

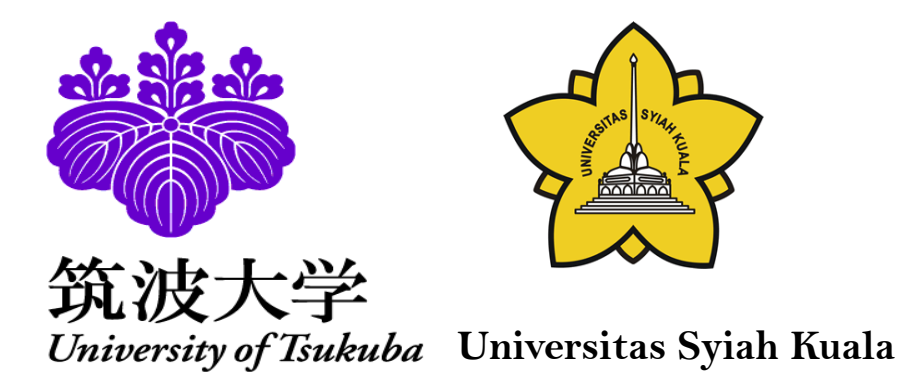


Land use changes in the urban growth process after the tsunami using RS and GIS: A case of Banda Aceh, INDONESIA

Ashfa Achmad^{1/2}

¹ Division of Spatial Information Science, Graduate School of Life and Environmental Sciences, University of Tsukuba, JAPAN

² Architecture Department, Engineering Faculty, Syiah Kuala University, Banda Aceh, INDONESIA



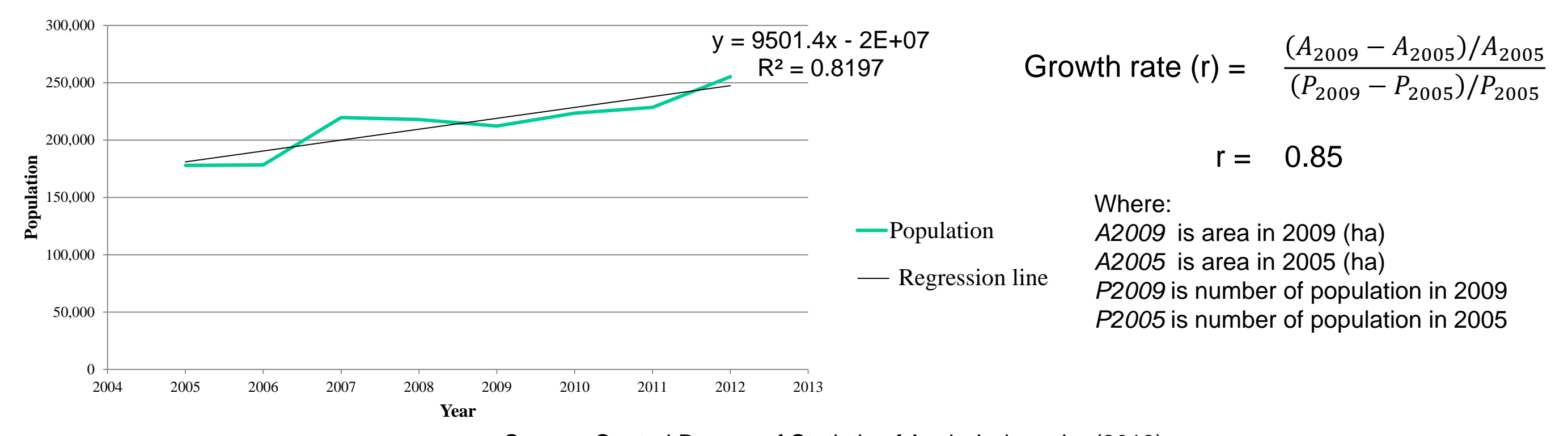
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Introduction

The main purpose of this study is to examine the land use changes in the post-tsunami urban growth process of Banda Aceh, Indonesia (Fig. 1).

Methods

- Land use changes were detected from a time series analysis of satellite images of 2005 and 2009.
- The characteristics of the land are divided into urban built-up area (BU), vegetation (VA), water body (WB), and wet land (WL).
- Supervised classification using maximum likelihood.
- Determining the training site, creating the signature file; and refining the classification.
- Accuracy assessment using 293 ground truth points.
- Markov Chain analysis for 2013 and 2019.



