SEQ's ONE TO ONE WATER SAVINGS PROGRAM

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Abstract

This paper provides an overview of the innovative One to One Water Savings Program implemented in the South East Queensland (SEQ) region of Australia in 2007. The program aimed to assist households classified as high water users (HWUs) to reduce their water demand during the worst drought on record. The program consisted of sending out a survey to over 79,000 HWUs using more than 800 L/household/day (L/hh/d) and for those that completed the survey, a personalised plan was provided on how to save water. The program had a unique combination of: a very large sample size (over 70,000 respondents); access to individual customer water meter readings; and availability of detailed household survey responses on water using practices. Due to this unique combination it was possible to investigate the suite of reasons why HWUs have above average water consumption. It was also possible to analyse how HWUs could save water to inform future water saving policy initiatives.

The analysis outlined in this paper draws on an extremely important water usage dataset, of a size that has never been collated and analysed before in Australia. The research is of significant importance at a regional, national and international level and will be of significant interest to those water resource managers facing a drought situation and those involved in water forecasting and demand management interested in understanding how water is being used and could be saved.

Introduction

The SEQ region of Australia has a population of 2.5 million. From early 2004 to the end of 2007 this large region experienced an unprecedented fall in dam levels, from just over 60% to less than 20%. The drought gripping the area was one of the worst on record. During this time strong measures were required to slow the depletion of the dam reserves through both demand and supply side measures (i.e. embedding water efficient behavioural practices into the community and developing new sources of water). To do this the Queensland Government set up the Queensland Water Commission (QWC) to develop and oversee the implementation of a diverse drought plan. This involved the implementation of water restrictions and short and long term demand and supply side drought measures from major water efficiency rebate programs through to the construction of the State's first major desalination plant.

During this period restrictions were tightened breaking new ground for the region in terms of the extent of behaviour change expected by the community. The campaign included "Target 140" encouraging individuals to reduce household water usage to less than 140 litres per capita per day (LCD), where 2004/05 levels had been over 220 LCD. This campaign was so successful that other jurisdictions have subsequently adopted a similar approach (i.e. Victoria – "Target 155").

Unpacking residential high water usage.

Figure 1. Twelve (former) councils participating in the One to One Water Savings Program.

The One to One Water Savings Program

As part of Level 5 water restrictions and "Target 140" the QWC released the One to One Water Savings Program. The QWC engaged the Local Government Infrastructure Services (LGIS) to implement the program which is an extraordinary water efficiency program in terms of both size and the timeframe in which it was completed. It involved:

- identifying HWU households (classified as those households using more than 800 L/hh/d) in the 12 participating councils (refer to Figure 1);
- providing a survey form to over 79,000 households in June 2007 (the Water Use Assessment Form) to find out why households were using so much water;
- receiving and processing more than 92% of responses by September 2007;

- providing a Personalised Water Savings Plan to each household that responded (using > 140 LCD) advising them on how they could reduce water consumption;
- collating water meter readings for each respondent post implementation of the One to One Water Savings Program; and
- by February 2008 undertaking a major data analysis exercise on the survey results, socio-economic data and water meter reading data to unveil the reasons behind high water use to inform future water policy direction.

Behind the scenes LGIS engaged a team of specialists to develop the survey, associated databases, conduct social marketing surveys and analysis, design the survey responses and conduct data mining and analysis of the survey results and associated water meter readings. Due to its significant experience in water efficiency the Institute for Sustainable Futures (ISF), at the University of Technology, Sydney, was engaged to assist in the development of the survey, the design of the personalised responses and subsequent analysis of the survey responses and customer water data. The analysis aimed to investigate the characteristics of HWUs, determine why they were using more water and how to assist HWUs to save water and ultimately inform future water policy in the region for this sub-sector.

