Supplementary materials for Michal Lehnert, Stevan Savić, Dragan Milošević, Jelena Dunjić and Jan Geletič. Mapping Local Climate Zones and their applications in Euro-pean urban environments: A systematic literature review and future development trends. ISPRS Int. J. Geo-Inf. 2021

Table S2. The list of 91 reviewed studies related to LCZs issues and with their content details.

No.	Study	DOI/website of the study	LCZs derivation method used	City/region analysed	LCZs classes detected	Type of analysis
1.	Savić et al. 2013	http://www.dgt.uns.ac.rs/dokumentacija/pannonica/papers/volume17_3_1.pdf	Expert knowledge-based	Novi Sad (Serbia)	2,3,5,6,8,9,10,A,D	Definition of LCZs classes for urban station sites
2.	Alexander and Mills 2014	10.3390/atmos5040755	Combined method	Dublin (Ireland)	2,3,5,6,8,9,A,D,G	Modeling LCZs mapping using LULC approach and UHI assessment
3.	Fenner et al. 2014	10.1016/j.uclim.2014.02.004	Combined method	Berlin (Germany)	5,6,A,B	Spatial/temporal analysis of the Ta among different LCZs based on UMN dataset
4.	Lelovics et al. 2014	10.3354/cr01220	GIS-based	Szeged (Hungary)	2,3,5,6,8,9,10,A,B,C,D,G	Development of GIS-based method for LCZs classification in built areas
5.	Müller et al. 2014	10.1007/s00704-013-0890-4	Expert knowledge-based	Oberhausen (Germany)	2,5,6,8,9,A,D	Thermal comfort assessment during extreme days based on LCZs differences
6.	Stewart et al. 2014	10.1002/joc.3746	Expert knowledge-based	Uppsala (Sweden)	2,5,9,D	Definition of thermal differences among LCZs pattern
7.	Unger et al. 2014	10.15201/hungeobull.63.1.3	GIS-based	Szeged (Hungary)	2,3,5,6,8,9,10,A,B,C,D,G	Development of GIS-based method for LCZs classification in built areas
8.	Wiesner et al. 2014	10.1127/0941-2948/2014/0571	Expert knowledge-based	Hamburg (Germany)	2,6,D	Thermal and soil moisture assessments based on different urban morphology
9.	Alexander et al. 2015	10.1016/j.uclim.2015.05.001	Combined method	Dublin (Ireland)	2,3,5,6,8,10,A,D,E,F,G	Implementation of urban energy balance model (SUEWS) based on LCZs pattern
10.	Bechtel et al.	10.3390/ijgi4010199	Remote sensing	Hamburg	All 17 LCZs	Development of the

	2015		imagery-based	(Germany); Dublin (Ireland)		WUDAPT L0 method
11.	Emmanuel and Loconsole 2015	10.1016/j.landurbplan.2015.02.012	Combined method	Glasgow (UK, Scotland)	2,5,6,9	Assessment of green infrastructure performance (GAR) in mitigation of urban overheating by using LCZs concept
12.	Gál et al. 2015	10.15201/hungeoGbául, l lT.6. 5et.2 a.l2	GIS-based	Szeged (Hungary)	2,3,5,6,8,9,10,A,B,C,D,G	Analysis of spatial and temporal patterns of Ta and UHI between LCZs; measurements obtained from UMN stations
13.	Leconte et al. 2015	10.1016/j.buildenv.2014.05.005	Combined method	Nancy (France)	2,5,8,6/9,A,B,D,E,G	UHI assessment based on LCZs pattern and using mobile measurements
14.	Lehnert et al. 2015	10.1007/s00704-014-1309-6	Expert knowledge-based	Olomouc (Czech Republic)	2_{CC},2_{BOC},4,4_2,5,5_6,6,6_5,9_5,B_D,B_{DW}	Development the LCZs classification approach to determine urban surface of UMN stations
15.	Šećerov et al. 2015	http://scindeks-clanci.ceon.rs/data/pdf/0354-8724/2015/0354-87241504174S.pdf	GIS-based	Novi Sad (Serbia)	2,3,5,6,8,9,10,A,D,G	Defining UMN stations based on LCZs derived from GIS-based method
16.	Skarbit et al. 2015	10.1109/JURSE.2015.7120497	GIS-based	Szeged (Hungary)	2,3,5,6,8,9,10,A,B,C,D,G	Airborne surface temperature differences based on LCZs concept
17.	Theeuwes et al. 2015	10.1088/1748-9326/10/11/114022	Expert knowledge-based	Basel (Switzerland)	1 – 10	Determine the sensitivity of the UCI in different LCZs
18.	Unger et al. 2015	http://real.mtak.hu/28561/1/a90bf7513efb86263e8dc6f781f040fa-119-3-2-unger-0903.pdf	GIS-based	Szeged (Hungary)	2,3,5,6,8,9,10,A,B,C,D,G	Temporal and intra-urban pattern of air temperature and PET based on LCZs; measurements obtained from UMN stations
19.	Alexander et al. 2016	10.1016/j.landurbplan.2016.02.006	Combined method	Dublin (Ireland)	2,3,5,6,8,A,D,F,G	Development of LCZs classification approach and heat index assessment
20.	Basset et al. 2016	10.1002/gj.2836	Combined method	Birmingham (UK)	1,2,5,6,10,B	Correlation of urban fraction data with

