European Commission

Natural Water Retention Measures

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Individual NWRM

Rainwater harvesting

Environment

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I. NWRM Description

Rainwater harvesting involves collecting and storing rainwater at source for subsequent use, for example, using water butts or larger storage tanks. Water butts are the most widely applied and simple rainwater harvesting technique, collecting rainwater runoff from roofs via a connection to the roof down-pipe. They are primarily designed for small scale use such as in household gardens, although a range of non-potable uses is possible.

A limitation of rainwater harvesting as an NWRM is that during wet periods, water butts are often full and water use may be low, resulting in little or no attenuation or reduction in outflow rates or volumes. As a result there are differing opinions about the role of rainwater harvesting in providing a water retention function. Tanks can be specifically designed and managed to accommodate storm water volumes, which is likely to be more effective when applied at a larger scale than individual properties. In general, however, rainwater harvesting should be considered only as a source-control component in a SuDS 'train' where, in combination with other measures, they will contribute to effective and sustainable water management.

II. Illustration

Example of rainwater harvesting from the USA

Source: http://www.clemson.edu/sustainableag/rainwater.html

III. Geographic Applicability

Land Use	Applicability	Evidence
Artificial Surfaces	Yes	Rainwater harvesting can be applicable to any roof, and potentially to other areas of hardstanding. With respect to CORINE Level 2 land uses, rainwater harvesting is applicable to: • Urban Fabric • Industrial/Commercial/Transport Units
Agricultural Areas	No	(although applicable to buildings in agricultural areas)
Forests and Semi-Natural Areas	No	
Wetlands	No	

Region	Applicability	Evidence
Western Europe	Yes	CIRIA (2009) identify that rainwater harvesting is most likely to be of use for runoff control where "yield is greater than demand". This is likely to be relevant across parts of Western Europe and should be determined on a site-specific basis.
Mediterranean	Yes	CIRIA (2009) identify that rainwater harvesting is most likely to be of use for runoff control where "yield is greater than demand". This is likely to be relevant to the Mediterranean region but should be determined on a site-specific basis depending on design (dimensions) and intended use of the water. In warmer climates, particularly the Mediterranean region, there could potentially be potential public health concerns if storage is not fully contained and protected, e.g. mosquitoes. Nevertheless rainwater harvesting is of value to this region: for example, as considered in case study Malta_02.
Baltic Sea	Possible	CIRIA (2009) identify that rainwater harvesting is most likely to be of use for runoff control where "yield is greater than demand". Therefore rainwater harvesting might be of less relevance for the Baltic Sea region as a whole, although has the potential to be applicable in specific situations. Due to the cold climate, insulation will be required to prevent freezing in winter.
Eastern Europe and Danube	Yes	CIRIA (2009) identify that rainwater harvesting is most likely to be of use for runoff control where "yield is greater than demand". This is likely to be relevant across

		parts of Eastern Europe and the Danube and should be determined on a site-specific basis.

IV. Scale

	0-0.1km²	0.1-1.0km²	1-10km²	10-100km²	100-1000km²	>1000km²
Upstream Drainage Area/Catchment Area	✓					
Evidence	The contributing area to a rainwater harvesting system is highly unlikely to be greater than 0.1 km^2, since it generally consists only of the roof of a building.					

V. Biophysical Impacts

Biophysical Impacts		Rating	Evidence
Slowing & Storing Runoff	Store Runoff	None to low	Rainwater harvesting stores runoff for local use, with the potential therefore to reduce both the rate and total volume of runoff. However the actual effectiveness of rainwater harvesting is highly dependent on whether the system is specifically designed for runoff storage or whether the primary aim is water storage. Unless space is specifically allocated for runoff storage, then there may be insufficient space to provide benefit. This may vary with region, season and the use of the water, for example Blanc et al (2012) note that in the UK, water harvested for irrigation is unlikely to be used in winter, so storage will remain full, leaving no space for runoff storage. In relation to this, CIRIA (2009) identify that rainwater harvesting is most likely to be of use for runoff control where "yield is greater than demand". CIRIA (2007) conclude that rainwater harvesting for runoff control is likely to be more effective for larger tanks than individual water butts.
	Slow Runoff	None to low	
	Store River Water	None	
	Slow River Water	None	
Reducing Runoff	Increase Evapotranspiration	None	
	Increase Infiltration and/or groundwater recharge	None	

