The extent and implications of the urban heat island phenomenon in Central European region

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EU Project

(Central Europe)

Investigates the UHI-phenomena in Central Europe

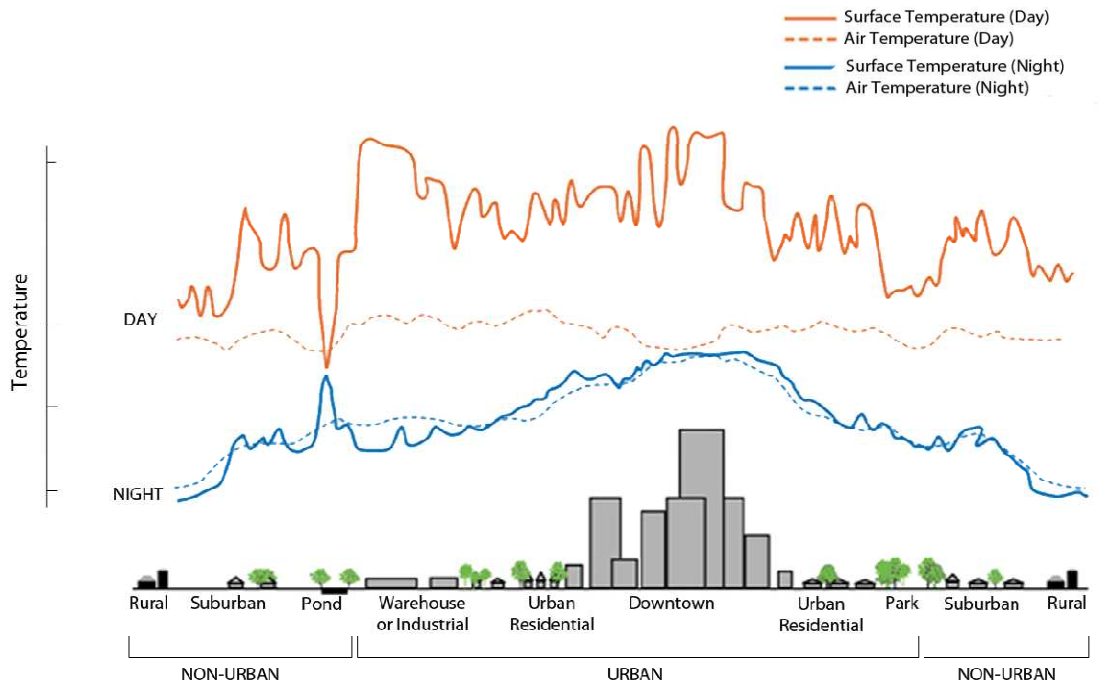
- The extent of the UHI effect in multiple cities in Central Europe
- Manifestation of the urban heat islands phenomena (temporal and spatial variations)
- Evaluation of mitigation and adaptation strategies

Participating cities

- The list of participating cities:
  - Budapest, Hungary
  - Ljubljana, Slovenia
  - Modena, Italy
  - Padova, Italy
  - Prague, Czech Republic
  - Stuttgart, Germany
  - Vienna, Austria

UHI phenomenon

- Temperature difference between the urban and the rural environment



Source: http://www.epa.gov/heatisland/about/index.htm

Methodology

- Quantifying the frequency, magnitude, and time-dependent (diurnal and nocturnal) UHI intensity distribution

- Focus:
  - Short-term (reference week) analyses
  - Long-term analyses

- The magnitude of the UHI effect is expressed in terms of Urban Heat Island intensity ($\Delta\theta$)

