Rainwater Harvesting in the UK – Current Practice and Future Trends

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Abstract

Rainwater harvesting (RWH), where runoff from roofs and impervious areas is collected and utilised, is receiving renewed attention as an alternative water source. RWH requires less treatment than greywater recycling, if being used for non-potable demand such as toilet flushing. However, there are challenges to overcome in the promotion and implementation of RWH in the UK; it is a relatively unproven technology and there are still many concerns to be assuaged. Nevertheless, the situation is beginning to change with welcome moves coming from the Government, the UKRHA and housing developers themselves, in response to an increasingly challenging water resources situation. This paper will provide a brief introduction to RWH, along with an overview of the current and future prospects of the technology within the UK.

Keywords: Rainwater Harvesting; Systems; UK; New Developments; Barriers; Legislation

Introduction

RWH is a simple technology that has been used for thousands of years as a way of storing water throughout the year, rather than relying on the seasonality of rainfall. Many civilisations have practised RWH, including the pre-Columbian Maya of the Yucatan peninsula. The Maya utilised below-ground cisterns called chultunes, which were used to store water. Chultunes were usually capable of storing 30,000l of water (Gill, 2000). In the UK, until the development of the mains-water grid during the 19th-century, rainwater harvesting was a standard feature of most new houses – it freed the occupants from having to share the village pump (Wright, 2006).

RWH is still widely used across the world. Developed countries are returning to the technique, as housing growth, changing lifestyles and climate change put pressure on already stretched water resources (Meera and Ahammed, 2006).

According to Konig (2001) RWH can help:

- Supplement the mains water supply for non-potable uses (toilet flushing, washing machines, garden irrigation, general cleaning);
- Reduce loads on sewers by acting as a source control measure;
- Reduce pollution to surface waters by reducing urban runoff;

- Improve urban landscapes (if integrated with sustainable drainage systems);
- Increase groundwater supplies (can be used to recharge aquifers, where suitable).

Although RWH can be applied to both roofs and other impervious surfaces, such as car parks, roads and pathways, the use of roof runoff for RWH is preferred as it generally contains lower levels of pollutants. Roof runoff can be affected by contamination due to debris arriving on a catchment. However, due to the processes of flocculation, sedimentation and bio-reaction microbial contaminant levels are often within standards for reused water requiring minimal extra treatment, unlike greywater (Leggett et al., 2001). Other catchments, however, are additionally exposed to higher levels of other contaminants, such as polycyclic aromatic hydrocarbons (PAHs) and heavy metals from vehicle and industrial emissions (Forster, 1999).

Roof Runoff Rainwater Harvesting Systems

Table 1 shows the classification of roof runoff rainwater harvesting systems (RWHS), along with a description of their flow regime. The most common types of RHWS used in developed countries are the direct and indirectly pumped systems.

Table 1 RWHS Categories (Source: Fewkes, 2005)

Type	Flow regime
Total flow	Water flows to storage via a filter designed so that if a blockage occurs, pipework upstream does not surcharge.
Diverter	Cross-flow filter used to divert water to storage tank; the volume collected is dependent on the flow rate in the collection pipe.
Retention and throttle	Additional storage is provided within the storage tank (a "retention" volume), which is released at a low flow rate via a throttle valve to sewers, decreasing incidents of sewer flooding.
Infiltration	Overflow from storage is permitted to infiltrate into ground, recharging the local water table.
Directly pumped	Water is pumped directly from a storage tank to appliances.
Indirectly pumped	Water is pumped from a storage tank to header tanks, which supplies a building.
Gravity fed	Storage tank is located in the building's roof space and supply is provided direct via gravity.

RWHS consist of a catchment area, a conveyance system and a storage tank. Rainfall is a stochastic event and so the supply of water is often more unpredictable than the demand (Dixon et al., 1999). Therefore the purpose of the tank is to maintain supply during periods when rainfall is low. However, the capacity influences the performance and cost of a system with the storage tank often being the most expensive part of a RWHS (Fewkes, 2005). Storage tanks can be fabricated from a range of materials, which are often geographically distinct due to differing local suppliers (Table 2).

