

# Spatiotemporal analysis of urban land changes in the major cities of Southeast Asia

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## Introduction

Urbanization can bring improvements to social welfare and economic development. However, it can also have serious impacts on the natural environment, both locally and globally (Grimm *et al.* 2008). Also, it is arguably the most drastic form of land transformation, which results in irreversible landscape changes (Estoque and Murayama 2014). In the context of landscape and urban studies, the analysis of the intensity and spatial pattern of urban land changes (ULCs) might be of help, as it can give some insights about the spatiotemporal pattern of future ULCs, including their potential environmental impact. The purpose of this study is to examine and compare the intensity and spatial pattern of ULCs in three major cities of Southeast Asia, namely Bangkok (Thailand), Jakarta (Indonesia) and Manila (Philippines), between the 1990s (1990-2000) and 2000s (2000-2010).

## Methodology

### Land-cover classification:

- Image data – Landsat imageries
- Time points – 1990, 2000 and 2010
- Approach – Random Forest image classification approach (Liaw 2002; R Core Team 2012).

### Land change intensity (LCI) analysis (interval):

– examines how the size and annual rate of change vary across time intervals (Aldwaik and Pontius 2012). In this study, it was done by:

- 1) calculating the annual change intensity (ACI) for each time interval (TI) (Eq. 1);
- 2) deriving the uniform intensity (UI) (Eq. 2);
- 3) determining the intensity category level (CL) value (Eq. 3);
- 4) applying the proposed LCI scale (Fig. 2).

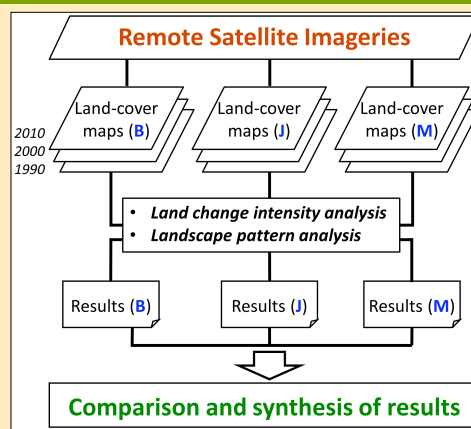


Fig. 1. Flowchart of the study. Note: B = Bangkok; J = Jakarta; M = Manila

$$TI - ACI = \frac{(LC/LA)}{TE} \times 100 \quad (\text{Eq. 1})$$

$$UI = \frac{[(LC_{t_1}) + (LC_{t_2})] LA}{(TE_{t_1} + TE_{t_2})} \times 100 \quad (\text{Eq. 2})$$

$$CL = \frac{(TI - ACI - UI)}{UI} \times 100 \quad (\text{Eq. 3})$$

**Key (others, refer to the text):**  
LC = land change  
From Non-built To Built  
LA = landscape area  
TE = time extent

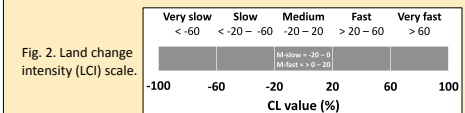


Fig. 2. Land change intensity (LCI) scale.

**Spatial pattern analysis:** The density of urban development along the gradient of the distance from the city center, and the patch cohesion index, which determines the level of physical connectedness of the corresponding patch type (e.g. built) (McGarigal *et al.* 2012), were determined.

## Results

### Intensity of urban land changes (temporal)

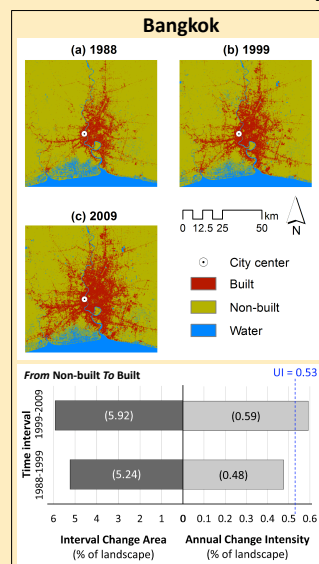


Fig. 3. CL values: 1988-1999 = -10.42 (medium slow); 1999-2009 = 11.46 (medium fast).

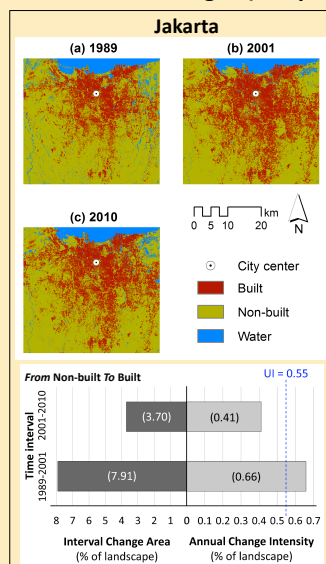


Fig. 4. CL values: 1989-2001 = 19.23 (medium fast); 2001-2010 = -25.64 (slow).

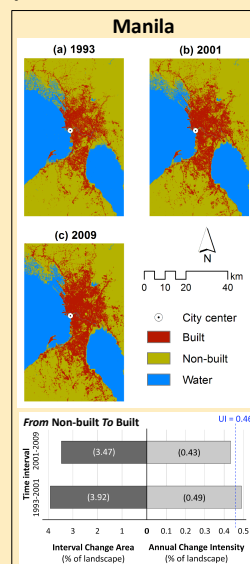


Fig. 5. CL values: 1993-2001 = 6.16 (medium fast); 2001-2009 = -6.16 (medium slow).

### Spatial pattern of urban land changes

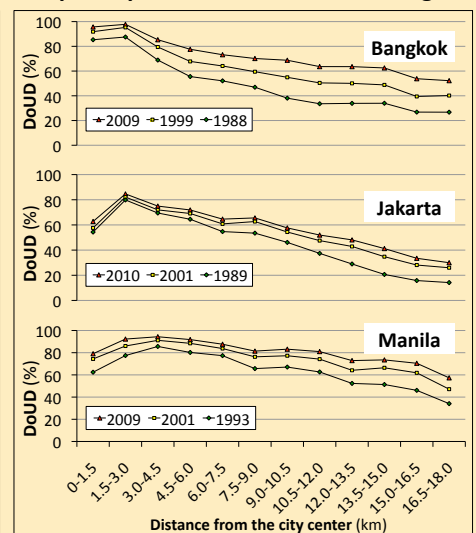


Fig. 6. Density of urban development (DoUD) along the gradient of the distance from the city center. Note: The area of the water class was not included in the calculation.

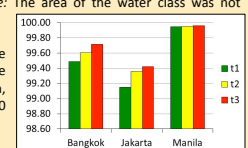


Fig. 7. Patch cohesion index of the built class. Note: Values that are close to zero indicate fragmentation, while values that are close to 100 indicate aggregation.

## Summary and Conclusion

- The ULCs (1990s-2000s) in the three cities were spatially and temporally non-stationary.
- The LCI analysis approach might help in the study of the drivers of ULCs. It can also be used as a diagnostic tool for evaluating land change projections.
- The three cities have been experiencing an infilling urban development pattern. Infilling pattern, if not monitored and controlled, can result to the loss of valuable urban green and open spaces.

## References

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