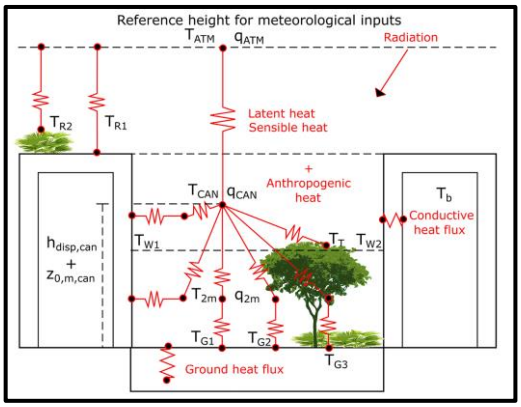
Master Project/Master Thesis:
How much heat reduction can Blue-Green Infrastructures achieve?

Keywords: blue-green infrastructure - microclimate - heat mitigation – modelling

Proposed: November 2022 **Valid until:** September 2023



Why is important to model urban microclimate?
Due to urbanization, cities and urban areas around the world are rapidly expanding, replacing natural habitat with anthropogenic landscape (Seto et al., 2012). This leads to several environmental issues, for example urban heat, which strongly reduces human well-being (Grimm et al., 2008). To optimize the implementation of infrastructure that mitigate urban heat, microclimate modeling is key to understand the impact of planned measure and to adapt the design of urban areas to maximize cooling effects (evapotranspiration, shadowing, wind, etc.).

What are BGI? Why is it relevant for urban microclimate?
Blue-Green Infrastructure (BGI, also called nature-based solutions) are recognized to potentially contribute in mitigating urban heat. BGI are defined as "an interconnected network of water bodies and green and open spaces" (Ghofrani et al., 2017), and consist of urban elements such parks, green roofs, bioretention basins, porous pavements, ponds, urban wetland and green walls. They are used as a strategy to increasing shading, evapotranspiration and albedo in urban areas (Balany et al., 2020).

How microclimate modeling can support BGI implementation?
While BGI are growing in popularity, more research is still needed to understand how well they are able to reduce temperatures and how performance varies between different BGI types. Several studies have quantified the effect on microclimate of single BGI elements (e.g., Berardi, 2016; Ferrari et al., 2020; Salata et al., 2017; Wang et al., 2016), however, little is known about the impact of strategies including diverse BGI types and implementation rates (Fu et al., 2022). For instance, it remains unclear whether implementing multiple BGI types would have a cumulative impact on temperature, or whether their marginal impact would plateau. Quantifying these aspects of blue-green infrastructure will support practitioners and decision-makers in making informed decisions.

How to model microclimate and BGI?

Only few urban microclimate model take into account the eco-hydrology of the city. Urban Tethys-Chloris (UT&C) model is one of the first urban canyon parameterizations to include eco-hydrology (Meili et al. 2020). UT&C is an opensource MatLab model that solves the differential equations for the urban energy balance, quantifying the effect of vegetation on urban climate and accounting for detailed plant characteristics. The outputs are the air temperature and humidity at 2 meter height and skin temperature of urban surfaces.

Objectives of the suggested topic

Depending on the type of the project (Master project or Master Thesis), the workload will be adapted.
Using an energy-balance model to set up a small-scale case study, the aim of this project is to answer to the following research questions:

- How well is the energy-balance model able to simulate the urban microclimate of a neighbourhood?
    - Develop an UT&C microclimate model of Basel (neighborhood in the city center)
    - Calibrate and validate the model with flux tower data (from University of Basel)

In case of a Master Thesis, these additional questions will also be investigated:

- How does the implementation of BGI influence the urban microclimate?
- How do different BGI types compare in terms of urban heat mitigation?

Specific information / Requirements

Good programming knowledge, experience with MatLab, confidence with energy balance and thermodynamics (or Hydrology II).

Advisors and Supervisors

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