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Local Climate Zone Map for China and its applications in local urban and regional development

Edward ng, The Chinese University of Hong Kong, Shatin, NT, Hong Kong; and C. Ren, Y. Xu, M. Cai, R. WANG, X. Li, M. Pesaresi, A. Florczyk, C. Corban, P. Politis, P. S. Yeung, W. P. TSE, M. F. WONG, and J. C. H. Fung

Abstract Text:

Chinese cities have experienced a fast urbanization since the late 1970s and this urbanization trend may still need another 20-30 years before the whole process completes. Their urban residents are especially vulnerable to current and future climate hazards because of high population density, compact urban setting and infrastructure and social-economic activities in landscapes that are exposed to sea-level rise, warming trends, and other extreme weather events (WMO, 2003, IPCC, 2014, UN-Habitat, 2011) . In the meanwhile, due to lack of urban climatic consideration in local development, such fast urbanization in China has caused a series of urban environmental problems, such as urban heat island effect, the pollution of rivers and seas, air pollutant effects and air quality degradation. These problems must not be under estimated, since they not only directly impact local residents' health condition, but also indirectly affect Korean, Japanese, and Taiwan people's living quality. Thus, there is an increasing international focus on Chinese cities' development and their environmental-related studies and a world-wide interest on developing a national-scale database on Chinese cities for scientific inquiry and policy formulation.

The initial concept of the Local Climate Zone (LCZ) classification system was developed by Stewart and Oke (2012). It aims to characterize local urban surfaces with regard to their effect on local climate. Recently researchers mapped out LCZs mainly at individual city level. Given fast urbanization in developing countries and regions, there is a need to develop regional and national LCZ data and their corresponding maps.

The study aims to contribute to this knowledge gap by: (a) applying the LCZ classification scheme into the Chinese cities by adopting the random forest classifier (Bechtel., 2015) to develop an open-access database; (b) using multi-satellite image resources (Landsat 8, Sentinel-1 and Sentinel-2) to develop a national LCZ map of China with 100m resolution; (c) selecting the Pearl River Delta region as case study of mega-region to develop its historical LCZ mapping (from 1990s to 2010s) via transfer learning; and (d) testing these developed data into the Weather Research and Forecasting (WRF) model simulations to examine the pure urbanization impact on local climatic conditions for better policy and local action;

The training samples of 60 provincial capital cities and three major economic regions in China were collected to capture both urban morphological features and land cover types. Multispectral indices derived from multi-satellite resources were inputted to improve the oval accuracy. In general at the city level, the overall accuracy of developed LCZ map can achieve 60%. For high-density cities in China, their accuracy result is relatively low. For the case study of the PRD region, ACM2 PBL Scheme coupled with Noah land surface model was used for WRF simulation configuration. The simulation results show due to large urbanization over the Pearl River Delta region, temperature at 2m above the ground is significantly increased over the built-up area not only in daytime, but also in night time. This is because large amount of heat is stored in the built-environment and retained in the land area so that the temperature is still higher than rural area during night-time. For wind environment, it is found that the strength of the sea breeze is increasing after urbanization from the 1980s to the 2010s, which may be caused by stronger temperature gradient between land and sea. The study also adopts Heat Index defined by US National Weather Service (NWS) to analyze thermal comfort situations. It is found that there is a significant increasing trend in heat index especially near coastal area during day-time.

The developed national LCZ map of China can provide researchers, scientists and the practitioners with a useful dataset and spatial information platform of urban morphology and land cover. For the case study of the PRD region, the findings also can let planners and governors have a quantitative understanding about the impact of urbanization on local climatic conditions. It also presents a potential methodology to develop historical land use information for those developing regions and countries. If linked with other geo-referenced urban information, there are many possibilities for various applications such as climatic-sensitive planning, land use predication, and analysis of climate-change induced health impact.

Figure 1 Developed historical LCZ maps of the PRD region and simulated temperature results by WRF model

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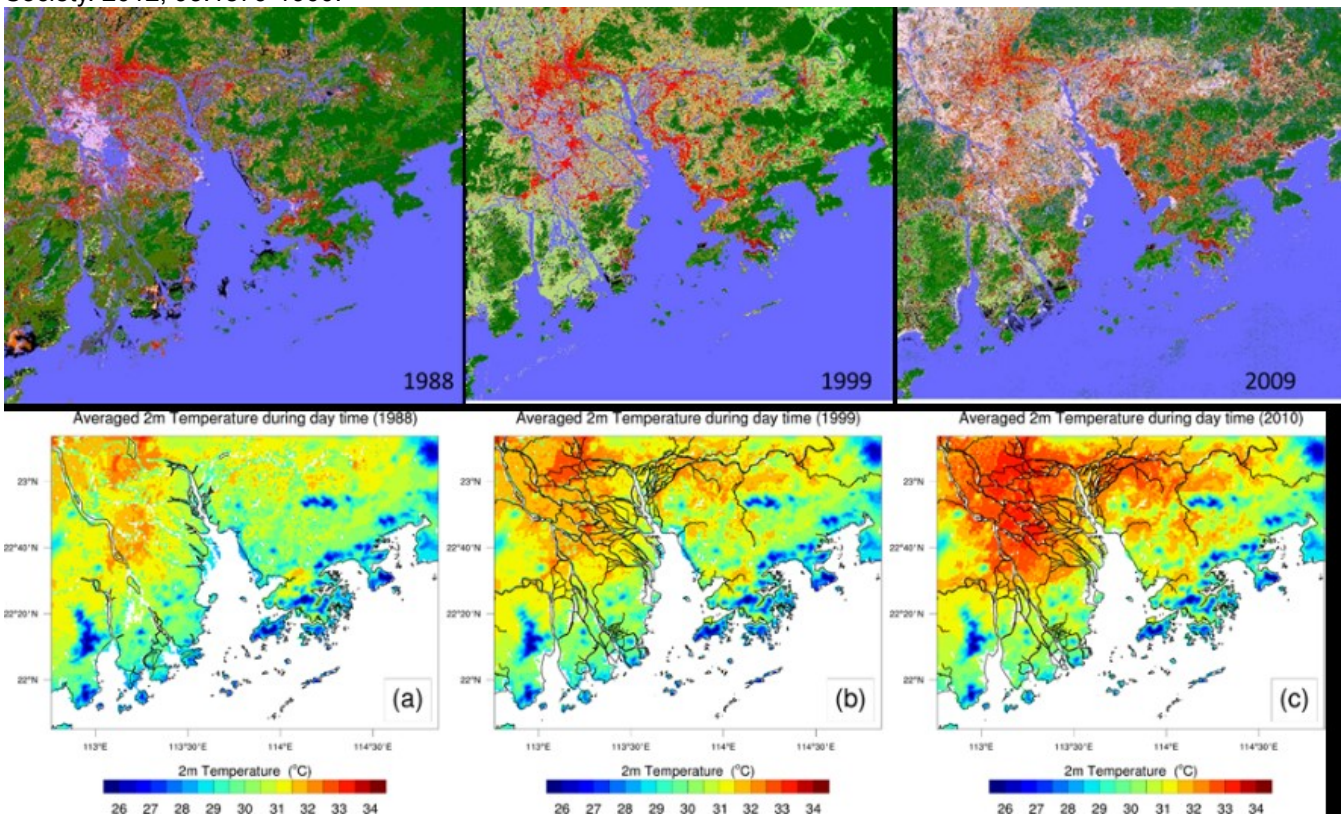

