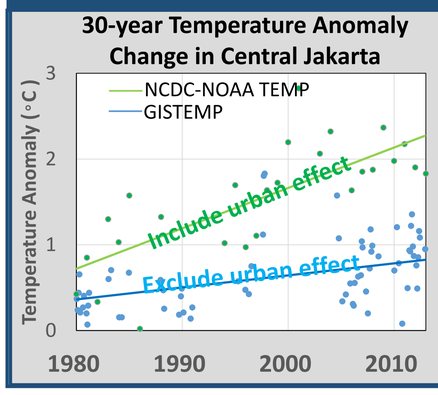
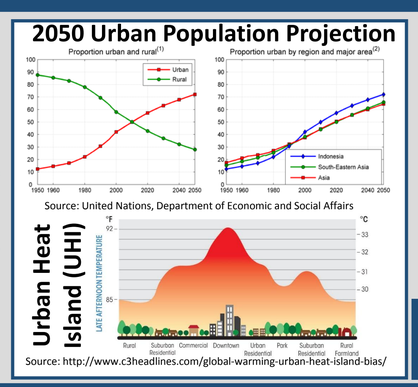
9th International Conference on Urban Climate (ICUC), 20th -24th July 2015, Toulouse France
Poster 12: GD – Local Climate Zones and Urban Database

Detection of Urban Environment from Landsat 8 for Mesoscale Modelling Purpose

Nisrina Setyo Darmanto, Alvin Christopher Galang Varquez, Manabu Kanda
Department of International Development Engineering, Tokyo Institute of Technology

Introduction





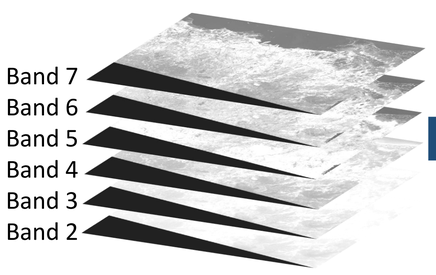
- **Rapid urbanizations** in megacities lead to urban temperature increase and Urban Heat Island (UHI).
- Mesoscale weather models such as Weather Research and Forecasting (WRF) are 3D weather models which can be used to understand and mitigate the urban phenomenon.
- Distribution of updated aerodynamic parameters[1] in urban areas improves surface momentum transport in WRF[2]. Its parameterization requires one **urban parameter, λ_p (ratio of the plane area occupied by buildings to the total floor area)**, which can be created from detailed morphological building data.
- **Problem**: Detailed building geometry is scarce in most megacities (e.g. Jakarta).

Objective : a. Detection of urban areas using Landsat 8 for mesoscale models; b. Derive an empirical equation to determine λ_p spatial distribution from detected urban areas.

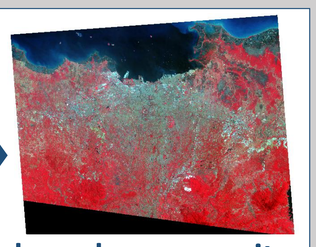
Methods and Materials

Landsat 8 satellite urban land use detection using SCP*

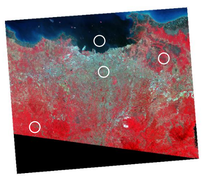
*Semi-Automatic Classification Plugin for QGIS [3]



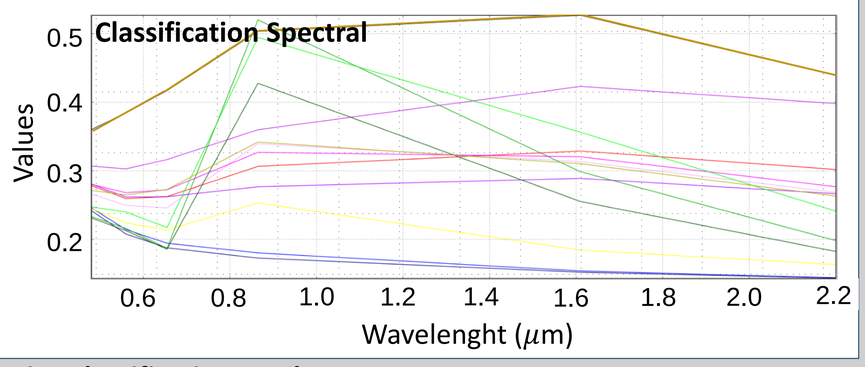
Pre-processing
- TOA reflectance conversion
- Dark Object Subtraction (DOS) 1



