Green Infrastructure Lab

UTS

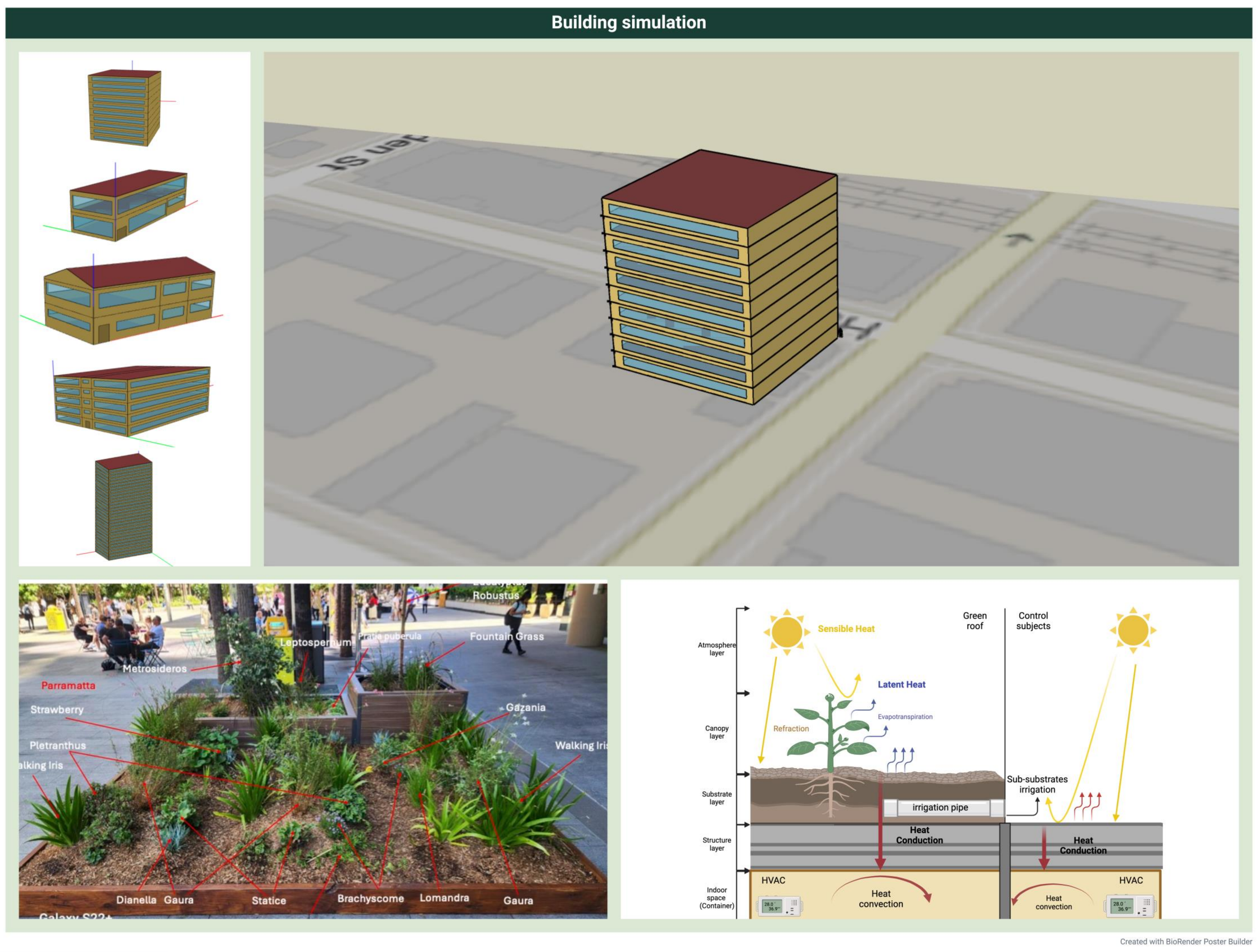
STUDENT RESEARCH

Harnessing the Power of Green: A Simulation-Based Study on the Energy Efficiency and Benefits of Green Roofs in Modern Architecture

SYNOPSIS

The urban heat island (UHI) has constantly searched for a sustainable remedy in recent years. Especially the demand for expanding green areas conflicts with the urban high-density architecture. The application of green roofs has emerged as a potential future trend. With regard to the concrete quantification of the environmental contribution of green roofs, plenty of uncharted research fields still exist.

