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# The importance of the Outdoor Thermal Comfort (OTC) for urban planning

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**The world is facing unprecedented speeds in climate change leading to an increase in global average temperatures (global warming). The Intergovernmental Panel on Climate Change (IPCC) 2018 special report is the most up-to-date and comprehensive explanation of the science of climate change. The report warns that, at the current rate of warming, the average temperature could increase by another 0.5°C within the next 30 years. It also urges that we need to build upon the solutions available today and focus on massive behavioral and lifestyle changes.**

As of 2014, more than half of the world population lives in cities. [1] As urban population grows, urbanization rates increase. The simultaneous impacts of rapid urbanization and climate change are taking the forefront on many research, governments' and companies' agendas due to projected trends. This is particularly important since urban areas absorb and retain significantly more heat than rural areas. This warmth of cities in contrast to their surrounding is known as «Urban Heat Island» (UHI) and will impact future energy demands as well as the expectation for thermal comfort in outdoor environments. As suggested by the United Nations Environment Program (UNEP), cities need to adapt to future urban climate, which can directly affect the human comfort and consequently our health. To this end, the understanding and the capability to predict and alter urban microclimates may help to adapt and improve aspects of Outdoor Thermal Comfort (OTC), especially in tropical climates.

## People's comfort and urban «climate-sensitive» design

There is an increasing awareness on how to design in accordance with the environment and the climate. Different climatic aspects such as climate conditions, seasonal variations and climate change bring additional demands on the planning and design of urban developments. Urban «climate-sensitive» design is defined as a process that considers the fundamental elements of microclimates for design purposes. The problem relies on the constant use of this concept to refer to any attempt of environmental design. Therefore, a more scientific approach is needed, which implies a method of inquiry that must be based on empirical and measurable evidence subject to specific principles of reasoning. Using data to improve design, also known as data-driven design, may support architects and urban planners as preconditions for the development of sustainable environments. In the new digital era, traditional methods for urban climatology can benefit from the Internet of Things and sensor networks where massive sets of data can be collected for scientific purposes.

Understanding people's behavior towards urban climate and ensuring that people are comfortable in outdoor spaces is also essential for the design of high-quality urban living. This makes human outdoor thermal comfort crucial when dealing with urban climate and city planning. Promoting the use of streets and outdoor spaces by pedestrians will benefit cities in physical, environmental, economical and social aspects. Consequently, making outdoor spaces attractive to people has become increasingly recognized as a goal in urban planning and design.

Among many factors that determine the quality of outdoor spaces, the urban microclimate is an important one as it greatly affects people's sensation of thermal comfort. Pedestrians are directly exposed to their immediate environment in terms of variations of air temperature, relative humidity, wind speed, and solar radiation.

## The measure of OTC in the urban micro-scale level

Urban planners intending to create comfortable microclimates can profit from easy methods for the assessment of the thermal component of climate. In the past decade, some studies on biometeorology and urban climatology have been used to enhance urban spaces by focusing on modeling and assessment methods from a thermo-physiological perspective. The degree of impact of outdoor thermal environment on thermal comfort varies with the thermal requirements of people in different climatic regions. A number of bio-meteorological indices have been developed to describe human thermal comfort levels by linking local

microclimatic condition and hu- [1] <https://population.un.org/wpp>



**[FIG. 1]** Portable weather stations. (Source: Recording for video clips for the Massive Open Online Course (MOOC) series on «Future Cities» by ETHZ)



[FIG. 2]

**[FIG. 2]** Water surfaces cool the environment and influence the microclimate. Place de l'Esplanade, Biel. (Photo: Sabrina Kessler)

man thermal sensation. A major group of such indices are the so-called «steady-state» models. These models are based on the assumption that people's exposure to a climatic environment has, over time, enabled them to reach thermal equilibrium, enabling these models to provide numerical solutions to the energy balance equations governing thermoregulation. One example of a widely-used index is the Physiological Equivalent Temperature, also known as PET. PET is a temperature dimension index measured in degrees Celsius, making its interpretation comprehensible to people without a great deal of knowledge about meteorology. [2] It is defined as the air temperature at which, in a typical indoor setting, the heat budget of the human body is balanced with the same core and skin temperature as those under complex outdoor conditions. [3] PET enables to compare the integral effects of complex thermal conditions outside with a person's own experience indoors. Other «steady-state» models that serve as analytical tools to assess human thermal responses to the local thermal environment are PMV, ITS, fuzzy-PMV, OUT-SET and COMFA.

For the calculation of these models, we need meteorological data. Since the outdoor thermal comfort is measured in the urban micro-scale level or street canyon level, it is important to collect local meteorological data in a pedestrian scale, usually by using portable weather stations. After calculating the outdoor thermal comfort, we could have an understanding of the thermal sensation of people in a specific location. As the microclimate is directly affecting the thermal sensation, we could explore ways of influencing the climatic conditions through design solutions.

[2] H. Mayer and P. Höppe. *Thermal comfort of man in different urban environments*. Theoretical and Applied Climatology, 38(1): 43–49, 1987.

[3] P Höppe. *The physiological equivalent temperature – a universal index for the biometeorological assessment of the thermal environment*. International journal of biometeorology, 43(2): 71–75, 1999.

The microclimatic conditions are affected by the built environment in terms of; anthropogenic heat, ground surface covering, evaporation and evapotranspiration of plants and shading by trees and man-made objects. The outdoor thermal comfort is generally studied on the urban micro-scale level, which is affected by the Canopy Layer Heat Island (CLHI). Taking that shade can block incident solar radiation, some studies have discussed shading effect on thermal environments. For example, street orientation and the height/width ratio have been measured to assess the shading levels in some studies. How outdoor thermal environment influence thermal sensations of people and their behavior (use of outdoor spaces) is of great interest for designing urban spaces.

