# Where is roofwater harvesting going?

Terry Thomas

**Roofwater harvesting can be a clean and convenient method of obtaining water. Terry Thomas considers the many advantages and disadvantages of its use, as well as its future prospects.**

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**Exhaustion of surface supplies and the falling levels of aquifers have motivated the large scale revival of DRWH in Northern China and elsewhere.**

Rainwater harvesting may be defined as the interception of precipitation before it has sunk into the ground and its human use close to where it falls. As one of the most basic water techniques, it has been employed by humans for agriculture and for domestic water supply for millennia. A sub-set of rainwater harvesting, and the subject of this article, is domestic rainwater harvesting (DRWH), which is usually manifest as roof runoff harvesting because ground runoff is too dirty for safe human consumption. DRWH is practised in a wide variety of ways: there are '$5 systems' and '$2000 systems' in current use. Other articles in this edition of *Waterlines* describe some of the substantial new activity in this field, which in the last decade has swung from decline to expansion. New national rainwater associations are regularly being formed (e.g. Germany 1996, Uganda 1998) and existing ones are attracting large audiences to their meetings (e.g. 600 delegates registered for a recent Mexican annual national rainwater harvesting conference).

Our purpose here, guided by the findings of a 'Rainwater Harvesting Research Group' with Indian, Sri Lankan, German and British members, is to identify the underlying advantages and disadvantages of DRWH and hence to forecast where the technique is likely to move in the coming decade.

## Past use

Rainwater collection in tanks and jars has a very long history. Whole civilisations in semi-arid areas have depended upon it for up to 3000 years, while there are a few areas of the humid tropics today where almost every household owns water-collection jars. Small islands without much groundwater (e.g. Bermuda) use rainwater extensively, as do a significant fraction of Australian farmhouses. Exhaustion of surface supplies and the falling levels of aquifers have motivated the large scale revival of DRWH in Northern China and elsewhere. Many institutional rainwater tanks have been installed in Africa in the last decade, reviving a tradition from earlier in this century. In Europe and Japan where RWH had fallen out of use, there has been a considerable revival in the last decade driven by environmental concerns.

## DRWH advantages

Rainwater collected at the home is intrinsically more convenient than water carried to the homestead from a point source some distance away. ('Convenience' features higher in the priorities of householders than in those of water supply planners, and it is well documented that arduous collection conditions drastically limit water consumption.) Moreover the biological and mineral quality of collected rainwater is generally higher than that of alternative water sources. Rainwater is also particularly suitable for laundry use on account of its softness — DRWH systems solely for laundry were formerly common in hard-water areas of countries like England. DRWH is often the only practical option for a household wanting to better its water supply above the level prevailing in its community. It offers householders independence from the control of outside bodies — an attractive attribute in an era when piped systems are increasingly being converted to private monopolies. DRWH makes few demands upon public funds or foreign capital; moreover its development is likely to have little impact upon other water sources and can be thus regarded as an 'extra' resource. Indeed its contribution in damping storm roof runoff to drains can be substantial and this can even benefit other water supplies.

## Disadvantages

Against these advantages we must set DRWH's several disadvantages. It is generally more costly than large-scale water technologies. It is especially so if used as the sole water supply in a climate with a long dry season. It is therefore more available to the richer members of any poor community and its use by them may divert funds or leadership away from more shared water sources. It also usually requires an adequate area of 'hard' roofing that discriminates against those who can only afford grass roofing.

By developing country (LDC) norms the quality of harvested roofwater is not low, but it is uncertain and rarely subject to professional scrutiny. Few water professionals are sufficiently proficient in DRWH to be able to offer realistic guidance with respect to quality issues. There is one type of tropical ill health that poorly executed DRWH may even exacerbate, namely the acquisition of disease from insect vectors breeding in rainwater tanks. In Northern countries, roofwater quality is usually regarded as falling seriously short of drinking water standards and therefore only used for secondary activities.

