4th Annual Water Efficiency Conference 2016

Coventry, UK, September 2016

Water Frontiers: Strategies for 2020 and beyond

Water Sensitive Design and Renewable Energy: Green Infrastructure as the future path for Flood Resilience, Food Production and Energy Saving

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EXCELLENCE WITH IMPACT

1. Background

International collaborative effort funded by Conventry University through the project entitled "***Investigation of Green Infrastructure as a combined technique for Bioretention, Flood Resilience and Renewable Energy***"

Partners in research

- **Coventry University (UK)**
  - Centre for Agroecology, Water and Resilience (CAWR)
  - The Centre for Low Impact Buildings (LIB)
  - School of Energy, Construction and Environment
- **University of Cantabria (Spain)**
  - GITECO Research Group
- **University of Oviedo (Spain)**
  - GICONSIME Research Group
- **North carolina State University (U.S.A.)**
  - Stormwater Engineering Group
- **Garden Organic (UK)**

2. Knowledge Gap, Aims and Objectives

KNOWLEDGE GAP

Detailed ***physical*** understanding of the ***processes*** that underpin the ***hydraulic, hydrological and thermal behaviour of swales*** when ***monitored in real-time under real storm events*** in the ***climate change*** era.

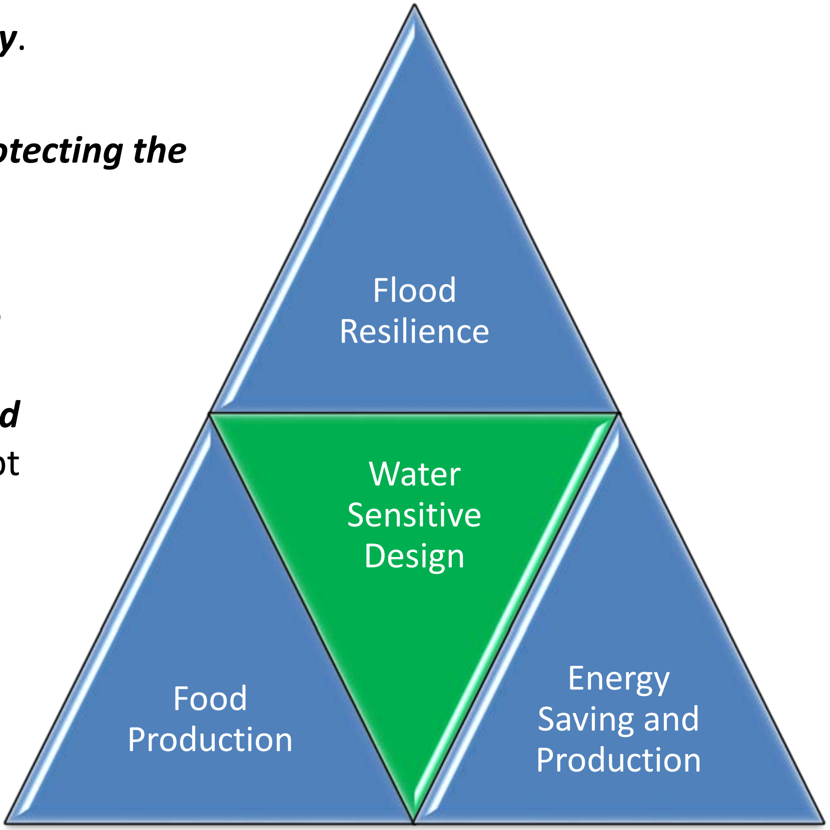
The ***combination of Green Infrastructure and Renewable Energy***.

AIM OF THE PROJECT

To ***provide flood resilience*** whilst ***creating better spaces*** and ***protecting the biodiversity of ecosystems***.

SPECIFIC OBJECTIVES

- To ***determine*** the ***hydraulic and thermal performance of GI in real-time*** under real and varying conditions.
- The generation of ***models of performance of the hydraulic and thermal behaviour of Green Infrastructure*** as proof of concept for their potential use as part of a geothermal system.
- ***Validation*** of the ***models of performance*** using the field and laboratory data.
- Estimating the ***transnational impact of GI***, via a comparison with U.S. case studies.
- Determination of ***water quality, chemical and biological pattern***s of GI performance.
- Assessment of the ***suitability*** of the water for reuse within ***Rainwater Harvesting Systems, Urban Agriculture and other non-potable uses***.



