Milan, heat mitigation strategy

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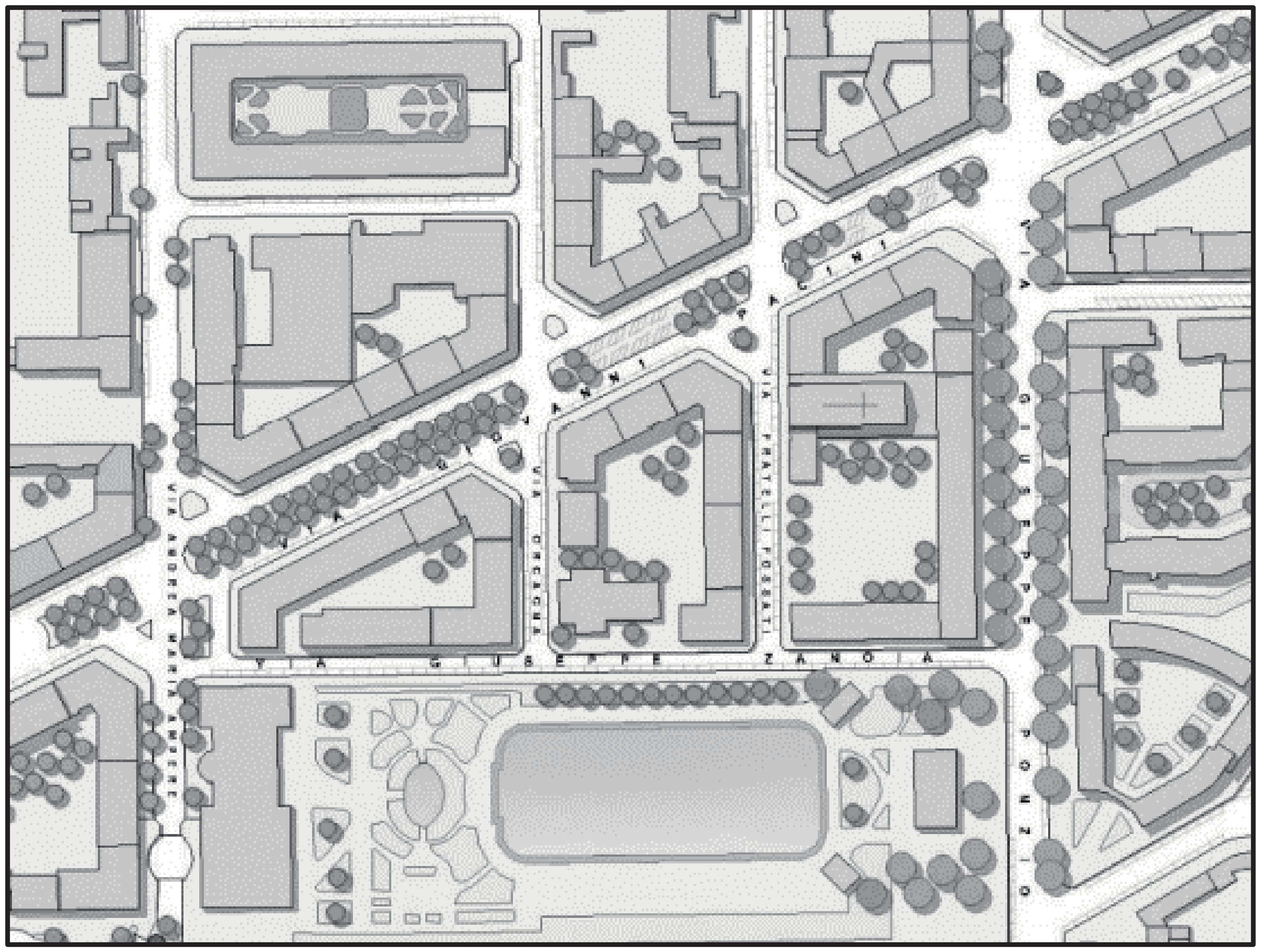
Aiming for outdoor thermal comfort while mitigating risk of increasing temperatures SLOD* in Milan.

