

# WATER USE DIARIES: A TOOL FOR HOUSEHOLD WATER MANAGEMENT

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## ABSTRACT

In many countries, like Australia, where rainfall is highly variable and drought is commonplace, effective water demand management strategies are required to ensure water supply can meet demand into the future. However, demand management strategies often neglect to take into account the community's behaviours and attitudes. Thus, they have mixed success in reducing household water use. New demand management strategies are needed. Strategies that enhance individual's capacity to understand their own water use and the opportunities they have to reduce their use so they can become their own household water managers. This paper introduces the use of water use diaries as a tool for household water management by describing two case studies, one in the Australian Capital Territory (ACT) and one in southwest Victoria (SW VIC), where water use diaries proved to be a useful tool for demand management.

## Introduction

For countries where rainfall is highly variable and droughts are commonplace, one of the key challenges for water managers is ensuring that water supplies can meet demand. This challenge is complicated when households and farms access water from a range of sources, such as rainwater tanks and dams, groundwater bores, and town supply as it is not clear how much water is being used. This situation is common in rural areas. In

these communities, if a demand management strategy is implemented, there is no means to measure the success of the strategy. For this reason many household demand management strategies are focused on town water supply in areas with meters with little attempt to measure or reduce the use of other sources of water. However, with many people making the 'tree change' and moving to rural blocks, the demand for water in these areas is set to increase.

Yet, understanding water use patterns is critical for sustainable water resources planning to ensure there are adequate quantities into the future (March and Sauri, 2010). Without consumption data the true extent of water use and supply issues is unknown (Satterthwaite, 2003; Wutich, 2009). Thus, rural water managers need a tool to provide them with water use data to inform demand management, that can also be used for water use behaviour change where it is needed.

## *Theory of behaviour change*

Research on behaviour change has demonstrated that behaviour change programs require an understanding of the context and psychology of the water users targeted to be effective in producing change. Social cognition models, such as the Theory of Reasoned Action (TRA) (Ajzen and Fishbein, 1980), Theory of Planned Behaviour (TPB) (Ajzen, 1991) and the Social Cognitive Theory (SCT) (Bandura, 1977), try to explain the factors that influence behaviour

decisions. The TPB, an extension of TRA, is the most extensively studied model. It states that the proximal determinant of behaviour is the intention to act. This intention is influenced by attitude towards the behaviour, subjective norm and perceived behavioural control (Ajzen, 1991). Perceived behavioural control can also act directly on behaviour. While SCT states that self-efficacy, one's confidence to carry out the behaviour, plays a central role in changing behaviour (Bandura, 1986; Marcus et al., 1992) along with goals, self-monitoring (Rovniak et al., 2002; Sniehotta et al., 2006) and outcome expectancies (Bandura, 1997). Self-efficacy and perceived behaviour control are agreed to be a similar constructs (Ajzen, 1998).

Despite the wide use of both TPB and SCT in behaviour studies, they are rarely used to develop and/or evaluate behaviour change interventions (see Hardeman et al., 2002 for a review).

### ***Theory to behaviour change intervention***

Thus, many behaviour change strategies, including water demand management, do not take into account the target individual's psychology, including their attitudes, beliefs and values, or their behaviours (Brown et al., 2010; Hardeman et al., 2002). This lack of integration of theory into behaviour change practice has led to many strategies failing to produce behaviour change. This is because interventions are more effective if they target known causal determinants of behaviour and behaviour change (Michie et al., 2008). But since many charged with developing behaviour change programs, such as water managers, are unfamiliar with social cognition models, the link between intervention and behavioural determinants is rarely made, particularly in water demand management.

Although there are a range of factors that have been identified as influencing water use behaviour (Jorgensen et al., 2009), one factor, related to self-efficacy and self-monitoring, is knowledge about water use and the potential to save water (Dziegielewski, 1991; Graymore and Wallis, 2010). Without a clear understanding of how much water is being used for different activities, householders are unlikely to realise the need to change their behaviour. This suggests that a tool that can increase self-efficacy and self-monitoring by helping people understand their water use and their opportunities for behaviour change could be an effective intervention.

