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Land use changes and residential area expansion in South Tangerang City, Indonesia

Rini Fitri, Reza Fauzi, Olivia Seanders and Dibyanti Danniswari
Department of Landscape Architecture, Universitas Trisakti, Jakarta, Indonesia

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Abstract

Purpose – The purpose of the study is to analyze changes in land use, specifically residential area expansion, in South Tangerang City and identify the factors that influence land use change.

Design/methodology/approach – The study used remote sensing methods in ArcGIS 10.8 for data analysis and processing, including spatial analysis and identification of land use changes. The study analyzed satellite images from 2010 and 2020 to identify changes in land use in South Tangerang City over the ten-year period.

Findings – The study found that the most significant land use changes in South Tangerang City between 2010 and 2020 were the reduction of mixed plantation area and the expansion of residential areas. The study identified the development of small townships by private developers as the main factor that influenced land use change in South Tangerang City.

Research limitations/implications – The study has several limitations, including a focus on only one aspect of land use change (i.e. residential area expansion), limited scope of the study area (South Tangerang City) and a reliance on remote sensing methods for data analysis.

Practical implications – The findings of the study can be used by policymakers and city planners to develop sustainable land use planning strategies that balance the need for urban development with environmental and social concerns. By understanding the factors that drive land use changes in South Tangerang City, policymakers can develop policies that encourage sustainable urban growth and development while preserving natural resources and protecting the environment.

Social implications – The study has social implications as the expansion of residential areas in South Tangerang City indicates a growing demand for housing in the area. The study highlights the importance of developing affordable and sustainable housing solutions to meet the needs of the growing population in South Tangerang City. Additionally, the study emphasizes the importance of understanding the social and economic factors that drive land use change and their implications for the well-being of local communities.

Originality/value – The residential area development in South Tangerang City is driven by private developers who make small independent cities that have all facilities in one area. These small cities attract people to reside and also drive high population growth in South Tangerang City, considering it is a buffer city of Jakarta that has good infrastructure development.

Keywords Land change, Regional development, South Tangerang

Paper type Research paper

Introduction

Changes in land use in Indonesia are increasing along with population growth and the increasing need for land for development, both for urban areas, settlements, and industrial and business development. The growth of industry and population, good urban social services also greatly determine the increase in the growth of spatial patterns in urban areas (Wang, Li, Long, Qiao, & Li, 2011; Poghosyan, 2018; Mahiny & Clarke, 2012; Han & Jia, 2017; Al-shalabi, Billa, Pradhan, Mansor, & Al-Sharif, 2013; Davis & Palumbo, 2008). The land

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change system in urban areas is the most dynamic globally. This change is driven by demand, mainly due to population growth, which has caused urban land to continue developing gradually.

If this changing trend continues, land conversion to urban areas is expected to nearly triple in the next 20 years (Dadashpoor, Azizi, & Moghadasi, 2019; Hersperger *et al.*, 2018; Verburg & Overmars, 2009; Asgarian, Soffinian, Pourmanafi, & Bagheri, 2018). The increase in the area of built-up land in urban areas occurs due to the construction of urban infrastructure and the construction of residential settlements due to the continued increase in the population of the city (Lamidi *et al.*, 2018). The World Bank even estimates that by 2025, the total urban population in Indonesia will reach 68% (Samad *et al.*, 2016). Economic development, population growth, and improvement in traffic infrastructure are the main factors driving land-use change and land cover change (Ninh & Waisurasingha, 2018). The land is a physical environment that includes soil, climate, relief, hydrology, and vegetation, affecting the potential use. It includes the consequences of human activities, both past, and present, such as reclamation of coastal areas, deforestation, and adverse effects such as erosion and salt accumulation (Hardjowigeno, 1993). Changes in land use cannot be denied due to growth and development in an area (Rustiadi, Saefulhakim, & Panuju, 2011; Harahap, 2013).

Land-use change has a more complex meaning because it also involves a natural (natural) and socio-economic perspective on changes in land use due to human activities that impact processes that occur on the earth's surface, including biogeochemistry, hydrology, and biodiversity. Land used for conversion from agricultural land to other activities such as settlements, industrial users, and infrastructure development is expected in urban-rural relationships (Prayitno *et al.*, 2019). Changes in land use tend to lead to the conversion of agricultural land to non-agricultural land or from non-built land to built-up land (Wahyudi & Munibah, n.d).