Pyramid of the Sustainable Management of water, food and energy

3. Research Structure

Source: http://www.deviantart.com/art/Time-Machine-257388593

January 2016. Beginning of the project

February 2016 – February 2017. Thermal performance

May 2016. Visit to the NCSU

June 2016 – June 2017. Field monitoring

July 2017. End of the project

Source: http://www.deviantart.com/art/Time-machine-324424956

4. Experimental Methodology

4.1. Laboratory and Field Experiments

Centre for Agroecology, Water & Resilience

Thermal Performance of Green Infrastructre (GI)

- Potential application within Ground Source Heat Pump technology
- Thermal Properties of the materials
- Thermal Evolution of a swale in the field

Hydraulic and Hydrological Performance of GI

- Field Monitoring of the hydrological performance of swales
- Hydrological performance under seasonal effects

Water Quality Analyses

- Laboratory analyses: TSS, Nitrate-Nitrite, BOD
- Field analyses: DO, Tª, EC, pH

Microbiological Performance

- Laboratory experiments: microscopy and water analyses

4. Experimental Methodology

4.2. Field Monitoring

The ***hydraulic performance*** is ***monitored by measuring their water levels*** and by comparing those with the ***rainfall data*** obtained from the UK Met Office for both locations during ***12 months***. This would allow to identify the ***seasonality effect***.

Location	Type of Green Infrastructure
Ryton Gardens, Coventry, West Midlands	**Swale connected to Green Roofs**
Hamilton, Leicester, East Midlands	**Sequence of Swales**