Source: Central Bureau of Statistic of Aceh, Indonesia, (2013)

Fig. 4. Population trend (2005-2009)

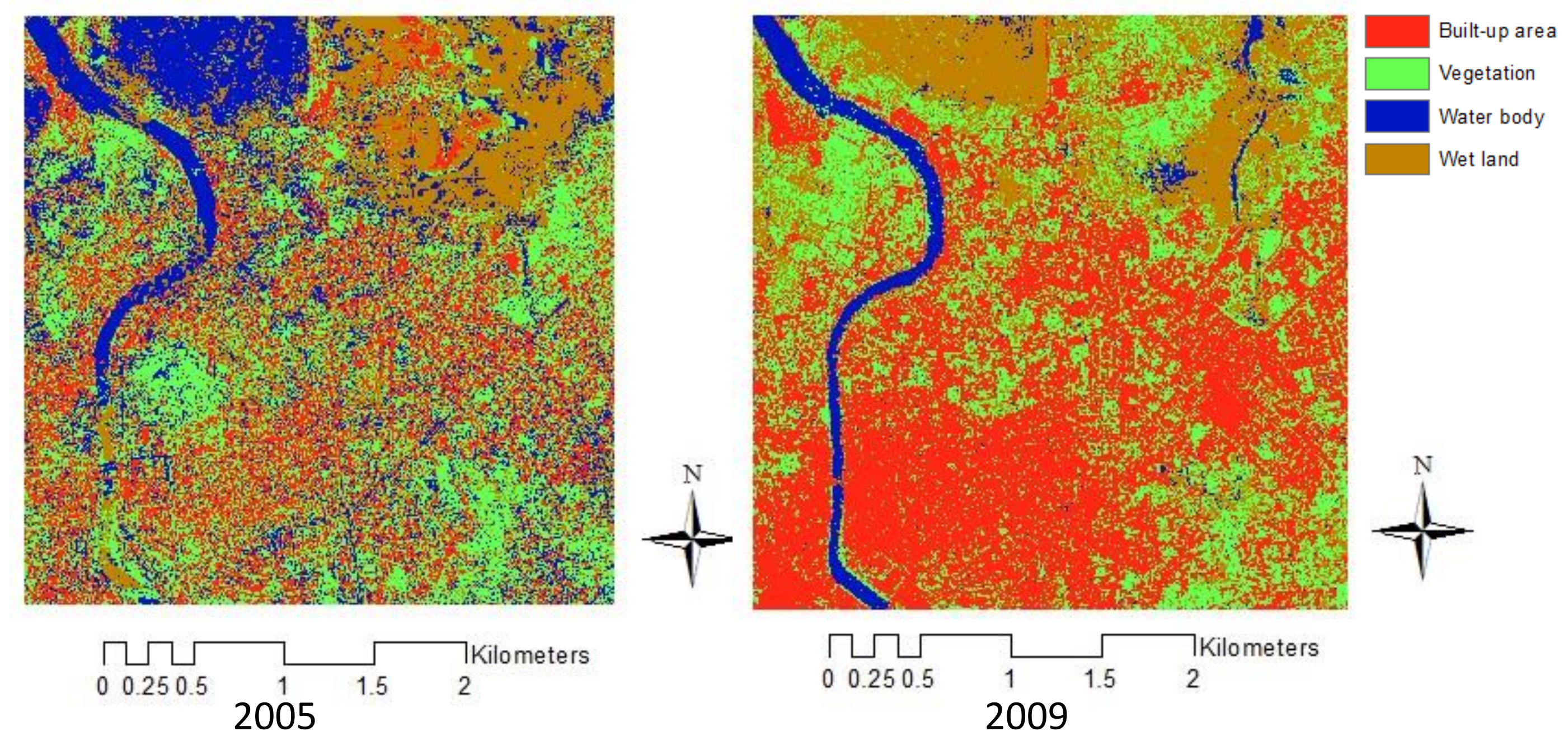


Fig. 5. Change in urban core (2005-2009)

Table 2. Markov Chain transition probabilities for 2013

| Given | Probability changing to | | | |
|-------|-------------------------|--------|--------|--------|
| | BA | VE | WB | WL |
| BA | 0.5244 | 0.3611 | 0.0298 | 0.0847 |
| VE | 0.4086 | 0.3186 | 0.0411 | 0.2317 |
| WB | 0.2175 | 0.2754 | 0.2847 | 0.2224 |
| WL | 0.2222 | 0.3772 | 0.1086 | 0.292 |

