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Voluntary relocation - an exploration of Australian attitudes in the context of drought, recycled and desalinated water

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Publication Details

Hurlimann, A. & Dolnicar, S. (2011). Voluntary relocation - an exploration of Australian attitudes in the context of drought, recycled and desalinated water. *Global Environmental Change*, 21 (3), 1084-1094.

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Keywords

drought, recycled, desalinated, water, australian, exploration, attitudes, context, relocation, voluntary

Disciplines

Business | Social and Behavioral Sciences

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Throughout history settlements have been abandoned due to lack of water. Such a fate is of concern to public officials in settlements facing water scarcity – a condition which is anticipated to increase due to the impacts of climate change, and other factors including increasing per capita water use, and population growth. Key questions surround how to best adapt to these circumstances. A strategy little explored is relocation. This paper presents results from a qualitative study conducted in eight geographically diverse Australian locations. The willingness of individuals to relocate under three hypothetical water scenarios was investigated: 1) if the water in their community ran out, 2) if recycled wastewater was put in their community's drinking water supply, and 3) if desalinated water was put in their community's drinking water supply. Results indicate that most people would not relocate if recycled or desalinated water was used to augment their community's drinking water supply, but they would if their water supply ran out. Our results highlight that while there is initial public opposition to the augmentation of existing potable water supplies with recycled or desalinated water, people would prefer these solutions, over being forced to move location. Respondents were highly aware of the social, economic and public infrastructure costs associated with relocation decisions. Relocation would therefore, for most, only be the very last option if their water demands could not be met. However, it was difficult for most to imagine the situation becoming so dire. Our results highlight the importance of a comprehensive and consultative approach to managing supply in water scarce locations.

Key words: relocation, adaptation, water, drought, Australia, recycled water, desalinated water

1. Introduction

Water is a resource which is critical to the survival, integrity and wellbeing of humans and the environment. However, the availability of fresh water supplies is becoming increasingly scarce, and is projected to intensify in the future. In the past, settlements have been abandoned due to water scarcity (Tannehill 1947; Wilhite 2005), a fate which most modern public policy officials would seek to avoid. However, little is known about the water circumstances which would drive populations to relocate. For example, there has been documented public opposition to potable recycled and desalinated water supply augmentation projects (Eccleston 2006; Sydney Community United against Desalination 2005), but would this opposition be significant enough to prompt those in opposition to relocate? Or would the community water supply running out be a trigger for people to move?

A review of water related behaviours by Hurlimann et al. (2009) found that limited water related social science has been undertaken to date. Most of the work which has been undertaken has focused on a very narrow range of water-related behaviours. Additionally, the reasons why people engage in specific water related behaviours is little understood. Research into a wider range of water related behaviours is essential, including the behaviour of relocation due to changing water circumstances.

The study reported in this paper contributes to this gap in knowledge by investigating, in the context of Australia, water related circumstances under which residents would consider relocating. Specifically, we investigate the willingness of individuals to relocate under three hypothetical water scenarios: 1) if the water in their community ran out, 2) if recycled wastewater was put in their community's drinking water supply, and 3) if desalinated water was put in their community's drinking water supply. This was investigated through a qualitative study, conducted in eight geographically diverse locations in Australia. Six to ten in-depth interviews and one focus group session was held in each of the locations, providing a rich data set from which

to base our analysis. The aim was to provide a detailed understanding of the relocation intentions of Australians under these three water circumstances and the factors which would influence these intentions.

We begin by providing a review of literature to demonstrate the importance of this research. We then provide details of our study's method before presenting and discussing the results of this research. Lastly, we provide concluding comments which highlight the contribution of our research in this increasingly pertinent area.

2. Literature Review

This review of literature is necessarily diverse due to the nature of the paper's subject. We begin by highlighting the importance of water to human and environmental integrity, before detailing the increasing scarcity of water and the various management responses employed to address this. We detail not only the policy and management debates surrounding these management responses, but also provide a précis of the social research undertaken to date. We then emphasise the possibility of mass migration due to water scarcity by providing an overview of historical cases. In doing so we demonstrate the paucity of research regarding people's willingness to voluntarily relocate due to water circumstances – an area to which our research seeks to contribute.

2.1 The importance of water

Water is critical for sustainable development, environmental integrity, the eradication of poverty and hunger, and is indispensable for human health and well-being (United Nations 2003). Throughout civilisation, the location of cities has been determined by ready access to safe drinking water (Lynch 1971). In developed nations water use has increased significantly over the past 100 years, particularly with the introduction of sanitary reforms and accompanying piped water and underground sewerage (Davison 2008). This contrasts with developing nations where such infrastructure is still largely lacking and per capita consumption is still relatively low. At present 1.6 billion people world wide do not have access to an adequate supply of safe fresh water daily, and 2.5 billion people live without basic sanitation (United Nations 2009).

The ample availability of water is also critical to the success of a city's further growth. As highlighted by Mumford (1989) water is one of the physical limits to metropolitan expansion: as a metropolis becomes more crowded the local water supplies are progressively abandoned for larger reservoirs of water. This is evidenced in cities such as New York (Mumford 1989) and Mexico City (Falkenmark and Lindh 1993). With the construction of the Croton system (of reservoirs and aqueducts) in 1842, New York was the first major city to achieve adequate supply of water. However in 1951, a year of drought, the city was dangerously close to running out of water (Mumford 1989).

