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How can daylight analysis of the public realm contribute to mitigate urban heat island effects?

Dense urban spaces are strongly affected by the consequences of urban heat island effects and global warming. The pressing need for a sustainable urban metabolism necessitates the following query: To what extent can the understanding of micro-climate analysis in particular outdoor daylight studies drive an informed urban design approach in order mitigate the effect of urban heat islands in metropolitan areas?

Data-driven simulations can be a critical step towards achieving practical design suggestions for a sustainable urban environment. Computational simulation methods allow to perform micro-climate analysis in order to derive human comfort level. Through specific daylight analysis with metrics of shadow studies, sunlight intensity, view from sky or visual comfort, the impact on the urban environment is quantified.

The presented work examines an urban fragment of public realm in central London through different micro-climate analysis. This urban context is modelled in the Rhinoceros 3D computer-aided design (CAD) application and computationally simulated within Grasshopper (a visual programming language) with the help of corresponding Energy-plus weather files (.epw). The digital representation is programmed to not only measure factors like sunlight hours, illuminance, pavement temperature and radiation in kwh/m2 but also correlates the outcome with other figures that contribute to human comfort, such as a wind analysis through computational fluid dynamics (CFD) or thermal comfort according to the Universal Thermal Comfort Index (UTCI).

The quantified result visualised in 3D as a heat map projected on the surfaces of buildings and pavement depict the areas which are most affected by high radiation and wind movement. As such spaces are classified as the most uncomfortable zones for people to dwell in, it allows urban designers to develop specific spatial interventions to either add shading devices, harness solar radiation through PV-panels or populate the zone with landscape elements to cool it down.

The benefits of including such a performance-driven approach in early design stages can lead to support sustainable design interventions of outdoor spaces. The quantified values can be aligned to human comfort level which can e.g. identify the most suitable spaces for people to sit for a short or longer period or encourage people to spend more of their time in outdoor spaces in order to support health and well-being. Furthermore, it can help identify the best locations and orientations of renewable energy production sources, and inform suggestions for planning policies and governmental guidelines. The understanding of spatial character through micro-climate analysis generates a comprehensive approach within the design process which can be used as a baseline strategy to create spaces to increase well-being and improve urban ecosystem.

Keyword 1

Daylight Analysis

Keyword 2

Micro-Climate

Keyword 3

Urban Heat Island Effect

Keyword 4

Sustainable Urbanism

Keyword 5

Computational Simulation

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