Survey Information Collated and Analysis Techniques Used

The survey

The survey (or Water Use Assessment Form) consisted of over 58 questions and sub questions. The information collated was considered from an end use perspective, that is, both the level of efficiency of appliances and water use behaviour around the home were investigated. To aid the analysis component of the program the questions were aligned where possible with standard Australian Bureau of Statistics (2007) questions in order to enable comparison with State and Australia-wide norms. The information provided by the survey was broadly categorised into the following groups:

- household statistics - rent/own, lot size, residence time, no. of occupants, age of occupants;
- lifestyle indicators - ownership of a pool, spa, lawn, special garden, pets, livestock;
- behaviour - loads of washing and dishwashing, dishwashing activities, no. of showers and baths, garden activities;
- uptake of technology, level of efficiency of different appliances and alternative water sources;
- type of washing machine, dishwasher, toilet, shower, use of rainwater or groundwater;
- uptake of subsidies and rebates;

- special circumstances - health conditions, home businesses, etc.
- leaks

Analysis techniques and statistical methods

A range of techniques and statistical methods were used to analyse this unique data set. By using the combination of survey results, water meter data and socio-economic data it was possible to view the households and their water use from multiple perspectives. The methods used included:

- frequency analysis
- cross tabulation analysis and development of graphical outputs
- basic demand management/ conservation potential options analysis
- basic participant versus control comparison for a subset of data
- regression analysis modelling (univariate and stepwise regression analysis of key variables and binary logistic regression),
- socio-demographic profiling and analysis using Mindshare – a proprietary data analysis tool.

Summary of Findings

The analysis conducted unveiled numerous new insights into the water usage of HWUs overall and for specific councils. The findings below provide a summary of key findings that will be of use to the water industry more broadly.

Pre and post intervention

The benchmark for water demand during the Level 4 restrictions in SEQ in the summer of 2006/07 was 140 LCD, reinforced by the "Target 140" campaign. A household using less than 140 LCD in this "summer" or "pre" period **before** the One to One Water Savings Program was considered "efficient", given the limited potential for outdoor water use due to restrictions rules. However, because the number of occupants within a household was not known before the survey forms were sent out, to determine LCD consumption households were selected for inclusion in the program based on a household demand of 800 L/hh/d or more. When later divided by the number of occupants stated in the survey responses it was found that 93% of the HWUs were correctly classified as "inefficient" (i.e. demand >140 LCD).

After households were selected for the program and returned their surveys, a special meter reading was taken, which allowed an estimate of the consumption for a period of time (referred to as the "winter" or "post" period) that largely overlapped the period **after** the program intervention. In the post period the HWUs reduced household demand significantly and the number of households using less than 140 LCD (and thus classified as "efficient") increased from 7% to 45%. This significant reduction is due to a combination of comparing summer versus winter usage, the effects of the One to One Water Savings Program and other restrictions and demand management programs highly active at that time.

Table 1. Key characteristics.

No.	Key characteristics	Queensland and Australia-wide norms
Across all councils		
1	Above average home ownership at 80% (ranging from 75% to 85% depending on council observed)	Queensland (69%), Australia-wide (72%)
2	High occupancy ratio of just over 4.6 (ranging from 4.46 in Gold Coast to as high as 5.13 in Beaudesert)	Queensland and Australia-wide (2.8) for detached dwellings
3	High proportion of teenagers (ranging from 21% to 27% depending on council)	Queensland (12%), Australia-wide (13%)
4	High proportion of pools with an average of 50% (ranging from 14% to 63%)	Queensland (18%), Australia-wide (12%)
For majority of councils		
5	High proportion of households operating a small business 18% (15% to 21%) with 441 (3.5%) indicating high water use, 23% indicating medium and 73% indicating low.	No state or nation-wide comparison data available
6	High proportion of households with major leaks recorded, 22% (ranging from 19% to 33%)	No state or nation-wide comparison data available
Other key characteristics		
7	High proportion of households with rainwater tanks, 28% (ranging from 22% to 68%)	Queensland (22%), Australia-wide (19%)
8	Lower than average uptake of the HWWRS (excluding HWWS) at 11%	SEQ average (excluding HWWS) 16.6%.

Notes – HWWRS – Home WaterWise Rebate Scheme, HWWS – Home WaterWise Service.

The average overall demand for the pre period for all 12 councils was 1,126 L/hh/d or 290 LCD. In the post (winter) period (where data was available for 10 of the 12 councils) the overall demand dropped by over 35% to 724 L/hh/d or 174 LCD. None of the councils reduced their average demand to below 140 LCD, however, a high proportion of individual households did (a shift from 7% to 45%).