One tool that has potential here is activity diaries, as diaries can enable self-reflection, which can be an agent of behaviour change (Bell and Morse, 2005; Lucas et al., 2008). Reflection allows people to assimilate their learning, and store it for action or dismiss it as irrelevant (Reid et al., 2009), enhancing learning and informing behaviour (Akbar, 2003). The use of diaries is common in a range of behaviour change studies (Bolger et al., 2003; Heeb and Gmel, 2005; McNaughton et al., 2005). For the most part, they have been used to determine behaviour (O'Toole et al., 2009), test behaviour models (Zhang and Fujiwara, 2006), monitor for changes in behaviour post-intervention (Wutich, 2009) and explore individual's connection to water (Allon and Sofoulis, 2006). Recently diaries have been used to catalyse behaviour change by increasing self-monitoring with behavioural weight loss programs (Carels et al., 2005) and blood pressure control treatment (Steurer-Stey et al., 2010).

Further, Hunter et al. (2006) and Reid et al. (2009) found that behavioural change could be promoted by recording environmental behaviour in a diary as it heightened awareness and focussed

participants' minds on the issue. However, its use for water conservation has not been investigated. Therefore, the aim of this paper is to explore water use diaries as a potential new approach to household demand management. This paper describes the results of two case studies where water use diaries were used to determine householders' water use patterns, and encourage water use behaviour change.

## **Background**

### ***Australian Capital Territory***

Developed in response to the need for detailed household scale water use data, the ACT study aimed to develop a tool to generate qualitative and quantitative data capable of clarifying the gender implications within households of current water policies and practices. A pilot study in the rural ACT region, consisting of a seven day diary and self-paced questionnaire, was run in the summer of 2007/08 (Lahiri-Dutt and Harriden, 2008). Interested in the widespread applicability of the approach, The Gender and Water Alliance

(<http://www.genderandwater.org>) funded a larger trial in ACT in October 2008. Designed to refine the diary, formalise the method and investigate the robustness of the approach, the project also sought to investigate its potential in other geographical, economic and socio-cultural contexts. Another survey was run in October 2009, to further test the method's robustness and reliability. Unanticipated sensitising effects of diary participation were noticed during this trial. Thus, in October 2010 all participants of the previous surveys were invited to complete a self-paced questionnaire, or provide an interview, exploring the nature of the water use behaviour change, if any, since completing the water diary.

### ***Southwest Victoria***

The Reshaping Water Saving Attitudes in southwest Victoria project aimed to

develop effective demand management strategies to reduce water use by residents and farmers in rural and regional urban areas. The project was based on a community-based social marketing approach of identifying barriers and motivators to water conservation behaviours and developing and testing behaviour change tools to overcome the common barriers identified. Through in-depth interviews (Graymore and Wallis, 2010) and surveys (Graymore et al., 2010b) patterns of water use, attitudes, motivators and barriers to water conservation of Wannon Water (the local water authority) customers were explored. A range of motivators and barriers to water conservation were identified, with some differences identified between residential customers and farmers. These findings were used to develop and pilot a behaviour change program utilising a number of behaviour change tools, including a water saving information kit, water diary, water audit, water saving prompt labels, commitment to a use target and personal contact with the researcher. The results of the pilot study in terms of the effectiveness of the water use diary are described here. Other results can be found in Graymore et al. (2010a).

## **Methods**

### ***Australian Capital Territory***

Participants volunteered in response to calls posted in public spaces, such as neighbourhood notice boards, and sent through community group email lists. Each of the water diary surveys, referred to here as the rural pilot (the summer 07/08 pilot trial), WD08 (Water Diary 08) and WD09 (Water Diary 09), consisted of a seven day water diary and a self-paced questionnaire. The rural pilot was run as an electronic diary; WD08 and WD09 were both participants in hard copy format. The diary itself covers a 24 hour period (except the rural pilot which covered 5.30 am to 12 am) with water use recorded in 15 min increments by

activity (from a list of activities) and individual who used the water. The rural pilot and WD08 diary included an 'authority' column to identify if a relationship existed between those with the authority to allocate water and those using the water.