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Submitter's E-mail Address:
renchao@cuhk.edu.hk

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First Presenting Author
Presenting
Edward ng
Institute of Future Cities
The Chinese University of Hong Kong
School of Architecture
The Chinese University of Hong Kong
Shatin, NT 000000
Hong Kong
Phone Number: 85239436515
Email: edwardng@cuhk.edu.hk
Student? No
Second author
Chao Ren
School of Architecture
The Chinese University of Hong Kong
The Chinese University of Hong Kong
Shatin
New Territories,
Hong Kong
Phone Number: +852 39435397
Email: renchao@cuhk.edu.hk
Student? No
Third author
Yong Xu
Institute of Future Cities
The Chinese University of Hong Kong
The Chinese University of Hong Kong
Shatin
New Territories,
Hong Kong
Phone Number: +852 39435397
Email: xuyong@cuhk.edu.hk
Student? No
Fourth author
Meng Cai
School of Architecture
Chinese University of Hong Kong
The Chinese University of Hong Kong, Shatin, New Territories
Hong Kong, 000000
Hong Kong
Phone Number: (852)64870834
Email: caimeng@link.cuhk.edu.hk
Student? Yes
Fifth author
Ran WANG
School of Architecture
Chinese University of Hong Kong
AIT, CUHK
Shatin, N.T.
Hong Kong
Phone Number: 852-39438101
Email: wangran1017@link.cuhk.edu.hk
Student? Yes
Sixth author
Xinwei Li
Institute of Future Cities
The Chinese University of Hong Kong

The Chinese University of Hong Kong
Shatin
New Territories,
Hong Kong
Phone Number: +852 39435397
Email: lixinwei@cuhk.edu.hk
Student? No
Seventh author
Martino Pesaresi
Joint Research Centre
European Commission
Directorate of Space, Security and Migration; Disaster Risk Management Unit
Ispra, TP 267
Italy
Phone Number: +39 0332789524
Email: martino.pesaresi@jrc.ec.europa.eu
Student? No
Eighth author
Aneta Florczyk
Joint Research Centre
European Commission
Directorate of Space, Security and Migration; Disaster Risk Management Unit
Ispra, TP 267
Italy
Phone Number: +39 0332789524
Email: Aneta.FLORCZYK@ec.europa.eu
Student? No
Ninth author
Christina Corban
Joint Research Centre
European Commission
Directorate of Space, Security and Migration; Disaster Risk Management Unit
Ispra, TP 267
Italy
Phone Number: +39 0332789524
Email: Christina.CORBAN@ec.europa.eu
Tenth author
Panagiotis Politis
Joint Research Centre
European Commission
Directorate of Space, Security and Migration; Disaster Risk Management Unit
Ispra, TP 267
Hong Kong
Phone Number: +39 0332789524
Email: Panagiotis.POLITIS@ext.ec.europa.eu
Eleventh author
Pak Shing Yeung
Environmental Science Programs, School of Science
The Hong Kong University of Science and Technology
School of Science
The Hong Kong University of Science and Technology
Kowloon, 000000
Hong Kong
Phone Number: +8522358 8363
Email: jasontwp1218@gmail.com
Student? Yes
Twelfth author
Wai Po TSE
Environmental Science Programs
The Hong Kong University of Science and Technology
School of Science
The Hong Kong University of Science and Technology
Kowloon, 000000
Hong Kong
Email: jasontwp1218@gmail.com

Thirteenth author
Mau Fung WONG
Environmental Science Programs
The Hong Kong University of Science and Technology
School of Science
The Hong Kong University of Science and Technology
Kowloon, 000000
Hong Kong
Email: michaelwong22mu@gmail.com
Fourteenth author
Jimmy C.H. Fung
Division of Environment and Sustainability
Hong Kong University of Science and Technology
Clear Water Bay, Kowloon
Hong Kong, 999077
Hong Kong
Phone Number: +852-59379122
Email: majfung@ust.hk
Student? No

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