Upon further inspection of water demand it appears that the demand of the non HWUs in the 12 participating councils dropped by 22% between the pre and post periods whilst the HWUs reduced their overall average demand by 40%. At the same time it was observed that the HWUs in the pre period had an uptake of 11% for the Home WaterWise Service (HWWS), similar to the overall uptake of the 12 participating councils. However, in the post period the HWUs increased their uptake to 22% compared to 19% for the overall 12 participating councils, indicating a positive uptake of demand management programs as a result of the One to One Water Savings Program.

The drop in demand can therefore in part be explained by water savings associated with the One to One Water Savings Program and other efficiency activities. However, with insights from further analysis such as frequency analysis, discussed below, it appears this drop in demand is also associated with significant discretionary outdoor water demand being used by the HWUs in the pre (summer) months despite Level 4 restrictions having been in place during the pre period analysed. This was further verified with the results of a basic participant versus control comparison for one of the councils with available data. Investigations in other areas of Queensland, namely Hervey Bay where Wide Bay Water has been able to observe the effectiveness of restrictions through the use of smart meters, have found numerous cases of customers not complying with restrictions in force and using banned sprinklers at night (Turner *et al* 2009).

Approximately 9% of the 79,843 households did not return their survey forms. These "non compliant" households had an average demand in the pre period of 1,225 L/hh/d. Whilst only 100 L/hh/d (9%) higher than the "compliant" group, this was statistically significant.

Frequency analysis characteristics of HWU households

The investigations undertaken focused on determining why HWUs use so much more water on a per household and per person basis. The HWUs were compared against state and national norms where data was available.

The HWUs were found to have a higher proportion of end uses related to outdoor demand such as pools, lawns and gardens, which increase overall demand especially in the pre (summer) period. A higher than average number of households were also found to have indoor appliances such as efficient washing machines and dishwashers and a normal proportion of efficient showerheads and dual flush toilets. This indicates that these households have a higher demand primarily due to outdoor water use factors and it is highly likely that these households used water in the pre (summer) period, which was outside water restrictions rules.

Key characteristics that stand out when looking at frequency analysis, which may potentially have an impact on water usage, are summarised in Table 1.

Household size comparison

As part of the analysis it was observed that whilst households with large families use more water overall per day, such households are likely to become more efficient (use less water) on a per person basis as the number of people in the household increases. This is most obvious with respect to outdoor water usage where for example in two similar houses with an occupancy of (a) 2 people and (b) 4 people with similar size gardens, the gardens may require a similar volume of water, yet the demand will actually be divided by 2 people for household (a) and 4 people in household (b). This increase in efficiency is also likely to be observed for various indoor appliances, with which economies of scale can be achieved when shared by a larger group of people in a household. These economies of scale are shown in Figures 2, 3 and 4 for washing machines, dishwashers and showers respectively. As would be expected the economies of scale for showers are less pronounced.

These results are extremely useful for those practitioners building end use demand forecasting models that integrate detailed stock models. The results are also useful for targeting water efficiency programs. Various studies have evaluated the savings associated with specific appliances. For example Kidson *et al* (2006) found that a pilot rebate program for 4A washing machines achieved a saving of 23 kL/hh/a and Turner *et al* (2005) reported on the savings from various showerhead programs being approximately 14 to 16 kL/hh/a. These studies show actual savings achieved from these programs for an average household which is likely to have an average occupancy of approximately 3. By replacing washing machines (currently 80% inefficient) and showerheads (currently 45% inefficient) in HWU households with a high occupancy ratio, significantly higher water savings could be achieved for each single device replaced compared to those savings stated in the literature. This in turn would result in a low unit cost water efficiency program.

Additional segmentation using water and frequency analysis

The HWUs were segmented in terms of water demand to determine how much water various groups with specific household characteristics use, where water savings potentially exist and to gain a better understanding of the groups that might need to be targeted with a water efficiency program and associated communication strategy. Groups of interest are discussed below.

When comparing **renters versus owner occupiers**, renters were found to use more water on average (during the post winter period) because they commonly have equipment and appliances that are less efficient than owner occupant households. Many efficiency programs concentrate on homeowners. Whilst HWU renters only represented 19% in SEQ, which may be similar for other areas, this still provides significant opportunity for savings and a targeted indoor water efficiency program tailored for renters that have specific barriers to implementing water efficiency.

