Journal of Engineering and Applied Sciences 13 (2): 350-352, 2018
ISSN: 1816-949X

Urban Mapping Local Climate Zones Based on Morphology Categorization

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Abstract: There is liberal evidence of the cooling effects of Green Infrastructure (GI) that has been expansively documented in the narrative. Conversely the study of the thermal profiles of different GI typologies requires the categorization of urban sites for a meaningful comparison of results, since, detailed spatial and physical characteristics produce distinct microclimates. In this study, the Local Climate Zones (LCZ), a scheme of thermally relatively homogeneous urban structures proposed by Stewart and Oke was used for mapping and classifying the urban morphology of a study area in Sydney, Australia. A GIS-based workflow for an automated classification based on airborne remote sensing data is presented. The datasets employed include high resolution hyper spectral imagery, LiDAR (Light Detection and Ranging) and cadastral information. Future stages of this research include coupling this method with a newly developed GI typology for a more widespread analysis of the cool effects of GI by taking into account the morphological disparities of LCZ.

Key words: Urban climate, heat mitigation, urban heat Island, urban form, green infrastructure, expansively

INTRODUCTION

There is plenty evidence of the thermal benefits of Green Infrastructure (GI), specifically the mitigation of the Urban Heat Island (UHI) phenomenon. However, the application, transferability and comparability of studies are limited by the great range of land surface descriptors and GI typologies (Bechtel and Daneke, 2012). At first, the study of the thermal profiles of GI requires an suitable description and categorization of urban sites given that specific spatial and physical description produce distinct microclimates. This categorization system targets investigations at local scale (neighbourhoods and precincts) and requires the estimation of key parameters such as building and vegetation heights, aspect ratio (H/W), Sky View Factors (SVF) and different surface fractions (pervious, built and impervious ground) (Kaloustian and Bechtel, 2016; Bowler *et al*., 2010).

Local Climate Zone (LCZ) classification using the World Urban Database and Access Portal Tools (WUDAPT) Method has been explained by Ren *et al*. (2016). Measurement of static shift in MT and CSAMT surveys it covered by Macnae *et al*. (1998).

In this study, we present a methodology for the programmed classification of LCZ based on high resolution airborne remote sensing data. Both object-oriented and pixel-based approaches are used here for the extraction of built and natural features from hyper spectral imagery, LiDAR and cadastral data. Moreover, LCZ can facilitate the comparison of the cooling effects of different GI typologies by taking into account the morphological disparities of urban landscapes.

MATERIALS AND METHODS

Study area: The study area is situated within the greater urban area of Sydney, Australia's major city with a population of 4.6 million circulated across 12400 km^2 Sydney is located on the South-Eastern seaside (33.8°S latitude) and has a temperate oceanic (Cfb) climate with calm Winters and warm Summers (Bechtel *et al*., 2015, 2016). Due to time and cost constraint for data acquirement, we focused on a fraction of the middle ring Sydney suburbs comprise a variety of urban morphologies. The case study is located 12 km from the coast and has a relatively flat topography (Irger, 2014; Stewart and Oke, 2012). It is characterised by mixed urban form mostly dominated by low density areas intersperse with forested, brown field and industrial land. Most of the green open spaces are determined along the Cooks River.

RESULTS AND DISCUSSION

The automated categorization of LCZ for the study area (1429 grids of 100×100 m) is presented in Fig. 1. A total of seven built types (LCZ 2, 3, 5, 6, 8, 9 and 10) and 4 natural types (LCZ A, B, D and E) were identified. LCZ 1, 4, 7, F and G were not identified for this study. It can be examined that the urban structure of the middle ring suburbs of Sydney is subjugated by LCZ 6 open low-rise (n = 862, 59.9%) and LCZ 9 sparsely built (n = 286, 19.9%), followed by LCZ B scattered trees (n = 115, 8%) and LCZ D low plants (n = 47, 3.3%). Contrastingly, a smaller number of grids were classified as LCZ E paved (n = 36, 2.5%), LCZ 3 compact low-rise (n = 29, 2%), LCZ 2

