The potential for rainwater harvesting to supplement domestic water supply in an Aboriginal community in semi-arid South Australia

MERYL PEARCE, EILEEN WILLIS, TOM JENKIN and SIMON WURST

Abstract

Less than 4 per cent of Indigenous Australians living in discrete communities use rainwater as their primary source; while 62 per cent rely on groundwater for their potable supply. Yet the sustainability of water resources in many remote areas is questionable. This paper examines the potential for rainwater harvesting for domestic use in Koonibba Aboriginal community. The community's perceptions of their current water supply problems are outlined. Rainwater could be used to lower the salinity of the mains supply, and alleviate pressure on the aquifer system. The benefits of rainwater harvesting outlined in this paper may apply to other communities in semi-arid regions of Australia.

Introduction

In rural South Australia, domestically harvested rainwater is used as the main drinking water supply in 82% of households (Heyworth et al. 1998). In South Australia as a whole 52% of households rely on rainwater and 27% use bottled water for drinking purposes (ABS 2001). By contrast, only 3.7% of Indigenous Australians living in discrete communities use rainwater as their primary source; while 62% rely on groundwater for their potable supply (ABS 2002). Yet the sustainability of water resources in many rural areas is questionable and the groundwater highly mineralised (Sampson and Dodds 2002).

There is documented evidence that rainwater harvested from large, non-domestic roof catchments is the sole potable supply in two remote Aboriginal communities in South Australia: Oak Valley and Nepabunna (Figure 1; Willis et al. 2004). These two communities comprise less than 2% of the total rural Aboriginal population in South Australia.

While it has been reported that both rainwater and groundwater supplies are under utilised in three Aboriginal communities in the central desert region of Australia (Yuen 2004), much of the north and north west of South Australia live under the threat of limited sustainability of their groundwater resources, are in a semi-arid to arid climate, and experience frequent and prolonged periods of drought. Against this background, is rainwater in remote Aboriginal South Australia a neglected resource? This paper examines the potential of rainwater as a supplementary water resource in Koonibba, a community on the far west coast of South Australia (Figure 1).

In the early 1900s rainwater-runoff was collected from localised, impermeable granite outcrops in Eyre Peninsula for domestic and small scale stock watering. Low concrete walls channelled the runoff from the foothills of the outcrops to built-up or underground storage structures, some of which were covered with corrugated iron roofing to prevent

Figure 1: Location of Koonibba and a number of other Aboriginal communities in South Australia
Rainwater harvesting in an aboriginal community

contamination and losses through evaporation. Many of the rainwater catchment systems continued to provide a supplementary and freshwater supply into the early 1970s (Twidale and Smith 1971; Twidale et al. 1985). Engineered catchment rainwater harvesting (RWH) systems have also been widely used on farms in semi-arid parts of Western Australiasince the 1950s (Laing 1981; Richardson et al. 2004), but more recent use of catchment-scale RWH, if it occurs, is not well documented. A cement-asphalt catchment provided a supplementary non-potable supply to Koonibba until 1980 (Kavanagh 2004, pers. comm.). The catchment system at Koonibba, as in other areas in Australia, fell into disuse ‘not because they did not work but because reticulated supplies became available and were more convenient and secure’ (Environment Policy Division 1998, p. 20). Furthermore, in the case of Eyre Peninsula, catchment systems fell into disrepair because it was cheaper to access the reticulated supply than install or maintain the granite catchment rainwater-runoff systems (Twidale and Smith 1971).

In 2003, residents of Koonibba expressed their desire to harvest rainwater for community use. This paper presents the perceptions of the community on RWH, and outlines the benefits of large scale RWH. Factors hindering the implementation of RWH are not presented here as they are discussed in Pearce et al. (in press). While details are given specific to Koonibba, the findings presented here may well apply to other rural communities in semi-arid regions of Australia and elsewhere.

