Eng D
“Rainwater Harvesting in The Wild”

Peter Melville-Shreeve
University of Exeter & Severn Trent

Thanks to sponsors, supervisors and collaborators

UNIVERSITY OF EXETER

EPSRC

SEVERN TRENT

What's Great in Water Sector Innovation

- Waste Water
- Nutrient Recovery
- Microbial Electrolysis Cells
- Heat Recovery
- Spin-it-'til-it drops
- SuDS
- Real-Time Systems

- Smart Data Collection
- Data Analytics
- Data Mining

- Water
- Blackwater Reuse
- Greywater Reuse
- Rainwater Harvesting
- Smart Metering
- Pressure Management
- GIS Tools

Project Aim and Methods

Aim: *Develop a methodology to design and evaluate stormwater control and water demand management benefits of multi-purpose rainwater harvesting (RWH) systems.*

1) Literature review of RWH in the UK
State of the art RWH decision support tools.

2) RWH configurations
A comprehensive review of RWH configurations

3) Laboratory Work
Data collection & analysis for a range of RWH.

4) Real-world Monitoring Studies
Data from RWH systems monitored.

5) Develop a RWH Evaluation Tool
A new Decision Support Tool.

SuDS

Data Analytics

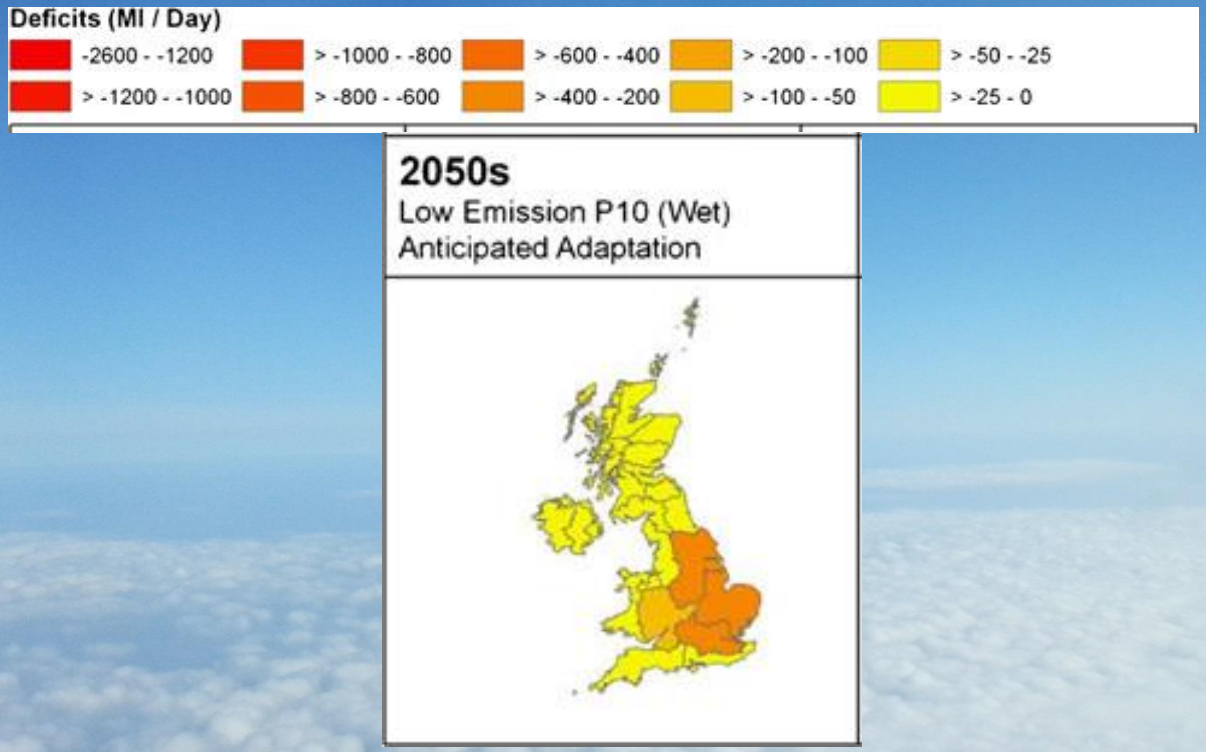
Rainwater Harvesting

1) Literature Review

1) Do we really need innovation?

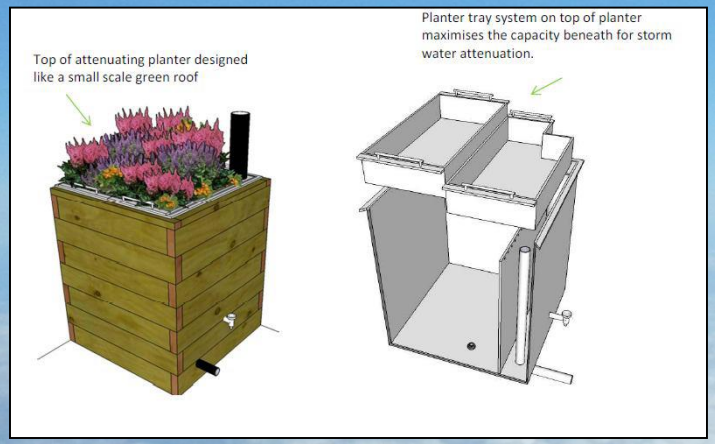
A.N. Other Water Company:

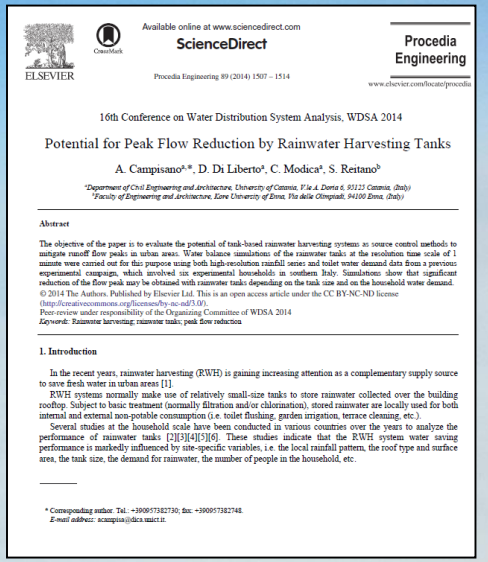
"We don't do RWH, it sounds a bit risky, I'm sure we have plenty of water anyway?"



1) Literature Review

2) State of the Art Rainwater Harvesting





ELSEVIER

Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 89 (2014) 1507 – 1514

Procedia Engineering

www.elsevier.com/locate/procedia

16th Conference on Water Distribution System Analysis, WDSA 2014

Potential for Peak Flow Reduction by Rainwater Harvesting Tanks

A. Campisano[a,*], D. Di Liberto[a], C. Modica[a], S. Reitano[b]

[a]Department of Civil Engineering and Architecture, University of Catania, V.le A. Doria 6, 95125 Catania, (Italy)
[b]Faculty of Engineering and Architecture, Kore University of Enna, Via delle Olimpiadi, 94100 Enna, (Italy)

Abstract

The objective of the paper is to evaluate the potential of tank-based rainwater harvesting systems as source control methods to mitigate runoff flow peaks in urban areas. Water balance simulations of the rainwater tanks at the resolution time scale of 1 minute were carried out for this purpose using both high-resolution rainfall series and toilet water demand data from a previous experimental campaign, which involved six experimental households in southern Italy. Simulations show that significant reduction of the flow peak may be obtained with rainwater tanks depending on the tank size and on the household water demand.

Peer-review under responsibility of the Organizing Committee of WDSA 2014
Keywords: Rainwater harvesting; rainwater tanks; peak flow reduction

1. Introduction

In the recent years, rainwater harvesting (RWH) is gaining increasing attention as a complementary supply source to save fresh water in urban areas [1].

RWH systems normally make use of relatively small-size tanks to store rainwater collected over the building rooftop. Subject to basic treatment (normally filtration and/or chlorination), stored rainwater are locally used for both internal and external non-potable consumption (i.e. toilet flushing, garden irrigation, terrace cleaning, etc.).

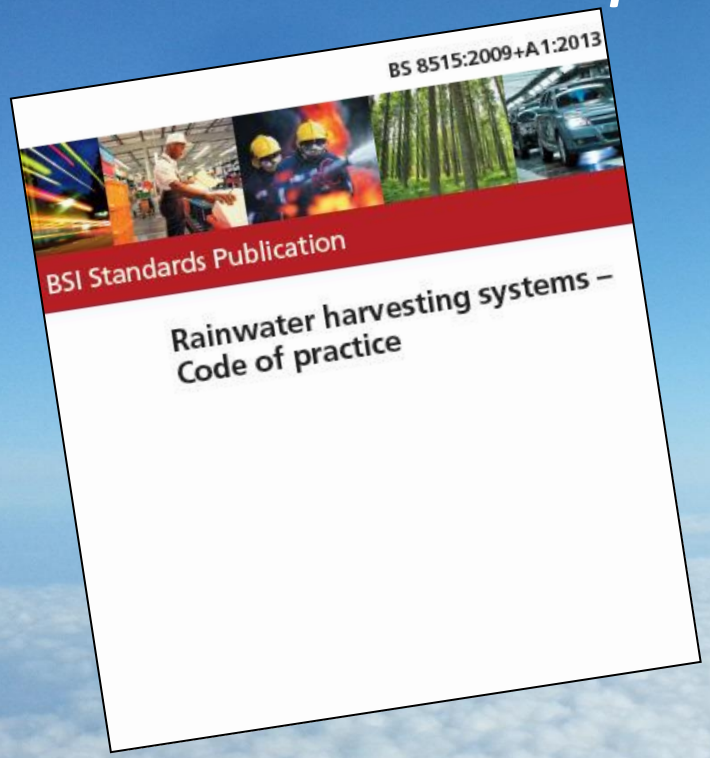
Several studies at the household scale have been conducted in various countries over the years to analyze the performance of rainwater tanks [2][3][4][5][6]. These studies indicate that the RWH system water saving performance is markedly influenced by site-specific variables, i.e. the local rainfall pattern, the roof type and surface area, the tank size, the demand for rainwater, the number of people in the household, etc.