						UHI component
21.	Brousse et al. 2016	10.1016/j.uclim.2016.04.001	Remote sensing imagery-based	Madrid (Spain)	All 17 LCZs	Contribution of the LCZs scheme in urban climate models
22.	Danylo et al. 2016	10.1109/JSTARS.2016.2539977	Remote sensing imagery-based	Kyiv; Lviv (Ukraine)	2,4,5,6,8,9,A,B,C,D,E,F,G	Testing the accuracy of the LCZs from the WUDAPT L0
23.	Geletič and Lehnert 2016	10.1515/mgr-2016-0012	GIS-based	Brno; Olomouc; Hradec Králové (Czech Republic)	1,2,3,4,5,6,8,9,10, A,B, C,D,E,F,G	Development of GIS-based method for LCZs classification in built areas
24.	Geletič et al. 2016a	10.15201/hungeobull.65.2.7	GIS-based	Brno (Czech Republic)	1,2,3,4,5,6,8,9,10, A,B, C,D,E,F,G	Comparison (validation) of Ta from model MUKLIMO_3 with real temperature measurements from 5 stations in different LCZs
25.	Geletič et al. 2016b	10.3390/rs8100788	GIS-based	Prague; Brno (Czech Republic)	2,3,4,5,6,8,9,10,A,B, C,D,E,F,G	LST assessment obtained from Aster and Landsat datasets in different LCZs
26.	Gémes et al. 2016	10.1515/jengeo-2016-0004	GIS-based	Szeged (Hungary)	2,3,5,6,8,9,10,A,B,C,D,G	Analysis of long term and seasonal development of urban LST and SUHI based on LCZs
27.	Herbel et al. 2016	10.15201/hungeobull.65.2.3	Expert knowledge-based	Cluj-Napoca (Romania)	1,2,3,6,8,9,B	Assessment of the UHI sensitivity in different LCZs
28.	Lelovics et al. 2016	https://www.met.hu/en/ismeret-tar/kiadvanyok/idojaras/index.php?id=507	GIS-based	Szeged (Hungary); Novi Sad (Serbia)	2,3,5,6,8,9,10,A,B,C,D,G	Intra-urban temperature observation based on LCZs concept and UMN datasets
29.	Milošević et al. 2016	10.15201/hungeobull.65.2.4	GIS-based	Novi Sad (Serbia)	2,3,5,6,8,9,10,A,D,G	PET assessment based on different LCZs
30.	Skarbit and Gál 2016	10.15201/hungeobull.65.2.8	Remote sensing imagery-based	Szeged (Hungary)	2,3,5,6,8,9,A,B,D,G	Temperature analysis using MUKLIMO_3 microclimate model
31.	Wouters et al. 2016	10.5194/gmd-9-3027-2016	Combined method	Belgium cities	All 17 LCZs	Modelling of UCPs and its impacts on LST pattern
32.	Arnds et al. 2017	10.1007/s00704-015-	Combined meth-	Hamburg	2,4,5,6,8,10,A,B,D	Modeling the spatio-

