Climate-sensitive Urban Growth:
A parameterized design-feedback tool for outdoor thermal comfort

The world is facing unprecedented speeds in climate-change leading to an increase in global average temperatures, commonly referred to as global warming. In addition, cities absorb and retain significantly more heat than rural areas. This warmth of cities in contrast to their surrounding is known as ‘Urban Heat Island’ or UHI. One of the most important factors affecting the intensity of the UHI is the configuration of buildings, which also influences human outdoor thermal comfort. Understanding and especially being able to predict and manipulate urban microclimates may help improve aspects of outdoor thermal comfort.

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, this concept requires a more scientific approach, which implies a method of inquiry that must be based on empirical and measurable evidence subject to specific principles of reasoning. The outdoor thermal comfort is generally studied on the urban micro-scale, and can be described and linked to microclimatic conditions by steady-state assessment methods. With this information and after field measurements, a ‘predicting tool’ can be implemented in order to simulate how changes in design details influence outdoor thermal comfort. This methodology has been a reliable data source for studies in different climatic conditions, but barely implemented in tropical climates, where challenges of warm-humid/dry conditions are found.

The aim of this research is to develop a parameterized design-feedback tool that correlates microclimate conditions, outdoor thermal comfort (OTC) indices and urban morphology in order to explore climate-sensitive urban design. This will be possible by using an OTC index as an indicator for the understanding of the microclimate conditions in specific urban environments. With a tropical savanna climate, the city of Barranquilla was chosen as case study in order to verify and implement the methodology. To achieve the aforementioned research goal, the method is divided into three work packages: (i) measurement network for data collection, (ii) data processing and calculations, (iii) and simulation using regression. The first part consists on the installation of a weather station network in a preselected urban area. This measurement network will collect and visualise on an online platform the microclimate data throughout a year. The second work package aims to perform OTC calculations using the Physiologically Equivalent Temperature (PET) index and the Rayman model. Additionally, thermal sensation surveys will be performed to validate the PET calculations. The last work package aims to develop an interactive visualization tool, which simulated the PET for the city of Barranquilla using regression methods. At the end, the tool will be presented to city planners to evaluate its use for city development purposes.

In this way, the parameterized design-feedback tool will support the urban design process by visualizing and simulating the thermal comfort of pedestrians in different parts of the city. This will enable the exploration of design decisions by city planners and climate-change adaptation measures by policy makers. Therefore, this research will contribute to urban planning practices as a decision-support tool to provide guidelines for the construction of ‘climate-sensitive’ urban strategies that enhance outdoor thermal comfort and adapt to the coming climate.

Image 1: Project aims; Image 2: Methods: i. Measurement network for data collection, ii. data processing and calculations, iii. and simulation using regression. Image 3 & 4: Thermal sensation mobile app