# Comparison of Land Cover and Land Use Data for Urban Climate Modelling in Southeast Asian Cities – A case study of Johor Bahru


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## Introduction

### Background

For accurate urban climate modeling, terrestrial data are an important input. The quality of terrestrial data has an impact on simulation results. Outdated land cover data, for instance, may not represent the actual conditions on the ground. As an alternative to land cover data, the use of land use data may be applicable. They are provided by urban planning authorities and represent the current utilization of land in respective areas. Nevertheless, most of the cities in Southeast Asia experience rapid urbanization associated with urban sprawl. This often leads to changes in urban landscape where abandoned open spaces occur even in the city center. These unauthorized spaces may not be represented by land use data. Land cover data, in contrast, show the actual situation on the ground and might be more suitable for simulation of urban climate. However, cities located in tropical regions are generally affected by high incidence of cloud cover throughout the year. Preparation of land cover data in areas severely affected by clouds requires a sophisticated approach and comprehensive tools.

### Objective

- Comparison of land use and land cover data for the simulation of urban climate in Johor Bahru, Malaysia

### Research Area

- Johor Bahru is located in the southern-most tip of Peninsular Malaysia
- Second largest city after Kuala Lumpur and the capital of Johor State
- Rapid urban development under the guideline of the Comprehensive Development Plan (CDP) 2006
- Weather conditions are characterized by southwest, northeast, and intermonsoon seasons

