Household use of and satisfaction with alternative water sources in Victoria Australia

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Abstract

Climate change is increasing the variability of rainfall, and thus the availability of water supplies in many areas of the world. These impacts are already being felt in the state of Victoria, Australia where a 12 year drought period was recently experienced. Restrictions to water use have been implemented, as one component of a broad policy approach to manage the drought. While anecdotal evidence suggests that the substitution of centralised water supplies is occurring, this has not been proven empirically. This paper reports results from a survey of households in Victoria regarding their use of alternative water sources. The study found that substitution is occurring. Garden watering is the purpose which has the highest rate of alternative water source use. In total 41.6% of respondents always, and 33.2% sometimes use an alternative water source for garden watering. The most commonly used alternative source of water for garden watering is water previously used in the laundry (30.7%). The alternative source of water used was found to vary depending on the purpose of the water use. High levels of satisfaction were found for all alternative water sources used. Several barriers were found to the use of alternative water sources, the main of which were: inflexibility of existing infrastructure, cost, policy, and housing status. The results have implications for water retailers, policy makers and governments in locations facing water shortage.

Key words: alternative water sources, domestic, Australia, community, drought, adaptation

1. Introduction

The supply of water in cities of developed nations is dominated by a centralised approach through which supply is continuously available. As hypothesised by Cheesman et al. (2008), this water is relatively cheap overall (with high variation between individual cities and nations), thus substitution (with alternatives) does not occur. This is in contrast to the situation in many developing nations, where centralised supplies are not uniformly implemented, and when implemented are often

44 unreliable. Research indicates that some households in developing nation locations substitute
45 centralised water supply with alternative water sources for reasons including availability, water
46 supply shortage, negative pressure, poor quality, and unplanned settlement patterns (Dutta et al.
47 2005; Pattanayak et al. 2005).

48
49 While at present substitution largely does not occur in developed nations, this may change due to
50 the projected impacts of climate change – including the increasing variability of rainfall and thus of
51 the availability of water supplies (Intergovernmental Panel on Climate Change 2007). Increased
52 drought conditions are already being faced in some areas of the world. This is often coupled with
53 increasing pressure on water supplies from population growth and increasing per capita demand. In
54 some instances (including areas of Australia), the decreasing availability of water has led to
55 restrictions to the use of potable water from centralised supplies, as one component of policy to
56 manage centralised water sources. Thus, the previous absence of widespread substitution in
57 developed nations may change. This article explores the informal and non-centralised substitution
58 of potable water with alternative water sources, in the context of the state of Victoria, south-eastern
59 Australia. This is important given there has been limited research published about substitution of
60 potable water sources in the context of developed nations. Anecdotally it is evident in Victoria that
61 substitution is occurring as an adaptive response to restrictions to water use from centralised
62 supplies – however this has not been empirically proven.

63
64 The aim of this research was to test this observation empirically. The guiding research question
65 was: how are drought-impacted households responding to water use restrictions in Victoria
66 Australia? Specifically this research was interested in 1) whether households are using alternative
67 water sources, 2) if so, what water sources they are using, and for what purpose, and 3) whether or
68 not they are satisfied with the use of these alternative water sources. In this research project the
69 term ‘alternative water source’ was used to identify any source of water used that was an alternative

70 to common water behaviours prior to the introduction of water use restrictions and the increased
71 awareness of the need to conserve water due to drought conditions. As such, alternative water
72 sources considered in this study ranged from sources such as water from rainwater tanks, recycled
73 water, greywater systems, reused water from the laundry, and also included sources such as water
74 collected in buckets from showers and reused bath water.¹

75
76 This paper begins with an overview of the current water context in Australia and Victoria. This is
77 followed by a synopsis of previous research regarding household use of alternative water sources.
78 The research method employed is then detailed, followed by the presentation and discussion of the
79 results and their implications.

81 **2. The Water Context in Australia and Victoria**

82 Over the past few decades, many of Australia's capital cities and regional areas have faced
83 significant challenges to water management with an insufficient quantity of water available to meet
84 demand. These challenges have arisen due to a number of factors including drought, population
85 growth and increasing per capita demand. As a result, a suite of initiatives have been suggested by
86 governments. These include demand side solutions such as conservation programs, as well as large
87 scale supply-side solutions such as augmentation of existing supplies, for example indirect potable
88 reuse schemes (IPR), seawater desalination plants, and construction of dams. Many of these
89 proposals have been controversial both politically and publicly. A proposal to implement IPR in
90 Toowoomba Queensland failed after significant challenges politically and publically (Hurlimann
91 and Dolnicar 2010). Desalination plant proposals in Sydney and Melbourne have faced significant
92 public opposition largely based on environmental concerns (see: Sydney Community United against
93 Desalination 2005; Watershed Victoria 2009 etc.).

