Mitigation strategies of the urban heat island intensity in Mediterranean climates: simulation studies in Rome (Italy) and Valparaiso (Chile).

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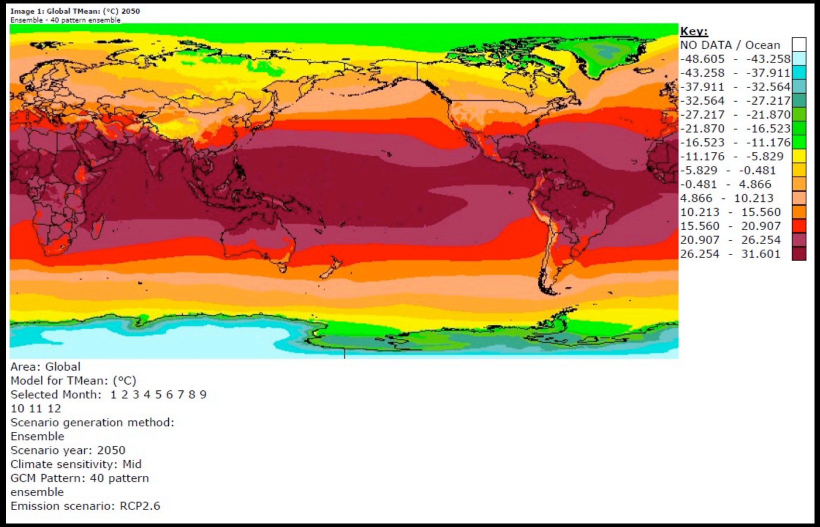
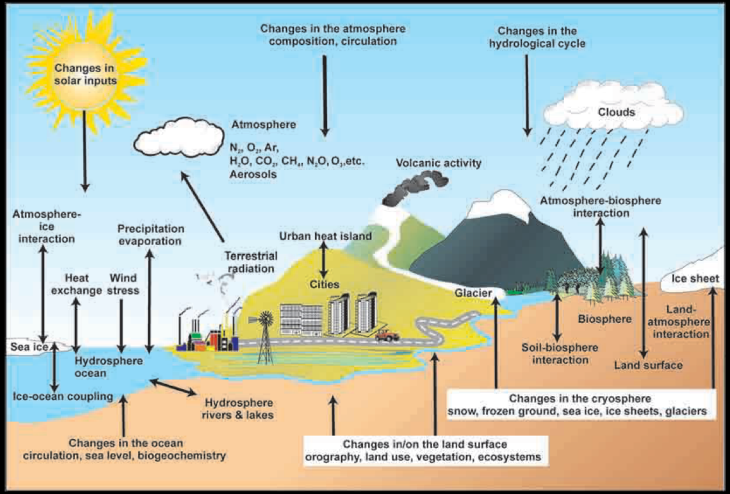
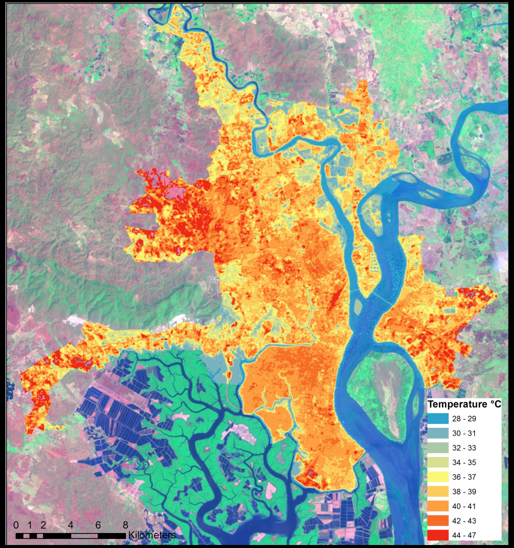
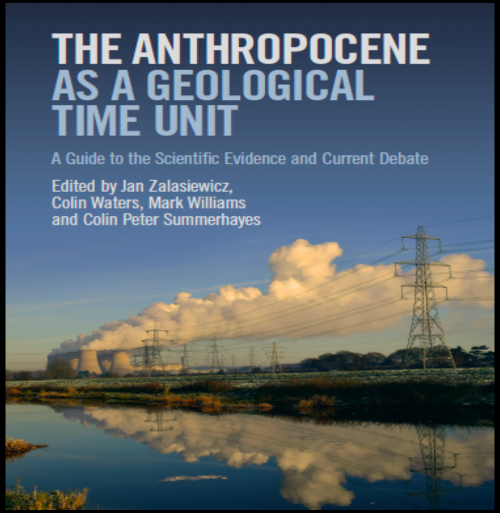
Climate change and the built environment