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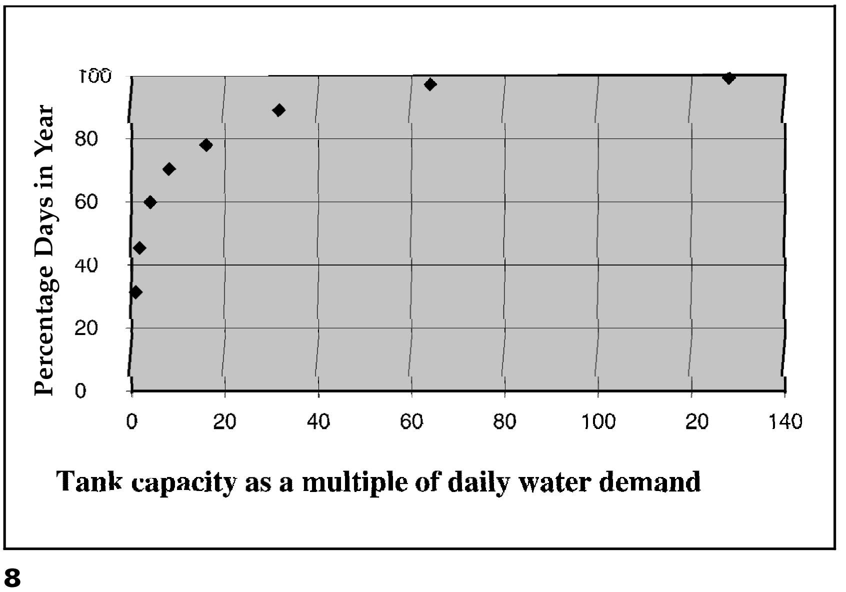
DRWH experiences some local difficulties, due to its incompatibility with the norms of many water aid agencies and its requirement for physical space (for surface or underground tanks) within a building plot. Its taste may be unfavourable compared with that of mineral-rich local groundwater. More widely DRWH is constrained by the meagreness and variability of annual roof runoff wherever roof area per person or annual rainfall is low: poor single storey housing in the humid tropics may readily supply 20 litres per capita per day (lcd) but the roofs of multi-storey slums in a semi-arid country may fail to supply more than 5 lcd.

Figure 1 shows how the percentage of days per year that roofwater is available from a tank increases rapidly with tank size. Thus in western Uganda an economical tank whose volume only equals 8 days' water demand will meet their demand for 70% of the days in a typical year. However, it takes a much more costly tank (at least fifteen times bigger) to achieve 99% availability. The graph represents RWH with adequate roof catchment in an area of two seasonal rainfalls. In an area of single seasonal rainfall (e.g. Monsoon climate) the tank sizes would have to be roughly doubled to get the same availabilities.

Figure 1. Graph showing tank capacity to satisfy demand.




## 'Total' versus 'partial'

Historically DRWH has been most commonly used as a (rather costly) means of meeting all the water requirements of a household. An alternative of growing importance is to use it for partial supply — either all water for part of the year or say only drinking water for the entire year. Studies show that both the urban and rural poor in tropical countries already commonly use more than one water source, switching between them in response to changing availability, cost, convenience or perceived quality. There are many ways of employing rainwater as a partial supply. At one extreme it can be used freely just while it is freely available (during the rainy season). At the other extreme it can be stored as a reserve and kept for use at the end of a dry season when other sources have run dry. Between these extremes are various management strategies that vary rainwater consumption with the season and with the quantity remaining in store.

## Specific scenarios

Future expansion of DRWH seems likely, but will take different forms in different environments. Any discussion has therefore to address one such environment at a time. Four important scenarios will be considered.

### *Semi-arid zones*

The well-documented approaching 'global water crisis' most immediately affects semi-arid countries with growing water consumption. In these areas total DRWH at high cost is often suggested, all other sources being even more costly. Without subsidy, it is hard to see 'total' domestic (as opposed to institutional) RWH ever being affordable or for adequate hard roof area being available except at very low rates of water consumption. Expansion in these areas will either be restricted to say school supplies or will require advances in water treatment that allow ground runoff and simple large ground tanks to be employed. Recent North Chinese and NE Brazilian experience suggests this may be feasible using covered and sunlit tanks respectively.

Terry Thomas

Cement rainwater jars being delivered in Phnom Penh.

### *Dispersed settlements in the humid tropics*

Opportunistic roofwater and tree-water collection has long been practised in the humid tropics — bowls are for instance put out under the eaves during rainfall. Improved water supplies have generally taken the form of developing point sources from which water has to be hauled manually. The convenience of these is often very low and consequently consumption is severely limited by the high queuing and carrying time needed per litre of water: consumptions as low as 4 lcd have been reported despite high rainfall. Here we may expect considerable growth in the usage of DRWH systems costing under say $50 to relieve collection effort and water insecurity for a substantial part of each year. That part may be 5 months in Monsoon areas and 10 months in equatorial areas having two rainy seasons. Such very low cost systems can be integrated with other sources, for example 7-day storage can be employed for DRWH in the wetter months and as a buffer or even treatment facility for carried water in the driest months. The increasing human settlement of areas above the spring line, for whom water carriage is always uphill, favours the take-up of partial DRWH. The movement towards better roofing in humid areas also favours DRWH, however the trend towards multi-storey housing is an unfavourable one.

