URBAN CLIMATOLOGY

3. The climate of Brno as an example (data, methods, main outcomes)

Paper to read

MORAVIAN GEOGRAPHICAL REPORTS 3/2015, Vol. 23

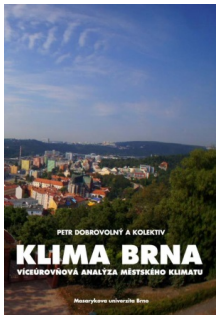
The spatial variability of air temperature and nocturnal urban heat island intensity in the city of Brno, Czech Republic

Petr DOBROVOLNÝ [a*], Lukáš KRAHULA [a]

https://is.muni.cz/auth/el/sci/podzim2022/ZX601/um/67875456/03_Dobrovolny_Krahula_MGR_2015.pdf

Motivation

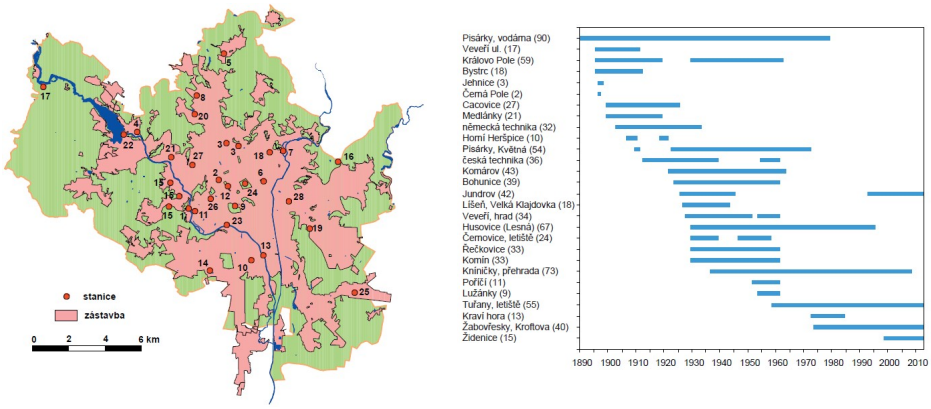
- What are the typical features of spatial and temporal variability of the main meteorological elements?
- What is the intensity of urban heat island (UHI) during days with the radiation-driven weather?
- What is the contribution of individual factors to UHI formation?



3.1 Local geography

- complex relief
- typical land use distribution

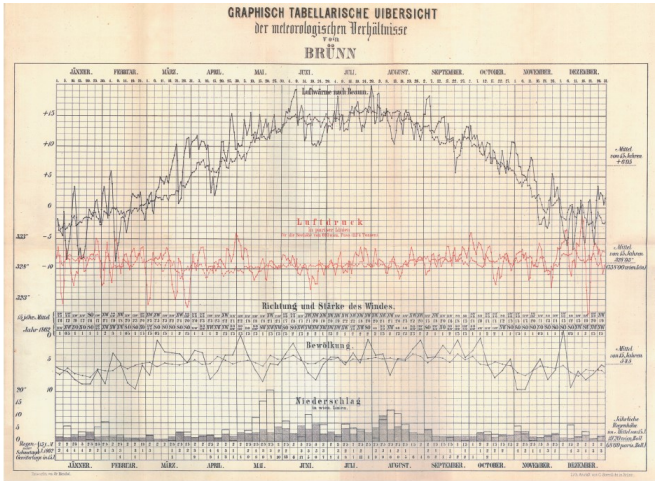
3.2 History of meteorological measurements



The network of meteorological stations (left) and its temporal evolution (right) in the Brno area in 1890–2012.

„Compiled" Brno temperature and precipitation series start already in 1799 and 1803 respectively

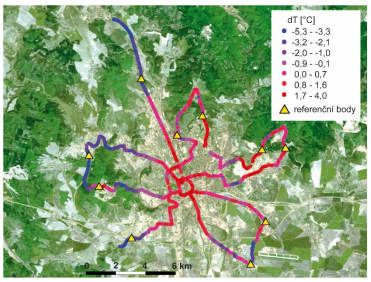
3.2 History of meteorological measurements



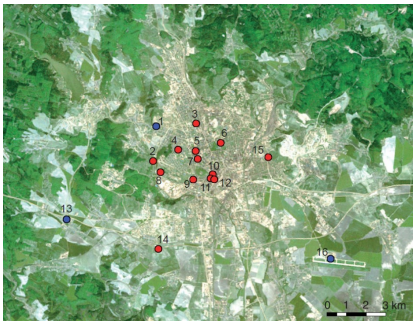
Gregor Johann Mendel, the abbot of the Augustinian monastery in Brno and the most famous person among Brno meteorological observers, and his graphic-table overview of meteorological observations in Brno for 1862 (Mendel 1863)