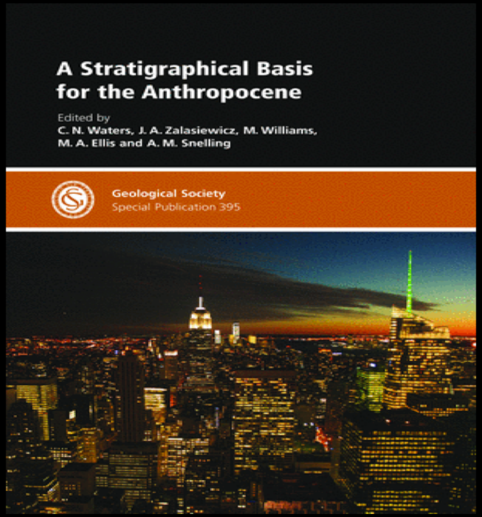


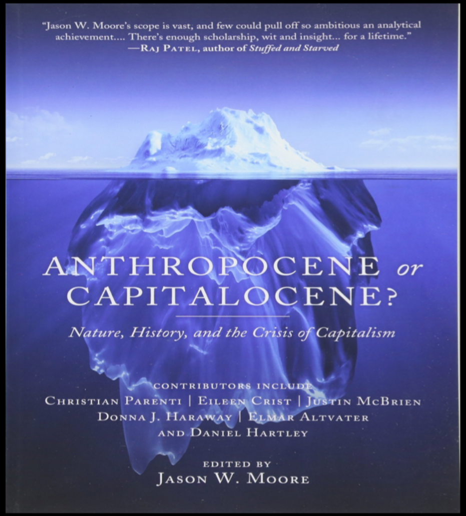


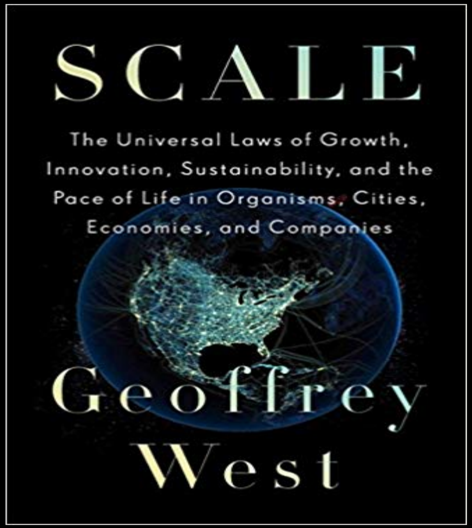


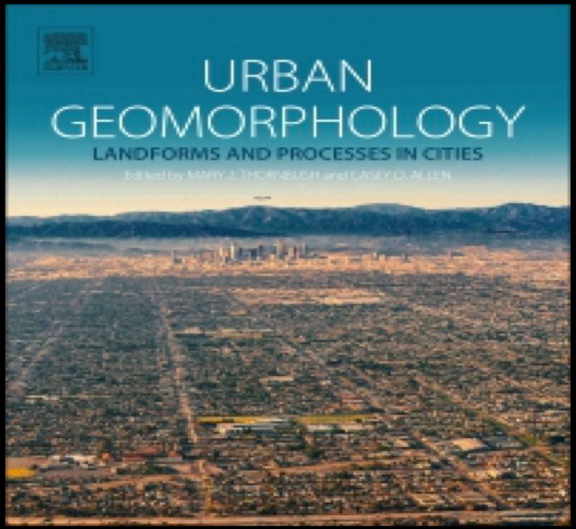
Anthropocene? Urbanocene? Capitalocene?











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When did the Anthropocene begin? A mid-twentieth century boundary level is stratigraphically optimal

Jan Zalasiewicz [a], Colin N. Waters [b], Mark Williams [a], Anthony D. Barnosky [c], Alejandro Cearreta [d], Paul Crutzen [e], Erle Ellis [f], Michael A. Ellis [b], Ian J. Fairchild [g], Jacques Grinevald [h], Peter K. Haff [i], Irka Hajdas [j], Reinhold Leinfelder [k], John McNeill [l], Eric O. Odada [m], Clément Poirier [n], Daniel Richter [o], Will Steffen [p] ... Naomi Oreskes [x]

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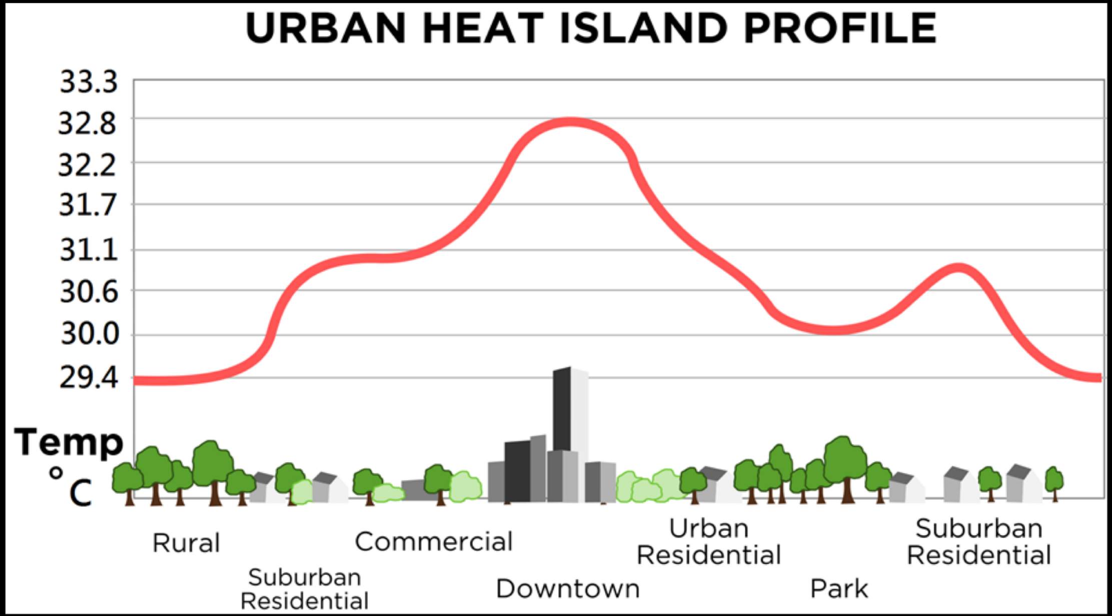
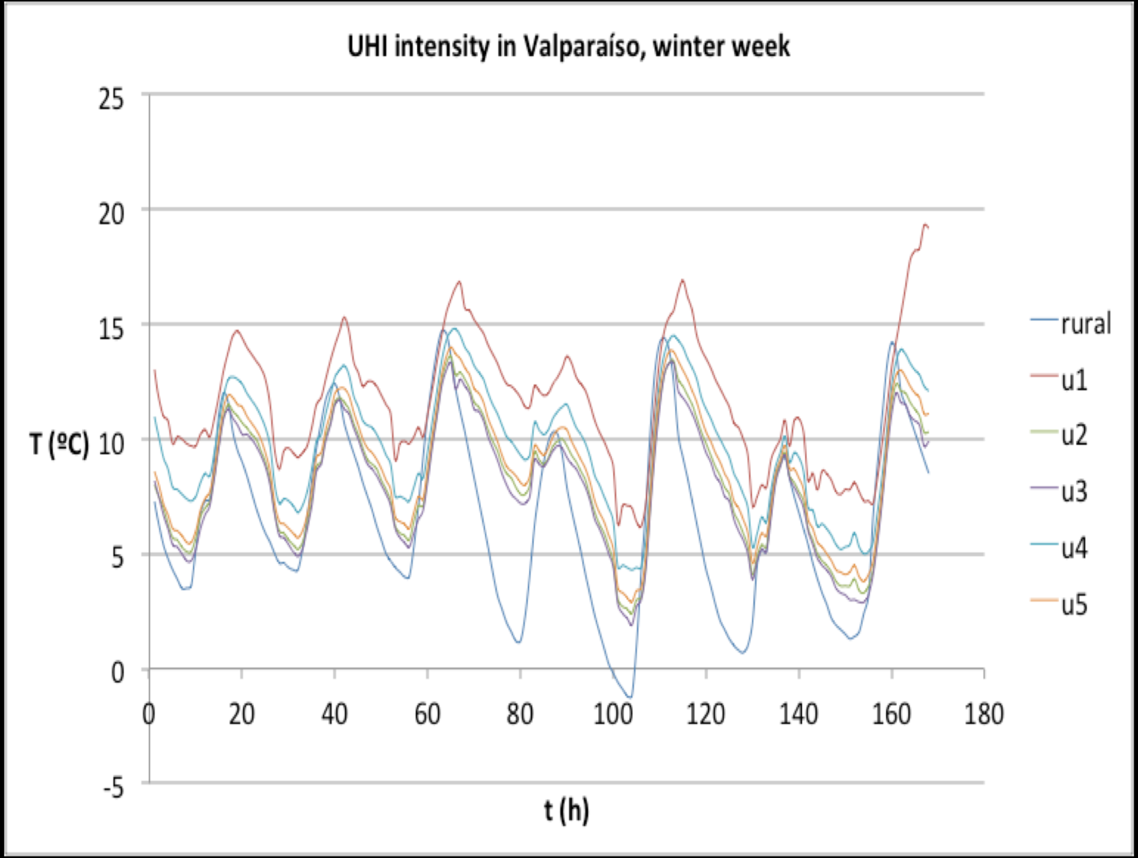
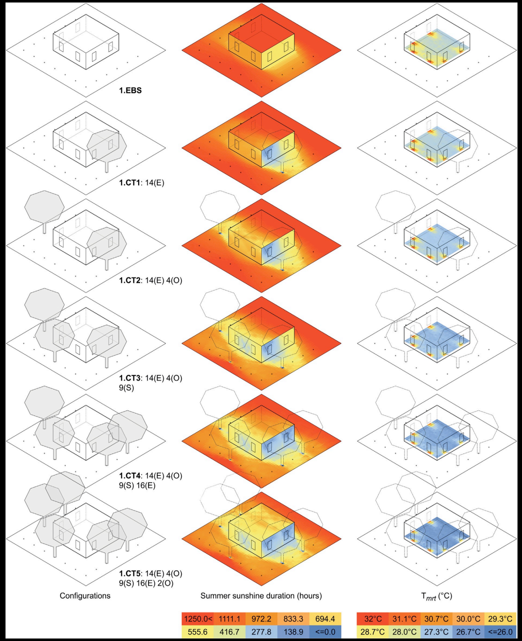
Urban Heat Island





