Spatial Analisis Using Multitemporal Remote Sensing to LULC Identify, Case Study in Semarang City 1992 - 2019

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Abstract: Land use/land cover is one of the dynamic surface parameters that will changes. Semarang is the capital city of Central Java Province which experienced a fairly high land cover change. This study has aim to analyzing land use land cover change in Semarang City using multitemporal satellite imagery. So that the knowledge of the direction of change can be used for recommendations for regional development planning. The impact of regional development is the land cover changes, that is occur from agricultural land into built land. Analysis with remote sensing data is a cheap and accurate method to identifying of the land cover changes. Landsat imagery is data that has a long data record series. So that the data can be used to surface monitoring. Landsat image data has a multispectral band that can be used for digital analysis. Maximum likelihood Classification is a digital classification that gives quite accurate results. The results obtained in this study is map comparison of the land use type in Semarang City between 1992 and 2019. Changes occur on agricultural lands and bare land into settlement, so that the right targets in development need to be. So that the results can be used as recommendations for the Central Java Provincial Government for the direction of the sustainable development sector.

Keywords: land cover; land use; sustainable development

1 Introduction

Semarang, had central areas modeled after ideal Dutch port cities together with church, canals, and townhouses. The Dutch imposed the colonial cities' landscapes with alien cultural and physical environments (Lukito & Pratama, 2018). Migration to cities will continue because of economic, political and social factors, Semarang has several planning systems relating to various sectors for development and spatial planning (Friend et al., 2014). Although the political and socioeconomic transition is generally recognized as an important driver of land use change (Václavik & Rogan, 2009).

Semarang is the capital city of Central Java that has a population about 1.3 million people, the position of Semarang is very strategic as a regional transport (Pratikso, Mudiyono, & Adhi, 2017). It is the only city in the province of Central Java that can be categorized as a metropolitan center. The city is an international seaport and serves as a transit node between the two main growth poles of Indonesia, Jakarta and Surabaya (Hadi et al., 2016).

Along the development and construction of Semarang, it has caused a change in the physical condition of the city, i.e. land use change. It surely incur its own problems in the city (Pratikso et al., 2017). Semarang, that development is included in the category fairly fast, particularly after the opening of toll road Semarang-Bawen (Pangi, Ramadhan, Astuti, Harjanti, & Yesiana, 2017). Although Ratnasari (Ratnasari, 2016) stated that Changes in land use that connect between regions and urban centers develop into commercial areas characterized by changes in land use in trade and services and industrial activities. This is also seen in changes in land prices with an annual average along the corridor above 20%.

The growing population and increasing socio-economic necessities create a pressure on land cover, this pressure results in unplanned and uncontrolled changes in Land use landcover (Ntuk et al., 2018). Land use landcover change (LULCC) is urbanization induced, rapid pace of urbanization has been shown to be a global problem present in most of the developing countries (Balogun, Adeyewa, Balogun, & Morakinyo, 2011). Land use/land cover (LULC) changes play a major role in the study of global change. Land use/land cover and human/natural modifications have largely resulted in deforestation, biodiversity loss, global warming and increase of natural disaster-flooding (Reis, 2008).

Geographical Information Systems (GIS) and remote sensing are powerful tools to derive accurate and timely information on the spatial distribution of land use/land cover changes over large areas (Al Mashagbah, Al-

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Adamat, & Al-Amoush, 2012). Remote sensing data and GIS techniques provide efficient methods for analysis of land use issues and tools for land use planning and modeling (Shravya & Sridhar, 2017). Remote sensing makes possible the availability of aerial photographs and satellite imageries, which information on land cover could be easily extracted (Ntuk et al., 2018). Change detection is the process of identifying differences object at different times, the ability analysis by using multitemporal data sets (Suzanchi, Sahoo, Kalra, & Pandey, 2006). This study has aim to analyzing land use land cover change in Semarang City using multitemporal satellite imagery. So that the knowledge of the direction of change can be used for recommendations for regional development planning.

2 Methods

2.1 Description of the study area

Semarang City is the mother of the Central Java province, the city is located about 485 km east of Jakarta, or 308 km west of Surabaya. Semarang borders the Java Sea on north, Demak Regency in the east, Semarang Regency in the south, and Kendal Regency in west. The area of this study is around 1.14% of the area of Central Java Province. The city of Semarang has a unique topography in the form of a narrow lowland area and a hilly area that extends from the west side to the east side of the city of Semarang.