3.3 Database

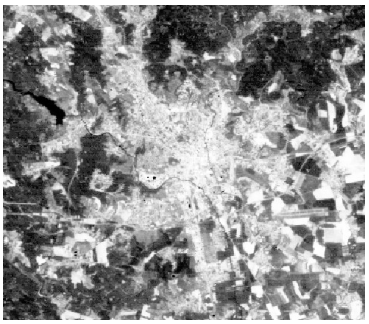
Meteorological data



Mobile measurements



Professional stations (blue) and special-purpose measurements (red)



Thermal satellite imagery

3.3 Database

Geographical database (explanatory variables)

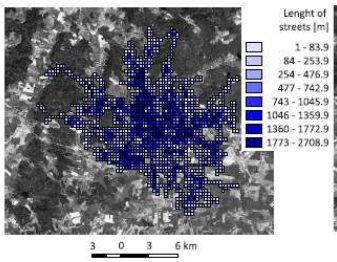


Figure 2 Total length of streets (further TLoS) calculated for a regular grid (300 x 300 m) in the study area.

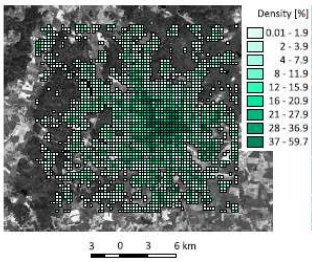


Figure 3 Density of buildings (%) (further DENS) calculated for a regular grid (300 x 300 m) in the study area.

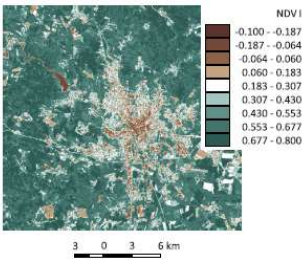
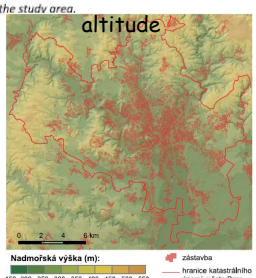
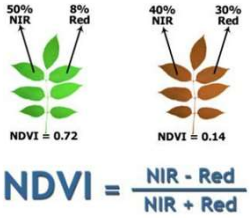


Figure 4 Normalized Difference Vegetation Index (further NDVI) as an indicator of vegetation amount and vigor in Brno area.

