



Automated high-resolution LCZ mapping from multi-source satellite images

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Introduction



- Local Climate Zones (LCZs) is a new standard for characterizing urban landscapes, providing a holistic classification approach that takes into account micro-scale land-cover and associated physical properties.
- LCZ classification schema
 - Qualitative criteria, subject to subjective interpretation
 - Hard to validate the LCZ map accuracy
- LCZ product
 - LCZ 100-meter resolution is available globally
 - Accuracy is hard to assess
- LCZ generator: a Web application that generates LCZ map from satellite images based on human-defined training data for each city



Automated LCZ Mapping



- LCZ classes are defined based on 3-D structure of urban landscape
- Classical optical satellite images provides 2-D (horizontal) structure semi-explicitly and the vertical (height) information implicitly (relies on spectral information)
 - This is why training datasets for each cities are needed
- Recent space-based Lidar mission, the Global Ecosystem Dynamic Investigation (GEDI), can potentially provide 3-D structure of urban landscape quantitatively.
 - GEDI was designed for investigating forest vertical structure
 - We found it can also be used to measure the 3-D structure of cities
 - Combination of GEDI derived quantitative 3-D info with optical remote sensing images can potentially map LCZ at high spatial resolution automatically and objectively
 - The ground footprint of GEDI is 25 meter.





LCZ 1: Compact high-rise

LCZ 2: Compact mid-rise

LCZ 3: Compact low-rise





modis_nonvegetated	57
modis_nonvegetated_sd	7.82
modis_treecover	12
modis_treecover_sd	7.82

100





gedi_urban_proportion	100
modis_nonvegetated	57
modis_nonvegetated_sd	7.79
modis_treecover	17
modis_treecover_sd	7.79





NASA IDS Meeting





LCZ 4: Open high-rise



100

8

7.91



modis_treecover
modis_treecover_sd
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LCZ 5: Open mid-rise



gedi_urban_proportion	89
modis_nonvegetated	19
modis_nonvegetated_sd	7.48
modis_treecover	15
modis_treecover_sd	7.48





LCZ 6: Open low-rise



NASA IDS Meeting

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LCZ 7: Lightweight low-rise

LCZ 8: Large low-rise

LCZ 9: Sparsely built

LCZ 10: Heavy industry







90

80

70

60

20

20

40

Percent Energy Returned

60

80

5

11

32

3.91

3.91

RH (m) 50

gedi urban proportion

modis nonvegetated sd

modis nonvegetated

modis treecover sd

modis treecover







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60

80

90

89

1

12.93

100



Quantitative Criteria LCZ 1: Compact high-rise



- RH100>30m
- RH50>20m
- Urban Proportion>75%
- MODIS Nonvegetated>75%







Quantitative Criteria LCZ 2: Compact mid-rise



- RH100<30m
- RH50>10m
- Urban Proportion>75%
- MODIS Nonvegetated>75%







Quantitative Criteria LCZ 3: Compact low-rise



- RH100<10m
- RH50>3m
- Urban Proportion>75%
- MODIS Nonvegetated>75%







Quantitative Criteria LCZ 4: Open high-rise



- RH100>30m
- RH50>20m
- Urban Proportion>75%
- MODIS Nonvegetated [50%, 75%]







Quantitative Criteria LCZ 5: **Open mid-rise**



- RH100<30m
- RH50>10m
- Urban Proportion>75%
- MODIS Nonvegetated [50%, 75%]







Quantitative Criteria LCZ 6: Open low-rise



- RH100<10m
- RH50>0m
- Urban Proportion>50%
- MODIS Nonvegetated [25%, 75%]







Quantitative Criteria LCZ 8: Large low-rise



- RH100>10m
- RH50<5m
- Urban Proportion>75%
- MODIS Nonvegetated>75%







Quantitative Criteria LCZ 9: Sparsely built



- RH100<30m
- RH50>0m
- Urban Proportion [25%, 75%]
- MODIS Nonvegetated<25%







Example of Result





Google Map Image



Landsat Image

LCZ Classification based on Landsat and GEDI



Global LCZ 100m Product

- Compact highrise
 Compact midrise
 Compact lowrise
- Open highrise
 Open midrise
 Open lowrise
- Lightweight lowrise
- Large lowrise
- Sparsely built
- Heavy industry



GEDI profiles on 100-meter LCZ Guangzhou, China













Heavy industry









- Combination of Space Lidar and optical data could potentially generate LCZ map globally at high spatial resolution both objectively and automatically
- Need to have quantitative definition of each LCZ class
 - Enable the quantitative evaluation of LCZ mapping accuracy
 - Easy to parameterize the LCZ classes in models
 - Urban climate community needs to work together to come with the definition
- Need to clarify if LCZ class is defined at spatial-resolution level or regional level

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