INCORPORATING RAINWATER RE-USE SYSTEMS INTO URBAN SUSTAINABILITY PLANNING IN WESTERN AUSTRALIA

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ABSTRACT

The WA Department for Planning and Infrastructure is developing a Building Sustainability Index for dwellings in the residential sector. The program has the working title of WA BASIX. It is a performance based development approval scheme which sets minimum water and energy efficiency targets for dwellings. Dwelling designs are assessed and their water and energy use predicted. Building permission will be granted to dwellings which meet the efficiency targets. One of the strengths of WA BASIX is that it dictates the target, but leaves the designer, builder, or owner free to choose the pathway they will take to meet the efficiency targets. Thus Western Australians can choose between options such as efficient appliances, smaller irrigated areas, higher proportions of "Waterwise" plants, or swimming pool covers.

One pathway for the water efficiency target is to capture and re-use rainwater for loads which currently use mains supplied water. There are many factors which impact on the efficacy of a rainwater re-use system, and therefore its ability to reduce the demand for utility supplied water.

This paper explores these issues, and demonstrates how rainwater re-use systems can be configured and then quantitatively assessed as part of a formal planning tool, even if that tool covers the range of climate zones in WA. The paper finds that this type of assessment process is needed to ensure that systems such as this deliver real gains in a formal urban sustainability planning tool.

INTRODUCTION

The use of rainwater tanks as a pathway to urban water efficiency/conservation is increasingly common in Australia. A number of jurisdictions across the country have mandated rainwater tanks for new dwellings. In WA, some local government jurisdictions have also actively considered similar regulation. However, the benefits of a rainwater tank are more variable than other more common water efficiency measures such as dual flush toilets or water efficient showerheads. The full cost of a rainwater tank and its associated plumbing is also usually significantly higher than other water efficiency technologies.

These factors have triggered some debate as to the technical and economic merits of the use of rainwater tanks in the urban environment. This itself has led to some debate concerning the equity of the use of rainwater as a mainstream water efficiency measure. All three of these streams of debate have been drawn together through the development of the building sustainability index, BASIX. Originally formulated for NSW, the BASIX program is currently being investigated by the WA State Government for possible implementation in WA.

TECHNICAL CONSIDERATIONS

Perth has a climate characterised by dry, hot summers, and mild winters. The mean monthly rainfall and temperature for Perth are shown in Figure 1.

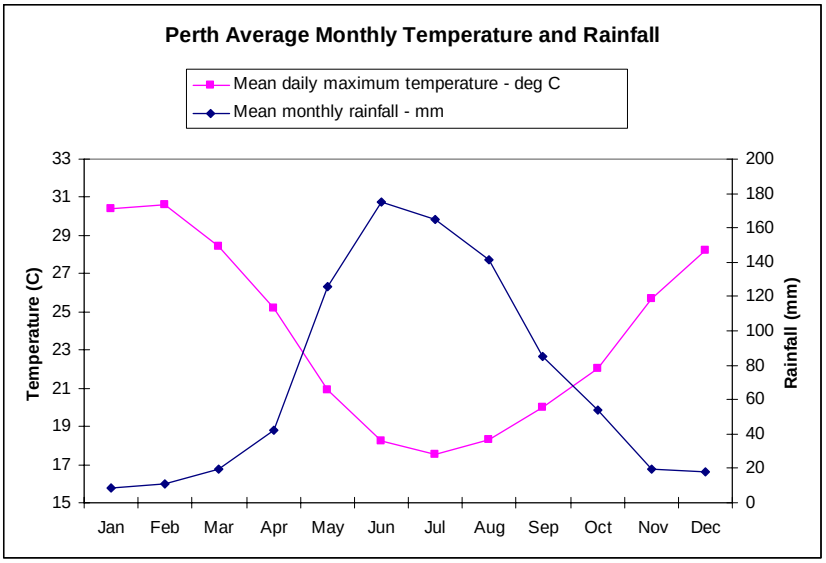

Figure 1: Mean monthly rainfall and temperature, Perth.

It is also noteworthy that Perth gets in rainfall in relatively few rain days. For example, Perth has a higher mean rainfall (865.8 mm) than Melbourne (543.8 mm) but receives its rainfall in an average of only 123.4 days/annum compared to 140.9 days/annum for Melbourne. The pattern of rain days is also atypical compared to centres such as Melbourne with Perth having more rain days/month during the winter months and fewer during the balance of the year. This is shown in Figure 2.

