Investigating the Urban Heat Island Effect in Small- to Medium-sized Cities in Austria (ADAPT-UHI)

Linda See[1], Maja Žuvela-Aloise[2], Brigitta Hollosi[2], Sandro Oswald[2], Alexander Storch[3], Gundula Prokop[3], Wolfgang Schieder[3], Stefan Guggenberger[4] and Wolfgang Hafner[4]

25-26 April 2019

Why are we studying this?

Cities are vulnerable to increasing temperatures from climate change because of the urban heat island (UHI) effect, which impacts human health and well-being. To adapt to a warmer climate in the future, cities need guidance regarding what measures are most effective and how they can best adapt to climate change in the future. Large cities such as Vienna have climate change adaptation strategies. Yet smaller- to medium-sized cities are also faced with increasing temperatures and effects from the UHI and hence need advice on how to act. The ADAPT-UHI project aims to provide this advice to three pilot cities: Klagenfurt, Salzburg and Mödling, by generating scenarios of adaptation produced by an urban climate model, along with other outputs including a UHI risk index map and green and blue quality maps of the city.

Urban climate modelling

The urban climate model used in the ADAPT-UHI project is called MUKLIMO_3 (Figure 2) and allows for modelling at a spatial resolution of 20-200m. The model requires a number of inputs such as land cover/land use, vegetation cover and height, impervious surfaces, etc., which we obtained from the cities of Klagenfurt, Mödling and Salzburg or from other sources such as Copernicus.

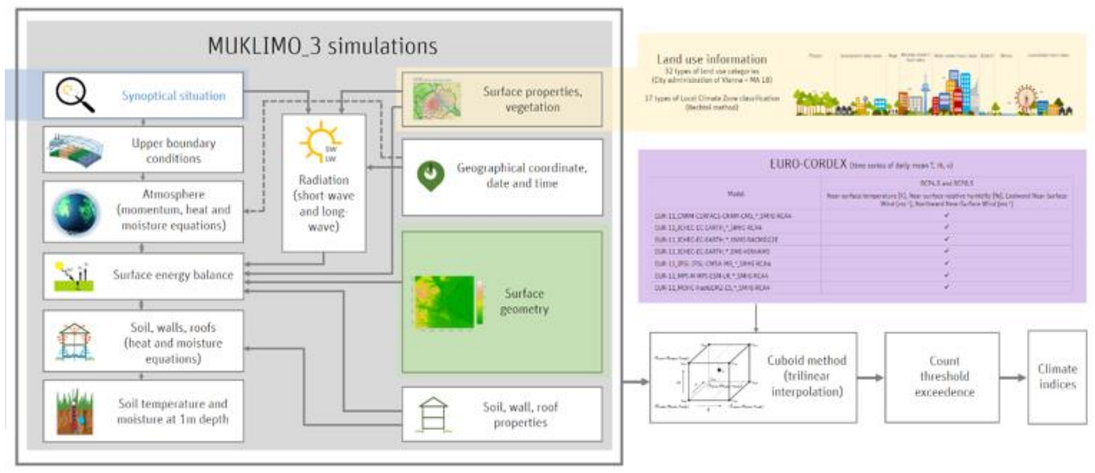


Figure 2: The MUKLIMO_3 urban climate model

The model is then set up for each city, the past and current climate are then simulated, and the model outputs are validated using meteorological data. Using European climate projections, the model is then used to simulate future climate. Figure 3 shows the annual number of summer days (Temp. > 25 C) for the three cities and three time periods under an RCP8.5 scenario, which has high greenhouse gas emissions in the future. The numbers are predicted to increase quite significantly for all three cities in the future.