2.2 The increasing scarcity of water

Increasing water scarcity is threatening the future of many human settlements. The reason for this water scarcity is often due to a complex mix of factors including increasing population, increasing per capita consumption, increasing pollution of freshwater sources, and climatic changes. The seriousness of water scarcity globally has been acknowledged in numerous declarations by the United Nations (including: United Nations 2003). Further, the Intergovernmental Panel on Climate Change (2007) recognises the impact climate change will have on water resources – mainly with increasing variability of rainfall, with the specific impacts depending on location. Details of projected impacts of climate change for water resources are detailed by Arnell (1999).

2.3 Responses to water scarcity

There are many possible management responses to adapt to water scarcity, each having different implications for planning, economies, communities and the environment. Water management strategies range from restricting the use of water (demand management), through to augmentation of supply with additional sources of water (such as the addition of desalinated seawater or recycled sewage into supplies). In many locations, a suite of options are chosen.

2.3.1 Demand management

Water restrictions are often seen as a temporary action to manage a short term shortage (Bailey et al. 1992), although in some instances (e.g. prolonged water shortage such as that occurring in Melbourne, Australia) the on-going use of restrictions is necessitated. There are various ways by which authorities seek to encourage the conservation of water resources, these include but are not limited to voluntary and mandatory restrictions to water use for both residential and commercial users, the use of pricing mechanisms (such as charging for water; charging using an increasing block tariff), and providing financial incentives for the installation of water efficient fixtures and appliances. Research has demonstrated that members of the public hold very positive attitudes towards water conservation overall (including: Dziegielewski 1991; Murphy et al. 1991; Rea & Parker Research 2007; Roseth 2006).

2.3.2 Water supply augmentation

Popular in many developed nations is the augmentation of supply with desalinated or recycled water. Until recently, the desalination of seawater was largely limited to the Middle East – where water shortages were wide spread, but access to relatively cheap energy was available. However given desalination technology improvements (e.g. increasing energy use efficiency) and increasing water scarcity, augmentation of supplies with desalinated water in areas outside the Middle East is increasing. More recent factors for the increase in seawater desalination include political concerns about community attitudes to the alternative of potable recycled water use.

Recycled water use is both extensive and well established in many locations around the world. The first dual system (delivering lower quality water for non-potable purposes through separate infrastructure) in America was built in 1926 to serve Grand Canyon Village (Okun 1997). There are now over 200 communities in America that are served by dual systems including San Jose, Los Angeles, St Petersburg and Tuscan (Okun 2002). However non-potable use of recycled water is not limited to the USA, it is used in many other locations including in Israel, Africa and Australia for agricultural use, and for toilet flushing in Japan and Australia.

Augmentation of potable water supplies with highly treated wastewater and desalinated water is also increasingly occurring. Direct potable use of recycled water was first implemented in 1969 in Windhoek, Namibia, a water scarce city (du Pisani 2005), but is utilised in other locations too. A major portion of Israel's wastewater is treated then used to recharge groundwater, which is drawn upon for the nation's potable distribution (Dishman et al. 1989). Additionally, in 2003 the Singapore government adopted indirect potable reuse of 'NEWater' – highly treated wastewater which is added to their potable supplies (Seah et al. 2003).

These supply side solutions utilise centralised infrastructure and require little behaviour change, yet have been met by public resistance in some circumstances. Due to increasing water scarcity in many locations in Australia, a key policy question at present is whether or not potable reuse of recycled water should occur. This has been closely debated in media outlets following a referendum held in the town of Toowoomba Queensland regarding whether or not to introduce highly treated wastewater into potable supplies (e.g. Eccleston 2006). The community voted against the recycled water plans after significant political manoeuvring and a negative information campaign by a group called 'Citizens Against Drinking Sewage' (Hurlimann and Dolnicar 2010). Seawater desalination proposals in Melbourne and Sydney have also faced community opposition (Sydney Community United against Desalination 2005).

Community attitudes regarding the use of recycled water, have been widely researched (including Bruvold 1988; Bruvold and Ward 1970; Lohman and Milliken 1985; Australian Research Centre for Water in Society 1999; Hills et al. 2002; Hurlimann 2008; Jeffrey 2002; Marks et al. 2006). This body of work concludes that attitudes to recycled water depend on the use to which it is being applied. Uses with low personal contact (e.g. garden irrigation) are highly accepted, whereas uses with high personal contact (e.g. drinking) face significant resistance.

Recently, similar research has been conducted in the context of seawater desalination (Dolnicar and Hurlimann 2010; Dolnicar and Schäfer 2009) and stormwater (Nancarrow et al. 2002). Dolnicar and Schäfer

compared Australian public attitudes to desalinated seawater and recycled wastewater concluding that people's preferences, again vary by use: for uses with high personal contact, desalinated water was preferred, but for uses with low personal contact, recycled water was preferred. A recent study found that these attitudes have changed since more information about both recycled and desalinated water has been available to the Australian population: people still prefer desalinated water for uses with high personal contact, but do not have a preference for uses with low personal contact (Dolnicar and Hurlimann 2010). In researching attitudes to the use of various alternative water sources, Nancarrow et al. (2002) found the preferred alternative was reuse of treated stormwater for parks and gardens (96.3%) and the reuse of greywater for gardening (86.5%).