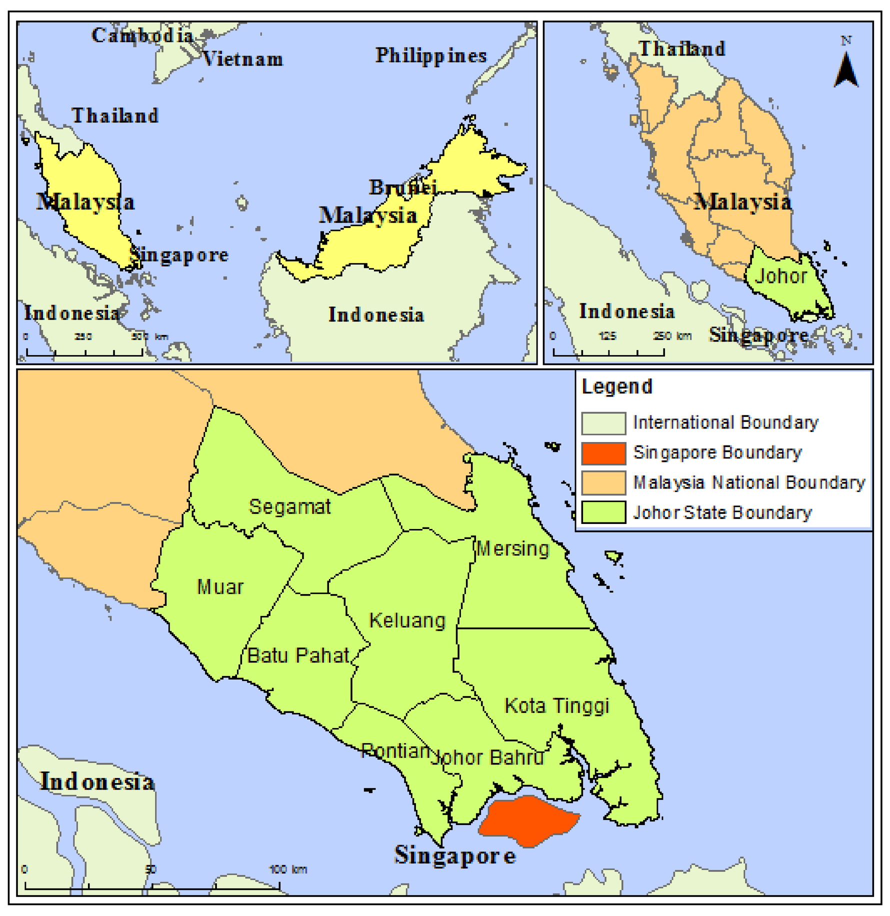



Figure 1: Geographic location of the research area

## Methodology

### Methodological Framework

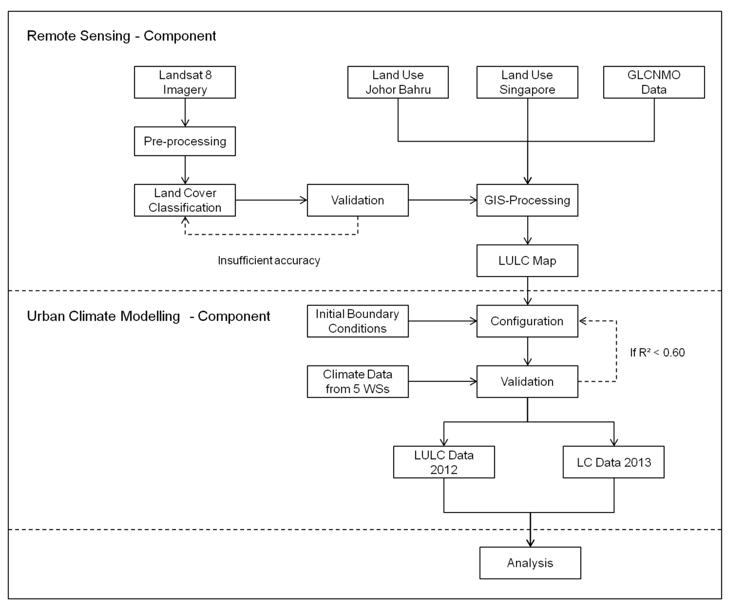



Figure 2: Methodological approach

### Urban Climate Model

- Numerical mesoscale model – Weather Research and Forecasting (WRF)(version 3.6.1)
- Grid cell resolution of 0.5 km, vertical resolution of 30 layers

Table 1: WRF parameters and configuration for domain 1 to 4

| | Domain 1 | Domain 2 | Domain 3 | Domain 4 |
|---|---|---|---|---|
| Resolution | 13.5 km | 4.5 km | 1.5 km | 0.5 km |
| Domain Size | 204×204×30 | 204×204×30 | 198×198×30 | 204×204×30 |
| WRF Version | WRF ARW v. 3.6.1 | | | |
| Land use/cover Data | GLCC | GLCC | GLCNMO | Landsat 8 |
| Initial Boundary Condition | GRIB1 NCEP FNL | | | |
| Longwave Radiation | RRTM Scheme | | | |
| Shortwave Radiation | Dudhia Scheme | | | |
| Surface Layer | Monin-Obukhov Similarity Scheme | | | |
| Land-Surface | Noah LSM | | | |
| Center Point | 103.749997°E 1.527785°N | | | |
| PBL Type | YSU Scheme | | | |
| Microphysics | WRF SM 3-class Scheme | | | |
| Cumulus Scheme | Kain-Fritsch Scheme | | | |
| Period for Simulation Validation | 00:00 UTC 12 to 00:00 UTC 18 June 2013 | | | |