### *Urban settlements in the tropics*

In many ways the greatest water problems are those of the urban poor, for which universal solution by classic methods (especially provision of piped supplies) is unaffordable despite their theoretical economies of scale. Many slum dwellers purchase water from vendors, collect from urban springs or queue at intermittently pressurised tap stands. In each case quality can be very poor, money or time cost is high and there is little water security. Partial DRWH looks quite promising here but research is required into matching system design to the low funds, insecure tenure and small roofs of poor urban households. Mosquito control needs special attention in these circumstances, as does tank design to attenuate bacterial levels via storage. Widespread take-up of low-cost urban DRWH seems over 10 years away in Africa and Central America, although it is already practised in some SE Asian countries like Cambodia. Meanwhile we may expect expansion of DRWH by middle class households not served reliably by pipe and hopefully some 'trickle-down' of new treatment technologies from richer countries.

**We may expect considerable growth in the usage of DRWH systems in the humid tropics.**

### *DRWH in 'post-industrial' countries*

To achieve savings in storm drainage capacity or to increase water security, water and drainage authorities have started to encourage citizens to install outdoor roofwater tanks to supply gardens or car


Louis Meulstee/Panos Pictures

washing. Architects of commercial buildings are increasingly designing them to utilise roof runoff on site rather than discharging it to drains. For special local reasons (e.g. availability of stored water to fight fires after disruption of the mains by an earthquake in Japan, aquifer depletion in Germany) substantial subsidies to introduce partial DRWH are already available in some places. The general assumption in these countries is still that roofwater will never meet their ever-rising drinking water standards and that it should be used only for undemanding applications like toilet flushing. So DRWH has become intimately linked with domestic greywater recycling in countries like Germany and UK. Further expansion depends partly upon politics — the success of 'green' parties — and partly upon development of technologies to make DRWH maintenance-free. Where DRWH is already practised, for example on Greek islands or in New Zealand suburbs, its expansion may depend upon improving in-tank disinfection techniques to at least approach piped water standards. New technology such as efficient self-cleaning filters and low-wattage UV disinfection has already made it possible, although not yet cheap, for DRWH to reach the highest water standards and a few installations in the USA have been approved against such standards.

## Conclusions

Growing out of a mixture of tradition, innovation in the face of serious local water-supply difficulty, and formal R&D, a substantial growth in use of RWH seems likely in the coming decade. The policy environment is becoming more favourable to such a 'subsistence' or 'private' technique and reliance upon multiple sources is becoming more acceptable amongst water professionals. Current research should soon remove most of the lingering uncertainty about harvested rainwater quality and may also advance domestic-scale water treatment and water quality monitoring. Substantial reduction in the cost of RWH system components — of storage tanks in particular — is still needed if DRWH is to sit alongside the use of untreated groundwater or treated surface waters as a standard supply technology. We should expect to see roofwater collection incorporated in many commercial buildings and some houses in temperate countries over the coming decade and its rural use considerably expanded in the humid tropics. In dry climates extensive urban use of RWH still seems unlikely; in equatorial climates however its extensive use by poor urban households is a serious possibility whose realisation depends on the outcome of current research.

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**about the author**
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**Coming up in the April 2000 issue**

VISION 21
In an edition co-ordinated by Belinda Calaguas — Advocacy Officer at WaterAid — Waterlines will focus on Vision 21, the Vision for Water for People for the twenty-first century.

Vision 21 is concerned with water supply, environmental sanitation and hygiene. It forms part of the World Vision for Water for Life and the Environment for the 21st Century which will be presented at the World Water Forum and the Ministerial Conference to be held in the Hague between 17 and 22 March 2000. Vision 21 sets the goal of a Basic Water, Sanitation and Hygiene Requirement, and targets universal access to safe water and adequate sanitation by 2025. Writers discuss the core points and essence of the Vision, and the advocacy agenda to achieving targets along with the events of the Forum are assessed.

The Vision 21 edition will include an editorial from Richard Jolly, Honorary Chairperson of the Water Supply and Sanitation Collaborative Council (WSSCC) and articles outlining the vision and specific instances where it can be implemented.