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Harvesting water that falls on country

Planning for rainwater tanks in remote Australia

CRC for Water Quality and Treatment

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Centre for Appropriate Technology Inc.

First published in 2005 by
Centre for Appropriate Technology Inc.
PO Box 8044
Alice Springs NT 0871
www.icat.org.au

This guide outlines some of the practical lessons learnt from CAT's research on rainwater harvesting in remote Indigenous communities. It is intended to be a useful guide with handy hints and information for people planning to harvest rainwater for drinking purposes. This document is intended to be used in conjunction with other comprehensive information available on rainwater tanks and maintenance such as the *Guidance on the use of rainwater tanks* published by the Australian Government (2004).

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Harvesting water that falls on country: Planning for rainwater tanks in remote Australia.

The Centre for Appropriate Technology would like to acknowledge and thank the following parties for their contributions toward projects from which much of the information in this publication was derived:

Cooperative Research Centre for Water Quality and Treatment.
Aboriginal and Torres Strait Islander Commission.

CONTENTS

1 INTRODUCTION

Rainwater harvesting is one of the oldest methods of collecting water for domestic purposes. This document reports specific understandings from CAT's work in rainwater harvesting projects in remote communities and provides guidance for those considering installing rainwater tanks for drinking water purposes. This report outlines special considerations and lessons learnt through CAT's research activities on rainwater harvesting from 2001-2005 in remote Indigenous communities. Research outcomes from two projects provide the majority of the information presented – The Mutitjulu Rainwater Harvesting and Point of Use Treatment System Trial (2001-2005) and the Mabunji Rainwater Harvesting Management Program (2004-2006). These projects found that rainwater harvesting provided a plentiful supply of rainwater for drinking purposes.

Rainwater tank systems vary in complexity. Some of the traditional Sri Lankan systems are no more than a pot situated under a piece of cloth or plastic sheet tied at its corners to four poles to filter water in rural Indian villages (Padre 2003; Colwell *et al*. 2003). Some of the sophisticated systems manufactured in Germany incorporate clever computer management systems, submersible pumps, and links into grey water and mains domestic plumbing systems (IDTG 2002). Somewhere between these two extremes is a design to harvest rainwater that is appropriate for remote Indigenous communities.

Anecdotal observations in addition to evidence in the review of the water report suggest that rainwater tanks had been frequently used on different remote communities up until the early 1990s after which time many of the tanks and infrastructure had been removed (HREOC 2002: 26). Tanks were removed because first, groundwater supplies were augmented to provide a more reliable and abundant water supply that could provide for all domestic and livelihood needs. Second, the health risks of having an un-maintained tank, either by mosquito borne disease or poor water quality, were considered to be higher than the benefits.

More recently, people have expressed a preference for rainwater tanks to provide a source of drinking water. Many remote communities are considering installing rainwater tanks because people would like to make use of the water that falls on their country. This positive attitude toward rainwater tanks is probably further encouraged by the wider trend in Australia wide to conserve water. This community demand has provided the impetus to revisit approaches to rainwater harvesting and management and provide information for improved and informed planning and management methods.

2 BACKGROUND

Rainwater tanks may be a valuable installation in areas not serviced by mains water or where potable supplies of water are limited. People living in small remote communities are less likely than residents in capital cities to have a reliable, reticulated supply that fully meets requirements and water quality standards (Smith 1998). The economies of scale in these areas, particularly headwork and treatment facilities, put the cost of conventional systems, beyond the reach of small communities (Newton 2001).

Many of the smaller communities and outstations often rely on local water sources, such as groundwater, soaks and river water (ABS 2001; Hearn *et al.* 1993). Rainwater tanks can provide a significant source of water in even the most arid zones of Australia. In the driest state, South Australia, 51% of people use rainwater tanks within the state and 80% of those are within rural, remote and arid areas (Government of South Australia 2004). Moreover, Conway *et al*. (1999a) calculated the rainwater harvesting potential in Giles, central Australia. In Giles the median rainfall is 119 mm per year, in an average year a house with a 266 m^2 roof area could collect 61.25 kL of water in a 27 kL tank and provide 168 L of water per day (Conway *et al*. 1999a).

Furthermore Conway *et al*. (1999b) calculated the rainfall harvesting potential in ten remote Indigenous communities and found that it was viable even in areas with very low and variable rainfall. The main issue is making the rainwater harvesting efficient. For example, at Yuendumu, a house with a 200 m^2 roof area could provide 5 people with 15 L per day of drinking water even in the lowest year of rainfall on record, if a tank with a capacity of 22 kL storage is installed. The rainwater could be used as a reliable source of potable water or as a valuable supplementary source.