2.3.3 Other adaptation strategies

Other adaptation strategies include financial assistances packages. Given the acknowledged impact that drought is having on some rural Australian communities, the Federal Government announced in 2007 a 'Drought Assistance Package' which includes provision for an 'Exceptional Circumstances Exit Grant' (Department of Agriculture Fisheries and Forestry 2007). This is a one-off grant of up to \$150,000.00 for eligible farmers affected by severe drought conditions to help them leave farming. Various other adaptation strategies not discussed here are also possible. Some may be maladaptive (see Barnett and O'Neill 2010). Little social research has been conducted into other adaptation strategies.

2.4 Population relocation due to water scarcity

Once water supply options have been exhausted and are insufficient to meet demand, relocation becomes the only option. But relocation of a city's population comes at significant social, cultural, environmental and economic costs. Infrastructure is abandoned and the need for housing, transport, and employment at the relocation destination is significant. Therefore it is critical for policy makers to understand triggers of population relocation. While mass relocation due to water scarcity sounds like a theoretical concept, history proves the contrary: many settlements have been abandoned due to the unavailability of water (Tannehill 1947; Wilhite 2005). A summary of locations and the reasons for their abandonment are detailed in Table 1.

Documented cases date back from Mesopotamia in 2300 BC, through to the Great Plains region of the USA in the 1930s. While drought played a major role in all cases, it was often coupled with other environmental or economic challenges. As identified by Barnett (2003), people rarely migrate for environmental reasons alone, but in combination with a range of development and governance factors.

More recently, many settlements find themselves on the brink of abandonment because of unprecedented demand for water (Brown 2001; Falkenmark et al. 2004; Postel 2000). Demand for water is exceeding supply in many areas. In some regions this is threatening the production of an adequate supply of food, with farmers having to revert to rain fed farming in many areas, including China (Brown and Halweil 1998). Of particular concern is the rate at which ground water resources are being extracted, often beyond natural regeneration (Seckler et al. 1999). In 2007, the small town of Euroa in the Australian state of Victoria, ran out of water. Water was brought to the township by truck from near-by areas to meet residential needs (Kleinman 2007). This demonstrates the real threat of water scarcity, the implications of which for larger cities and regions will be more difficult to manage and potentially more devastating because of the scale.

Insert Table 1

The need to relocate because of environmental reasons is predicted to increase with the impacts of climate change (Hermesmeyer 2005; Loughry and McAdam 2008). Williams (2005) advocates against relocation, given people have a spiritual connection to land, and because past relocation projects have failed. Baer (2008) highlights that poor people are disproportionately relocated as a result of drought, and that this has emotional and mental health implications for individuals.

While the body of work on water management strategies is extensive, only a little work has been done to understand relocation, be it voluntary or involuntary. Some research has been undertaken which studies involuntary resettlement due to land inundation associated with the construction of dams (see for example:

Tankha et al. 1999; Yuefang and McDonald 2004). A small number of studies have investigated relocation due to water scarcity, particularly in developed nations. Alston and Kent (2004) conducted a study in Australian state of New South Wales on the social impacts of the 2002-2003 drought. They identified that one negative impact for some families was the need for one member to move to a new location to find work. At times, whole families were forced to relocate because of the severity of drought. Their study concludes that the loss of population in many rural communities has been exacerbated by drought.

Gebre (2002) researched the attitudes of Ethiopians in drought affected areas toward voluntary and involuntary relocation in the 1970s and 1980s. Family and friends were found to play an important role in the decision to voluntarily relocate: some respondents indicated that they reluctantly resettled to avoid family separation. Dependents had no choice but to respect the decision of their carers. Some people claimed they resettled due to pressure from friends and neighbours.

As demonstrated in the above review, because of the paucity of research globally concerning attitudes and willingness to relocate due to water supply changes, and because of the significant impacts this could have on human settlements, it was considered an important research prerogative for this study to address. Below, the research method employed to address this gap is described.

3. Research Method

3.1 Locations of study

Eight locations around Australia were chosen for study based on their contrasting water characteristics: Adelaide, The Mallee, Melbourne, Sydney, Brisbane, Toowoomba, Darwin and Perth. The location of each is shown in Figure 1. Additionally, key population, rainfall and water supply information about each location is provided in Table 2. All of these locations, apart from Darwin, have experienced periods of drought of varying intensity over the past decade and a half. Recently (Australian summer 2010-2011) the drought in eastern Australia broke in dramatic fashion, with significant and devastating flood events recorded in large areas of the

states of Queensland, New South Wales and Victoria (see Queensland Government 2011; Victorian Government 2011).

Insert Table 2 and Figure 1

3.2 Participant recruitment

Respondents were recruited by a professional market research company who ensured that a heterogeneous (age, gender, religion) group of respondents was selected. The aim was to conduct ten 45-minute interviews and one focus group with ten people at each location, however this aim was not achieved. The final sample contained 66 interviewed respondents and 63 focus group participants, thus 129 people participated in total. The details regarding number of respondents for interviews and focus groups in each location can be found in Table 2.

The interviews and focus groups were conducted (and recorded) by one of the authors with the support of three trained research assistants using the same interview guides. Interviews took between 45 minutes and one hour, while the focus groups were typically one and a half hours in duration. Transcribed interviews served as the basis for (double) coding and categorisation of statements which was done following principles advocated by Marshall (2002) and Richards (2005).