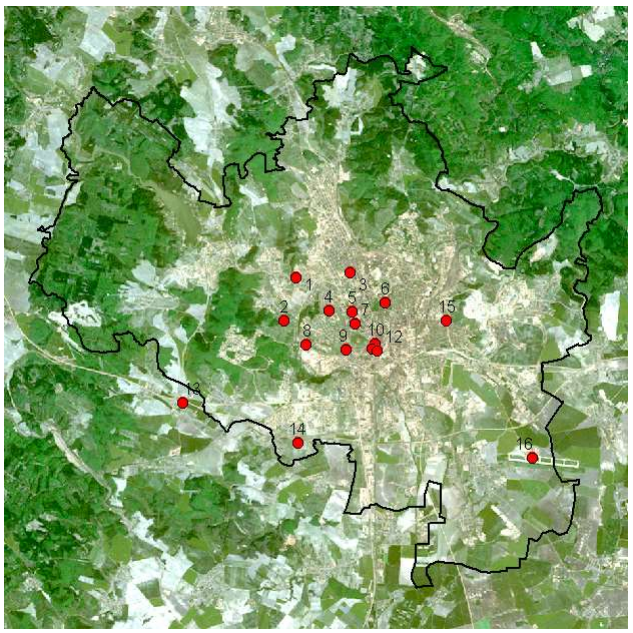


Sky View Factor



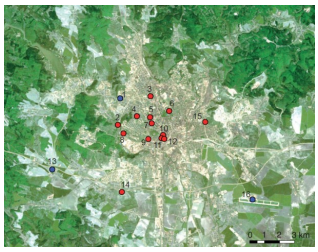
$$NDVI = \frac{NIR - Red}{NIR + Red}$$

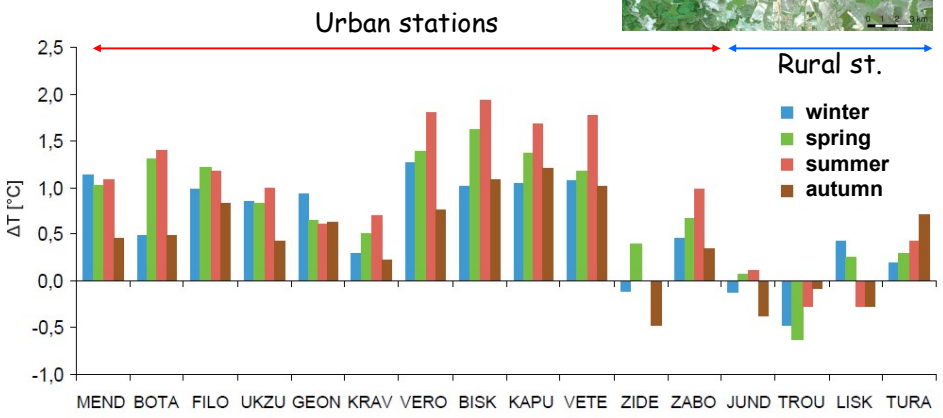
Automatic meteorological stations



stanice	NV	NDVI	DENS	SVF
MEND	210	0.29	20	0.38
BOTA	242	0.18	27	0.52
FILO	232	0.21	39	0.34
UKZU	218	0.34	14	0.50
GEON	226	0.31	17	0.30
KRAV	297	0.35	16	0.58
VERO	222	0.02	46	0.21
BISK	245	0.11	41	0.47
KAPU	221	0.05	43	0.63
VETE	237	0.26	25	0.53
ZIDE	215	0.31	19	0.52
ZABO	236	0.40	20	0.58
JUND	257	0.55	7	0.71
TROU	277	0.36	9	0.71
LISK	238	0.52	1	0.71
TURA	241	0.24	5	0.98

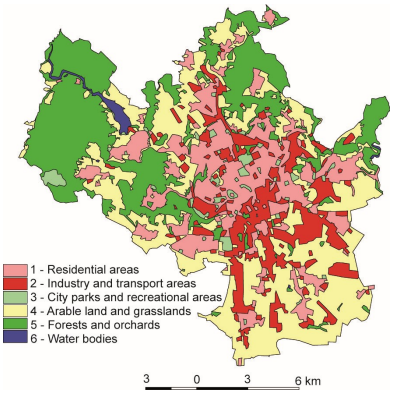
3.4 Atmospheric UHI derived from station measurements

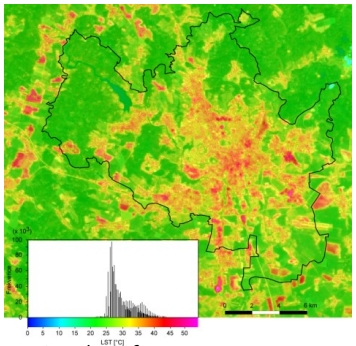




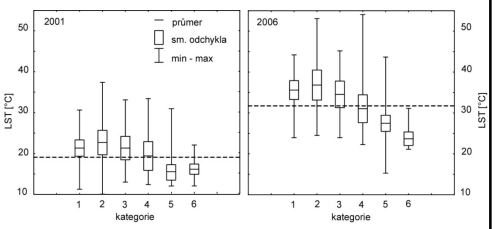
Intensity of AUHI (ΔT) defined as a difference of air temperature at a given station and mean air temperature at all rural stations