The research presented a simulation comparing results from an energy model of six urban buildings for assessing building energy consumption and UHI mitigation. The outcomes provide a comparison of the heating and cooling performance after retrofitting buildings with green roofs, together with an assessment of the building performance changes from installing the Plantabox system as a green roof, to elucidate the reasons behind the differences on energy consumption.



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OBJECTIVE

Quantifying the contribution of the green roof to the environment, in particular to the overall energy performance of different types of urban architecture.

METHODOLOGY

The simulation extension of the plant boxes on the roof, in combination with SketchUp building models and energy calculations from EnergyPlus (using OpenSudio software).

ESTIMATED RESEARCH LENGTH

The modelling analysis required further validation in relation to a series of field studies, which took about 5 months to complete.

REFERENCES

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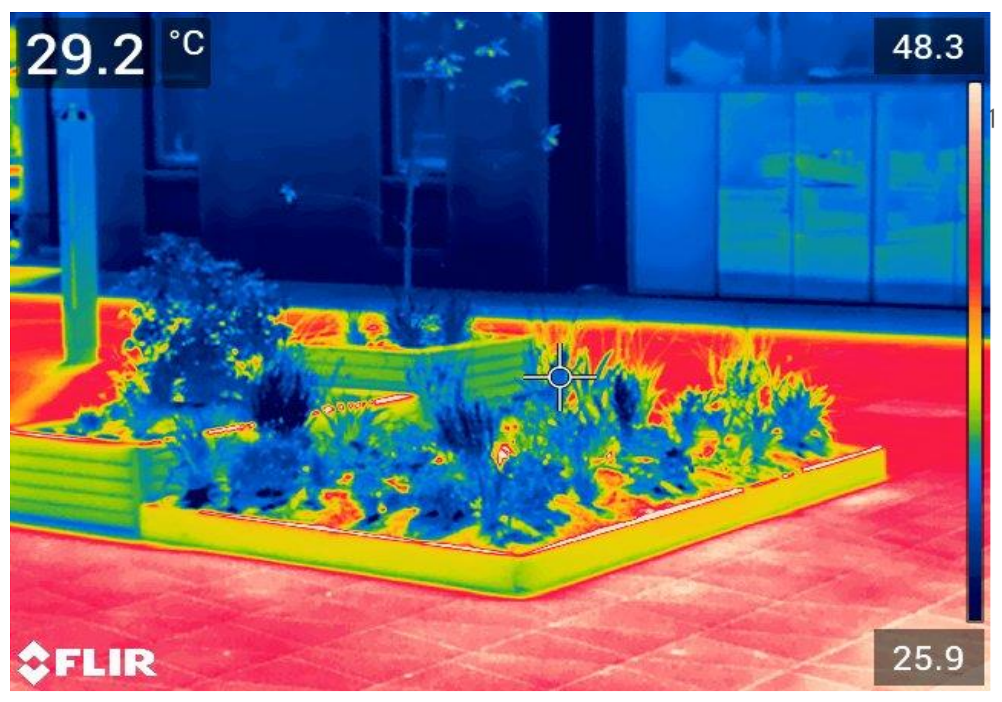
[2] L.S.H. Lee, C.Y. Jim, Thermal-irradiance behaviours of subtropical intensive green roof in winter and landscape-soil design implications, Energy and Buildings 209 (2020) 109692.

[3] N.H. Wong, Y. Chen, C.L. Ong, A. Sia, Investigation of thermal benefits of rooftop garden in the tropical environment, Building and Environment 38(2) (2003) 261-270.

BACKGROUND

The urban heat island (UHI), leading to high temperatures inside the city, has been an ongoing area of significant concern over recent years. The consequences for the public include a potential 20% higher rate of heat-related deaths; increased heat-related illness complications; and energy and economic costs. by 2019, 46% of Sydney residents were suffering from the UHI. The installation of green roofs on buildings has been identified as a potential solution to this issue, as it provides an effective increase in urban green space as well as compatibility with urban-specific high-density planning.