Northern Italy has suffered intense heat stress. The current trend of average temperature increase represents a risk for this area, in particular for Milan given its population density. In this context, this work was dedicated to screen state of the art heat mitigation strategies that could improve the residents' thermal comfort and diminish heat-related hazard.

Within the framework of the funded research project BE S2ECURe and the MSc thesis project at Politecnico of Milano, an ENVI-met simulation-based analysis was performed for increasing temperatures – *Slow Onset Disaster (SLOD).

Six different scenarios were tested to evaluate their potential risk reduction capacity. They included evaluating the effect of nearby water bodies, modifying radiative properties of finishing surfaces, and integrating natural based solutions.

Simulation Scenarios: ENVI-met software



*Extracted from Google Maps

Scenario 0 (S0) – Baseline
- Identification of the hottest areas
- Identification of the reference points

- **Scenario 1 (S1):** Increase of streets and pavements albedo
- **Scenario 2 (S2):** Increase of facade albedo
- **Scenario 3 (S3):** urban Greening implementation (street trees and grass)
- **Scenario 4 (S4):** vertical Greening application (living walls)
- **Scenario 5 (S5):** Combining S3 + S4
- **Scenario 6 (S6):** Combining S3 + S1

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The computer-based microclimate simulations made with ENVI-met allowed to depict how the six scenarios modified the urban fabric response to the environmental conditions. All the scenarios displayed a modification to the heat related risk of inhabitants, however the natural based solutions seemed to be the most appropriate.

Most of the proposed strategies, reduced considerably the heat related risk present in the baseline situation by acting directly on the hazard and vulnerability. The best potential risk mitigating scenario is the one that implies the presence of urban greenery, both singularly used (S3) and in combination with the increase in albedo (S6) and with living walls (S5). Air temperature, mean radiant temperature and PET underwent reductions, helping in alleviating UHI effect and Global Warming in urban areas, respectively of 0.49°C, 5.32°C and 3.05°C on average.

In particular, the increase in shaded areas with trees and the decrease of heat entrapment motivated such improvements on PET.

Moreover, the implementation of urban greening in the studied case could bring additional benefit. Such integrations have been also considered useful in mitigating the effects of other types of SLODs. For instance: flooding, which represents 69% of the extreme events affecting the city of Milan in the decade from 2010 to 2020; loss of biodiversity and desertification.

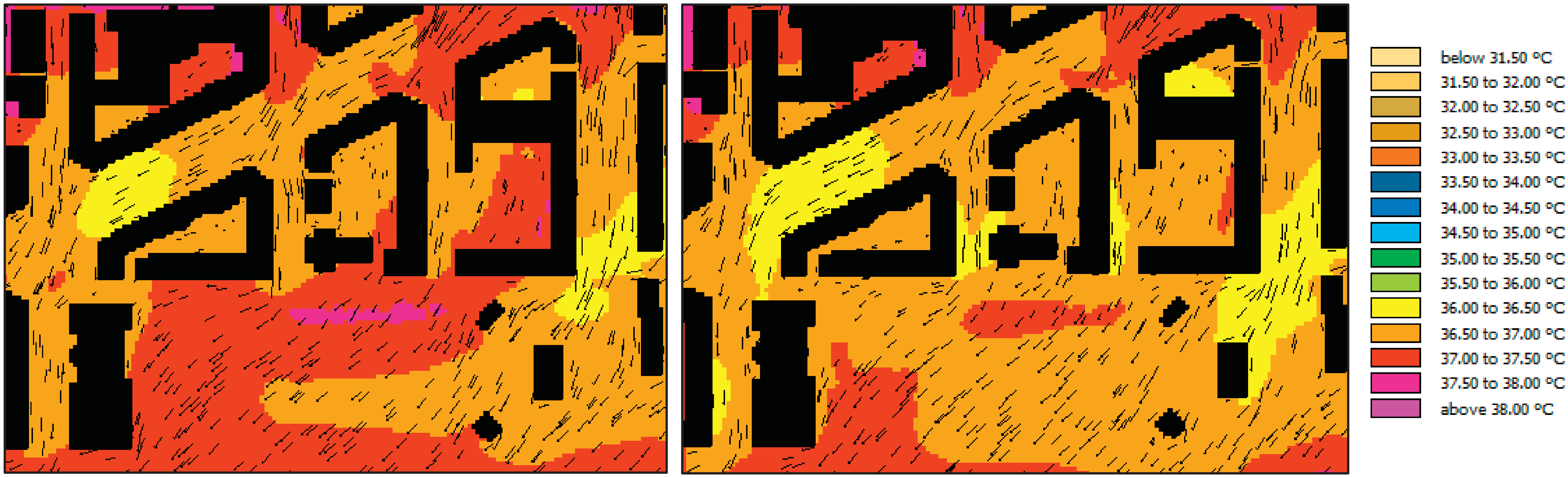
Evaluation criteria:

