Roofwater harvesting in Africa

Terry Thomas

In few areas of Africa is roofwater harvesting likely to be sufficient for all domestic needs, at a reasonable cost. But despite this and other factors that have so far prevented the widespread dissemination of this technology, roofwater harvesting is gradually being recognized as a partial solution to the need for clean water, close to the home.

Domestic roofwater harvesting (DRWH) is dependent upon rain. The water volume (litres) that can be practically collected in a year is the product of roof area in m^2, the annual rainfall in mm and a capture coefficient of around 0.65. (The capture coefficient might be increased by 20 per cent for a very expensive DRWH system or reduced by 20 per cent for a very cheap one.) Typical African domestic roofs are around 7 m^2 per inhabitant; institutional roofs might add only a further potential 0.5 m^2 per person. We can combine this information with rainfall data to predict a yield per person for different climatic regions (see Table 1).

Table 1 establishes that there are few parts of Africa where DRWH alone could meet the 20 lcd (litre/capita/day) WHO 'standard' throughout the year, yet almost everywhere potable water needs could be met in the wet season. African water consumption is low and in most rural areas, 14 lcd of clean water would constitute a satisfactory supply. This could be achieved via DRWH for most of each year for one-third of the households in the continent, excluding Egypt (which has a significant fraction of Africa's population and yet almost no rain). This calculation is based on the figures from the 'Max daily yield wet season(s) only' column in Table 1, an estimation of population inhabiting different rainfall zones and the assumption that two-thirds of households in areas with over 1000 mm of rainfall have at least 5 m^2 of hard roofing per inhabitant.

So there is potential, particularly as DRWH has the rare property of 'delivery to the doorstep' in a continent where carrying water is a major burden. With good practices, DRWH can deliver safe water and therefore counts as a premium source – clean, convenient and often cheap. DRWH has a particular attraction where the distance to point sources such as wells is high due to hilly terrain or where local groundwater is over-mineralized.

Table 1 Per capita yields from roofwater harvesting in various climatic regions

Climate	*Examples*	*Annual rainfall (mm)*	*'Wet' months per year*[1]	*Max. daily yield over 12 months* (lcd)[2]	*Max. daily yield wet season(s) only* (lcd)
Arid	Khartoum, Gaberone	200	2	2.5	15
Semi-arid	Bulawayo, Bamako	400	4	5	15
Mediterranean	Cape Town, Rabat	600	6	7.5	15
Humid coastal	Luanda, Beira	1000	6	12.5	25
Equatorial (2 wet seasons)	Kampala, Zanzibar	1500	9	18.5	25
High rainfall	Freetown, Douala	>2500	7	>31	>53

1. Generally reduces to a single, short, summertime wet season if over 10° from Equator
2. litre/capita/day

Yet other than the 'informal' collection of runoff in household utensils, DRWH is still uncommon in Africa, despite a decade of local attempts to promote it.

The explanation might lie in roofing. In a few areas there is still a predominance of round houses or grass roofs, both unsuitable for DRWH. However 'hard' roofing, especially corrugated iron, has become the norm both in high rainfall areas and in larger settlements. As grass roofing often correlates with relative poverty, even a low fraction of thatched housing creates problems for DRWH with aid agencies eager to focus resources upon the poorest families. Looking ahead we can confidently expect a further growth in the hard-roofed fraction (e.g. >60 per cent in Uganda rising at 2 per cent per year), which favours DRWH, but also a trend (e.g. in Nigeria) towards two-storey housing, whose smaller roof area per inhabitant disfavours it.

Constraints

Besides the obvious factors like rainfall adequacy and roofing suitability, many more subtle factors are at play. These include excessive cost, novelty, a tradition of communal water sources,

Informal rural domestic rainwater harvesting

This roofwater harvesting system in Ethiopia is of too high a quality for the house it serves

poor reputation and uncertainty about performance.

Excessive cost is widespread. Inexperience, and a reluctance to use commercial suppliers, place African DRWH costs well above those in other continents; rarely can one find crude investment–payback times of under 12 months. DRWH has often been used for purposes like women's mobilization and has been loaded with extra costs in consequence. Many demonstration systems have been designed using DRWH as a *sole* water source – a role it can sometimes perform, but only at very high cost. (Multi-sourcing is almost always the norm in rural Africa but it does not appeal to water professionals.) DRWH technology is rarely researched or refined before adoption for specific programmes and over-costly designs are commonly used. The standard of durability or finish demanded of DRWH systems is often much higher than those of the houses they serve.

Novelty is a factor that raises costs, lowers performance and puts off potential users. Africa seems more risk averse than Asia and therefore more wary of novelty, so the time needed to normalize a new technology – e.g. to develop competitive supply chains for components – seems long. Certain forms of institutional and middle-class urban roofwater harvesting do go back 50 years, but usually the traditions of use were broken by the arrival of piped water at precisely those buildings. Aid funding, so important for African water infrastructure, has been available for demonstration and subsidy but rarely for supply-chain development.

Communal sources, not usually commercially owned or managed, form the backbone of rural water supply. Provided walking time and management difficulties are discounted, such sources as shallow wells are cheaper than universal DRWH. Moreover both government and NGOs disapprove of installing subsidized infrastructure on private property, as DRWH may require. This objection is however weakening as more weight comes to be given to water-supply convenience and as the need grows to persuade beneficiaries to contribute more of the cost of their water infrastructure.

Poor reputation is not a major issue except in areas where DRWH has been promoted for use by schools and has failed. The failures, and they are widespread, have been mainly due either to failure to define ownership or to poor installation issues peculiar to institutional applications. However, such systems bring all forms of DRWH into disrepute.