¹ A distinction is made in this study between 'grey water': domestic wastewater excluding toilet waste (e.g. water from the kitchen sink, laundry and bathroom) and 'recycled water': treated wastewater (water collected and transported through sewers) treated to a standard satisfactory for its intended use'

95 The long term implications of climate change for Australia's water resources are predicted to be
96 significant. Recent research which has modelled the implications of a 0.9°C increase in global
97 average surface air temperature indicates there will be less runoff in southeast Australia (Chiew et
98 al. 2009). This is coupled with research modelling the impacts of drought since 2001 on the
99 Murray-Darling Basin, Australia's most economically significant river basin. The results found that
100 since 2001 average groundwater loss amounts to seven times the annual sustainable yield adopted
101 for ground water use.

102

103 The state of Victoria has been particularly impacted by drought, with many areas of the state facing
104 prolonged periods of below average rainfall. In June 2009, water storages in the dams which supply
105 the state's capital city Melbourne were at only 25.5% of their capacity – the lowest level since the
106 main dam began filling. Inflows into Melbourne's main storages were below average for the twelve
107 year period 1997-2009 (Melbourne Water 2009b). During this time average inflows were only
108 385,000,000m³/y, compared to the average 615,000,000m³/y across the period 1913-1996
109 (Melbourne Water 2009b). In 2010, rainfall was above average. The situation is also serious for
110 regional areas of the state. In March 2009, Bendigo's dam levels were at only 15.8% of capacity,
111 and Ballarat's 17.8%. Other towns are in a more dire situation, for example the town of Euroa ran
112 out of water in 2007, and had to have water trucked in to residents (Kleinman 2007). Since this
113 time water resources have been somewhat replenished in these locations.

114

115 In response to these prolonged drought conditions, various policies have been put in place by the
116 Victorian Government (Government of Victoria 2005; 2006; 2007; 2009). Notably restrictions to
117 potable water use were implemented in most areas of the state. The severity of the restrictions and
118 their duration vary from location to location depending on the water context. In general, restrictions
119 in Melbourne range from Stage 1 (mild) to Stage 4 (major). In other areas of the state the range of
120 levels of restrictions vary (e.g. in some instances there are 6 levels of restrictions) by jurisdiction,

121 but the principles remain the same. Stage 1 water restrictions were introduced in 2002 when the
122 capacity of Melbourne's dams dropped to 50%. Progressively more severe restrictions were
123 introduced as water levels plummeted. In August 2003 Stage 2 restrictions were introduced. These
124 were replaced by five 'permanent water saving rules' in March 2005. In January 2007 Stage 3
125 restrictions were introduced, followed by Stage 3a in April 2007 (Melbourne Water 2009a). Stage
126 3a water restrictions limit use of water outdoors to two days a week, between the hours of 6am and
127 8am. Industry and local government are subject to water conservation plans (which set specific
128 targets for the reduction of water use based on the industry type and its individual characteristics).
129 Alternative water sources (e.g. rainwater and grey water) can be used at any time. Stage 4
130 restrictions (the most severe in the state e.g. lawns and gardens can not be watered at any time)
131 should have been triggered when the dams got to 29% of capacity, however politically the decision
132 was made to not implement this level of restriction. In 2010, water restrictions have returned to
133 Level 2 given the above average rainfall, and city's storages returning to 51% of capacity in
134 November 2010.

135

136 The government of Victoria has implemented many programs to encourage the conservation of
137 water. These include behavioural change programs such as the 'Target 155' voluntary campaign
138 introduced in December 2008, which has set the aim for each Melbournian to use no more than
139 155L of water per day (Government of Victoria 2008). With every water bill, customers are
140 provided with information about how to save water around their home. They are also given
141 information about their household water consumption and how it compares to state government
142 targets (depending on how many people live in their house). There have also been financial
143 incentives established – there are rebate schemes available for the installation of various water
144 saving products for the home. The products eligible for a rebate include: water efficient shower
145 heads; low volume dual flush toilets; and rainwater tanks; greywater reuse systems; and home water
146 audits. The on-going restrictions to water use have created a market for water saving products such

147 as plastic buckets for collecting water in showers and baths, plastic in-lines for kitchen sinks which
148 can easily be lifted out and poured onto the garden after washing dishes. These products are widely
149 sold in hardware stores.

