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Vegetation and built –up area transformation on coastal area as capital city: case study of Makassar city, Sulawesi Island, Indonesia

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Abstract: Makassar City's population has been reaching 2.03% annually. Based on that data, it can be assumed that the extend of buildings also increasing along with the growth of population. The objective of this study are to distinguish difference of NDVI and NDBI in Makassar City in year 1998 and 2018, using Landsat-5 and Landsat-8 OLI imageries, and also to compare 2018 processed imagery, both NDVI and NDBI actual condition. This Study was used moderated spatial resolution Landsat in 1998 to 2018. Field study was conducted on Makassar city, Sulawesi island. The normalized difference built-up index and normalized difference Vegetation Index were used for mapping urban built-up areas and vegetation area. The methods for extraction of built-up and vegetation areas using Landsat imagery comprised four major steps: preprocessing and examination of satellite data, image enhancement through resolution merging, development of vegetation and built-up area extraction method, and accuracy assessment. The analysis of NDVI and NDBI in Makassar city showed the qualitative information about the vegetation and built-up area for 20 years (1998 to 2018). The time series of the annual averages of NDVI and NDBI values showed a decrease in vegetation rates and an increase in built-up areas.

Keywords: built up area, vegetation, Landsat, Makassar city

1. INTRODUCTION

Makassar City's population has been reaching 2.03% annually. Based on that data, it can be assumed that the extend of buildings also increasing along with the growth of population. This phenomena not only happened in Makassar City, but also in other metropolitan cities around the world. Acording to The prospect of World Urbanization, revision 2014, cities expansion has been reaching the stage where more than 54% of global population living in urban areas. This number will be growing over time and it is predicted that the world's population will be increased by 66 % or 5 billion people by the year 2050 (Gago et al. 2013). Most of this population growth will take place in developing countries, including Indonesia. Some study of build-up area were conducted that use Landsat imagery data (Wang et al. 2018, Nong et al. 2014).

The development and growth of Makassar City as the main town of the metropolitan area of Mamminasata, recognized by intensively occurring urbanization and village-city migration. Remote sensing technology can be applied as a method to efficiently identify built-up areas and vegetation in

Makassar City, within short period of time and with accountable result. Vegetation and built-up areas identification were done digitally using Normalized Difference Vegetation Index (NDVI) and Normalized Difference Built-up Index (NDBI) variables respectively (Wang et al. The objective of this study are to distinguish difference of NDVI and NDBI in Makassar City in year 1998 and 2018, using Landsat-5 and Landsat-8 OLI imageries, and also to compare 2018 processed imagery, both NDVI and NDBI actual condition.

2. MATERIAL AND METHODS

2.1 Study area

This research was conducted among the vegetation and build up area in Makassar city, South Sulawesi, Indonesia which The geographical boundary between 119°18'27,97" – 119°32' 31,03"E longitude and 5°14'49" – 5°30'30,18"S latitude. Makassar is one of thirty-four capital provinces in Indonesia.

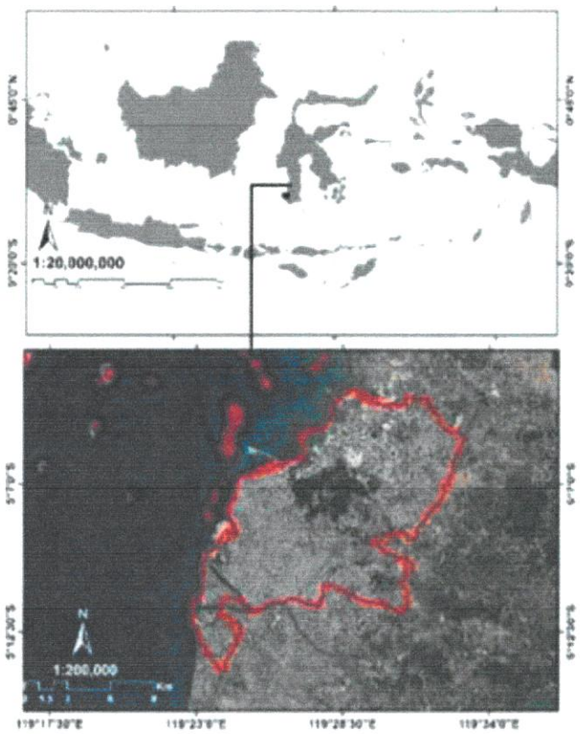

Figure 1. Map of the study area, Makassar city in Sulawesi island, Indonesia

2.2 Data Collection

The study was carried out using multi-temporal satellite images of Landsat. The Landsat images data was downloaded from USGS data archive (http://www.eros.usgs.gov) including A Landsat Thematic

Mapper (TM) images (08 August 1998) and a Landsat 8 (Operational Land Imager, OLI) image (15 August, 2018)), were used in this study. Landsat image was processed using software ArcGIS 10.5 from ESRI.

2.3 Pre-Processing Imagery

Time series data Landsat imagery were used in this research to obtain information about actual vegetation and build-up area from two time series. We preferred to use Landsat TM and OLI after geometrically, radiometrically corrected, and cropping images.