Average values were calculated for the hottest hours of the year (critical period).

Maximum localized reductions were found for Tmr and PET, equal to a delta of 21.07°C and 9.84°C.

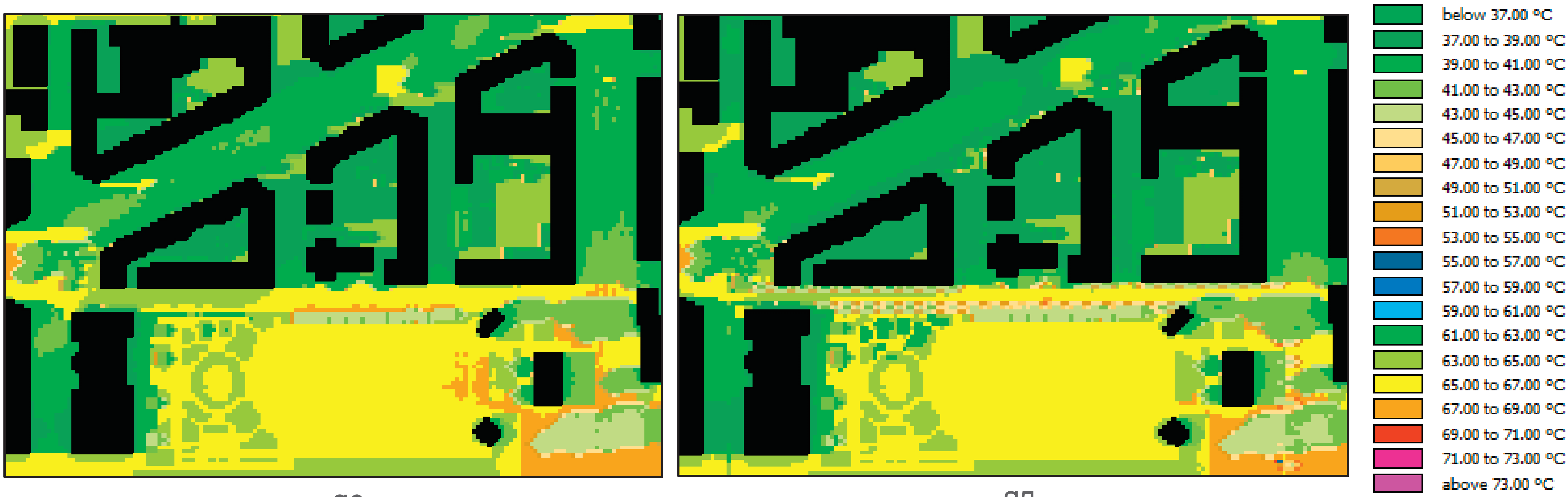
Output variables

Potential Air Temperature (Tair) [°C] – 5.00 p.m.