Households with businesses (18% of respondents) were found to have significantly higher water use than those without, in both the pre (summer) and post (winter) periods, 1,182 versus 1,113 L/hh/d and 770 versus 713 L/hh/d respectively. However, it was found that the small number of households (441) that indicated they had high water use, dominated the water usage results. Small tailored programs that investigate how to assist households with a home business classified as high water using could potentially achieve significant savings.

A surprisingly high proportion of households (22%) indicated that they had **major household leaks**. Those that reported a leak (likely to be active in the pre summer period) had a much higher water demand (1,273 L/hh/d) than the average in the pre (summer) period across all councils. In the post (winter) period the average of the group reporting that they had the leak fixed reduced to 722 L/hh/d. Those that reported a leak in the pre period which was repaired in the post period consistently demonstrated a reduction in demand often showing lower household demand than those reporting no major leak. This implies that major leaks are a significant contributing factor to high water use and when fixed can substantially reduce demand. Limited research is available on household leaks but recent research carried out in Hervey Bay in Queensland (Britton *et al*, 2008) verifies that significant savings are possible through household leak detection and repair.

The HWUs have a higher than average proportion of **households with 11-19 year olds** ranging between 21% and 27%, depending on council, compared to the State and Australia-wide averages of 12% and 13%. From the analysis households with a high proportion of teenagers, 11-19 year olds, use more water per person than 20-70 year olds. This is also the case for 3-10 year olds that used very similar per person usage to the 11-19 year old teenagers. This higher water usage in the 3-10 and 11-19 year old brackets is more evident in the post (winter) period when indoor water usage dominates. This finding implies that households with this age bracket have higher water use on a per person basis than households with predominantly adults (20-70 year olds), which could be related to behaviour around indoor end uses such as showers, washing machines and dishwashers. Creating schools programs that specifically target education on water efficiency in the 3-10 and 11-19 year olds could represent a major opportunity to save water in this age group, which will have long-term benefits as they grow older.

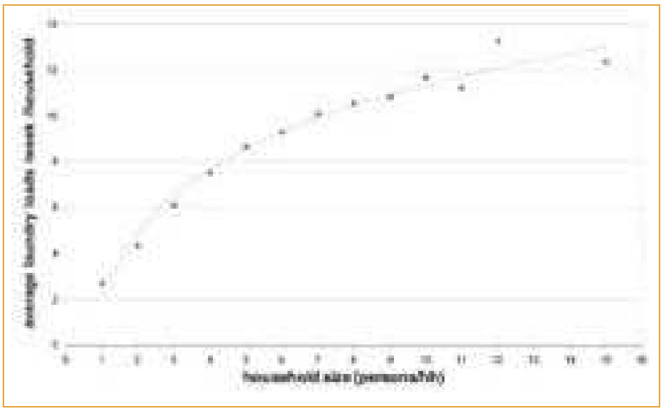

Figure 2. Average loads of laundry per week by number of people in household.

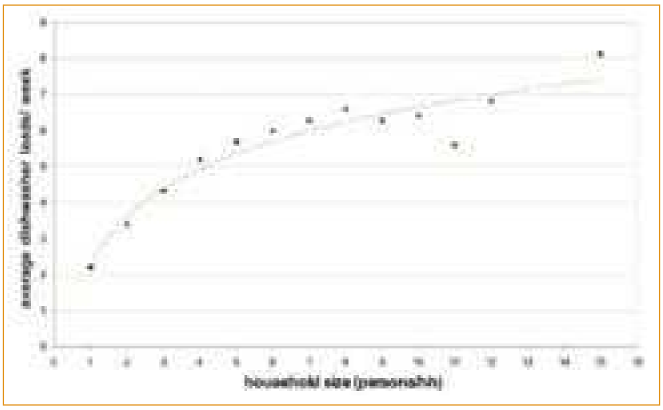

Figure 3. Average dishwasher loads per week by number of people in household.

