What are we saving anyway? The results of three water demand management programs in NSW, Australia

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Abstract The use of demand management programs to achieve permanent and reliable decreases in water consumption through retrofits of water using equipment is relatively new in Australia, and has been carried out on the basis of models which predict savings, and on results of demand management programs undertaken overseas. The availability of information on actual savings achieved by demand management programs in Australia is extremely limited. This paper outlines the results of the evaluation of three retrofit programs undertaken in NSW, two of which involved a visit by a plumber to households to carry out a retrofit of indoor water using equipment at a subsidised price; the other taking a "hands-off" approach and relying on a discount incentive mechanism to increase the market share of water efficient showerheads.

Keywords Demand management; evaluation; quantitative analysis; retrofit program

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Introduction

Demand management programs to reduce water consumption are being considered and implemented by water utilities across Australia. The basis of these programs tends to be estimates of likely savings as calculated from laboratory based tests on water using equipment or assumed savings based on the technical or theoretical water use of equipment; or on data from studies undertaken abroad (mainly the US) on realised savings from similar programs. Given that water use in Australia is different to that of the US (for example, the amount of water used by toilets is much lower in Australia than the US), there is a necessity to determine what savings are being realised by demand management programs in Australia.

This paper discusses the evaluation of three demand management programs undertaken in New South Wales. All the programs discussed use a subsidy mechanism in order to induce people to install water efficient appliances within their households. The focus of these programs was on indoor water use efficiency only. One efficiency program focussed on a relatively "hands-off" approach to demand management by increasing the market share of water efficient (AAA-rated) showerheads through the provision of a point-of-sale discount, while two of the programs discussed were more interactive in that they involved sending a plumber to participant households in order to install water efficient equipment. The programs are described in more detail below.

Rous house tune-up

The House Tune-Up Program was one aspect of an overall demand management strategy being implemented by Rous Water. The House Tune-Up program took place in Rous Water's service area on the northern coast of New South Wales, running through most of 1998 and into 1999. The program provided an average of $89 worth of appliances and service at a cost of $15 to participants in order to carry out the following work (where necessary):

- adjusting single flush toilets to 9L flush and repairing leaking toilets;

- installing water efficient (AAA-rated) showerheads;
- installing tap-flow regulators and repairing leaking taps; and
- checking and adjusting the temperature of hot water systems to 60°C in order to decrease energy consumption.

Smart showerhead program

This program promoted the sale of water efficient (AAA-rated) showerheads through the provision of a point-of-sale $10 discount on the purchase of a conforming showerhead at a participating retailer. Vouchers were provided to people with their water and energy bills, as well as having vouchers available in stores. The program took place in the greater Sydney region, commencing in July 1998 and running through to October 1999.

Pilot retrofit program

The pilot program for a large scale indoor residential retrofit program in Sydney Water's supply area was undertaken in Shellharbour, south of the Sydney metro region from April to July 1999. Similar to the Rous House Tune-Up program, this involved the provision of water efficient appliances and a plumber's services at a subsidised cost to customers. Participants paid $15 (later amended to $22 including GST for the final program) to receive equipment and services worth approximately $120 including:
- installation of a water efficient (AAA-rated) showerhead (additional showerheads were installed for a cost of $37.50 per unit);
- installation of tap flow regulators or aerators in kitchen and bathroom taps;
- adjustment of single flush toilet volumes to 9L/flush through the installation of a float valve or cistern weight; and
- checking for leaks and making minor repairs.

Methodology

A comparison group analysis approach was used in evaluating the reduction in the demand for water achieved by each program. Comparison group analysis has been used to determine estimates of the impact of retrofit programs in other instances where detailed information about the households taking part in the programs was not available (Bruvold and Mitchell, 1993; Nelson, 1992). Where more detailed information about households is available, regression analysis has tended to be the preferred method of analysis (Bruvold and Mitchell, 1993; Michelsen *et al.*, 1999; Renwick and Green, 2000; Whitcomb, 1991). The availability of data and cost of obtaining such detailed information was a barrier to carrying out a regression analysis based evaluation for the programs discussed in this paper.