150

151 Overall, the drought and subsequent government and community initiatives have combined to lead
152 changes in water use culture. Prior to this drought, average water use was high, for example in the
153 1990s the typical Australian consumed 390 – 1450L of water per day – which includes both indoor
154 and outdoor use (Crockett and Carroll 1997). This compares to Crockett and Carroll’s calculated
155 comfortable requirement of 125L per person per day, and a basic need of 60L per person per day
156 (Crockett and Carroll 1997; Gleick 1996). The present average use of water in Melbourne has been
157 close to the target of 155L per person per day (Melbourne Water 2009c) representing a significant
158 decrease in water use over the past decade. Additionally, water authorities have noted decreased
159 inflows into sewers during this time. This decrease is attributed to behaviour changes resulting
160 from water restrictions – such as people capturing shower water in buckets and diverting laundry
161 water to the garden (Victorian Water Industry Association 2007). It should be noted that while the
162 Victorian Government is encouraging water conservation behaviour, it is also constructing the
163 largest desalination plant in the southern hemisphere, designed to supply 150m³ per year, and is
164 expected to be completed by the end of 2011.

165

166 **3. Prior research regarding household use of alternative water sources**

167 Research into the substitution of alternative water sources for centralised supplies has
168 predominantly been conducted in developing nations, where the provision of centralised supplies of
169 water are less abundant, or unreliable. The coping strategies employed depend on the
170 characteristics of the supply, and the adaptive capacity of the household / individual (Pattanayak et
171 al. 2005; Zérah 2000).

172

173 In developed nations, the use of alternative water sources can be grouped into two major categories.
174 The first is the focus of this study: smaller scale more informal and non-centralised initiatives (such
175 as rainwater tanks, capturing shower water in buckets etc). Secondly, large scale solutions such as
176 third-pipe systems or centralised augmentation (for example with desalinated seawater,
177 groundwater, highly treated recycled wastewater or agricultural reuse), which are implemented at
178 the scale of an estate/suburb/city/region. A review of literature surrounding public opinion of
179 alternative water sources and water conservation was conducted. The review found that while
180 significant research has been conducted regarding community attitudes to water conservation (see
181 for example: Bruvold and Smith 1988; Flack and Greenberg 1987; Moore et al. 1994; Roseth 2006)
182 and large scale (centralised) water alternatives such as water recycling (see for example: Bruvold
183 1972; Bruvold 1988; Dolnicar and Schäfer 2009; Friedler et al. 2006; Hurlimann 2008; Marks et al.
184 2006; Po et al. 2005), very little research has been conducted into actual household water use (a
185 notable exception: CSIRO 2002), particularly the substitution of alternative water sources for
186 centralised supplies in developed nations. However, given the increasing impact of drought in
187 Australia, research in this area is emerging.

188

189 Miller and Buys (2008) conducted research in South-East Queensland Australia principally focused
190 on public perceptions of recycled water. Of their 408 respondents, they found that one third stated
191 they always collect 'warm up water' (cold water running from the hot tap), 38% use a rainwater
192 tank, and just over 40% reuse bath, shower and washing water. However the study did not
193 investigate other alternative water uses, or for what purposes the alternative water sources
194 researched were used. Additionally, a national Australian study by Dolnicar and Hurlimann (2010)
195 found that 34% of respondents have a rainwater tank, 47% recycle water from the washing
196 machine, 44% recycle water from their shower. Like Miller and Buys, other alternative water
197 sources, and purpose of use were not investigated. Additionally, four major qualitative Australian
198 studies were identified and are described below.

