

URBAN CLIMATOLOGY

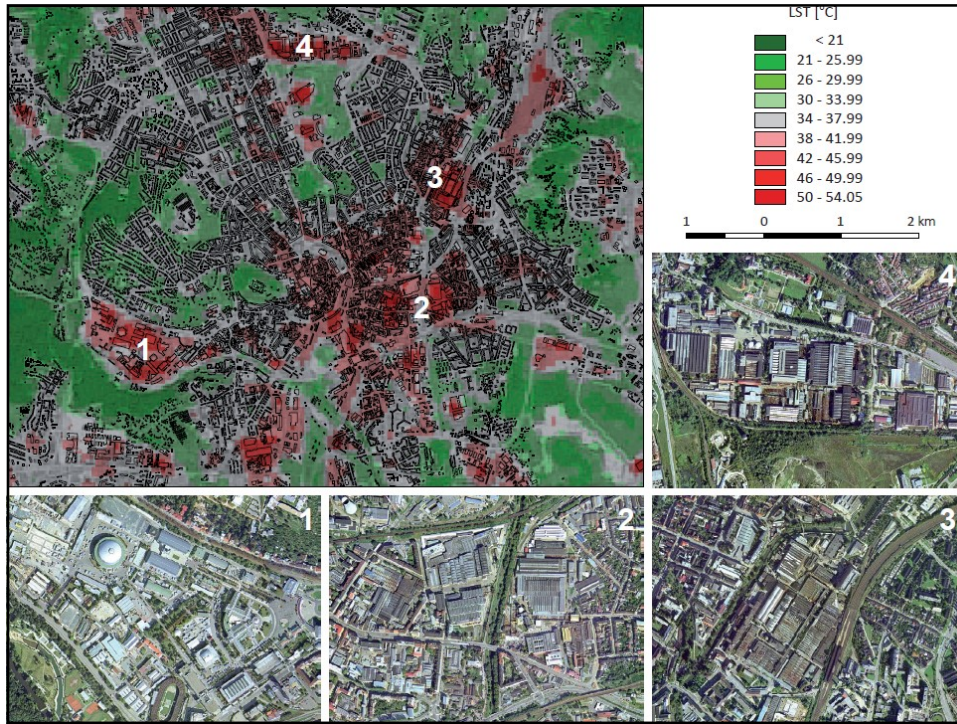
VIII. Urban climate classification, Local Climate Zones

Paper to read

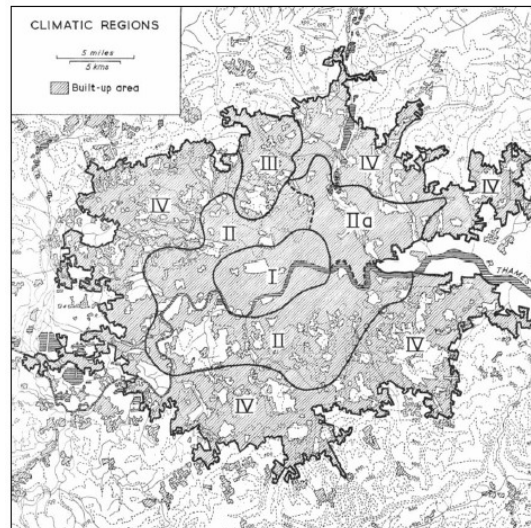
**1.1 THERMAL DIFFERENTIATION OF LOCAL CLIMATE ZONES USING TEMPERATURE OBSERVATIONS
FROM URBAN AND RURAL FIELD SITES**

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University of British Columbia, Vancouver, Canada

https://is.muni.cz/auth/el/sci/podzim2020/ZX601/um/67875456/08_local_climate_zones.pdf



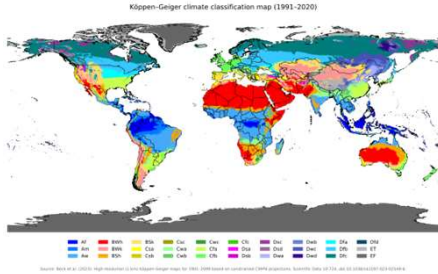
8.1 Urban Climate Classification



Chandler (1965) , Climatic regions of London

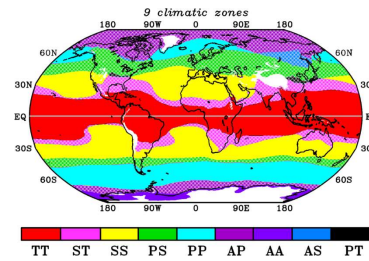
Types of Climate Classification

Conventional (formal) type of classification.



