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Building a Bridge from Vienna to Tallinn - Climate resilient Cities through Nature Based Solutions

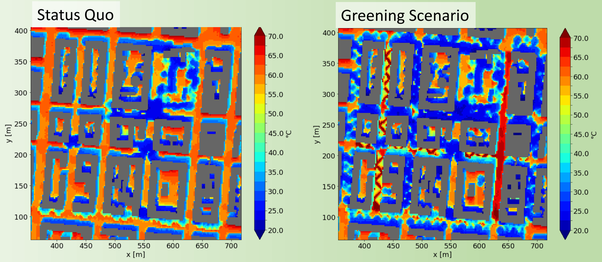
Over the past 20 years **Vienna** has been increasingly suffering from hot summer temperatures related to the human-made climate change. Cities are especially affected by the increasing global temperatures, since the characteristics of urban environments (reduced long-wave emissions towards the sky due to the blockage effect of surrounding buildings, construction materials, anthropogenic heat production, lack of green and blue infrastructure) further increase ambient temperatures and result in **urban heat islands**. Therefore, Vienna setup the Urban Heat Island Strategy Plan[1], where the importance of natural areas etc. was emphasized. At the same time, there is a steady influx of people putting more pressure on the available space. Therefore, the **existing, densely built-up areas and available open spaces** need to be transformed!

Nature based Solutions (NbS) play a crucial role in improving the liveability of the city, such as extensive greening, unsealing of surfaces (e.g. parking spaces), façade and roof greening as well as providing natural shading through trees. They are not only extremely **effective on reducing prevailing temperatures,** but also support the overarching goal of **climate neutrality** in contrast to technical solutions such as air conditioning. Even though their effectiveness is well known, the **implementation** is still only **slowly** happening due to multiple reasons: resistance by urban dwellers due to limited space and different user needs (e.g. parking), by city governances due to costs and concerns about gentrification (upscaling of neighborhood causes increased rent). All mentioned aspects have been investigated for Vienna.

One **specific quarter of Vienna** was chosen to simulate the impact of bundles of measurements (Fig. 1), within currently given constrainsts. Thus only houses that are classified for green roofes were greened. Further, distinctions of the bundles were made between technical and nature based solutions (NbS), thus in two streets only technical solutions such as triangular sun sails, fog showers and brightened paving stones were implemented. On the other hand within two streets only NbS (facade greening, unsealed parking lots, trees, street green and water features) were assumed. The simulations were done for a hot summer day with low wind speeds (autochthone conditions) using the ENVI-Met[2] model

2) Mean Radiant Temperature, z=1.5m, 2pm

A reduction of mean radiant temperature (MRT) is mainly achieved through shading objects with stronger effects caused by trees than by sun sails. Increase in MRT due to brighter pavestones can be observed as well and must not be neglected as influencing factor on thermal comfort of pedestrians.



1) Quater and simulated bundles of measures

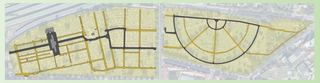
3) Difference in Air Temperature between Status Quo and greening scenario (z=1.5m, 2pm) – mean temperature reduction is about 0.5°C, maximum reduction up to 2°C

To reduce the urban heat island effects, **Vienna** puts specific efforts into greening of densely built areas. **Cemeteries** offer a great potential, since some are already (partly) green oases that provide recreational space for people and cooling for the residents. The great potential of the cemeteries, which are often centrally located and are seldom rededicated to other purposes, can be increased by deliberate greening and unsealing measures. The impact of **moderately and maximum unsealing** currently sealed paths and **graves, as well as tree planting** (under current constraints) and the opposite effect (completely sealed, reduction of trees) was investigated using the ENVI-Met model.

4) Cemetery Meidling - Status Quo (@Google Maps)

Status Quo Scenario – black paths are sealed

Maximum Greening Scenario – black paths are sealed

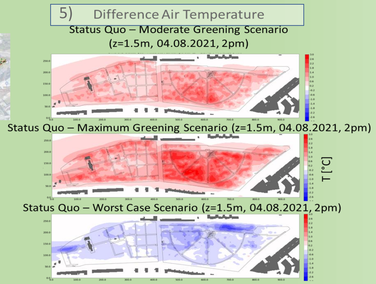


Tree plantings within the cemetery

Trees – green dots are Status Quo
Black – Moderate Scenario
Red – Maximum Scenario

Circled green areas are transformed into forest cemeteries:
Moderate – right one
Maximum – both areas

5) Difference Air Temperature



The unsealing of paths, graves and the additional planting of trees result in a significant decrease of air temperature up to 1.5-2°C at the cemetery itself, and a reduction of about 1°C in the adjacent streets (Figure 5). On the contrary, completely sealing the cemetery (worst case) increases the prevailing temperatures between 0.5° to 2°C compared to the current situation.