The study area

Koonibba (population: 100) lies 40 km north west of Ceduna. The region experiences warm to hot summers and mild winters. Mean daily maximum summer temperatures are just under 30°C, although temperatures at times exceed 40°C. The mean annual rainfall at Ceduna is 300 mm; around 20 mm, or more, per month falls during April to October, with an average of 93 rain days each year. Since 2001, the region has experienced about 10% less rainfall, with more severe drought conditions in the adjacent Eyre Peninsula region (Bureau of Meteorology 2004). Water restrictions have been in place since 2002 (SA Water 2004).

Koonibba receives water from the Tod-Ceduna water supply system which provides water to Ceduna, Port Lincoln and other communities on Eyre Peninsula. The demand for water in the region has increased steadily over the past six decades and the Tod River has proved to be a limited supply. Increasing salinity and other water quality concerns have led to the recent exclusion of Tod River water from the supply. The service provider has been forced to access a number of localised and limited aquifers throughout the Eyre Peninsula (Taylor 2003), and the supply now comprises mostly groundwater, though surface water can still be used in the system. Water is pumped to a storage facility where it undergoes disinfection before being piped to consumers (Dowling 2003).

When available, domestically harvested rainwater is used for drinking purposes. All new houses built in Aboriginal communities are provided with a 13.7 m³ polyethylene rainwater tank. In the past, and in addition to domestic RWH, rainwater was collected for potable use from the roofs of a conglomeration of administrative buildings and workshops. The rainwater fed into two storage tanks and was used to supplement the mains supply, although in years with adequate rainfall it provided water to the community for several months (Kavanagh 2004, pers. comm.). In 1990 the storage tanks and roofs were replaced. The central roof RWH system and the mains water extension from Ceduna were maintained by the Department for Aboriginal Affairs and Reconciliation (DAARE) until late 1997 when the system was again upgraded under a Housing Infrastructure Priority Projects (HIPP) programme. The infrastructure improvements were negotiated between the Koonibba Aboriginal Community Council, the Aboriginal and Torres Strait Islander Commission.
(ATSIC), SA Water, and the Ceduna District Council, of which Koonibba is a constituent. The project cost $5 million and was funded by ATSIC and the State Government (Government of South Australia 2000). Once the upgraded mains water system was operational, the HIPP project manager decided that it was appropriate for the central roof RWH system to be isolated from the community reticulation system, and its use was thus abandoned (Kavanagh 2004, pers. comm.).

**Methodology**

The research employed a qualitative case study approach based on a semi-structured, focus group interview with six adult members of the community (around 13% of the population over 24 years of age). The focus group session was semi-structured in that the participants raised and discussed the water issues of concern to them. The researchers had a predetermined list of topics (cultural relationships to water; water regulation; user pays; quality; sustainability) that, if towards the end of the focus group session had not been discussed by the participants, were raised by the facilitator. Focus group interviews provide a complex account of the richness of community attitudes, experiences and desires of individuals and groups (Cameron 2000), and enable the researchers to engage with the community (Parry-Jones 1999). Approval to conduct the research was gained from the South Australian Aboriginal Health Council and the Flinders University Social and Behavioural Science Ethics Committee, and an Aboriginal reference group guided some aspects of the research endeavour. The focus group was taped, transcribed and returned to participants for verification. The transcript was analysed by the research team for emerging themes and a community report was produced. The community then verified the report. In addition to the focus group, the research team conducted site visits of the water infrastructure, the former RWH catchment site and disused storage tanks, and a water hole of cultural significance.

**Results and Discussion**

Participants comments are presented (in italics) with some discussion under the following headings:

- Community perceptions of their water supply
- The feasibility of RWH at Koonibba
- Benefits of RWH
- Concerns over RWH

**Community perceptions of their water supply**

When participants at the focus group session were asked to comment on their water supply, their initial response was:

*There is no water, and continued:*

*The water here is very, very poor. I’ve got to walk around with an empty container to somebody’s house just to go and get water. Fresh water. Nearly everyday.*

*Every house has [a rainwater tank], most of the houses tanks are empty. Empty because of last year’s hot weather. And they drink more rainwater than anything else. And now, they talking about droughts coming.*

