WUDAPT, uWRF, ENVI-MET Coupling for Site-Specific Urban Heat Island Analysis in San Jose, CA

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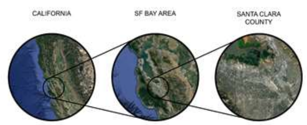
Motivation & Objectives

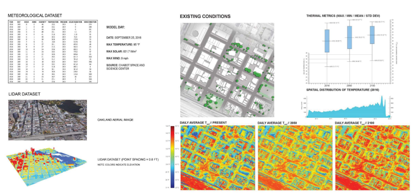
Sound environmental planning is among the top objectives of city governments. Urban heat islands are among the top stressors on city populations.

We present here progress on a linked WUDAPT, uWRF, ENVI-MET building-scale urban heat island analysis for sites in San Jose, California. Specific aims are to develop practical computational methods to evaluate site-specific performance metrics of alternative design scenarios, and to identify opportunities of data exchange between different platforms of spatial exploration and development.



Background

Previous work studying high temperatures at urban scale for Oakland, California. A similar type of analysis is envisioned for San Jose, applying WUDAPT, uWRF and ENVI-MET for advanced meteorological inputs broader architectural scenario analysis.



Acknowledgements

WUDAPT: http://www.wudapt.org/

uWRF: Salamanca, F., Krpo, A., Martilli, A. et al. 2010: Theor Appl Climatol (2010) 99: 331. https://doi.org/10.1007/s00704-009-0142-9

ENVI-MET: http://www.envi-met.com/

The authors thank Dr. Harrison Fraker and Dr. Iryna Dronova at the UC Berkeley College of Environmental Design for assistance in planning and carrying out this ongoing research.

WUDAPT

A Level 0 WUDAPT Local Climate Zones (LCZ) analysis was performed for San Jose, CA. Each LCZ characterizes a temperature regime associated with the local land use / land cover environment.

WUDAPT LCZ Analysis: San Jose (CA)

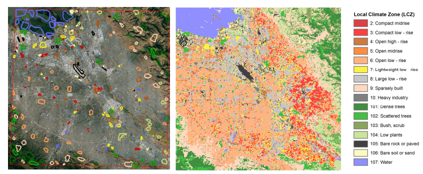


Figure 3. Training samples (left) and LCZs (right) constructed using the WUDAPT SAGA LCZ generation algorithm. The resulting LCZ field indicates a clear distinction between the compact newer residential developments on east, mixed industrial/residential in central, and older residential areas on west sides of city.

Accuracy Matrix

	CLASS	1	2	3	4	5	6	7	8	9	10	101	102	103	104	105	106	107	SumUser	AccUser
LCZ 1 Compact high-rise	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
LCZ 2 Compact mid-rise	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0.00
LCZ 3 Compact low-rise	3	0	0	0	0	0	24	0	1	0	0	0	0	0	0	0	0	0	25	0.00
LCZ 4 Open high-rise	4	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0.00
LCZ 5 Open mid-rise	5	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.00
LCZ 6 Open low-rise	6	0	0	0	0	0	52	0	1	0	0	0	1	0	0	0	0	0	54	96.30
LCZ 7 Lightweight low-rise	7	0	0	0	0	0	10	0	4	0	0	0	0	0	0	1	0	0	15	0.00
LCZ 8 Large low-rise	8	0	0	0	0	0	2	0	14	0	0	0	0	0	0	0	0	0	16	87.50
LCZ 9 Sparsely built	9	0	0	0	0	0	2	0	0	7	0	1	2	1	5	0	0	0	18	38.89
LCZ 10 Heavy industry	10	0	0	0	0	0	0	0	3	0	1	0	0	0	0	0	1	0	5	20.00
LCZ A Dense trees	101	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	13	100.00
LCZ B Scattered trees	102	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	100.00
LCZ C Bush, scrub	103	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	2	0.00
LCZ D Low plants	104	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	6	100.00
LCZ E Bare rock or paved	105	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	3	0	5	0.00
LCZ F Bare soil or sand	106	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	100.00
LCZ G Water	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	30	100.00
	SumProd		0	0	1	0	90	0	26	7	1	15	4	1	12	2	6	30	195	
	AccProd				0		57.778		53.846	100	100	86.667	25	0	50	0	33.333	100		

Overall Accuracy: 0.646154
Kappa: 0.571797

Table 1. Assessment matrix associated with the LCZ analysiss in Figure 3. The overall accuracy of the LCZ classification is 64%. Greatest misclassification are for open low rise and lightweight low rise, and open low rise and compact low rise.

