POLITECNICO DI TORINO
SECOND SCHOOL OF ARCHITECTURE
Master of Science in Architecture
Honors theses

Theoretical and experimental study on the thermal behavior of green roofs
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The work accomplished in this thesis regards the study of thermal behavior of green roofs.
The purpose of the experimental analysis performed on green roofs is to evaluate the thermal performance of the entire system in relation to its moisture content, density, thickness, thermal conductivity and specific heat of the material components of the stratigraphy, external air temperature and global solar radiation. To do this were carried out several measurement campaigns during the heating and cooling periods of the buildings.
More precisely, I wanted to identify a mathematical model amenable to the trend of temperatures at some depths in the soil of the green roof systems.
Since the alternation of night and day creates in general a 24 hours cyclic trend of the temperatures and heat fluxes, with maximum peaks during the day and minimum during the night, less than sudden changes in the weather, the model can be approximated with a trigonometric sinusoidal function.
To optimize thermal performance of green roofs were evaluated several static and dynamic physical parameters.

Three different types of roofs were analyzed in Turin, to reflect the casuistry of the main division of green roofs:

- Extensive green roof, by the offices of the Department of Regione Piemonte in Corso Regina Margherita 174;
- Light intensive green roof, by the I classrooms of Polytechnic in Via Boggio;
- Intensive green roof, by the laboratories of Environment Park in via Livorno 61.

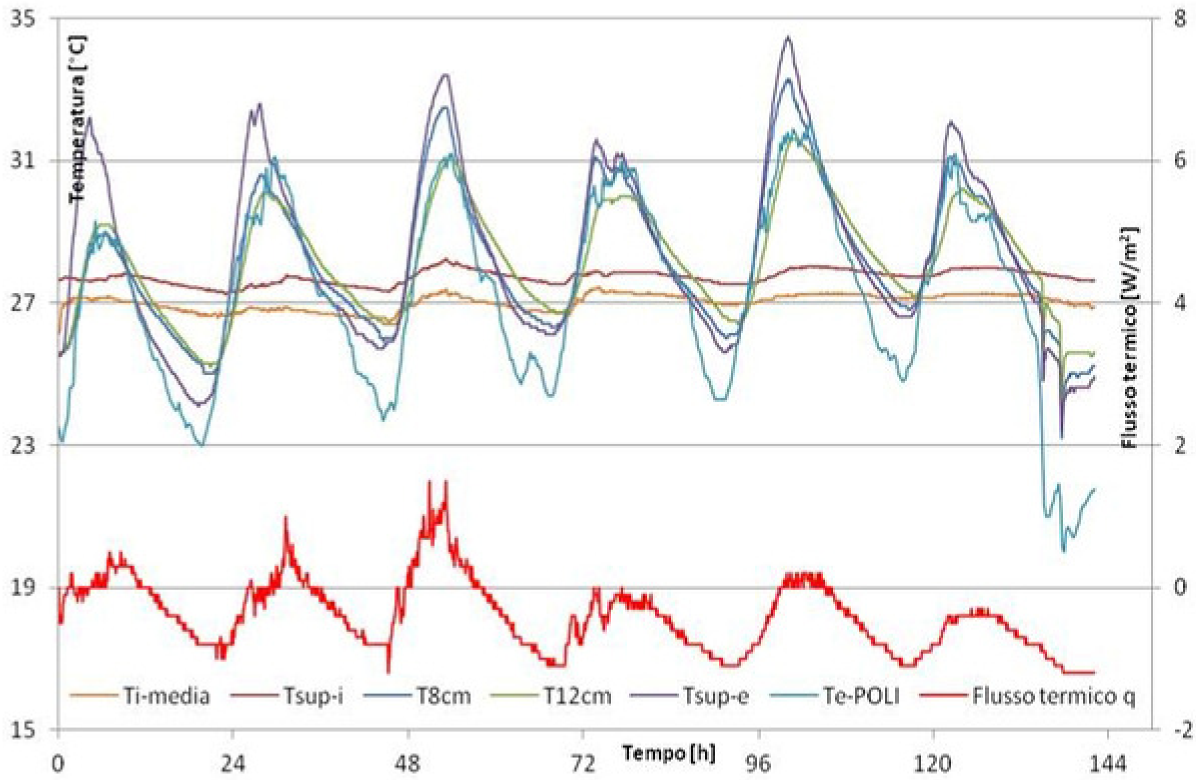
In this experimental study different parameters were used to analyze the thermal behavior of green roofs. The quantities involved were divided in measured parameters and calculated parameters. The measured parameters are tightly tied to the measurement campaigns carried out.