Methodology

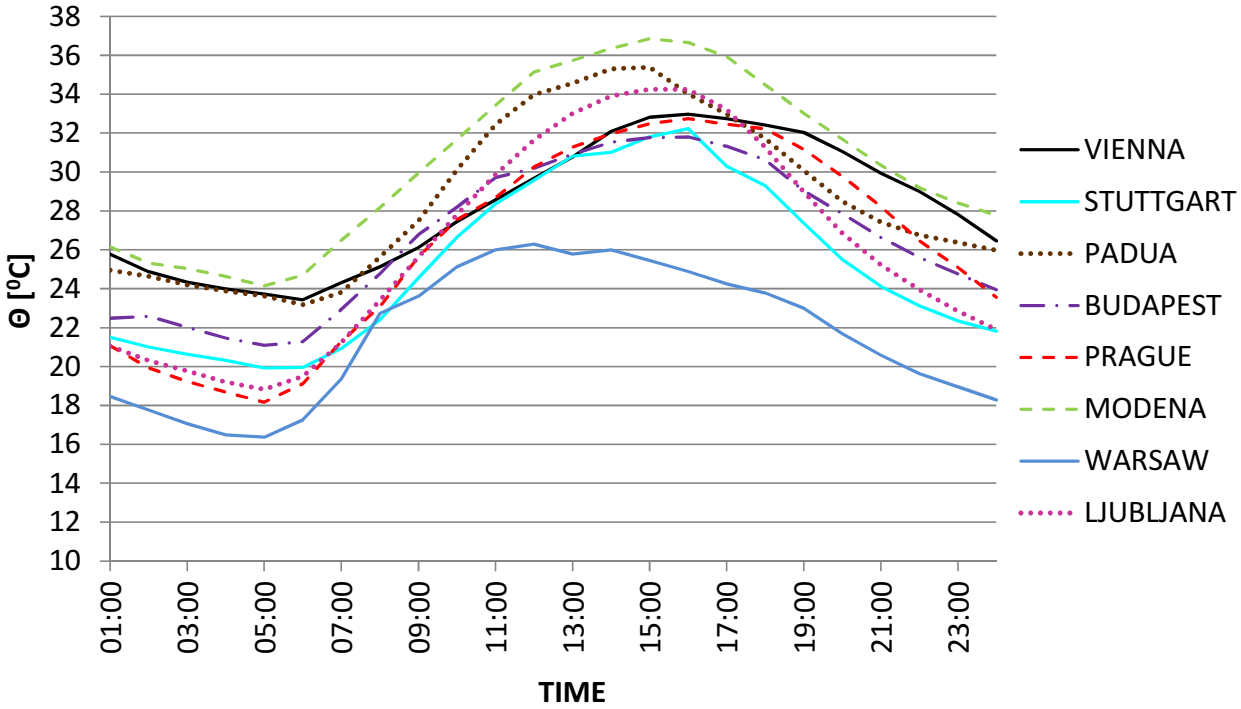
- Each participating city provided data (including air temperature, wind speed, and precipitation) from two representative weather stations (one urban and one rural)

- Short-term:
  - The hourly-based UHI intensity has been derived from data sets in a course of a reference week

- Long-term:
  - Mean annual (urban and rural) temperatures and UHI values were derived for a period of 30 years