200 Allon and Sofoulis (2006) conducted cultural research on domestic water use in Western Sydney.
201 They found that while people are prepared to employ do-it-yourself measures to save water, they
202 are ‘stuck’ within current socio-technical systems. Many participants of the study were found to be
203 prepared to do more with improved knowledge, better leadership, fewer obstacles and more
204 incentives to bring about a different kind of water culture (Allon and Sofoulis 2006). Askew and
205 McGuirk (2004) also explored socio-cultural factors which influence community behaviour and
206 water consumption in Australia. In particular, they investigated water use patterns associated with
207 new suburban gardens. These patterns included excessive usage, swimming pools, car washing and
208 garden irrigation. Forty eight households were surveyed by mail at a new housing estate at Hunter,
209 near Lake Macquarie, Australia. Their research highlights the importance of understanding the
210 social value of ‘the garden’ when investigating garden watering consumption. Social value
211 (cultural capital) of water and social conformity was found to increase domestic water usage in
212 terms of frequency, and patterns of water use (Askew and McGuirk 2004).

213

214 Head and Muir (2007) have researched changing cultures of water use in Eastern Australia. They
215 found that there is a commitment by residents to reduce water consumption, which was manifest in
216 a variety of changed practices. These changed practices include collection of bath water, shower
217 water, cold water running hot, and various other types of water. Most of these practices were found
218 to be “*hidden in the rhythms of daily life*”. The authors argue that the relationship between house
219 and garden is one in which people see, understand and participate in the network of water storage
220 and distribution. They argue that it is this process that enhances their capacity to manage and reduce
221 consumption. These authors further found a contradiction between participants’ aspirations for
222 water conservation, yet a tension with the pleasure derived from water and their expressed desires
223 for more watery environments. A fourth study by Clarke and Brown (2006) investigated factors
224 that influence domestic water consumption within Melbourne and the use of alternative water

225 sources including desalination, greywater, and rain water. They found that difficulty, cost and
226 renter status were key barriers to widespread implementation of alternative water use and
227 conservation.

228

229 These studies indicate the various ways in which Australian water cultures have transformed over
230 the past decade, and how water is no longer seen as a single use ‘commodity’. Rather water is a
231 complex resource and life line which is carefully used by residents. The majority of these studies
232 are qualitative in nature. Their strengths are in the provision of detailed accounts of water use and
233 cultures in distinct locations. However one weakness is that due to their qualitative nature they are
234 not representative of a particular population, thus conclusions can not be drawn regarding the
235 detailed practices of the population of a city or state. This is where the current research reported in
236 this paper will make a contribution, the method for which is detailed below.

237

238

239 **4. Research Method**

240 A telephone survey was the primary method chosen to address the research questions. The surveys
241 were conducted by professional interviewers who used the Computer Assisted Telephone
242 Interviewing (CATI) Program (as described in Babbie (2008)). Four hundred and ten Victorian
243 households were surveyed (over a one week period 25 November 2008 – 1 December 2008).
244 Participants were recruited from locations across Victoria in line with Australian Bureau of
245 Statistics (2009) census information about location of residence. Thus, the sample was stratified –
246 75% of respondents were from metropolitan Melbourne, 20% from regional Victoria and 5% from
247 rural Victoria. While location was the primary sampling aim, the survey company were also asked
248 to recruit an even distribution of gender. Home telephone lists consisting of these location types
249 were used for recruitment. Mobile phone were not used given the location of residence, and thus,
250 landlines were paramount for recruitment. While information is not available nationally, or for the

251 state of Victoria, available data for the state of Western Australia indicates that 10.7% of
252 households do not have a landline connection (Australian Bureau of Statistics 2008).
253

254 The surveys took 18 minutes on average to complete, with a response rate of 31% and a total of 410
255 completed surveys. To assess the use of alternative water sources by Victorian households a list of
256 10 purposes for water use (listed in Table 1) were read out to each participant. For each purpose,
257 respondents were asked to indicate how frequently they use an alternative source for that purposes
258 (always, sometimes, never, or not applicable). If respondents replied 'always' or 'sometimes' they
259 were asked which water source they use. A list of nine alternative water sources² (rainwater tank;
260 bore/ground water; reused laundry water; reused bath water; collect shower water in buckets;
261 greywater system; recycled water; private dam water; buy water/cart/truck water in from other
262 areas) were provided to the interviewers to facilitate ease of data entry (and to eliminate
263 respondents terminating the interview based on time). Facilitation was also provided for
264 respondents to state other water sources not listed. These alternative water sources listed are widely
265 known to Victorian residents due to the conservation programs implemented by the government as
266 described in section 2 above.
267

