MICROCLIMATE MITIGATION FOR REDUCING SUMMER OVERHEATING IN HISTORIC DISTRICT

Summary
The present work analyzes the local microclimate of different areas in central Italy, with particular attention to an historic district, by means of coupled experimental and numerical approach. Four different areas characterized by different boundary conditions in terms of buildings’ density, construction materials, and amount of greenery are selected as case study. The monitoring campaign shows how buildings’ density and greenery percentage are able to considerably affect the daily temperature ranges by generating a night cooling up to 5°C between dense urban areas and green suburban areas. Additionally, the urban area with the highest vegetation percentage presents the lowest temperature fluctuation, i.e. 16.1°C during the day, despite the highest sky view factor, due to the vegetation buffering effect. The numerical analysis highlights the major role of greenery in generating temperature drops in summer (i.e. -0.8°C).

Key-words Urban microclimate; Urban Heat Island; Experimental monitoring; Microclimate simulation

1. Introduction and Motivation
The alteration of local microclimate parameters in the built environment is due to a modification of the energy balance inside urban areas which depends on several factors, e.g. the limited evapotranspiration, the thermo-physical properties of construction surfaces, the geometry of the urban settlement, and anthropogenic heat sources (Taha, 1997). Many mitigation strategies were developed and tested both experimentally and numerically over the years, such as the implementation of greenery inside built areas (Bowler et al., 2010), or the application of high-albedo materials (Akbari et al., 2016). Building upon previous studies, the present work investigate the variation of microclimate boundary conditions, in terms of configuration, density, presence of vegetation and anthropogenic heat sources, within different areas located in the same climate zone. Moreover, the urban heat island intensity of the historic urban district is assessed, and specific tailored mitigation solutions are proposed for being applied in such architectural heritage context.

2. Methodology and Case Study
Four locations characterized by different local boundary conditions in terms of density and vegetation level were selected in central Italy, i.e. an historical urban district, a more recent urban neighborhood, a suburban green area, and a rural green area. A monitoring campaign carried out during summer 2015 allowed to collect the main microclimate parameters within the different areas. Additionally, a numerical analysis was performed to evaluate the thermal benefits achievable in the urban historical district thanks to the implementation of two main innovative mitigation techniques: the introduction of a vertical green facade to increase the built surfaces percentage covered by vegetation (S1), and the implementation of highly reflective roofs (S2) and pavements (S3), to increase the original albedo by 0.35.

3. Discussion of the Results
The monitoring campaign shows a significant reduction of the daily temperature fluctuation in the urban areas compared to the suburban ones, imputable to local microclimate effect, with maximum discrepancies of 2°C and 5°C between the recent urban neighborhood (URN) and the historical one (HUC), respectively, compared to the suburban green area (SGA) (Fig.1). An inverse correlation between the air temperature and relative humidity is also detected, which is lower in the historic district due to the buffering effect of the historic buildings’ massive ancient constructions. The microclimate simulation of the different mitigation
scenarios for the historic district, characterized by the worst thermal environmental performance due to the nighttime urban heat island, the high building density, and the lack of vegetated surfaces, shows the major impact of the introduction of greenery (S1) and cool pavements (S3) in reducing peak outdoor air temperatures during the day, leading to up to 0.8°C and 0.6°C reduction in summer, respectively (Fig.2).

4. Conclusions

The microclimate variation due to different local boundary conditions in areas situated within the same climate zone, with particular attention to the urban heat island assessment in a historical district, is investigated. The experimental campaign shows urban heat island intensity leading to night temperature differences up to 5°C in the urban historic area with respect to the suburban green area. Urban density level and greenery percentage are the parameters mostly affecting air temperature profiles. The numerical analysis shows the major role of greenery and cool pavement in mitigating microclimate at local scale in summer.

5. References