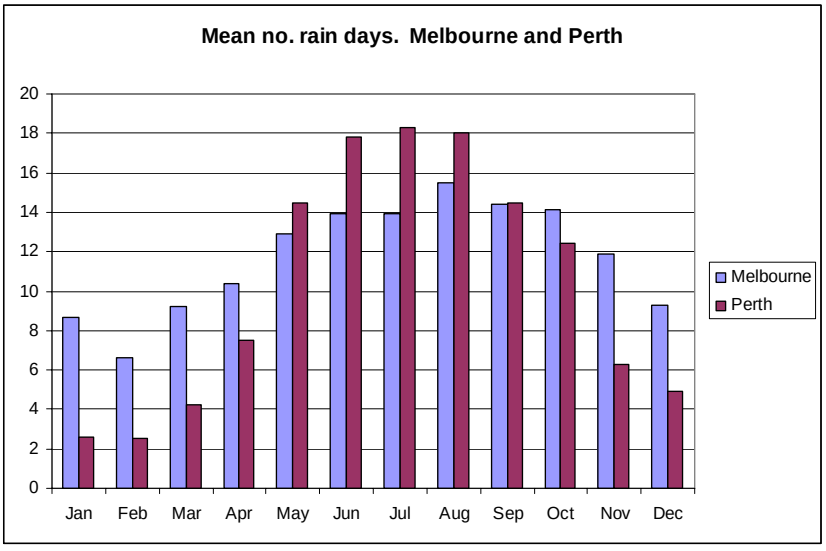

Figure 2: Mean monthly rain days, Perth and Melbourne

This climate pattern has implications for the efficacy of a rainwater tank being fed from the roof of a domestic residence in Perth, and servicing a water substitution load for the same residence. It is the prime factor behind a reasonably widespread dismissal of the usefulness of rainwater tanks in Perth. This is especially the case when one attempts to use domestic irrigation as the water load being met by the tank.

In that circumstance the arguments against the use of a rainwater tank are threefold:

- The irrigation demand doesn't exist when the tank is full
- The capacity of the tank is insufficient to meet the load in the rainfall shoulder periods
- The tank is empty when the irrigation demand is present.

However, the efficacy of the rainwater tank in Perth changes if one shifts the water load to being a more stable, and less climate dependent load such as feeding toilets and washing machines. In such cases the profile of the rainwater tank still remains one of overflow in winter, and emptying in summer, but the water savings are appreciable. Modelling conducted by the Department for Planning and Infrastructure (DPI) in Perth shows that potable water savings of between 30 kL/annum and 50 kL/annum are available depending on the roof size caught, the tank capacity, and the extent of the indoor load. A summary of this modelling is shown in Table 1

Potable Loads	Load (L/day)	Load (kL/annum)	Roof area plumbed (m2)	Tank size (kL)	kL/annum saved
Toilet only	112	41	100	2.5	32
Toilet only	112	41	100	4.5	34
Toilet only	112	41	150	2.5	35
Toilet only	112	41	150	4.5	36
Toilet and Washing machine	181.5	66	100	2.5	43
Toilet and Washing machine	181.5	66	100	4.5	45
Toilet and Washing machine	181.5	66	150	2.5	49
Toilet and Washing machine	181.5	66	150	4.5	51

Table 1: Rainwater savings, Perth.

This work indicated that the best combination of roof area, tank size and water load is one of the 2 options presented in the last 2 lines of the table. The model outputs for these 2 options are presented below (in the order they appear in the table).

Option 7

Annual Demand	66	kL
Potable top up	18	kL
Water Savings (kL/annum)	49	kL/annum
As a % of demand	73%	

Option 8

Annual Demand	66	kL
Potable top up	16	kL
Water Savings (kL/annum)	51	kL/annum
As a % of demand	76%	

It should be noted that while the smaller 2,500 litre tank produces savings which are only 2,000 litres/annum less than the larger tank, the unit cost of the water saved is less than that saved by installing the larger tank.

On this basis, it would seem that the recommended package for dwellings in Perth should be 150 sq.m. of roof area plumbed to a 2.5 kL tank, which is connected to the toilet and the cold water feed of the washing machine. This was the package shown as *Option 7*.

The quantum of potential water savings available from a rainwater tank compares very well with those available from other, better known domestic water efficiency measures. These are shown in Table 2 below.

Element	**Potential annual savings (kL)**
Shower	24.0
Toilet	15.5
Taps	3.0

Table 2: Potential water efficiency savings, Perth.

FINANCIAL CONSIDERATIONS

Despite the favourable potential water savings, the cost of purchasing and installing a rainwater tank can be significant. Cost benefit analysis work conducted by the DPI showed a unit cost of rainwater in the order of $7/kL for the two scenarios shown above. However, it should be borne in mind that very few conventional water efficiency measures can compete with the cost of utility supplied water. Measures such as dual flush toilets, garden bores, and water efficient washing machines all return unit costs for water saved higher than the water Corporation tariff. The only conventional water efficiency measure which routinely has a lower unit cost than the utility is the water efficient showerhead.

The unit cost of water saved is a real consideration for government's considering mandating any particular water efficiency measure.

EQUITY

Given, the reasonably high cost of a rainwater tank and its associated plumbing, the mandating of such measures in a blanket regulation can cause equity concerns. This is especially the case if the regulation is enacted in the absence of any other "sustainability" measures. That is, a home owner can go to significant effort and cost in designing a sustainable house and land package, and still face exactly the same impost of the rainwater tank as another home owner who has done nothing to enhance the sustainability of their dwelling.