2.2 Data

This study is based primarily on interpretation satellite imagery using digital spectral. Landsat is satellite imagery has data record series, so that can be using monitoring landuse land cover. The data used in this study are Landsat TM (1992) images and Landsat OLI images (2019). Both of these image sensors have the same spatial resolution, but for Landsat TM has 8 bit data sets while Landsat OLI has 16 data sets. Landsat satellite imagery provide multispectral data from, given that the purpose of this paper was to provide a general land use/land cover change analysis, the spatial resolution of Landsat data was appropriate.

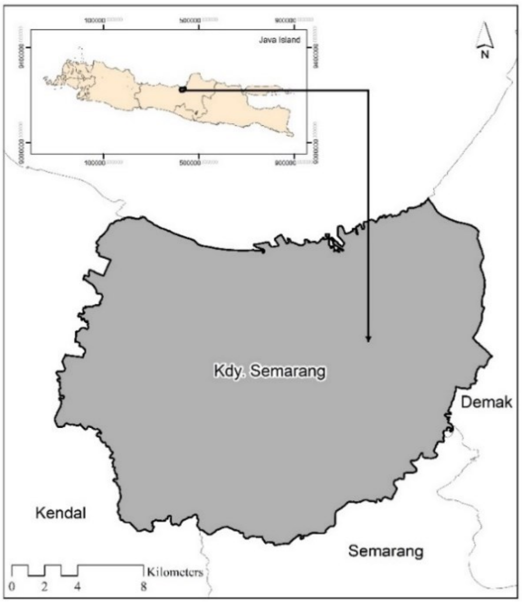

Figure. 1. Location of The Study Area

2.3 Analysis

In this study, we present an approach for identifying major LULCC in Semarang City, by applying remote sensing techniques to compare two sets of multispectral satellite imagery, Landsat TM (1992) and Landsat OLI (2019), 27 years duration data. Data continuity requires consistency in the interpretation of image data acquired by different sensors. Calculation of radiance is the fundamental step in putting data from multiple sensors and platforms onto a common radiometric scale (Chander, Huang, Yang, Homer, & Larson, 2009). The calibration is given by the following expression for at satellite spectral radiance,

$L\lambda$:

$$L\lambda=((Lmax\lambda- Lmin\lambda))/((Qcalmax-Qcalmin))\ (Qcal-Qcalmin) + Lmin\lambda \quad (1)$$

Conversion of spectral radiance to reflectance, the apparent reflectance, which for satellite images is termed reflectance, ρ, relates the measured radiance, L (which is what the formulae above will output), to the solar irradiance incident at the top of the atmosphere and is expressed as a decimal fraction between 0 and 1:

$$\rho\lambda = (\pi . L\lambda . d2)/(ESUN\lambda . COS\ \theta) \quad (2)$$

Classification technologies on quantities of remotely sensed imagery, extracting interesting patterns and rules from data sets composed of images and associated ground data is very important for resource discovery (Perumal & Bhaskaran, 2010). The quality of a supervised classification depends on the quality of the training sites. The statistical method employed for the earlier studies of land-cover classification is the maximum likelihood classifier (Perumal & Bhaskaran, 2010). Maximum Likelihood is a supervised classification method derived from the Bayes theorem, which states that the a posteriori distribution P(i|ω), i.e., the probability that a pixel with feature vector ω belongs to class i . The remote sensing data have been used in various fields of application, land use/land cover generated from remote sensing image interpretation are the surface database (Raharjo, Gunawan, & Hadi, 2016). Land use/land cover classes using versatile land use classification scheme for local physical planning (Danoedoro, 2009).

3 Result and Discussion

Although NASA stated that Calibration data, In remote sensing, measurements pertaining to the spectral or geometric characteristics of a sensor or radiation source. Actual processing algorithm applies the relative gains and biases calculated by the histogram analysis performed on every image just prior to radiometric correction. A critical step in such a process is sensor radiometric calibration to an absolute scale, yielding image data at the top of the atmosphere in physical units.

Digital classification is based on pixel values which are spectral information from objects on the surface. As a result of the complexity of atmospheric particles, the different dimensions of illumination and shadow about objects on different surfaces have different reflections. The results obtained from radiometric correction show pixels in the values 0-255.

The 1992 Landsat sun elevation angle is 43°, the minimum spectral radiance value (Lminλ) and the maximum spectral radiance value (Lmaxλ) on the corresponding gain sensor and the offset used in 1992 Landsat calibration. Radiometric calibration in 2019 Landsat imagery, object reflection value (reflectance), pixel values (DN) can be directly converted by looking at MTL data (file metadata). This image has a sun elevation angle of 56° with Multi Band Reflectance (Mρ) of 0.00002 and Reflectance Add Band (Aρ) of -0.100000.