2.1 Health considerations

Rainwater is usually fit to drink if it ‘is clear, has little taste or smell and is from a well maintained tank’ (Australian Government 2004). Rainwater can be contaminated from chemical or microbiological contamination but risk of contamination is generally low for well-maintained system.

Chemical contamination can occur from industry or traffic; however there is little likelihood of this contamination in remote regions. The greatest potential water quality risk in remote communities is microbiological contamination. Microbiological contamination may come from the faeces of small animals such as birds, mammals, reptiles and amphibians that have access to roof surfaces or tanks. The remote environment may also provide opportunities for faeces to be carried onto the roof if attached to dust particles. Water quality testing of rainwater in selected communities in the Anangu Pitjantjatjara Lands in 2000 found a prevalence of indicator organisms in many rainwater tanks (Plazinska 2003). The results appear typical for rainwater contaminated by debris and faecal matter from the roof. In general though reports of illness associated with rainwater tanks are relatively infrequent, despite the prevalence of indicator organisms (Australian Government 2004: 11).

Aside from contamination, rainwater tanks that do not have adequate mosquito protection present a health risk because the water provides a suitable habitat for mosquito breeding. Certain types of mosquito can be vectors of arboviruses, including dengue virus (Australian Government 2004: 13), Ross River Virus and Barmah Forest virus (Doggett and Russell 1997). The NT and QLD have regulations to prevent mosquito breeding in rainwater tanks (NT 1998; QLD 1996). It is possible to treat water if mosquitoes are present but the best approach is to prevent mosquitoes entering the tank (see section 4).

TIPS

- The health risks associated with rainwater tanks can be kept to a minimum by ensuring effective planning, having a good technically designed system and including regular maintenance routines.

3 CONTEXT: REMOTE COMMUNITIES

Most off the shelf technologies are less suited to remote areas. Conventional technology design is embedded with assumptions that are not applicable to remote communities. For example, parts and accessories may be difficult to replace or arid climatic conditions (including dust and heat) may reduce the life span of the technology. Most importantly, people living in remote areas tend to move around and most technology designs assume people will be permanent residents and therefore routine maintenance can be performed as required.

This section explains special considerations and lessons learnt through CAT's research activities on rainwater harvesting from 2001-2005. Two projects, at Mutitjulu and Mabunji, had the initial focus on specific technologies and identifying modifications to improve harvesting efficiency and water quality. These projects integrated water maintenance programs at a household level and community or regional agencies level.

3.1 Environmental conditions and security of supply

Across Australia there is high variation in the rainfall patterns. Overall, rainfall is low, evapotranspiration and rainfall variability is high (Smith 1998). Effective rainwater harvesting depends on the optimum match between:

- Rainfall data
- Roof area
- Water storage capacity
- Daily consumption rate.

There are guides available to calculate potential yields for particular roof areas and rainfall (see Australian Government 2004).

Many remote regions do not have a comprehensive historical record of rainfall data. In such cases a regional average, provided by the Bureau of Meteorology, will suffice.

The volume of water required each day is usually a calculation that is based on the number of people in the household. Remote communities or outstations usually have a highly variable house occupancy rate. It is recommended that when calculating the daily consumption rate for remote communities, an overall household daily requirement that takes into account extra water use needs such as cooking is recommended.

TIPS

- Check the internet for rainwater harvesting potential software programs.
- Use an average household L/day figure to calculate daily water requirements for a variable populations.

The map in Figure 1 indicates areas of rainfall variability across Australia. For example Darwin's rainfall is reasonably reliable, the lowest ever annual rainfall is 1024.7 mm and the highest is 2776.6 mm, with an average of 1705.7 mm. This means that every year a reasonable amount of rainfall is guaranteed. This is represented as a blue shaded area and classified in the lowest five percent for unreliability. Alternatively, Alice Springs' rainfall is highly variable, since the lowest ever annual rainfall is 53.8 mm and the highest is 902.9 mm, hence there can be years with nearly no rainfall and years with flooding.

Figure 1: Rainfall variability map of Australia (Bureau of Meteorology).