Implementation of LCZs into uWRF

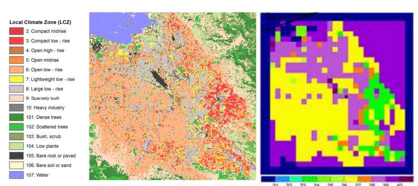
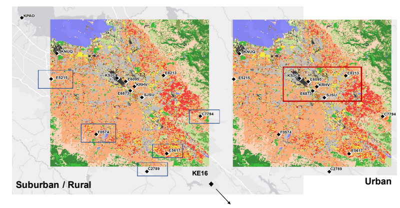


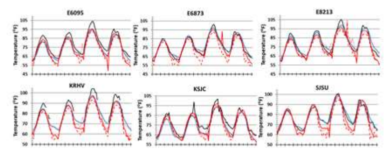
Figure 4. LCZs were resampled from the native 100 x 100 m grid to a 1 x 1 km grid for input to uWRF. Native grid (left), resampled grid (right). The distinction between land-use types on east, central and western sides of city is preserved (see Figure 3).

uWRF

uWRF simulations for San Jose have been carried out. To guide setting urban surface parameters, we performed a standard WRF and three uWRF simulations, comparing temperatures at urban and suburban/rural sites. We simulated the heat-wave period June 16 – 20, 2017.



Urban



Suburban/Rural

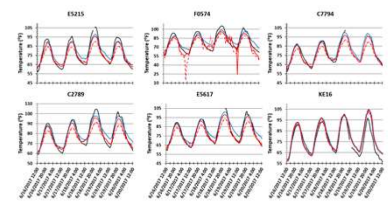
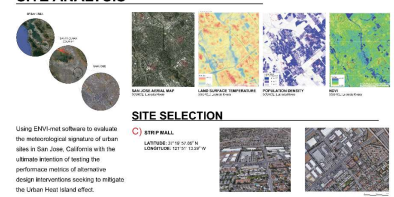


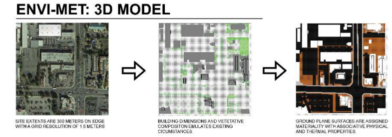
Figure 5. Two-meter temperatures: (black) observed, (blue) standard WRF, (red) three uWRF cases with different heat capacity, thermal conductivity and urban fraction specifications for urban land-use grids. Urban site comparisons on top, suburban/rural site comparisons on bottom.

ENVI-MET

SITE ANALYSIS



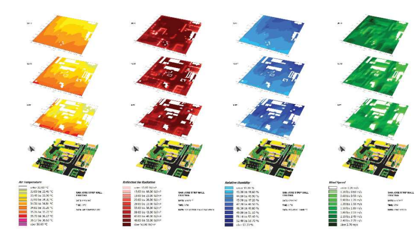
ENVI-MET: 3D MODEL



METEOROLOGICAL INPUTS: uWRF

DATE: June 18th 2017
TIME: 3:00 PM
WIND SPEED: 1.5 m/s
WIND DIRECTION: 242° (SOUTH WEST)
ROUGHNESS LENGTH AT MEASURED SITE: 0.1
SPECIFIC HUMIDITY AT MODEL TOP: 7.7 g/kg
RELATIVE HUMIDITY: 43.10%
AIR TEMPERATURE: 38.30 °C
DIRECT SOLAR RADIATION: 1004.7

EXISTING SITE CONDITIONS



+0.3 ALBEDO - GROUND PLANE + WALL + ROOF