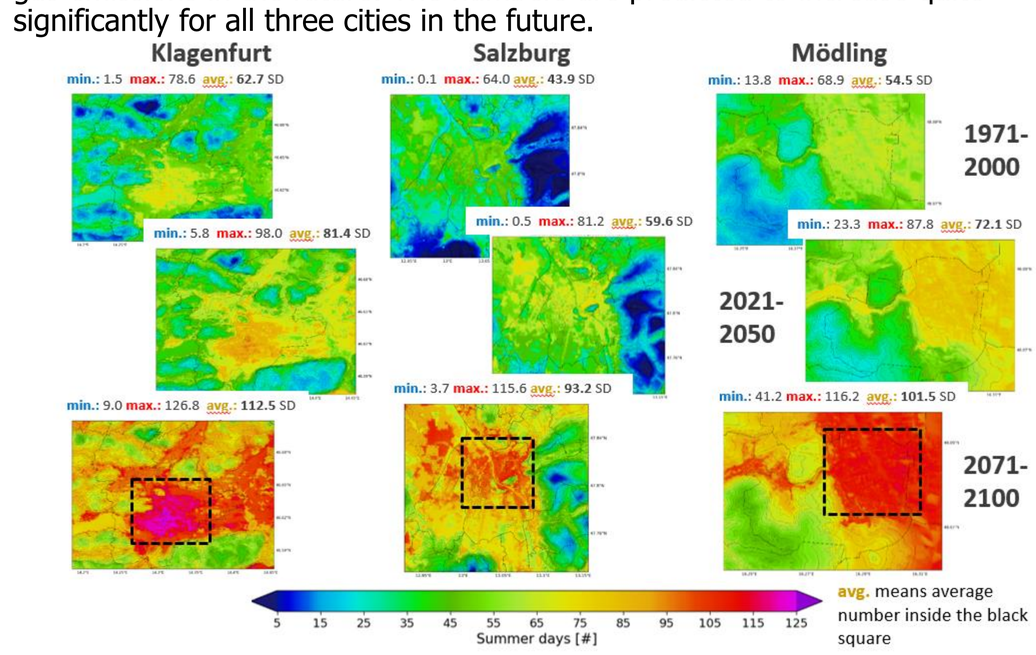


Figure 3: Model simulations of past and future climate of the average number of summer days (Temp. > 25 C) for the three pilot cities

UHI risk index

This risk index will be available as at a 100 m resolution for all of Austria. It consists of a UHI intensity indicator based on the following factors:

Meteorological indicators (30% - data set for 1 km x 1 km) based on perceived temperature of Hot Days (HD) and Tropical Nights (TN) during heat periods (HP) defined by both; based on data from the last 15 years
- (5%) Average annual number of days of HP in d/y (+)
- (10%) Average maximum duration of annual HPs in d/y (+)
- (15%) Duration of the longest HP in d (+)

Land use indicators (60% - with high local impact)
- (25%) Share of soil sealing (+)
- (10%) Share of green area (divided into forest and non-forest) (-)
- (25%) Share of blue area (-)

Building structure (10% - with very high local impact)
- (10%) Degree of shading by buildings per building area (-)

This UHI intensity indicator is then multiplied by a 'population at risk' indicator, which includes factors such as the population over 60. The UHI risk indicator map will be available by the summer of 2019.

The ADAPT-UHI methodology

User needs and data collection has been our starting point. Workshops were held with the cities of Klagenfurt, Salzburg and Mödling to understand their needs in the context of climate adaptation and to collect data needed for the urban climate model, the UHI risk index and the green/blue quality maps.

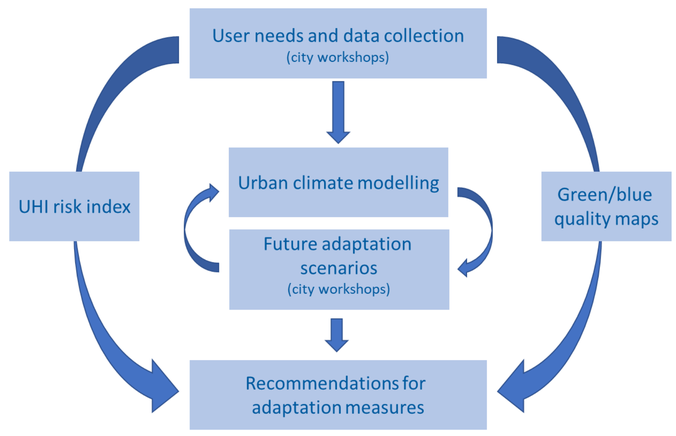


Figure 1: Stages in the ADAPT-UHI project (described in more detail below)

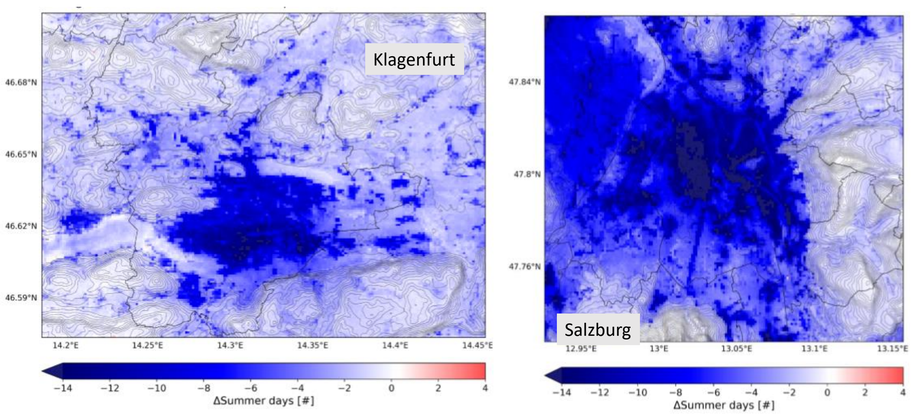
Future adaptation scenarios

There are a number of different adaptation measures that can be simulated with the urban climate model. Table 1 lists different scenarios that are modelled for each city. Changing the albedo contributes to a 'white' city while other adaptations ('green' city) represent adding more green spaces and trees to a city.