According to Wu (2008), there are economic, social, and environmental impacts on changes in agricultural land use. Among the significant socio-economic impacts is the reduced availability of land for food production and the reduction of open land with all the environmental benefits for residents. The dynamics of land-use changes often lead to changes in land quality, including a mismatch between land capability and use. The capital city of Indonesia, Jakarta, and its surrounding satellite cities, undergo rapid land use conversion from vegetated to built-up area in the past decades (Arifin, Mukhoriyah, & Yudhatama, 2018; Dewi *et al.*, 2020). South Tangerang City is one of Jakarta's buffer cities that is located at the west of Jakarta. Previously, it was a part of a larger municipality area, Tangerang Regency, until it became its own city in 2008. As the land price in Jakarta keeps increasing, many people who work in Jakarta reside in South Tangerang City. South Tangerang City has the highest population growth rate compared to other neighboring cities of Jakarta (Saifullah, Barus, & Rustiadi, 2017). As a result, the residential housing development in South Tangerang City becomes massive. Uncontrolled housing development eventually leads to reduction of its residents' quality of life. Existing research has analyzed land use changes in South Tangerang City (Danniswari, Honjo, & Furuya, 2020; Saifullah *et al.*, 2017).

However, existing studies classified the built-up area as a single category. Considering the significant issue of South Tangerang City is the rapid housing development, this study separates the built-up area into two categories: residential and other built-up area. The objective of this research is to analyze the land use change of South Tangerang City, Indonesia, from 2010 to 2020, while focusing on the expansion of residential area. By extracting the residential area from the built-up category, this study offers a distinctive insight compared to existing studies.

Methodology

Study area

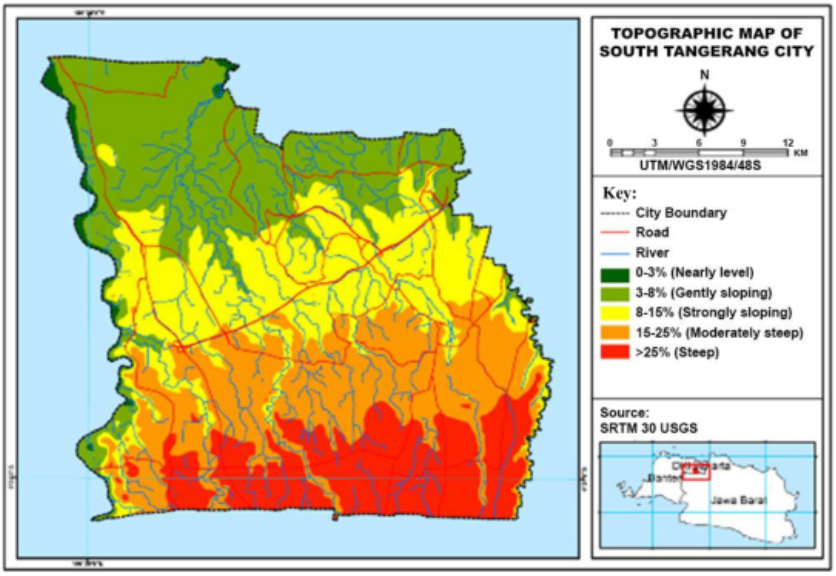
The study area is South Tangerang City, geographically located at coordinates: 6°39'00"–6°47'00" South Latitude and 106°14'00"–106°22'00" East Longitude. The South Tangerang City is located in Banten Province and one of 8 (eight) regencies/cities in Banten province. South Tangerang City has an area between 0-25 m above sea level and is located in the eastern part of Banten Province. South Tangerang City is located 30 kilometers west of Jakarta and 90 kilometers southeast of Serang or the capital city of Banten Province. Topographically, most of South Tangerang City is a low-lying area with a relatively flat topography with a slope of 0 –25%. It can be seen from Figure 1 shows the topographic map of the study area.

Data

The data used for analyzing the land use changes are Landsat 7 and Landsat 8 imageries in 2010 and 2020, respectively. The images have a spatial resolution of 30 m and were obtained from the United States Geological Survey (USGS) website. We also use a map of South Tangerang City obtained from the Indonesia Geospatial Information Agency. This map is used to set the boundary of the study area.

Data analysis

Data analysis and processing are carried out using ArcGIS 10.8 program to input, store, recall, process, analyze and produce output and display the data geospatially. First, the Landsat images were interpreted and classified following the supervised classification method (maximum likelihood algorithm). When interpreting the image, we use a combination of Band 5-4-3 in Landsat 7 and Band 6-5-4 in Landsat 8. After that, the classification results' accuracy is assessed by comparing it to the ground truth data. If the overall accuracy ≥80% and the Kappa coefficient ≥0.8, the result is considered reliable and used for further analysis. If the accuracy is



Source(s): SRTM 30 USGS with authors' modification (2022)

Figure 1.
Topographic map of South Tangerang City

less than the desired values, the image interpretation and classification processes are repeated. The results of land use map of year 2010 and 2020 are then compared to produce the land use change map. The data analysis process is shown in a flow chart (Figure 2).

