Imperial College London

IMPACTS OF BLUE-GREEN SOLUTIONS ON URBAN SUSTAINABILITY

E-19

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INTRODUCTION

The police station area, part of the Decoy Brook catchment in London, UK, has been identified as a 'flood risk zone'. A previous analysis of the catchment area proposed disconnection of the majority of roofs from the central drainage system by means of rainwater harvesting (RWH) and Sustainable Urban Drainage Systems (SUDS). However, the previous study only relied on a small variety of data without accounting for the local environmental conditions which could seriously influence the results (Ossa Moreno & Mijic, 2015). For this reason, the model needs a more holistic and complete urban water management analysis, which is performed using a more holistic modelling tool, the Urban Water Optioneering Tool (UWOT) (Rozos & Makropoulos, 2013), to quantify the effects of RWH on urban sustainability.

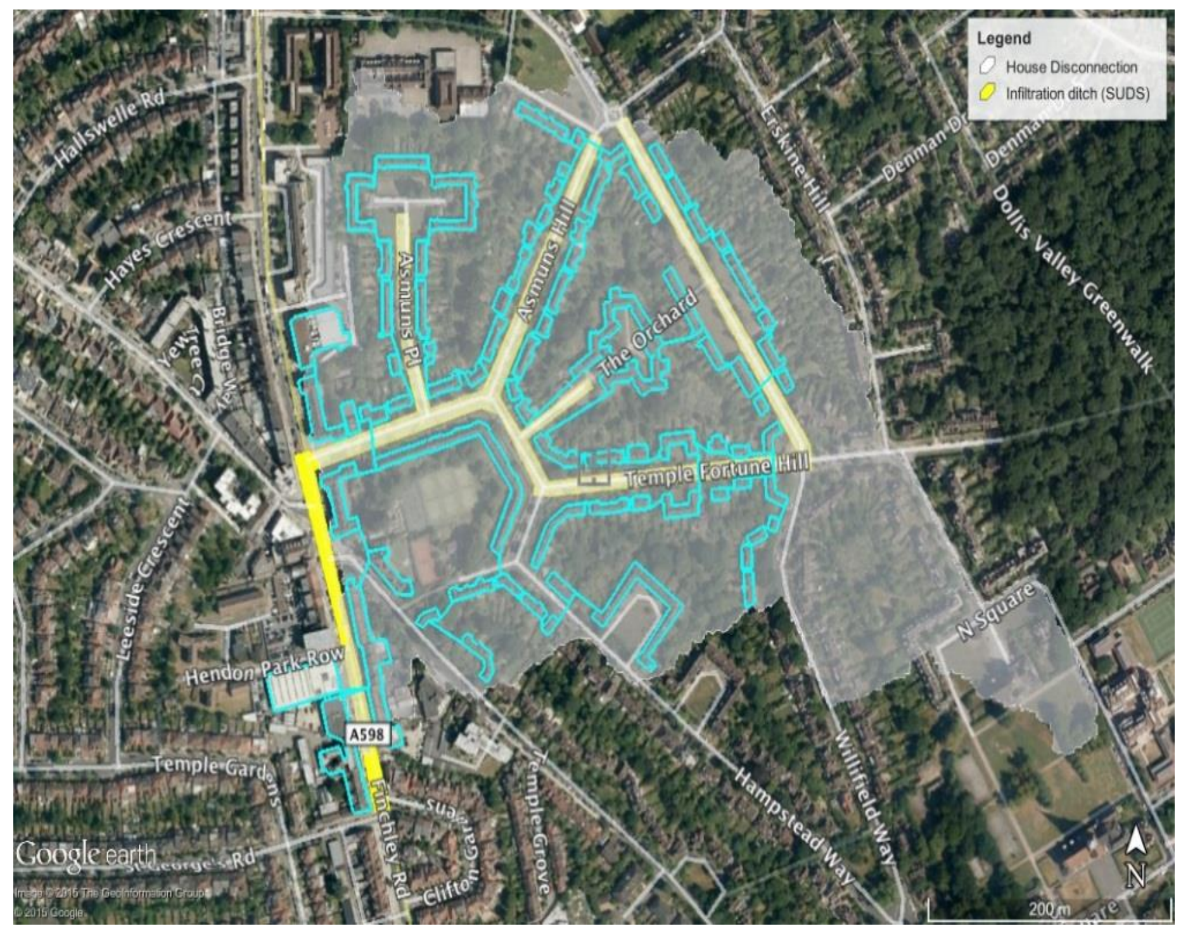

Figure 1: Police station sub-catchment showing the disconnection of roofs and implementation of SUDS

METHODOLOGY

Spatial data from the catchment is processed to create two representative units: a household and a commercial one.

Figure 2: Representative Household and Commercial Unit

	Total Area (m^2)	Unit Area (m^2)	No of units (m^2)