	Increase soil water retention	None	
Reducing Pollution	Reduce pollutant sources	None	Water quality improvements can be achieved prior to use by filtration or other treatment, as required, but the basic process of harvesting will have little influence on water quality
	Intercept pollution pathways	None	
Soil Conservation	Reduce erosion and/or sediment delivery	None	
	Improve soils	None	
Creating Habitat	Create aquatic habitat	None	
	Create riparian habitat	None	
	Create terrestrial habitat	None	
Climate Alteration	Enhance precipitation	None	
	Reduce peak temperature	None	
	Absorb and/or retain CO_2	None	

VI. Ecosystem Services Benefits

Ecosystem Services		Rating	Evidence
Provisioning	Water Storage	High	Rainwater harvesting captures rainwater at source, which is then stored to be used for irrigation or other (usually) non-potable purposes.
	Fish stocks and recruiting	None	
	Natural biomass production	None	
Regulatory and Maintenance	Biodiversity preservation	None	
	Climate change adaptation and mitigation	Medium	Rainwater harvesting can contribute to climate change adaptation through providing a contribution to sustainable water supply.

	Groundwater / aquifer recharge	None	
	Flood risk reduction	None to Low	Rainwater harvesting, when designed to accommodate it, stores rainfall and reduces the total volume of runoff, thereby contributing to flood risk management.
	Erosion / sediment control	None	
	Filtration of pollutants	None	
Cultural	Recreational opportunities	None	
	Aesthetic / cultural value	None	
Abiotic	Navigation	None	
	Geological resources	None	
	Energy production	None	

VII. Policy Objectives

Policy Objective		Rating	Evidence
Water Framework Directive			
Achieve Good Surface Water Status	Improving status of biology quality elements	None	Although providing a contribution to sustainable water use, rainwater harvesting has limited potential to significantly influence any aspect of the Water Framework Directive, at least when considered in isolation. If rainwater harvesting use is widespread or is targeted to address a specific supply problem, it is possible there could be some improvement to hydromorphology and/or groundwater quantitative status through reduced use of water resources, although this is likely to be minor in most cases.
	Improving status of physico-chemical quality elements	None	
	Improving status of hydromorphology quality elements	None to Low	
	Improving chemical status and priority substances	None	

<table>
<tr><td rowspan="2">Achieve Good GW Status</td><td>Improved quantitative status</td><td>None to Low</td><td rowspan="4"></td></tr>
<tr><td>Improved chemical status</td><td>None</td></tr>
<tr><td rowspan="2">Prevent Deterioration</td><td>Prevent surface water status deterioration</td><td>None</td></tr>
<tr><td>Prevent groundwater status deterioration</td><td>None</td></tr>
<tr><td colspan="4">Floods Directive</td></tr>
<tr><td colspan="2">Take adequate and co-ordinated measures to reduce flood risks</td><td>None to Low</td><td>Rainwater harvesting, when designed to accommodate it, stores rainfall and reduces the total volume of runoff, thereby contributing to flood risk management.</td></tr>
<tr><td colspan="4">Habitats and Birds Directives</td></tr>
<tr><td colspan="2">Protection of Important Habitats</td><td>None</td><td></td></tr>
<tr><td colspan="4">2020 Biodiversity Strategy</td></tr>
<tr><td colspan="2">Better protection for ecosystems and more use of Green Infrastructure</td><td>None</td><td></td></tr>
<tr><td colspan="2">More sustainable agriculture and forestry</td><td>None</td><td></td></tr>
<tr><td colspan="2">Better management of fish stocks</td><td>None</td><td></td></tr>
<tr><td colspan="2">Prevention of biodiversity loss</td><td>None</td><td></td></tr>
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VIII. Design Guidance