Historical water consumption records from the water suppliers (in this case, Sydney Water and Rous Water) were used to determine how water consumption in the program participant groups and a comparison group for each program changed over time. The two Sydney-based programs used quarterly billing period data, while the Rous program evaluation relied on bi-yearly data. Each billing period has been loosely associated with a season for ease of discussion. The data from Sydney Water is discussed as summer, winter, etc., while data from Rous Water is discussed in terms of the wet season and dry season as this is more apt given the near sub-tropical climate of the region. For each program, the comparison group was composed of approximately the same number of non-participant households chosen from similar localities as the participants.

The evaluation involved determining whether the comparison and participant groups had similar consumption patterns in the pre- and post-program time periods. The comparison group essentially acts as a control for influences such as climate and other factors affecting water use, i.e. educational campaigns. This method assumes that the participant group would behave in the same manner as the comparison group to climate and other non-program variables. Rather than simply determining whether significant changes in water consumption had occurred from pre to post program periods (which usually do occur since climate varies over time), this analysis looked at how water consumption in the comparison and participant groups changed over time.

The change in consumption from pre- to post-program time periods was calculated for each property. This change in consumption was then analysed to determine whether the change was similar in the comparison and participant groups over the same time period.

Results

Two sample t-tests were carried out to determine whether the comparison and participant groups of each program had similar demands for water over time. The results are shown in Figure 1 below.

The results show that the comparison and participant groups of the Sydney Water Pilot Retrofit Program and the Smart Showerhead Program were similar prior to either program being implemented. After the programs were implemented, the participant groups had significantly lower consumption in all post-program time periods analysed. Conversely, the participants of the House Tune-Up Program had significantly higher consumption than the comparison group prior to the program taking place. The consumption of the two groups after the program was similar.

The change in water use from pre- to post- program periods was calculated in each reading period for each property. It was felt that the change in use from pre- to post- program periods was a more accurate method for determining likely program savings then analysis of actual demand. This was based on an assumption that the change in demand was more likely to account for behavioural aspects of water use, and that assumptions about similar shifts in water use between the comparison and participant groups were more likely to be accurate than assumptions of similar demand for water over time within the participant and comparison groups. This was based on the fact that the participant groups in all three programs elected to take part in the programs while the comparison households chose not to.

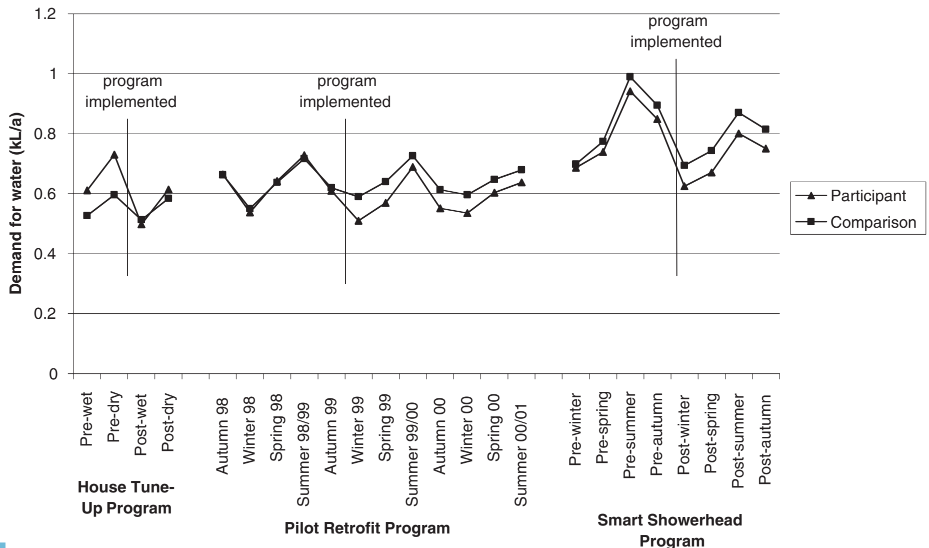

Figure 1 Average demand for water for the participant and comparison groups of the three programs across all time periods used in the analysis. The P-value of two-sample t-tests on the demand are shown for each time periode

The results of t-tests analysing the change in consumption for the comparison and participant groups of all three programs is shown in Table 1. This analysis was undertaken for each time period for which both pre- and post-program demand data was available.