The land use of the study area is classified into nine classes, which are (1) road: road networks and associated land, (2) paddy field: land for paddy plantation, (3) field cropland: land for growing crops such as corn, sorghum, etc., (4) shrubs: land dominated by small woody plants (<3m), (5) mixed plantation: land that consists of two or more species of plants including trees, (6) residential area: land for housing, (7) built-up: land for built-up areas other than residential area, including commercial and industrial land, (8) bare land: open soil and unplanted farmland, and (9) water body: areas covered by water, including lake, pond, etc.

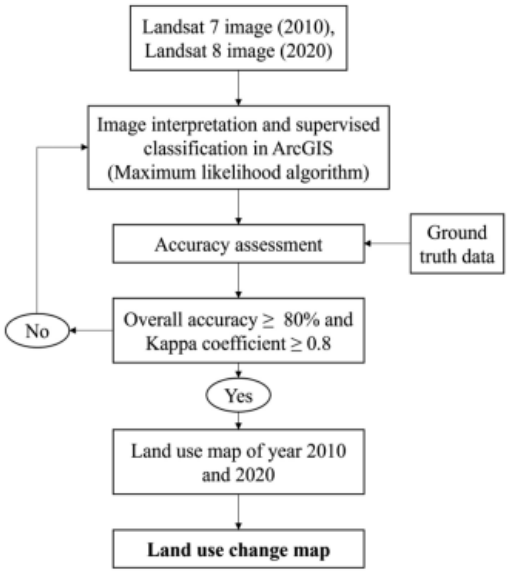
Results and discussion

Land use change in 2010-2020

The results of land use classification are presented in Table 1. In 2010, the use of land in South Tangerang City is dominated by the land use for residential area with an area of 7,754 hectares (47.03%). It is followed by the use of land for mixed plantations, bare land, field cropland, paddy field, built-up, water body, road, and shrubs. In 2020, the use of land in South Tangerang City is still dominated by the land use for residential area with 10,021 hectares (60.78%). Then, it is followed by the use of land for mixed plantations, field cropland, built-up, bare land, paddy field, water body, shrubs, and road.

The land use in 2010 and 2020 are presented in a graph form to see the difference more clearly (Figure 3). Land use classes that increase in 2020 are paddy field, field cropland, shrubs, residential area, and built-up. meanwhile, land use classes that decrease in 2020 are bare land and mixed plantation. Road and water body coverage are still the same in these two periods.

The results of land use classification map in 2010 and 2020 are presented in Figure 4. From a visual observation, it is obvious that in 2010, the coverage of mixed plantation is larger than in 2020. In 2020, a quite large coverage of the mixed plantation has become residential area.



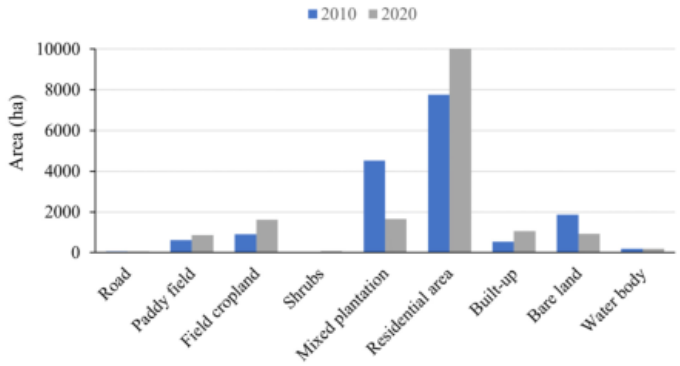
Source(s): Prepared by authors (2022)

Figure 2.
Methodological flow chart of the study

Class	Area (ha) 2010	Area (ha) 2020	Area (%) 2010	Area (%) 2020
Road	60	60	0.36	0.36
Paddy field	617	870	3.74	5.28
Field cropland	899	1623	5.43	9.84
Shrubs	26	72	0.16	0.44
Mixed plantation	4,529	1,659	27.47	10.06
Residential area	7,754	10,021	47.03	60.78
Built-up	535	1056	3.25	6.4
Bare land	1,874	930	11.37	5.64
Water body	196	196	1.19	1.2
Total	16,486	16,486	100	100

Source(s): Table by authors 2022

Table 1.
The land use in South Tangerang City from 2010 to 2020



Source(s): Figure by authors (2022)