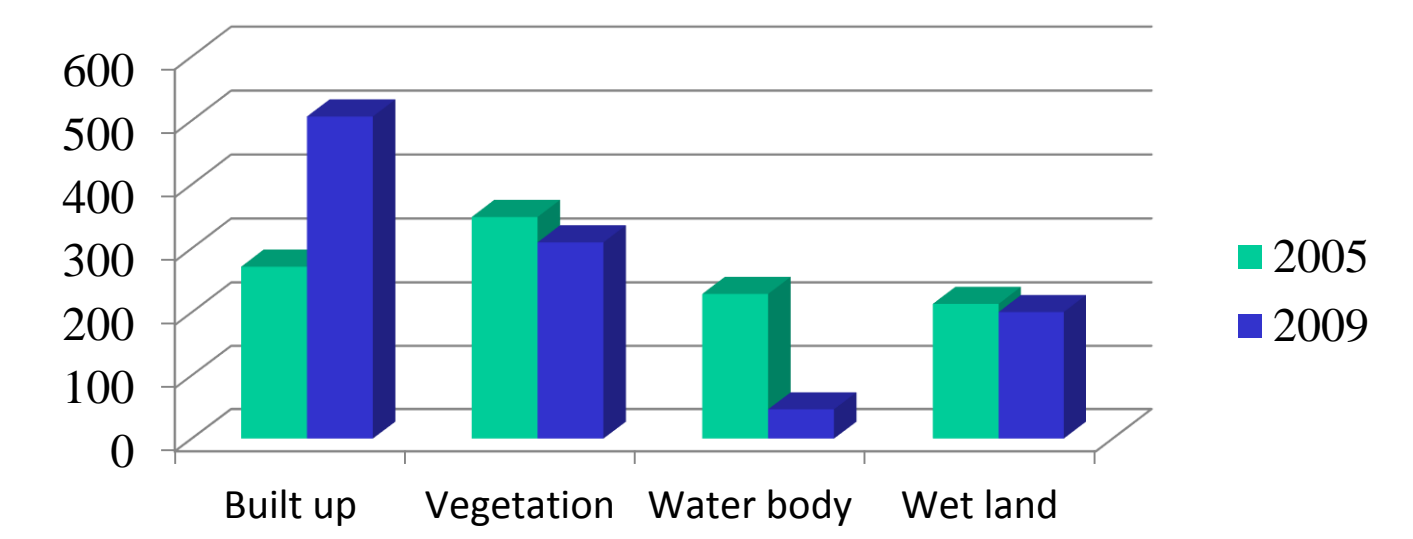


Fig. 6. Land use changes in urban core (ha)