This could as a disincentive for homeowners who may have otherwise been prepared to invest in sustainable building practices. In effect, the rainwater tank which was intended to be a policy "floor" may well become a "ceiling" with individuals reluctant to do more.

"SMART" POLICY

With the above points in mind, there is a an argument against the mandating of rainwater tanks per se. However, the quantum of water they can save is higher than most conventional water efficiency measures. One way for regulators to capture the potential for this saving is to not consider the rainwater tank in isolation, but as part of an integrated sustainability planning package. The building sustainability, or BASIX program is one such package.

Originally developed for NSW, the BASIX program is under investigation for implementation in WA. The BASIX program functions by calculating a baseline for water and energy use in domestic dwellings and then setting targets for the reduction in water and energy use from that baseline. House and garden plans are assessed as part of the approval process and permission to build is only granted if the design meets the targets. In this way the water and energy savings are captured at the design phase and not at the more expensive and logistically difficult retrofit phase.

In nesting the rainwater tank within the rest of the suite of water efficiency measures, BASIX allows householders to either take up the opportunity for rainwater use, or to select some other pathway to the water target. Other pathways include the normal in-house water efficiency measures (dual flush toilets, water efficient showers, water efficient washing machines) along with measures such as decreasing the area under active irrigation, selecting native or "Waterwise" plant or turf species, greywater, and the use of swimming pool covers.

The choice of pathway selected by the householder will reflect their individual position after considering personal circumstances such as lifestyle considerations (pools and spas, aesthetics (native garden V cottage garden), "civic duty" (willing to pay more per kL for water), health (greywater) etc.

RAINWATER IN BASIX

The BASIX program has a number of iterative feedback loops for rainwater and other elements which make it a sophisticated assessment tool. The programming behind the calculation engine essentially reduces all proposed efficiency measures to the number of units of the resource (kL, tonnes of greenhouse gas) which will be saved and awards the measure a points score based on this.

The BASIX engine uses the postcode of the intended dwelling to incorporate critical climatic data such as the rainfall profile, evaporation and temperature and dwelling characteristics such as the number of bedrooms to infer household size and therefore demand for resources. The program also draws on conventional building assessment programs such as the Building Code of Australia BCA) to assess characteristics such as thermal comfort.

In the case of water efficiency, a showerhead installed in a 1 bedroom unit will return a different annual water saving total than one in a 4 bedroom house. Similarly, reducing the irrigated area by 10 m^2 in the Perth metropolitan are will produce a different saving score to the same measure in the arid north, or the milder south of the state.

A number of factors are explicitly considered by the BASIX program in assessing the points score awarded to a rainwater tank configuration. The first is the climate zone in which the tank will be situated. BASIX draws on mean monthly rainfall data from the Bureau of Meteorology (BoM) to assess the potential run off in monthly increments.

Run-off is calculated as a function of the rainfall profile, and the roof area which is plumbed to the tank with storage capacity dictated by the tank volume. Naturally storage capacity is capped at 100% of the tank volume with no consideration given to harvested rainwater which is deemed to go to overflow.

BASIX considers that the rainwater must go to a beneficial end use to be awarded a score under the assessment program. A beneficial use is one which displaces a potable water load through the meter. As mentioned previously, these loads can consist of toilet cisterns, washing machine feeds, or irrigation.

BASIX uses building characteristics such as the number of bedrooms to infer household ppulatio. This is then used to calculated the load for the rainwater use in appliances such as toilets and washing machines. As was the case previously, a rainwater tank of a set configuration will score differently in a 1 bedroom unit than in a 4 bedroom house as the demand for rainwater will be significantly different.

BASIX also assesses the demand for water for ex-house applications for rainwater. Here factors such as the area to be irrigated are considered, along with the characteristics of the species to be irrigated. Climate is also assessed with consideration given to factors such as the reduced demand for

irrigation in the winter months, and the unavailability of rainwater in the summer months when the irrigation demand is at its highest.

It is for reasons such as this that rainwater tanks installed in Perth conserve more water when configured for non-climate dependent loads such as in-house demand for toilet flushing and washing machines.

URBAN AND RESOURCE PLANNING BENEFITS

By subjecting water and energy efficiency initiatives to a rigorous assessment, and incorporating this process into the planning system, programs such as BASIX not only capture the efficiency gain but also the information on its quantum and location. In greenfields developments this results in a fuller understanding of the resource demands of the development and greater certainty about elements such as peak and base loads for water and energy, and load profiles in general.

The BASIX program will result in reduced demand for water and energy as a whole. However, it is hoped that the types of information sets such as this will result in diminished need for suppliers to build in excess system capacity to cater for variable and unpredictable loads.

The BASIX programs have capacity for secondary program elements to deal with the assessment of existing homes (probably at the time of sale), and major renovations. If these program streams are fully implemented, 50% of Perth's housing stocks would be assessed and improved within an 8 year time frame.

This rapid penetration of the city's housing stocks, the efficiency gains, and the documentation through the planning process would generate a powerful management data set for the continued management of resource delivery to the city.