FLIR IMAGERY OF PARRAMATTA TEST SITES

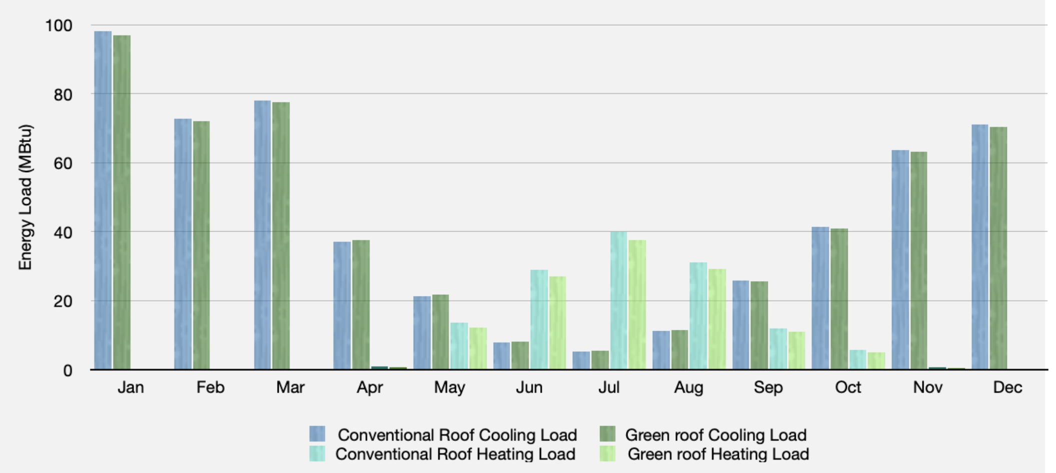


EXPECTED RESEARCH CONTRIBUTION

A building simulation based on the International Building Code (IBC) and ASHRAE Handbooks, combined with weather data, as well as previous literature relating to green roof parameters. A reality-based simulation of the building analyses enables the quantification of the contribution of green roofs to the urban environment.

Furthermore, based on the software simulation with building models, changes in the construction performance of buildings allow for further elaboration on the mechanisms by using green roofs to save energy.

MONTHLY HVAC LOAD PROFILES 10 FLOORS COMMERCIAL BUILDING



ANNUAL BUILDING SENSIBLE HEAT GAIN COMPONENTS

	Opaque Surface Conduction and Other Heat Addition [GJ]			Opaque Surface Conduction and Other Heat Removal [GJ]		
	Conventional Roof	Green Roof	Heat infiltration rate change(%)	Conventional Roof	Green Roof	Heat retention rate change(%)
10 Floors commercial building						
Floor 10	0.004	0.007	**-75.00%**	-9.349	-10.307	**-10.25%**
Total Facility	0.022	0.025	**-13.64%**	-292.953	-293.315	**-0.12%**
10 Floors apartment				0.958	0.362	
Floor 10	0.003	0.002	**33.33%**	-16.813	-15.83	**-5.85%**
Total Facility	10.852	10.891	**-0.36%**	-166.005	-162.593	**-2.06%**
5 Floors school				-0.983	-3.412	
Floor 5 northern classroom	0.005	0.004	**20.00%**	-10.364	-10.082	**-2.72%**
Floor 5 southern classroom	0.005	0.003	**40.00%**	-17.563	-16.794	**-4.38%**
Total Facility	43.749	43.649	**0.23%**	-159.196	-158.266	**-0.58%**
2 Floors house				-0.769	-0.93	
Floor 2	1.259	1.265	**-0.48%**	-4.203	-3.712	**-11.68%**
Total Facility	9.742	9.801	**-0.61%**	-25.074	-24.513	**-2.24%**
2 Floors restaurant				-0.491	-0.561	
Dining room floor2	0.001	0	**100.00%**	-57.778	-56.169	**-2.78%**
Total Facility	26.186	26.208	**-0.08%**	-108.679	-106.186	**-2.29%**
30 Floors commercial building				-1.609	-2.493	
Floor 30	0.006	0.001	**83.33%**	-34.592	-27.873	**-19.42%**
Total Facility	6.535	6.518	**0.26%**	-659.057	-651.063	**-1.21%**