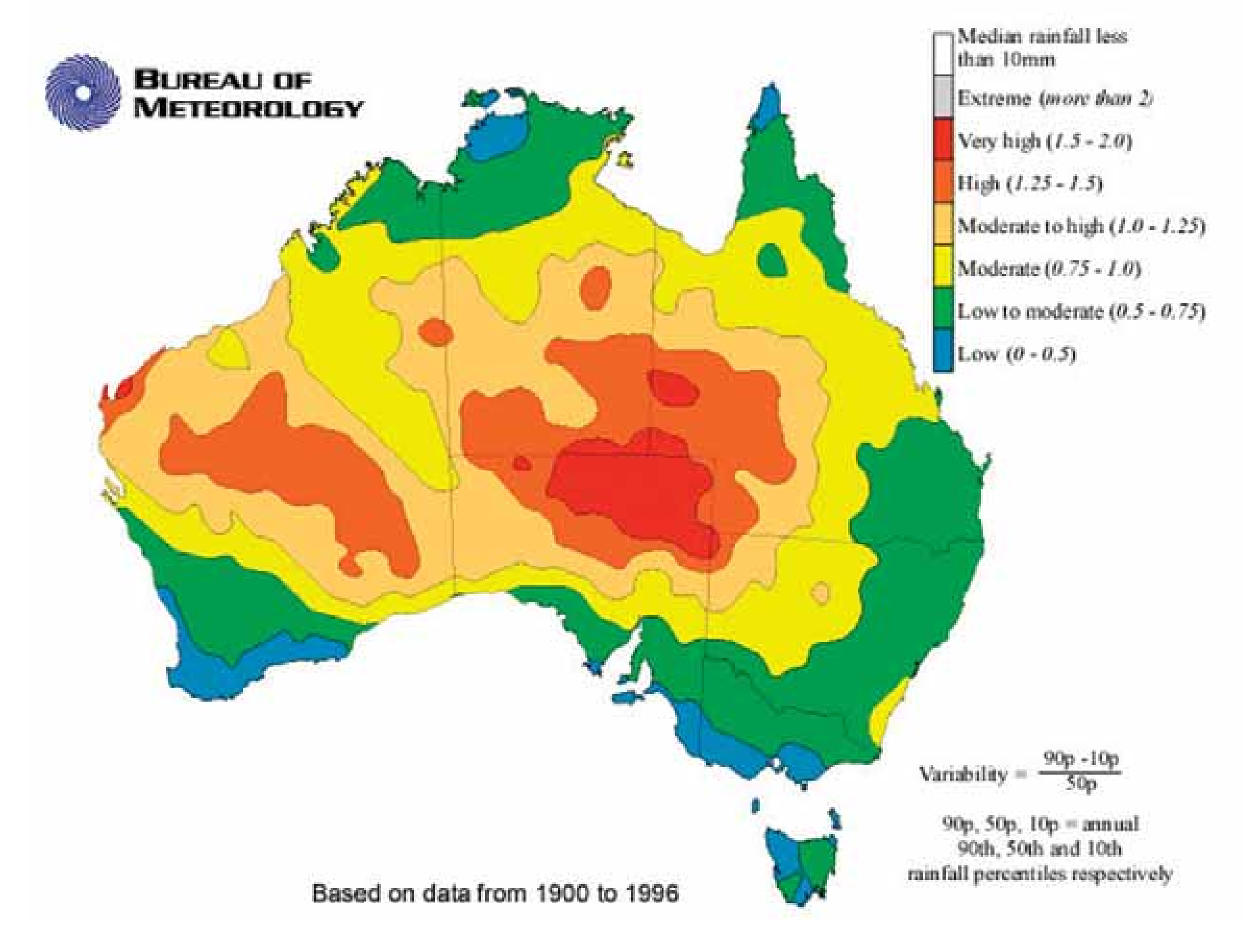
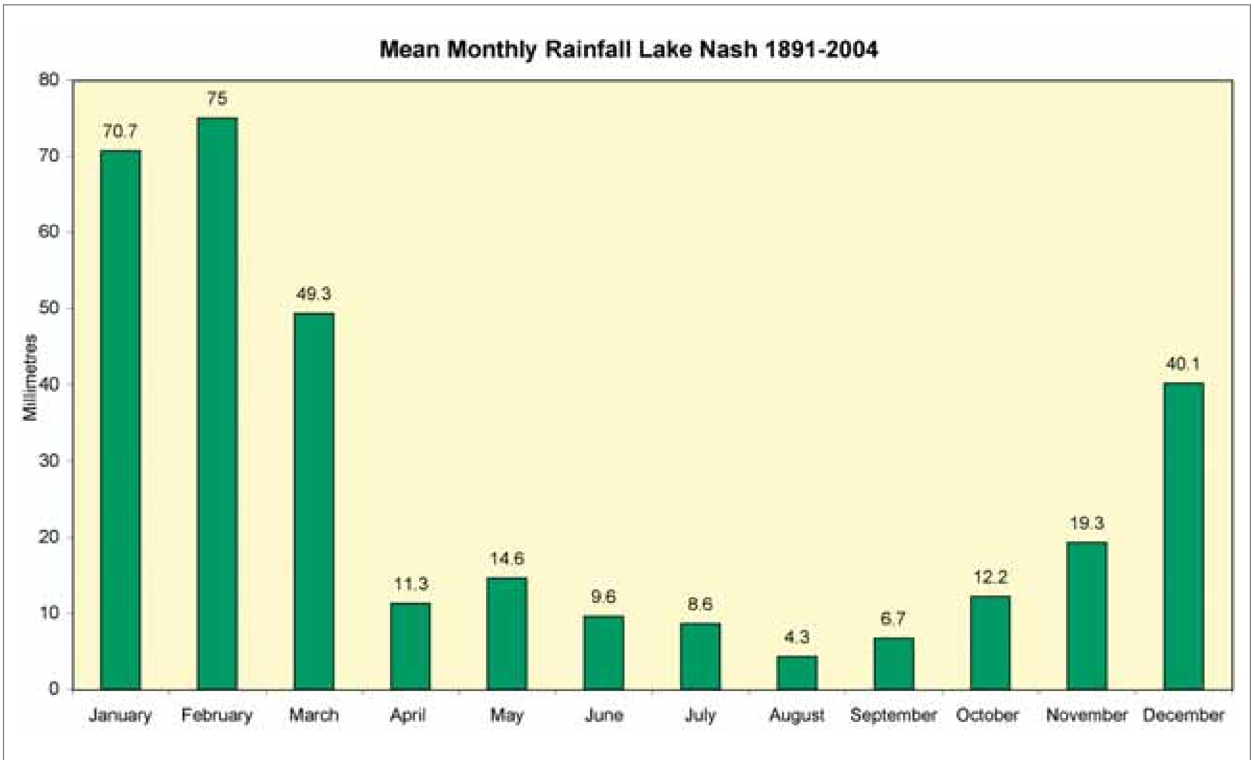