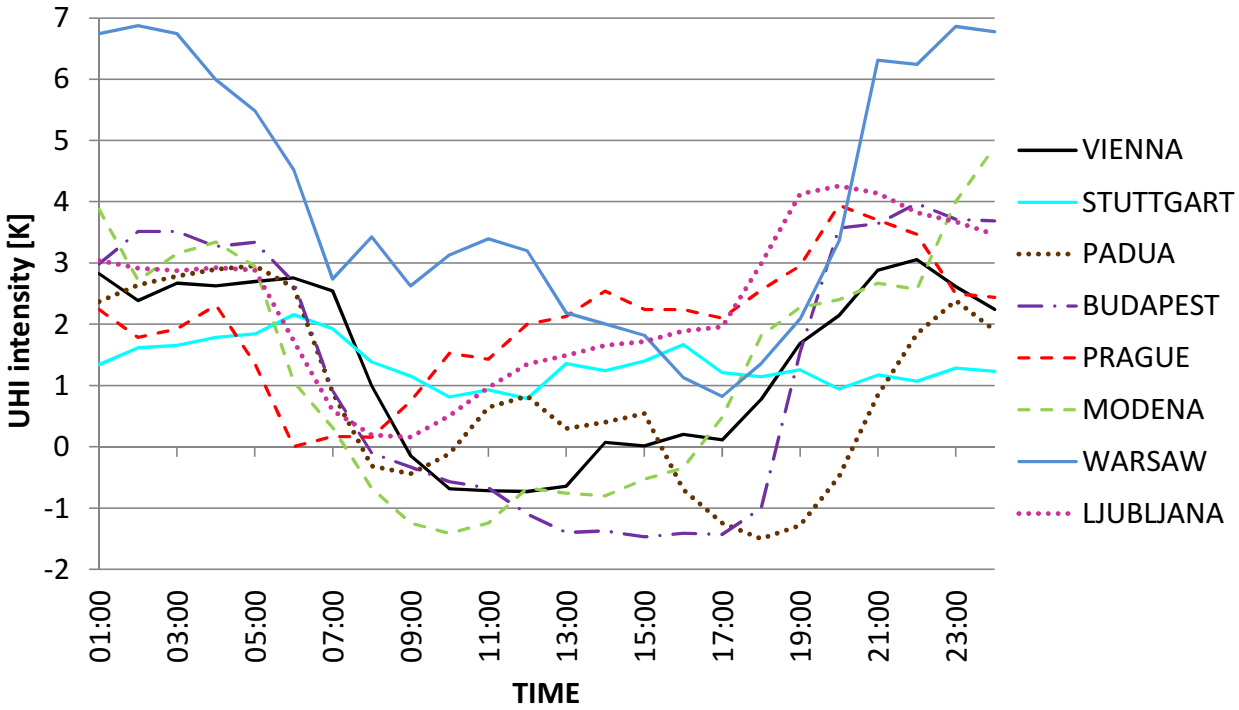
Results – short-term analysis

Mean hourly urban temperature distribution for a reference summer day



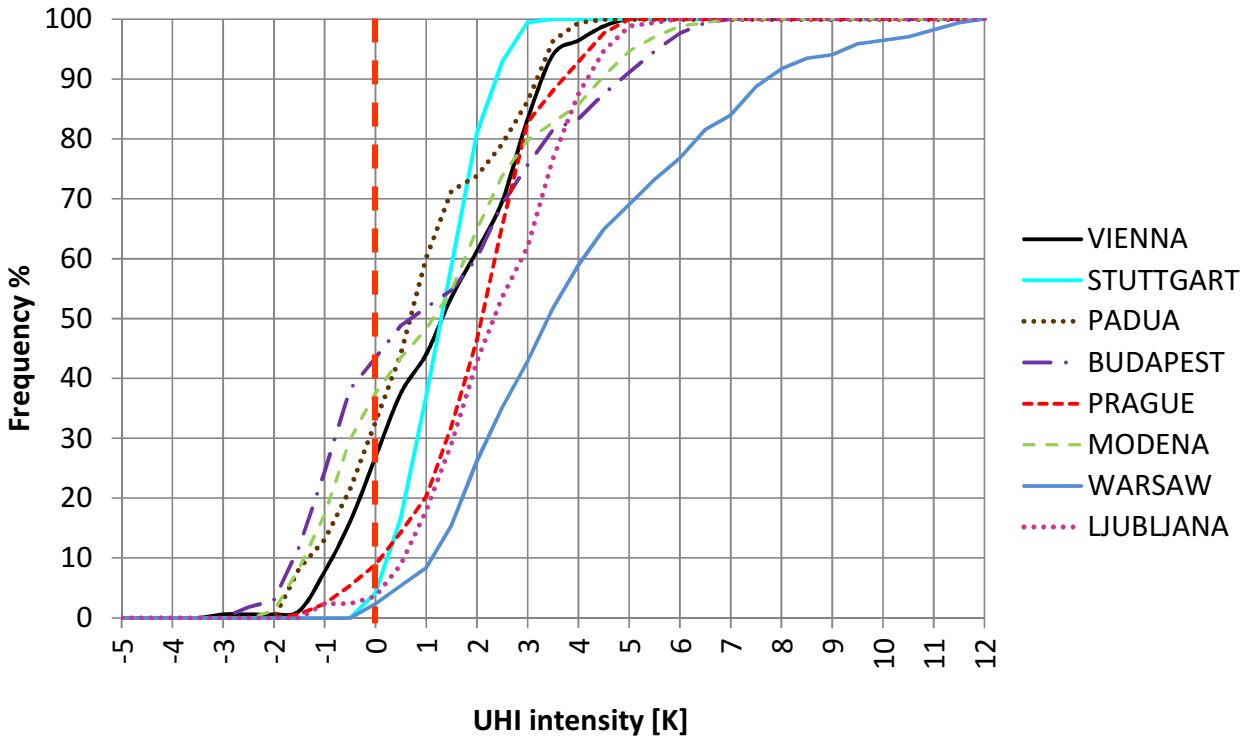
Results – short-term analysis

Mean hourly UHI intensity distribution for a reference summer day



Results – short-term analysis