		1687-4	od	(Germany)	,E,G	temporal differences of UHI based on UMN data
33.	Fenner et al. 2017	10.1127/metz/2017/0861	Remote sensing imagery-based	Berlin (Germany)	2,4,5,6,8,9,A,B,C, D,F,G	Temperature analysis using CWS and LCZs spatial pattern
34.	Leconte et al. 2017	10.1007/s00704-016-1886-7	Combined method	Nancy (France)	2,5,8,6/9,D	Analysis of nocturnal Ta in LCZs using mobile measurements
35.	Nedkov et al. 2017	10.3897/oneeco.2.e14499	Combined method	Bulgarian cities	All 17 LCZs (except LCZ 1)	Using LCZs concept in implementation of ecosystem classes by MAES typology
36.	Skarbit et al. 2017	10.1002/joc.5023	GIS-based	Szeged (Hungary)	2,3,5,6,8,9,10,A,B, C,D,G	Assessment of air temperature indices measured from UMN; spatiotemporal analysis is based on LCZs concept
37.	Tornay et al. 2017	10.1016/j.uclim.2017.03.002	Expert knowledge-based	France cities	1 – 10	Development of GENIUS typology
38.	Verdonck et al. 2017	10.1016/j.jag.2017.05.017	Remote sensing imagery-based	Antwerp; Brussels; Ghent (Belgium)	1,2,3,6,8,9,10,A,B, D,E,G	Improvement the LCZs mapping AO from the WUDAPT L0
39.	Wicki and Parlow 2017	10.1117/1.JRS.11.026001	Combined method	Basel (Switzerland)	2,3,5E,6,9,10,A,C, D,G	Implementation of LCZs classification approach using LULC scheme
40.	Beck et al. 2018	10.1016/j.uclim.2018.04.007	Remote sensing imagery-based	Augsburg Germany)	2,5,6,8,A,B,D,F,G	Air temperature differences based on LCZs pattern
41.	Bocher et al. 2018	10.1016/j.uclim.2018.01.008	GIS-based	France cities	1,2,3,4,5,6,7,8,9,10	Development of open geoprocessing framework to calculate LCZs classes
42.	Droste et al. 2018	10.1088/1748-9326/aad8ef	Expert knowledge-based	Basel (Switzerland)	1 – 10	Assessment of urban wind island effect
43.	Geletič et al. 2018	10.1016/j.scitotenv.2017.12.076	GIS-based	Brno (Czech Republic)	1,2,3,4,5,6,8,9,10, A,B, C,D,E,F,G	Modelling and analyzing spatiotemporal variability of OTC in LCZs of central European city

44.	Goncalves et al. 2018	10.3390/cli6030070	Combined method	Braganca (Portugal)	2,3,5,8,9,A/B,C/D	Modeling of UHI and UCI patterns in different LCZs
45.	Hammerberg et al. 2018	10.1002/joc.5447	Remote sensing imagery-based/GIS-based	Vienna (Austria)	All 17 LCZs	Comparison of air temperature patterns using WUDAPT and GIS LCZs mapping
46.	Hu et al. 2018	10.3390/ijgi7090379	Remote sensing imagery-based	Globally, including European cities	All 17 LCZs	Implementing Sentinel-1 data for global LCZs mapping
47.	Lehnert et al. 2018a	10.3354/cr01508	GIS-based	Brno; Olomouc (Czech Republic)	1,2,3,4,5,6,8,9,10, A,B, C,D,E,F,G	Accessing the temperature differences among LCZs established by mobile measurements
48.	Lehnert et al. 2018b	10.5937/gp22-19750	GIS-based	Olomouc (Czech Republic)	1,2,3,4,5,6,8,9,10, A,B, C,D,E,F,G	Air temperature assessment in different LCZs and identify heat stress vulnerable spots; datasets are obtained from mobile measurements
49.	Oxoli et al. 2018	10.3390/ijgi7110421	Remote sensing imagery-based	Milan (Italy)	2,3,5,6,8,B,D,G	Air temperature pattern based on LCZs
50.	Quanz et al. 2018	10.3390/cli6010005	Combined method	Berlin (Germany)	2_B	Micro-scale variability of Ta in densely built-up LCZ
51.	Qui et al. 2018	10.3390/rs10101572	Remote sensing imagery-based	Amsterdam (The Netherlands); Zurich (Switzerland); Rome; Milan (Italy); Paris (France); Munich; Cologne; Berlin (Germany); London (UK)	All 17 LCZs (except LCZ 7)	Using CNN and multi-source data to improve the WUDAPT L0 approach
52.	Richard et al.	10.1016/j.uclim.2018.10.	Remote sensing	Dijon	2,3,4,5,6,7,8,9,10,	Investigation of UHI