## Land Use and Land Cover Map

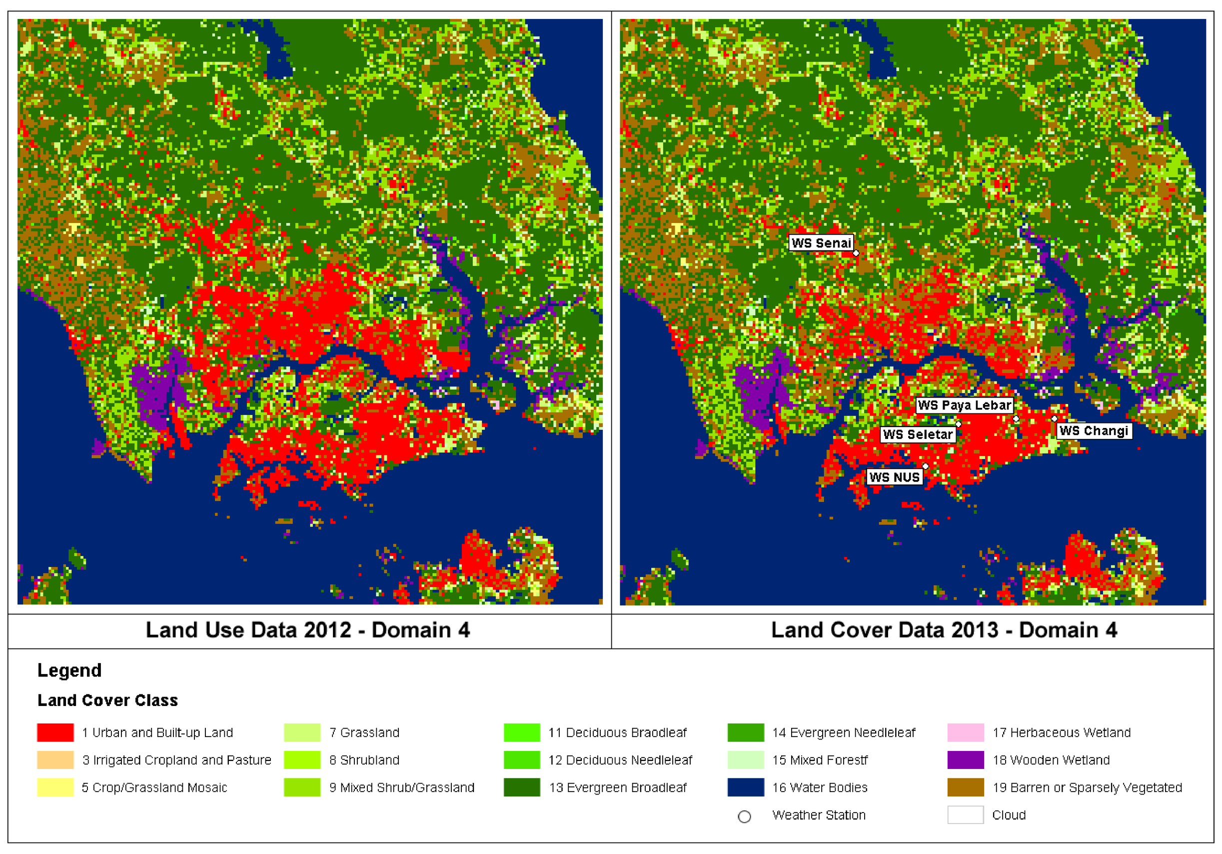



Figure 3: Land use and land cover mal for domain 4

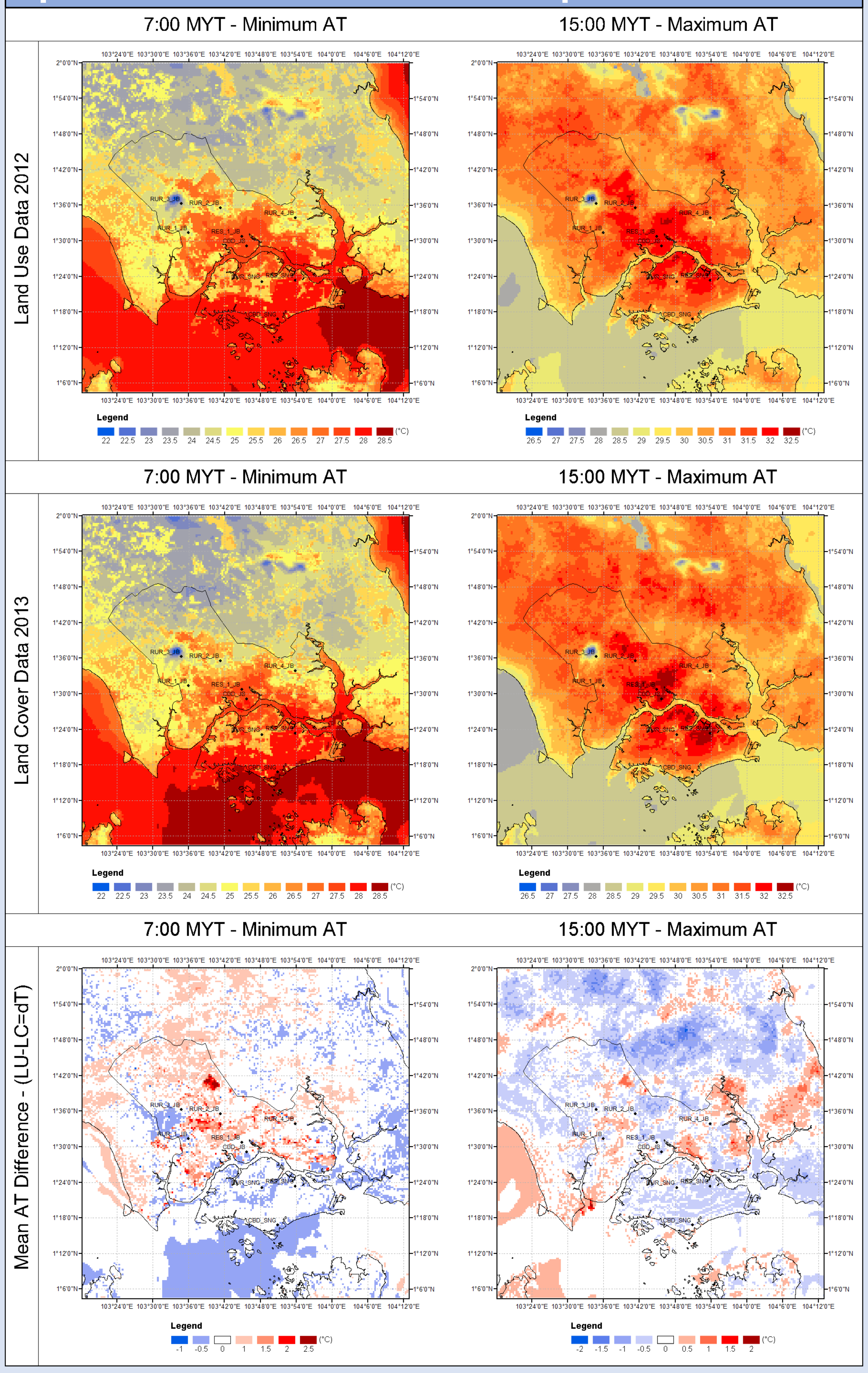
### Land Use Data

- Application of land use data results in an increase of urban and built-up areas of 31.44 %
- Small scale open spaces, construction sites, and small green areas are not sufficiently represented by land use data
- Land use data include future development which are not found on the ground
- Land use data can be obtained from respective urban planning authorities
- Land use data of two adjacent cities may differ in their creation date and thus reflect different stages of development

### Land Cover Data

- Produced using Landsat-8 images and supervised classification method (Maximum Likelihood Algorithm)
- Overall accuracy resulted in 83.33 % (for scene 1) and 87.40 % (for scene 2)
- Land cover data do not distinguish between natural forest and palm oil plantations
- High cloud contamination in the research area complicated creation of accurate land cover data
- Rapidly changing urban and rural landscape is well represented by produced land cover data

## Spatial Distribution of Air Temperature




## Comparison of Land Use and Land Cover Data

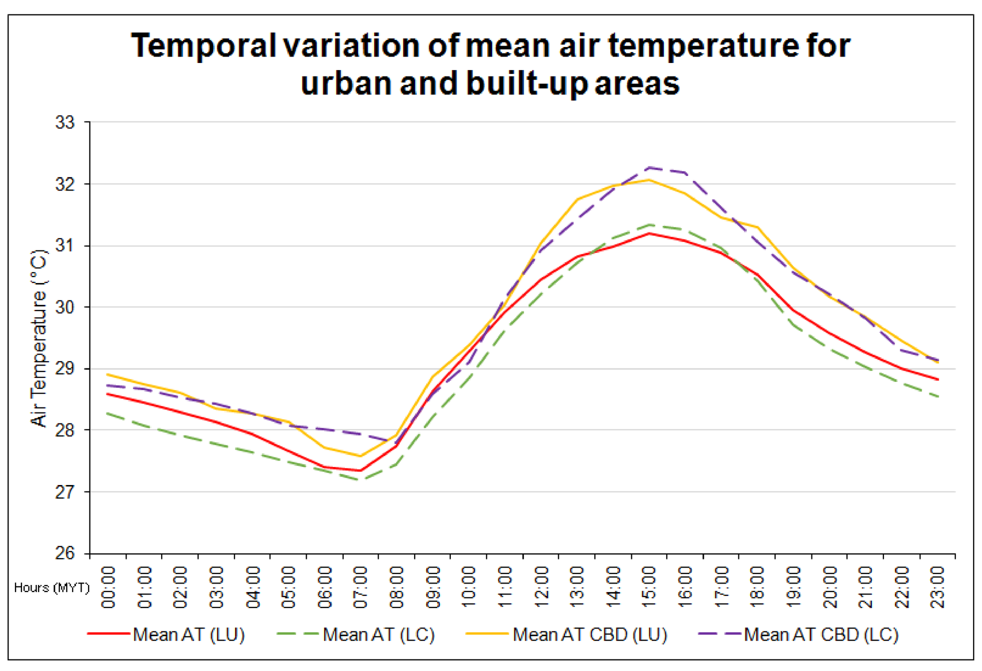



Figure 5: Temporal variation of mean air temperature

- Mean air temperature shows an increase in the case of land use data during night hours
- Between 15:00 MYT and 16:00 MYT, the air temperature reaches its equal values
- Application of land use and land cover data has only a minor impact on the simulation of air temperature in the CBD:

| | Land Use | Land Cover |
|---|---|---|
| Mean AT | 29.25 °C | 29.05 °C |
| Mean AT in CBD | 29.72 °C | 29.70 °C |

- Expansion of areas with higher urban AT in case of LU data due to increased urban and built-up area (31.44 %)
- Increase of AT mainly in suburban areas (0.5 to 1.5 °C)

## Conclusion

- LU data (in most cases) easily available from urban authorities
- For application in urban climate models an increase in AT should be considered while utilizing LU data
- In urban areas with high density, consideration of small scale green areas and open spaces may affect urban climate
- In case of Johor Bahru, LU data do not sufficiently represent small scale green areas and open spaces
- In particular in tropical regions, production of LC data may be associated with certain difficulties (dense and persistent cloud cover )
- LC data represent actual development on the ground more accurately