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Adaptive capacities and resilience in urban and landscape planning

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Motivation, Background and Aims

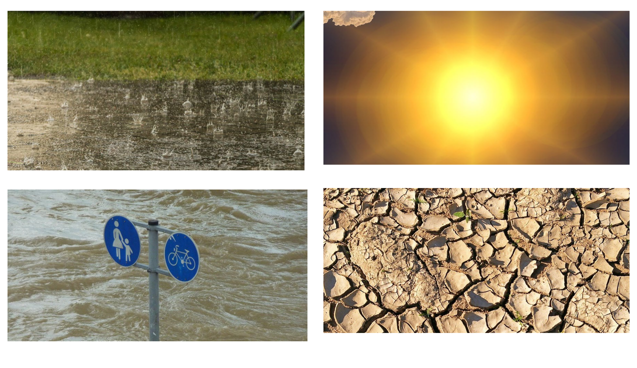


Figure 1: Heavy rain, flooding, heat and drought are key challenges of climate change in spatial planning

Climate change and the consequences for planning

Urban areas are particularly affected by climate change: the ever-progressing urban development in combination with the increased occurrence of extreme weather events has resulted in a growing number of hot days and warm nights that result in increasing heat stress. In addition, more frequent and intense heavy rain events are expected but also an increase in heavy rainfall events (IPCC 2021).

Challenges or research gaps addressed by the research project

- ✓ There is a lack of methods for the elaboration of planning advice maps.
- ✓ Changes of precipitation cannot be depicted for the small scale necessary for planning
- ✓ Deciding on the most effective measures depending on the structural-spatial framework is often complex (and costly due to complex simulations).
- ✓ There is a lack of instruments to steer and monitor implementation.

Theoretical framework concept for urban climate analyses and the planning recommendation maps