The measurement campaigns were carried out respecting the ISO 9869 standards. The purpose of the measures was to compare the thermal behavior of the layers of the green roof systems with the calculated parameters.

To evaluate the thermal performances of the stratigraphy of the roof, instrumentation was positioned as follows:

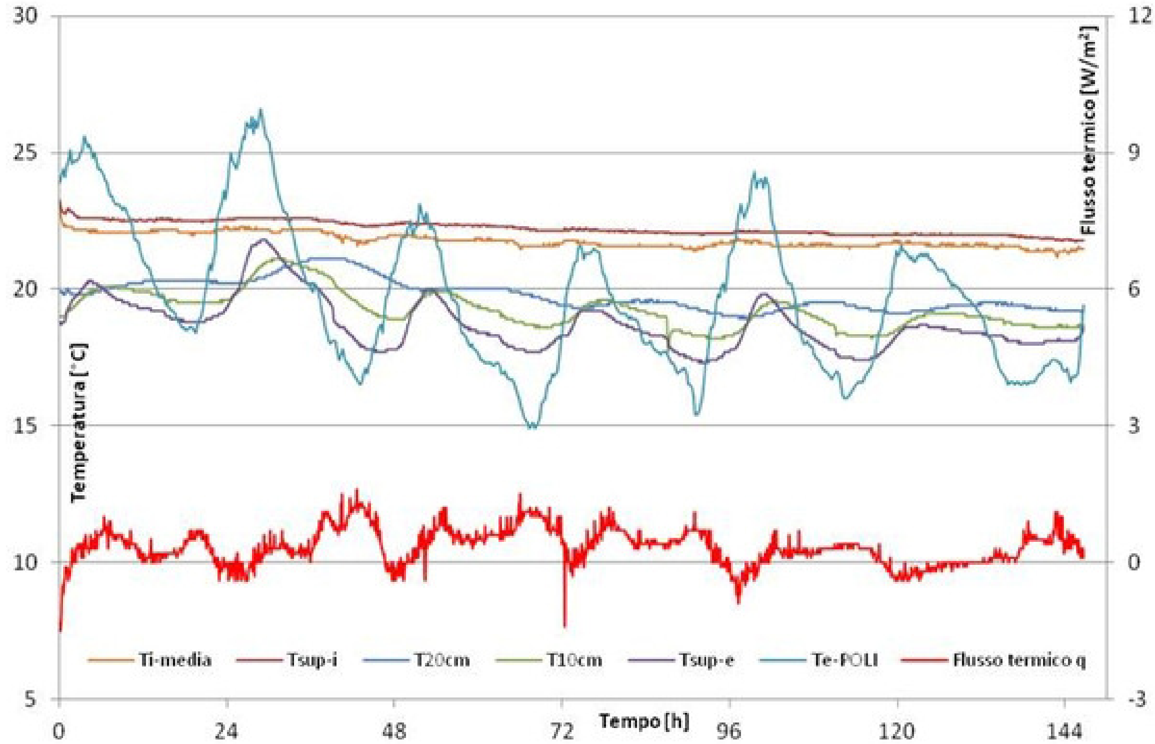
- a heat flow meter on the intrados of the insole;
- three thermocouples on the intrados of the insole;
- three external thermocouples positioned at two different depths in the soil and one on the surface of the soil;
- two probes for indoor temperature, positioned at two different heights from the floor.
- a data-logger to acquire the readings of the probes.