Participants at the focus group were asked generally about their water supply, yet their initial comments related only to rainwater (as opposed to the mains supply). Residents reject the treated potable mains supply in favour of the more palatable but potentially contaminated rainwater source:

*Our mains water, a lot of people say it’s drinkable but, yucky taste; got a funny taste to it; ... not for consuming and I can drink it but only for boiling it up and using it for a cup of tea.*

The salinity of the Koonibba water supply of 891 mg/l is within the recommended Australian Drinking Water Guidelines (ADWG) of 500–1000 mg/l (NHMR 1996), but has reached
Rainwater harvesting in an aboriginal community

1500 mg/l at times (Taylor 2003). By comparison, the mean salinity of mains water in Adelaide is 369 mg/l and in rural South Australia is 534 mg/l (SA Water 2002). From a microbiological point of view, recent testing of the mains water in Koonibba showed that the water conforms to the microbiological standards set by the ADWG. When asked whether they would start drinking the mains water when the rainwater ran out, the comments were varied:

I guess we’d start drinking the mains water.

I’d go buy it, I wouldn’t give that to my baby.

This behaviour of rejecting a treated supply in favour of a more palatable but untreated source has been reported elsewhere in Australia (HREOC, 2001). Yuen (2004), however, found that in three communities in the central desert region of Australia people drank from the source that was most readily available regardless of safety or palatability.

The feasibility of RWH at Koonibba

The daily water use at Koonibba is around 453 l/p (based on the average use between June 2000 and June 2003). Applying the average roof area of a house in Koonibba (200 m²) and the mean annual rainfall (300 mm) yields 9% of annual household use. If the roofed area of the administrative buildings and workshops (3,930 m²) are included in the calculation, RWH from the total roofed area of the community yields 16% of the annual water use. The previous ground catchment surface comprised asphalt. Extending the calculation to the ground catchment area (24 000 m²), and applying a rainfall-runoff efficiency value of 81% for asphalt surfaces (Li et al. 2004) yields 5832 m³/annum. If new plastic material were laid with a runoff efficiency between 57 and 76% (Li et al. 2004) the catchment would yield between 4104 and 5472 m³/annum. Rainwater harvested from all the roofs and the ground catchment would thus provide between 41 to 51% of the community’s annual water needs.

The value of domestic RWH as a supplementary water supply in semi-arid and low-income areas throughout the world is well documented (Hartung 2002; Martinson and Thomas 2003; Rees et al. 2000; Thomas 2000). Not only are domestic scale systems of value but larger catchment and storage systems are needed to ensure a supply into the drier months. It is thus as a supplementary water supply that RWH would be feasible in Koonibba, but from a financial perspective RWH could be deemed less viable. Richardson et al. (2004) provide a comparative review of costs associated with eight different types of engineered RWH catchments. Besides storage and treatment costs, land preparation costs and the choice of surface material determine the cost of RWH catchments. In the literature reviewed by Richardson et al. (2004) compacted soil surfaces provided the cheapest catchment option and concrete the most expensive. In 1998 the Environment Policy Division (1998) priced a RWH catchment scheme to support 100 people near the Gawler Ranges (which receives 250 mm of rainfall per annum) at between $4 to $9/m³ depending on the preparation and surface composition of the catchment.

To determine whether a cost-effective solution to the regional water crisis could be achieved for the Eyre Peninsula, Taylor (2003) looked at the feasibility of wastewater reuse, desalination, and RWH catchments. Based on a RWH catchment area of 2 300 000 m², an annual rainfall of 400 mm, and the average water use in country regions of South Australia (599 l/p/d), the system would provide a daily water supply to around 4000 people. Taylor (2003) considered land preparation, surface lining, storage and contingency costs, and concluded that RWH was not a viable option at that scale, but would be feasible for small communities. According to Taylor (2003), land preparation costs were around $10/m², and the price of materials suited to the harsh climatic conditions ranged from $4/m² for high density polyethylene (HDPE) plastic to $12/m² for reinforced polypropylene lining. The rainfall-
runoff efficiency of plastic lining is 57 to 76% (Li et al. 2004). Applying Taylor’s (2003) costs for land preparation and HDPE lining to the catchment area at Koonibba (24,000m²), for the expected life span of HDPE lining (15 years) yields a cost of $4.09/m³. With the additional storage and treatment costs taken into account the cost of the catchment-harvested rainwatersupply would be comparable to that of reverse osmosis technology. For reverse osmosis to be feasible there must be a reasonable supply of water available (even saline water). In terms of alternative water resources, rainwater is thus one of the few options available, though the cost of setting up the system appears to be prohibitive. Reverse osmosis could nonetheless be used to improve the aesthetic quality of the mains water, and a dual reticulation system introduced throughout the community. While this would improve the acceptability of the mains water as a potable supply within the community, it would not alleviate their water scarcity concerns.