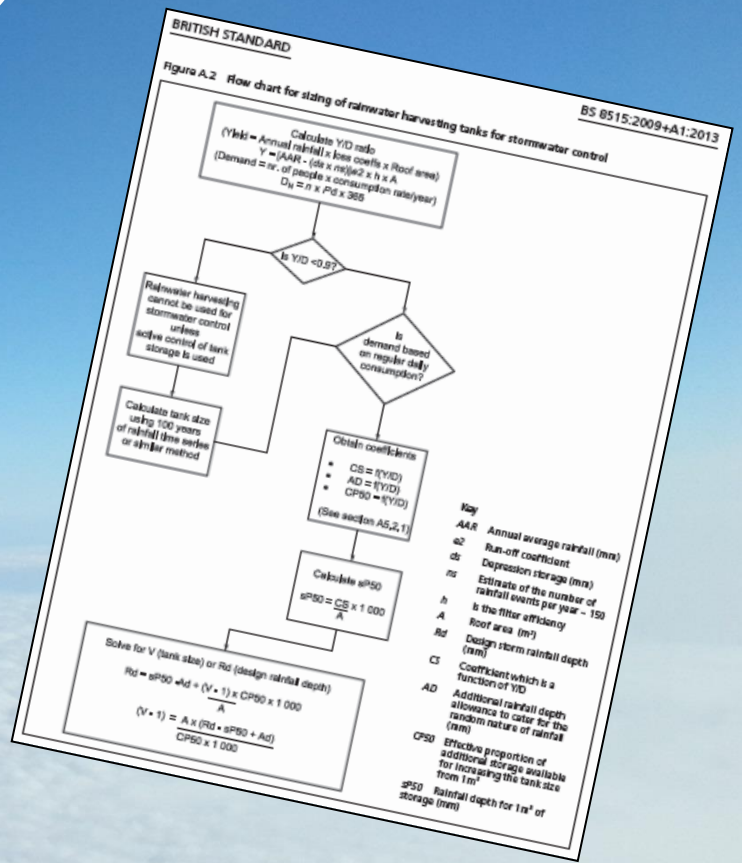
* Corresponding author. Tel.: +390957382730; fax: +390957382748.
E-mail address: acampisa@dica.unict.it.

1) Literature Review

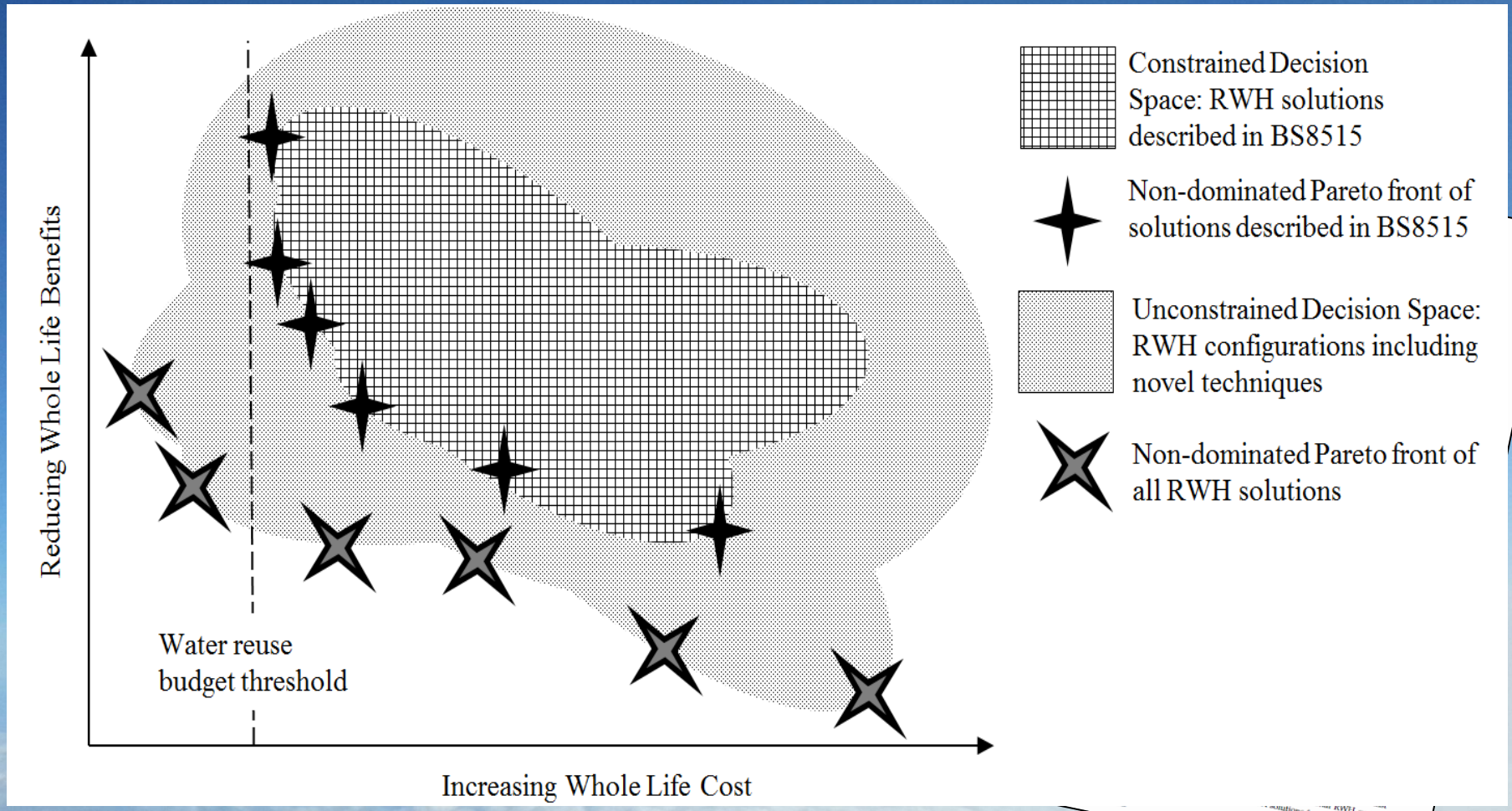
3) Conclusions: What's needed next?

