Enhancing transport modelling with microclimate simulations

an interdisciplinary approach to climate adaptation modelling within the KNOWING project

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A major shortcoming of strategies for climate resilient cities is the **omission of interactions** between climate adaptation and mitigation actions, both in modelling and implementation.

Depicting these interactions is crucial in understanding the full impact of mitigation and adaptation measures, as their impact cascades into many sectors.

Creating tomorrow's Tallinn (Estonia):

Within the KNOWING project, future scenarios for the city of Tallinn (Estonia), incorporating traffic related mitigation and heat related adaptation measures, are modelled in close exchange with city representatives. Four scenarios were developed with the **goal of heat reduction and a climate neutral transportation system**:

Status-quo → 2030 → 2040 → 2050

The status-quo depicts the current city structure and traffic. For the future scenarios, changes in the city structure were modelled based on detailed planning information on building and traffic developments. Furthermore, additional greening measures (planting trees, desealing and renaturalization) were applied gradually from 2030 to 2050.

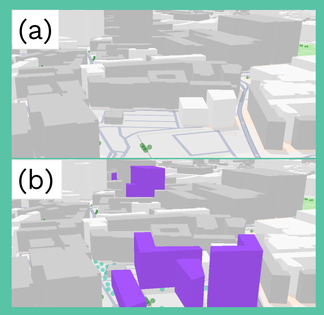

Fig. 1: Example of city structure changes between status-quo (a) and 2030 (b).

Microclimate Simulations

To understand the microclimate as well as to identify heat stress hotspots of the city, the state-of-the-art model PALM-4U is used. A hot summer day with boundary conditions from a mesoscale climate model is applied to the status-quo city as well as a Tallinn of 2030, 2040 and 2050.

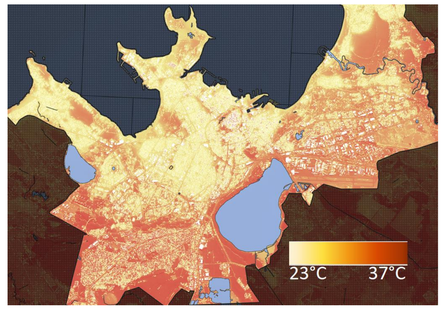

Fig. 2: PALM-4U output: highly resolved 2m temperature at 12 UTC.

Interaction with microclimate simulations

City structure changes

Future transport infrastructure changes have been implemented as land-use changes within PALM-4U. Desealing of street lanes as well as parking lots and added street greenery within the future scenarios is applied in PALM-4U based on the modelled changes in transport infrastructure.

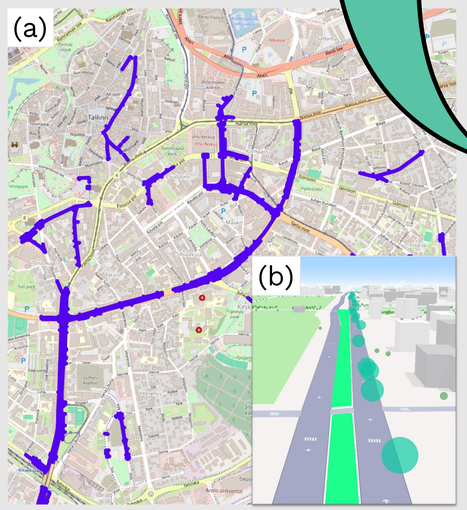

Fig. 4: Selected map section showing streets with an envisioned drop in traffic (a) and an example street with added street greenery, (b).

Interaction with transport modelling

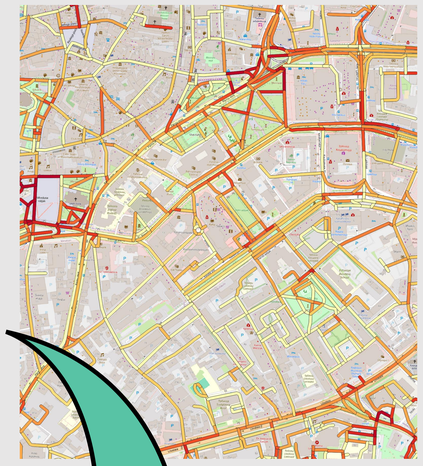

Fig. 3: Aggregated heat stress indicators on transport links on a selected map section.

Routes with high heat stress

Street canyons with high heat stress during daytime might be avoided by cyclists and pedestrians alike. To quantify this, grid boxes signalling a high heat stress, are aggregated on the network links of the transport model, quantifying the exposure and allowing to define additional weights for these passages. The weights account for a disutility within destination choice, mode choice and route assignment procedures.

Transport modelling

The traffic and transport sectors are simulated with PTV Visum (transport model routing framework) and ABM light (Python based framework for multimodal mobility demand calculation), which aims to depict passenger and freight transport activities and traffic flows for a typical workday for the status-quo, 2030, 2040 and 2050.

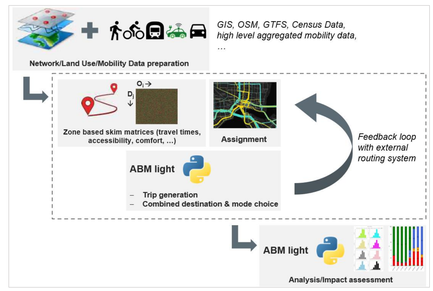

Fig. 5: Overview of the model process of ABM light.

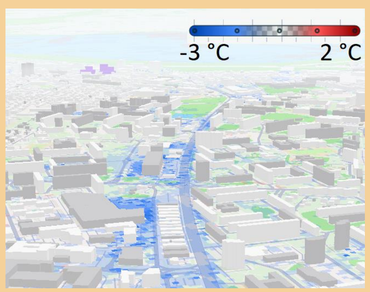

Fig. 6: Selected map section showing streets where reduced traffic led to more space for greenery and a reduced max. temperature (shown in blue).

Main findings

Adaptation and mitigation measures go hand in hand

This approach actively integrates actions from the transport and microclimate modelling fields through close collaboration between experts and modelers, establishing a foundation for deeper model interactions in the future.

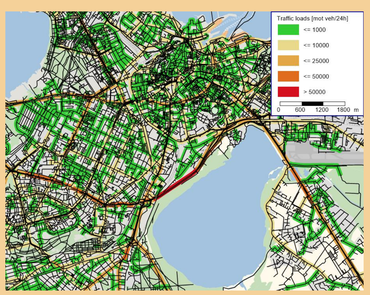

Fig. 7: Selected map section depicting the simulated workday traffic load for 2050.

KNOWING

Framework for defining Climate Mitigation Pathways based on Understanding and Integrated Assessment of Climate Impacts, Adaptation Strategies and Societal Transformation

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