Respondents were asked whether they had previously relocated (migrated) because of reasons of water supply. Then they were presented – in the same order for all respondents - with the following three hypothetical water scenarios:

- 1) if the water in their community ran out,
- 2) if recycled wastewater was put in their community's drinking water supply, and
- 3) if desalinated water was put in their community's drinking water supply

Respondents were asked if they would consider relocating under each of these circumstances, and were also asked who would influence their decision to relocate and not relocate, and how the identified person/s would influence them. Other questions were asked about their attitudes to and perceptions of other water issues such as water conservation and water supply augmentation.

4. Results and discussion

The focus of the reporting of results is the responses from the interviews. Quotations from the focus groups are used to illustrate and support these results in more detail.

4.1 Prior relocation due to water supply issues

Two respondents indicated they had previously relocated because of water supply. One Darwin man interviewed was formerly in the army, he explained that in the army they moved from one place to another for reasons of water supply. The other respondent moved from one location because:

"The water tasted like blood and we all got gastro nearly every week." [female, Toowoomba]

Those who indicated they had never moved for water supply reasons were asked why not. The majority of respondents indicated they had never needed to. Two respondents said that they have had to buy water in the past, because they harvested their own water which ran out (e.g. tanks and bores). One respondent from The Mallee talked about the need to be continually vigilant with regards to the water levels given their dependence on a private (decentralised) rainwater supply:

"Have not had to [relocate], I'm on rainwater and it has never run out where ever I lived. It has gone short and I've had to watch it." [male, The Mallee]

Across the study, particularly in The Mallee area, distinctly different views were expressed by farmers when compared to 'hobby farmers' or 'tree changers' (those who have moved from the city to rural areas - for a

discussion of this term see: Gibson et al. 2005). Farmers commented that the others (non-farmers) did not know how to manage their water supply, often running short and having to get water trucked in. There was an expressed skill, care, philosophy, and experience needed to manage decentralised water supplies, particularly through times of drought.

4.2 Stated intention to relocate under three hypothetical water scenarios

The results regarding stated intention to relocate for each hypothetical scenario can be seen in Table 3. The majority of respondents indicated they would relocate if the water ran out (n=51). This was the situation which Alston and Kent (2004) found did force some families in rural New South Wales to relocate. Conversely, the majority of respondents indicated they would not relocate if recycled water or desalinated water was added to the drinking water supply (n=58 and 62 respectively). This is despite the high level of public resistance to drinking potable quality recycled water (including but not limited to: Bruvold 1988; Lohman and Milliken 1985; Hurlimann 2008; Jeffrey 2002).

Insert Table 3

There was not a significant difference found between the number of respondents who stated they would relocate if recycled water or desalinated water was added to their supply. This is despite a preference for drinking potable quality desalinated water over recycled water, which has been observed in previous social research (Dolnicar and Schäfer 2009; Dolnicar and Hurlimann 2010). Our results indicate that people would rather drink potable quality recycled or desalinated water, than have to relocate because of water scarcity. Reasons why respondents said they would or would not relocate under each scenario are discussed in turn below.

4.2.1 If the water ran out

In order to gain an understanding of relocation intentions, participants were asked why they responded in the manner they did. The response relating to 'if the water ran out' can be found in Table 4. The main reason stated was survival (n=29). One respondent highlighted the need for the situation to be very serious to relocate [male, Darwin], and another pointed out that there is an assumption that there would be somewhere else to go [male, Darwin]. For those respondents who indicated they would not relocate if the water ran out, the main reason for this response was that they believed there would be other ways to get water (n=3), or that they had a particular attachment to the area that would prevent them from relocating (n=2). This relates to Williams' (2005) arguments against relocation in the context of the West African Sahel, given people's connection to land. Four respondents did not know whether or not they would relocate.

Insert Table 4

Interview respondents in both Sydney and Darwin unanimously indicated they would relocate if the water supply ran out, whereas in all other locations, the responses were mixed. At the time of survey, Sydney and Darwin were arguably the locations with the most fortunate water supply situation. These results suggest that the experience of drought may make people more resilient, or less willing to relocate. At the end of their interview one Darwin participant reflected on the drought impacting other parts of the country and acknowledged the need to respect natural resources:

"It is not debated sufficiently here. I think the issue of the southern states are as bad as they are because people didn't talk about it early enough. We might end up having more constraints on our water up here and we should start planning for that now. I guess it is about good stewardship of natural resources." [female, Darwin]

In Toowoomba, focus group participants (T1 – T5) discussed the severity to which the drought would have to be to relocate. They also considered the implications on their property values. An excerpt from the focus group demonstrates this:

T1: *"It really is only begging the question because this water crisis is not only affecting our area but the whole country, apart from the tropics, so moving from the situation where there is no water to where there is, is only temporary."*
[male, Toowoomba]

T2: *"I think you have to look at relocation as a bit harsh. How many farmers leave their land because of drought? You live with it, there are always alternatives, you can always buy it. There will always be a hole in the ground somewhere with water."* [male, Toowoomba]

T3: *"It would have to be an absolutely extreme situation where you are."* [male, Toowoomba]

T4: *"If Toowoomba did run completely out of water and you owned the house you lived in, what would it be worth?"*
[male, Toowoomba]

ALL: *"Nothing"*

T4: *"So how would you buy a house elsewhere?"* [male, Toowoomba]

T5: *"I wouldn't relocate, I would just get more tanks and hope it would rain."* [female, Toowoomba]