Design Parameters	Evidence
Dimensions	The dimensions of rainwater harvesting must explicitly consider whether the system is solely designed to provide water supply (considering the volume required for use as well as the rainfall characteristics), or whether additional capacity will be included to store runoff (only when the latter is included can rainwater harvesting be considered to be an NWRM). The storage itself must have an appropriately sized drainage area. Rainwater harvesting is generally implemented on a small scale (CIRIA (2007) suggests 2 m^3 as an average attenuation volume for an individual house). As such the dimensions of the contributing drainage area may be that of a household roof, but it could also be a larger area such as a car park. Most rainwater collection tanks are manufactured from plastics, but other materials could be used if they are protected against the corrosive effects of the stored water and any disinfectants used. The storage of rainwater does not have to be in a traditional tank, e.g. the void space in sub-base material of a permeable paving system or within geo-cellular modular units can also be used. An overflow system is necessary in all types of rainwater harvesting systems.
Space required	The simplest and most widely used harvesting technique is the water butt, the space required for which is determined by the size of the tank needed to achieve the stormwater attenuation volume. Space requirements are in general minor. Larger tanks can be underground structures, in which case there is no requirement for surface space.
Location	Storage tanks can be located almost anywhere in urban areas, but where possible, should be in their catchment area. Consideration should also be given to siting the storage tank close to where the rainwater is to be treated and reused, due to the additional components that may be required to treat the water. In all cases, the storage tanks need to be easily accessible.
Site and slope stability	Storage tank should be placed on level and stable ground.
Soils and groundwater	Where underground tanks are to be used, to prevent ingress of groundwater, materials should be robust enough to withstand pressures from earth, surcharge loads, vehicular loading, floating, and groundwater itself.
Pre-treatment requirements	Treatment requirements depend on the intended use of the water. Either pre-treatment or treatment after storage can be incorporated as necessary. Pre-treatment in the form of filtration is generally required to avoid unwanted inputs such as leaves, twigs, insects, etc. that could plug pipes. In order to avoid bacterial contamination, it is best if the tank is below ground, or at least non-transparent.

Maintenance requirements	Regular inspection and maintenance is essential for rainwater harvesting systems to ensure effective ongoing operation in storage and treatment. Maintenance should include: • Monitoring of tank, inlets and outlets for debris and sediment build up • Monitoring of pumps and treatment filters for functionality • Monitoring of areas for overflow and erosion damage • Monitoring of roof / drainage area filters • Replacement of any filters • Clearing of tank, inlets, outlets and impermeable drainage area • Repair tank from erosion / damage (CIRIA, 2007)
Synergies with Other Measures	To be effective for managing runoff, rainwater harvesting should be used as a component in a sustainable drainage system train, e.g. downstream of green roofs and in conjunction with other SuDS measures.

IX. Cost

Cost Category	Cost Range	Evidence
Land Acquisition		Storage tanks can generally be situated on the same land from which it takes its stormwater, thus no further land acquisition is expected to be necessary. Given the small space required, and the possibility of underground storage, the implementation of this measure should not come as an opportunity cost of using existing land acquired for development.
Investigations & Studies	€0 – €10k	For tanks of a large size, or for collective or public uses, the sizing should be optimised by assessing the available rainfall and the demand.
Capital Costs	€5-€60 per m^2 roof area services	The capital cost of rainwater harvesting measures is considerable depending on the system design and how it is incorporated into the building structure. Environment Agency (2007) indicates the broad range of costs, which includes the potential range of costs for retrofitting rainwater harvesting to existing buildings.
Maintenance Costs	€0.25-€1.00 per m^2 roof area services	Maintenance costs are low, although also have a broad range (Environment Agency, 2007). The UK Suds Calculator website (www.uksuds.org) provides maintenance costs as €8 per m^3 of storage provided.
Additional Costs	n/a	