Households disconnected	49768.78	96.80	514
Households connected	6202.86		64
Commercial properties disconnected	4665.75	87.02	74

Five different scenarios are investigated to evaluate the effects on urban sustainability. In addition, analysis of effects of extreme weather conditions is performed for the year 2010 (wettest year within the simulation period).

Scenario 1	Base case scenario (centralised drainage system, no reuse)
Scenario 2	Base case scenario with irrigation from potable demand
Scenario 3	Disconnection of roofs and irrigation of gardens only
Scenario 4	Disconnection of roofs and reuse for appliances only (toilet and washing machine)
Scenario 5	Disconnection of roofs – reuse for both irrigation and appliances

OPTIMISING THE RAINWATER TANK SIZE

Scenario 5 is selected as the one which maximises the usage of harvested water. The rainwater tank size is optimised according to the maximum potable water demand reduction and it is found to be 2.2m^2/property.

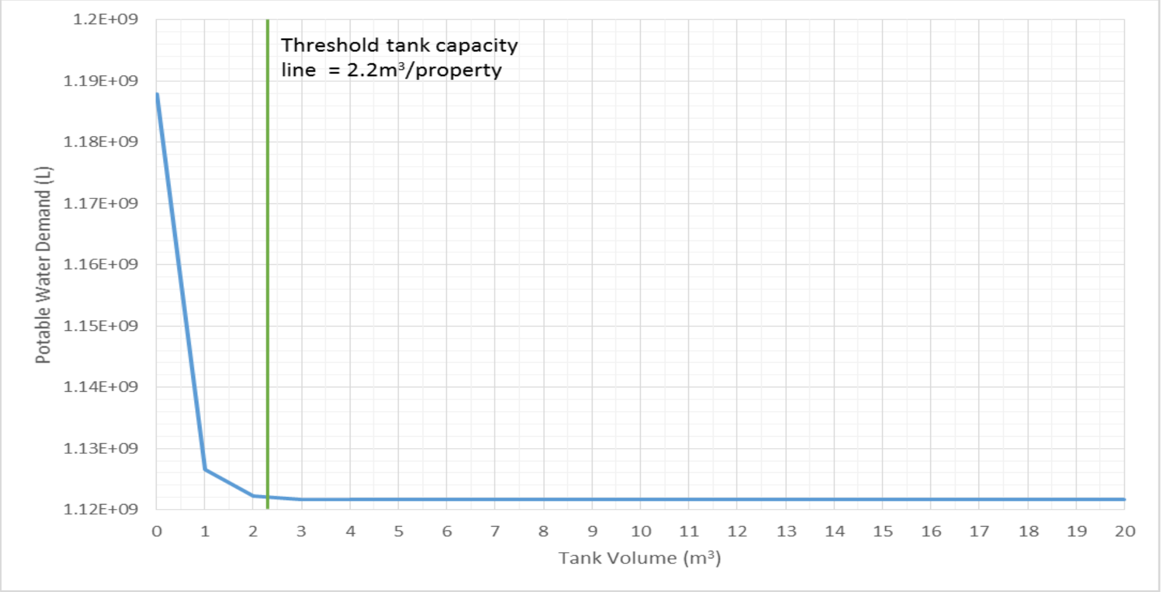

Figure 3: Potable water demand variation for different tank sizes

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REFERENCES

Ossa Moreno, J. S., Mijic, A. (2015) Improved techno-economic evaluation of Blue Green Solutions for managing flood risk to infrastructure