268 Respondents were asked to rate their satisfaction with each alternative source of water they use on
269 an 11-point Likert (1967) scale based on the Juster (1966) scale of 0-10 where 0 = not at all
270 satisfied and 10 = extremely satisfied. Respondents were also asked when they started using these
271 alternative water sources. A series of questions to gauge respondents' attitudes to water were then
272 provided followed by the collection of demographic characteristics of respondents. An open ended
273 question about alternative water use was included in the survey to provide further insights into
274 responses to the closed ended questions. After the closed questions about alternative water use,
275 respondents were then asked 'would you like to make any other comments about the use of

² A list of definitions for each alternative water source was provided to the survey company in the 'briefing notes'. See note 1 for some important definitions

276 alternative water sources?'. Responses to this open question were coded for analysis in line with
277 protocols advocated by Marshall (2002), Richards (2005) and Babbie (2008).

278

279 The author provided the survey company with briefing notes to disseminate to the interviewers
280 working on the project. This included background information about the survey and the water
281 situation in Victoria. It also contained definitions of key terms and alternative water sources used in
282 the survey. Two conference calls were held between the researcher and all interviewers, firstly to
283 run through the survey and discuss any questions they had, and secondly to discuss any follow-up
284 questions after the first night of surveys.

285

286

287 **5. Results**

288 Demographic information collected indicates a wide cross-section of people surveyed. A higher
289 proportion of respondents were female (59%) (corresponding to a higher ratio of women to men for
290 the state of Victoria 97.5 males for every 100 females, but for Australia the ratio is 99.2 males for
291 every 100 females). Most respondents (52%) were aged between 25-54 years of age (median age of
292 36.8 for Victoria), and were employed full time (40%). Most respondents (34%) lived in two
293 person households (average Victorian household size of 2.6 occupants), 46% of respondents had
294 school education only - no university or certificate degree (compared to 48% of the Victorian
295 population) and a total of 83.7% of respondents lived in single (separate) dwellings (compared to
296 78% for the state of Victoria).

297

298 **5.1 Water supply and conservation measures**

299 Given the survey was state-wide, only 91.7% of the 410 respondents were connected to a mains
300 (town/city) supply. Of the respondents not connected to mains, 32 identified rainwater tanks as
301 their main water source, 8 bore/ground water, and 1 channel (irrigation) water. A number of these

302 respondents had multiple water sources (e.g. rainwater tanks and a bore). A total of 40.7% of
303 respondents throughout Victoria had a rainwater tank installed. This figure is comparable to the
304 rainwater tank installation rates found by Miller and Buys (2008) and Dolnicar and Hurlimann
305 (2010). One respondent did not know what type of water supply they had, and four respondents
306 indicated they live in an estate which has a third-pipe system (non-potable recycled water system).
307 With regards to water restrictions, 42.2% indicated they were on level 3a, 16.3% level 4 and 13.4%
308 level 3. An additional 9.3% of respondents did not know what level of restrictions they were on.
309 The remanding respondents were on restrictions ranging from level 1 to level 6.

310

311 Respondents were asked about water appliances in their home. The following provides an overview
312 of the percentage of respondents with various water efficient appliances:

- 313 - 93.5% of respondents have at least one shower. 29.3% of all respondents indicated that
314 none of their showers have efficient shower heads.
- 315 - 57% of respondents indicated that none of their taps have efficient tap heads
- 316 - 99.3% of respondents have a washing machine. 50% of all respondents indicated they have
317 a water efficient washing machine.
- 318 - 59.3% of respondents have a dishwasher. 27.3% of all respondents have a water efficient
319 dishwasher.
- 320 - 44.1% of respondents have one toilet in their house, 45.6% have two, and the rest have three
321 or more. The majority of respondents had dual flush toilets (85%).
- 322 - 22% of respondents have evaporative air conditioners, the majority of which used drinking
323 water from mains supply to operate.

324 The information above indicates there is significant potential for improved water efficiency
325 practices with regards to household appliances and water fixtures.

326

327 **5.2 Use of alternative water sources**

328 The first component of the survey gauged household use of alternative water sources for ten
329 purposes. The results of this question can be found in Table 1. Respondents who indicated they
330 had an independent supply (not connected to a centralised supply) were omitted from analysis –
331 given they always use an alternative source, and would have significantly biased the results. Thus
332 the sample size for this component of the research is 368.