It was evident that many participants were unable to envisage the natural limits of water. As demonstrated by the following quotes, participants from focus groups in all locations indicated that they found it difficult to imagine water running out, and that the situation would have to be dire for them to relocate:

"If it got bad I'd shift....if it got to the point where you were really struggling in all ways, you had water cut off." [female, Brisbane]

"You would have to have absolutely no rain for that to happen" [male, The Mallee]

"It would have to be very, very serious to even consider relocating" [male, Darwin]

"We would relocate just because there would be nothing here it would be a total drought. Would all the infrastructure remain?" [male, The Mallee]

"It would be a last option. We would have to – but I would be annoyed" [male, Perth]

"I think if we had to relocate because there was no water....the country would be bankrupt because our properties would be worth nothing. That is all a doomsday thing, it is the bottom of the barrel, I mean, where are we going to go?" [male, Toowoomba]

As evidenced from the above quotes, a particularly strong theme to emerge is a concern about the impact of relocation to personal and community finances – both current and future. One respondent from the Adelaide focus group believed there were other options: *"There are other alternatives before relocating e.g. recycled water" [female, Adelaide].*

The responses indicate the participants would explore many options before deciding to relocate. Respondents indicated they would delay relocation for numerous reasons, including attachment to place (resonating with Williams' 2005 research), social considerations (resonating with Gebre's 2002 research) and financial investments in the place.

4.2.2 If recycled water was put in the drinking water supply

Reasons detailing why respondents would or would not relocate if recycled water was added to their supply are detailed in Table 5. Two of the three people who indicated they would relocate were from Melbourne. Those who stated they would relocate each provided a different explanation ranging from concern about getting sick [female, Adelaide], to economic considerations [male, Melbourne]. The main reason cited by those respondents who would not relocate was that they are happy to drink recycled water (n=13), and they

feel that it is safe to drink (n=9). Five respondents indicated they would obtain another source of water (e.g. rainwater/bottled water) for drinking purposes. Respondents from the focus group in The Mallee had the following to say:

M1: *"If they put recycled water in the supply I would just get a couple more tanks, fill them up next time it rains."*[male, The Mallee]

M2: *"You could just have the tank water for drinking, and the recycled water could be for everything else, washing, gardening."*[male, The Mallee]

The question was not applicable for two interview respondents who had their own supply of water (tank water), one added *"even so it wouldn't worry me"* [male, The Mallee]. Only five respondents acknowledged that all water is recycled, or that they are drinking recycled water in some form. This was particularly pertinent for Adelaide residents whose potable water is source from the Murray River, however only one Adelaide respondent [male] said they are drinking recycled water from their own rainwater tank.

Insert Table 5

A similar sentiment was expressed in focus group discussions. The following is an excerpt from the focus group discussion in Darwin, after the facilitator had asked respondents whether they would relocate if the authorities put recycled water in the supply:

D1: *"No. You would be up in arms that they did it, but you still need water to drink. Everyone would drink bottled water for about three weeks, then realise that it was too expensive and just drink it and realise it is probably nicer. I don't think the public should have a choice. The government should just make a decision and stick with it."* [male, Darwin]

D2: *"It is all well and good to say that we should have a say, but once it is done, it is done"* [female, Darwin]

D3: "That is right" [female, Darwin]

D4: "How did they survive down in Victoria?" [male, Darwin]

These responses indicate that some people would be angry at first, but then accept that water is critical for their survival. In many instances people expressed that having recycled water in the supply was better than having to relocate. This resonates with research conducted in Toowoomba, where 66% of respondents agreed that using recycled water is OK if absolutely necessary (Hurlimann and Dolnicar 2010). The concerns participants raised about drinking recycled water are also similar to other research. In a large scale nationally representative study, Dolnicar and Hurlimann (2010) found that 64% of respondents were sceptical of how clean/safe recycled water is.

4.2.3 If desalinated water was put in the drinking water supply

Explanations relating to adding desalinated water in the supply can be found in Table 6. The two respondents who indicated they would relocate if desalinated water was added to the supply had very different reasons. One said they would do so if they got sick [female, Adelaide], the other said they would have to weigh up all the options [female, Melbourne]. The majority of respondents who said they would not relocate said that this was because they did not have a problem with it (n=22) or that it is safe and healthy to drink (n=12). Other respondents indicated conditions under which they would not relocate, for example, that as long as it did not impact their quality of life. This strong indication that people would not relocate if desalinated water was added to their community's water supply resonates with previous research which has found high levels of acceptance for potable use of desalinated water (Dolnicar and Schäfer 2009; Dolnicar and Hurlimann 2010).

Insert Table 6

Two respondents from Perth indicated that they had not relocated even though desalinated water has been added to their drinking water supply (the other respondents from Perth did not acknowledge that desalinated water had already been added to the supply). Many respondents did not see the need to relocate if desalinated water was added to the supply.

4.3 Social influences

Respondents were asked who would influence their relocation decision. As can be seen from Table 7, the most influential person was the respondents' partner, followed by other family members. Many respondents believed that no one would influence their decision. Only a few indicated that experts in government or science might be influential. When asked how these people would influence them, the key responses were through the evaluation of options (n=8), the fact that they make decisions together (n=7), and that their opinions are valued (n=4). These results are in line with those of Gebre (2002) who found that in the context of Ethiopia, family and friends were influential in drought-triggered relocation decisions.