Figure 2: Mean monthly rainfall at Lake Nash (NT) (Bureau of Meteorology).



The water storage capacity of most systems is based on rainfall at a location. In arid environments the median rainfall calculation should be used. In temperate environments, the mean (average) rainfall calculation is the preferred calculation. It is important to manage consumption levels when rainfall is low, particular in arid zones. Computer based models are available to determine the 90% and 99% security of supply (Australian Government 2004). A larger storage tank would be more beneficial for maximum water storage.

The management of rainwater tanks needs to suit local weather patterns such as high variations in rainfall or large periods without rainfall. Figure 2 shows the mean monthly rainfall for Lake Nash. For six months of the year there is little rainfall, however the wet season reliably brings rain. For optimum turnover of stored rainwater a management strategy would use the rainwater so that the tanks are nearly empty by late October – ready to be filled with water in the following wet season.

Understanding the intensity of rainfall is critical for designing infrastructure to match the potential volume of rain (see section 3.2.1). The intensity of rainfall refers to the volume of water that falls within 24 hours. The infrastructure will need to be sized adequately.

TIPS

- Size tanks based on average or median rainfall.
- Mean (average) rainfall is more appropriate figure to use when determining rainwater for temperate climates.
- Median rainfall is more appropriate figure to use when determining catchments for arid climates.
- Size gutters and pipes on maximum rainfall events.

3.2 Infrastructure choices

Limited maintenance regimes, environmental and social conditions mean that robustness is fundamental if infrastructure in remote communities is to be sustainable. Choices about infrastructure need to be made balancing different and competing needs.

3.2.1 Roof catchment

Most rainwater harvesting utilises the roof as the catchment. A comprehensive listing of preventive measures to reduce the contamination from the catchment can be found in the '*Guidance for use of rainwater tanks*' by the Australian Government (2004).

Solar hot water systems can interfere with the roof catchment. It is important to avoid any guttering directly beneath the hot water system. Solar hot water systems contain heat transfer fluid. Fluids used currently have food grade constituents (Solahart 2005). Solar hot water systems in remote areas are usually connected to bore water. Concentrated scale (calcium) can build up and get flushed into the rainwater tank (see Figure 3). Before any maintenance work is carried out, the gutters should be sealed to protect the rainwater tank from any debris /material or fluids in the solar system.

Figure 3: A maintenance worker cleans scale from a solar hot water system. Gutters should be blocked so that the scale does not flush into the rainwater tank.

