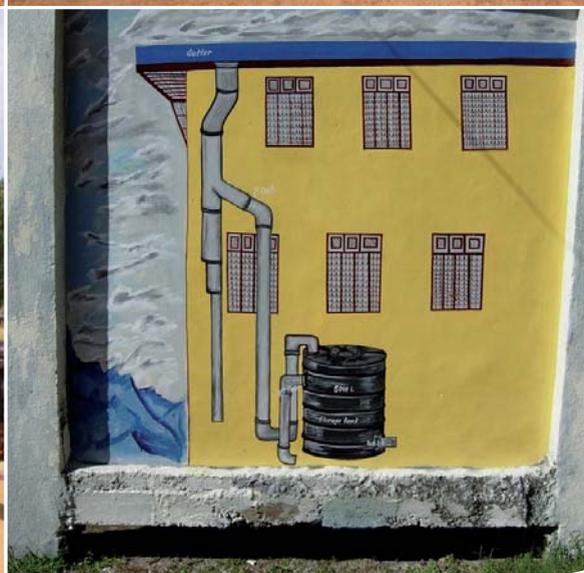
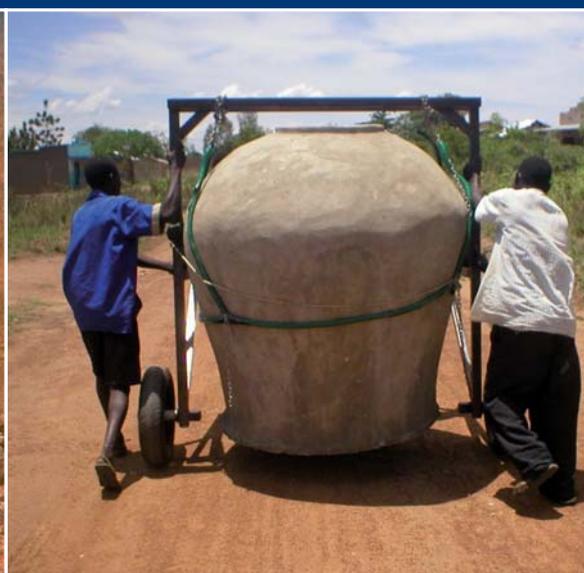
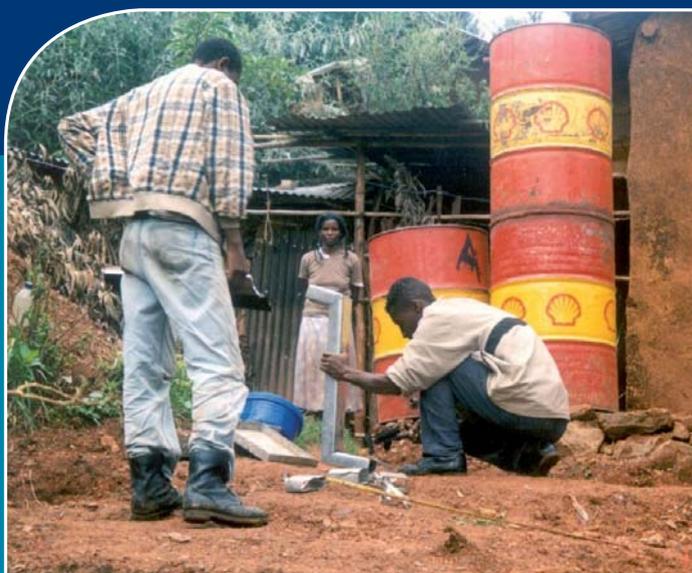


Roofwater Harvesting

A Handbook for Practitioners



T.H. Thomas and D.B. Martinson

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Thomas, T.H. and Martinson, D.B. (2007). *Roofwater Harvesting: A Handbook for Practitioners*. Delft, The Netherlands, IRC International Water and Sanitation Centre. (Technical Paper Series; no. 49). 160 p.

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ISBN 9789066870574

Editing: Peter McIntyre

Layout and printing: Meester en de Jonge, Lochem, The Netherlands

Cover photos:

Configuration of drums. Photo by B. Woldemarium

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Mural on roofwater harvesting at the Tri-Chandra College, Kathmandu, Nepal. Photo by D. de Jong, IRC

Institutional roofwater harvesting and its design problems:

unworkable school system (plastic entrance to the tank is above gutter level), photo by T.H. Thomas

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Technical Paper Series 49
IRC International Water and Sanitation Centre
Delft, the Netherlands
2007



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Preface

The growing role of roofwater harvesting

Water professionals are becoming increasingly worried about water scarcity. The UN World Water Development Report of 2003 suggests that population growth, pollution and climate change are likely to produce a drastic decline in the amount of water available per person in many parts of the developing world. Domestic Roofwater Harvesting (DRWH) provides an additional source from which to meet local water needs. In recent years, DRWH systems have become cheaper and more predictable in performance. There is a better understanding of the way to mix DRWH with other water supply options, in which DRWH is usually used to provide full coverage in the wet season and partial coverage during the dry season as well as providing short-term security against the failure of other sources. Interest in DRWH technology is reflected in the water policies of many developing countries, where it is now cited as a possible source of household water.

Rainwater systems deliver water directly to the household, relieving the burden of water-carrying, particularly for women and children. This labour-saving feature is especially crucial in communities where households face acute labour shortages due to the prolonged sickness or death of key household members, increasingly as a result of HIV/AIDS, coupled with a reduction in the availability of labour due to education and migration.

There has been much recent activity concerning domestic roofwater harvesting in countries as far apart as Kenya, China, Brazil and Germany. Many countries now have Rainwater (Harvesting) Associations. The technique is approaching maturity and has found its major applications where:

- rival water technologies are facing difficulties (for example due to deterioration in groundwater sources)
- water collection drudgery is particularly severe (for example hilly areas of Africa).