	2018	002	imagery-based	(France)	A,B,C,D,E,G	and climate modeling based on LCZs and UCZs
53.	Savić et al. 2018	10.1007/s11069-017-3160-4	GIS-based	Novi Sad (Serbia)	2,3,5,6,8,9,10,A,D,G	Heat wave risk assessments for different built-up LCZs
54.	Unger et al. 2018	10.1007/s00484-017-1440-z	GIS-based	Szeged (Hungary)	2,3,5,6,9,D	Intra-urban diurnal and seasonal investigation of PET index in LCZs in and around Szeged
55.	Verdonck et al. 2018	10.1016/j.landurbplan.2018.06.004	Remote sensing imagery-based	Antwerp; Brussels; Ghent (Belgium)	1,2,3,6,8,9,10,A,B,D,E,G	Thermal behaviour analysis based on LCZs and using UrbClim model
56.	Wicki et al. 2018	10.3390/cli6030055	Combined method	Basel (Switzerland)	$2,2_3,2_{10},2_A,6,10_2,A_E,D,D_9,E_{10},G_A$	Modeling and evaluation of UHI intensity in different LCZs
57.	Bechtel et al. 2019a	10.1016/j.uclim.2018.10.001	Remote sensing imagery-based	Globally, including European cities	All 17 LCZs	Development of the WUDAPT L0 method
58.	Bechtel et al. 2019b	10.1016/j.uclim.2019.01.005	Remote sensing imagery-based	Globally, including European cities	All 17 LCZs	Investigating SUHI based on LCZs concept
59.	Bokwa et al. 2019	https://doi.org/10.1016/j.enbuild.2019.07.023	Remote sensing imagery-based/GIS-based	Bratislava (Slovakia); Brno (Czech Republic); Kraków (Poland); Szeged (Hungary); Vienna (Austria)	All 17 LCZs	Thermal spatial distribution based on LCZs using MUKLIMO_3 microclimate model
60.	Demuzere et al. 2019a	10.1371/journal.pone.0214474	Remote sensing imagery-based	European continent	All 17 LCZs	Improvements of the WUDAPT L0 method using EE
61.	Demuzere et al. 2019b	10.1016/j.uclim.2018.11.001	Remote sensing imagery-based	Globally, including European cities	All 17 LCZs	Improvements of the WUDAPT L0 method using EE
62.	Feng et al. 2019	10.1002/gj.3619	Combined method	Birmingham (UK)	1,2,5,6,10,B	Analysis of canopy and surface UHI in different urbanization

63.	Fenner et al. 2019	10.1088/1748-9326/ab506b	Remote sensing imagery-based	Berlin (Germany)	2,4,5,6,8,9,A,B,C, D,F,G	Temperature analysis using CWS and LCZs spatial pattern during HWEs
64.	Fonte et al. 2019	10.1016/j.uclim.2019.100456	Remote sensing imagery-based	Hamburg (Hamburg)	1,2,4,5,6,8,10,A,B, D,G	Enhance the WUDAPT L0 LCZs classification using OSM
65.	Geiss et al. 2019	10.1109/JSTARS.2019.2917755	Remote sensing imagery-based	Cities in Germany; The Netherlands; UK	Density/Height classes based on LCZs concept	Implementation of urban morphology classification based on Sentinel-2 and TanDEM-X data
66.	Geletič et al. 2019a	10.1016/j.buildenv.2019.04.011	GIS-based	Prague; Brno (Czech Republic); Novi Sad (Serbia)	1,2,3,4,5,6,8,9,10, A,B, C,D,E,F,G	Inter-/intra-zonal seasonal variability of SUHI based on LCZs and implementation of land cover subclasses
67.	Geletič et al. 2019b	10.1007/s10584-018-2353-5	GIS-based	Brno (Czech Republic)	1,2,3,4,5,6,8,9,10, A,B, C,D,E,F,G	Spatial modeling of summer temperatures using the MUKLIMO_3 model and based on LCZs
68.	Hidalgo et al. 2019a	10.1016/j.uclim.2018.10.004	Remote sensing imagery-based/GIS-based	Paris; Toulouse; Nantes (France)	All 17 LCZs	Quality assessment of LCZs mapping comparing WUDAPT L0 and MApUCE approaches
69.	Molnar et al. 2019	10.1007/s00704-019-02881-1	Combined method	Szeged (Hungary)	2,3,5,6,8,9,D,G	Modeling intra-urban temperature pattern in HW periods
70.	Pour et al. 2019	10.1080/22797254.2018.1564888	Expert knowledge-based	Olomouc (Czech Republic)	2,4,5,6,8,A,G	Thermal data analysis in different LCZs
71.	Qui et al. 2019	10.1016/j.isprsjprs.2019.05.004	Remote sensing imagery-based	Amsterdam (The Netherlands); Paris (France); Munich; Cologne; Berlin (Germany); Milan (Italy); London (UK)	All 17 LCZs (except LCZ 7)	Contribution of automatic mapping using Sentinel-2 and Re-ResNet