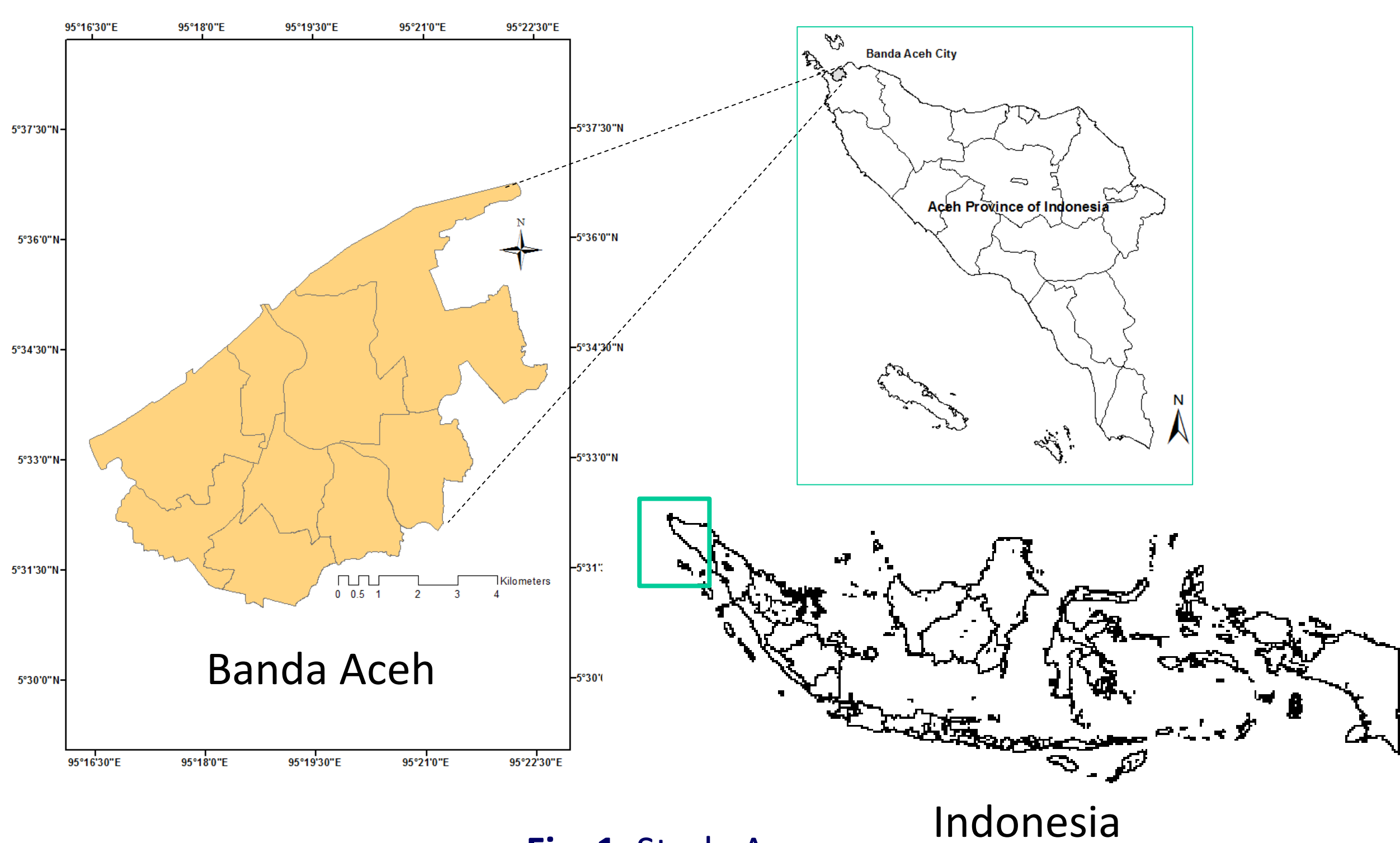


Fig. 1 Study Area

Results

Table 1. Accuracy assessment results

| Year | Overall Classification Accuracy (%) | Overall Kappa |
|------|-------------------------------------|---------------|
| 2005 | 77.82 | 0.679 |
| 2009 | 89.42 | 0.846 |

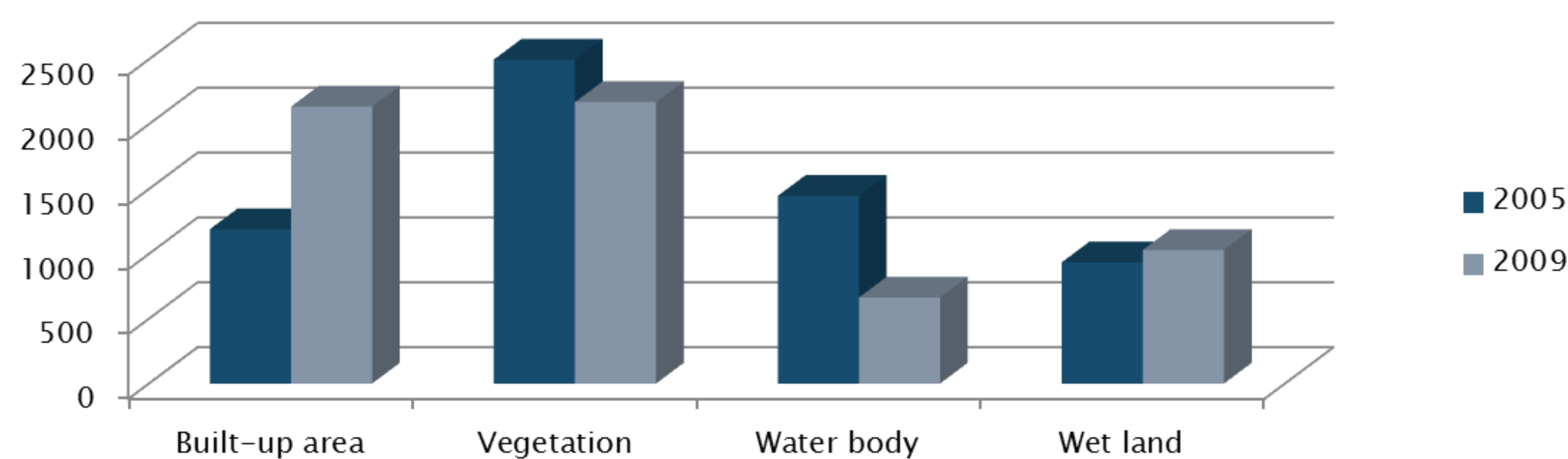


Fig. 2. Land use changes based on class category (ha)