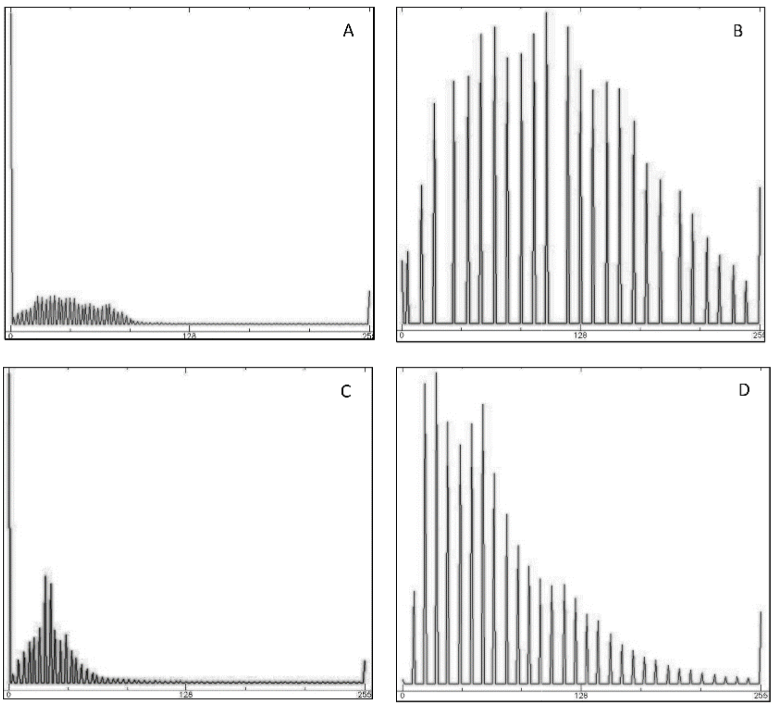

Figure. 2. Output histogram, A. Landsat 1992 before radiometric correction; B. Landsat 1992 after radiometric correction; C. Landsat 2019 before radiometric correction; D. Landsat 2019 after radiometric correction.

Image calibration carried out in this study in addition to radiometric calibration to obtain reflectance values of objects on the image sensor, spectral objects that are compared are the same object and do not change. The type of land cover uses the Danoedoro classification (Danoedoro, 2009), the land cover used in this study is an object that can be interpreted from Landsat image data (medium resolution). These types of land cover include water bodies, coastal pond, field pattern, mosaic of mixed vegetation, mosaic of trees and herbaceous vegetation, other barren land with specific shapes, non-isolated built up area, and sedimentation.