"Methods to enable RWH as Stormwater Control Tool….*(which provides low-cost water… at a reduced energy/carbon cost… whilst mitigating droughts… and improving our customer's satisfaction… at no cost to the water company.)*"

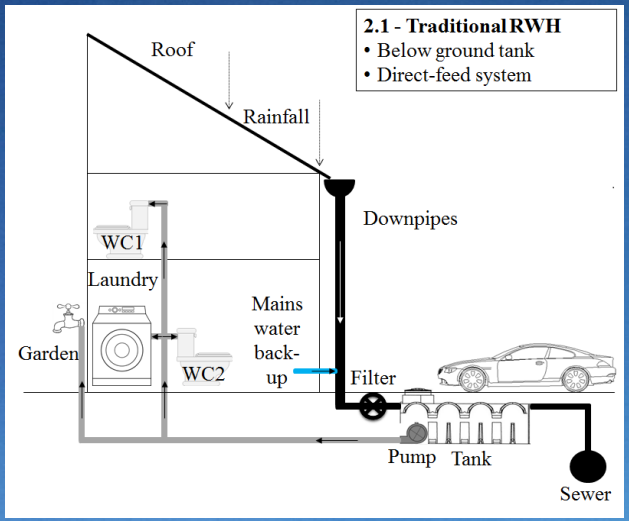


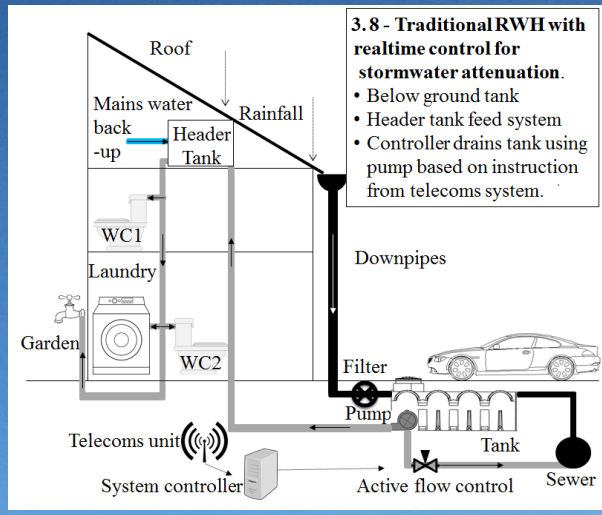


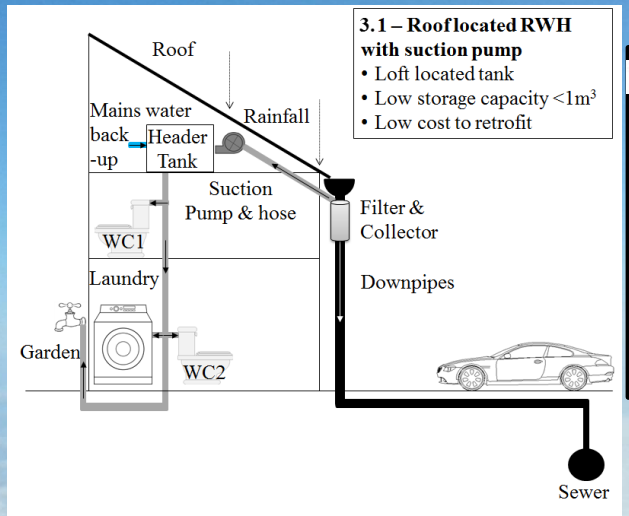
2) RWH Configurations

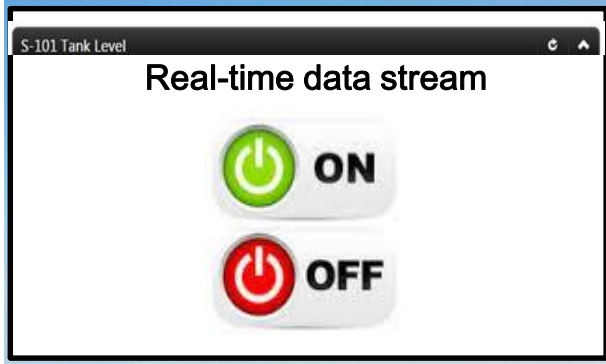


2) How many RWH Configurations are there?