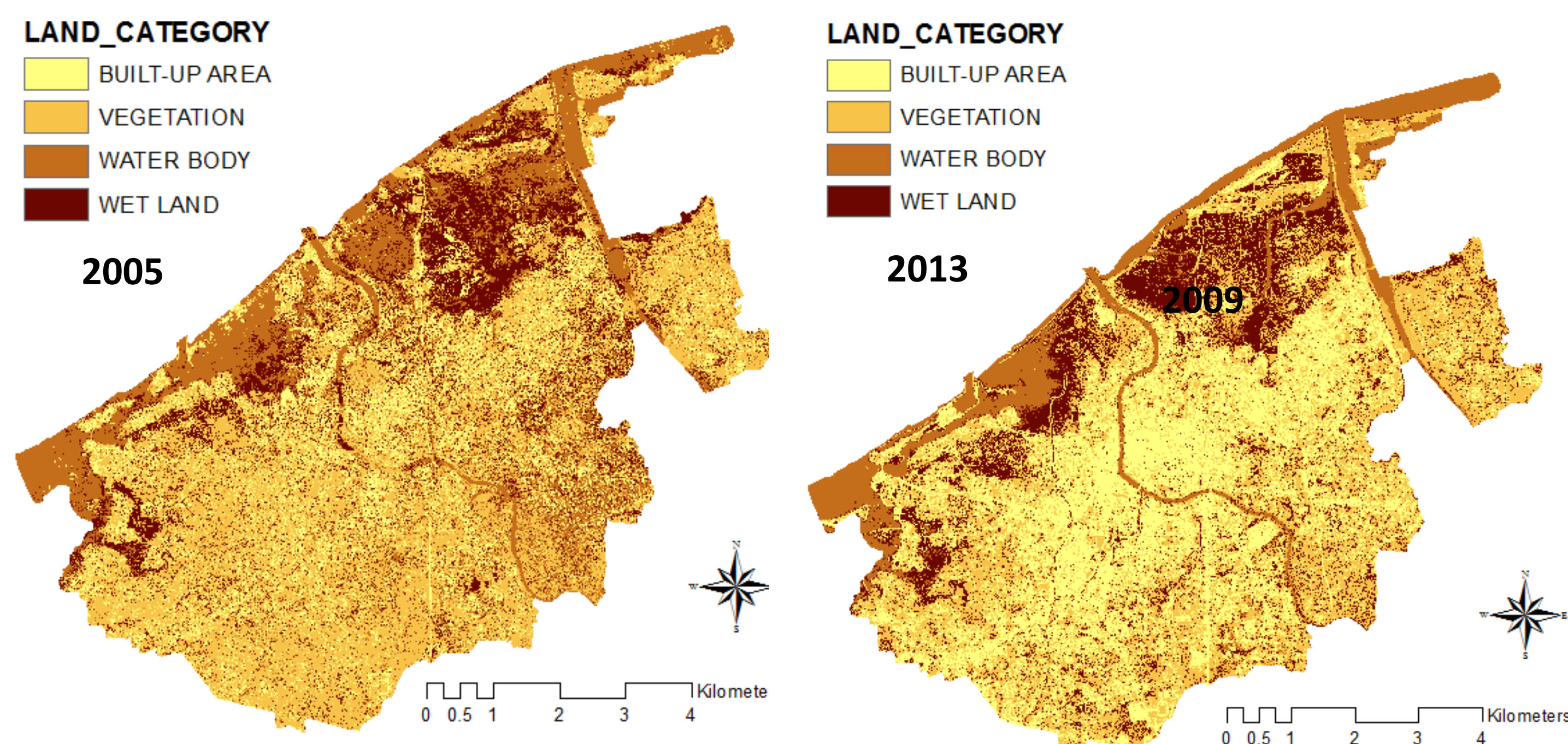


Fig. 3 Result of land classification maps of Banda Aceh, Indonesia for 2005 and 2009

Discussion

The growth of built-up area nearly doubled during the four years, especially for the provision of housing and urban infrastructure (Fig 2, Fig 3, Fig. 5, Fig 6, and Fig.7). The population growth was very fast. In 2005, the population of the city was 177,881, whereas in 2009 it increased to 212,241 (approximately 19% within 4 years) (Fig.4). Vegetation decreased about 15% and will continue to decline because of the rapid population growth. There is a need to balance the built-up area with the quality of environment, which plays an important role in a complex urban ecosystem, for aesthetic, recreational, and economic benefits. Future predicting of LUC is important for aiding planning and to achieve sustainable development.