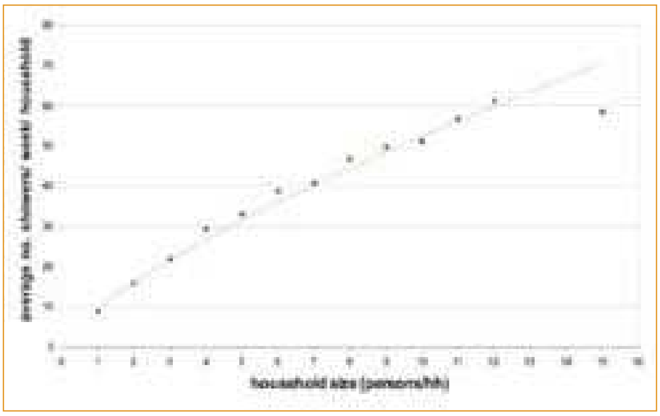

Figure 4. Average number of showers per week by number of people in household.

Households with outdoor uses such as swimming pools and lot sizes greater than 1,000 m^2, show higher than average water demand, especially in the pre (summer) period. In SEQ over 50% of HWU respondents had a pool but only 19% of these indicated that they have a pool cover. In limited available research water savings of 8 kL/hh/a have been identified (although of marginal statistical significance) in areas such as the Gold Coast (Snelling *et al*, 2006) where pool cover water efficiency programs have been employed. In areas of high evaporation where HWUs are likely to have pools it would be advantageous to investigate a swimming pool cover program together with other pool water saving initiatives.

The proportion of **households with rainwater tanks** was higher than the State average (28% versus 22%, ranging from 22% to 68% depending on council). Analysis indicated households with a rainwater tank used marginally more than those that don't in the pre (summer) period (1,136 versus 1,121 L/hh/d) but in the post period this was reversed (692 versus 735 L/hh/d) with savings being achieved in the winter months. Households with bores and spear pumps had consistently higher average demand in both the pre (summer) and post (winter) periods. Hence the existence of an alternative water source does not necessarily result in lower water use overall. Limited research on rainwater tank savings has been undertaken in Australia. In the Gold Coast (Snelling *et al*, 2006), it was found that rainwater tanks do provide a saving (approximately 20 kL/hh/a) but this is significantly less than estimated theoretical savings of approximately 70 kL/hh/a (Coombes and Kuczera, 2003). Hence there is significant scope to increase the water savings achieved from rainwater tanks (both already installed and being installed) through connection to more indoor end uses to maximise potential savings. However, care needs to be taken in the rainwater configuration chosen to minimise the potential impacts on energy usage (Retamal *et al* 2009).

Socio-economic analysis

The HWUs group was found to be biased towards households with mid to high socio-economic standing (SES) and high family orientation (56%), although the definition of high family orientation is a complex mix of measures obtained from census data such as household composition, number of vehicles, whether dwellings are being purchased and if females aged 35 to 54 in the household are employed part-time. It was found that there was very little difference in the occupancy ratio of these two groups (high and low family orientation).

The HWUs had a fairly even split between high (31%), medium (32%) and low (26%) SES, with the disadvantaged only representing 12%. Splitting by family orientation the majority were high family orientation at 72%.

Households with a high SES used more water per person (316 LCD), compared to the medium, low and disadvantaged (288 LCD) groups especially in the pre (summer) months due to a higher proportion of outdoor end uses.

As the SES of households increases from disadvantaged to high, households have a higher proportion of gardens and swimming pools, which are likely to increase outdoor water demand, especially in the pre (summer) period when outdoor demand dominates. However, as SES increases, ownership of efficient indoor technology such as efficient front loading washing machines, dishwashers and efficient showerheads, also increases. This will lower indoor demand of high SES households compared to lower and disadvantaged SES households. This lower indoor demand will be more prominent in the post (winter) period when outdoor demand is at a minimum. A program targeting how to help disadvantaged households increase efficient indoor appliances would be highly beneficial.

Conclusions

A suite of different analytical techniques and statistical methods were used to explore this extraordinary data set. The findings summarised in this paper represent a small proportion of the findings but highlight some observations which may be of use to other areas in terms of explaining high water usage.

Segmentation and other forms of analysis can enable us to identify potential opportunities to save water. It identifies key barriers to more efficient water use, such as renters with less efficient equipment, as well as market segments for which tailored offers and communications programs could be designed, such as pool owners and households with businesses.