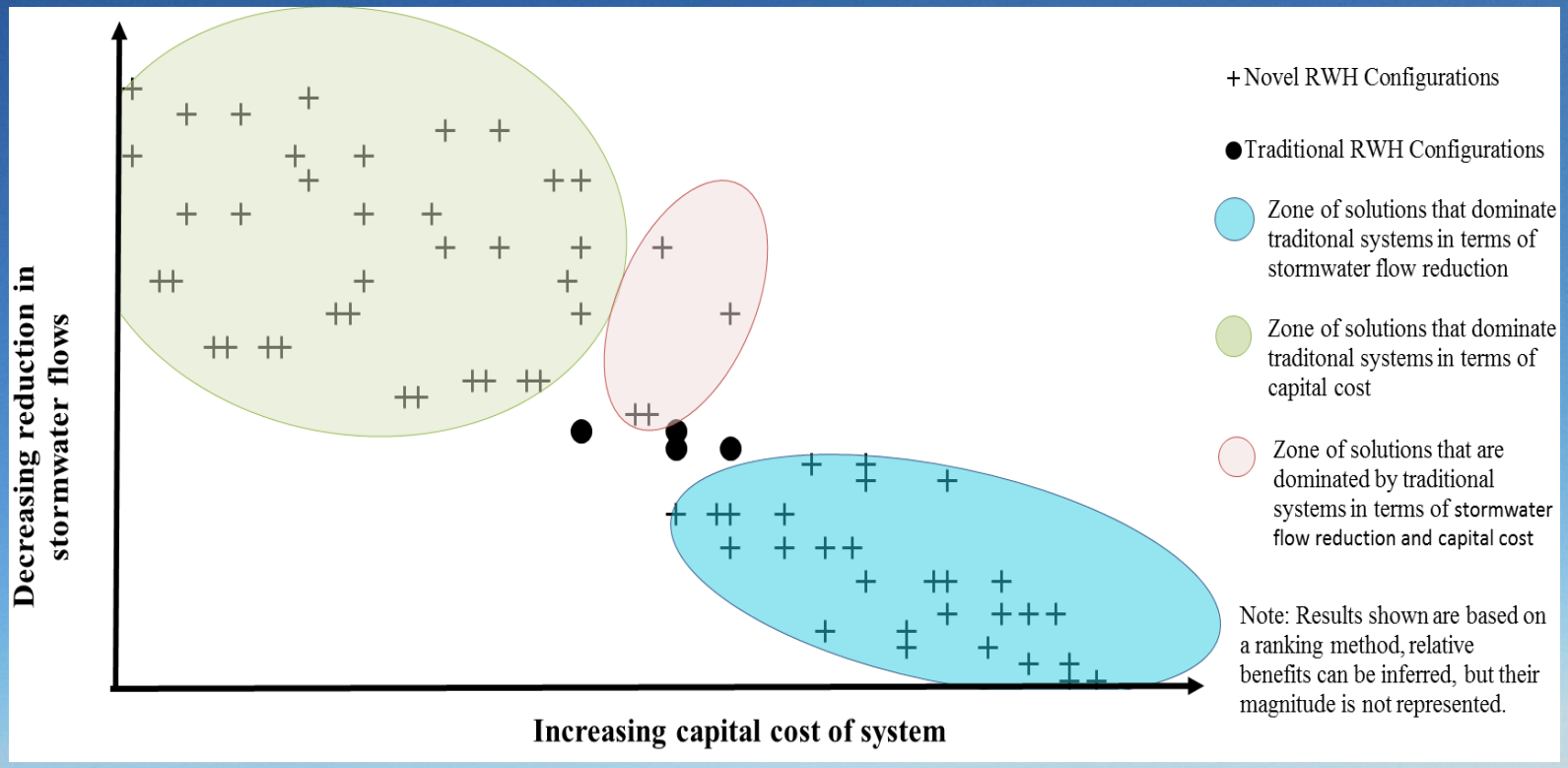






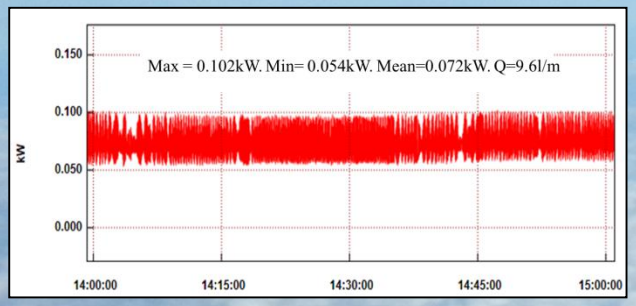


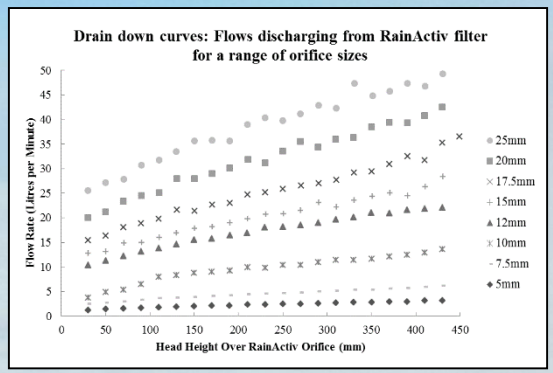
2) There are 72 RWH Configurations…



3) Lab Work


EXPERIMENTAL RAIN WATER
PUMP No. 1
PUMP No. 2


Max = 0.102kW. Min= 0.054kW. Mean=0.072kW. Q=9.6l/m
kW
0.150
0.100
0.050
0.000
14:00:00
14:15:00
14:30:00
14:45:00
15:00:00


Drain down curves: Flows discharging from RainActiv filter for a range of orifice sizes
Flow Rate (Litres per Minute)
Head Height Over RainActiv Orifice (mm)
25mm
20mm
17.5mm
15mm
12mm
10mm
7.5mm
5mm