The results of the t-tests of the change in consumption from pre- to post-program periods between the comparison and participant groups across all three programs show that the participant groups consistently decreased their consumption in relation to the comparison group. This result is significant at the 0.05 level for all time periods for which data was available for the House Tune-up Program and the Pilot Retrofit Program. While the same trend is seen in the results of the Smart Showerhead Program, these are not significant for all seasons tested.

The change in consumption of the comparison group was subtracted from that of the participant group to determine the decrease in consumption of the participants of the various programs. The decrease found for each program is shown in Figure 2.

On average, the House Tune-Up Program participants showed a decrease of 33.6 ± 26.3 kL/a and 37.2 ± 29.6 kL/a in the wet and dry periods respectively. The confidence intervals are relatively large for this analysis as the sample group was relatively small. The overall average annual reduction of the Pilot Retrofit Program participants was 19.6 ± 5.0 kL/a. This was for all program participants regardless of what items were installed at the premises, therefore including some houses which had nothing installed (no further efficiency mechanisms were required or existing fixtures were not suited to a retrofit) or simply had leaks repaired. The average reduction in demand achieved by participants of the Smart Showerhead Program was 16.5 ± 6.6 kL/a. The difference in average savings for the two relatively similar programs (the House Tune-Up Program and the Pilot Retrofit Program) may be due to high water users generally making up the participant group of the House Tune-Up program. This may indicate that the participants of the program were households

Table 1 The t-test results for determining the change in water consumption from pre- to post-program time periods for comparison and participant groups for all three programs

Program	Time period		Mean change (kL/d)	Sample size (N)	95% confidence interval	P-value
House tune-up	Wet season	Participant	0.107	87	0.015, 0.169	0.020*
		Comparison	0.015	131		
	Dry season	Participant	0.117	86	0.013, 0.190	0.024*
		Comparison	0.015	180		
Pilot retrofit program	Winter 98 to 99	Participant	–0.025	805	–0.033, –0.066	0.00*
		Comparison	0.025	3625		
	Spring 98 to 99	Participant	–0.080	3344	–0.053, –0.074	0.00*
		Comparison	–0.017	3633		
	Summer 98 to 99	Participant	–0.039	3458	–0.036, –0.060	0.00*
		Comparison	0.009	3497		
	Autumn 99 to 00	Participant	–0.114	3433	–0.052, –0.078	0.00*
		Comparison	–0.049	3483		
	Winter 99 to 00	Participant	–0.003	3440	–0.038, –0.061	0.00*
		Comparison	0.046	3505		
	Spring 99 to 00	Participant	–0.038	3454	–0.035, –0.060	0.00*
		Comparison	0.010	3517		
	Summer 99 to 00	Participant	–0.090	3448	–0.040, –0.066	0.00*
		Comparison	–0.037	3490		
Smart showerhead program	Winter	Participant	–0.068	775	–0.032, –0.108	0.00*
		Comparison	0.002	1232		
	Spring	Participant	–0.070	774	–0.010, –0.071	0.01*
		Comparison	–0.029	1235		
	Summer	Participant	–0.150	774	–0.005, –0.078	0.03*
		Comparison	–0.108	1223		
	Autumn	Participant	–0.104	774	0.005, –0.062	0.10
		Comparison	–0.076	1228		