The implementation of the IPCC risk concept in urban climate analyses

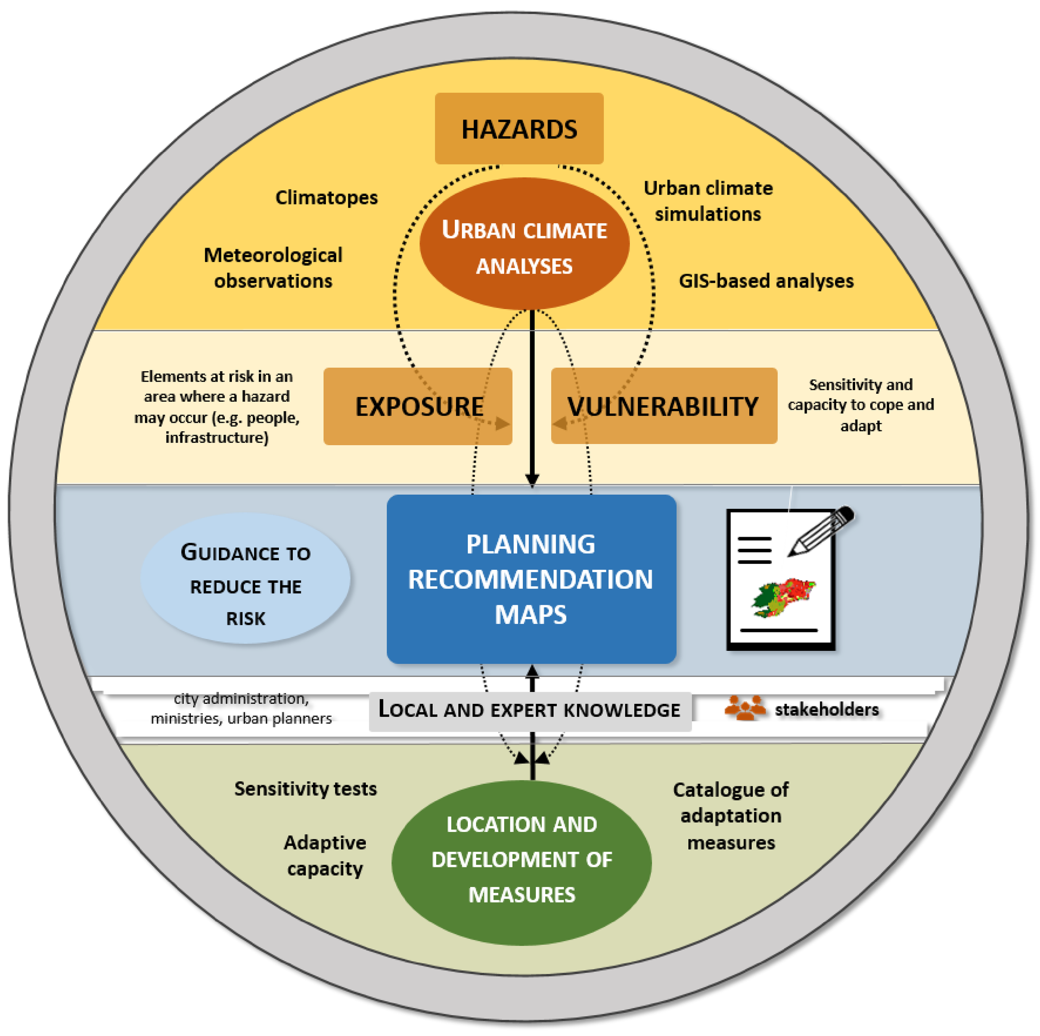


Fig.2: Methodological framework and crucial steps of the development of urban planning recommendation maps. Credit: GeoSphere Austria/Hollosi, adapted from EU-GL (2011)

In the context of climate change impacts, risks arise from the **dynamic interactions between climate-related hazards and the exposure and vulnerability** of the affected human or ecological system to those hazards (IPCC 2014).

Based on a sample of 12 urban **climate analyses including planning recommendation maps** from Switzerland, Germany and Austria, we conducted a **comparative analysis of the processing steps** conducting the analyses leading to planning recommendation maps.

Based on the comparative analysis we recommend the following **framework for urban climatic analysis aiming for planning recommendation maps** that take into account the IPCC risk concept as well as the allocation difficulties or overlaps of the three analysis components in practice. This framework can support practice and research in the further development of climate-sensitive urban and spatial planning.

Components of Urban Climate Analyses for the Development of Planning Recommendations and Planning Recommendation Maps

Urban climatic analyses must include four components to enable spatial climate change adaptation:

(1) **urban climatic analysis** related to the **hazard** component,

(2) in depth **social and spatial analysis** related to **exposure and vulnerability** components,

(3) **adaptation measures and effects** related to the sub-component of vulnerability, the **adaptive capacity** component and thus

(4) planning recommendations and **planning recommendation maps as "guidance to reduce the risk".**

Practical cooperation with municipalities for analysis and methods development

Test site: municipality Perchtoldsdorf

Perchtoldsdorf is a municipality in Lower Austria with ~ 15.000 inhabitants at the south-western border of the City of Vienna.