Searches for boundaries between areas using variable values and simple logical rules (e.g. Köppen climate classification)

Genetic type of classification.



Searches for typical areas whose climate is formed (controlled) by forcing factors like relief, land-cover (e.g. Alisov, Flohn classification)

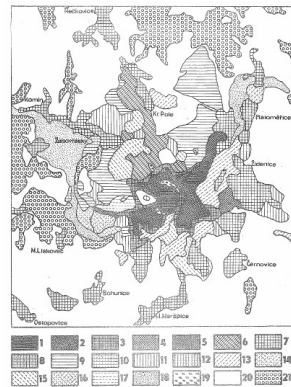
Urban Climate Classification

Conventional (formal) type of classification.



Synthetic map of temperature, moisture and wind conditions in Brno.

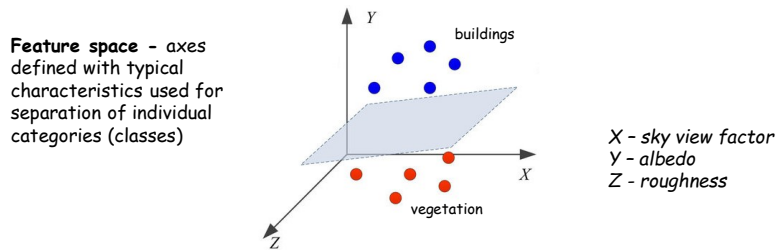
Genetic type of classification.



Topoclimatic regions of Brno (Quitt 1977)

Types of Climate Classification

An example of the 3D **feature space** and two searched categories only



Supervised classification

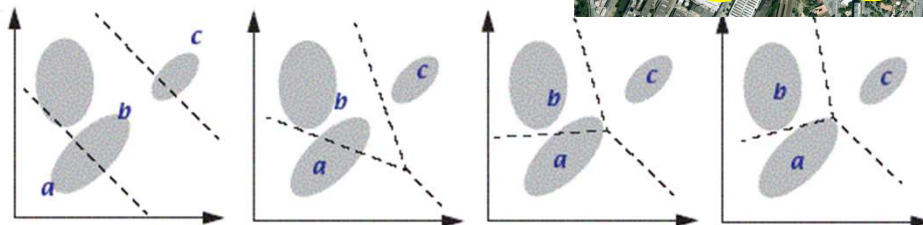
User defines typical occurrence of classes in the form of training sites