Table 2 Storage tank materials across the world (Source: Konig, 2001; Thomas, 2006)

Material	Country
Concrete	Germany; Bangladesh; Thailand; Ethiopia
Metal	Australia(Steel); Uganda (iron)
Plastic (including glass reinforced plastic)	Germany; UK; Uganda; Australia
Brick	Uganda; Ethiopia; Sri Lanka; Thailand

RWH in the UK – Current Practice

In the UK, interest in RWH research, technology, development and utilisation has yet to mature, though several initiatives are in place to promote RWH. For example, in 2004 the UK Rainwater harvesting Association (UKRHA) was established to:

- Serve as a focal point for organisations;
- Provide information to members, the public and industry;
- Address standards, legislation and technology
- Participate in committees and dialogue with Government Departments

However, RWHS are not yet common in England and Wales due to two main reasons (EA, 2003):

- High capital and maintenance costs;
- Concern over water quality and possible associated health risks.

Other barriers include a relatively cheap mains water supply, a lack of interest from water service providers (WSPs), an unproven cost-benefit analysis and being a generally unproven technology in the UK. There is also emotional resistance as RWH is seen as an unconventional approach to water supply, even for non-potable uses (Brown, 2007).

A recent House of Lords report (HL Paper 191-II, 2006) conducted a thorough examination of the water resources situation in the UK and asked the Government, the regulator (Ofwat) and the water service providers (represented by Water UK) for responses, which were documented in a follow-up report (HL Paper 21, 2007). Criticisms were mainly directed at the Government and Ofwat, though Water UK did not escape completely. Principal criticisms focused on complacency in regard to developing standards for sub-potable water use, along with commitments to education and supporting innovation. RWH was not widely mentioned by any of the consulting parties.

The situation is exacerbated by the use of a rateable value payment system for domestic (household) properties, which prevents a customer benefiting fiscally from RWH unless their property has a meter (now compulsory on all new dwellings) (Hassell, 2005). Despite 98% of domestic properties being on a mains supply, only 27% are metered. Figure 1 demonstrates the current level of metering penetration in the UK compared with other European countries.

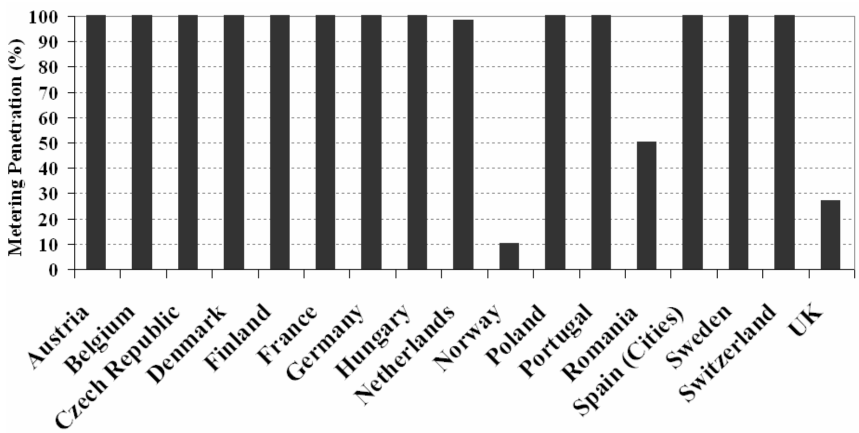

Figure 1 Water Meter Penetration in European Countries (Waterwise, 2007).

Despite these barriers, there are many systems currently operating in the UK, on a range of scales; single dwellings, sports and community centres, supermarkets, sustainable housing developments and, until recently, the millennium dome (the reclaimed water system was recently removed). Table 3 gives a summary of the larger housing developments with RWHS. As can be seen the variation in payback period is large and although the developments are of differing size, this is not the only reason for the difference. Water charges are higher in the South West Water area (approximately £3.70/m^3), which supplies Devon, whereas Wessex Water, which supplies Somerset, has an average charge of £2.30/m^3. This demonstrates one of the challenges facing large-scale implementation of RWH in the UK; the variation of fiscal benefit depending on WSP.