333

334 *Insert Table 1*

335

336 As can be seen from Table 1, garden watering is the purpose which has the highest rate of
337 alternative water source use for Victorian households on a centralised water supply, with 41.6% of
338 respondents always using an alternative source of water, and 33.2% of respondents sometimes use
339 an alternative source of water. Respondents who indicated they always or sometimes use
340 alternative sources of water were asked what alternative sources of water they use for each purpose.
341 Table 2 details these results which show that the alternative water source utilised varies for each
342 specific use. For garden watering, the most commonly used alternative source of water is reused
343 laundry water (30.7%). At a later point in the survey one respondent said the following statement,
344 indicating an increased awareness of water that is associated with alternative water use:

345 *“I didn't realise the washing machine used so much water before we started using the diverter valve”.*

346

347 *Insert Table 2*

348

349 A number of respondents indicated they use an alternative source of water other than that included
350 in the survey list. This includes 26 respondents who have some innovative way of collecting rain
351 water (other than in a formal rainwater collection tank) to water their gardens. For car washing an
352 additional 27 respondents indicated they go to a car wash. While this might not be considered an
353 ‘alternative water source’ by some, it does indicate an adaptive strategy they have implemented in

354 response to water use restrictions, and their desire for a clean car. For drinking purposes, 10
355 respondents indicated they drink (purchased) bottled water.

356

357 Respondents were also asked how long they had been using these alternative water sources. The
358 average length of time each alternative water source has been used can be found in Table 3. The
359 results indicate that on average permanent infrastructure additions (such as rainwater tanks) have
360 been implemented for a longer period of time than less permanent alternative water sources (such as
361 the use of buckets to collect shower water).

362

363 *Insert Table 3*

364

365

366 **5.3 Satisfaction with use of water from alternative sources**

367 Respondents were asked to rate their satisfaction with the alternative water sources which they use
368 as substitutes for water from centralised supply systems. The mean ratings for each source can be
369 seen in Table 3. The highest mean satisfaction rating was obtained for rainwater tanks, with a mean
370 of 8.6. The lowest mean satisfaction rating was for collection of shower water in buckets and
371 buying water (for which there were only two respondents) with a mean of 7.0. Despite having the
372 lowest satisfaction, the mean rating indicates a modest level of satisfaction. It should be noted that
373 respondents were not asked to rate their satisfaction with their centralised water supply. As such,
374 satisfaction with alternative water sources can not be compared to the centralised supply. Due to
375 constraints of the survey length, respondents were not asked to explain their levels of satisfaction.
376 It would be useful in future to explore why people were less satisfied with collecting water in
377 buckets than with rainwater tanks. One explanation for this lower level of satisfaction associated
378 with collection of shower water in buckets and re-using laundry water could be due to the greater
379 level of labour and effort involved.

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Respondents were given the opportunity to make any other comments about the use of alternative water sources. In total 285 respondents provided a comment. These were coded and summarised, and can be found in Table 4. The majority of respondents indicated that they were in favour of the use of alternative water sources (n=182). Only two people opposed the use of alternative water sources outright. The main themes to emerge from responses to this question relate to barriers to the use of alternative water sources.

Insert Table 4

Comments were received from tenants who perceived barriers to the use of alternative water sources due to their inability to adapt their household infrastructure due to their housing tenure status. Respondents suggested there should be ways to subsidise landlords to give them incentive to install alternative water sources in rental properties. One respondent expressed frustration that they can not make these adaptations themselves, and another was frustrated by promises (by the housing commission) to install water saving devices, but this not coming to fruition. Similarly, Clarke and Brown (2006) found that tenant status was a barrier to the implementation of alternative water use and water conservation.

Other respondents mentioned general barriers they perceive to implementing the use of alternative water sources. These barriers included (but were not limited to): on-going maintenance costs for alternative water systems; government set water consumption targets not having high enough aspirations; disincentives of current water charges (based not just on consumption but also a comparatively high ‘service’ fee); policy impediments (e.g. the requirement to have a licenced plumber install a rainwater tank), and housing tenure status. These findings resonate with those of Allon and Sofoulis (2006) while people are prepared to

406 employ do-it-yourself measures to save water, but they are constrained by the current socio-
407 technical systems of water provision and wastewater disposal. It will be important for
408 government policy to address these barriers if it seeks to increase residential use of alternative
409 water sources.