The diary includes a demonstration page and an information page. The demonstration page provides guidance for data entry. The information page, which includes space to describe water-using appliances, evolved from a list of generic water use volumes for common activities to a series of estimate training exercises to increase accuracy and specificity of diary estimates.

To enhance the qualitative information, 50% of the participants in WD08 and WD09 were surveyed, with the balance completing the questionnaire. The majority of the interviews were conducted in the participant's dwelling, providing opportunity to see household water infrastructure and water management in action. The return rate for the rural pilot was 33%; for WD08 85%; and WD09 83%.

Where applicable, participants were asked to take meter readings, to help assess the accuracy of diary estimates. For the rural pilot and WD08 meter readings were requested at the start and end of the diary period. Participants who took more readings during the period provided more accurate use estimates. Thus, with WD09 participants were asked to take daily readings.

In 2010, a survey (called WD10) of the sensitising effect of diary participation and the enduring nature of any water use change was carried out. Seventeen of the 43 households that completed a water diary in previous years agreed to participate. Ten households were interviewed; the balance completed a questionnaire, with all questionnaires returned.

### **Southwest Victoria**

Forty-four Wannon Water customers were recruited through letters and postcards sent to randomly selected customers inviting participation in a pilot water use behaviour change program. This resulted in a diverse range of socioeconomic backgrounds, water use attitudes, behaviours, and property types, including residential, hobby farms and farms (defined by participants). The pilot behaviour change program (called the program) ran for four weeks, with as many participants as possible (n=27) visited at the start of the program to provide instructions and carry out a pre-program interview to determine baseline behaviour and attitudes. Participants were given a water saving information kit, water use diary, water use audit and either prompt labels, a water saving commitment form or no additional behaviour change tools. Participants were asked to fill in the audit (on the first day of the program) and diary (everyday for four weeks) and use this information to consider where they could make changes to their water use. If they saw an opportunity to save, they were asked to try a new behaviour for the activity. At the end of the program, participants were visited again to collect diaries and audits and to carry out a post-program interview to determine any changes in behaviour and evaluate the program. Twenty-three diaries were returned, an 85% return rate.

To determine changes in household water use, water meter readings were taken the week before the program, weekly for the next five weeks, then one month, two months and five months after the program finished. For comparison, a control group of randomly selected Wannon Water customers had their meters read.

Pre- and post-program interviews, diary and water use data were used to determine changes in behaviour and attitude related to diary use. Interview data was analysed using a case-by-case

matrix using a person/question approach (Miles and Huberman, 1994). While water use data was analysed using descriptive methods.

## Results

### ***Australian Capital Territory***

The water diary surveys produced meaningful gender disaggregated household water use data. The data can be analysed by an individual's use or by behaviour; individual household use or compare across the households by gender, activity or other variable (i.e. location, income or age). Analysis has focussed on water use rank order (behaviours ranked by volume of water used), water chore gender participation rates and comparisons of household understanding about their water use (from the questionnaire) and their actual water use (from the diary).

WD08 and WD09 both indicated a shift in water use rank order from that previously recorded in the ACT. The rank order (Table 1) is shifting due to the combined influence of water restrictions, increased use of dual flush toilet and low-flow showerheads and changing social norms. In addition to the 'standard' rank order identified, another rank order (called Future? in Table 1) emerged where laundry was the only common feature. This may become the dominant rank order in the future due to savings in toilet and shower use and technologies, and increasing cultural demands for clean clothes (Shove, 2003).

While overall gender chore participation rates indicate women have a substantially higher rate than men, in some households and for some activities rates are equitable (i.e. within 60-40 range), particularly in rural households. Also it appears that women in rural households have more involvement with their water supply infrastructure due to their reliance on rainwater tanks, bores and the

associated pumps and pipes. In terms of the ability to manage their own water supply, rural women appear advantaged over most urban women (Lahiri-Dutt and Harriden, 2008).