Insert Table 7

Respondents from focus groups in each location indicated that family and friends would be very influential. One participant said *"it would be good if the whole town could come with you"* [male, The Mallee]. Some examples include the following:

"..... You have your friends and family here. They tie into your decisions." [female, Brisbane]

"My son would be upset about moving away from his friends." [male, Brisbane]

"It would mean the breakdown of social networks" [female, The Mallee]

Respondents also acknowledged the financial impact of relocating, and the implications for infrastructure and the country at large:

"The government would have to help fund infrastructure and manage transition." [female, Perth]

"Industry would already have to be set up in the new towns to ensure that people had jobs" [male, Sydney]

"Roads and rail systems are established in the larger cities, so we may have to lose these if we move" [male, Sydney]

Emerging from responses was the importance people placed on family, and their own assessment of the situation. Respondents' connection with the place, and the social and economic investments they had made, were raised as major considerations, particularly in the regional locations of study.

5. Conclusions

Water is a critical resource. Throughout history the success of human settlements has been determined by ready access to water. Many settlements have had to be abandoned due to water limits. Water is becoming increasingly scarce in many locations around the world due to factors such as increasing per capita demand for water, population growth, and the impacts of climate change. In Australia, relocation has recently been triggered in rural and regional locations due to drought. However, despite this increasingly dire situation for water resources globally, little is known about human responses when faced with water scarcity. This study contributes to building knowledge in this area by investigating willingness to relocate under three water related scenarios in the context of Australia.

This study is limited in the following ways: Firstly, hypothetical scenarios were used. The dangers of this are that (1) some people had difficulties imagining the most extreme scenario and that (2) only statements about behavioural intentions can be made, not actual behaviour. It would be interesting, in future, to study actual

relocation decisions that have been made by people due to water scarcity. Secondly, the sample used was not nationally representative because it was qualitative in nature and the aim therefore was to talk to the widest range of different people, not a representative sample. Thus the conclusions we draw from this sample must be considered within this limitation. However, based on the present study a replication study with a nationally representative sample would be possible. Finally, the study was conducted in Australia only. Replication in other countries, particularly developing nations, would be of great interest.

Results indicate that people in locations with varying water context are generally very aware of the recent drought in Australia and the possible implications of it. A diversity of attitudes to the relocation scenarios was found, with variance between location and personal experience and circumstance. Many respondents had difficulty imagining the water situation getting so bad that they would have no other choice but to relocate. Respondents expressed significant attachment to place and voiced concerns about the social and financial impacts of having to relocate – not only for themselves, but for their families and the wider community. They acknowledged the social and infrastructure capital that would be abandoned as a result.

Contrary to what prior research suggests, our results indicate that changes to water supply, such as augmentation of potable water with desalinated or recycled water, would not be likely to lead to significant relocations. People's decision to relocate would mainly be made in conjunction with close family, a finding which supports the work of Gebre (2002) in Ethiopia. Respondents were highly aware of the social, economic and public infrastructure costs associated with relocation decisions. Relocation would therefore, for most, only be the very last option if their water demands could not be met.

The results of the study have policy implications. People generally stated they would not consider relocating unless they are forced to do so (e.g. there is not enough water). Despite documented public resistance to water augmentation projects, the vast majority of people participating in this study indicated they would not consider relocating if recycled or desalinated water would be added to their tap water. This highlights the

importance of a comprehensive and consultative approach to managing supply in water scarce locations to avoid mass migration. Our research highlights that while there is initial public opposition to the augmentation of existing potable water supplies with recycled or desalinated water, people would prefer these solutions, over being forced to move location. Additionally, it is worth noting that if a community is forced to move due to lack of water, this will only exacerbate (or potentially create) water scarcity and population pressures in other areas. Thus migration can not be seen to solve the problem, rather it is a perpetual problem.

A significant difference in the number of respondents who stated they would relocate if recycled water or desalinated water was added to their supply was not observed. This finding is of particular interest given the current preference of Australian policy makers for desalination over potable recycled water use (despite in most cases having greater associated negative economic, environmental and social impacts), which appears to be driven by the belief that public resistance will be lower for desalination. Some respondents indicated that while they may oppose the introduction of desalinated or recycled water initially, they would ultimately accept it, if necessary.

The results of our study should not be seen as supportive of water policy making without adequate public consultation. Our paper does not explore the implications of such methods of decision making, which are anticipated to have far reaching social, cultural, economic and environmental implications. Indeed, the implementation of water infrastructure projects with limited public consultation may be politically unwise, as has been the case for a number of recent Australian examples. Water infrastructure projects such as desalination and recycled water plants may well be maladaptive, if as highlighted by Barnett and O'Neill (2010) they address one of the five pathways through which maladaptation arises. Barnett and O'Neill reveal that the desalination plant Melbourne, built in response to water stress, exhibits all five types of maladaptation. Thus, such considerations, in addition to public opinion, should be made by water policy managers. Results of this study may be of interest to wider climate change related issues which may require voluntary relocation as an adaptive strategy. One such situation may be in the context of bushfires in Victoria Australia.