410

411

412 **6. Discussion and Conclusions**

413 This research has provided insight into the use of alternative water sources by Victorian households,
414 the majority of which are facing restrictions to water use due to the impact of a 12 year period of
415 drought across the state. The study found that a significant majority of households are participating
416 in the use of alternative water sources as encouraged by the government, and that they have been
417 doing so for a period of at least two years. In total, 40.7% of respondents surveyed had at least one
418 rainwater tank on their property, and 8.3% of respondents were not connected to a mains water
419 supply, thus they always use an alternative source(s) of water.

420

421 Garden watering was found to have the highest rate of alternative water source use. In total 74.8%
422 of respondents sometimes or always use an alternative source of water on the garden. The most
423 commonly used alternative source of water for garden watering was found to be reused laundry
424 water (28.5%). People were found to discriminate between sources of water for various uses. The
425 alternative source of water used varied dependent on the purpose of the water use. With regards to
426 satisfaction with the use of alternative water sources, high levels of satisfaction were found for all
427 alternative water source used. Respondents were most satisfied with water from rainwater tanks.
428 Several barriers were found to the use of alternative water sources, the main of which included
429 inflexibility of existing infrastructure, cost, policy and housing status. It would be beneficial in
430 future to explore the volumes of alternative and centralised supplies used by consumers, and the

431 timing (daily and seasonally) of this use. Such information would further inform water supply
432 planning.

433

434 The results from this study raise implications for water retailers, government and policy makers.

435 The results indicate that due to water restrictions and drought Victorian households have altered

436 their water use patterns. Victorians have started to substitute other sources of water for centralised

437 supplies. While a benchmark study on alternative water use was not conducted prior to the

438 introduction of wide-spread water restrictions, evidence including reduced bulk water consumption

439 figures, and reduction of inflows into the sewer (see Victorian Water Industry Association 2007),

440 suggests that in the absence of restrictions, this substitution could not have occurred on such a scale.

441 This behaviour change has impacts for inflows into sewers, and thus government access to water to

442 recycle and sell. Additionally these behavioural changes may have interesting implications for

443 demand for potable water, and revenue for retailers, particularly if restrictions to water use are

444 lifted. Thus, now Melbourne is only on Stage 2 restrictions (two steps lower than at the time of

445 survey), it would be interesting to compare behaviours.

446

447 In Melbourne, restrictions may well be lifted once the desalination plant starts producing water for

448 the city, which is anticipated to occur by the end of 2011. This desalination plant will be built at a

449 significant cost to the Victorian Government, the cost of which is already being passed on to

450 consumers of water. Once on line, the Victorian government will financially be in a position which

451 sees it likely to encourage the use of desalinated water. The use of desalinated water by consumers

452 will bring the government financial benefit – in comparison to the use of alternative water sources

453 from which the government will not make a direct financial gain – yet the individual customer will

454 gain financially. However, in the longer term, given the significant impact climate change is

455 predicted to have on water resources for the state, the encouragement of desalination may actually

456 be detrimental given high greenhouse gas emissions, and possible further costs likely due to
457 anticipated future introduction of future carbon taxes or carbon pollution reduction schemes.

458

459 An addition question the connection of the desalination plant raises (or indeed significant rainfall to
460 fill-up the city's dams again) is – will the convenience of water use facilitated by a centralised
461 supply outweigh any financial/environmental savings made by the use of alternative water sources
462 in the absence of restrictions? Further research would be beneficial to understand long term
463 behaviour, and in the absence of restrictions, and how behaviour may change as the level of
464 restriction changes. Additionally, it would be beneficial to identify the cost of adaptation to water
465 restrictions, and if this is impacted by a household's financial position. Additionally, while the
466 proportion of respondents who used alternative water sources was high, it would be beneficial to
467 understand why some respondents had never, or seldom use alternative water sources.

468

469 It is clear that the situation in Victoria differs significantly from that of the substitution of water
470 sources which occurs in developing nations and is well documented in literature. In Victoria the
471 use of water restrictions is a short term water quantity management strategy which relies on the
472 collective cooperation of customers. To help the community cope with restrictions to use, many
473 alternative water sources have been advocated by the government (as discussed in section 2 of the
474 paper). These initiatives have since been adopted by customers, and opportunities for new water
475 saving products have entered the market place. However in Victoria, this substitution of water use
476 mainly occurs for the purpose of maintaining aesthetics, rather than necessary uses of water (e.g. to
477 maintain gardens rather than to obtain drinking water). This is in contrast to substitution which
478 occurs in developing nations, which as indicated in literature (e.g. Pattanayak et al. 2005; Zérah
479 2000) occurs for necessity, and due to the unreliability of centralised supplies (quality, timing,
480 pressure etc).