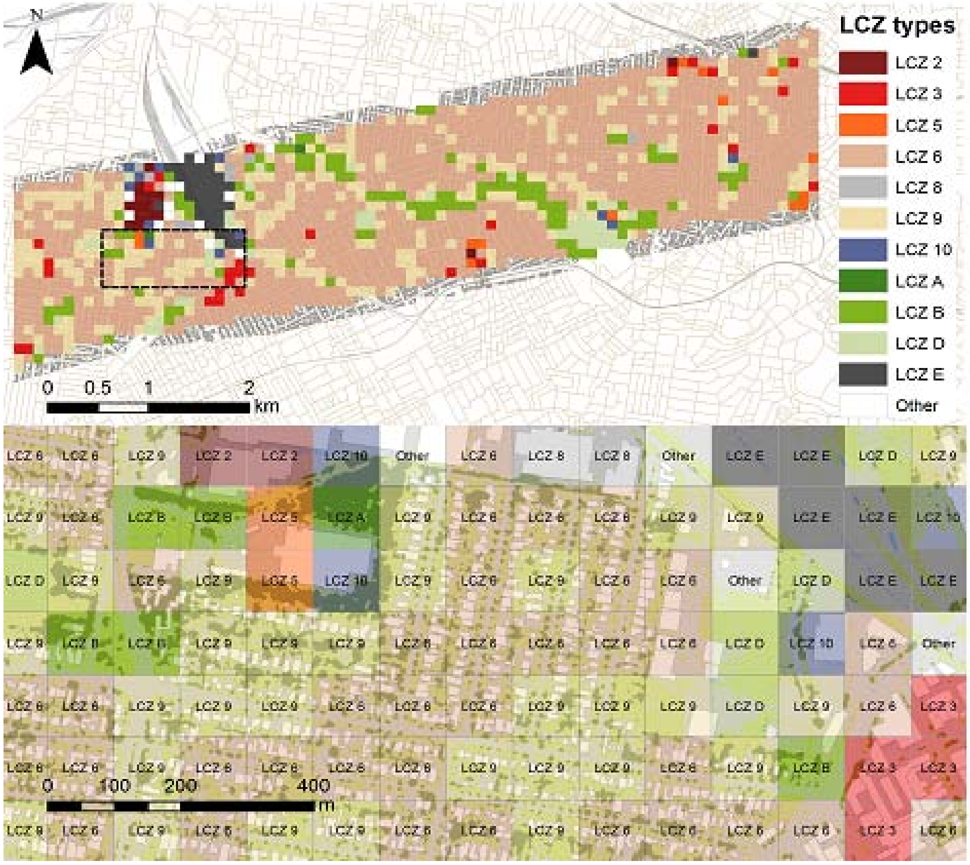

Fig. 1: LCZ study area 1429 grids of 100×100 m

compact midrise (n = 15, 1%), LCZ 5 open midrise (n = 14, 1%) and LCZ 10 heavy industry (n = 12, 0.8%) while very few areas were identified as LCZ 8 large low-rise (n = 8, 0.6%) and LCZ A dense trees (n = 2, 0.1%). Unidentified areas named as ‘other’ (n = 13, 0.9%) were not properly classified as these possess characteristics of multiple LCZ and varied surface fractions.

CONCLUSION

This study presents a method for the automated categorization of LCZ that was successfully derived from multiple airborne remote sensing data. Results presented here demonstrate the applicability of our method and values in the context of Sydney with <1% of unnamed areas. The classifications show a good visual agreement when compared against airborne imagery; however, results are conditional on further accuracy assessment such as ground truthing and confusion matrix. The results also provide evidence that LCZ can be used to categorize morphological profiles to support varied climatologically studies. However, high variability of surface fractions were observed within each LCZ; an issue that could be resolved by combining built and natural LCZ.

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