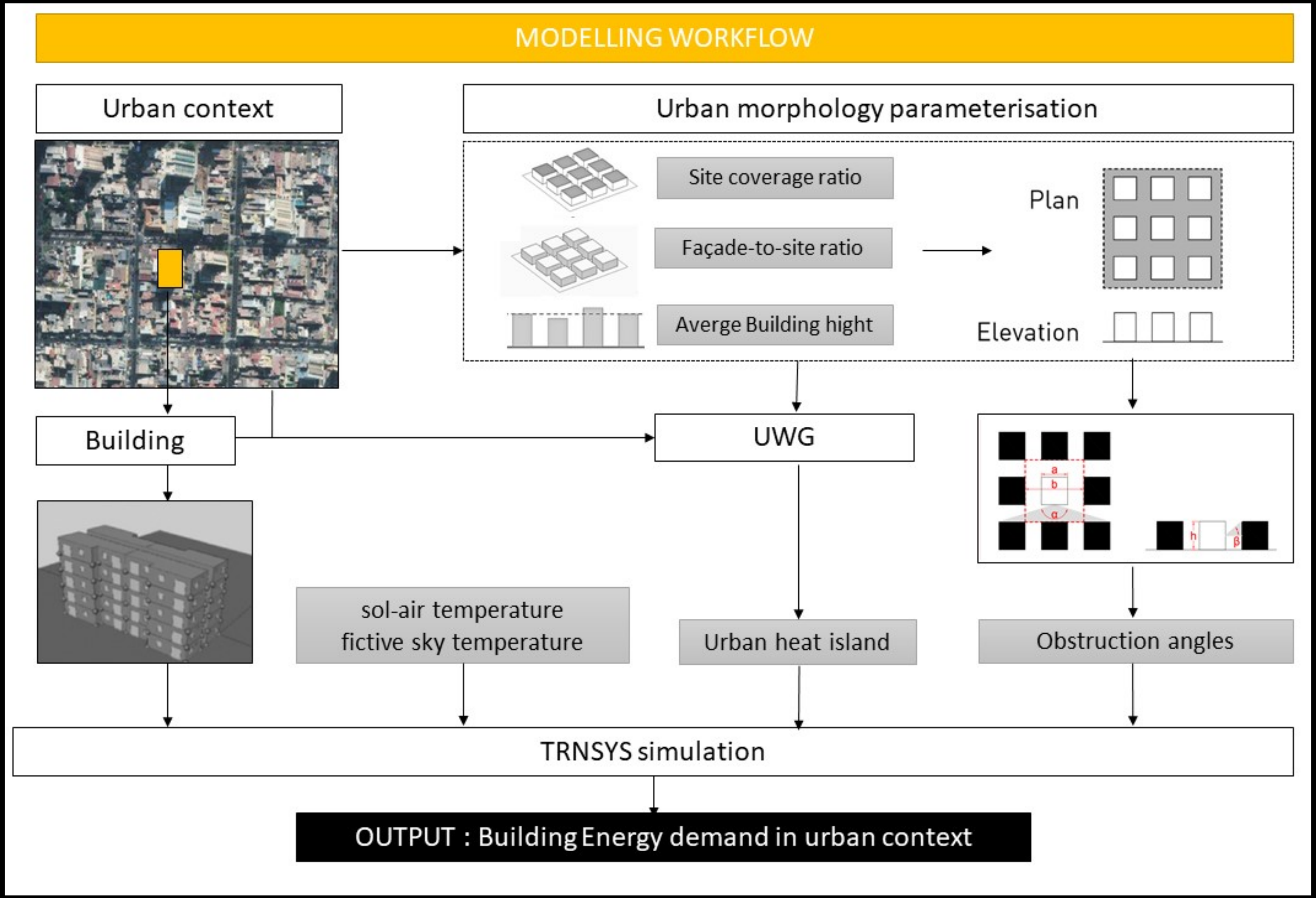
Green infrastructure as adaptation and mitigation strategy



Some research recently conducted

- Inostroza, Palme, De la Barrera (2016). “A Heat Vulnerability Index. Spatial Patterns of Exposure, Sensitivity and Adaptive Capacity for Santiago de Chile.” **PlosOne 11(9)**
- Palme, Inostroza, Villacreses, Lobato, Carrasco (2017). “From Urban Climate to Energy Consumption: Enhancing Building Performance Simulation by Including the Urban Heat Island Effect.” **Energy and Buildings 145**.
- La Rosa, Privitera (2018). “Reducing Seismic Vulnerability and Energy Demand of Cities through Green Infrastructure.” **Sustainability 10 (8)**
- Calcerano, Martinelli (2017). “Numerical optimization through dynamic simulation of the position of trees around a stand-alone building to reduce cooling energy consumption.” **Energy and Buildings 112**