4) Real-world Data

Water Efficiency Conference 2016

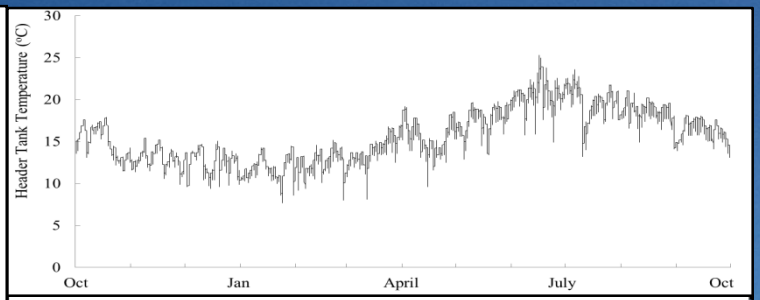
Evaluating FlushRain Retrofittable Rainwater Harvesting: A Pilot Study

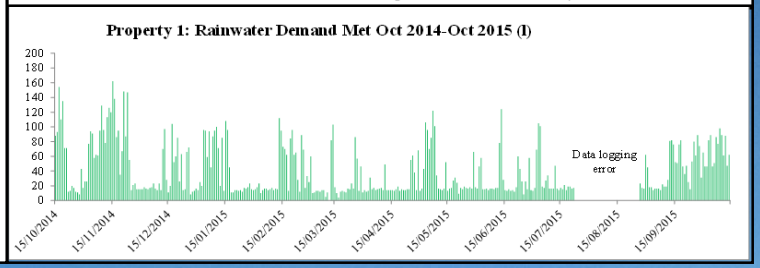
Peter Melville-Shreeve[†*], Sarah Ward[†], David Butler[†].
[†]University of Exeter, Centre for Water Systems,

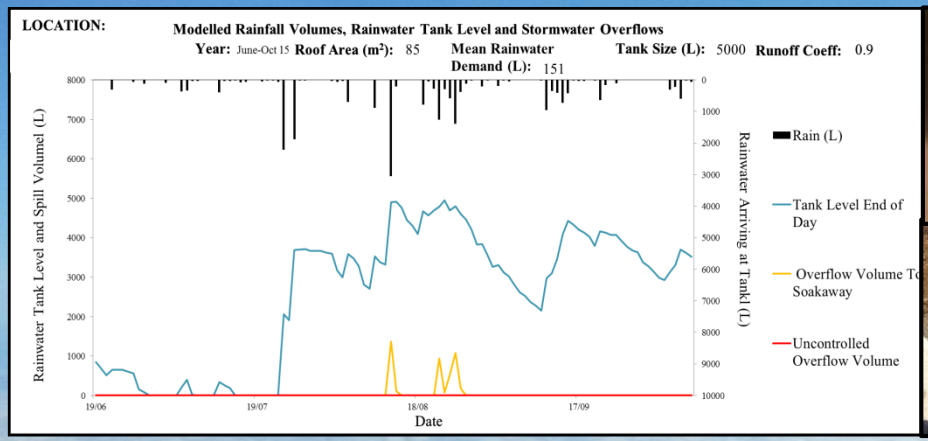
ABSTRACT

Aims: To evaluate a novel rainwater harvesting (RWH) system in a real-world setting.
Study design: A RWH system (FlushRain) was retrofitted to a house and monitored.
Place and Duration of Study: Exeter, UK. 12 months to October 2015.
Methodology: Meters and data loggers were used to record water savings, electricity consumption, rainfall and rainwater temperatures. Calculations were used to establish potential cash savings, and reductions in stormwater discharges.
Results: Monthly water savings were highly dependent on rainfall yields as the small tank volume was quickly emptied by the users. Annual water savings equated to 15m³ (£83 saving) despite a relatively small tank capacity (280l). Energy consumption was higher than expected at 3.08kWh/m³ (£6.95 cost). This was linked to the high standby-power consumption of the control-board rather than the cost of pumping water into the tanks. Capital costs for future installations have been estimated at approximately £1000 giving a simple payback period of approximately 12 years. Despite concerns that roof-located water tanks may experience higher water temperatures than below ground systems, mean monthly tank water temperatures were reported in the range of 11.5-20.6°C. Widely used chemical toilet treatments were used at the point of use to mitigate any potential risks associated with using rainwater in WCs. No frost issues were observed during the study with a minimum temperature recorded at 7.7°C.
Conclusion: A novel RWH system was installed and its performance monitored. Financial savings in areas with frequent rainfall (and high water costs) are sufficient to offset the cost of installation with a payback period of 12 years. Significant rainwater discharge reductions were achieved (38% annually) as a result of the system's installation.