3.5 Intensity of surface UHI in Brno area

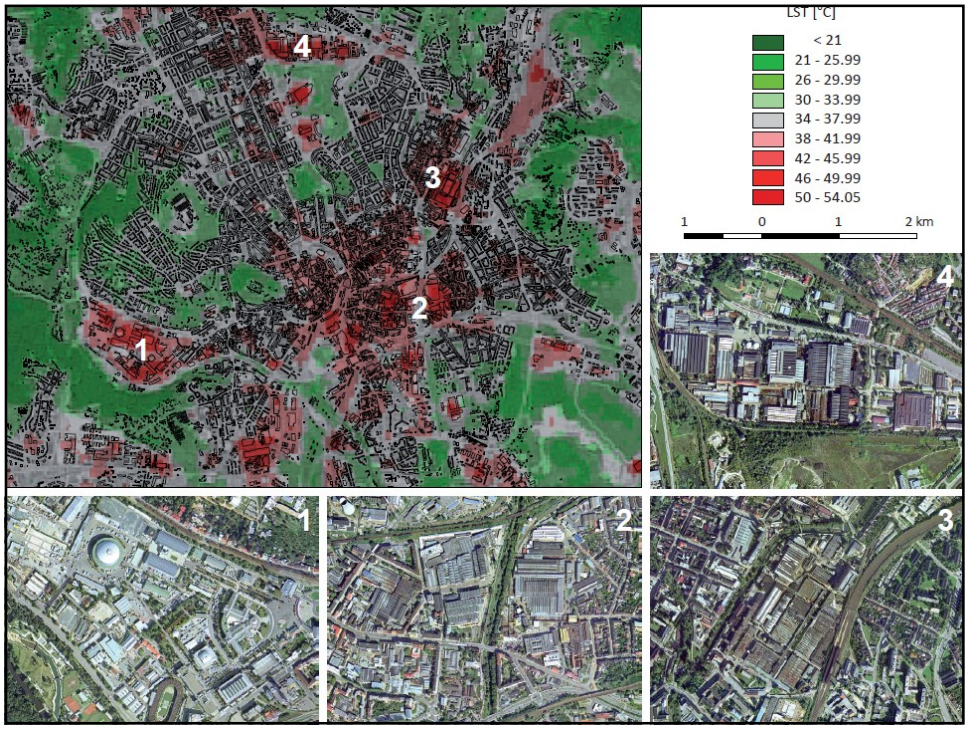




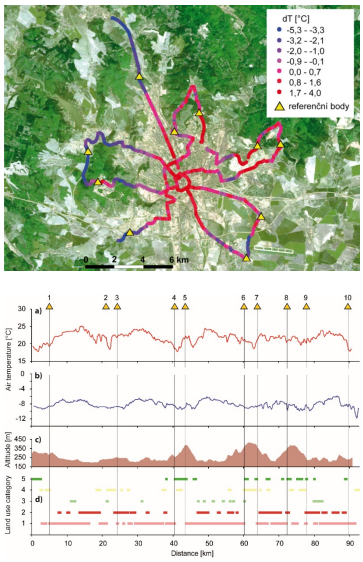
Land surface temperatures, 15 July 2006

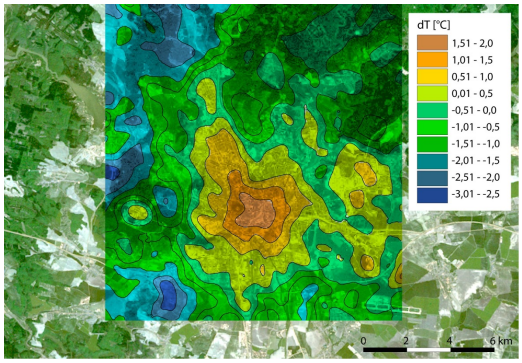


Industrial areas most contribute to SUHI intensity SUHI intensity 4,2 °C ~ 6,7 °C



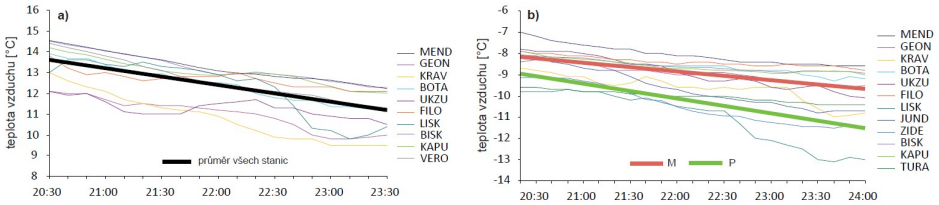
3.6 Nocturnal UHI intensity derived from mobile measurements



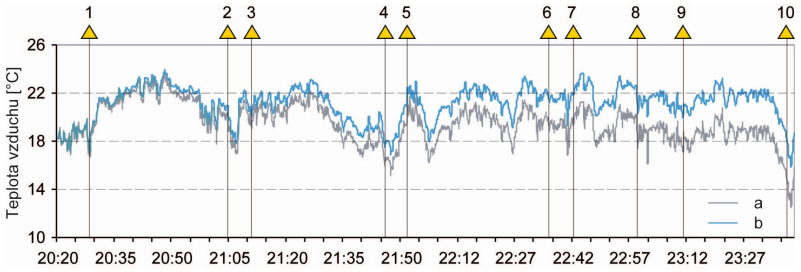


Typical spatial distribution of air temperature in central part of Brno in early night hours; air temperature is expressed as deviation (dT) from mean value of the study area and is typical for clear and calm weather during summer