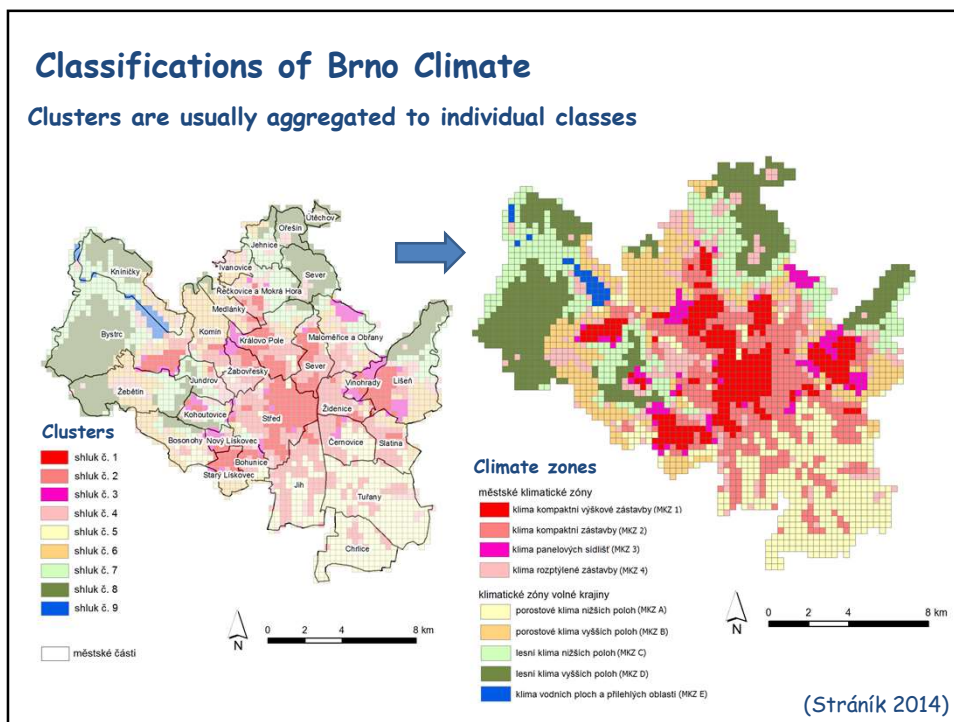
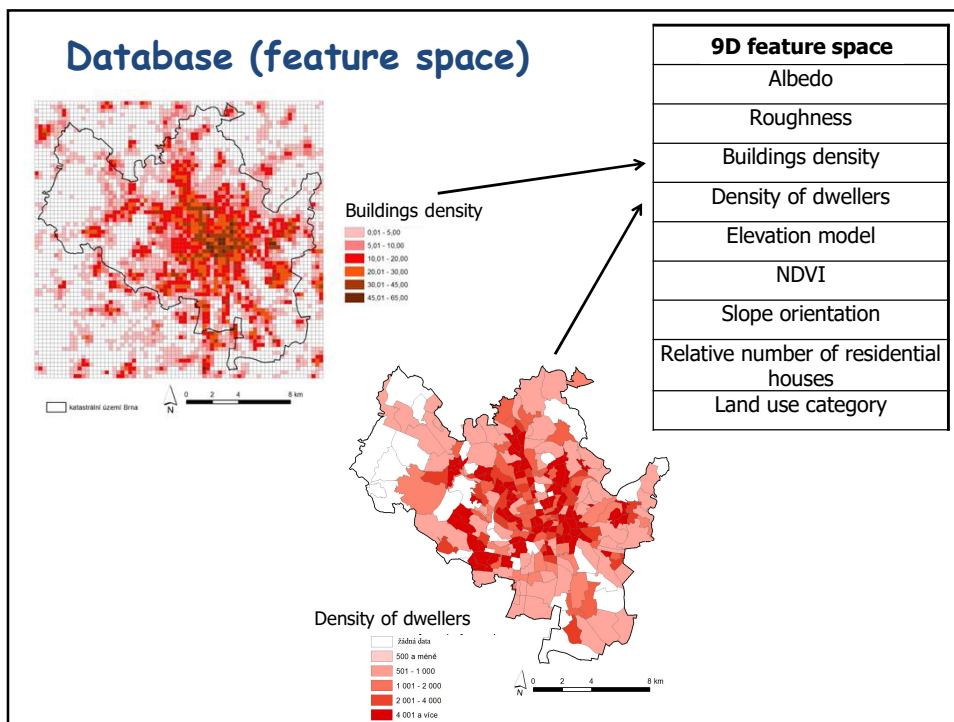
Unsupervised classification

User defines only approx. number of classes and the algorithm identifies them in a feature space

Urban climate classification using Cluster analysis



Iteration algorithm - from initial position of typical „training sites“ it searches repeatedly for the most similar parts (cells) of multidimensional feature space



Urban Climate zones (Oke 2004)

Urban Climate Zone, UCZ ¹	Image	Roughness class ²	Aspect ratio ³	% Built (impermeable) ⁴
1. Intensely developed urban with detached close-set high-rise buildings with cladding, e.g. downtown towers		8	> 2	> 90
2. Intensely developed high density urban with 2 - 5 storey, attached or very close-set buildings often of brick or stone, e.g. old city core		7	1.0 - 2.5	> 85
3. Highly developed, medium density urban with row or detached but close-set houses, stores & apartments e.g. urban housing		7	0.5 - 1.5	70 - 85
4. Highly developed, low or medium density urban with large low buildings & paved parking, e.g. shopping mall, warehouses		5	0.05 - 0.2	70 - 95
5. Medium development, low density suburban with 1 or 2 storey houses, e.g. suburban housing		6	0.2 - 0.6, up to >1 with trees	35 - 65
6. Mixed use with large buildings in open landscape, e.g. institutions such as hospital, university, airport		5	0.1 - 0.5, depends on trees	< 40
7. Semi-rural development, scattered houses in natural or agricultural area, e.g. farms, estates		4	> 0.05, depends on trees	< 10

Key to image symbols: buildings; vegetation; impervious ground; pervious ground

¹ A simplified set of classes that includes aspects of the schemes of Auer (1978) and Ellefsen (1990/91) plus physical measures relating to wind, thermal and moisture controls (columns at right). Approximate correspondence between UCZ and Ellefsen's urban terrain zones is: 1(Dc1, Dc8), 2 (A1-A4, Dc2), 3 (A5, Dc3-5, Dc2), 4 (Do1, Do4, Do5), 5 (Do3), 6 (Do6), 7 (none).