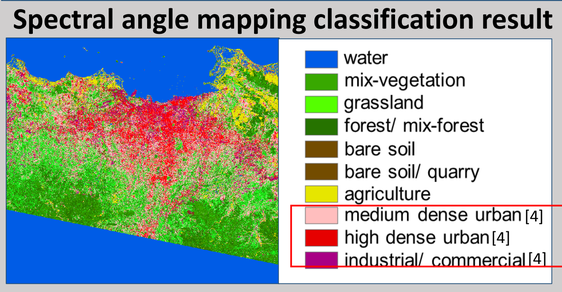
False color composite



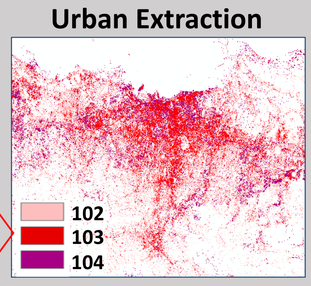
Selection of land cover class (ROI)



Spectral angle mapping classification result



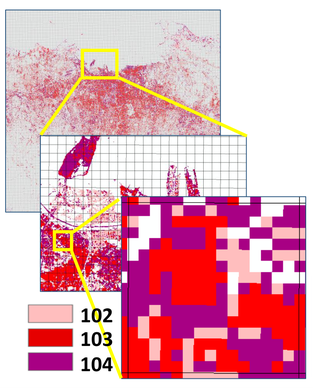
Urban Extraction



Land use update

Urban ratio

1-km Grid Urban Ratio ($r_{102}, r_{103}, r_{104}$) Creation



$$r_{102} = \frac{total\ area\ of\ 102\ in\ 1-km\ grid}{total\ area\ of\ non-102\ in\ 1-km\ grid}$$

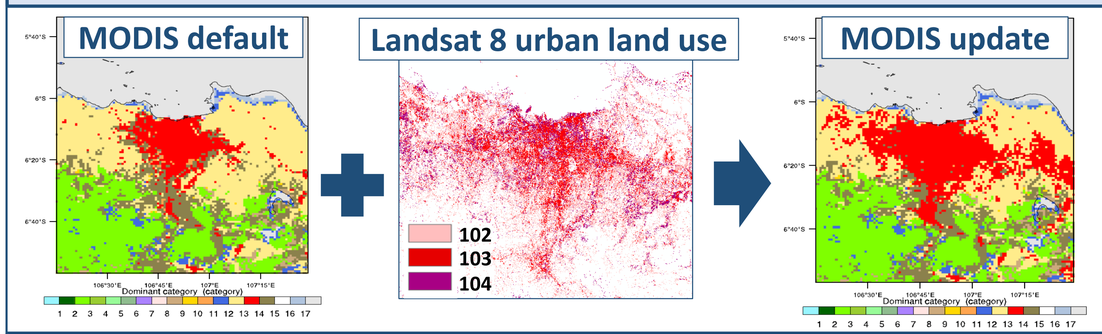
$$r_{103} = \frac{total\ area\ of\ 103\ in\ 1-km\ grid}{total\ area\ of\ non-103\ in\ 1-km\ grid}$$

$$r_{104} = \frac{total\ area\ of\ 104\ in\ 1-km\ grid}{total\ area\ of\ non-104\ in\ 1-km\ grid}$$

$r_{102}, r_{103}, r_{104}$ are to be compared with real λ_p to define empirical equation