Rozos, E. & Makrpoulos C. (2013) Source to tap urban water cycle modelling. *Environmental Modelling and Software*. 41, 139-150

DRAINAGE AND POTABLE DEMAND EFFECTS

The runoff going to the drainage system is reduced by the same amount for scenarios 1 and 2. The maximum reduction is observed for scenarios 4 and 5 which is identical. For the wettest year simulation, drainage is reduced more than for the ten year period. The maximum reduction is observed to be 78.87%. The total drainage reduction can lead to enormous advantages on a local level such as enhanced flood protection, less expenditure on operation and maintenance of the drainage system and relief from large runoff loads. Also, the maximum peak runoff reduction is observed in the wettest year. The significant peak runoff reduction can save expenditure since drainage systems have to be designed for a smaller peak daily runoff load. The maximum total potable demand reduction is 12.67%. This results in savings for the residents. In more arid climates, this could result in increased resilience to drought. However, the peak potable demand increases compared to the base case scenario (scenario 1). Therefore, the water companies would have to modify the water supply systems' dynamics through pressure management to accommodate for larger peak daily potable demand. The property owners who invest in RWH technologies are expected to pay off the capital cost in less than five years and from then on enjoy a less polluted environment from reduced drainage and lower yearly expenses for potable water.

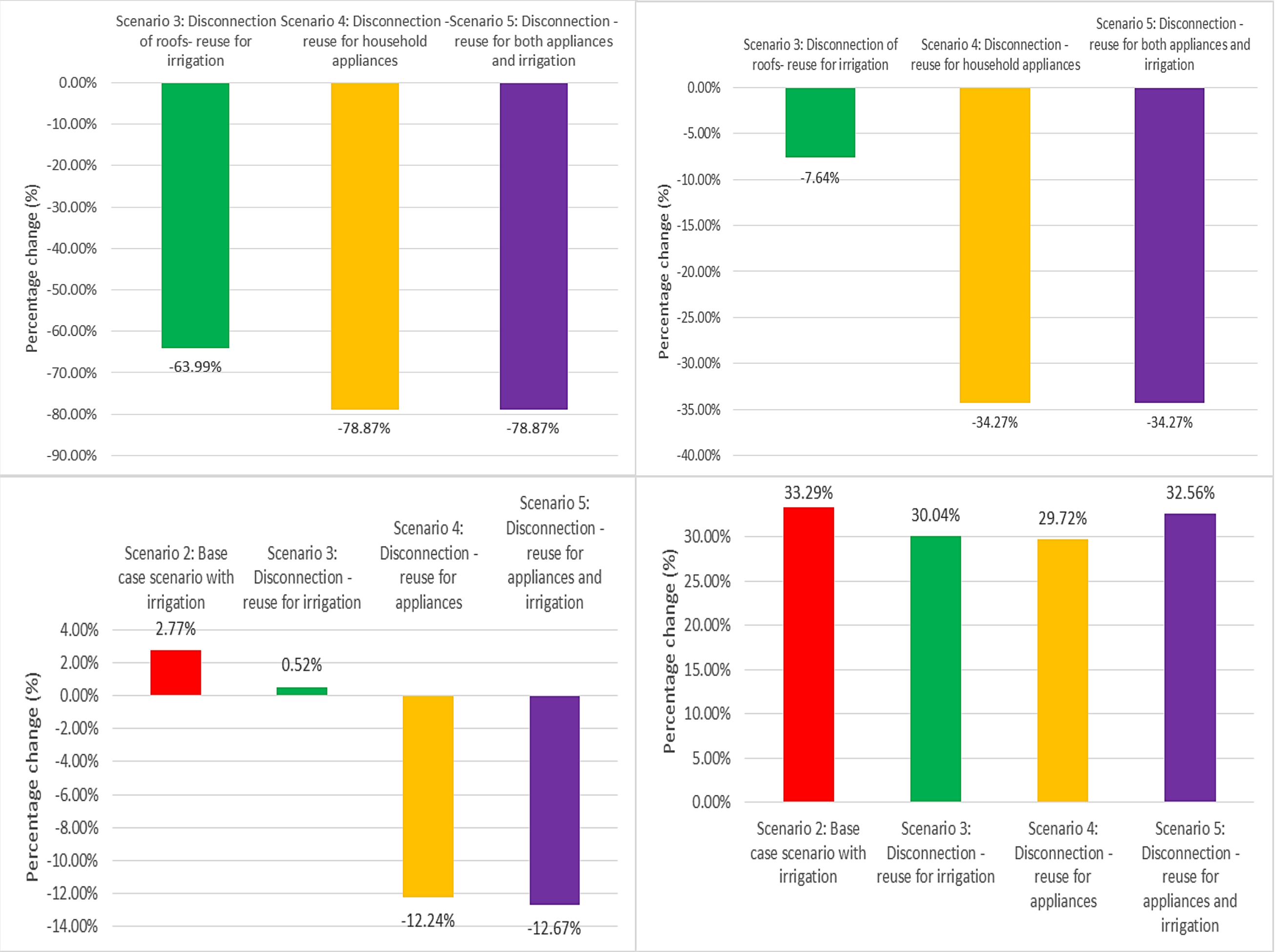

Figure 4: Runoff change (2010) (top left) Peak runoff change (2010) (top right) Potable demand change (2001-2011) (bottom left) peak potable demand changes (2001-2011) (bottom right)

EVAPORATIVE COOLING EFFECT

It is observed that the energy equivalent of evaporative cooling is significant, therefore implementation of RWH and SUDS results in lower energy expenses for heating/cooling as well as reduction of the Urban Heat Island (UHI) effect.