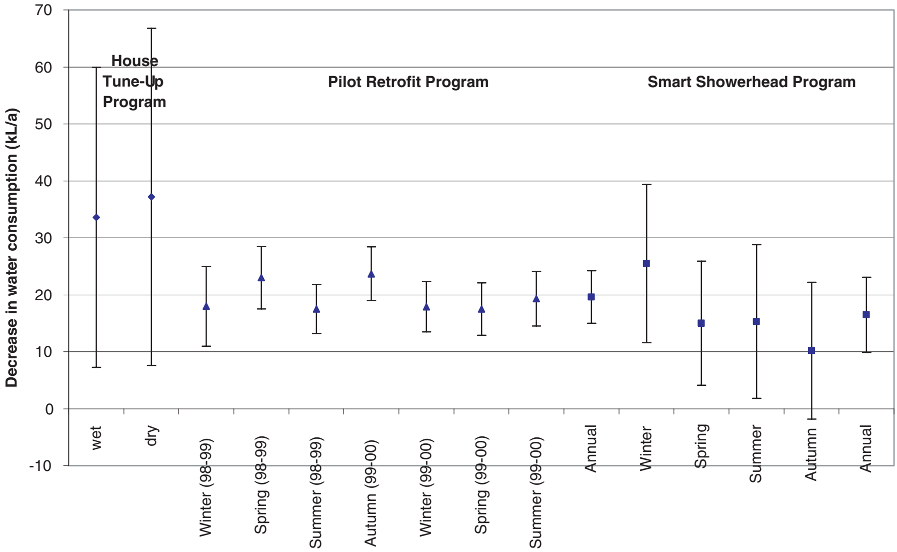

Figure 2 Estimated reduction in demand for the three programs for all time periods evaluated, showing the 95% confidence intervals

where demand reductions were relatively easy to achieve as water use was relatively inefficient. This is in contrast to the participants of the Pilot Retrofit Program where the participant group had a similar demand for water to the comparison group, and therefore may have been more water efficient to begin with than the participants of the House Tune-Up Program.

The Smart Showerhead Program was substantially different from the other two programs in that it did not involve a visit by a plumber, meaning that the extent of actual installation of equipment was not as clear. The other two programs also included water efficiency measures other than water efficient showerheads. The discussion below shows that this may influence the extent of the savings noticed in the various programs.

Savings based on efficiency measures

The Pilot Retrofit Program had a sufficiently large sample group to allow evaluation of savings attributable to the various efficiency measures installed. As mentioned above, the program involved the installation of a range of efficiency measures. A record of the actions undertaken was maintained for each household. These were used to group the participants into one of seven categories based on what efficiency mechanisms were installed in the household. Analysis of variance (ANOVA) was used to determine whether there were differences in the change in water use from pre- to post-program periods for the categories, and a Fisher's pairwise comparison was carried out to determine which categories were significantly different from others at a 0.05 level of significance.

Table 2 shows the estimated average demand reduction achieved by each combination of water efficiency measures installed for the seven billing periods that were analysed. The reduction in demand attributable to the installation of only an efficient showerhead is similar to the reduction found for participants of the Smart Showerhead Program who are assumed to have only installed efficient showerheads on their premises. Some of the categories had small sample sizes (such as those participants having only a tap aerator / regulator installed) and therefore show very high variance in their confidence intervals and estimated savings.

Four of the groupings had a relatively high number of households in them (N>150)

Table 2 Estimated average yearly savings from the various efficiency measures installed as part of the pilot retrofit program

Measures installed	**Estimated savings (kL/a)**
Efficient showerhead	14.5 ± 10.3*
Tap aerator/regulator	20.2 ± 40.0
Cistern weight/flush arrestor	11.0 ± 22.3
Tap aerator/regulator and cistern weight/flush arrestor	11.0 ± 18.1
Efficient showerhead and cistern weight/flush arrestor	18.4 ± 7.8*
Efficient showerhead and tap aerator / regulator	19.6 ± 7.8*
Efficient showerhead, cistern weight/flush arrestor and tap aerator/regulator	23.3 ± 6.5*

* significant reduction at a 0.05 level of significance

allowing more meaningful analysis. These were the households that had the following efficiency measures implemented:

- a water efficient showerhead only;
- a water efficient showerhead and adjustments to the toilet flush mechanism;
- a water efficient showerhead and a flow regulating device installed on taps; or
- a water efficient showerhead, adjustments to the toilet flush mechanism and a flow regulating device installed on taps.

These groups tended to show significant reductions in the demand for water across all time periods analysed. The demand reduction achieved by each of the above four groups over time is shown in Figure 3. The demand reduction is worked out in relation to the demand for water of the comparison group, so that the change in demand of the comparison group was subtracted from that of each of the participant groups in the same time period.