Whilst this data set is exceptional in terms of size, it demonstrates how a combination of techniques can be used on a smaller sample to view the water usage of a particular sub-sector and aid the design and implementation of both short-term drought response measures and long-term demand management programs.

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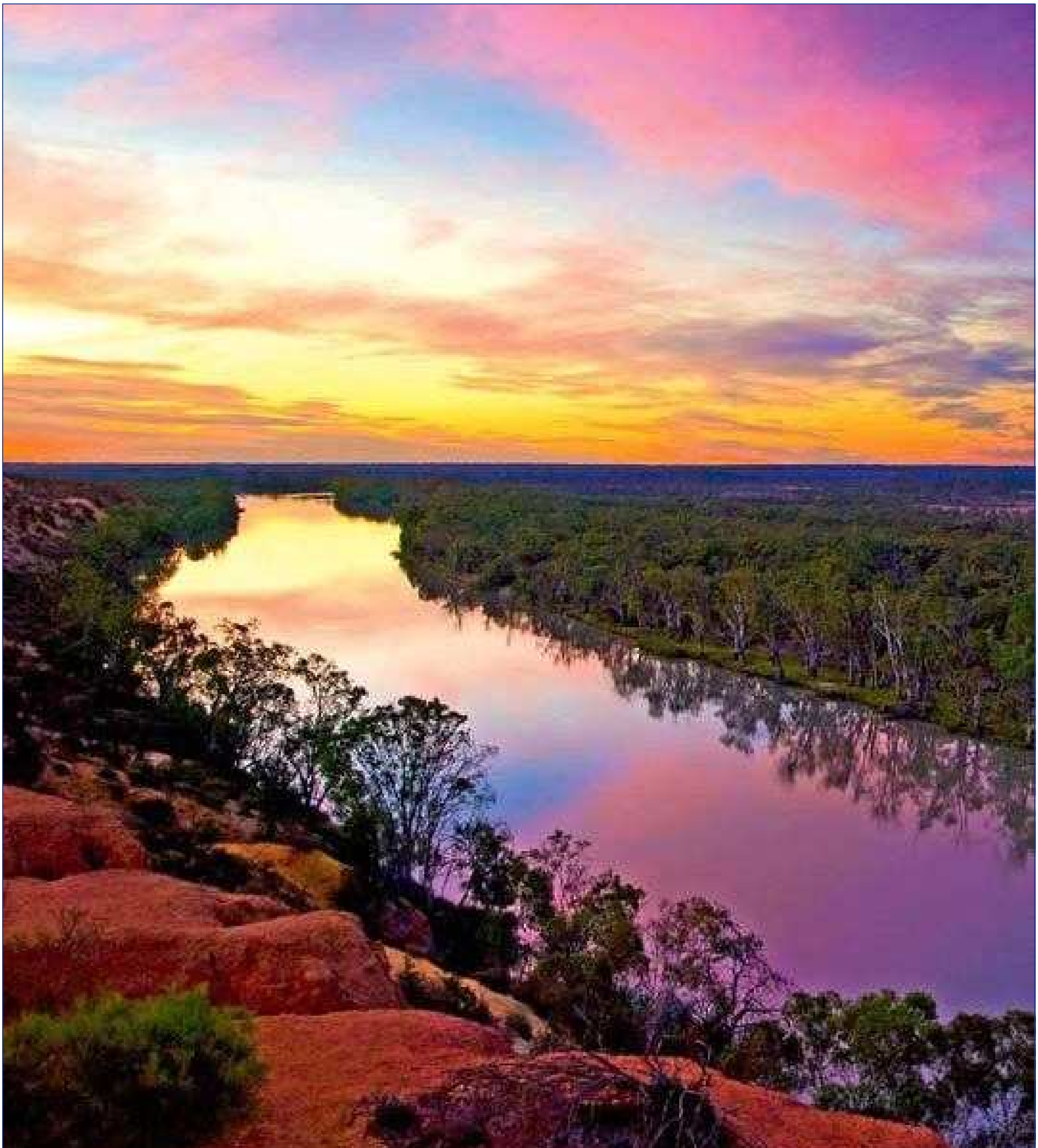

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OUR COVER

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