantified there cannot be a basis for effectively comparing water sources.

Australia's incredibly variable water supply has meant that very large storage reservoirs have been the mainstay of providing secure water supplies. These reservoirs are capable of holding water from wet years to maintain supplies over extended dry periods. As demand on these storage systems increases the supply becomes more vulnerable to extended droughts. The design of these storages is highly dependent on the worst drought in the historical record. All of Australia's major cities are becoming increasingly susceptible to changes in the inflows to reservoirs.

The cost of providing reliable supply has been implicit rather than explicit. The embedded insurance premium was reflected in the overall cost of supply based on the cost of building and operating the water supply system. Prices reflect costs of infrastructure and the cost of providing secure supplies is not explicitly reflected in water prices. This weakens the price signals to consumers and the urban utilities providing water.

A homogenous level of water security has been delivered to all Australian households. Typically this has been expressed in terms of the probability of having water supply restrictions imposed at about 95 per cent. As a consequence, every household is likely to face water restrictions around once every 20 years. As higher levels of security are sought, the cost escalates rapidly since there is a nonlinear relationship between water security and the physical infrastructure that supports it.

It is not possible to provide a range of reliability options to consumers if the insurance premiums associated with the different levels of security are not quantified. Without this quantification, it is not possible to calculate and charge appropriately for different levels of reliability. However, imposing one standard level of reliability effectively subsidises customers wanting high levels of reliability with those who would prefer a lower level of reliability, while not meeting the latter's preferences.

Historically, augmentation decisions have been based on the contribution they make to the overall cost of the water supply system. Ideally, water supply augmentation decisions should be based on the contribution a water supply option makes to the overall insurance premium. Failing to account for the security of a water source results in highly secure sources being expensive during times of plentiful water and relatively cheap in times of water scarcity.

Planning augmentation has only been done periodically. Typically a strategic planning exercise is conducted and reviewed every five years. Such planning is vulnerable to more extended droughts beyond the experience of the historical record. If an insurance premium is set over a suitable timeframe it should enable clear price signals for augmentation on an ongoing basis. However, the historic lack of a quantified insurance premium meant that by the time it was recognised that the water security of Australia's urban centres was potentially in danger, politicians intervened in decision making to guarantee the security of water supply.

The $30 billion in recent augmentation investments, such as desalination plants in every mainland capital city, means that Australians have once again embedded an insurance premium in physical infrastructure. Since these desalination plants, if they were operating at maximum capacity, could potentially supply nearly half of capital city water needs based on 2008–09 water consumption, it represents a very secure source of most of the nation's water.[2] But has too much or too little insurance been purchased?

Quantifying the water security insurance premium

Urban water wholesale prices could include a variable component based on the cost of the insurance premium. Quantifying the insurance premium would enable more effective augmentation decisions and allow differentiated levels of service to customers based on their preferred level of security. It would provide important information for planning future augmentations, while providing critical pricing signals to customers in order for them to adjust behaviour.

Customers could be offered a range of service levels to reflect their preferred level of water security. They could be given a range of options whereby the price they pay for water is linked to when restrictions are applied. Those desiring a reduced probability that water restrictions be applied would pay a premium on their annual water bills.

The overall level of reliability demanded by consumers is likely to vary. A number of studies that have examined the social costs imposed by restricting the use of water on some households found that they are large, with potentially substantive differences in household water preferences. These studies have found that the average social costs of water restrictions per household were found to increase with the severity of the restriction. Recent high levels of water restrictions were found to have cost approximately half the annual water bill in terms of preferences to avoid them.[3] Providing a price incentive to consumers would provide water utilities with a better guide as to the real demand for water and a willingness to pay for security.

If significantly heterogeneous preferences for water reliability emerge then there is likely to be major efficiency gains for urban water planners. This is particularly true given the growing populations in Australia's urban centres and the uncertainty around future water supply levels. The recent drought brought home the challenge of continuing to provide high levels of water reliability services for all households and the escalating costs involved in delivering it.

The risk of running out of water in the future is critically dependent on the level of water in the reserves at the moment. If water is spilling over the dams, the value of insuring future water supplies is probably very low. Establishing an overall level of desired water reliability for an urban centre would be the first step in efficiently quantifying an insurance premium. This premium should be calculated on an annual basis to reflect changes in the level of water storage. The end of the spring filling season would be an appropriate time to establish the annual premium which would constitute a variable component of the wholesale water price.