X. Governance and Implementation

Requirement	Evidence
Stakeholder involvement	The effective planning, design, construction and operation of urban NWRM requires the involvement of a wide range of stakeholders. This may be less relevant at the individual household scale, but for larger schemes it will be an important consideration. Stakeholders may include local planning authorities, environmental regulators, sewerage undertakers, highways authorities, private landowners and land managers, and other bodies with responsibilities for drainage and water management (e.g. irrigation bodies, drainage boards, etc). Effective planning is essential to delivering urban NWRM, since they must be delivered within the constraints of the urban environment. This requires alignment between stakeholders from planning authorities through to developers and land owners.
Ensuring clear responsibility for maintenance	The adoption of SuDS has historically been a major issue in ensuring their long-term effectiveness. For rainwater harvesting on individual properties this may not be an issue, but in those cases the effectiveness for stormwater attenuation may be limited. Responsibilities are more relevant for larger schemes such as those draining communal buildings or car parks.
Ensuring that appropriate design standards and effective designs are implemented appropriately at each location	The preparation of planning guidance and/or SuDS guidance documents that set out planning and design criteria can assist in this.

XI. Incentives supporting the financing of the NWRM

Type	Evidence
National and local legislative and regulatory requirements	Some countries and territories encourage and/or require the use of Sustainable Drainage systems in new development, and rainwater harvesting systems may contribute to these. For example, in the Flanders region of Belgium, regulation requires new houses to have a rainwater harvesting tank, with the joint purpose of conserving water supply and reducing urban runoff (Campling et al, 2008). National and local instruments are the most widely effective for SuDS due to their wide-scale application at the household or very local level. The possibility of local incentives should always be explored (since they cannot be covered here comprehensively).
National and local charging incentives	The uptake of SuDS may be achieved by tax or water charging incentives. For example, in England households can receive a reduction on their water bills if their surface water drainage does not discharge to the sewerage network, and rainwater harvesting may contribute to achieving this. In France, a tax credit equivalent to up to 15% of the equipment costs has been introduced to encourage the uptake of rainwater harvesting (MEDDE, 2013)

XII. References

Reference	Comments
Blanc, J, Arthur, S and Wright, G (2012) Natural flood management (NFM) knowledge system: Part 1- Sustainable urban drainage systems (SUDS) and flood management in urban areas.	A literature review of hydrological effectiveness of SuDS, focussed on Scotland but drawing on literature from elsewhere.
Campling, P., de Nocker, L., Schiettecatte, W., Iacovides, A., Dworak, T., Kampa, E., Alvarez Arenas, M., Cuevas Pozo, C., le Mat, O., Mattheiss, V. and Kervarec, F (2008). Assessment of alternative water supply options: Final summary report. Report for the European Commission under service contract no. 070307/2008/496501/SER/D2.	
Environment Agency (2007) Cost benefit of SUDS retrofit in urban areas.	
CIRIA (2009) Overview of SuDS performance: Information provided to Defra and the EA	Review of recent evidence of SuDS hydrological and water quality effectiveness.
MEDDE (Ministère de l'Écologie, du Développement Durable et de l'Énergie) (2013) "La récupération de l'eau de pluie", Website, Last updated: March 21 2013. http://www.developpement-durable.gouv.fr/La-recuperation-de-l-eau-de-pluie.html	
www.uksuds.org – SuDS Construction and Maintenance Costs Calculator	This site has been developed by HR Wallingford to provide tools for site drainage design and evaluation, aimed at developers and SuDS Approval Bodies in the UK and Ireland. The site is updated with current thinking on SuDS and the requirements of UK and Ireland SuDS standards. The site includes a cost calculator to provide indicative costs of SuDS scheme components for construction and maintenance – the generic unit cost factors have been used when this website is referenced.
Woods-Ballard, B, Kellagher, R, Martin, P, Jefferies, C, Bray, R and Shaffer, P (CIRIA) (2007) The SuDS Manual, CIRIA C697.	A comprehensive manual for SuDS design and wider information. Draws on the knowledge developed through many preceding CIRIA studies.