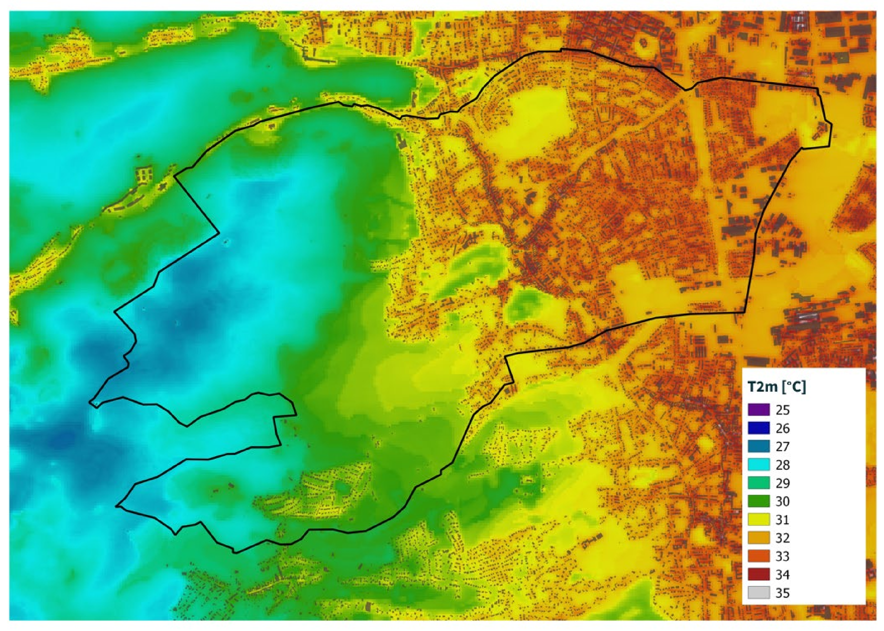


Fig. 3: 2 m air temperature (12 UTC)

Thermal component

The **simulations** carried out with the urban climate model MUKLIMO_3 (Sievers, 2016) are based on real-case conditions for a selected day during a heatwave event (17.08.2022). The model was initialized with meteorological data from the weather forecast model AROME. The distribution of near-surface air temperature with a **spatial resolution of 20 m** indicate **areas prone to heat stress**, providing the basis for an urban climate analysis. (Fig. 3).

Urban climate projections

The **mean annual number of summer days** and it's evolution towards the end of the 21st century is shown in Fig. 4, indicating a **strong increase in heat load under the scenario RCP 8.5.**

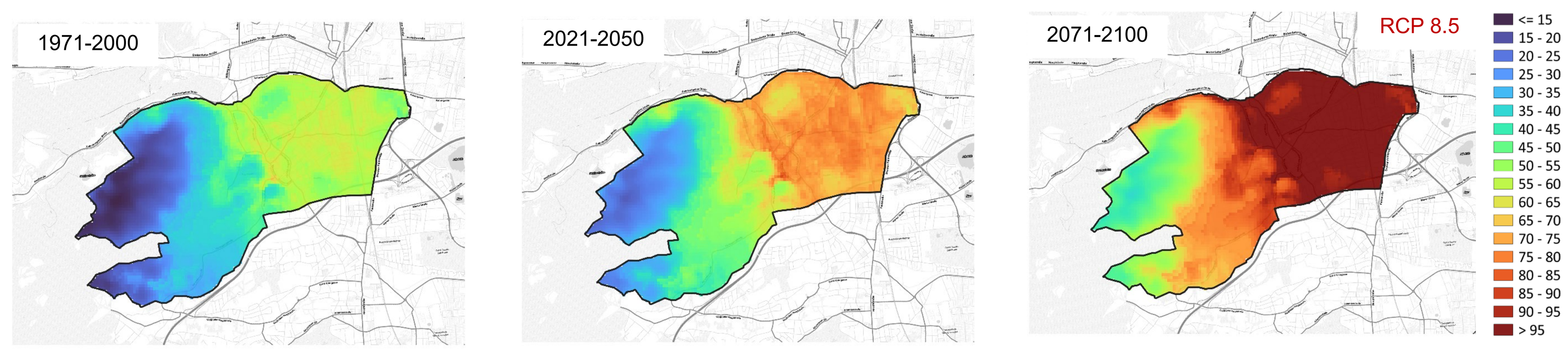


Fig. 4.: Mean annual number of summer days based on the MUKLIMO_3 model results (50 m spatial resolution) and regional climate projections from EURO-CORDEX (ensemble mean), using the cuboid method (Früh et al. 2011)

Dynamical component

To take into account the **dynamic component** of the analysis, the cold air drainage model KLAM_21 (Sievers, 2005) is applied to simulate important **nocturnal cold air flows** under fair weather conditions. Fig. 5 shows the spatial distribution of the height of the cold air layer 2 and 4 hours after sunset.