**Benefits of RWH**

The main benefits to be gained from the greater use of rainwater are that it can be used to lower the salinity of the mains water, and provide a supplement (41 to 51%) to the current supply:

*Our water is just going to run out...we are not the only community I am sure. But if there is going to be an issue with water and it becomes a health issue, and people are going to start drinking mains water, and then if the reservoirs dry out, where are we going to get the water from?*

*At the moment we are trying to get that catchment redone, to catch all the rainwater and save it for summertime, when the water is going to run out in the reserves.*

One of the main factors facilitating the growing use of rainwater in both rural and urban communities throughout the world has been the decline in the quality and quantity of water supplies (Gardner et al. 2001; Smet 2003). In Australia there is constant attention on the need for alternative sources of water, greater water use efficiency and demand management strategies (COAG 1994; Commonwealth of Australia 2002; COAG 2004). With questions on the future sustainability of the groundwater supply in parts of South Australia, supplementation with rainwater would lower dependence on the aquifers. The value of using rainwater (albeit on a domestic scale) to supplement water supply and extend the life of groundwater supplies in the central regions of Australia has been documented by Grey-Gardener (undated; 2002; 2005).

Koonibba receives water from the Tod-Ceduna system which is deemed a reliable supply. In the unusual event of a system breakdown, a ready supply of rainwater in storage could serve as a backup supply. Some Aboriginal communities in the far north regions of South Australia have reported that when there are water supply breakdowns it can be a number of days before backup pumps or alternative supplies are delivered to the communities (Willis et al. 2004). Concerns over the water supply are not confined to Koonibba. Local farmers who do not have access to the pipeline have water carted to them. Up until mid-2001 the farmers received a subsidy, but without the subsidy the farmers now pay ten times the price of water on Eyre Peninsula (Gilfillan 1999).

The value of rainwater as an emergency supply is seen in a case study of San Felipe, Mexico (Perez 2002). The water availability in San Felipe is similar to Koonibba, with an annual rainfall of 302 mm, high rates of evaporation and no permanent rivers or easily accessible alternate water supplies. San Felipe used spring water as its main supply, with rainwater as a supplement. In 1999 the spring dried up during a severe drought leaving only the rainwater in storage to sustain the community. Similarly, Mou (1995), and Mourits and Kumar (1995,) report on the value of stored rainwater during times of drought in Yuanshi, China and parts of Fiji respectively. Rainwater, as a backup supply, was also found to be of value in parts

Rainwater harvesting in an aboriginal community

of Bangladesh where public water supplies were unreliable (Hartung 1999).

While the value of rainwater has been widely acknowledged, not all studies agree. Sharma (2002) states that despite great financial outlay, more watershed RWH projects in India have failed to protect the people from the impacts of drought, than have succeeded. Sharma argues that an approach that considers traditional community conservation practices, as occurred in Sukhomajri, not only cost less but benefits were shared equally among the community. On the other hand, where check dams were installed under the watershed projects in Gujarat State only 16% of households benefited, and this proportion fell where other structures were implemented, with the benefits less apparent.