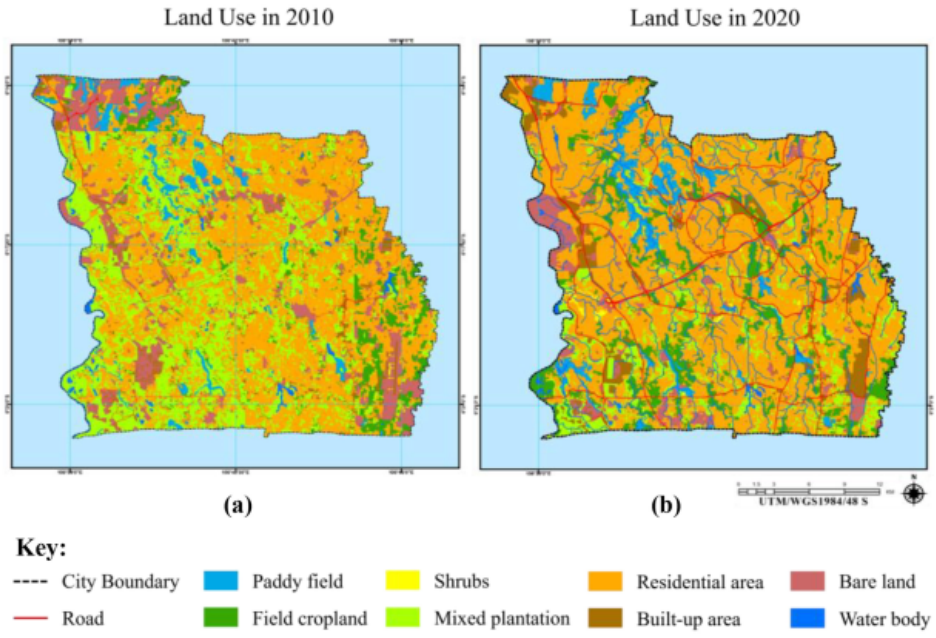
Figure 3.
Comparison of land use in 2010 and 2020

After classifying the Landsat images of 2010 and 2020, we can see that there are changes in the land use coverage area. By subtracting the land use coverage of 2010 from the coverage of 2020, we get the area differences (Figure 5). A green bar indicates an increase in the area of the land use class, while a red bar indicates a decrease. Land use classes that experienced an increase include built-up, residential area, shrubs, field cropland, and paddy field. Meanwhile, land use classes that experienced a decrease include bare land and mixed plantation. The land use area of water body and road remain the same in 2020.

From the presented results, we can see the largest land use change is the reduction of mixed plantation and the expansion of residential areas. It suggests that the reduction of mixed plantation areas is due to the expansion of residential areas and other built-up area. Residential housing development is usually accompanied with the development of shopping malls, hospitals, and other commercial buildings, hence the increasing other built-up area.

Increasing areas of field cropland and paddy field, and decreasing areas of bare land could be related to the time when the satellite image is taken. Since field cropland and paddy field are areas that are covered by plants temporarily, they could be bare when the satellite image was taken in 2010 and covered with plants in 2020. Although, there is also a possibility that the land use actually increased.

Figure 6 shows areas that are changed (red) and not changed (green). If we observe closer, the subdistricts at the west side of South Tangerang City underwent bigger changes than



Source(s): Figure by authors (2022)

Figure 4.
Land use map in (a) 2010 and (b) 2020

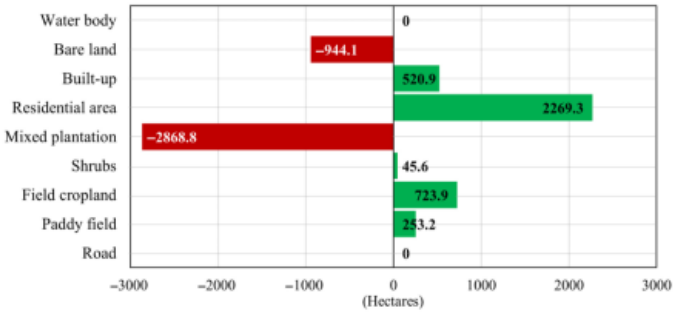


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Figure 5.
Land use change in 2010 and 2020 in South Tangerang City

subdistricts at the east side. The east side of Tangerang City is Jakarta Capital City that is already dominated by built-up coverages before 2010. It implies that the west side underwent many developments between 2010-2020. Subdistricts that underwent bigger changes are Serpong Utara, Pagedangan, Serpong, and Setu Subdistricts. There are many residential housing developments in these areas.