Here are the results of the measurement campaigns of the cooling period for the three types of roof:

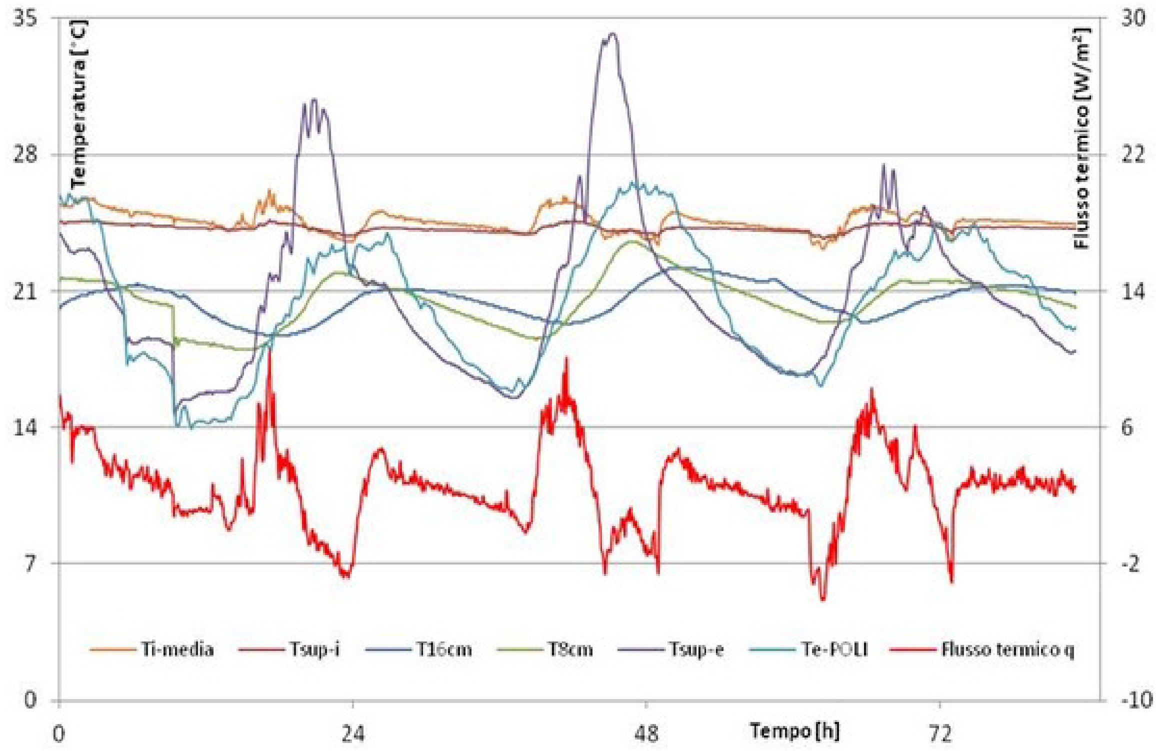


Temperature and heat flux measured in Regione during the measurement campaign of 26 June - 2 July 2012

Ti-media is the indoor average temperature, Tsup-i is the internal surface temperature of the insole, T8cm is the temperature recorded by the probe at 8 cm depth of the soil, T12cm is the temperature recorded by the probe at 12 cm depth of the soil, Tsup-e is the surface temperature of the soil, Te-POLI is the temperature of external air recorded by Polytechnic of Turin’s meteorological station.



Temperature and heat flux measured by the I classrooms of the Polytechnic, during the measurement campaign of 18-24 September 2012



Temperature and heat flux measured at Environment Park during the measurement campaign of 11-15 June 2012

It was therefore developed a linear regression model to evaluate the expected values of the measured parameters conditioned by the calculated parameters.

In the linear regression equations all calculated parameters multiply their coefficients of the regression method.

In conclusion, calculated parameters that affect the most measured parameters are surface mass and heat capacity. High values of density and specific heat, and so thermal capacity and thermal inertia, determine materials suitable for summer protection with good phase shift and attenuation of the thermal wave.

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