**Table 1: Water use rank orders of ACT participants**

Traditional*	Standard	Future?
Garden	Bath & shower	Laundry
Bath & shower	Laundry	No further discernable pattern
Toilet	Toilet	
Laundry	Kitchen	
Kitchen (dishes, food preparation)		

\* rank from Mitchell et al. (1999 p7); author's nomenclature

Another significant observation was the range and depth of water management expertise that exists in households. This was evidenced by the water conservation practices used by the participants (in Table 2). While all the water conservation practices promoted by the local water authority were used, a number of other conservation practices were used by participants. Additionally, the high rate of water reuse, complete with household 'rules' to guide which water is reused for what activities, further demonstrates participants water management expertise.

The results of WD10 provide direct evidence of a discursive unfreezing (Jackson, 2005) of household water uses and behaviours resulting from water diary participation. Every household reported an increased awareness of their water use. Even households with low water use reported learning something new about their water use. For example, one household noticed how the number of 'squirts' of the tap added up to a significant volume.

From these results, the water diary has proven not only able to generate reliable gender disaggregated household water use data, but also to elucidate a range of water use values and practices not commonly exposed by traditional end

use studies. The diaries have also proven a useful tool to sensitise people to their household water use and provide them with information to change behaviour.

### **Southwest Victoria**

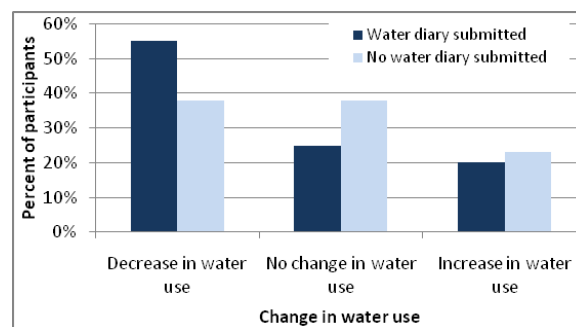
The diary component of the program in SW VIC was designed to encourage reflexivity, as well as help researchers understand participant's water use behaviours and how these changed during the program. From the interview results (Table 3) and the water use data (Figure 1), it appears that the diary had a number of impacts on participants. Firstly, the diary was reported to be thought-provoking, raising awareness about water use in participants. Secondly, for some participants it caused a change in water use behaviour. And thirdly, in combination with the other tools used in the program it provided an acknowledgement of their water saving efforts.

The interview data shows that writing in the diary triggered participants to think about their household's water use. Indeed 46% of participants stated that it raised their awareness of how they use water, bringing water use to the front of their minds. While 27% of participants stated that filling in the diary either provided a challenge on how to do better the next day, helped them evaluate their use or kept a check on their use. These results demonstrate the reflexivity of the diary process where participants recorded their daily use, learned from it and used it to inform the next day's use.

The behaviour options listed in the diary, such as a cup for rinsing after teeth brushing or running a tap, appear to have helped with the reflection process as they provided suggestions for behaviour change. This was evidenced by participant comments on their behaviour change and also from their diary entries, with 12% of participants

stating that the diary caused them to change their behaviour, and 61% of participants having changed at least one behaviour during the program often to the lower water using option in the diary. Like the ACT study, the range of water saving behaviours used extended beyond that the local water authority recommended demonstrating water management expertise.

Evidence of behaviour change was also seen in the water use data, with 55% of participants who used the diary had a decline in their water use during the program (Figure 1). Of the participants who were higher than average users before the program, 58% had an average 25% decline in household water use.



**Figure 1: Percent of participants in SW VIC program with a decline in use by diary use.**

It must be noted that the exact impact of the diary on behaviour change was difficult to distinguish from that of personal contact and the audit. However, when participants were asked what they liked most about the program the diary was mentioned by the second highest number of participants, with raising awareness about water saving being mentioned the most. Thus, the findings of the southwest Victoria case study suggest that the diary has potential as household water management behaviour change tool.

### **Discussion**

The key findings of the two case studies demonstrate that water diaries: 1) offer a reliable, robust and participatory tool

to generate a vast range of household water use data that can be used by individuals, communities and policy makers; and 2) sensitise residents to their water use and provide them the information and impetus to change water use behaviours. Thus, these studies demonstrate the potential diaries have as a water management tool.