A further potential benefit of a RWH system at Koonibba is the opportunity for community participation, empowerment and ownership through a self-managed rainwater supply. The importance of engaging a community in decisions pertaining to RWH is highlighted in the study of San Felipe, Mexico (Perez 2002). Perez states that while San Felipe benefited from a funded RWH agricultural project, the project was seen as a failure because it was not self-sustaining; a factor attributed to the lack of engagement of the local community in the decisions that were taken by the project managers. Perez (2002) concludes that community involvement should empower the local people, otherwise sustainable development will not be achieved.

Concerns over RWH

Despite the feasibility and potential benefits of RWH in Koonibba, such projects would not be without obstacles. The barriers to RWH are discussed in Pearce et al. (in press) and thus not repeated here, nonetheless, a brief summary of the key issues is warranted. There would be concerns over the microbiological quality of the harvested rainwater. Cunliffe (1998) and Plazinska (2000; 2003) state that thermotolerant coliforms are a ‘common occurrence’ in domestic rainwater tanks in a number of remote Aboriginal communities, and given the high incidence of ill-health among Aboriginal people (ABS 2003), a greater assurance with routine testing and management of rainwater systems would be required. Responsibility for the integrity of large, communal RWH systems—where they are used as a potable supply—would require the adoption of sensitive negotiations between state agencies. Furthermore, RWH projects can be costly, not only in terms of the initial outlay but also for long-term maintenance; this raises questions around who would finance and maintain such systems.

The way forward

Some of the reasons given for the success of a RWH project in the semi-arid Gansu Province, China, were that it was a simple project that harnessed local initiative and that there was merit in ‘tinkering with what already exists’ (Cook and Huilan 2002, p. 79). In Koonibba, given the scarcity of water, the availability of land, the interest of the community and the success of RWH there in the past, there is the potential for much to be gained from RWH. Where properly installed and maintained, RWH systems can provide a cost effective and valuable source of water and alleviate pressure on surface and groundwater resources (Grey-Gardiner 2002; Plazinska 2000; Richardson et al. 2004). Residents at Koonibba expressed a preference for drinking rainwater and a desire to reinstate a RWH system. The timing is thus right for an agency to engage the community further and bring to fruition the RWH system. To this end, recent developments have seen a number of applications from state-based bodies submitted to the Commonwealth Government for funding for this purpose. While initially this may be for non-potable use it could nonetheless serve as a critical ‘first step’ in the process of elevating the value of large scale RWH systems in semi-arid regions of Australia.
Acknowledgements

Veolia Water (Australia), the South Australian Department for Aboriginal Affairs and Reconciliation (DAARE), and Flinders University are thanked for funding the research; the CRC for Aboriginal Health for dissemination funding, and Grant McLean and John Kavanagh (formerly of DAARE) and Jonathan Churchill (Adelaide University) for their contribution.

References

Rainwater harvesting in an aboriginal community


Martinson, D.B. and Thomas, T. 2003, ‘Better, faster, cheaper; research into rooftop water harvesting for water supply in low-income countries’, ARCSA, Austin, Texas, (online), available: http://water\rwh-publications\ext pubs by us\arcsa austin 2003\ARCSA.


NHMRC (National Health and Medical Research Council) 1996, Australian drinking water guidelines, NHMRC, Canberra.

Parry-Jones, S.A. 1999, Optimising the selection of demand assessment techniques for water supply and sanitation projects, London School of Hygiene and Tropical Medicine, WEDC, Loughborough University, UK.


Plazinska, A.J. 2000, Microbiological quality of drinking water in four communities in the Anangu Pitjantjatjara Lands, South Australia, Bureau of Rural Sciences, Canberra.

Plazinska, A.J. 2003, Microbiological quality of rainwater in several communities in the Anangu Pitjantjatjara Lands, South Australia, Bureau of Rural Sciences, Canberra.


Thomas, T. 2000, ‘Where is rainwater harvesting going?’, *Waterlines*, vol. 18, p. 3.


1. Meryl Pearce is a Lecturer and Tom Jenkin is a PhD student in the School of Geography, Population and Environmental Management, Flinders University. Eileen Willis is a Lecturer at the School of Medicine, Flinders University. Simon Wurst was an environmental engineer with the South Australian Department for Aboriginal Affairs and Reconciliation, and now works for SA Water.