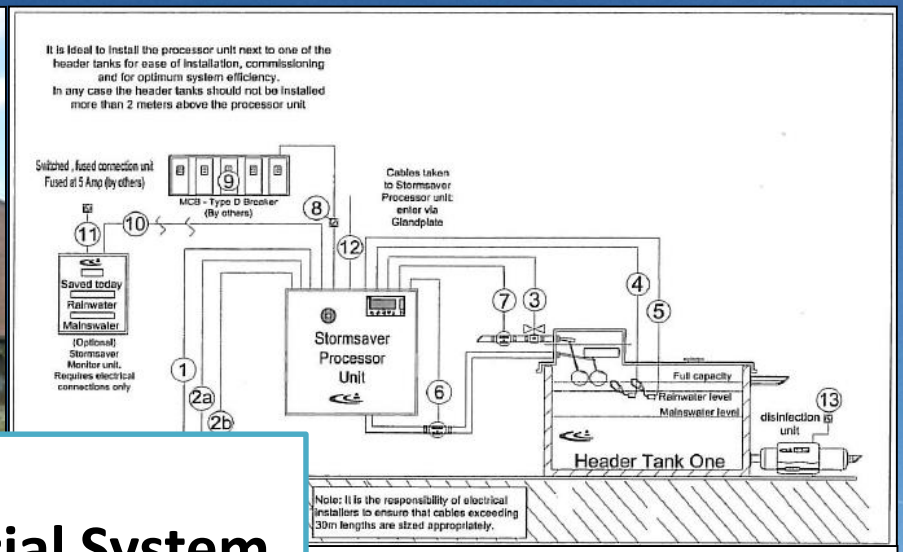
Keywords: Rainwater Harvesting, Retrofit, Stormwater Control, SuDs, Water Efficiency.