S0 S5

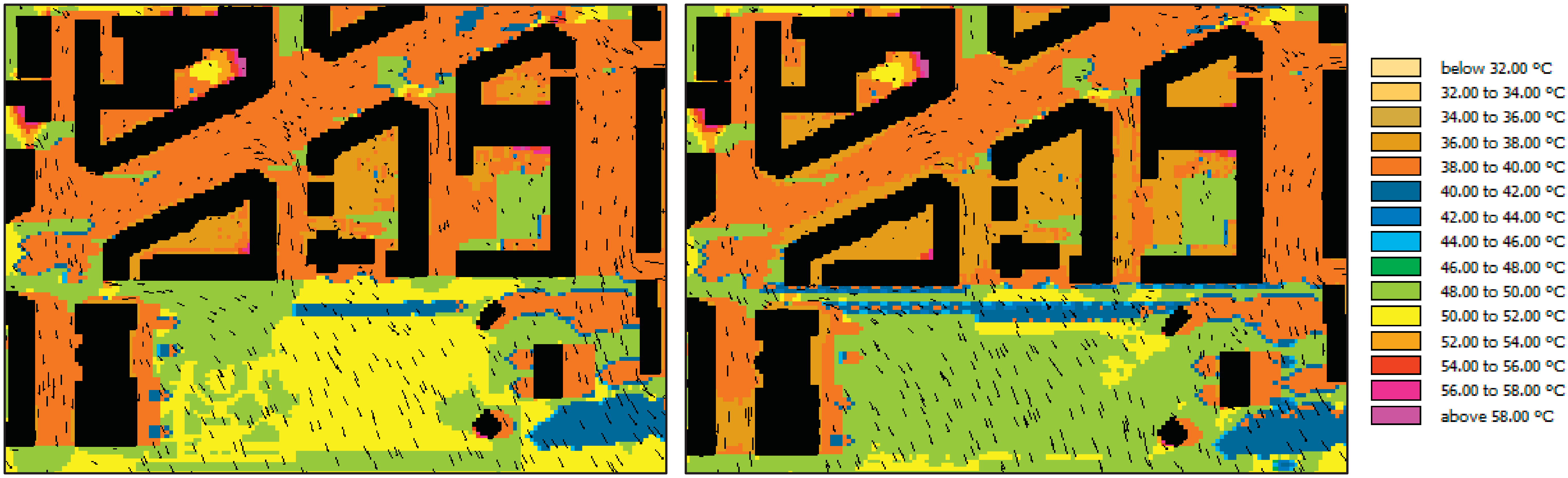
Mean Radiant Temperature (Tmr) [°C] – 5.00 p.m.



S0 S5

Output variables

Physiological Equivalent Temperature (PET) [°C] – 5.00 p.m.