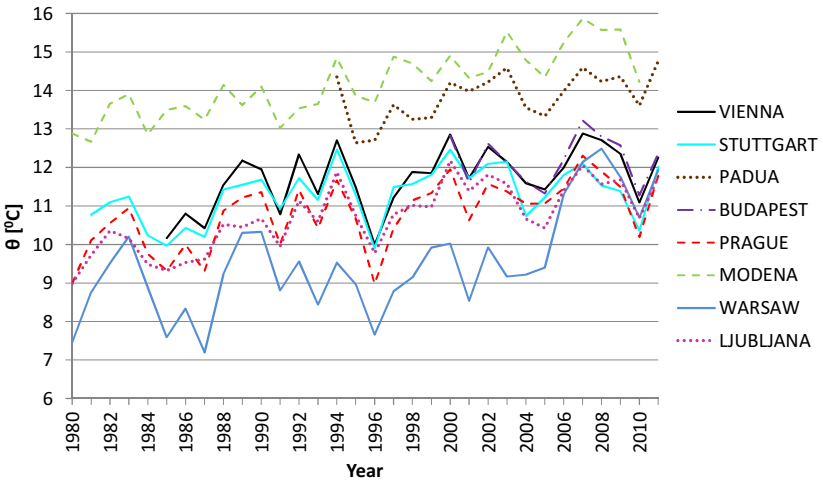
The cumulative frequency distribution of UHI values for the participating cities for a one week summer period



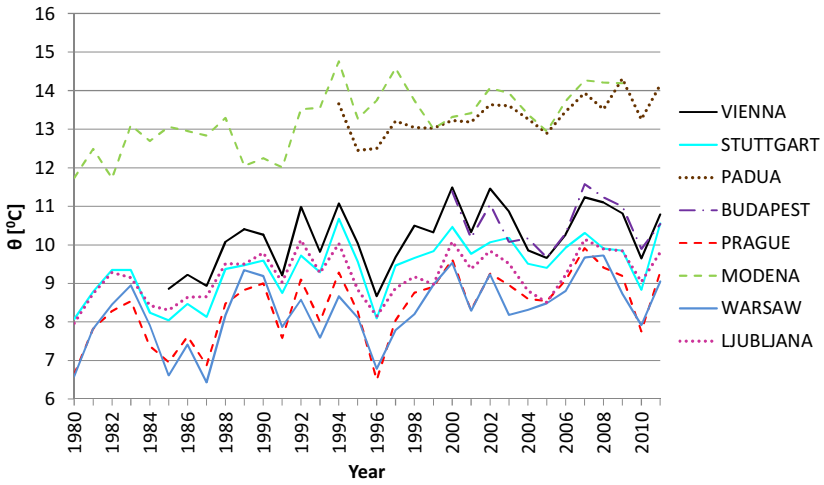
Results – long-term analysis

Development of (mean annual) urban and rural temperatures over a period of 30 years, respectively