Correction of the mobile temperature measurements



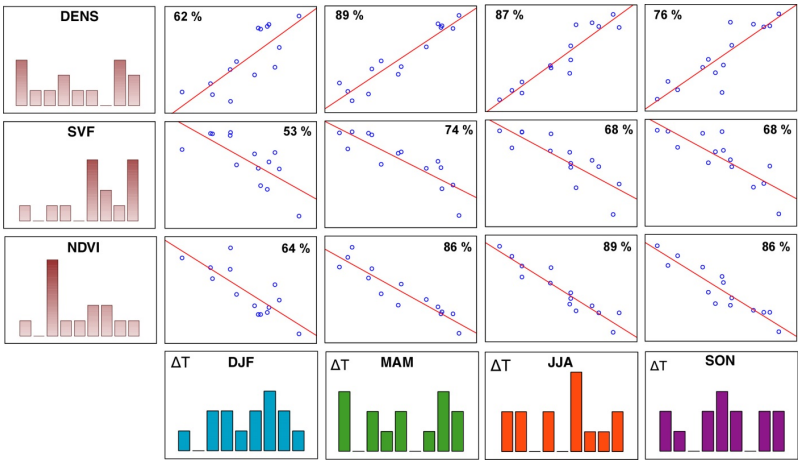
Examples of air temperature drop at stations during mobile measurements: (a) 19. 4. 2011 – the same intensity of temperature decline; (b) 31. 1. 2012 – different temperature decline on urban (M) and rural (P) stations



Mobile air temperature measurements on 3 August 2011 in Brno area; a – original temperature measurements, b – values corrected for temperature decay with time

3.7 The role of explanatory variables

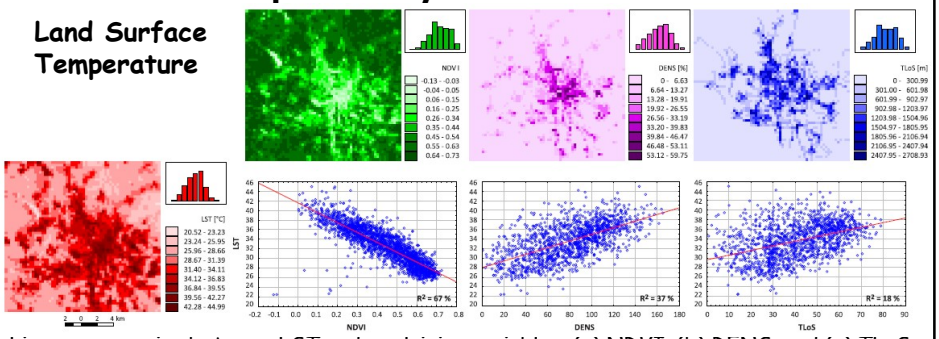
Air temperature



Linear regression between intensity of UHI (ΔT) and explanatory variables for individual seasons in Brno region; numbers represent percentage of explained variance

The role of explanatory variables

Land Surface Temperature



Linear regression between LST and explaining variables: (a) NDVI, (b) DENS, and (c) TLoS in Brno region; LST and NDVI data is from 15 June 2006 and R^2 is explained variance

Pearson correlations between air temperature measurements and selected parameters of environment along the traverses. NDVI represents amount and vigor of vegetation, DENS represents density of buildings calculated for 300 m square grid and NV stands for altitude a.s.l. Significant correlations at α = 0.05 are in bold

NDVI is the best explanatory variable

Termín	NDVI	DENS	DEM
19.4.2011	**-0,66**	**0,57**	**-0,40**
9.5.2011	**-0,44**	**0,45**	0,04
8.7.2011	**-0,71**	**0,65**	**-0,44**
3.8.2011	**-0,46**	**0,41**	-0,04
13.9.2011	**-0,60**	**0,58**	**-0,38**
27.9.2011	**-0,46**	**0,41**	-0,07
1.11.2011	**-0,30**	**0,34**	0,14
3.1.2012	**-0,53**	**0,55**	**-0,35**
31.1.2012	**-0,61**	**0,61**	**-0,42**

3.8 Final remarks and questions

1. Why is it useful to have a long term meteorological measurements?
2. What are the main data types we need for an analysis of urban climate?
3. What parts of the city are most susceptible to higher temperatures?
4. Compare positive/negative features of satellite thermal mapping and mobile measurements used for air temperature measurements in urban environment