3.2.2 Rainheads

A rainhead sits under the gutter and diverts the leaves and rubbish away from the downpipe (see Figure 4). Two or three different diameter meshes in the rainhead act as a sieve to catch the leaves and allow the water to flow into the downpipe. Some rainheads on the market have mosquito proof mesh which act to keep mosquitoes from entering the tank. Rainheads require regular cleaning. A rainhead has a series of mesh that is layered in reduced diameter. The finest mesh, in particular can become blocked and impervious to water. Rainheads used in CAT trials show limited effectiveness in remote communities because the construction is not robust, the mesh became blocked and regular cleaning was a burden on the community.

Figure 4: Leafbeater rainhead that fits beneath the gutter to strain water before it goes down the downpipe. This design was trialled at Mutitjulu community.

3.2.3 Pipes

The selection of the size and material of pipes should be made after taking into consideration local conditions. The size of pipes should be determined using seasonal rainfall data. In most arid regions, torrential rain occurs seasonally where a large volume of water may fall in a matter of minutes. To capture this water wide gutters (i.e. >150 mm wide) and wide downpipes (i.e. >100 mm) are required, with a large storage capacity (i.e. more than 10,000 L). Polyethylene parts and tanks are popular because they are quite light and easy to handle and transport but can split and break easily compared with metal downpipes. CAT trials have found that polyethylene pipes are not robust if situated in an exposed position, such as doorways. Underground piping may be required if the rainwater tanks are situated more than a couple of metres from the house or structure. The pipes should have an end cap to release any sediment that could accumulate in the pipes. Screens placed within the tank inlet pipes and the pipes that connect tanks help stop debris passing through the system. Screens in the pipes also stop mosquitoes getting through the system. Should a breakage occur, adding screens creates a sectioning approach which helps to separate the rainwater harvesting system.

3.2.4 First flush devices

First Flush devices or diverters (see Figure 5) can be an effective measure to reduce the amount of leaf litter, dust and other debris entering the rainwater tank. The first flush of water in a rain event washes the roof and hence may contain high amounts of accumulated dust, bird and animal droppings, leaves and other debris – especially if it has been a long time since the last significant rain event. Recent reports by Gardner *et al*. (2004) showed that diversion of the first flush will reduce the load of bacteria entering the tank forming an effective barrier but further investigation is needed to determine how effective first flush diverters are in reducing microbial contamination.

From our experience, first flush devices have been used ineffectively in remote communities. The cheapest and simplest first flush device, for example is a length of PVC pipe prior to the tank inlet with an 'end cap' securing the end of the pipe. To work effectively, the end cap needs to be unscrewed after every rain to release the dirty water. This system requires people around all the time, or at least after rainfall which is not possible in many communities. Hence the system is inefficient because if the dirty water is not released, during the next rainfall the first flush water off the roof will be directed into the storage tank. In addition, the pipe can easily split or snap off. In such cases, good rainwater is leaked out of the PVC pipe.

Figure 5: A first flush device.

An alternative to the PVC pipe with an end cap is a self-draining first flush device. These systems require less maintenance, but the benefits need to be weighed up with the costs. In desert regions, dust forms a large portion of the first flush and the drain pipe can block easily, which in effect only increases maintenance load since it will require unblocking and cleaning out. Gardner and colleagues (2004) found that a self-draining first flush device on a demonstration house lost 29% of the water.

A first flush device should be sized to capture enough water from the roof to be effective. Many first flush designs divert the first 25-100 litres of rainwater. Wade (1999) recommends that 2 mm of water is required to cover the entire roof area to properly flush all debris off the roof. Housing in arid and temperate regions tends to have large roof areas because of verandahs (often in excess of 250 m^2). A first flush device that captures 100 L of water would not be enough to 'flush' the roof properly, unless there are multiple devices attached to each separate downpipe.

3.2.5 Settling tank

In response to the difficulties encountered on communities with rainheads and first flush devices, CAT trialled a 545 L settling tank in two remote community projects. The settling tank acts as a large first flush device. The water from the roof is directed into the tank. Inside the tanks are two screens that are made from 50 µm filtering material (see Figure 6). The water is filtered as it moves through the settling tank into the storage tank. The screens sit neatly between the corrugations in the tank. The screens can be removed to clean or flushed with water from a garden hose through the top of the tank.

Figure 6: Filter screen placed in settling tank.

The settling tank design is robust, accurately sized to wash first flush from entire roof area (roof area in the trial sites was 250 m^2) and stores enough water to be diverted for other useful purposes, such as the garden.

Figure 7: Technical drawing of the settling tank and storage tank design.