When looking at the **average of the cemetery area**, the greening scenarios display a temperature reduction of 0.1 to 0.8°C, depending on the intensity of the measures and the time of day (Fig. 6, green bars). The transformation of the cemetery to a parking lot f.i. would increase the prevailing temperatures of about 0.5°C (Fig. 6, red bar).

6) MEAN AIR TEMPERATURE DIFFERENCE [°C]

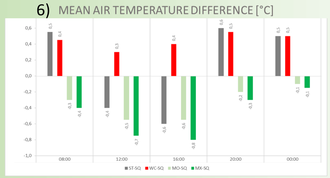
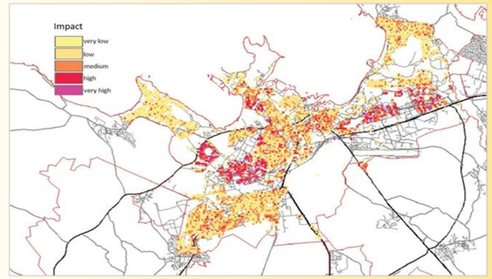


Table 1: Infiltration potential

	WC	SQ	MO	MX
Infiltration potential	5%	47%	63%	67%
Difference (SQ scenario)	-42%	0	16%	20%

As a further step, **the air temperature of the city quarter (ST, Fig.1) was compared to the current setup (SQ) of the cemetery** (Fig. 6, grey bar). The results show that in the morning and evening the cemetery exhibits colder conditions than the city quarter. During the day the shadowing effect of the buildings cause lower temperatures in the street canyons than within the cemetery, which is only partly shadowed due to trees. In addition to the temperature effect, the cemetery studied has a large **infiltration potential of precipitation (Table 1)**, which may be of great importance for the built-up city due to the increase in heavy precipitation events caused by climate change.

One of the main climate risks affecting the city of **Tallinn** is the formation of heat islands, which is increasingly affecting the wellbeing of the citizens. The vulnerability of the area to the effects of heat waves depends on the built structure and on a neighborhood's population's age (children and the elderly) and social status (economic opportunities, level of education). In fact, July 2021 brought a death rate increase of over 40% among the risk groups in Estonia. As more **vulnerable groups** are more likely to have less awareness and poorer economic opportunities, the city must support them in coping with the dangers of heatwaves.



Vulnerability to Urban Heat Island (UHI) effect in Tallinn. The impact is highest in areas where a large part of the population belongs to risk groups, and also the UHI effect is strong. Source: University of Tartu (2016).

NEXT STEPS

The findings from the studies of **Vienna** with respect to

- adaptation of city quarters: impact of NbS and technical solutions on prevailing local climate
- (social) housing regulations needed to prevent green gentrification (SENSUS[3] project, not shown here)
- Willingness to pay of citizens (SENSUS project)

are discussed with representatives of Tallinn through KNOWING[4] to ensure a sustainable transformation and adaptation to the emerging risk of heat.
The experiences of **Tallinn** with respect to the prevailing green cemeteries, their usability as recreational areas etc. are discussed to facilitate the transformation of cemeteries within Vienna.

SUMMARY

For **Vienna different options to decrease the prevailing urban heat islands were investigated in detail**, using a 3D microclimate model. Therefore, the effect of realistic NbS and technical measures on the local climate of a **city quarter** were simulated.
Furthermore, the potential of **transforming an existing graveyard** towards a greener area within the city was analysed by simulating the effect of a moderate and maximum unsealing and greening. Additionally, the negativ effect of transforming the cemetery to a parking lot f.i. was quantified.
Both studies show a **decrease in air temperature of about 1°C** through the implementation of NbS, highlighting their potential.

PROJECTS & CONTACT

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- [3]SENSUS (funded by the Vienna Science and Technology Fund (WWTF) [10.47379/ESR20011])
- [4]KNOWING – www.knowing-climate.eu

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[1]https://www.wien.gv.at/umweltschutz/raum/uhi-strategieplan.html
[2]https://www.envi-met.com/software/