Conclusion

- Urban growth (2005-2009) tend to stay away from coastal areas.
- Population growth (approximately 19% within 4 years) was more rapid than the growth of built-up area with a growth rate of 0.85.
- The projection of land use/cover changes of 2013 (Fig. 8) using Markov Chain (Table 2) shows a continuing trend of increase in built-up area.
- Next step is to predict the future land use/cover changes for 2029.

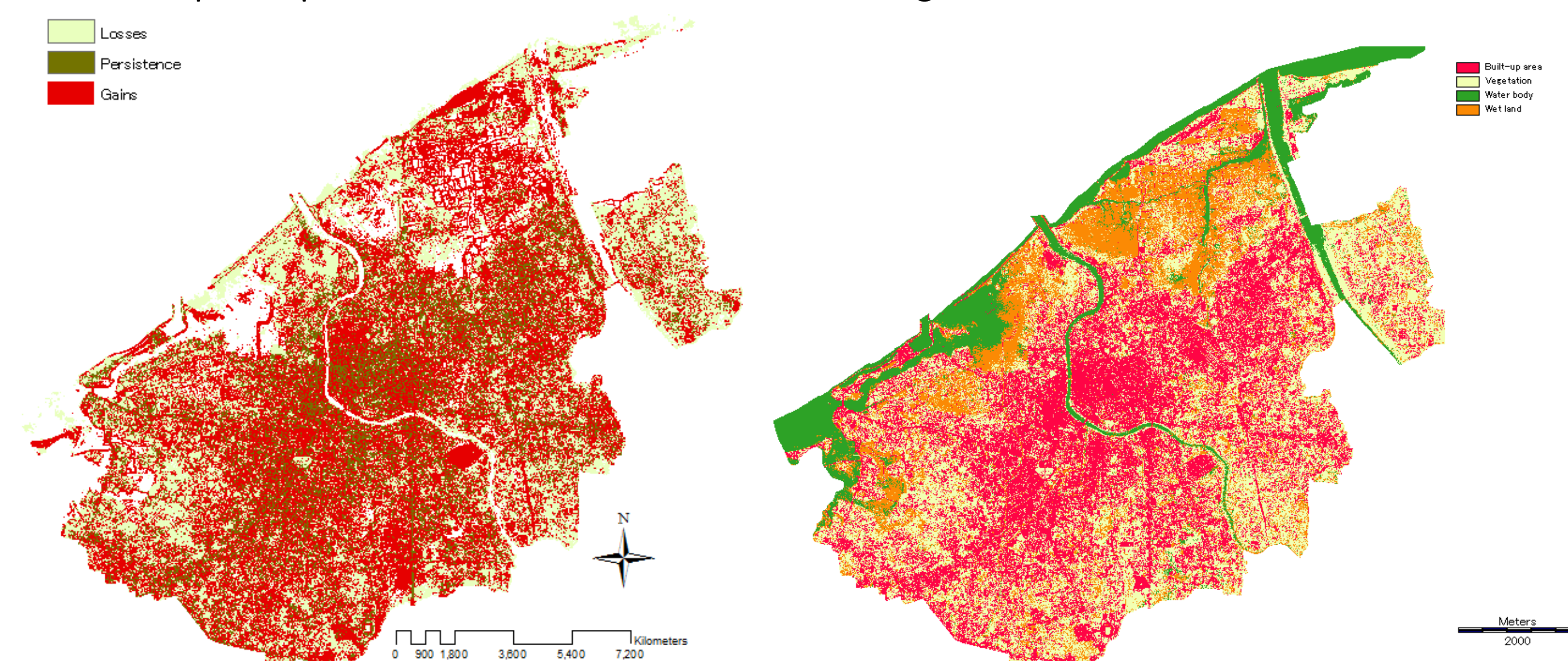


Fig. 7 Gains and losses in built-up area

Fig. 8 Projected land use maps of 2013 and 2009 through the CA-Markov