² Effective terrain roughness according to the Davenport classification (Davenport *et al.*, 2000); see Table 2.

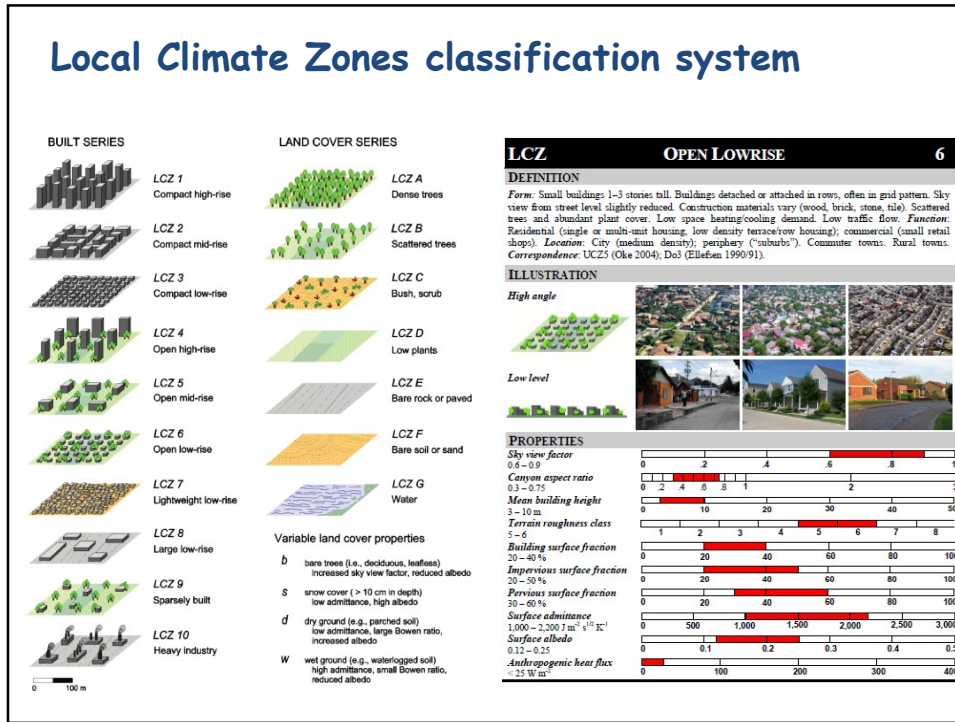
³ Aspect ratio = z_0/W is average height of the main roughness elements (buildings, trees) divided by their average spacing in the city centre this is the street canyon height/width. This measure is known to be related to flow regime types (Oke 1987) and thermal controls (solar shading and longwave screening) (Oke, 1981). Tall trees increase this measure significantly.

⁴ Average proportion of ground plan covered by built features (buildings, roads, paved and other impervious areas) the rest of the area is occupied by pervious cover (green space, water and other natural surfaces). Permeability affects the moisture status of the ground and hence humidification and evaporative cooling potential.