Methodology workflow

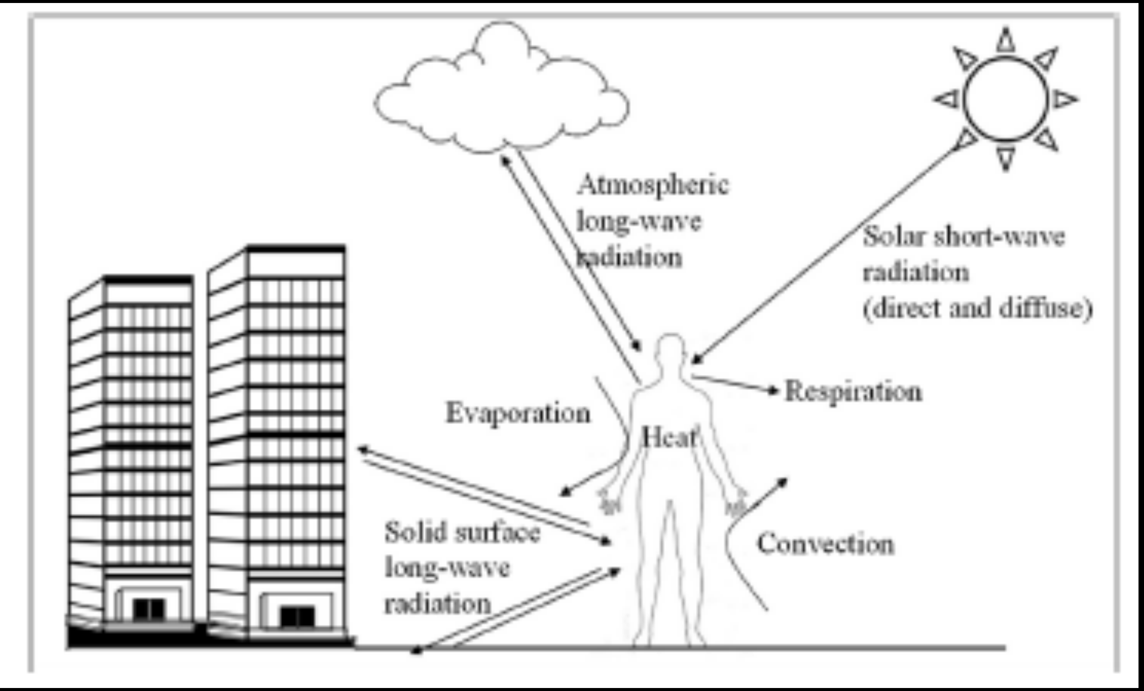


PMV evaluation

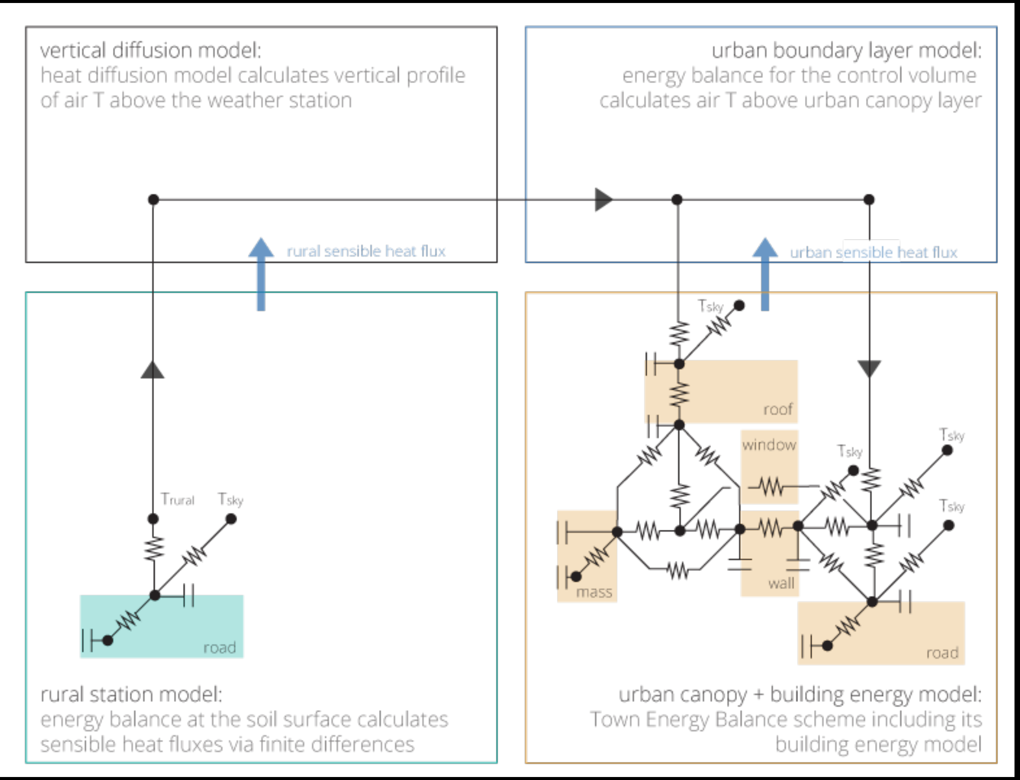
PMV = (0.303 e-0.036M + 0.028) L

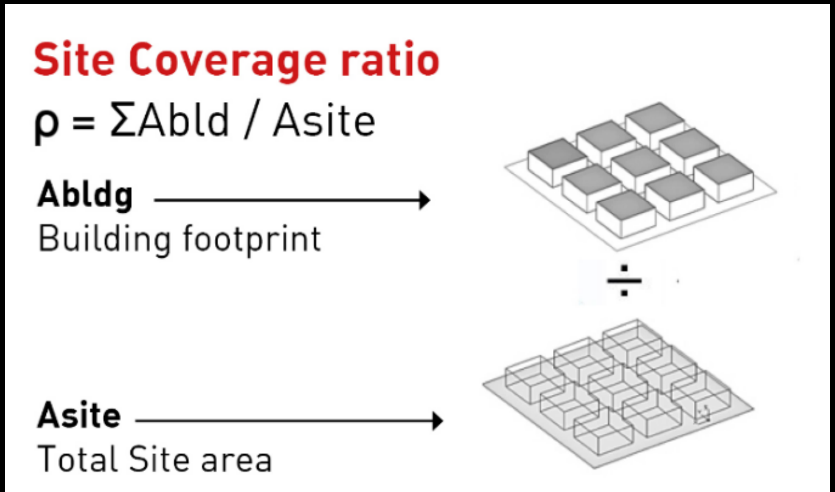
M is the metabolic rate of the human body

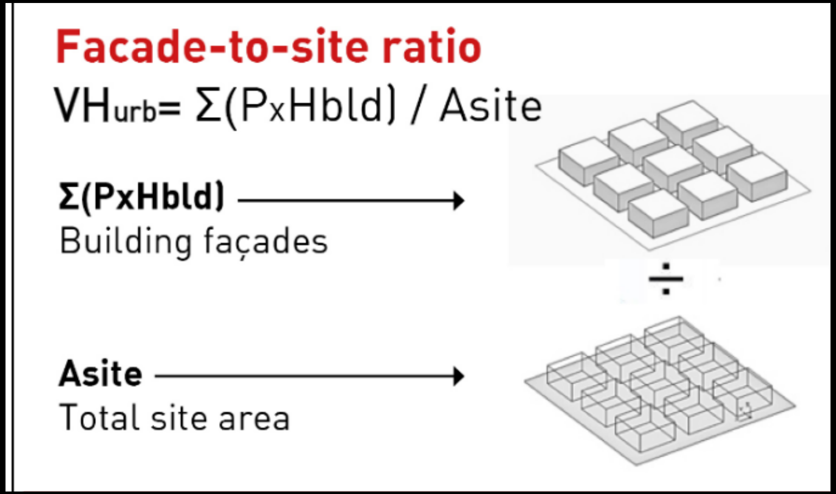
L is the thermal load of the human body, depending on various concepts (heat transmission, respiration, sweat, etc.)