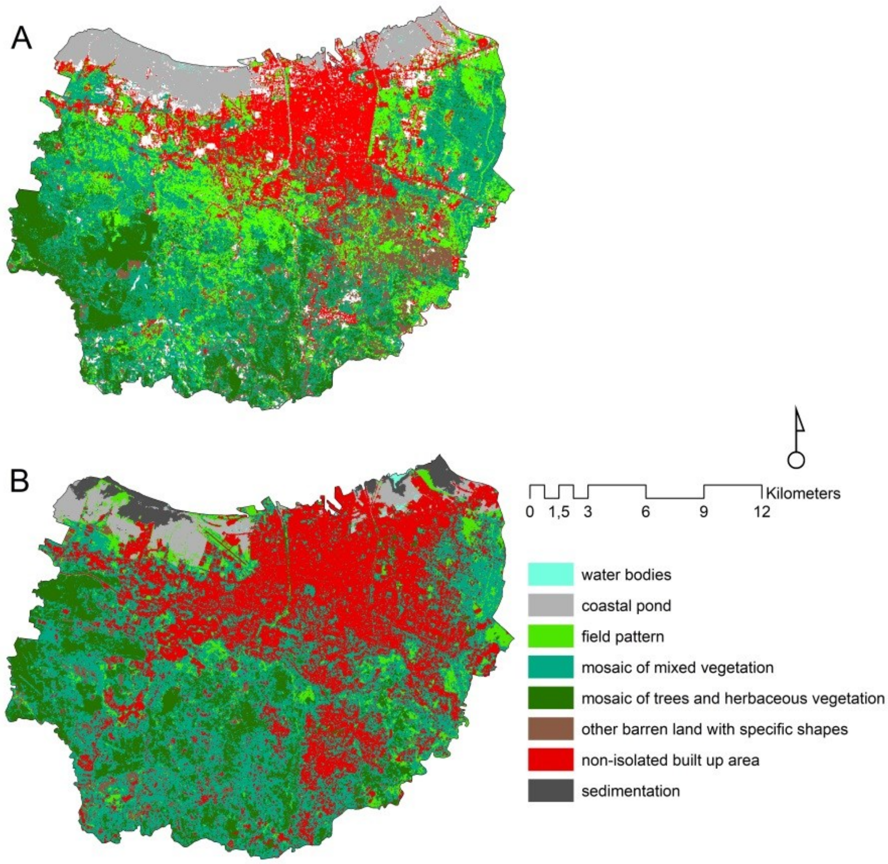

Figure. 3. Types of land cover in Semarang City, A. Year 1991; B. Year 2019

Water bodies constitute an inundation of sea water that enters the land, in 1992 the area was only about 0.06% of the area and increased to 0.15% in 2019. This also indicates that buildings are increasing so that there is a decrease in surface or surface water more and more.

Coastal pond which originally amounted to 7.03% in 1992 decreased to 4.28% in the area in 2019. Population growth resulted in land pressures, so that coastal lands were used for settlement.

Table 1: Land cover in Semarang City, 1992 and 2019

Land cove type	1992	2019
Snow	5,60	0,00
Water bodies	0,06	0,15
Coastal pond	7,03	4,28
Field pattern	17,88	5,59
Mosaic of mixed vegetation	29,25	39,23
Mosaic of trees and herbaceous vegetation	14,63	13,56
Other barren land with specific shapes	8,14	1,81
Non-isolated built up area	17,42	33,19
Sedimentation	0,00	2,19

The field pattern whose distribution tends to be in the upper (periphery) region has a relatively high decline, ie from 17.88% in 1992 reduced to only 5.59% of the total area in 2019. The pressure on agricultural lands is also due to an increase building land. However, the mosaic of mixed vegetation has increased from 29.25% in 1992 to

39.23% in 2019. Mosaic of mixed vegetation may be in the form of buildings that have vegetation either tree plants or lower plants.

Mosaic of trees and herbaceous vegetation decreased significantly but in 1992 it had an area of around 14.63% and decreased by 1.07%, in 2019 the land cover change up 13.56%. Meanwhile, the land cover for other barren land with specific shapes decreased by 6.32% from all areas, namely in 1992 amounting to 8.14% and decreasing in 2019 to 1.81%. Land cover types is Non-isolated built up area is a type of land cover that has undergone many changes. In 1992 the area was 17.42% and in 2019 it changed to 33.19%, indicating that an increase in land was built around 15.77% in the period of around 27 years.

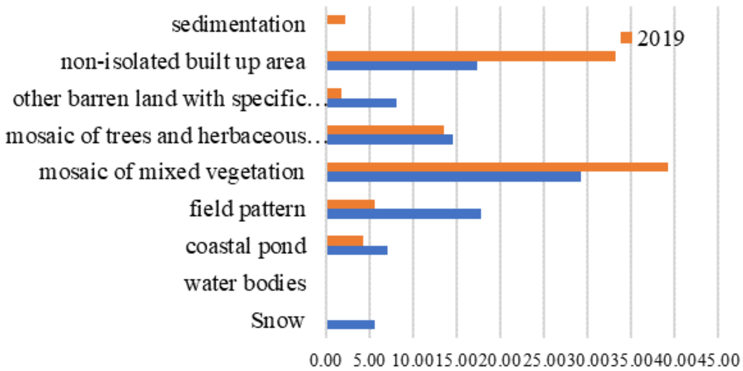

Figure. 4. Comparison of the extent of land cover types in 1992 and 2019

The city of Semarang as the provincial capital is a destination for Central Java people in socio-economic aspects. The level of capability of the region in creating a conducive economy has resulted in developments in the form of companies and infrastructure. So that relatively high population growth results in the need for residential land, so it urges non-built land to change its use into residential land.

The analysis of the development of built-up land in the area of Semarang City can be divided into 5 parts in general based on the road construction corridor. The change in the distribution of built-up land is mostly located towards the Semarang - Solo corridor and the second most change is in the Semarang - Kudus corridor. While changes in the distribution of settlements in the Semarang - Grobogan corridor are also relatively high at the third order change. The Semarang - Yogyakarta Corridor is in fourth place for changes in the distribution of built-up land, and the last change in land constructed is in the Semarang - Kendal corridor.