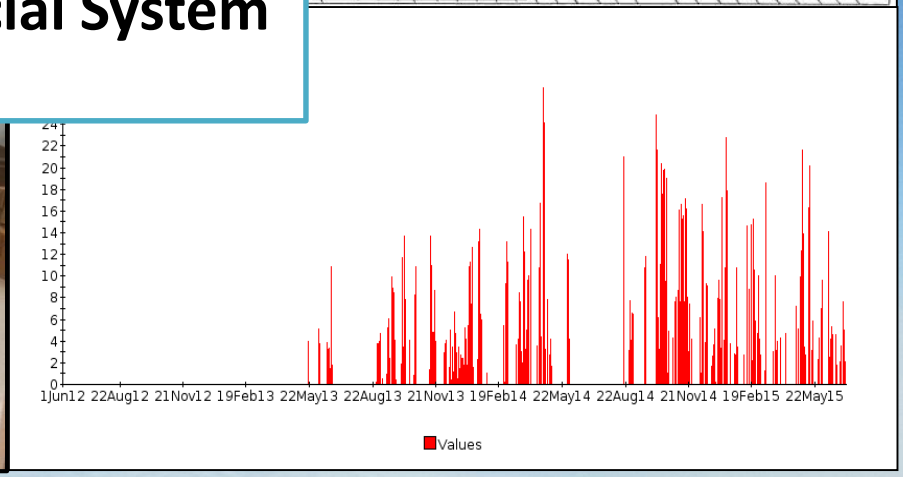




4) Real-world Data

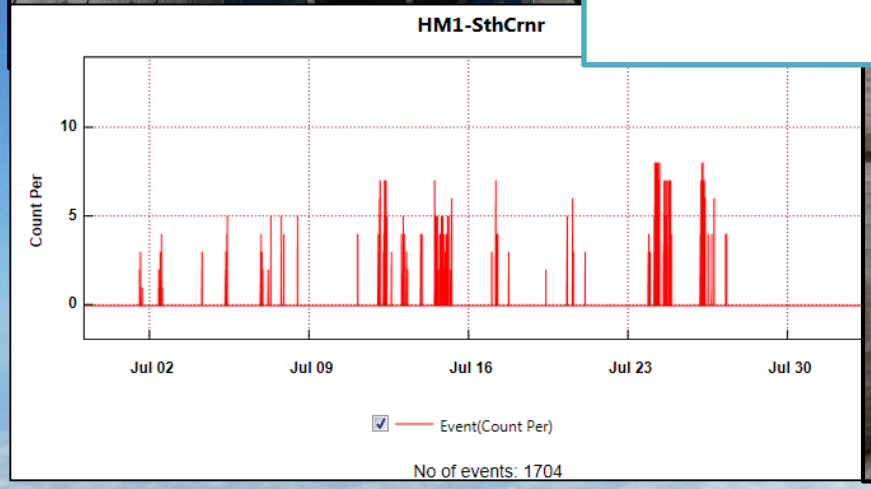


Commercial System



4) Real-world Data

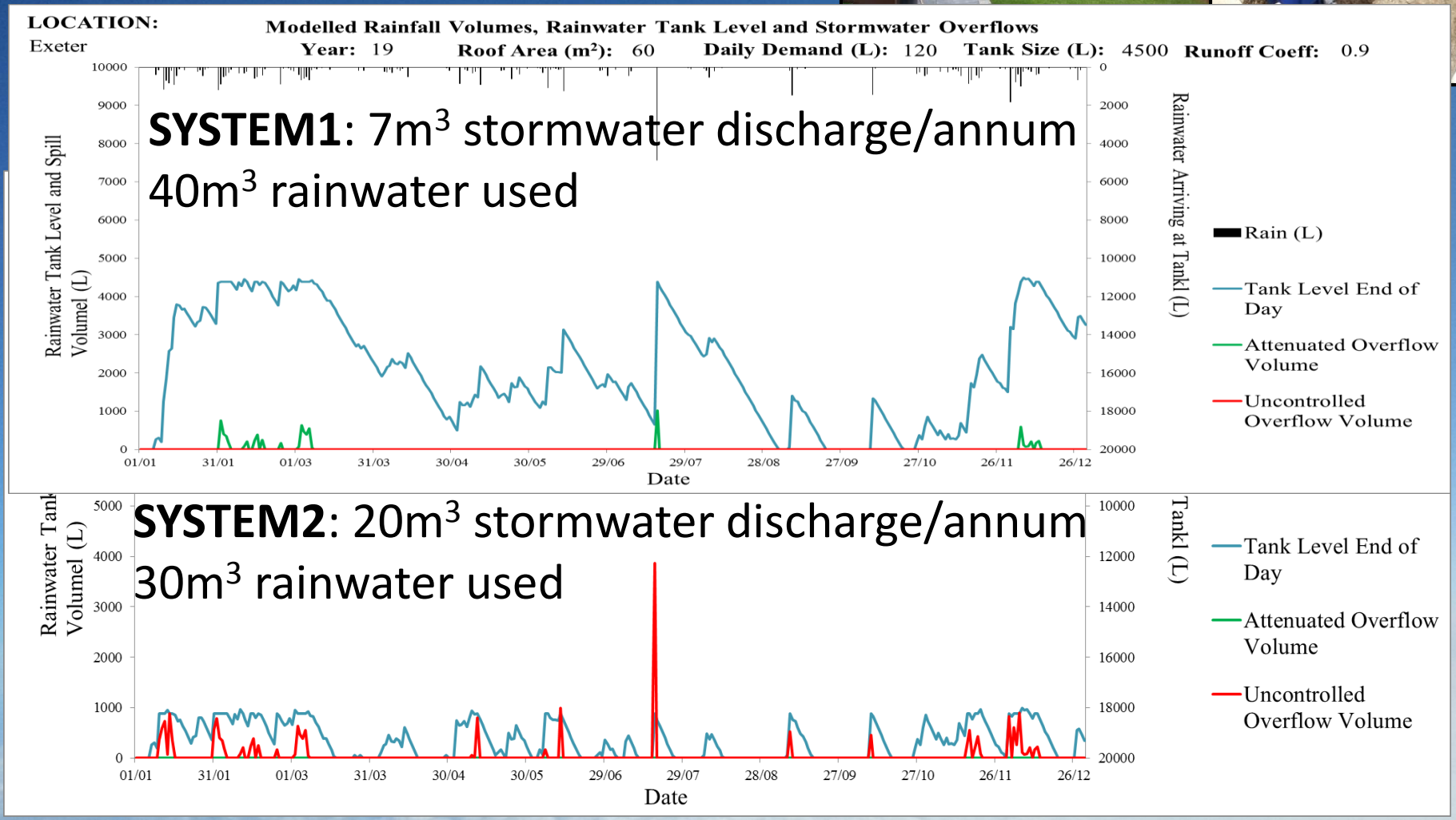
Zero Energy System



5) A RWH Evaluation Tool

- Time Series Rainfall Data
- Rainwater Demand Model
- RWH Configuration
- Stormwater Control Features
- Simulation Module

5) Model Outputs

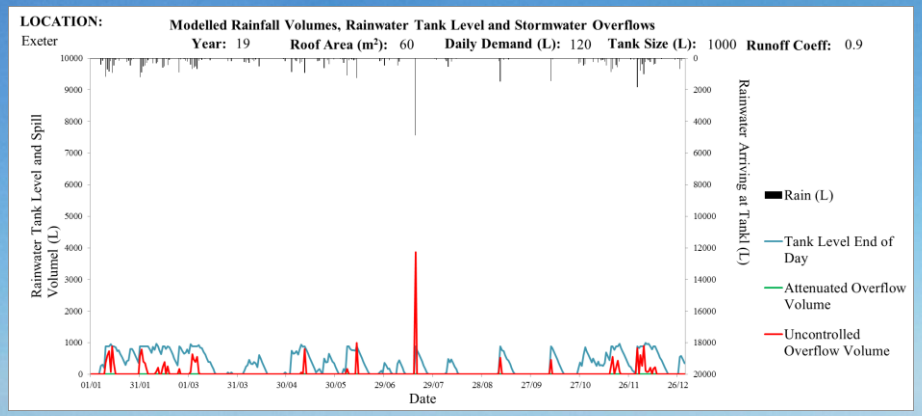


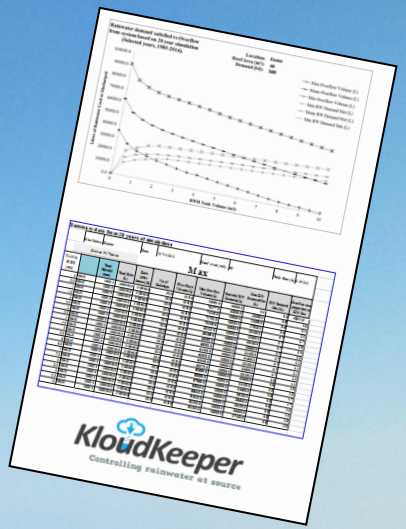
Three Messages?

1) Literature review identified state of the art RWH configurations and a multi-criteria analysis used to evaluate their abilities to satisfy a variety of objectives.

2) Lab work and real-world data has provided evidence of RWH's true functionality.

3) Decision Support Tool developed to enable methods to be commercially applicable.





The three routes: Where Next?

Academia? <u>Correct</u>

<u>Correct</u>

Industry?

or Start-Up?

<u>Correct</u>

KloudKeeper
Controlling rainwater at source

Contact: pete@kloudkeeper.co.uk

“Nothing is more powerful than an idea who’s time has come”
Victor Hugo