In some locations, such as India, DRWH has been strongly linked with aquifer replenishment programmes. Elsewhere it is seen as an attractive technique, in part because it fits with the decentralisation of rural water supply and is suitable for household management.

Purpose of this handbook

This handbook has been written to assist NGO and government staff responsible for implementing domestic roofwater harvesting systems or programmes. It is also meant to serve as a source of material for rainwater harvesting associations preparing national design guidelines in local languages. Finally, it could be used by individual householders or masons literate in English to design single roofwater harvesting systems.

Part A (Chapters 1 to 4) is focused on answering the question “When should DRWH be considered as a water supply option for a specified location or country?” This entails addressing other questions, such as, “How might DRWH be combined with other water sources?” and “How can DRWH systems be delivered?” Thus, Part A is aimed at those with responsibility for choosing technology – for example managers of NGO and governmental water programmes.

The rest of the handbook, Part B, is aimed at those implementing DRWH programmes and concentrates on which of the many forms of DRWH should be used in particular circumstances.

The handbook is primarily focused on ‘low-cost’ DRWH in the ‘humid tropics’. It is deliberately specialised in geographical scope and target group, and more prescriptive than the good review of rainwater harvesting practice contained in John Gould and Erik Nissen-Petersen’s 1999 book: *Rainwater Catchment Systems* (See Chapter 11 for references and for sources of further information on domestic RWH).

By ‘humid tropics’ we mean areas close to the Equator where rainfall is at least 800 mm per year and where normally not more than three successive months per year have negligible rainfall. However many of the techniques described are also suitable for the Monsoon tropics where annual rainfall is over 1,000 mm but the dry season is long (up to five consecutive months with negligible rainfall).

The table below shows how typical water yields vary with climate (tropical locations are shown in bold). Note that the rain per month in the wet season does not vary greatly across the tropics.

‘Low cost’ is an inexact term: we essentially mean ‘affordable in a developing country’. Providing domestic water in rural areas via ‘point sources’, such as protected shallow wells, springs, boreholes and gravity schemes, appears to cost at least US\$ 50 per household. In many ways, DRWH gives a better water service than do point sources, because it entails no fetching or queuing. It would be attractive to define ‘low-cost’ as meaning ‘costing not more than US\$ 60 per household’ (roughly the cost of a corrugated iron roof for a small house.) Unfortunately, this is too difficult a cost target for DRWH to reach except under especially favourable climatic conditions. The handbook has therefore been written using US\$ 100 per household as a nominal cost ceiling for a system that will meet the bulk of a demand for 100 litres of clean water per household per day. Elaborate and high-performance DRWH systems costing over US\$ 1,000 per household, which can be found in countries like USA, Australia and Germany, lie outside the scope of this handbook.

Climate	Examples	Annual rainfall mm	'Wet' months / year*	Mean daily yield over 12 months (large store RWH)	Mean daily yield in wet season(s) (low-cost RWH)
		mm		litre/person/day	litre/person/day
Arid	Khartoum Karachi	200	2	2.5	15
Semi-arid	Bulawayo N Peru	400	4	5	15
Summer rains	Guayaquil S W China	800	4	10	25
Humid coastal & Monsoon	Chennai Beira	1,000	6	12.5	25
Equatorial (2 wet seasons)	Kampala Ibadan	1,500	9	18.5	25
High rainfall every month	Singapore Manaos	2,000	12	25	25
V High rainfall seasonal	Freetown Yangon	>2,500	7	>30	>50

Table assumes 7 sq m of roofing per person; *'wet' = rainfall over 40 mm/month

As a short handbook rather than a lengthy research report, this publication offers only brief evidence to support its recommendations and suggestions. Much of that evidence has however been published elsewhere, for example at the biennial conferences of the International Rainwater Catchment Systems Association (IRCSA)

All the hardware recommended has been field-tested.

Background and acknowledgements

In 2000 the UK Government's Department for International Development (DfID) granted a contract to the Development Technology Unit at Warwick University, UK to research low-cost domestic roofwater harvesting for application in poor households in tropical countries. The research was undertaken in collaboration with local NGO partners, namely Water Action in Ethiopia, Lanka Rain Water Harvesting Forum in Sri Lanka and ACORD in Uganda. The study centred on developing and field testing low-cost DRWH technologies in one urban/peri-urban and two rural communities in each country, (see www.eng.warwick.ac.uk/dtu/pubs/rwh.html for reports). The research

programme culminated in March 2003 with national workshops in all three countries, feedback from which has been incorporated in this handbook.

That work built upon other research into tropical roofwater harvesting undertaken from 1998-2001 with support from the European Union and involving a partnership of British, German (FAKT), Indian (IIT Delhi) and Sri Lankan (LRWHF) organisations. The geographical focus of both research programmes was on areas where DRWH is comparatively easy and hence cheap to practice, rather than the semi-arid areas hitherto targeted by most roofwater-harvesting programmes. Lessons learnt during two further studies in Uganda since March 2003, funded respectively by the Ugandan Directorate for Water Development (DWD) and the Southern & Eastern Africa Rainwater Network (SEARNET), have also been incorporated in the handbook.

As a result of these and other recent programmes, the art of DRWH has advanced considerably in recent years. It is the purpose of this handbook to communicate these advances in a form suitable for practitioners to apply directly. Of course, further improvements in DRWH technology, including cost reductions, can be expected in the coming decade.

The authors of this handbook are happy to acknowledge with thanks the financial support of DFID and the European Union. Helpful advice from many friends, students and rainwater harvesting specialists, especially those in Sri Lanka, India, Uganda and Ethiopia, has been incorporated.