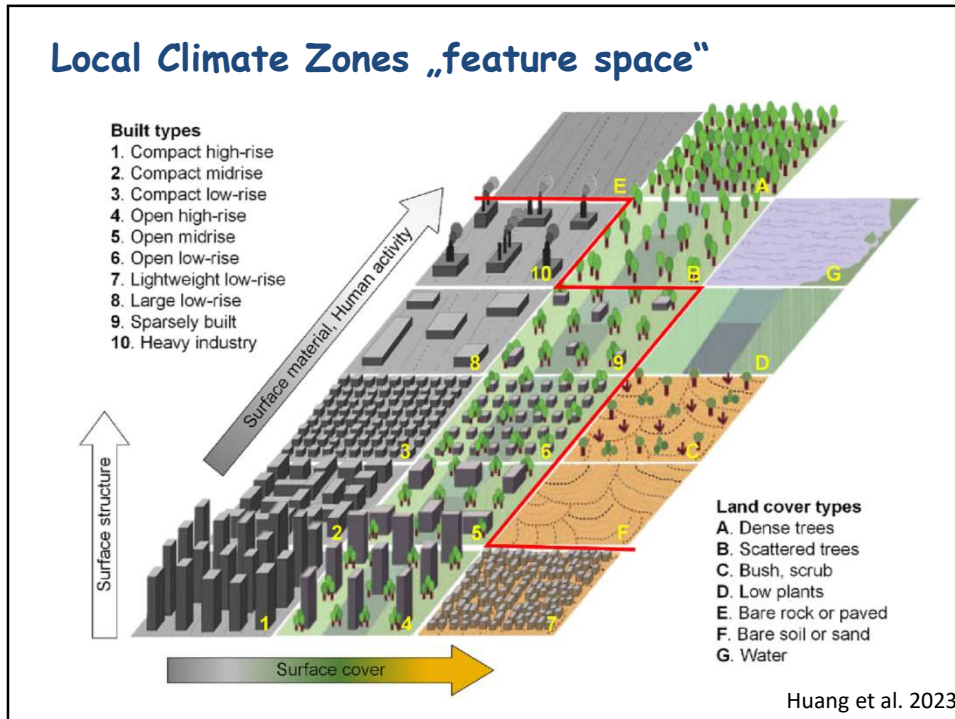
8.2 Concept of the Local Climate Zones (LCZ)

- For a long time, there was no universal approach to describe and characterize the physical nature of cities for urban climatologists.
- Much of the existing terminology was not transferable across cultural and geographical regions.
- To help standardize methods of observation and documentation in urban heat island studies, Stewart and Oke (2012) developed the [Local Climate Zone \(LCZ\)](#) classification scheme.

Local Climate Zones classification system



Local Climate Zones „feature space“



Local Climate Zones classification system

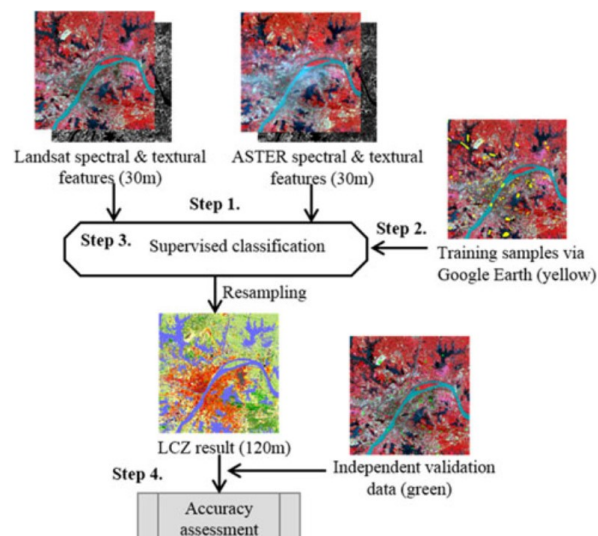
- Local climate zones are formally defined as regions of uniform surface cover, structure, material, and human activity that span hundreds of meters to several kilometers in horizontal scale.
- Each LCZ exhibits a characteristic geometry and land cover that results in characteristic screen height temperature regime that is most apparent over dry surfaces, on calm, clear nights, and in areas of simple relief.
- LCZ scheme consists of 17 standard LCZs, of which 15 are defined by surface structure and cover and 2 by construction materials and anthropogenic heat emissions. The standard set is divided into "built types"(1-10), and "land cover types"(A-G)

There are several **methods how to define LCZ:**

- Method based on automatic classification of satellite imagery (WUDAPT, Bechtel et al.)
- GIS method using geo-database and a set of logical rules in the form of decision tree

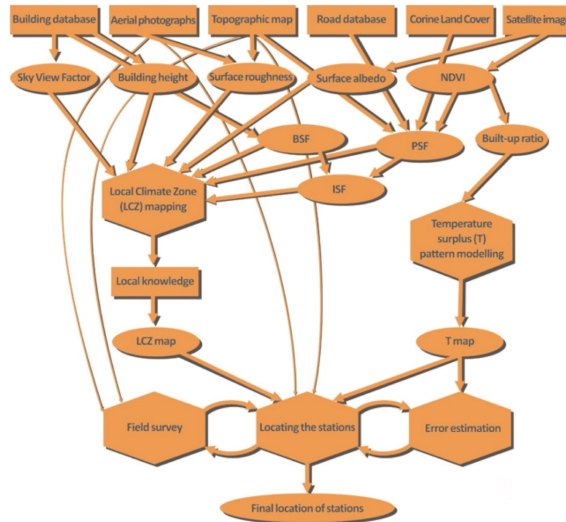
LCZs classification algorithms

- **WUDAPT** (World Urban Database and Access Portal Tool) – automatic classification of multi-source satellite images