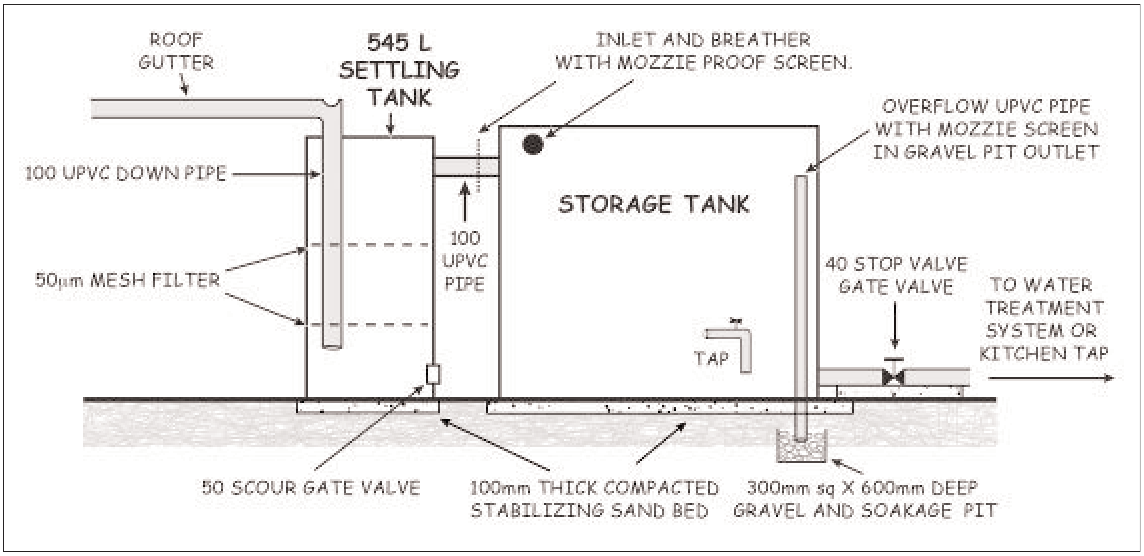


Figure 7 shows the design of the rainwater tank infrastructure. The design includes barriers for vermin, debris and dirt, stainless steel screens over the air vents and a screen to keep leaves from entering the down pipe to the tank. The standard model for a 545 L tank is open at the top with a large mesh basket attached. This basket should be sealed with an impermeable cover such as acrylic.

This screen filters (see Figure 7) inside the settling tanks reduces the amount of debris and dust from entering the storage tank and hence, improve the water quality. Microbiological monitoring was conducted on the rainwater before and after the settling tank screens in a controlled environment. The results showed a 90% reduction of *E. coli* from the water in the settling tank compared to the water after the screen. Additionally, turbidity tests were conducted to measure any reduction in turbidity between the settling tanks and the storage tank. The results showed a reduction by 70% of the filtered water (see Grey-Gardner 2003). Further improvements to the screen filters, such as effective means to securing them, would reduce the transfer of particles from the settling tank to the storage tank. At present some water can slip through between the edges of the screen.

3.2.6 Tanks

There are a variety of rainwater tanks available commercially. Most communities have installed polyethylene tanks because they are easy to transport, reasonably priced and have a 25 year life expectancy with a significant warranty period of up to 20 years. Polyethylene tanks are also easily repaired if damaged by patching the hole or sticking a hot iron on it. Stainless steel gutters and fittings have been used successfully in the Mabunji project with a polyethylene tank. These fittings are robust and non corrosive, although expensive.

Steel tanks are also commercially available, although galvanised steel is not inherently resistant to corrosion which can be a particular problem in acidic conditions. It is essential that metal components (e.g. fittings and gutters) of steel tanks are compatible, as this can contribute to corrosion. In particular, zinc alum roofing used together with galvanised gutters and tanks can lead to rapid corrosion of the galvanised parts (Duncan and Wright 1991). Additionally, copper or copper alloy fittings (brass or bronze) should not be connected directly to steel tanks. New tanks (Texas Water Development Board 1997) may leach excess concentrations of zinc, which could affect the taste of stored rainwater. Studies in Auckland by Simmons *et al*. (2000) reported that roof-collected rainwater supply has a relatively poor physicochemical quality. They attribute this mainly to corrosion of galvanised iron, lead and lead-based paints on the catchment surface. The priority for tanks installation is the exclusion of all unauthorised entry by children or vandals. The system should have as many screens as possible to stop contamination.