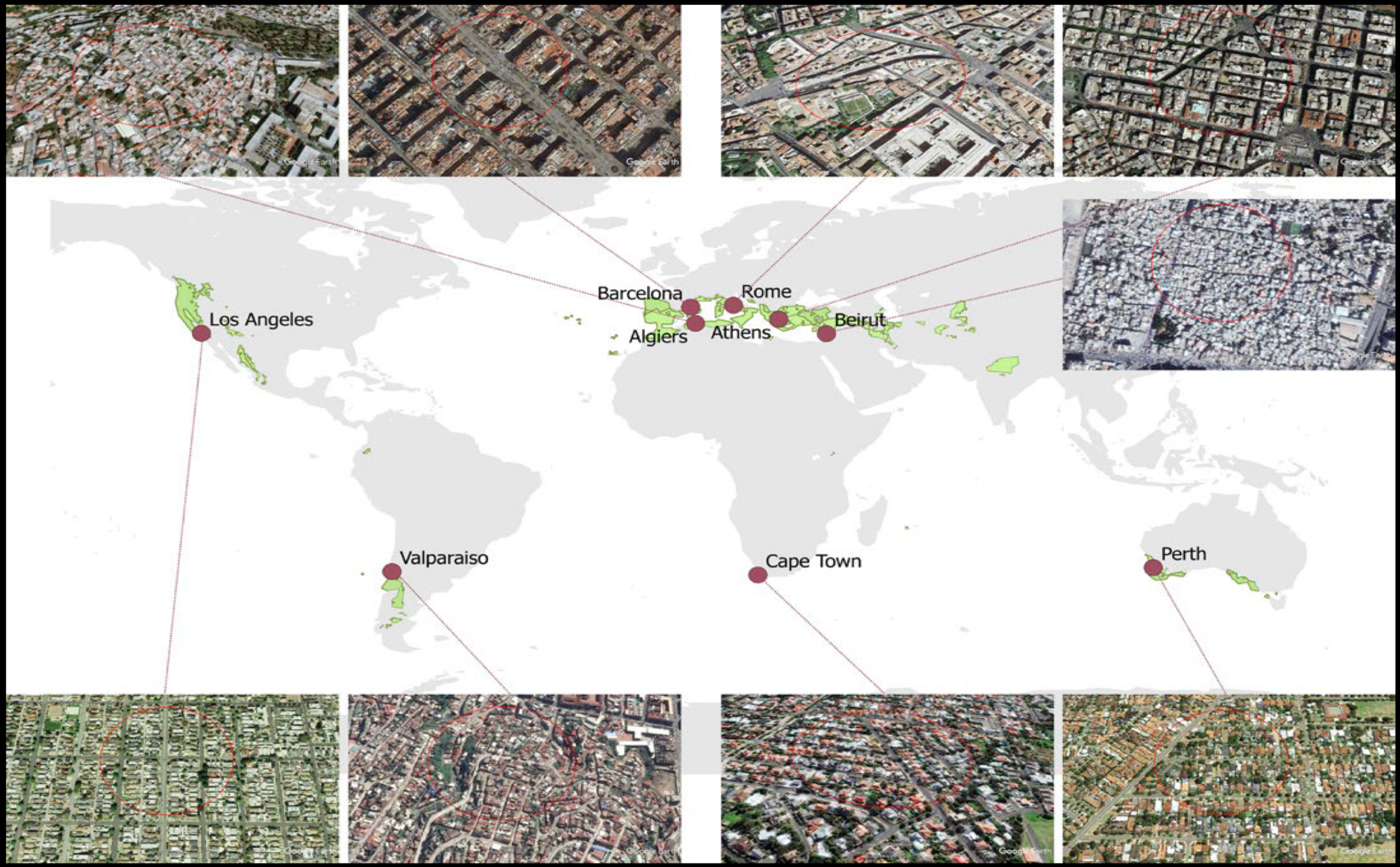
Urban Weather Generator







Cases of study: Meditarranean climates

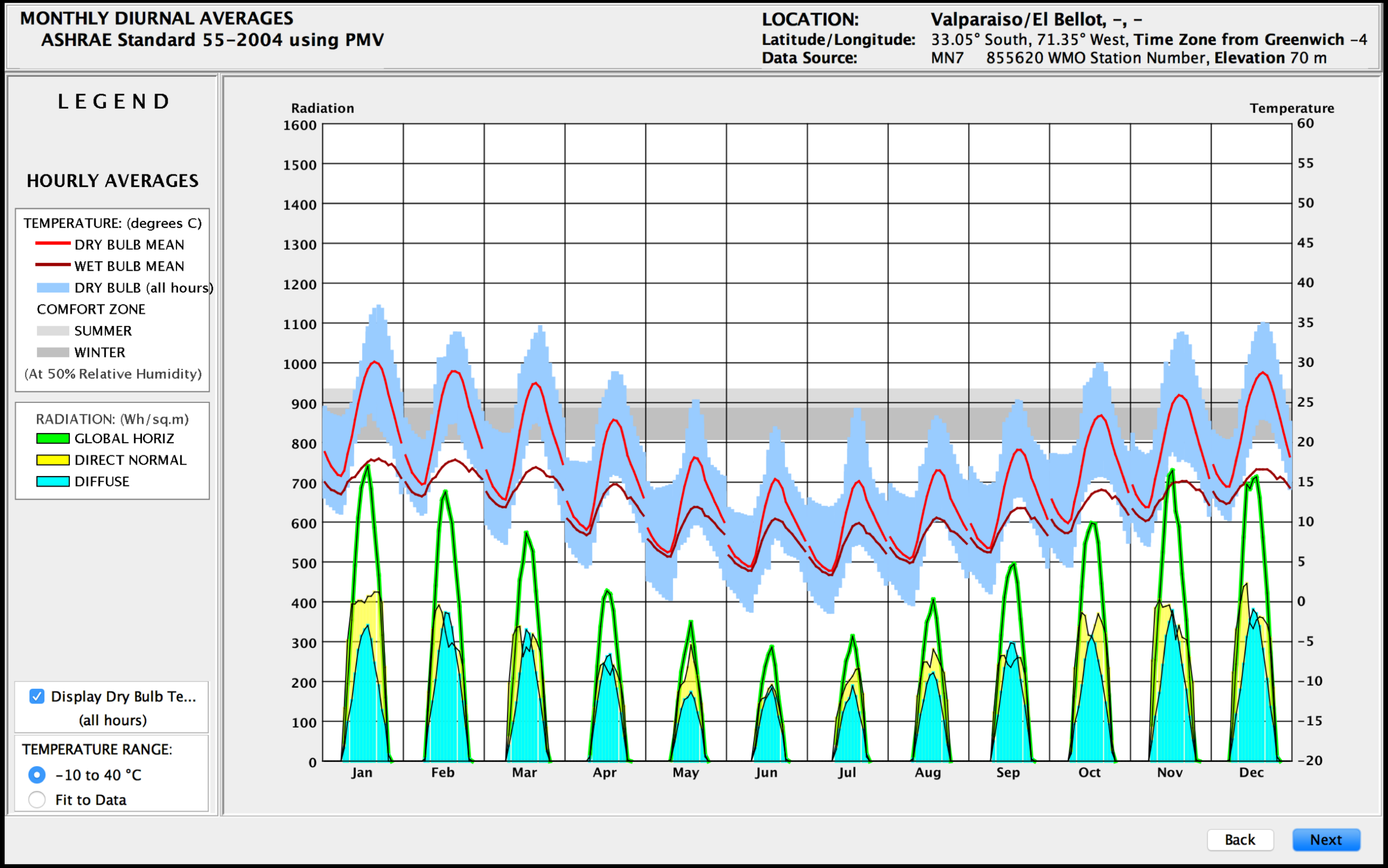


Cases of study

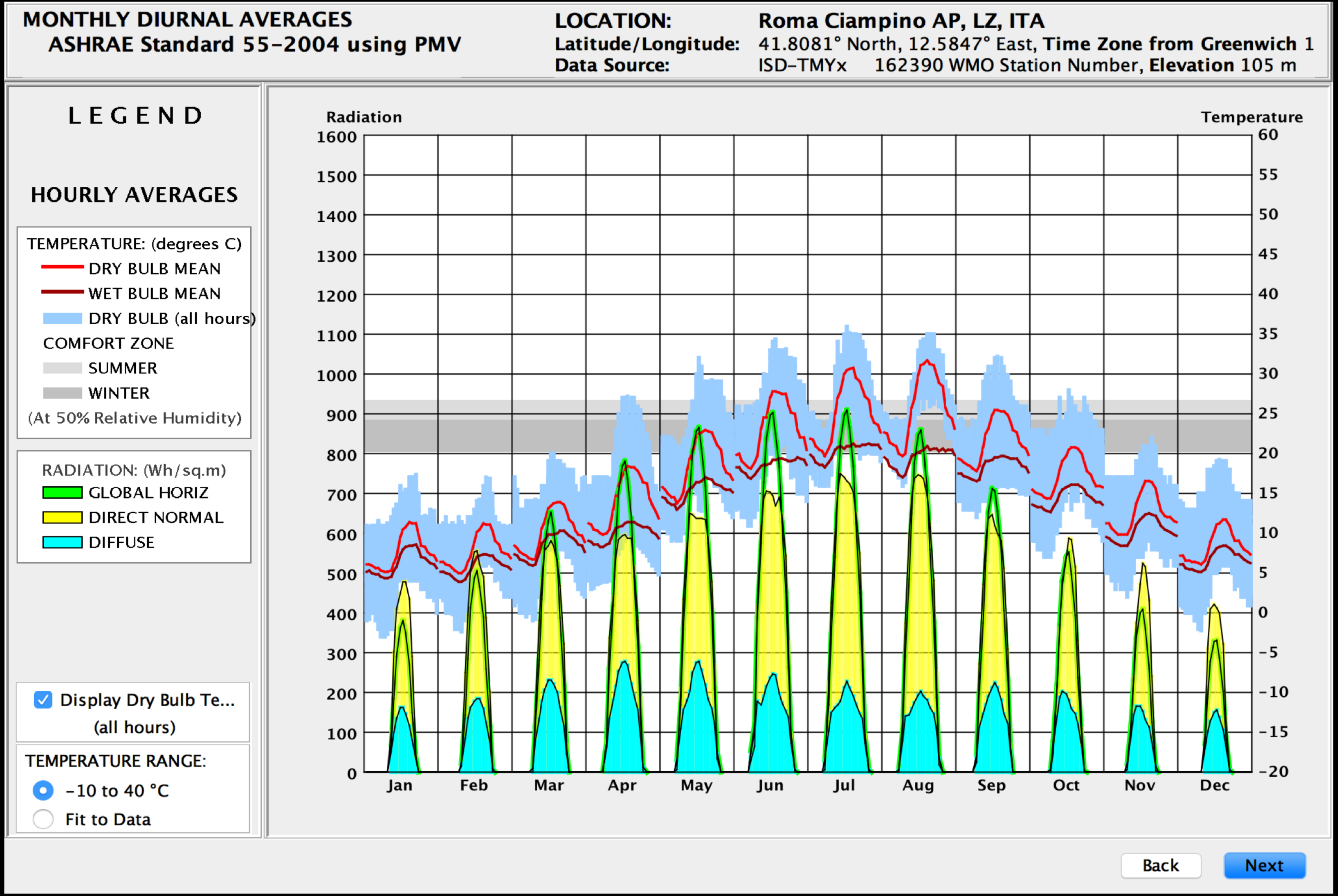
Rome sectors of Prati and Tridente

Valparaiso sectors of Centre and Recreo

Valparaiso climate



Rome climate



Parameters used in UWG and TRNSYS

	Rome Tridente	Rome Prati	Valparaiso Center	Valparaiso Recreo
Reference site				
Latitude (º)	41.54		33.02	
Longitude (º)	12.29		71.36	
Urban Area				
Site coverage (-)	0.7	0.49	0.49	0.62
Façade ratio (-)	1.96	1.43	1.24	1.48
Average height (m)	16.5	19.5	14.4	8.36
Tree coverage (-)	0.03	0.05	0.01	0.05
Vegetation coverage (-)	0.04	0.1	0.02	0.1
Anthropogenic heat (W/m^2)	25			
Materials				
Wall materials and thickness	Bricks 43 cm			
Roof materials and thickness	Insulated 38 cm			
Roof albedo (-)	0.25			
Road albedo (-)	0.2			
Rural				
Albedo (-)	0.2			
Emissivity (-)	0.95			
Vegetation coverage (%)	48			

U wall (W/m^{2}K)	U roof (W/m^{2}K)	U floor (W/m^{2}K)	Infiltration (h^{-1})	Glazed surface main façade (%)	Occupancy (people)	Gains (W7m^2)	Cooling set point (°C)
2.15	0.57	1.88	0.7	27	2	5	26

Mitigation/adaptation strategies

Mitigation should be addressed considering strategies that could also be adaptive.