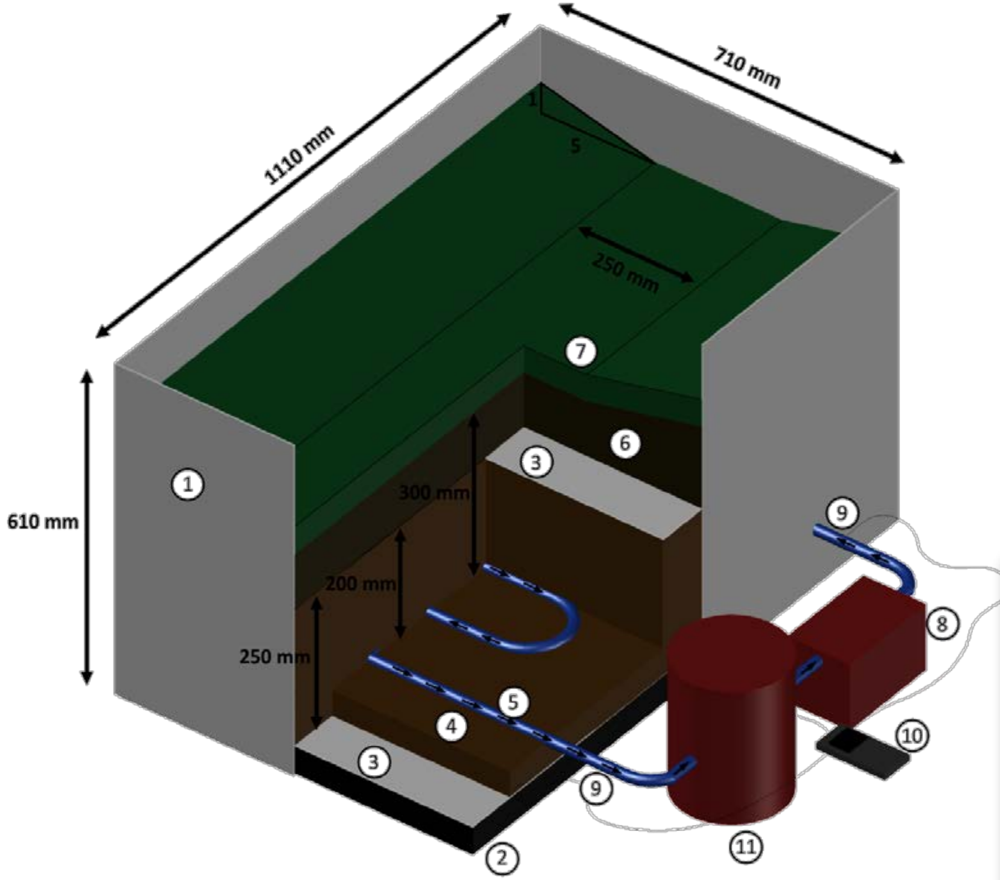
Source: Google Maps

Water level monitoring devices are utilised such as the ***OTT Orpheus Mini*** which is placed at the ***discharge point*** of the swale in Ryton and at the inlet and outlet points in the site in Hamilton (Table 1). The temperature (fundamental for the purpose of checking the potential benefits of these systems for their use as part of a geothermal energy system) will also be measured in real-time in both locations.

Water quality parameters such as ***Electric Conductivity (EC), pH, Dissolved Oxygen (DO) and LDO*** will be measured periodically through the use of a ***multi-parameter portable meter HACH HQ40d***.

4. Experimental Methodology

4.2. Laboratory Experiments (Initial Experiments)



(1) Polyethilene container; (2) Plastic cells; (3) Non-woven polypropylene based geotextile; (4) Sub-base layer; (5) Flexible pipe; (6) Base layer; (7) Vegetated surface; (8) Hydraulic pump; (9) Thermocouples; (10) Digital thermometer; (11) Water reservoir tank

Thermal Performance Tests

- 5^0C
- 10^0C
- 20^0C
- 30^0C
- 40^0C
- 50^0C

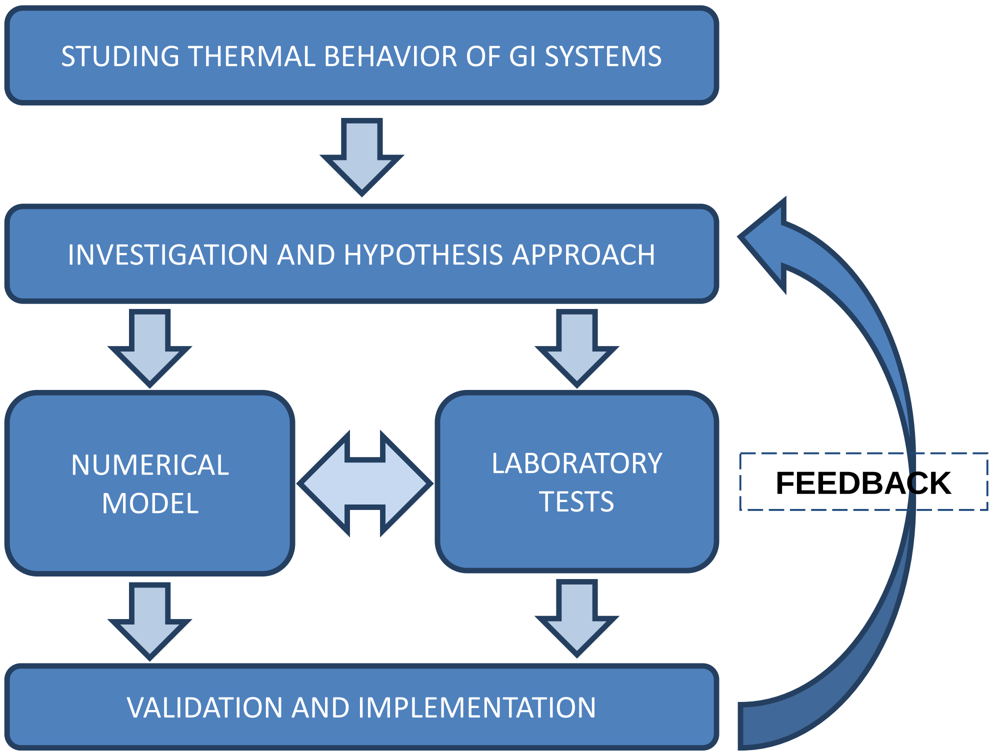
4. Experimental Methodology

4.3. Numerical Modelling Simulations

The Hybrid Engineering (HE) methodology applied for this research project

Numerical simulations will be divided into two steps as per indicated as follows:

- Numerical Simulation of GI. The thermal performance of GI will be studied in finite element models (FEM) and validated through the experimental results obtained in the thermal performance of GI.
- Design Of Experiments (DOE). This technique will be used to determine the influence of different GI parameters (geometry, thermal properties of the materials used, etc.). The results obtained would allow optimising these systems for its implementation to real scale, adding real value for money to the project.