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Figure 1: Map of Australia indicating the eight locations of study

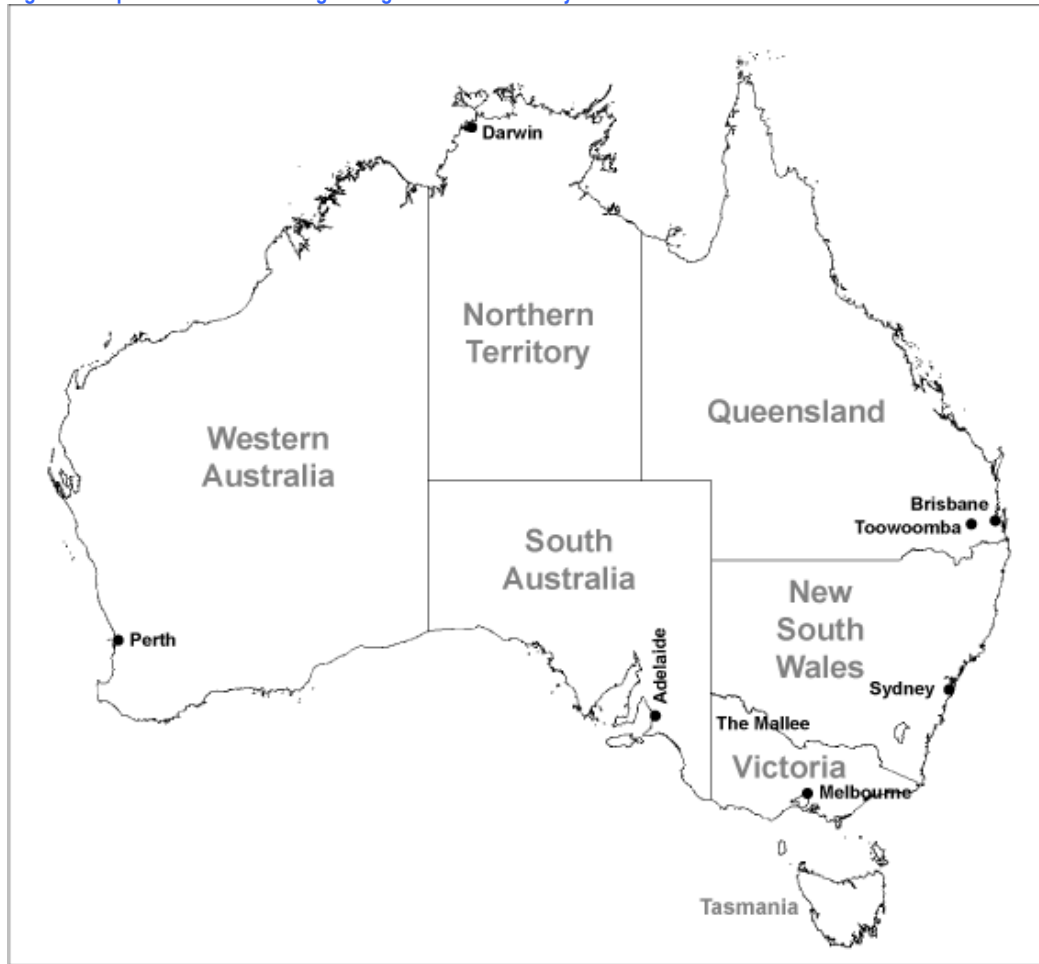


Table One: Information about select locations in which populations have relocated because of water scarcity

Location	Country	Year settled	Year abandoned	Documented reasons why the location was abandoned
Fatehpur Sikri	India	1571 AD	1585/6 AD	Lack of water
				In favour of another capital (Lahore)
				Institutional change
				Brackish (salty) nature of the local water
				Religious explanations
Angkor	Cambodia	802 AD	1431 AD	The existing water management systems became blocked by soil as a consequence of land clearing to accommodate the growing city. This was deemed too expensive and complicated to repair.
				Water system network failure - unable to cope with climate change and new monsoonal patterns.
Maya Civilisation cities	Mexico	750 AD	900 AD	Severe droughts
				Climate change
				Rapid expansion during 'climatically favourable' times resulted in a population at the maximum carrying capacity, leaving Maya particularly susceptible to droughts.
				Warfare, overpopulation, environmental damage, drought and extravagance
				Foreign invasion, revolution, collapse of trade routes, epidemic disease, drought, ecological collapse.
Loss of the royal court and the erosion of public faith in the hierarchy.				

Great Plains/Dust Bowl region	USA	1540 AD	1930s AD	Severe drought combined with the Great Depression, dust storms, the misuse of land (agricultural practice), difficult social conditions and migration out of the region.	
Akkadian cities (Mesopotamia)	Iran, Syria and parts of Turkey	2300 BC	2200 BC	Drought	
				Combination of climatic catastrophes: volcanic eruption, drought, migration straining the regions resources	
				Conventional explanations (prior to Weiss): overpopulation, provincial revolt, nomadic incursions or managerial incompetence	