Some researcher call this vision “Adaptigation” (Galderisi, 2015)

The benefits of adaptive/mitigative strategies are clear (Stone, 2012)

In this work we checked three strategies:

- Increasing the green areas of neighbours in a 100% respect to actuality
- Changing the materials of pavements and roofs for selective cool materials
- Reducing anthropogenic heat generation by cars in a 50%

Results: parameters for comfort

PMV parameters	
Metabolsim (Met)	2
Clotching (Clo)	0.5
Clotching factor	1.15
Efficiency of the body (%)	50

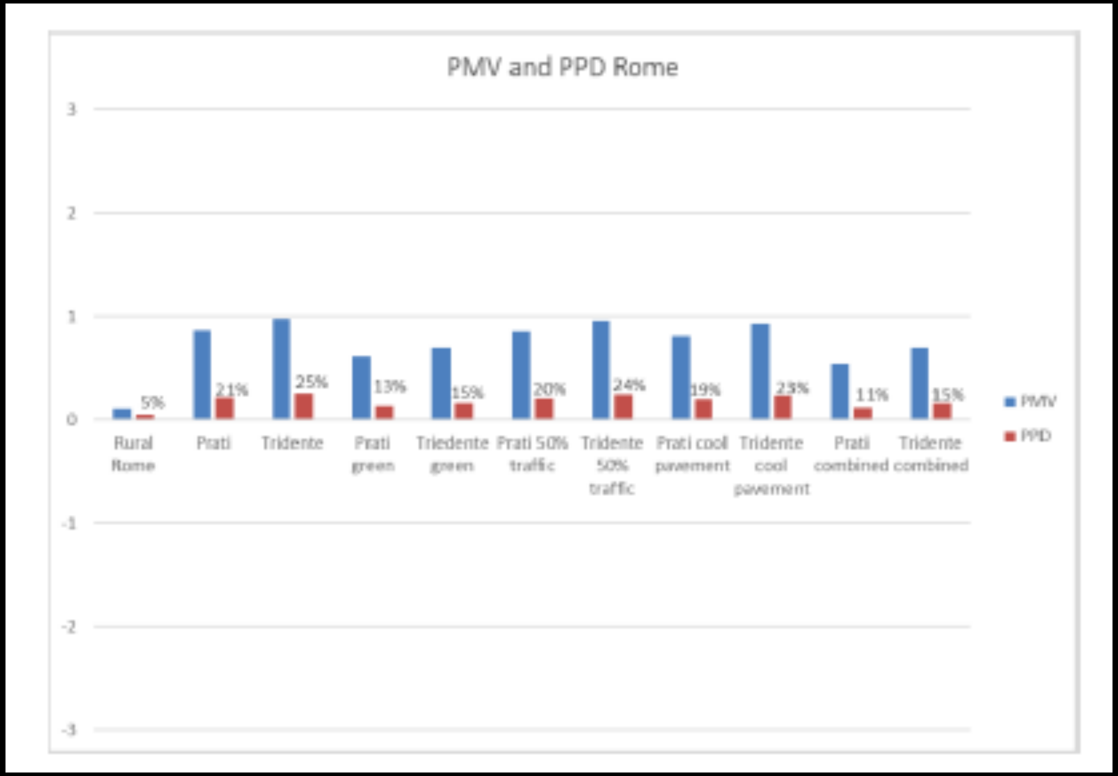
Table 3: PMV parameters, Rome

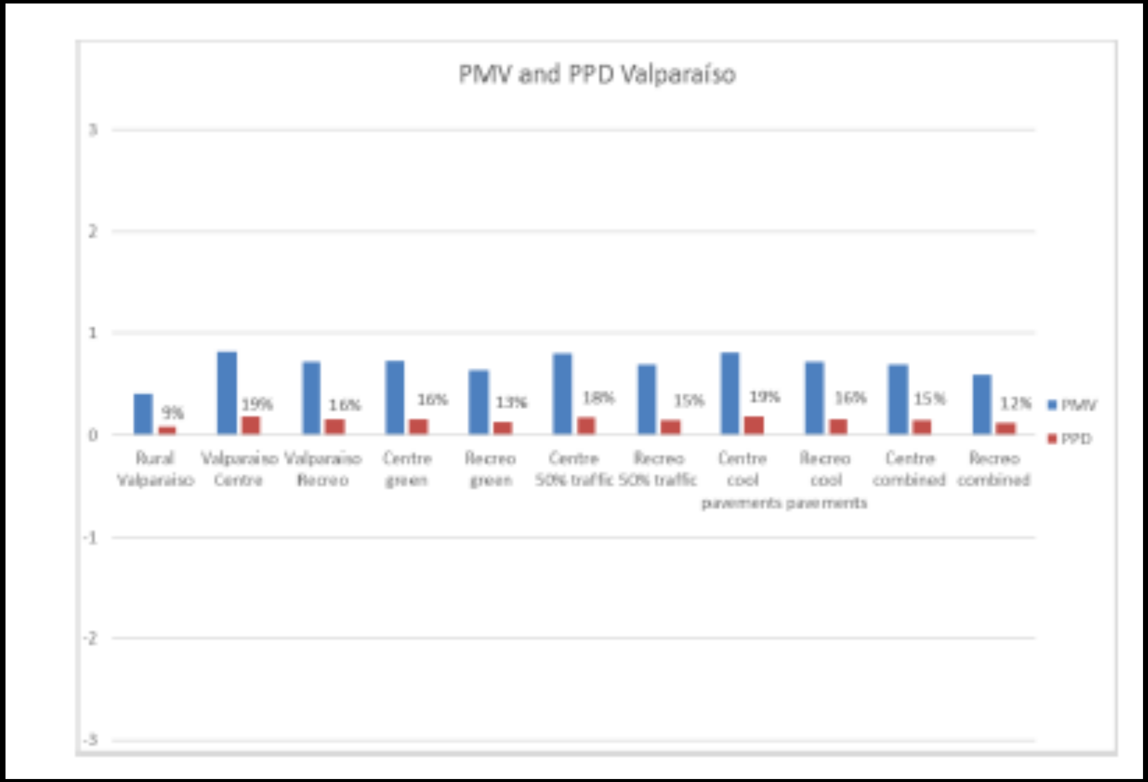
	Rural Rome	Prati	Tridente	Prati green	Tridente green	Parti 50% traffic	Tridente 50% traffic	Prati cool pavement	Tridente cool pavement	Prati combined	Tridente combined
V (m/s)	0.5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Hr (%)	45	40	38	41	40	40	38	40	40	41	40
T (°C)	28	30	31	29.5	29.8	29.9	30.9	30	31	29.3	30.8
Tmr (°C)	30	32	33	28	29.5	29.9	32.9	31	32	27	28.3