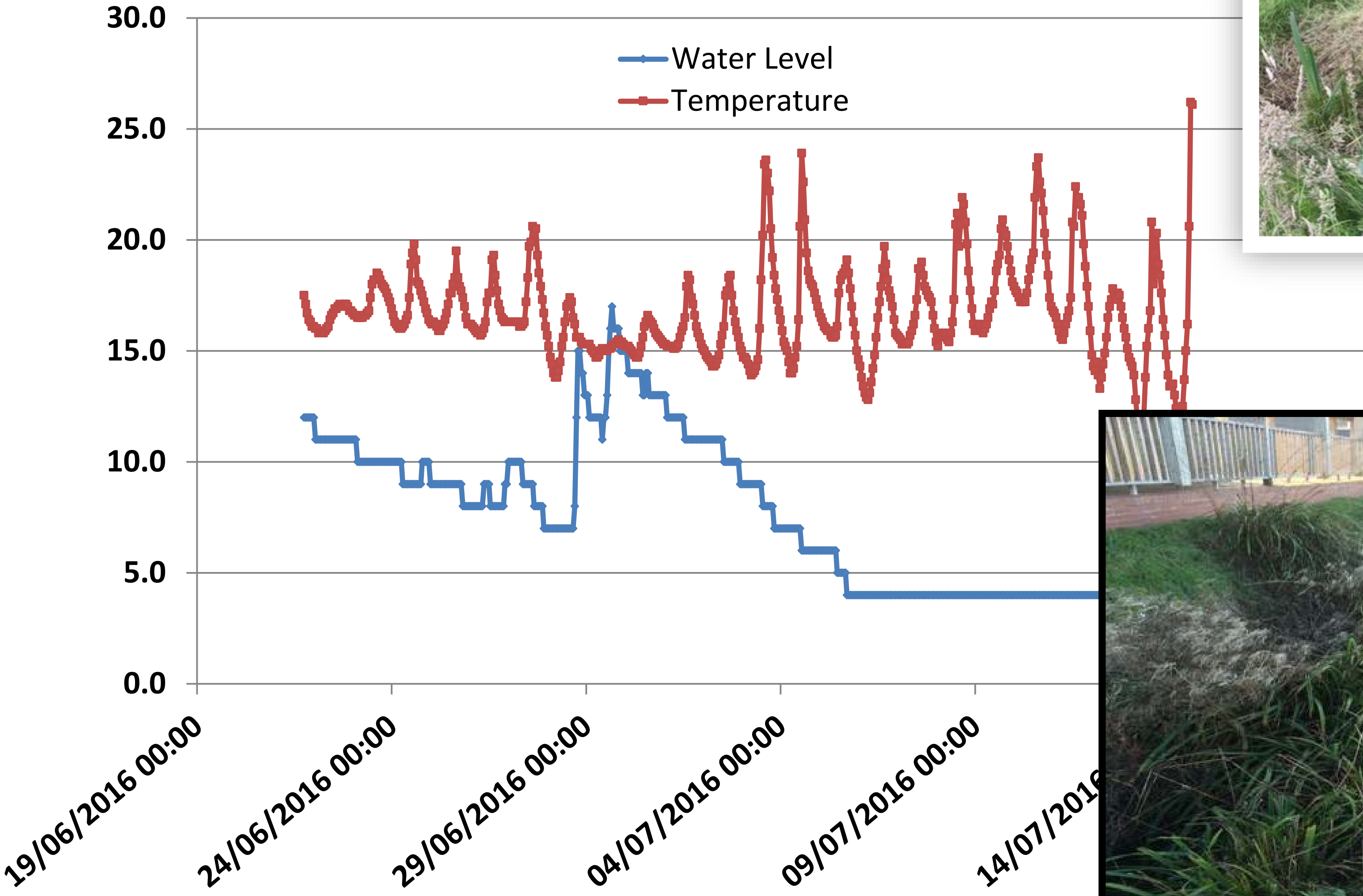


4.4. Green Infrastructure Workshop

CAWR TV Broadcasting! LIVE from around the world

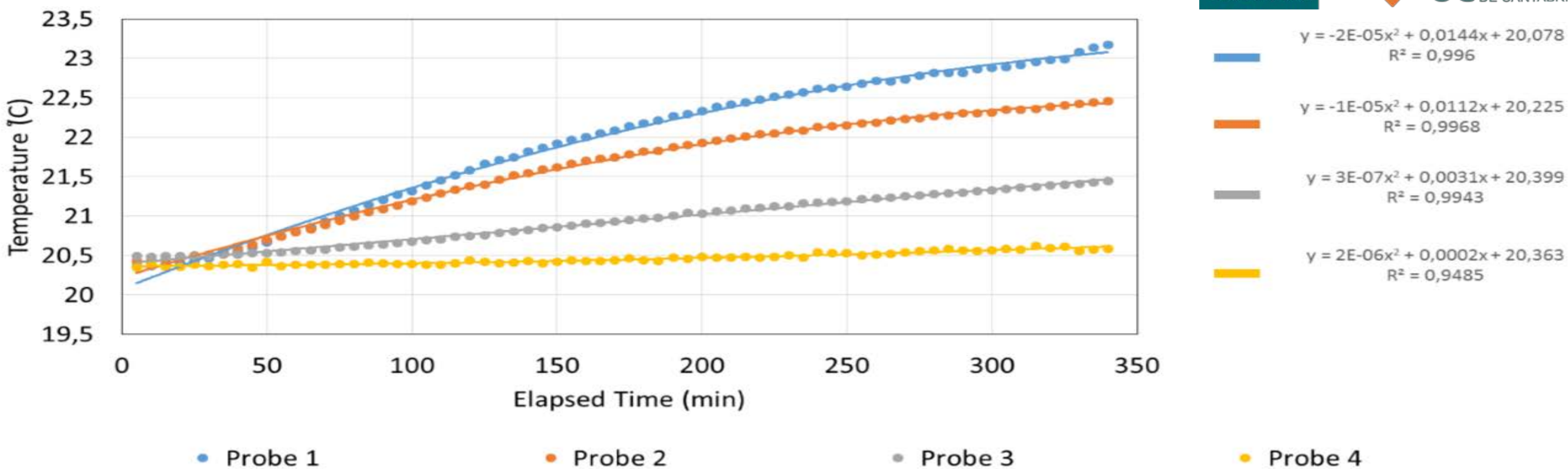
