Introduction

The study of urban heat island (UHI) effect has long been limited by non-standardized definition and inadequate description of the classification of field sites. To standardize UHI study world-wide, Stewart and Oke (2012) developed a culturally-neutral framework for describing urban morphology named Local Climate Zones (LCZ).

There are many studies for evaluating the performance of LCZ scheme by using air temperature data. But the relationship between land surface temperature (LST) and LCZ scheme is still remain uncertain. The key research question is to investigate whether each LCZ class can portray a characteristic land surface temperature regime. Two major cities, San Francisco and San Jose, in San Francisco Bay Area were chosen as case studies.

Methods and Materials

(1) LCZ maps were firstly extracted following the World Urban Database and Access Portal Tools (WUDAPT) method. (Figure 2)

(2) Secondly, Landsat 8 images were used for deriving LST by split window algorithm. In order to analyze the relationship between LST and LCZ, we calculated the LST of two cities in typical summer and winter time from 2015 to 2017, respectively (Figure 3).

(3) To understand the relationship between LCZ and LST, further quantitative analyses have been done to explore the relationship between these two parameters. The Box-plots were used as the graphic display method to present the distribution and the range of differences of LST among LCZ categories (Figure 4).

Differences between mean LST of each LCZ class were analyzed by one-way analysis of variance (ANOVA) test. When the ANOVA test indicated there is significant differences in LST, the Tukey-Kramer multiple comparison analysis was then applied to determine which LCZ classes share similar characteristics of mean LST and which LCZ classes are different.

The results of multiple comparison analysis are presented in matrix format showing if there is statistically significance for each pair (Figure 5). If the multiple comparison results suggest that there is significant difference between the mean LST of this pair, which is a “positive” result in this research. Otherwise is a “negative” result.

Results & Conclusions

The key findings of this study are summarized as follows:

- Characteristics can be observed in Box-plot graphs:
- Different LCZs show different land surface temperature signatures
- Large low-rise has the highest LST in built-up categories followed by Compact Building types. Bush & scrub has the highest temperature in natural categories

Results of ANOVA test and multiple comparisons:
- The feature of LSTs differ significantly between LCZ categories for most of the situation.
- Better performance of distinguishing LST of LCZs are found for LCZs that are structurally different
- The sample size of each LCZ category also has influence on final results
- Seasonal differences of LST using LCZ classification scheme can be observed. The temperature differences are more significant in summer and more homogenous in winter

Figure 3. LST map of San Francisco (left) and San Jose (right) (a) summer 2015, (b) winter, 2016, (c) summer, 2017, (d) winter, 2016

Figure 4. Box-plots with LSTs in LCZ classification system (two samples)

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Key References