Uncertainty about performance applies both to water quantity and quality. RW stores usually run dry in their first year of use because it takes householders time to learn their proper management. Severe drought also leads to water exhaustion. RWH is not normally operated as a 'source of last resort'. In the case of quality, the uncertainty arises mainly from user inability actually to monitor water quality but also because bad design and sloppy maintenance *can* introduce a risk of excessive pathogens (and an FC count that occasionally exceeds 100).

Steady progress

So far it has been argued that DRWH has a substantial potential niche in African water supply, but has not yet occupied it. Things are, however, changing. There is a steady growth in the number of national RWH associations, up threefold from a decade ago. DRWH has received explicit mention in water policies and there have been some national DRWH strategy studies by governments (e.g. Uganda in 2004, which is now also officially 'piloting' DRWH in several water-stressed counties). As well as some continuation of local DRWH programmes, general WATSAN agencies are beginning to consider the technique as a normal one. A few water professionals have come to realize there is a DRWH 'ladder' of options – from enhancement of existing

Low-cost 'Thai jars' are trialled in Uganda. These have been manufactured in a workshop then transported to the household informal DRWH to the installation of 'sole-source' systems in those contexts where rival technologies are expensive or of low performance. As DRWH is a household-scale option, they see it can be targeted at particular categories of homestead, for example those with disabilities or those (often over 50 per cent) located more than 500m from existing protected sources. Indeed it is the growing acceptance of the need for a higher access standard (when defining rural water coverage) that most favours DRWH expansion.

A commercial DRWH industry is slowly developing in several countries, different sorts of producer supplying the low-income rural market (e.g. with gutters or small cisterns) and the high-income peri-urban market (with plastic and concrete tanks, filters, pumps and systems that can be converted to mains supply when piped water finally reaches new suburbs).

What is still conspicuously lacking is any sort of national demonstration/testing station where variants of DRWH might be assessed, refined, displayed and training offered. Such stations are not essential, but they would certainly accelerate the DRWH learning process and help hasten reduction in the cost of reliable systems.

We should expect DRWH to take off first not in locations of greatest water stress (where RWH is also an expensive technique because in such places it requires large cisterns), but where it is cheapest and easiest to use. Thus the equatorial band (with its 'double rains'), islands and mountainous areas are where we may first expect a substantial growth in the use of 'aerial' water. However acceptance of the propriety of differentiating between households on the basis of their individual water needs is expected to open the door to the use of DRWH for those with greatest need in tandem with traditional point-source supplies. This will likely be matched by a steady growth of low-cost medium-performance self-supply forms of DRWH.

About the author

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resources **guide**

Rainwater harvesting

This list of resources on rainwater harvesting provides a good foundation for readers who are interested to learn more on the topic.

Books

- Gould, John and Erik Nissen-Petersen (1999) *Rainwater Catchment Systems for Domestic Supply: design, construction and implementation*, ITDGP, Rugby, UK.
Covers all aspects of design and construction, including training, operation and maintenance. Also includes case studies from around the world that will help anyone intending to design and construct a rainwater catchment system.

- Pacey, Arnold and Adrian Cullis (1986) *Rainwater Harvesting: the collection of rainfall and runoff in rural areas,* ITDGP, Rugby, UK.
Emphasizes the importance of social, economic and environmental considerations when planning and implementing projects.

- Watt, S.B. (1978) *Ferrocement Water Tanks and their Construction,* ITDGP, Rugby, UK.
Describes how cylindrical water storage tanks of up to 150 cubic metre capacity can be built using wire-reinforced cement mortar.

Organizations

- International Rainwater Catchment Systems Association
www.ircsa.org
Set up to promote rainwater harvesting technology, this website provides news of training events and the biannual conference; also factsheets on the technology.

- Domestic Roofwater Harvesting Research Programme
www.eng.warwick.ac.uk/dtu/rwh/index.html
This is an excellent site with numerous useful links, covering most technical aspects of roofwater harvesting with an emphasis towards tropical areas and developing countries. It has a very useful online calculator for assisting with determining the appropriate size and predicting the performance of roofwater systems.

- Rainwater Harvesting Toolkit http://www.rainwater-toolkit.net/index.php
This is a very user-friendly site covering technical aspects of rainwater harvesting, case studies, socio-ecomomic, health and water quality aspects focused towards rural communities in developing countries.

- Lanka Rainwater Harvesting Forum
www.rainwaterharvesting.com
This site covers issues relating to rainwater harvesting traditions and practices in Sri Lanka

- SEARNET www.searnet.org
This gives information about SEARNET and its national affiliates who are working to promote rainwater harvesting in Africa and South Asia and offers information on rainwater harvesting as a viable water source for irrigation and domestic needs.

- The International Rainwater Harvesting Alliance
http://www.irha-h2o.org/
The official website of the IRHA which was created during the World Summit for Sustainable Development as a response to the ever-increasing water management crisis.

- www.lboro.ac.uk/orgs/well/resources/technical-briefs/technical-briefs.htm
Originally published individually in *Waterlines*, these highly illustrated technical briefs bring together a body of information and guidance that has already proved of great practical help to agencies and fieldworkers.

- Solar Water Disinfection Process (SODIS)
www.sodis.ch
This site explains the Solar Water Disinfection (SODIS) process is a simple, cheap and practical way to treat rainwater by removing harmful pathogens and is showing great potential to improve the health of those still without access to safe drinking water.

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