Understanding and especially being able to predict urban microclimates may also help improving aspects of the performance of the adjacent buildings. Urban design decisions create microclimates that either accentuate or moderate the properties of the background climates affecting the energy consumption of buildings. Working in accordance with the outdoor thermal comfort of people in cities not only helps planners to design more livable urban spaces but also supports the implementation of adaptation measures for climate change.

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#### MORE INFORMATION AND REFERENCES:

«*City in your hands*». Gerhard Schmitt, Estefania Tapias & Marta H. Wisniewska. 2018 (<https://books.apple.com/us/book/city-in-your-hands/id1451584143?ls=1>)

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#### ZUSAMMENFASSUNG

## Die Bedeutung des Outdoor Thermal Comfort für die Stadtplanung

Der vom Intergovernmental Panel on Climate Change (IPCC) publizierte Sonderbericht 2018 liefert die zurzeit aktuellste und umfassendste Erklärung zur Wissenschaft des Klimawandels. Unter anderem warnt das IPCC darin vor einer möglichen Erderwärmung von 1.5°C bis Mitte des Jahrhunderts.

Durch die steigende Urbanisierungsrate rücken «Urban Heat Islands» immer stärker in den Vordergrund. Diese entstehen dadurch, dass Städte deutlich mehr Wärme aufnehmen und speichern als ländliche Gegenden, was zu sichtbaren Temperaturunterschieden führt. Das Umweltprogramm der Vereinten Nationen (UNEP) weist darauf hin, dass sich Städte an das veränderte Stadtklima werden anpassen müssen. Diese Veränderungen können sich direkt auf den menschlichen Komfort auswirken, welcher mithilfe des OTC-Index («Outdoor Thermal Comfort») gemessen wird und auf thermophysiologischer Bewertungsmethoden beruht. Das daraus resultierende Verständnis und die Fähigkeit zur Vorhersage von Veränderungen des städtischen Mikroklimas können dazu beitragen, diese Aspekte anzupassen und zu verbessern.

Die Nutzung dieser Daten zur Verbesserung der Gestaltung und des Designs kann Architekten und Stadtplaner bei der Entwicklung qualitativer Freiräume unterstützen. Diese tragen zur urbanen Lebensqualität bei und generieren für die Stadt einen physischen, ökologischen, wirtschaftlichen und sozialen Mehrwert. Die Menschen sollen sich auch zukünftig in der Stadt wohlfühlen.

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#### RÉSUMÉ

## L'importance du confort thermique extérieur pour la planification urbaine

Le Rapport spécial publié en 2018 par le Groupe d'experts intergouvernemental sur l'évolution du climat (GIEC) fournit l'explication scientifique la plus actuelle et complète du changement climatique. Le GIEC y prévient notamment que la Terre pourrait se réchauffer de 1.5°C d'ici au milieu du siècle.

Du fait de l'augmentation constante du taux d'urbanisation, le phénomène des îlots de chaleur urbains revêt une importance croissante. Celui-ci est dû au fait que les villes absorbent et emmagasinent beaucoup plus de chaleur que les régions rurales, ce qui se traduit par des différences de température sensibles entre les deux types de milieu. Le Programme des Nations Unies pour l'environnement (PNUE) relève que les villes devront s'adapter à l'évolution du climat urbain. Les changements en cours sont susceptibles d'affecter directement le bien-être humain, qui se mesure en l'occurrence par l'indice de confort thermique extérieur – lequel repose lui-même sur des méthodes d'évaluation thermophysiologiques. La compréhension de ce phénomène et la capacité de prévoir l'évolution du microclimat urbain peuvent contribuer à améliorer la situation.

L'utilisation des données y relatives peut aider les architectes et les urbanistes à concevoir des espaces non bâtis agréables, aptes à contribuer à la qualité de vie urbaine et à générer une plus-value physique, écologique, économique et sociale pour la ville. Il est primordial que l'être humain se sente bien dans les villes, et que cela reste le cas à l'avenir.

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#### RIASSUNTO

## L'importanza dell'Outdoor Thermal Comfort per la pianificazione urbana

Il rapporto speciale 2018 pubblicato dal Gruppo intergovernativo sul cambiamento climatico (IPCC) fornisce la spiegazione più recente e completa sulla ricerca nel campo dei cambiamenti climatici. L'IPCC mette in guardia, fra le varie cose, su un possibile riscaldamento globale di 1.5°C entro la metà del XXI secolo.

A causa del crescente tasso di urbanizzazione, le «isole di calore urbano» acquistano un peso sempre maggiore. Tali isole sono provocate dal fatto che le città assorbono e immagazzinano molto più calore rispetto alle zone rurali, con conseguenti differenze di temperatura. Il Programma delle Nazioni Unite per l'ambiente (UNEP) sottolinea che le città dovranno adeguarsi ai cambiamenti del clima urbano. Questi cambiamenti possono avere un impatto diretto sul comfort della popolazione, che viene misurato utilizzando l'indice OTC (Outdoor Thermal Comfort), basato su metodi di valutazione termofisiologica. La comprensione e la capacità di prevedere i cambiamenti nel microclima urbano può aiutare ad adattarsi e migliorare la problematica dell'eccessivo calore nelle città.

L'utilizzo dei dati per migliorare la progettazione urbana può aiutare architetti e urbanisti a sviluppare spazi liberi di qualità. Tali spazi contribuiscono alla qualità della vita e generano un valore aggiunto fisico, ambientale, economico e sociale delle aree urbane. Le persone dovrebbero quindi potersi sentire a proprio agio in città, anche negli anni a venire.