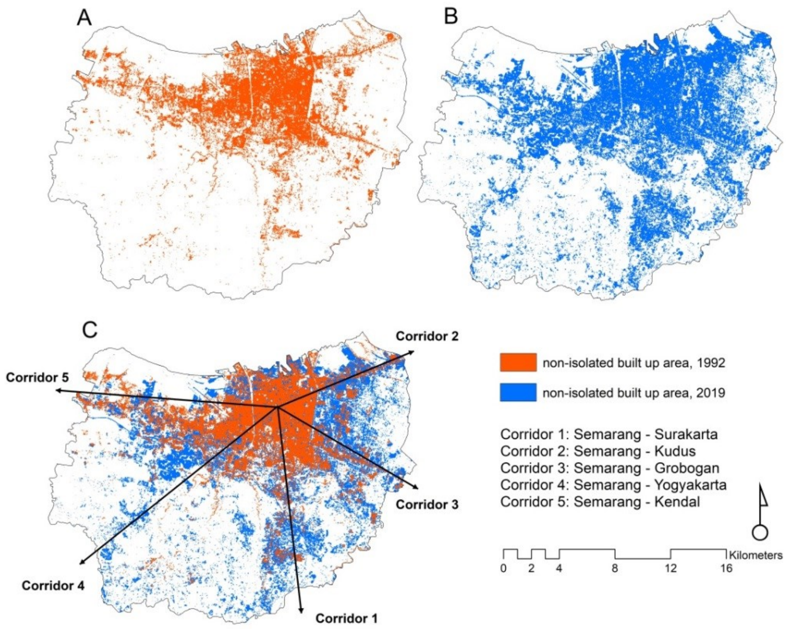

Figure. 5. The direction of development of land cover type is non-isolated built up area,
A. 1992; B. 2019; C. Overlay 1992 and 2019

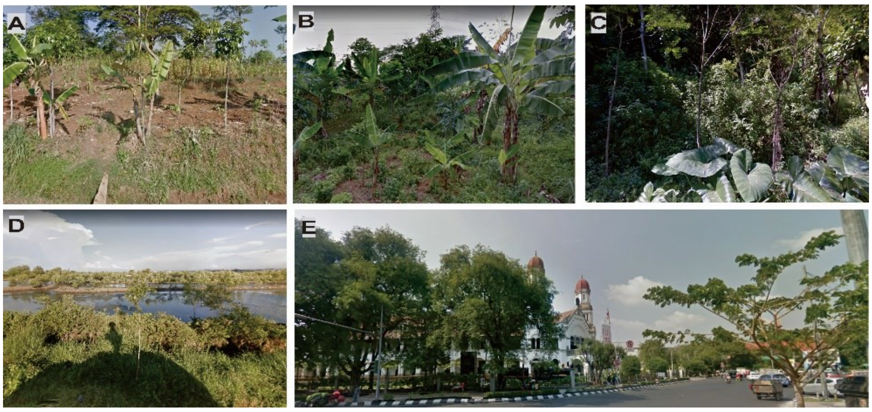

Figure. 6. Existing land use/land cover in study area, A. field pattern; B. mosaic of mixed vegetation; C. mosaic of trees and herbaceous vegetation; D. coastal pond; E. non-isolated built up area (Source: Google Map on field survey 2015)

4. Conclusion

The use of multitemporal remote sensing data is very effective for monitoring changes in land cover related to the development of a region. Landsat remote sensing images have the best data recordings at this time, although they have a medium-scale resolution but can be used to determine changes in cities / districts. The most extensive land cover change in Semarang City for 27 years was a non-isolated built-up area that experienced an increase of around 15.77% and a mosaic of mixed vegetation around 9.97% of the total area. While the land that experienced the highest decline was in the form of land cover fields which experienced a decline of around 12.50% and land cover for barren land with specific shapes around 6.32% of the area. The decrease in the two types of land cover was identified as a change in built-up land. The vastness of the built up land is due to the increasing economic factors in the region which will affect land needs, both for companies and residential land. Semarang-Surakarta Corridor and Semarang-Kudus corridor are areas that have the highest change of land not built into built-up land.

So that corridor-1, corridor-2, and corridor 3 need to be considered regarding the addition of public facilities, infrastructure improvements, and widening the main road. Because this is to anticipate the congestion that will occur. In corridor-4 and corridor-5, there are still a lot of productive agricultural land in the area, so that arrangements/regulations regarding buildings must be considered.

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