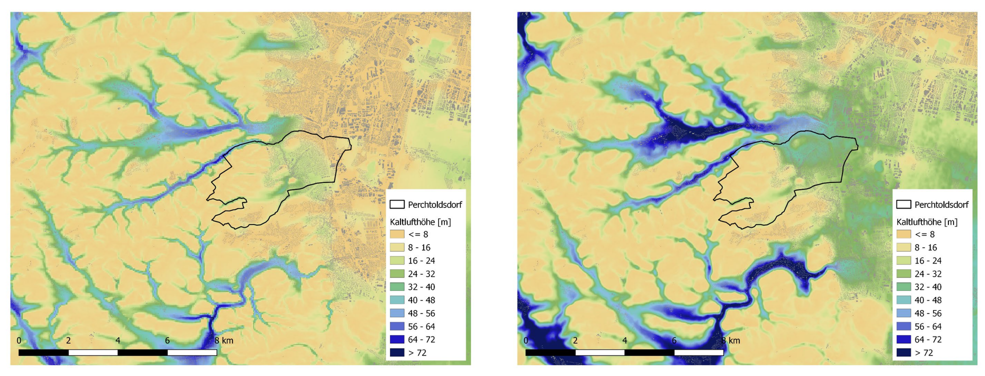
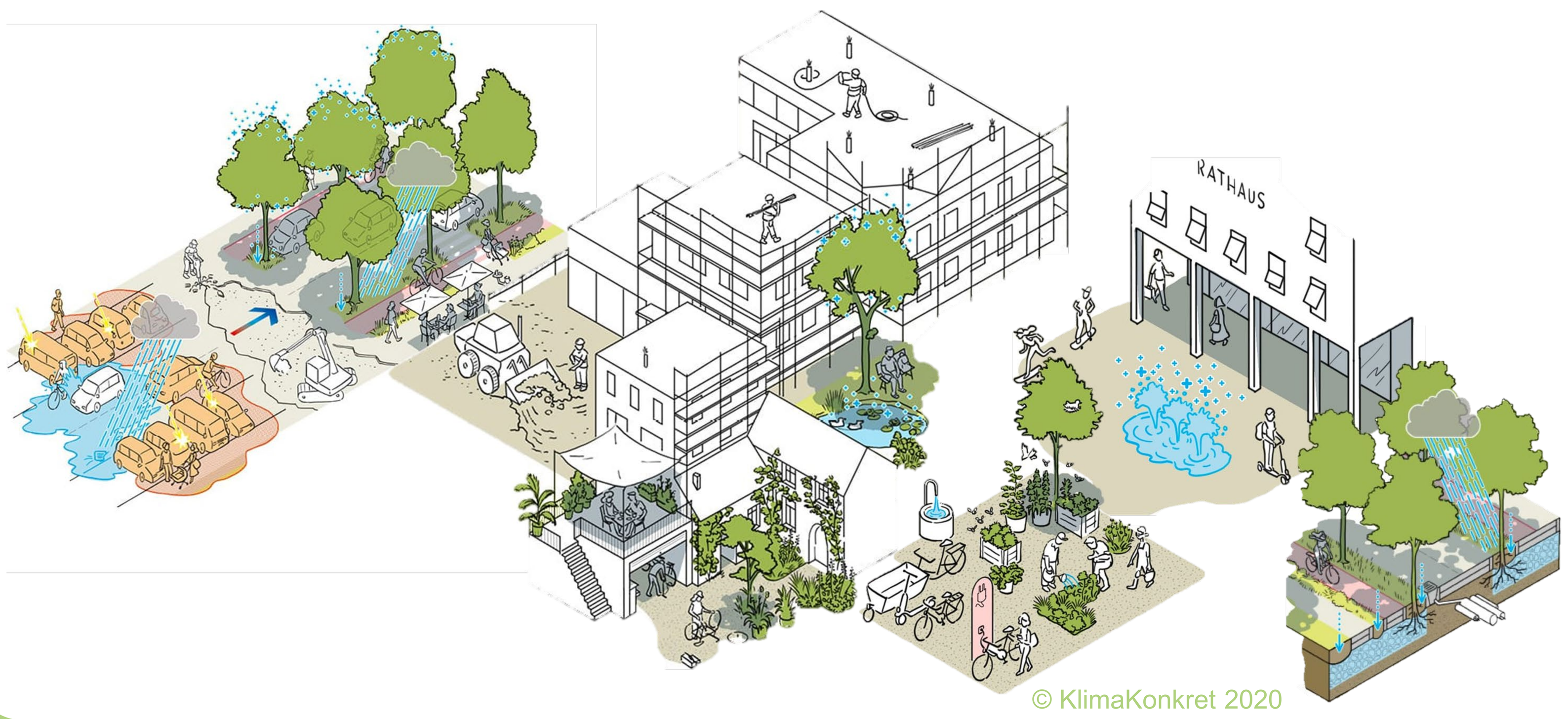