Table 4: PMV parameters, Valparaíso

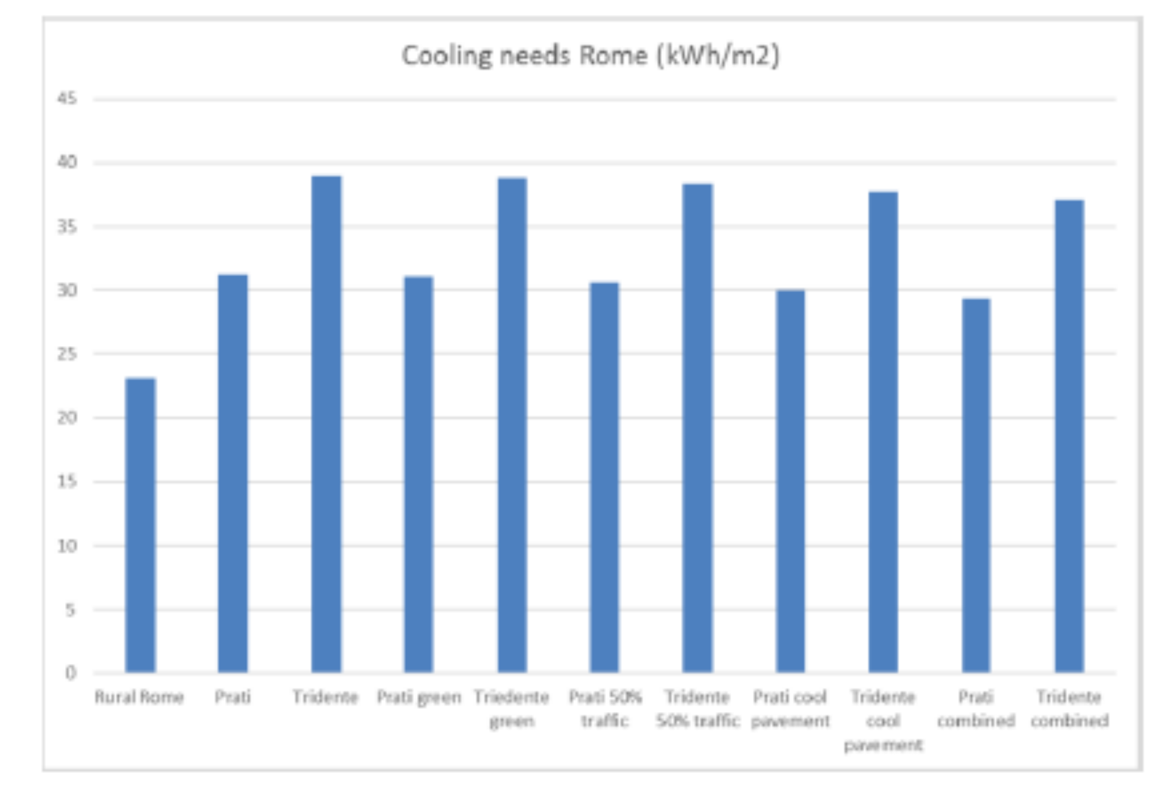
	Rural Valparaíso	Centre	Recreo	Centre green	Recreo green	Centre 50% traffic	Recreo 50% traffic	Centre cool pavement	Recreo cool pavement	Centre combined	Recreo combined
V (m/s)	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Hr (%)	30	28	28	29	29	28	28	28	28	29	29
T (°C)	33	34	33.5	33.5	33	33.9	33.4	34	33.5	33.3	32.8
Tmr (°C)	34	37	35.5	35	30	36	32	36	34.5	34	29

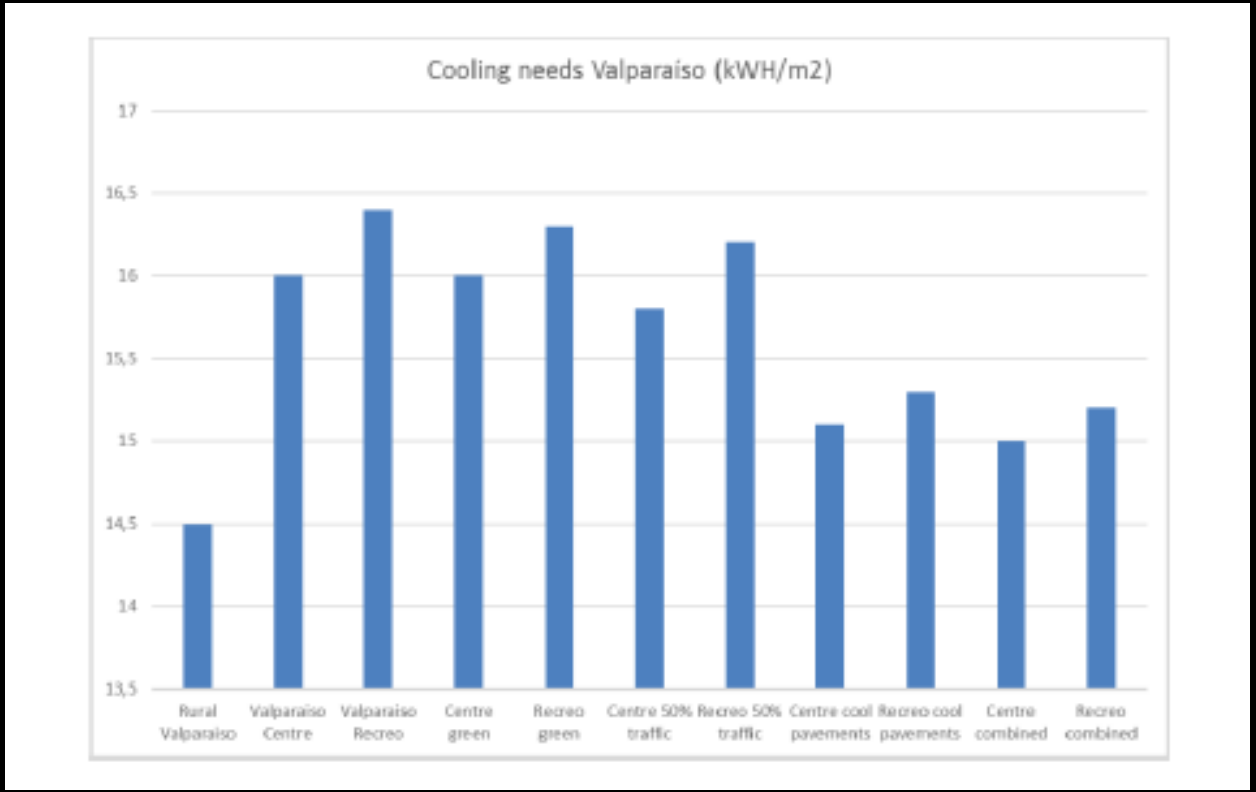
Results: outdoor comfort





Results: cooling needs





Conclusions

- UHI patterns ara similar for Valparaiso and Rome
- More dense environments (Tridente and Valparaiso Centre) have about 1-1.5 degrees more than others (Prati and Recreo)
- Green infrastructure is evaluated as the best strategy improving the outdoor comfort while changing cool roofs and pavements is evaluated as the best strategy to reduce cooling needs
- A combination of strategies can improve comfort in 50% and reduce cooling in 40%

Thank You for the attention!

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