URBAN

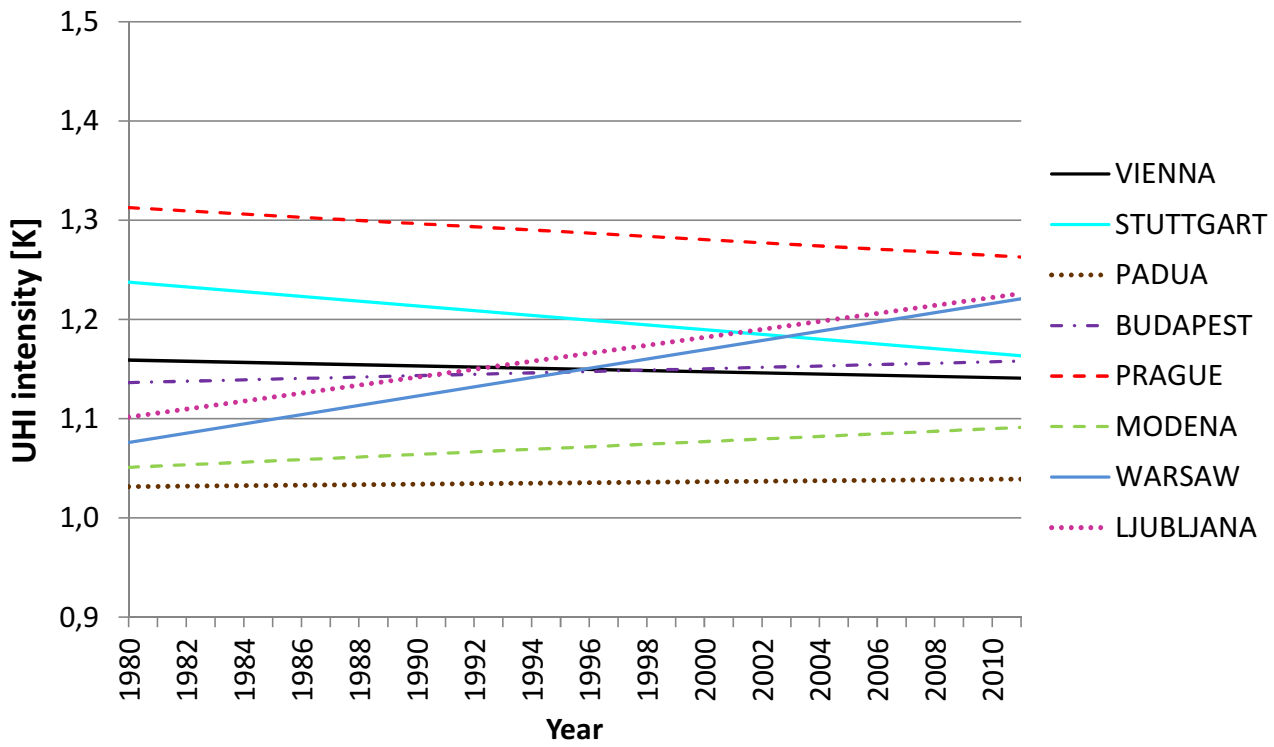


RURAL



Results – long-term analysis

Long-term UHI intensity trend over a period of 30 years



CONCLUSION

- The existence and significant magnitude of the UHI effect in all participating cities.
- A time-dependent (diurnal and nocturnal) UHI pattern implying larger UHI intensities during the night hours.
- Existing variation in UHI intensity in different cities, especially in terms of peak values.
- Warsaw experiencing higher UHI intensity levels when compared to other cities

ONGOING WORK

- A systematic framework for the evaluation of urban heat island mitigation measures
- The framework involves the following steps:
  - Selection of "Urban Units of Observation" (U2O)
  - Description of the status quo of U2O in terms of a structured set of geometric and physical properties
  - Selection of potential M&A measures
  - Description of specified M&A measures as changes to U2O variables
  - Evaluation of M&A measures

ONGOING WORK

Defined variables of Urban Unit of Observation (U^2O)

Geometric properties	
Sky View Factor	Ψ_{sky}
Aspect ratio	H/W
Built area fraction	A_b/A_{tot}
Unbuilt area fraction	$1- A_b/A_{tot}$
Impervious surface fraction	A_i
Pervious surface fraction	$A_p = (A_e + A_g + A_{H2O})$
Mean building compactness	l_c
Built surface fraction	A_s/A_b
Mean sea level	h_{sl}

Physical properties	
Albedo	ρ_{sw}
Emissivity	ε_{lw}
Thermal conductivity	$\lambda = (\lambda_i + \lambda_p)$
Specific heat capacity	$c = (c_i + c_p)$
Density	$\rho = (\rho_i + \rho_p)$
Anthropogenic heat output	Q_F

Thank you for your attention