72.	Rodler and Leduc 2019	10.1016/j.uclim.2019.100457	GIS-based	Nantes (France)	All 17 LCZs	Development of GIS-based LCZs classification based on Delaunay triangulation and Skeletonization algorithms
73.	Rostam and Beck 2019	10.5937/gp23-24238	Remote sensing imagery-based	Globally, including European cities	All 17 LCZs	Spatial relationship of LST and LCZs
74.	Šećerov et al. 2019	10.1007/s10661-019-7210-0	GIS-based	Novi Sad (Serbia)	2,3,5,6,8,9,10,A,D,G	Assessment of monitoring system of the UMN in Novi Sad
75.	Straub et al. 2019	10.1016/j.uclim.2019.100491	Combined method	Augsburg (Germany)	2,5,6,8,A,B,D	Modeling spatial pattern of UHI intensity based on UMN data
76.	Verdonck et al. 2019	10.1016/j.jenvman.2019.06.111	Remote sensing imagery-based	Brussels (Belgium)	1,2,3,6,8,9,10,A,B,D,E,G	Heat risk assessment based on urban planning and GHG emission
77.	Yoo et al. 2019	10.1016/j.isprsjprs.2019.09.009	Remote sensing imagery-based	Rome (Italy); Madrid (Spain)	2,3,4,5,6,8,9,10,A,B,C,D,E,F,G	Using CNN and RF classifiers to improve the WUDAPT L0 approach
78.	Dian et al. 2020	10.1016/j.uclim.2019.100573	Remote sensing imagery-based	Budapest (Hungary)	2,5,6,8,A,D,G	Spatio-temporal analysis of SUHI in LCZs pattern
79.	Droste et al. 2020	10.1002/qj.3811	Remote sensing imagery-based	Amsterdam (The Netherlands)	All 17 LCZs	Assessment of crowdsourced wind data based on LCZs
80.	Fricke et al. 2020	10.2478/mgr-2020-0004	Remote sensing imagery-based	Szeged (Hungary); Novi Sad (Serbia)	2,3,5,6,8,9,10,A,B,C,D,E,F,G	Spatio-temporal differences of SUHI in LCZs pattern
81.	Gardes et al. 2020	10.1016/j.scitotenv.2020.139253	Combined method	French cities	1,2,3,4,5,6,7,8,9,D,E,G	Investigation of the nocturnal UHI based on different urbanization patterns
82.	Leconte et al. 2020	10.1016/j.uclim.2020.100629	Combined method	Nancy (France)	2,5,8,6/9,A,B,D,E,G	Analysing the LCZs nocturnal cooling using mobile measurements
83.	Maharoof et al. 2020	10.1016/j.uclim.2020.100642	Combined method	Glasgow (UK, Scotland)	2	Investigating the microclimate in one densely built-up LCZ

84	Oliveira et al. 2020	10.1016/j.uclim.2020.100631	GIS-based	Athens (Greece); Barcelona (Spain); Lisbon (Portugal); Marseille (France); Naples (Italy)	All 17 LCZs	Development of the Alternative GIS-based method and evaluation of spatial differences using LST datasets
85.	Pour and Voženilek 2020	10.3354/GC2020-1-05	Expert knowledge-based	Olomouc (Czech Republic)	2,4,5,6,8,A,G	Thermal data analysis in different LCZs
86.	Rathmann et al. 2020	10.1016/j.ufug.2020.126622	Remote sensing imagery-based	Augsburg (Germany)	2,5,6,8,A,B,D,F,G	Exploring urban forest on bioclimatic conditions
87.	Rosentreter et al. 2020	10.1016/j.rse.2019.111472	Remote sensing imagery-based	German cities	1,2,4,5,6,8,9,10,A,B,C,D,E,F,G	Creation the workflow of LCZs mapping using Sentinel-2 and CNN
88.	Unger et al. 2020	10.1016/j.uclim.2020.100619	GIS-based	Szeged (Hungary)	2,3,5,6,8,9,10,A,B,C,D,G	Compare the thermal comfort conditions during HW and during a normal summer period
89.	Venter et al. 2020	10.1016/j.rse.2020.111791	Remote sensing imagery-based	Oslo (Norway)	2,3,4,5,6,8,9,A,B,D,E	Temperature differences in LCZs from remote sensing and crowdsourced data
90.	Vuckovic et al. 2020	10.1007/s12273-019-0564-y	Remote sensing imagery-based	Vienna (Austria)	2,6,D_E	Air temperature modeling based on LCZs pattern
91.	Zonato et al. 2020	10.1016/j.uclim.2020.100584	Remote sensing imagery-based	Bologna (Italy)	2,5,6,8,A,B,D,E,G	Implementing the novel WUDAPT approach to evaluate urban morphology