Table 3 RWH in Current UK Housing Developments (Source: Freerain, 2007; Rainharvesting, 2007)

Name	Location (County)	Size of Development	RWH/ Annum	Pay-back period (yrs)	Usage
Great Bow Yard	Somerset	12 houses	28m^3	24	WC; GT
Millennium Green	Nottinghamshire	24 houses, 1 office building	84m^3	unknown	WC; WM; GT
Barn Park	Devon	37 houses, 11 systems	194m^3	4.6	WC; WM; GT
Upton Green	Northamptonshire (New development)	Starting with 120 Houses	Unknown	Unknown	WC; GT

WC = toilet flushing; WM = Washing Machine; GT = Garden Taps

One of the developments monitored in detail, over the period of a year, was the Millennium Green housing development. The systems in this development contain tanks with a storage capacity of 18 days and a four bedroom house with a roof area of 153m² was expected to yield approximately 95m^3/year (annual rainfall of 622mm). Using a 3,500L directly pumped system, in conjunction with water efficient devices, household consumption was reduced by 50m^3/annum (50,000L). This indicates the system was operating at approximately 50% efficiency (though this may indicate seasonal effects, such as a dry summer).

Currently the retrofitting of systems is the most problematic area of the UK RWH market, with the following factors limiting opportunities (Fox, 2007):

- Roof drainage costs (requires overhaul of roof to drain to central point);
- Disturbing mature gardens for tank installation (plus expense);
- Separating internal plumbing into two distinct systems.

RWH in the UK – Future Trends

Motivation for the current refreshed interest in RWH has come from several directions. Recent droughts highlighted the limitations of water resources in some water supply areas, such as the South East (Hassell, 2005). Climate change projections have led to the realisation that hotter and drier summers and milder and wetter winters may become the norm for the UK (UKCIP, 2007). Further to this, new housing and commercial developments have been identified as being major contributors to urban stormwater runoff and increased localised flooding (EA, 2003). Finally, WSPs assert that domestic demand is the only component of total demand that is increasing (Kellagher and Maneiro Franco, 2005). All of these factors have direct implications for future water resource strategies.

The combination of the above factors means that the comparatively small UK installation and maintenance market, (market value approximately £5,000,000; Fox, 2007), is rapidly expanding with turnover doubling every year since 2002 (Hassell, 2005). Recent UK Government actions, in response to a call for more sustainable housing to reduce contributions to climate change, have resulted in several moves which will facilitate RWH implementation in both domestic and commercial developments.

RWH equipment is now included on the Enhanced Capital Allowance Qualified Water Technology list, which allows businesses to claim 100% capital allowances on investments, off setting the entire cost of equipment against taxable profits for the period during which the investment is made (DEFRA and HM Revenue and Customs, 2007). However, an equivalent incentive scheme to offset capital outlay for domestic systems, such as the subsidy system in Germany, has yet to materialise.

The Code for Sustainable Homes (CSH), released in December 2006, aims to lessen the impact of climate change through the use of sustainable construction practices and promotion of minimum standards for energy and water efficiency in new buildings. From April 2008 new homes will be required to have an Energy Performance Certificate based on a star rating system, which assesses sustainability across nine categories. For water consumption, points are scored for reduced internal per capita consumption (PCC) and for provisions made for external rainwater collection techniques, such as water butts and RWHS. The CSH will also assess the impact of a new development on urban runoff volumes, with developments facilitating a reduction in runoff generation scoring highest (DCLG, 2006).

In conjunction with the CSH, Building Regulations have been reviewed to strengthen legislation pertaining to existing buildings. Water conservation is considered which is likely to encourage rainwater harvesting in areas where water scarcity predominates (Hassell, 2005). This compliments the 1999 Water Supply (Water Fittings) Regulations, which legislate for the maximum water use of a range of fittings (Kellagher and Maneiro Franco, 2005). In addition to this, the Department of Communities and Local Government are currently consulting on whether to regulate water efficiency by assessing a new building in its entirety, in relation to a standard of 120-135l per person per day, or assessing separate components with minimum standards for key fittings (DCLG and DEFRA, 2006).

Further to this the Government's Market Transformation Programme (MTP) is currently consulting on the use of RWH and greywater reuse, which could help reduce potable mains water consumption, where non-potable quality water could be substituted. Major stakeholders, such as consultants, manufacturers, WSPs, and system end users, were consulted. Recommendations included using the Bathing Water Directives (1975 & 2006) for the provision of bacterial water quality guidelines and the use of a three-tiered scale was suggested for the technical requirements of differing building ownerships and sizes (Brown, 2007).

Conclusions

A properly designed and managed RWHS can help to considerably reduce water demand for non-potable uses. High capital and maintenance costs, relatively low water tariffs and a lack of regulations for safe use of rainwater are seen as the key barriers to the wider uptake of RWHS in the UK. A number of regulatory approaches and financial instruments are currently being explored to facilitate the utilisation of water demand management measures (such as RWH).

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