The money generated by the insurance premium would provide funds to undertake augmentation and to supplement the cost of water from different sources. An insurance premium that was rising to reflect increasing scarcity of water would stimulate augmentation decisions. Annual planning would then become the norm and would stimulate early action in another extended drought. It would also provide a method to quantify the value of alternative water sources.

The dynamic nature of the insurance premium would provide important information about the value of water supply from different sources. Recent augmentation decisions have created a portfolio of water supply options but there is no capacity to quantify the value of different sources. This is a fundamental challenge since the marginal cost of production is very different for a desalination plant compared with stormwater, for instance. However, each water supply option will have a different impact on the probability that an urban centre may experience challenges to its water security.

Valuing the water insurance premium

To put a price on the value of insuring water security involves quantifying a number of key variables that underpin its value. The underlying variables that will determine the value of an insurance premium (*IP*) would be determined via the formula:

$$IP = f(S, X, V, T) \text{ where:}$$

- *S* is the storage deficit, or the "air" in the storage systems;
- *X* is the amount of water demanded annually;
- *V* is the variability of the urban centres' water supply; and
- *T* is the time under which the insurance premium is calculated.

The value of an insurance premium will vary in proportion to the amount of air in the urban centres storage system. This reflects the fact that water security becomes both more difficult to insure and more valuable, as water becomes more scarce. Annually calculating the insurance premium, and reflecting it in the price of wholesale water supplies, would create powerful price signals to water utilities and consumers. The overall value of *S* would reflect both the total amount of air in the storage and the marginal cost of water supply from all sources.

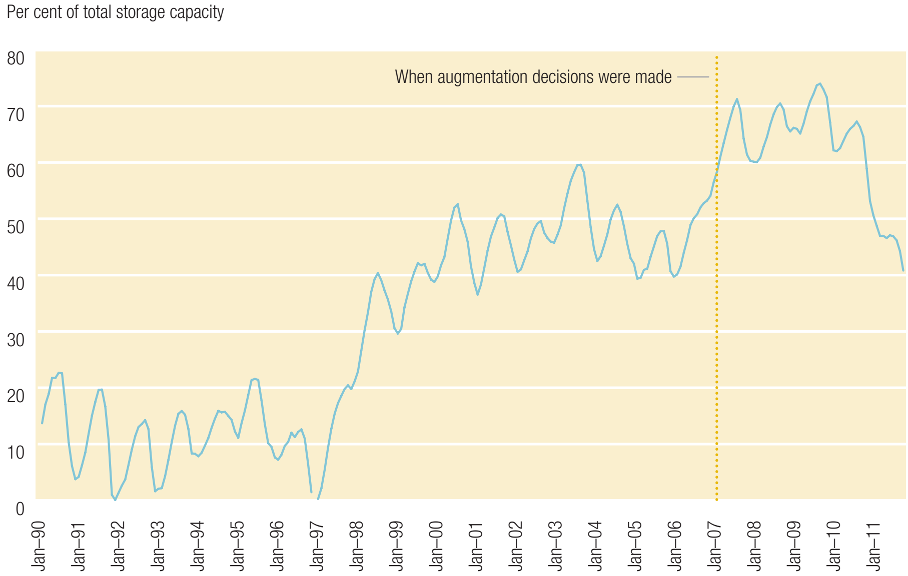
Figure 1 describes how *S* would have varied for Melbourne during the recent drought.

Having the insurance premium calculated annually at the end of the spring filling season would provide dynamic information about the state of water security. As the storage in the reservoirs fell the premium would rise. This price rise would trigger an augmentation response. In the first instance this would involve applying delaying tactics, as suggested by real options analysis. As the premium rises further, more expensive augmentation options would become cost effective in reducing the annual premium.

The amount of water demanded annually, represented by *X*, would change over the timeframe of the insurance premium. These changes, along with any likely imposition of restrictions that suppresses annual aggregate demand for water, would need to be incorporated into the insurance premium calculation.

The variability of water supply sources would be a critical determinant of their value to the overall insurance premium that exists for an urban centre. In particular, understanding the covariance of the different water sources is vital for appreciating the relative value of different water sources. This would include examining the variance of each supply such as the traditional storage reservoirs; desalination plants; potable

FIGURE 1
STORAGE DEFICIT IN MELBOURNE'S MAJOR STORAGES (THOMSON, UPPER YARRA, O'SHANASSY AND MAROONDAH RESERVOIRS)



Source: Melbourne Water

recycling and non-potable recycling; purchase of water from irrigation through investment in reducing losses, for instance the north-south pipeline; stormwater harvesting; rainwater harvesting; or any combination of the above.