Table 2: Details about the eight locations of study

Location	Population	Average annual rainfall	Water supply conditions	Research details
Adelaide	≈ 1 million	520mm	<ul style="list-style-type: none"> - water is sourced from the Murray River and the Adelaide Hills catchments - water restrictions are common - given characteristics of the Murray River, indirect potable reuse occurs 	Focus group participants: 8 Interviewees: 9
Brisbane	≈ 2.7 million	1200mm	<ul style="list-style-type: none"> - recent rains have broken a prolonged drought period for the city, water storages have returned to 100% of capacity - recycled wastewater will be used for indirect potable use when dams fall below 40% (Premier of Queensland 2007) - the Queensland government took ownership of a desalination plant located on the Gold Coast in October 2010 	Focus group participants: 7 Interviewees: 6
Darwin	≈ 110,000	1703mm	<ul style="list-style-type: none"> - located in a tropical region - water is sourced from a large dam - historically the city does not suffer from water shortage 	Focus group participants: 8 Interviewees: 8
Melbourne	≈ 3.8 million	650mm	<ul style="list-style-type: none"> - water is sourced from a series of large dams - after a 12 year drought period water storage levels fell to 25.5% of capacity, in December 2010 water storage levels have returned to 52% of capacity - water restrictions are in place - the government has commenced construction of a desalination plant to augment the city's supply 	Focus group participants: 10 Interviewees: 9
The Mallee	≈ 61,000	200-350mm	<ul style="list-style-type: none"> - rural area - the area has been facing a 10 year drought - residents not connected to a mains water supply (e.g. rely on rainwater tanks or private bores) were recruited for study 	Focus group participants: 10 Interviewees: 8
Perth	≈ 500,000	750mm	<ul style="list-style-type: none"> - water is sourced from ground water, dams and a desalination plant supplying 17% of the city's water needs - permanent water efficiency measures were introduced in October 2007 (Water Corporation 2007). 	Focus group participants: 3 Interviewees: 9
Sydney	≈ 4.2 million	1200mm	<ul style="list-style-type: none"> - water is sourced from dams - water restrictions currently in place ('water wise rules') - the government is preparing to build a desalination plant for the city – receiving vocal opposition from community groups (Sydney Community United against Desalination 2005). 	Focus group participants: 7 Interviewees: 9
Toowoomba	≈ 95,000	944mm	<ul style="list-style-type: none"> - water is sourced predominantly from dams - in early 2009 storages were at only 10% of capacity, they have returned to 34% of capacity in December 2010 - residents have been subject to water restrictions since 25 September 2006 - indirect potable wastewater reuse was proposed by the Council - the community rejected the proposed scheme in a 2006 referendum, after a significant negative 	Focus group participants: 10 Interviewees: 8

		campaign by community group 'citizens against drinking sewage' (Hurlimann and Dolnicar 2010)	
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Table 3: Interview respondents' attitude to relocating under three water scenarios

Relocate	If water runs out	Recycled water added to mains	Desalinated water added to mains
Yes	51	4	2
No	11	58	62
Don't Know / Not applicable	4	4	2

Table 4: Explanation of responses to the question of whether interview respondents would relocate if water ran out

Why respondents would relocate if water ran out		Why respondents would not relocate if water ran out	
Reason	Number of respondents	Reason	Number of respondents
For survival / for water purposes	29	There will be other ways to get water	3
Wouldn't have a choice	12	Attachment to current location	2
Would go to where there is water	2	Depends on the options	1
Commonsense	1	It is too expensive to move	1
I would need information about other options	1	I don't think we will ever run out	1
I'd install more tanks	1	No response	1
It would be very serious	1		
We might have to if no one builds a desalination or recycled water plant	1		
My job depends on water	1		
Would move if all other options exhausted	1		
We are assuming there would be somewhere else to go	1		

Table 5: Explanation of responses to the question of whether interview respondents would relocate if recycled water was put in the drinking water supply

Why respondents would relocate – recycled water		Why respondents would not relocate – recycled	
Reason	Number of respondents	Reason	Number of respondents
If I got sick	1	Happy to drink recycled water	13
If there is an economic benefit	1	Fine if it is safe and healthy to drink	9
Would consider it – but I don't think it is the right idea. Dual pipe systems would be ok.	1	No need to move if water available	7
		High purification / scientific standards mean it is fit to drink	5
		Other sources of drinking water	5
		Other response	5
		Impractical to move	3
		If it has to happen it has to happen	3
		Attachment to location	2
		Would be the same everywhere	2
		The authorities wouldn't put in something that wasn't safe	2
		Doesn't affect my lifestyle / quality of life	2

Table 6: Explanation of responses to the question of whether interview respondents would relocate if desalinated water was put in the drinking water supply

Why respondents would relocate – desalinated		Why respondents would not relocate – desalinated	
Reason	Number of respondents	Reason	Number of respondents
If I got sick	1	There is no problem with it	22
I would have to weigh up all the options	1	If it is safe and healthy to drink	12
		The authorities wouldn't do it if it wasn't safe	4
		Doesn't affect my lifestyle / quality of life	3
		As long as considered safe	1
		As long as it didn't become excessively expensive	1

		I would accept it was necessary	2
		Attachment to location	2
		There is no need for desalination	1
		I'm still here (Perth) and we have desalination	2
		Impractical to move	2
		There are other sources of drinking water (bottled water etc)	3
		Everyone will be in the same situation	1
		No need for desalination	1
		I would stay unless no other options	2
		I'd try it initially	2
		Wouldn't notice the difference	1

Table 7: Influence toward interview respondents' relocation decision

Person / other influence	Relocate (n)	Not to relocate (n)
Partner	18	16
Family member	12	14
My own	13	12
No one	7	12
Depends on friends and work	3	3
Based on fact	2	0
Scientists	2	1
Depends on financial situation	1	0
I wouldn't relocate	2	0
Government	1	1
Experts	1	0
Independent expert	0	1
Neighbours	1	0
Politicians	1	1
People in charge of infrastructure	1	0
Environmental scientists	0	1
Community	0	1
Anyone who can fix the supply	0	1
Don't know	0	1
Other	1	1