Fig. 5: Cold air height [m] 2 (left) and 4 (right) hours after sunset

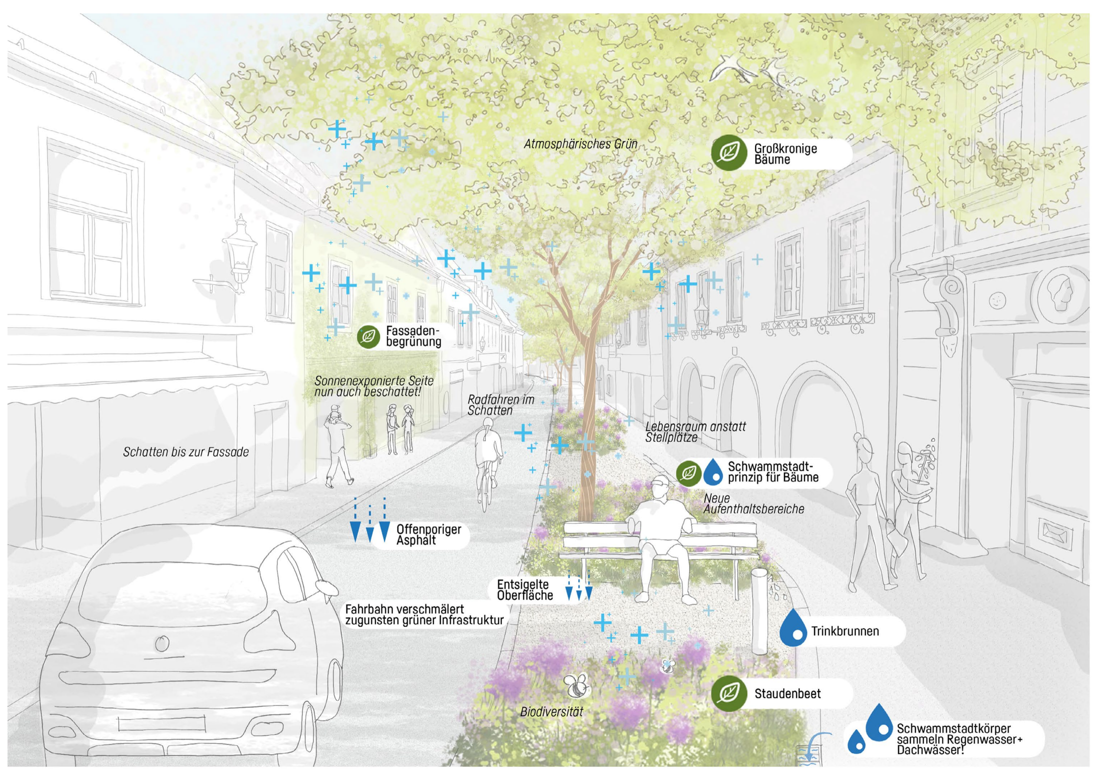
Practical cooperation with municipalities for implementation of adaptation

Important fields of action in planning for climate change adaptation in municipalities:

(1) Settlement development (planning and building), (2) Green spaces, (3) Water, (4) Mobility



Potential planning measures using the example of "climate-friendly roads":



Catalogue of measures and checklist for implementing concrete measures:

Evaluation of the measures under the aspects of:
- Effectiveness in heat
- Effectiveness during heavy rainfall events
- Effectiveness during drought

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