S0 S5

Mitigating Potential - Comparison

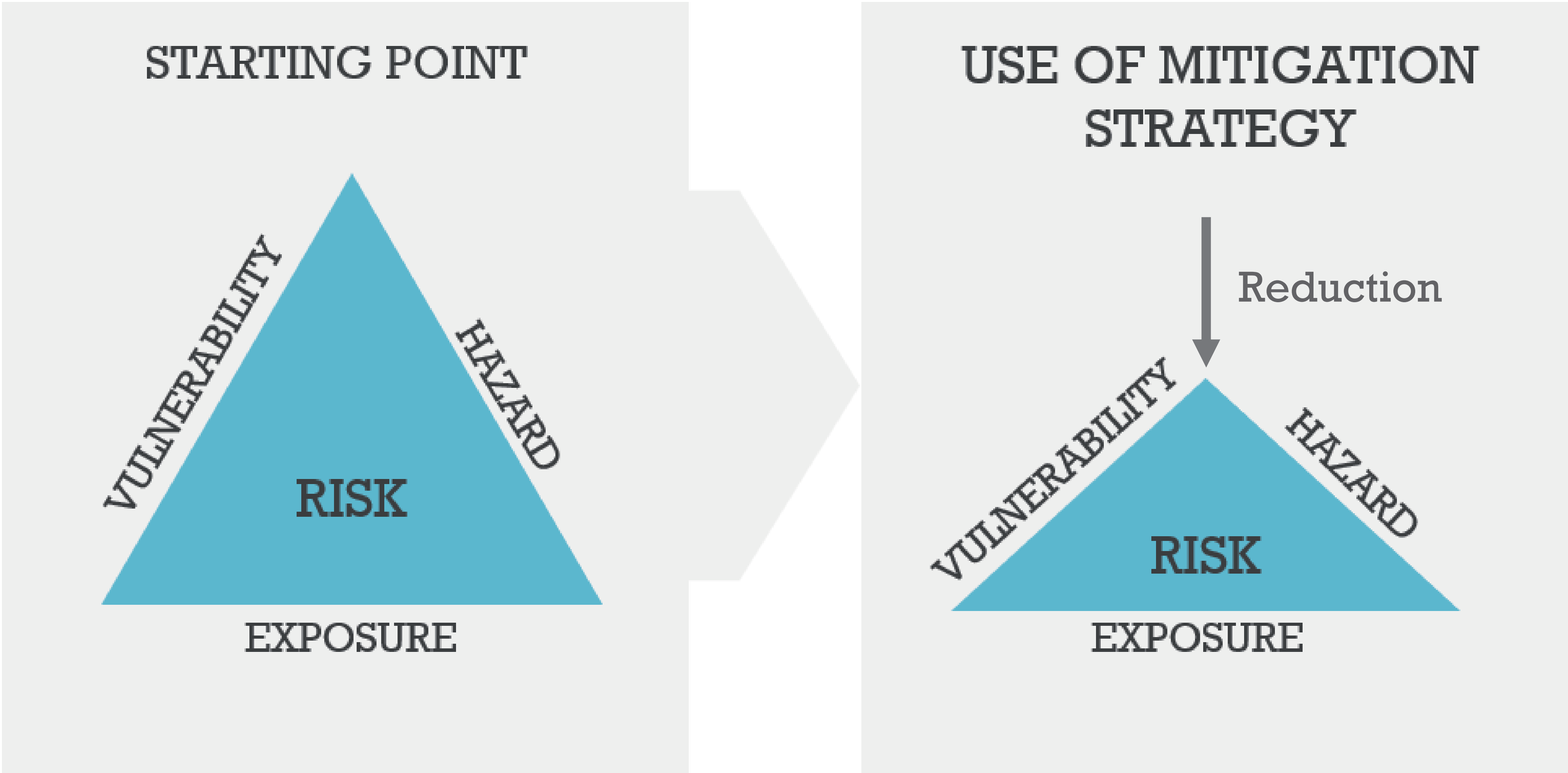
	Tair	Tmr	PET	
↑ STREETS ALBEDO (S1)	● ● ◐ ○	○ ○ ○ ○	◐ ○ ○ ○	**Not effective for Outdoor T. Comfort:**
↑ FAÇADE ALBEDO (S2)	○ ○ ○ ○	○ ○ ○ ○	○ ○ ○ ○	**Worsening Outdoor T. Comfort.**
URBAN GREENING (S3)	● ● ● ○	● ● ● ○	● ● ● ○	**Outdoor T. Comfort highly influenced.**

Mitigating Potential - Comparison

	Tair	Tmr	PET	
LIVING WALLS (S4)	● ◐ ○ ○	● ○ ○ ○	◐ ○ ○ ○	Outdoor T. Comfort slightly influenced.
LIVING WALLS + GREENING (S5)	● ● ● ●	● ● ● ○	● ● ● ○	Outdoor T. Comfort highly influenced.
↑ STREETS ALBEDO + URBAN GREENING (S6)	● ● ● ◐	● ● ● ○	● ● ● ○	Outdoor T. Comfort highly influenced.

Considerations

CRICHTON TRIANGLE – RISK ASSESSMENT



PET OUTDOOR THERMAL COMFORT RANGE 24 °C – 29 °C

$PET\_initial_{i,j} \approx 50$ °C
Avg $PET\_initial \approx 39$ °C

$\Delta PET_{i,j} \approx 10$ °C
ΔAvg $PET \approx 3$ °C

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Acknowledgements

The work was supported by the MIUR (the Italian Ministry of Education, University, and Research) Project BE S2ECURe - (make) Built Environment Safer in Slow and Emergency Conditions through behavioural assessed/designed Resilient solutions (Grant number: 2017LR75XK).

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Facts

Used Features: Thermal comfort in urban areas computing PET index; and evaluating environmental conditions with Mean Radiant and Potential Air temperature.

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