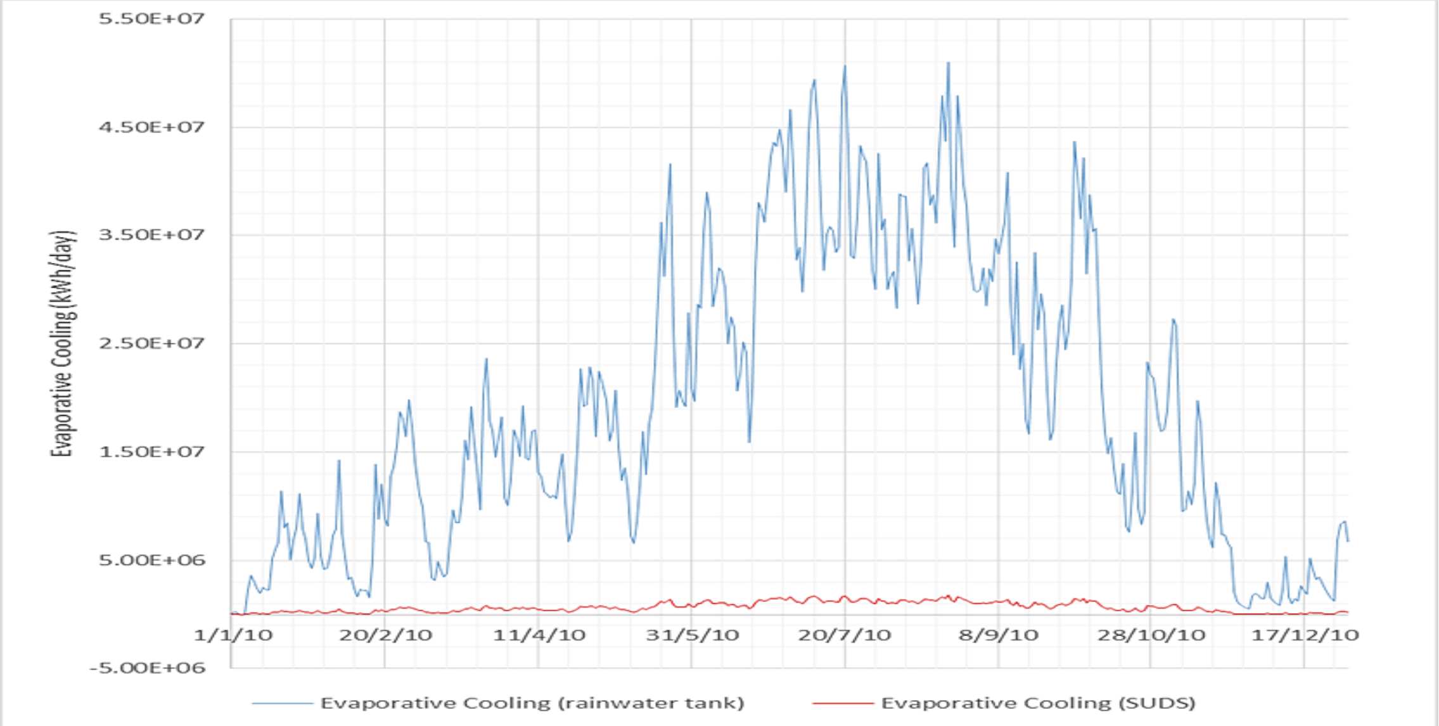

Figure 5: Energy equivalent of evaporative cooling effect

SENSITIVITY ANALYSIS

A sensitivity analysis for changes in the total rainwater tank size and SUDS size showed that the total runoff is more sensitive to SUDS changes while the peak runoff is more sensitive to rainwater capacity changes. This fact should be considered when designing an urban water management practice.

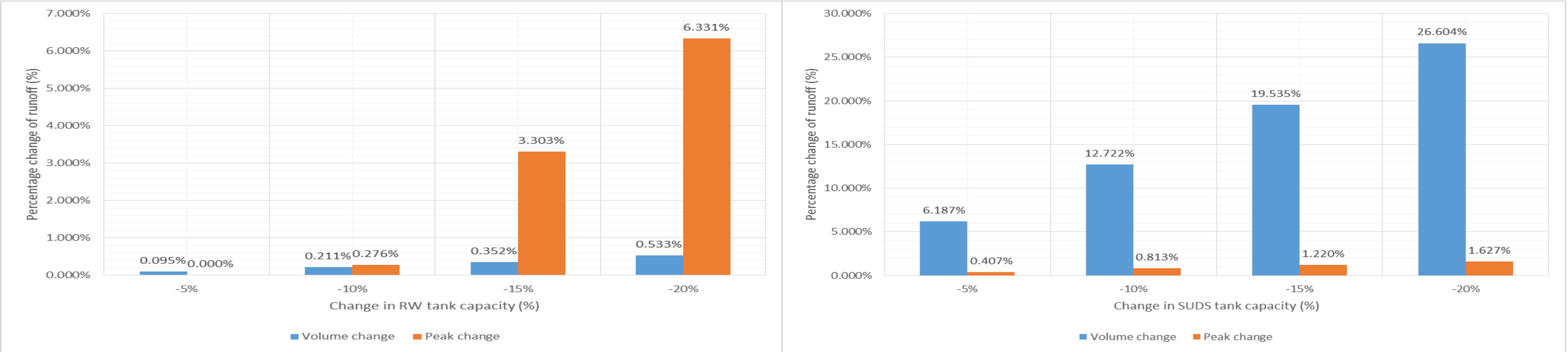

Figure 6: Runoff response to changes in rainwater tank capacity (left) and SUDS capacity (right)

FURTHER RESEARCH

Catchments of similar scale should be investigated to reach results for changes in different environmental conditions, technologies etc. Similar models could investigate long-term future urban development in terms of water. Larger scale catchments should also be investigated to provide a more holistic result of technology changes and increased urbanisation.