LCZs classification algorithms

- GIS and map algebra, decision trees



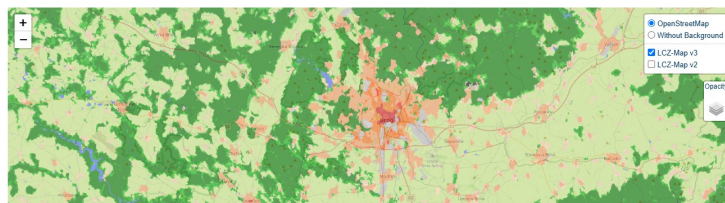
LCZ generator

lcz-generator.rub.de

LCZ Generator Home Training area submission Submissions Global LCZ Map FAQ

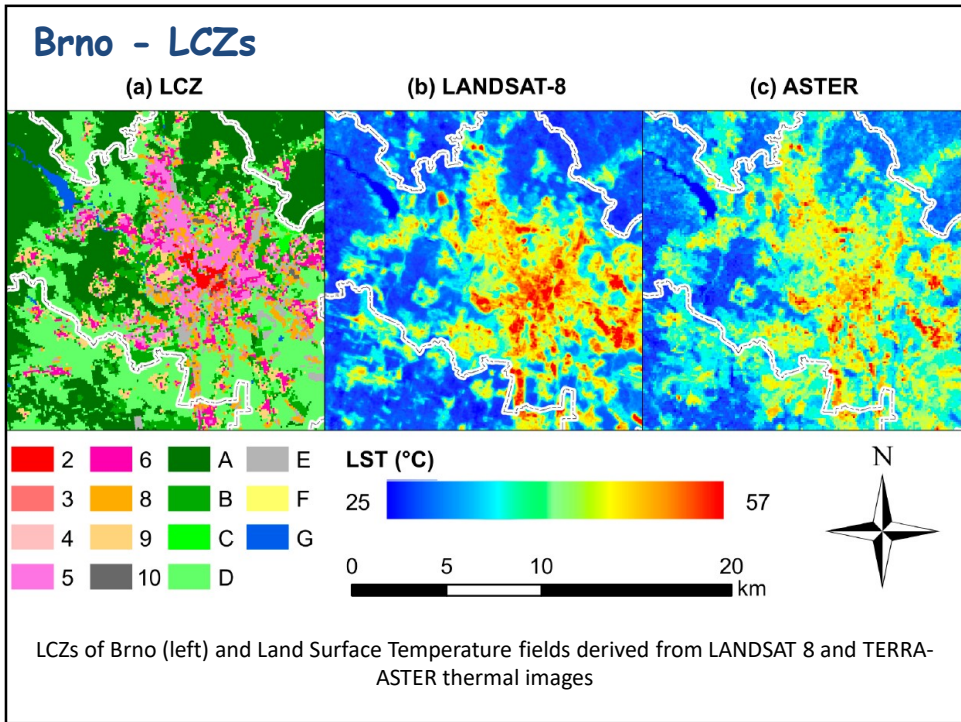
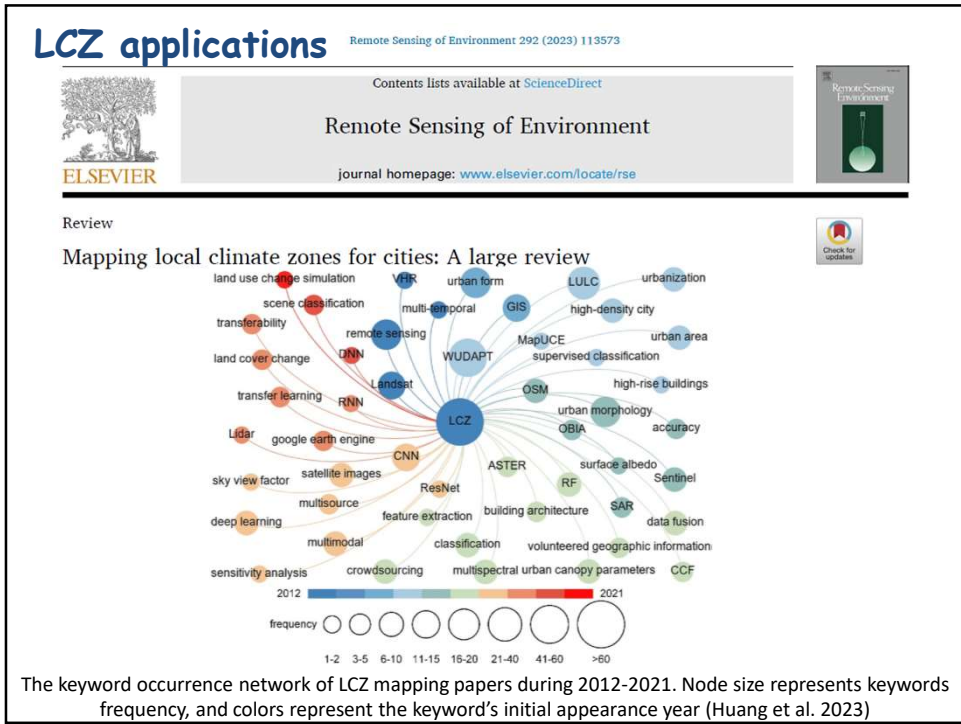
Welcome to the LCZ Generator!