5. Initial Results and Preliminary Discussions

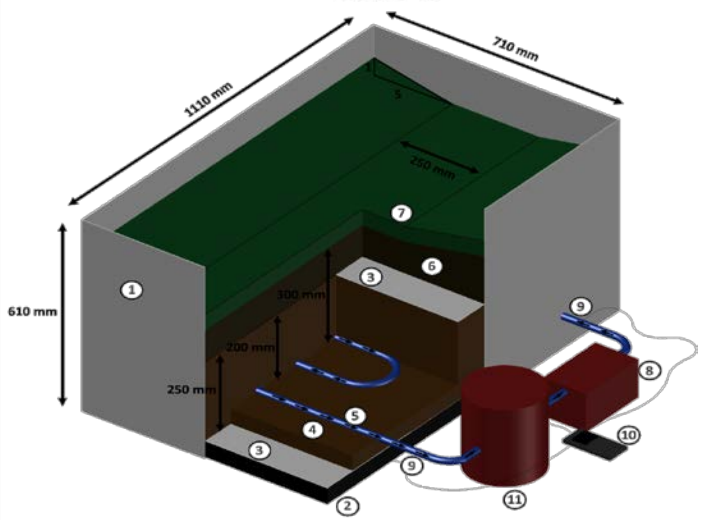
5.1. Field Monitoring *(24th June till the 14th July 2016)*