Options that are uncorrelated with rainfall are much more valuable in terms of their contribution to the overall insurance premium than to their contribution towards the overall level of water available for water storage.

The historical use of a 10 year timeframe, *T*, to evaluate water inflows has proved inadequate. The insurance premium would be more substantive the longer the timeframe in which decisions should be made. However, the longer the timeframe the more expensive the insurance premium on water security will be. Quantifying the appropriate timeframe is important in making meaningful decisions about the value of different water sources.

The various augmentation options should be evaluated on the basis of how they influence the overall insurance premium. This will be dependent on the water source's contribution to overall water storage capacity, its influence on the aggregated strike price of the collective option, the covariance matrix of the water source and existing storage reserves, in addition to the average cost of the water source. For instance:

- Desalination: offers a water supply that is highly uncorrelated with river inflows. As a consequence, desalination has an influence on the overall level of water storages available for urban water utilities and the variability of water stores. Given that desalinated water is perfectly uncorrelated with alternative water sources, it would have a significant influence on the variability of overall urban water supplies.
- Capturing stormwater: would have major two influences on the insurance premium. It would enhance the total reserves in the system, and it would influence the overall variability of water supply. The cost per megalitre in storage capacity would have to be assessed in comparison with the capacity of that storage to influence the variability of water supply. Given the probable correlation between stormwater supply and river inflows, it is likely that stormwater would not have a major influence on the overall insurance premium.

- Recycling: recycling capabilities provide a de facto expansion of the effective water storage limits in Australia. This source of water would also be highly uncorrelated with rainfall, potentially making it more valuable.
- Urban trading with agriculture: any purchase of water entitlements by an urban centre from irrigation would have a different variability. The value of the purchase as insurance would be dependent on the correlation of seasonal water allocations of the purchased entitlements and inflow into the city's reservoirs.
- Demand management: influencing the level of water demanded by individuals has the effect of changing the aggregate level of annual water demanded by consumers.

Quantifying the value of different water sources would guide augmentation decisions as well as being a fundamental component of managing a portfolio of water source options. Understanding the implications for the overall insurance premium is a prerequisite for evaluating the relative merit of alternative water sources. It is not possible to adopt a portfolio management approach to water supply management without quantifying the insurance premium.

Proposal

The recent augmentation decisions have resulted in very clearly defined levels of water supply reliability. There is now scope to provide customers with explicit options in terms of water security, providing an opportunity to quantify the community's preferred levels of reliability and to ensure that water sources are valued appropriately and are paid for equitably.

While a suite of options may develop to reflect customer preferences, particularly if effective competition is introduced into the bulk water market, currently there are two very clear levels of water security available to consumers. Those consumers desiring a high level of water insurance could pay a large proportion of the costs associated with desalination whereas consumers willing to accept higher levels of insecurity could have a reduced component added to their bill, reflecting their preferences for security.

As an example, customers wanting to pay a reduced insurance premium would accept water restrictions when storage levels fell below 50 per cent. Those customers who want higher water security and are willing to pay the insurance premium required to deliver it would only face water restrictions when storage levels fell below 30 per cent. This would provide a very direct price signal to consumers about the cost of delivering higher levels of security and achieve a more equitable distribution of those costs.

Having customers with a preference for high security pay for the majority of costs associated with desalination would eliminate the equity issues that currently exist. Rather than having a fixed charge to cover the cost of desalination imposed on all customers, it would be funded by those who desire the high level of security it provides. While not a perfect application of a quantified insurance premium, it represents an improvement on existing practice.

To explore how pricing policies and augmentation decisions could be influenced by quantifying an insurance premium, the approach should be retrospectively applied to the past 10 years of Melbourne's history. This would allow for the comparison of the decisions made with an application of the insurance premium. To achieve this would require an evaluation of the insurance premiums for the full range of options listed above both individually and in combination. It would also provide a test case for calculating the insurance premium in planning ongoing water supply for the city.

Endnotes

1 This view of water services reflects John Freebairn's (2012) interpretation of Lancaster's (1971) product characteristic model described in Freebairn, J., 2012, *Risk Aversion and Urban Water Decisions*, AARES 56th Annual Conference, Fremantle, February 2012.

2 Ross Young, (2011), 'The risks of urban water management,' The Australian Water Project Volume 1 Crisis and opportunity: Lessons of Australian water reform, CEDA.

3 Brennan D., Tasuwan S. and Ingram G. (2007), 'The Welfare Costs of Outdoor Water Restrictions', Australian Journal of Agricultural and Resource Economics, 51(3), 243–262.