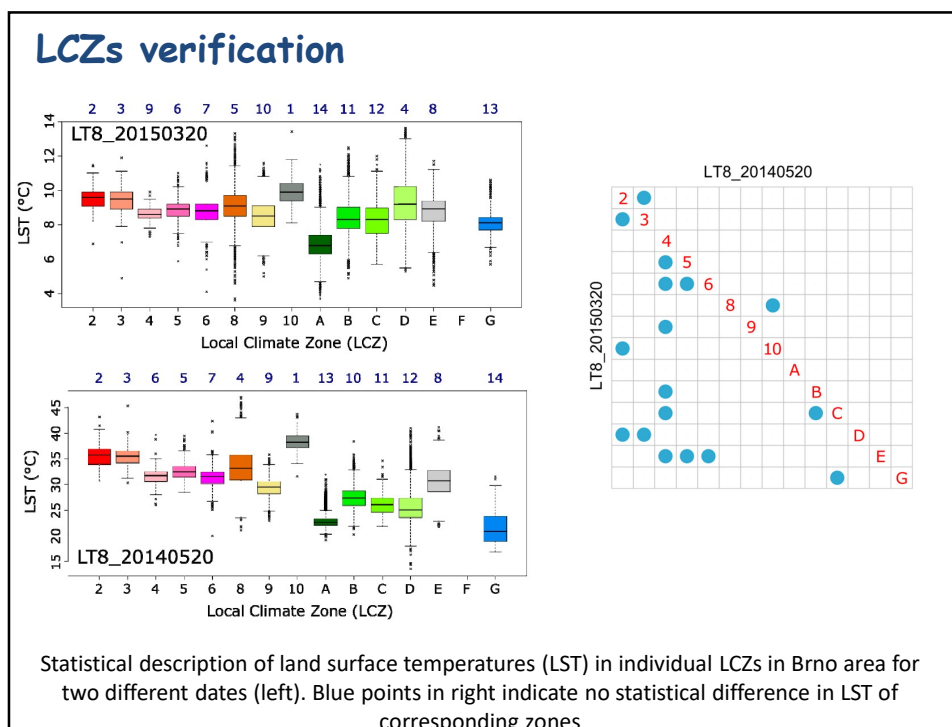
Fast and easy Local Climate Zone mapping



Local Climate Zones

- Built types**
- 1 - Compact highrise
 - 2 - Compact midrise
 - 3 - Compact lowrise
 - 4 - Open highrise
 - 5 - Open midrise
 - 6 - Open lowrise
 - 7 - Lightweight lowrise
 - 8 - Large lowrise
 - 9 - Sparsely built
 - 10 - Heavy industry
- Land cover types**
- A - Dense trees
 - B - Scattered trees
 - C - Bush, scrub
 - D - Low plants
 - E - Bare rock or paved
 - F - Bare soil or sand
 - G - Water





8.3 Final remarks and questions



1. Why is simple Urban - rural division insufficient in urban climatology?
2. What were the main reasons to create LCZ classification scheme in urban climatology?
3. How can be LCZs used for mitigation negative effects of UHI and heat waves?
4. How can be LCZ useful e.g. to architects, planners, ecologists, and engineers?