TIPS

- First flush devices that require manual release of dirty water after each rain suit locations that have a permanent population.
- First flush devices that have a hole to drain captured water often become blocked (with dust) and may not be a reliable method to drain water.
- Tanks and first flush devices that are not emptied may store water which can become stagnant Match the size of the first flush device to wash the entire roof area.
- Tanks should not have any unauthorised entry points

4 SAFETY OF DRINKING WATER

Planning and good management are critical to ensure that a rainwater harvesting system stores adequate supplies of good quality drinking water. It is important to keep the turnover of water high. Flush out old water in times of high rainfall to keep the water fresh.

4.1 Water filters

Water filters should not be necessary as a method of maintaining microbial, chemical or physical quality of rainwater (Australian Government 2004). As a priority barriers and remedial action should be the fundamental part of the rainwater harvesting system. CAT has not found a commercial water filter that can work using gravity feed. Sand filtration is one form of water filtration that does not require a pump. Although, sand filtration units can only filter small amounts of water, such as 25 L per day (Oakley 2003). Remote areas do not usually have a chemical contamination source. The water treatment options appropriate for microbiological contamination are outlined.

4.1.1 Ultra Violet (UV) irradiation

This involves using a UV light to kill bacteria. It is a very effective water treatment but it does not kill bacteria effectively on water that is not clear because it is difficult for the light to penetrate. It requires a reliable power supply and the UV lamp should be changed regularly (every 6 months). For the optimum results it should be used either at the point of use (i.e. under the tap) or used in combination with chlorination (CRCWQT 2004). UV systems have the effect of warming the water during treatment. Some people prefer not to drink warm water.

4.1.2 Ceramic filters

Ceramic filters are made of various clays including porcelain (see Figure 8). Water is filtered as it flows through the ceramic medium of very small pores size and removes microbacterial contaminants. These filters are very efficient in removing fine particles but it is not recommended for turbid water as clogging can occur easily. CAT has trialled small ceramic filters in remote communities because they are a simple and effective technology. Rainwater in general has low suspended solids and turbidity so the filters do not become easily blocked. The filters are available in cartridges which are easy to replace. Ceramic filters can be cleaned using a soft brush or a scourer pad. Most importantly the ceramic filters cannot deliver untreated water to the tap, if the used filters are not replaced or cleaned (see Figure 9). The filters can dry out without compromising the filter's integrity.

Figure 8: The ceramic filters are in a cartridge form. Cartridges should be replaced once a year and are easily cleaned using a scourer pad.

4.1.3 Activated carbon

Is the most widely used adsorbent material in water treatment, because it is highly effective in removing taste, odour compounds, giardia and cryptosporidium bacteria (depending on pore size). It can be used as a powder or in granular form. The activated carbon is usually placed in a column or filter and the water percolated through the bed of carbon granules. After some time the activated carbon will become saturated with the adsorbing material and will need to be replaced (CRCWQT 2002).

Figure 9: The pump and water treatment system installed in the case study trials. The filters are encased in the white cartridge holders.

TIPS

- A treatment system for a rainwater supply should not be necessary on a household supply if a regular roof and tank maintenance regime is carried out.
- Ensure the maintenance requirements are achievable and that replacement parts are easy to obtain and fit.

4.2 Water treatment

Refer to the '*Guidance for use of rainwater tanks*' by the Australian Government (2004) for procedures and dosages for water treatment.

4.2.1 Chlorination

Chlorination is the cheapest, method to disinfect water and is effective at low dose levels against bacteria, many viruses and giardia (CRCWQT 2002). It may be added to a rainwater tank as a powder or liquid. The effectiveness of chlorine in a rainwater tank is short-lived and it will only act on water in the tank at the time of dosing (Australian Government 2004). Chlorination of rainwater held in tanks is generally only recommended as remedial action (i.e. if there is known contamination).

4.2.2 Mosquito treatment

Prevention is the recommended method to control mosquitoes breeding in rainwater tanks. The World Health Organisation (2003) recommends all tanks have screens or other devices such as rainheads to prevent adult mosquitoes entering the tank and breeding. If there are 'wrigglers' or nymphs in the tanks there is no prescribed method of treatment, but adding chemicals (kerosene or liquid paraffin) to the water will kill them. Kerosene when added to surface will not mix through the tank. Additionally, prolonged use of kerosene can corrode tanks coated with Aquaplate or tanks constructed or lined with plastic. Paraffin can be used in all types of tanks, but coagulation can occur over time and deposits form on the sides of tanks (Australian Government 2004: 31).