5. Initial Results and Preliminary Discussions

5.2. Laboratory Experiments





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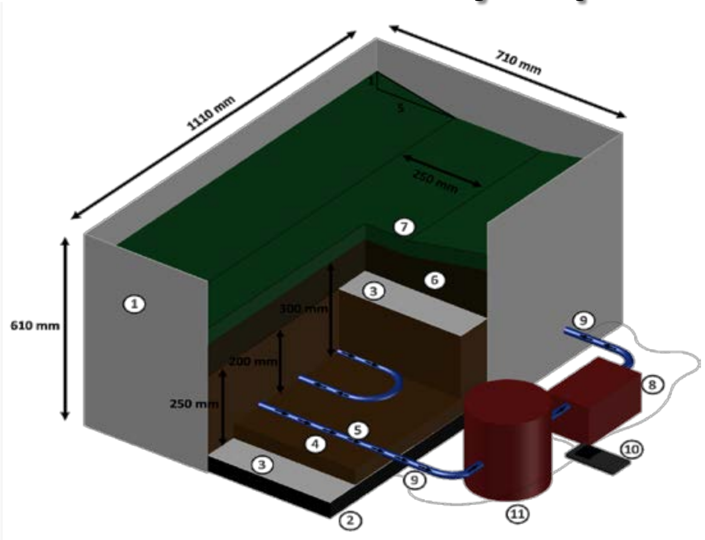