Those participants who had a showerhead and other measures installed consistently showed a significant decrease in consumption in relation to the comparison group. The average annual decrease for the group of participants installing a showerhead only was 14.5 ± 10.3 kL/a, based on the seven billing periods that were analysed. Due to the relatively low numbers of participants receiving only a tap regulator, or only a cistern weight it was not possible to carry out meaningful analysis of the likely savings from these measures directly. However, the number of households receiving these measures jointly with a showerhead was relatively high, and analysis of the reduction in the demand for water showed that each mechanism provided greater savings than simply a showerhead alone. Additionally, the

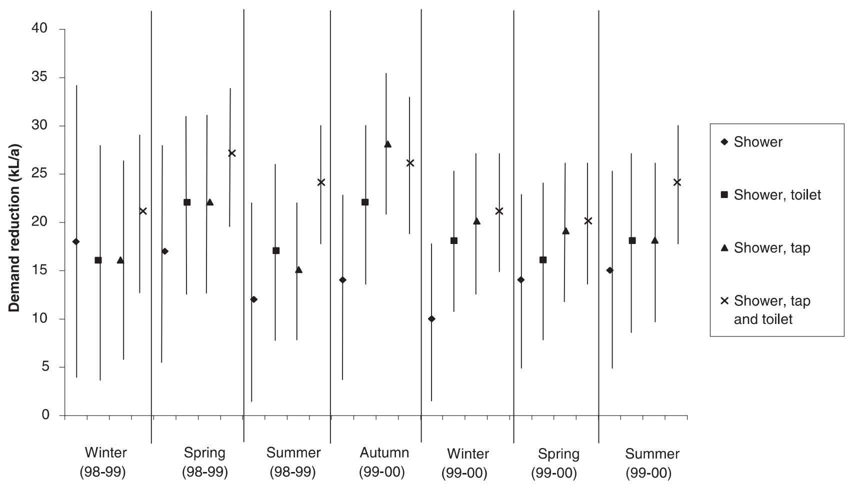

Figure 3 Savings attributable to various efficiency measures for each billing period analysed

estimated savings in households that had all measures installed compared to those that only had a showerhead installed indicated that installing cisterns weights (or other flush reduction devices to toilets) and flow regulators onto taps contribute significant savings. The estimated reduction achieved in households having a showerhead, cistern weight or flush arrestor and tap aerator or regulator installed was 23.3 ± 6.5 kL/a. This indicates that the marginal extra cost of installing such fixtures where a water efficiency program involves a professional visit to a household are providing savings which would otherwise not be realised.

Conclusion

The analysis of the demand reduction achieved by the House Tune-Up Program, the Pilot Retrofit Program and the Smart Showerhead Program provide evidence of savings achieved by demand management programs undertaken in Australia. All three programs show that significant reductions to demand have been achieved by the water authorities implementing the programs (in this case, Rous Water and Sydney Water Corporation). The demand reduction from the House Tune-Up Program appears to be the highest, though the variance in the results is high due to the relatively small sample size available for analysis. On average, the program participants showed a decrease of 33.6 ± 26.3 kL/a and 37.2 ± 29.6 kL/a based on analysis of demand in the wet and dry periods respectively.

The average demand reduction of the participants of the Sydney Water's Pilot Retrofit Program was 19.6 ± 5.0 kL/a. This was based on an overall analysis of all participants of the program, including those that had nothing installed and those that simply had leaks repaired. The participant group was sufficiently large to allow analysis of the reduction in demand based on the equipment installed through an analysis of variance using Fisher's pairwise comparisons. The results show that the majority of savings from the program can be attributed to the installation of water efficient showerheads (approximately 14.5 ± 10.3 kL/a). However, the installation of flow regulating devices to taps and flush regulators to toilets do provide significant additional savings, contributing to an overall reduction of approximately 23.3 ± 6.5 kL/a in those households where retrofits were made to taps and toilets as well as to showers. This indicates that there are significant savings to be achieved from ensuring that retrofit programs include taps and toilets in the program agenda, as well as the relatively high procurer of demand reductions, the water efficient showerhead.

The estimated savings from the Smart Showerhead Program were similar to that found in the analysis of savings from the Pilot Retrofit Program, with an estimated average reduction in demand being 16.5 ± 6.6 kL/a. Thus the demand reduction per unit from the two programs appears similar. However, the participant uptake rate of the Pilot Retrofit Program was substantially higher than that of the Smart Showerhead Program, indicating that the gross savings to a water utility from a more intensive and interactive program are likely to be much greater than those achieved by a more "hands-off" approach.

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