5 MANAGEMENT

Operational maintenance will determine the success of a rainwater harvesting system, even with the best design. Devolution of management responsibilities needs to vary in scale and type. Management responsibilities for everyday checking of infrastructure can be local whilst the housing responsibilities in remote communities usually come under a regional authority, i.e. a resource agency. It is important to separate the different responsibilities to suit the local circumstance and capabilities in the community. For example, each community should have a maintenance plan that is tailored to accommodate the fluctuations caused by the different conditions, climates and lifestyle or plans of the residents. Either way, maintenance is a continuum and management responses need to be adaptive. CAT recommends that in addition to appropriate and low maintenance designs, the project delivery and community participation are crucial to the longevity of the infrastructure and the acceptance of the maintenance responsibilities. Early in a project it is important to identify factors relating to service delivery and household lifestyle that may inhibit the project. Timing is crucial – the water supply system should be operational as soon as possible after installation to harness the community involved.

5.1 Household systems

Rainwater tanks that are located on a house can most effectively be maintained by the residents. Any management regime requires an understanding of the system, maintenance routine and potential hazards. Education and training must be appropriate and aimed at the literacy and numeracy level of the household owners. CAT has produced a booklet to help with training Indigenous people about maintenance responsibilities. The booklet titled 'How to look after your rainwater' is in a predominantly pictorial format and describes the maintenance procedures required for a rainwater harvesting system, with a ceramic treatment system (CAT 2005). Communities where there are high levels of mobility are less suited to household level management programs. In these cases, it may be better to have a maintenance program that is run by a resource agency or regional approach if the harvesting system requires attention when the householders are away. An example would be a first flush device that requires emptying or a check to make sure the system remains mosquito-proof. Most importantly, there needs to be an effective management plan in place.

5.2 Community systems

Rainwater tanks located on a community building that will supply water for community use, such as in council office or a school are a 'community water supply'. Health authorities are generally not prepared to endorse the use of untreated rainwater for public consumption because of the potential contamination and a lack proven data (Leder 2002). In Australia, drinking water that is not supplied by a utility and is not a private water supply (i.e. a tank on a house) is under the Food Act. Therefore the health authorities in your State or Territory can inform you of the obligations under food legislation. Operators of community-based supplies need water management plans to assure high water quality will be maintained. Regular water quality monitoring may also be necessary.

6 COST

The cost of providing infrastructure in remote areas is significantly higher than in urban areas. The costs to deliver a rainwater harvesting system can vary significantly depending on the market and other factors such as trading arrangements and labour availability. A general guide however of the capital cost of installing a rainwater harvesting system in a remote community is 85c per litre (CAT 2004; Grey-Gardner 2003). The figure includes the cost of all required infrastructure additional to the tank; such as gutters, downpipes, pumps, freight and installation of rainwater tanks to remote areas. This is a general guide and should be accurate to within 10% for installation of rainwater tanks up to 15,000 L capacity. A rainwater harvesting system that is designed as an integrated component of a new construction project is generally more cost effective than retrofitting a system onto an existing building (Texas Water Development Board 1997: 33). Retrofitting may have particular expensive specifications such as re-concreting floors.

7 CONCLUSION AND RECOMMENDATIONS

Achieving safe and secure drinking water supplies in remote communities involves a mix of policy and technical investment. Of which, rainwater harvesting techniques should be considered as a simple system that can be maintained by community members. Our work has shown that rainwater harvesting when properly managed can be an effective and sustainable supply of drinking water in remote areas (including arid regions). Recent designs of appropriate and robust infrastructure have helped to secure more continuous and safe water supply. In line with this, capacity building programs for households have led to increase in the support for rainwater tanks as a water supply in remote communities. But all of the above should be integrated with community participation models. Lastly, the recommendations below provide some thoughts when planning rainwater harvesting projects with the community you are working with.

Recommendations

A rainwater harvesting system should only be installed once it is clear that the maintenance requirements will be carried out effectively.

System design

- Refer to the Australian Government's '*Guidance on use of rainwater tanks*' for any aspects that are not covered in this document.
- Include as many barriers as practicable in the system design such as a first flush system, additional filters and screens at strategic locations in the system.
- Ensure that a competent person performs the sizing calculations for the tank and infrastructure and that an independent check is carried out.

Maintenance

- Ensure people are reminded of their maintenance responsibilities.
- Resources such as posters outlining the responsibilities required when, how and by who are an effective management tool.

Water treatment

- Water filters may be necessary if the rainwater harvesting system is part of a community water supply.
- Seek specialist and independent advice before choosing the technology.
- The selection will depend on the energy requirements for running the system, access to backup service, replacement parts and the maintenance requirements.

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