Table 1: Adaptation scenarios simulated with the urban climate model for each pilot city

Possible adaptation scenario	Changes to model parameters
Albedo of roofs	From 0.2 to 0.5 (in land use classes 1-7)
Albedo of walls	From 0.3 to 0.5 (in land use classes 1-7)
Albedo of impervious areas	From 0.2 to 0.4 (in land use classes 1-7, 13-17)
Impervious areas	-30% (in land use classes 1-6)
Amount of green roofs	50% (in land use classes 3, 4, 5 and 7)
Amount of trees	+50% (in land use classes 8-10 and 15-19)
Low vegetation increased	From 85% to 100% (in land use classes 1-7)
Combined scenario	Implementation of all changes listed above

The results from the combined adaptation scenario is shown in Figure 4 for the three cities while Table 2 lists the change in the number of summer days when applying the different adaptation scenarios.



The combined scenario shows decreases of 9.1, 11.5 and 5.0 summer days for the three cities if all adaptation measures are applied.

Table 2: Results of the urban climate model simulations for each city

Adaptation measure	Change in number of summer days (Temp. > 25 C)					
	Klagenfurt		Salzburg		Mödling	
	Average	%	Average	%	Average	%
Albedo roof 0.5	-2.7	-4.1	-4.2	-8.3	-1.5	-2.1
Albedo wall 0.5	-0.9	-1.4	-2.0	-4.0	-0.9	-1.3
Albedo street 0.4	-2.1	-3.2	-2.4	-4.8	-0.8	-1.3
Impervious area < 30%	-0.7	-1.1	-1.4	-2.8	-0.3	-0.4
Green roofs 50%	-1.3	-1.9	-2.7	-5.3	-0.5	-0.7
Number of trees + 50%	-0.5	-0.7	-1.6	-3.2	-0.7	-1.0
Low vegetation to 100%	-0.7	-1.0	-2.1	-4.1	-0.5	-0.7
Combination	**-9.1**	**-13.6**	**-11.5**	**-22.8**	**-5.0**	**-7.3**

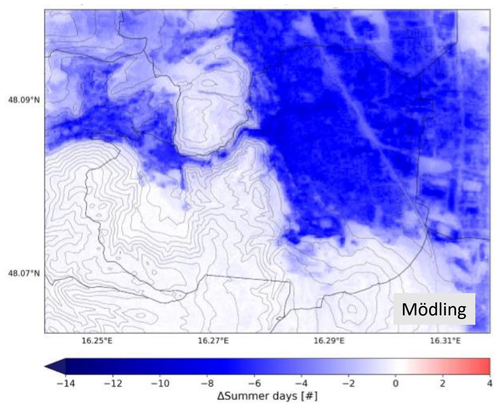


Figure 4: The decrease in annual summer days (Temp. > 25 C) from the combined adaptation scenario for the three cities

Green/blue quality maps

This task involves mapping the shading and evapotranspiration cooling by **green areas** and **blue areas** in the pilot city. The maps will show changes in evapotranspiration patterns during consecutive heat days, e.g., 8 days, 15 days, 25 days, etc. These maps will be useful for assessing the status of these areas, monitoring change over time, developing targets, and evaluating implementation measures. These maps will be available by the summer of 2019.

Recommendations and project outcomes

Over the next year of the ADAPT-UHI project, we will:

- Present the adaptation scenarios to the three cities and refine them based on urban plans in the future;
- Combine the inputs from the adaptation scenarios, UHI risk index and green/blue quality maps to provide recommendations for adaptation measures for the three cities;
- Place all the outputs onto the ADAPT-UHI visualization tool so that planners can view the scenarios and data sets in one place, to facilitate decision support;
- Develop guidance for other small- to medium-sized cities in Austria who could benefit from these types of climate services.

1 IIASA
2 ZAMG
3 umweltbundesamt
4 ipak International Project Management Agency Klagenfurt on Lake Wörthersee GmbH

powered by klima+ energie fonds
https://www.adapt-uhi.org