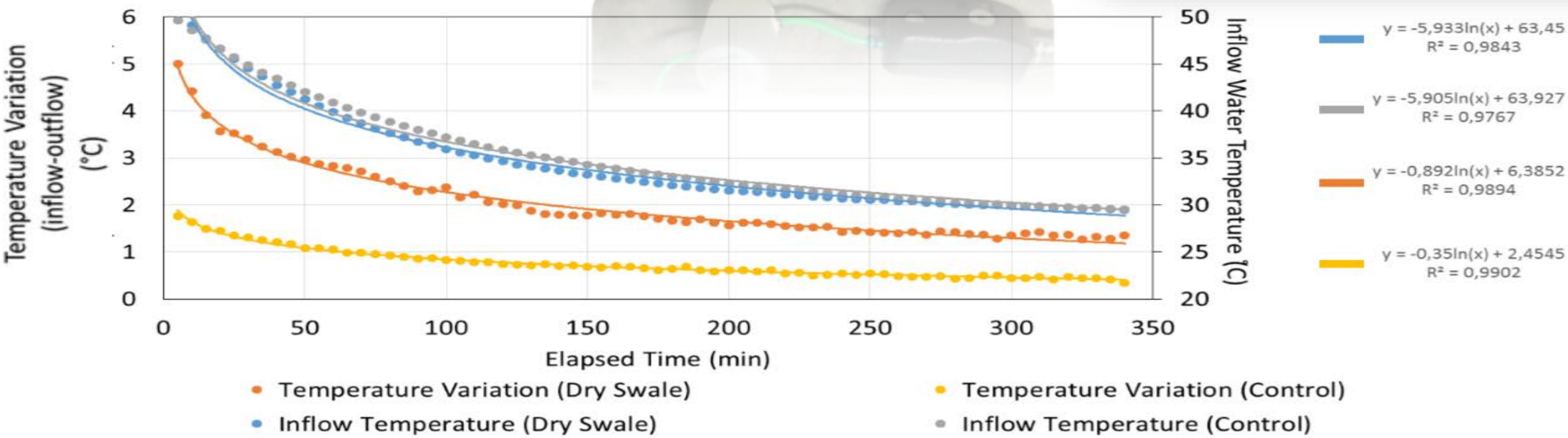

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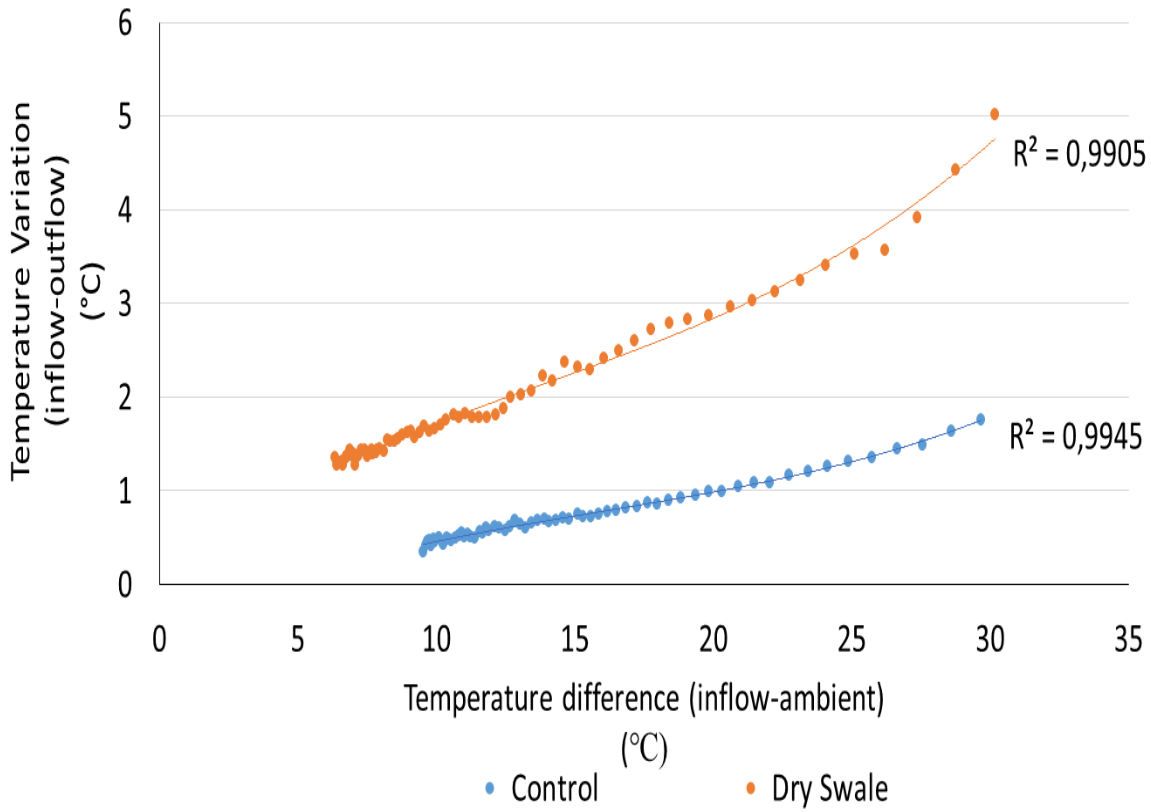

6. Preliminary Conclusions

A combined and ***new approach to Water Sensitive De***sign is possible by implementing the suggested "***Pyramid of the sustainable management of water, food and energy***" which aims to provide a wider benefit by ***enhancing the variety of ways to face infrastructural challenges such as flood resilience, food production and energy saving***.

A ***methodology in the laboratory and in the field*** can be established in order ***to determine whether a combined system of Green Infrastructure and Renewable Energy works*** as a proof of concept.

Initial results in the field and in the laboratory have shown a ***promising path towards the application of renewable energy in Green Infrastructure***.

7. Next Steps and Future Research

Thermal Performance of Green Infrastructre (GI)

- Thermal Properties of the materials
- Thermal Evolution of a swale in the field

Hydraulic and Hydrological Performance of GI

- Field Monitoring of the hydrological performance of swales

Water Quality Analyses

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Acknowledgements and contact

Coventry University
MODERN UNIVERSITY OF THE YEAR
2014, 2015 and 2016
Source: The Times and Sunday Times Good University Guide 2016

Thanks to Coventry University for funding the project entitled "Investigation of Green Infrastructure as a combined technique for Bioretention, Flood Resilience and Renewable Energy", framework of the research presented in this conference

Centre for Agroecology, Water & Resilience

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European Regional Development Fund
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Universidad de Oviedo
NC STATE
garden organic

Would you like to join us in this adventure?

Please contact us!

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"Cantabrum indoctum iuga ferre nostra"
"Invicta animi"

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