Results and Discussion

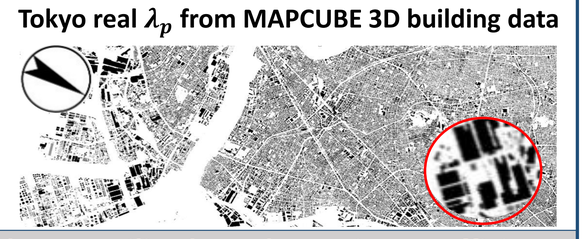
WRF MODIS 500-m urban land use update



Area of analysis and real λ_p source database

Jakarta real λ_p from Nokia Here Maps

Tokyo real λ_p from MAPCUBE 3D building data

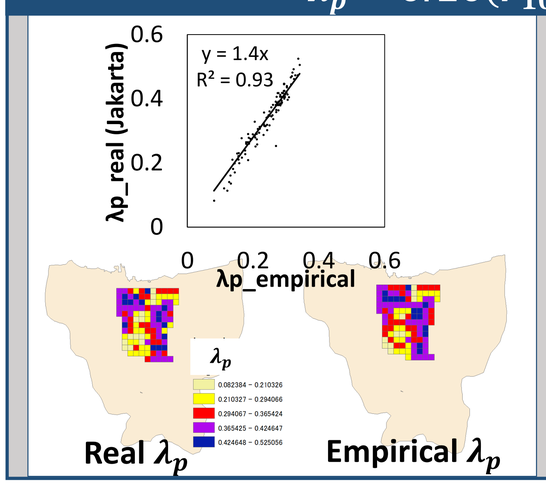


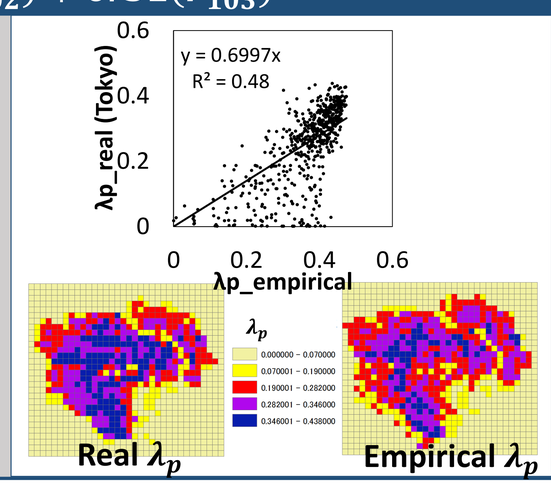
Ordinary Least Squares (OLS) method was utilized to determine coefficient value on each urban ratio as regressor variable towards real λ_p value as dependent variable. OLS result will be treated as λ_p empirical equation.

OLS for Jakarta	OLS for Tokyo
$\lambda_p = 0.19(r_{102}) + 0.51(r_{103}) + 0.29(r_{104})$ $R^2 = 0.86$	$\lambda_p = -0.31(r_{102}) + 0.425(r_{103}) - 0.517(r_{104}) + 0.0027$ $R^2 = 0.56$

OLS for Jakarta has more simple expression and intercept with 0. By neglecting r_{104} coefficient, a new λ_p empirical equation is expressed below and applied to Jakarta and Tokyo.

$$\lambda_p = 0.20(r_{102}) + 0.51(r_{103})$$





Conclusions and Future Works

Conclusions	Future Works
• Landsat 8 image was utilized to create latest area-specific land use database for updating mesoscale model existing database. The same SCP method can be applied to other areas. • Comparison between 1-km grid λ_p created from original building data, MAPCUBE and/or Nokia Here Maps, and urban ratio derived from Landsat 8 land use classification results that both of them has high correlation. • A general empirical equation to convert urban ratio to λ_p was validated for Tokyo and Jakarta. The same empirical equation can be applied to other cities as long as the urban ratio is strictly defined similar to this study.	1. Incorporating empirical λ_p (with other urban parameters) in WRF simulation and analyze its performance. 2. Applying the same method of land use update and λ_p creation by using explained method for other cities.

References (by order of appearance)

[1] Kanda, M., Inagaki, A., Miyamoto, T., Gryschka, M. and Raasch, S., 2013: A New Aerodynamic Parameterization for Real Urban Surfaces. *Boundary-Layer Meteorology*, **148(2)**, pp. 357–377
[2] Varquez, A. C. G., Nakayoshi, M. and Kanda, M., 2014: The Effects of Highly Detailed Urban Roughness Parameters on a Sea-Breeze Numerical Simulation. *Boundary-Layer Meteorology*, **154(3)**, pp. 449–469
[3] Congedo Luca, Munafo' Michele, Macchi Silvia, 2013: Investigating the Relationship between Land Cover and Vulnerability to Climate Change in Dar es Salaam. Working Paper, Rome: Sapienza University. Available at: http://www.planning4adaptation.eu/Docs/papers/08_NWP-DoM_for_LCC_in_Dar_using_Landsattt_Imagery.pdf
[4] Stewart, I. D. and Oke, T. R., 2012: Local Climate Zones for Urban Temperature Studies. *Bulletin of the American Meteorological Society*, **93(12)**, pp. 1879–1900.

Acknowledgement

This research was supported by the Environment Research and Technology Development Fund (S-14) of the Ministry of the Environment, Japan.