The factors of land use change

According to the results, the most significant change is the reduction of mixed plantation area, followed by the expansion of residential area. The residential area has been occupying the largest proportion of land use in South Tangerang City. The residential housing development keeps increasing as the population keeps growing due to people migration and

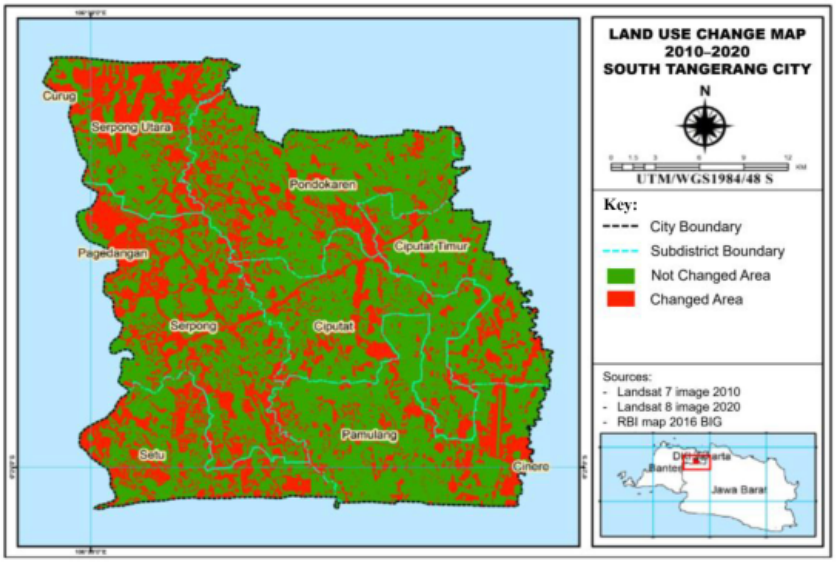

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Figure 6.
Change land use in 2010-2020 South Tangerang City

birth. South Tangerang City is considered as a good place option for people who wants to buy a house because it is a buffer city for Jakarta and the infrastructure development is more advanced compared to other Jakarta's buffer cities, such as Bekasi and Depok.

South Tangerang City has several townships or "small cities" that are planned by private developers with the intention to be an independent "city" where all facilities, from housing to industries, are provided in that area. Famous townships in South Tangerang City are BSD City and Alam Sutera. BSD City is a township that occupied about 6,000 hectares. It was first developed in 1989 and is still developing. The development becomes more rapid after the establishment of tollways that connects South Tangerang City and South Jakarta in 1999-2005 (Adhi, 2010). Alam Sutera occupied about 800 hectares of South Tangerang City. It was first developed in 1994 and is still developing. These townships offer a one stop living concept where the residents can meet all their basic needs, including the need for housing, education, employment, health, etc., in one place. BSD City is located at Serpong Subdistrict, while Alam Sutera is located at Serpong Utara Subdistrict. Both subdistricts are found to undergo bigger land use change compared to other subdistricts according to the results. The existence of these township attracting people to live in South Tangerang City because the housing area is well-planned, the accessibility is good, and the house price, including the living cost, is relatively cheaper compared to the similar housing environment in Jakarta.

The housing development, accompanied by other commercial buildings development in South Tangerang City, resulted in the conversion of vegetated areas into built-up areas. The increasing need for space with limited land availability results in changes in land use (Nuraeni, Sitorus, & Panuju, 2017; Ruswandi, Rustiadi, & Mudikjo, 2007). The development in South Tangerang City will undoubtedly affect the coverage proportion of vegetated area in the future. Even more vegetated areas will likely be converted once there is an urban expansion.

Conclusion

We classified the land use in South Tangerang City in the year 2010 and 2020 into nine land use classes, which are roads, paddy field, field cropland, shrubs, mixed plantation, residential

area, built-up, bare land and water body. By separating the residential area and other built-up classes, we manage to see which type of buildings that dominated South Tangerang City. In the span of ten years, mixed plantation and bare land areas are decreasing, while residential area, built-up area, paddy fields, field croplands and shrubs are increasing. The most significant land use changes are the reduction of mixed plantation area and the expansion of residential area. The expansion of residential area has most likely happened at the expense of mixed plantation area. The residential area development in South Tangerang City is driven by private developers who make small independent cities that have all facilities in one area. These small cities attract people to reside and also drive high population growth in South Tangerang City, considering it is a buffer city of Jakarta that has good infrastructure development.

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Corresponding author
Rini Fitri can be contacted at: rini.fitri@trisakti.ac.id

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