A key implication of the diary for water management in rural areas, in particular, is that it provides an accessible and affordable way to collect data on water use, while actively engaging users in their water use. This represents a solution to two problems facing smaller councils and regional water suppliers: unmetered properties and the need for effective demand management. Diaries are a cheaper option for determining household water use patterns for small councils compared to smart meters. While, as a participatory activity, the diary raises participant's awareness of their own water use potentially causing the 'culture change' required by water demand management and water policy goals.

The water diary can also draw attention to differences in rural and urban water use and values that have management implications. For example, the ACT study demonstrated that rural women have a different set of water management skills to urban women. Knowledge of these differences in water management skills provides vital information for water policy development in both environments. Indeed, much of the data has water management and policy development implications. The recognition of a newly dominant water use rank order can influence the nature of water conservation messages. While the ability to identify the types of water conservation behaviours commonly used by different groups within the community can ensure future behaviour change programs target behaviours not

commonly used or groups that high water users.

Additionally, the diary encourages reflection of household water use, helping participants understand how they use water and, upon reflection, allows them to identify opportunities to reduce their water use so they can become their own household water managers. In doing so, the diary encourages double-loop learning where householders reflection on the negative aspects of their behaviour may change their behaviour as their underlying presuppositions, values and norms are called into question (Romme and Dillen, 1997). Thus, the findings reported here, combined with that of Reid et al. (2009) provide evidence that diaries can be a useful a tool for behaviour change for natural resource use behaviours, as well as for health related behaviours.

## **Conclusion**

This paper reports on two case studies where water use diaries were used to record participant's water use and act as an educational tool to raise awareness of water use among householders to affect behaviour change so often called for in institutional water policies. These studies demonstrate the potential of water diaries as a tool for collecting water use data, and in doing so, they demonstrate that many householders are active water managers using a wide variety of water saving behaviours. This recognition of household water management expertise is an important step in developing effective institutional water management policies.

Although, in both studies the results are based on small numbers of participants, it appears from these findings that water dairies have the potential to develop householders water management expertise by making them aware of how they use water and helping them reflect on their potential to make changes to

their water use. Thus, they provide a useful inexpensive method to both measure and modify household water use. However, further research is required with participants in a range of settings to enable refinement of the tool and provide further evidence of the usefulness of diaries for water management.

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**Table 2: Supplier promoted versus ACT participant water conservation practices**

Supplier water conservation practices	Participant water conservation practices
Appropriate water levels in washing machines & dishwashers	Basin/bucket in sink to collect rinse water (e.g. vegies, hands)
Potable water reuse (i.e. shower & laundry)	'Dry' shower
Timer in shower	Not flushing the toilet with every use
Share bath/showers	Not showering daily
Taps off when brushing teeth	Stand in bucket while showering
'Water wise' appliance purchases	Don't use bath
Water garden by hand, buckets or cans	Toilet not connected to main supply
Sweep outside areas	Part flush of a single flush toilet or brick in cistern
No car washing	Wash dishes in basin/bucket
No taps running while cleaning	Not washing dishes daily
Maintaining taps and shower heads	Clothes not washed till dirty
Mulching, water crystals, drought tolerant plants	Avoid long/multiple showers/baths on laundry day
	Opportunistic capture of rainwater for pot plants
	Rags to clean windows and cars
	Collect left over drinking bottle water

**Table 3: SW VIC pilot program participants comments about the diary, their change in behaviour and attitude**

Water diary	Change in behaviour	Change in attitude
More aware of where water used	Think about where water used	Good for kids awareness
Uncovered set routine	Think about other changes can make to save	Influence of weather on use
Increased awareness of how to save	More vigilant checking for leaks	Rethink where could save more
Makes you think how much you use for each use	Identify areas for change	More aware of what we use and where could save
Makes you think each time turn on tap	Made us decide to do act	Mindset change
Causes you to think how can I do better	More water wise now	Constant thinking of saving/ intense desire to save
Draws attention to exceptional use	Acknowledgement of what doing already	Thinking of where water coming from & drought
	Changed to cup for teeth brushing	More conscious of value of water