481

482 Given Australia is the driest inhabited continent in the world, the behavioural changes reported in
483 this paper as a result of severe and prolonged drought, may be an indication of what is to come for
484 other developed nations.

485

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Table 1: Use of alternative water sources in Victorian households connected to centralised water supplies

Use	N	Stated frequency of use – percentage of respondents				
		Always	Sometimes	Sum of Always and Sometimes	Never	Not Applicable
Garden watering	368	41.6	33.2	74.8	21.5	1.1
Car washing	368	22.3	7.9	30.2	47.0	22.8
Cleaning (domestic)	368	4.3	17.4	21.7	76.1	2.2
Drinking	368	7.2	4.6	11.8	86.7	1.1
Pet water	368	5.2	5.7	10.9	53.3	35.9
Toilet flushing	368	3.3	7.1	10.4	88.6	1.1
Cooking	368	4.3	3.8	8.1	90.5	1.4
Clothes washing	368	2.4	4.9	7.3	91.0	1.6
Fill swimming pool	368	1.6	0.8	2.4	15.8	81.8
Showering	368	0.5	1.4	1.9	96.7	1.4

605

Table 2: What alternative water sources are used for different purposes – Victorian households connected to a centralised water supply

Use	Alternative water source: percentage of respondents who use each alternative water source for each particular use									
	Rainwater tank/s	Re-used laundry water	Collect shower water in buckets	Grey water system	Re-used bath water	Recycled water	Bore (ground) water	Private Dam water	Buy water (cart/truck) from another area	Other
Garden watering	25.0	30.7	19.0	9.2	8.7	3.3	1.3	0.3	0	15.2
Car washing	12.2	3.8	2.7	3.0	1.9	3.5	0.3	0.3	0	6.3
Drinking	8.7	0.3	0.3	0	0.3	0	0.3	0	0.3	3.0
Cleaning (domestic)	8.1	5.4	3.5	2.2	2.1	1.1	0.5	0	0	2.4
Pet water	7.1	0	0.5	0.5	0.3	0	0.5	0.3	0	1.9
Cooking	6.5	0.3	0.3	0	0.3	0.3	0.8	0	0	1.1
Toilet flushing	2.5	2.2	3.3	1.1	0.8	0.5	0.3	0	0	0.8
Clothes washing	2.4	1.1	0.5	0.3	0.3	1.4	0.5	0	0	0.8
Showering	1.7	0	0	0	0	0	0.3	0	0	0.3
Fill swimming pool	1.4	0	0	0	0	0	0.3	0	0.3	0.5

Table 3: Average length of time alternative water sources used and satisfaction* levels – Victorian households connected to a centralised water supply

Alternative water source use	Length of time alternative water source used		Satisfaction with alternative water source		
	N	Average time used – years (standard deviation)	N	Mean	SD
Private dam water	1	3.5 (n/a)	1	10	n/a
Rainwater tank	116	3.7 (2.8)	118	8.6	2.0
Grey water system	43	2.6 (2.1)	43	8.1	2.1
Re-use bath water	40	2.8 (2.3)	41	8.0	2.4
Bore (ground) water	8	5.1 (4.2)	9	7.8	2.0
Recycled water	34	4.1 (2.7)	33	7.8	2.2
Buy water (cart/truck) from another area	2	3.9 (n/a)	2	7.0	n/a
Re-used laundry water	126	3.1 (2.3)	125	7.7	2.3
Collect shower water in buckets	86	2.3 (1.7)	86	7.0	2.7
Other	87	2.8 (2.4)	n/a	n/a	n/a

*Satisfaction was rated on a scale of 0-10 where 0 = not at all satisfied and 10 = extremely satisfied

Table 4: Respondent comments about alternative water sources

Response	N
In favour of alternative water sources	182
Other response	35
Want more dams	7
In favour of water conservation	7
Lack of information on alternative water sources	5
Not willing to use alternative water source for human consumption	5
In favour of water restrictions	4
More people are aware of alternative water sources now	3
Against desalination plants and pipelines	3
Alternative water sources are expensive	3
Not willing to use alternative water source	2
Should not use potable water for flushing the toilet	2
Total	258

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