# Potentialities of infrared thermography application to green roofs aromatic plants surface temperature evaluation

[1]Cristina M. Monteiro, [1]Cristina S.C. Calheiros, [2]Paulo Palha, [3]Sara de Freitas, [3]Nuno M.M. Ramos, [1]Paula M.L. Castro

[1]CBQF – Centro de Biotecnologia e Química Fina – Laboratório Associado, Escola Superior de Biotecnologia, Universidade Católica Portuguesa/Porto, Rua Arquiteto Lobão Vital, Apartado 2511, 4202-401 Porto, Portugal; cmonteiro@porto.ucp.pt ; ccalheiros@porto.ucp.pt; plcastro@porto.ucp.pt

[2]Neoturf - Rua das Amoreiras Nº155, 4460-227 Senhora da Hora, Portugal; paulopalha@neoturf.pt

[3]CONSTRUCT-LFC, Faculty of Engineering (FEUP), University of Porto, Porto, Portugal, Rua Dr. Roberto Frias s/n, 4200-465 Porto, Portugal; sarafreitas@fe.up.pt; nmmr@fe.up.pt

## Introduction

In the last decades, urban environment climate has faced some gradual changes due to the replacement of vegetation by impervious areas. As a consequence, several environmental problems have appeared in urban centres.

Rooftops are a significant part of the hard surfaces in urban areas changing the heat balance and thus increasing the heat island effect. Vegetation can have a positive effect in the microclimate and macroclimate lowering urban air temperature in the buildings surroundings due to evapotranspiration and shading. Therefore, green roof technology may help to overcome this well-known problem.

In the present study, two green roof platforms with different substrates have been implemented with aromatic plant species. Infrared thermography studies have been performed to assess the effect of different aromatic plants on temperature mitigation. However, several limitations of this technique must be considered, namely, emissivity and exterior conditions. These limitations can be overcome with dynamic measurements, for different periods, which will be a future development of this work.

## Research Setup

### Green Roof design

Two extensive 20m$^2$ green roof platforms have been installed according to the FLL guidelines – figure 1.

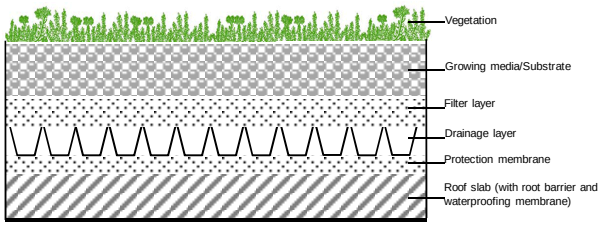


Figure 1: Green roof scheme

### Green Roof composition

| | Experimental | Commercial |
|---|---|---|
| **Vegetation** | ✧Aromatic species:<br>*Lavandula dentata*<br>*Satureja montana*<br>*Thymus pseudolanuginosus*<br>*Thymus caespititius* | ✧Aromatic species:<br>*Lavandula dentata*<br>*Satureja montana*<br>*Helicrisium italicum*<br>✧Sedum carpet (mixture of 11 *Sedum* sp.) |
| **Substrate depth** | 15 cm | 12 and 15 cm |
| **Substrate mixture composition** | ✧ Expanded clay (4-10 mm granulometry)<br>✧ Granulated cork (10-20 mm granulometry)<br>✧Organic matter from urban residues compost<br>✧ Crashed egg shell | ✧ Exclusive Neoturf mixture (fermented pine bark humus, selected blonde peat, expanded clay and special volcanic rock) |
| **Drainage layer** | ✧Expanded clay (2 cm height; 10-20 mm granulometry) | ✧ Alveolar recycled polyethylene (2 cm height) |

### Thermographic analysis

→ Qualitative infrared measurements (using a thermographic camera Thermo Tracer TH 7800 from NEC AVIO) have been performed – temperature differences between the different aromatic plants and the substrate were obtained.

## Results and Discussion

### Thermographic measurements

Experimental vs Commercial Green roof platform

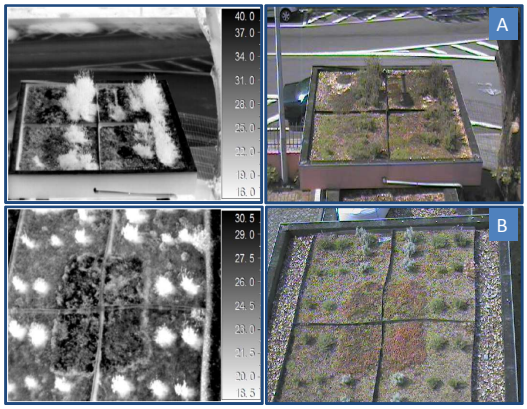


Figure 2: Experimental (A) and commercial (B) platform: thermogram at early afternoon and photography of the green roofs pilot systems

❑ Thermographic analysis showed:

- Lower surface temperatures for the green roof plants compared to the substrate;
- Different surface temperature for the aromatic plants used:

.:*Thymus caespititius* - characterized by a lower height and leaf density presents a higher surface temperature than the other aromatic species tested;

.:Sedum carpet - presents higher temperatures than the other aromatic plants

## Conclusions

The use of vegetation on roofs appears as a potential alternative technology that contributes to the mitigation of the urban heat island effect.

The green roof structure as building component influences the microclimate in urban areas, especially due to the vegetation contribution. This contribution was positively evaluated with infrared thermography measurements for different green roof plant species in spite of the inherent technology limitations.

The present research study will contribute to the application of infrared thermography as a technique to assess the surface temperature on green roofs vegetation at a smaller scale and to the urban environment at a larger scale.

Acknowledgements

C. M. Monteiro, C. S. C. Calheiros and Sara Freitas thank to Fundação para a Ciência e Tecnologia (FCT) and Fundo Social Europeu through the program POPH – QREN the grants SFRH/BPD/80885/2011, SFRH/BPD/63204/2009 and SFRH/BD/85838/2012, respectively. This work was supported by National Funds from FCT through project Pest-OE/EQB/LA0016/2013. Also, authors would like to express their gratitude to the dedication and assistance of Francisco Costa, João Rito e José Barros.