2.4 NDVI and NDBI Measures

In this study, two spectral indices were discussed, including Normalized Difference Vegetation Index and Normalized Difference Built-up Index. NDVI can be calculated as a ratio of red and the NIR bands of a sensor system, NDVI = (Infrared - Red)/(Infrared + Red). NDVI process produces new image with the value of pixel ranges from -1 to +1. NDBI is one of the widely applied indices for reinforeing building information and extracting built-up land from urban areas. Za et al. (2003). Develop NDBI values using data from Landsat TM imagery and can be used on Landsat OLI images with the equation, NDBI = (MIR-NIR)/(MIR + NIR).

2.5 Field survey

The field survey used in this study is to determine the vegetation and the built-up area in Makassar City. Field survey, carried out by taking vegetation and built-up coordinate points using Global Positioning System (GPS). The results of the field survey data are used to supporting data in identifying vegetation and built-up area in Makassar City with Geography Information System (GIS) based applications using ArcGIS software.

2.6 Accuracy assessment

Accuracy assessment was being conducted by Kappa Coefficient (k) for accuracy assessment which relies on image training area. Training area was delineation based on ground observation with 50 samples of training area with random sampling method.

Kappa ' mathematical accuracy is :

$$K = \frac{N\sum_{i=1}^{r} X_{II} - \sum_{i=1}^{r}(X_{i+} * X_{+i})}{N^2 - \sum_{i=1}^{r}(X_{i+} * X_{+i})}$$ (Congalton, et al. 1999)

Where :

N : the total Number of cell in the matrix,
r : the number of rows in the matrix,
X_{ii} : the number in row i and column i
x_{+1} : the total observations for column i, and
x_{1+} : the total observations in row i

3. RESULT AND DISCUSSION

3.1 Result

NDVI and NDBI

The analysis of NDVI and NDBI in Makassar city showed the qualitative information about the vegetation and built-up area for 20 years (1998 to 2018). The time series of the annual averages of NDVI and NDBI values showed a decrease in vegetation rates and an increase in built-up areas (Table 1 and 2). Image analyze results using parameters Normalized Difference Vegetation Index (NDVI)in 1998 to 2018 showed the high density category was decreased by 2.392 ha and increased by 1.990 ha for medium density category (Table 1).

Table 1. Result of NDVI on 1998 and 2018 in Capital Of The Province Of South Sulawesi

Years	NDVI						Total (Ha)
	Low		Medium		High		
	Ha	%	Ha	%	Ha	%	
1998	**4153**	**22.5**	**8353**	**45.23**	**5961**	**32.28**	18467
2018	**4555**	**24.7**	**10343**	**56.01**	**3569**	**19.3**	

From three samples within same location, which each of them has been zoomed in, vegetation index value can be observed (Figure 2).

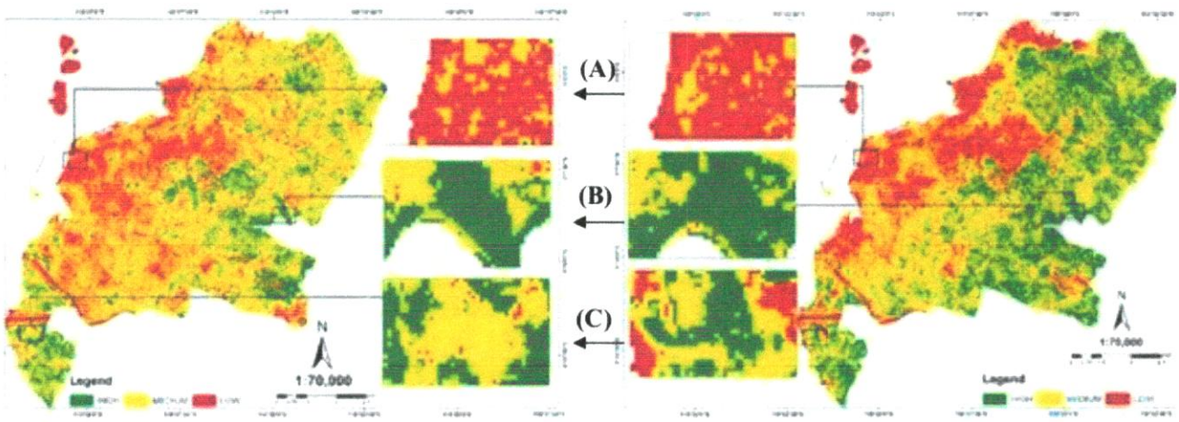

Figure 2. Results of NDVI classification in 1998 using Landsat-5 imagery with acquisition on August 8, 1998 and OLI Landsat-8 imagery for 2018 with acquisition on August 15, 2018. (A) arrow describes that the location since 1998 until 2018 already has low vegetation index. To the direction of (B) arrow, it can be seen that the vegetation index has been decreasing, At the beginning in 1998 the value was high (Thick Green), but then changes into Medium (Yellow) in 2018, even so, not 100% of the area experiencing changes. Meanwhile, for the (C) arrow it decreasing in 2018 into medium level, wich marked with Yellow colour.

Detection of the built-up area in Makassar city is carried out digitally using the NDBI variable introduced by Zha et al. 2003. Image analyze results using parameters Normalized Difference Built-Up Index (NDBI)in 1998 to 2018 showed the high density category was increased by 187 ha and decreased by 497 for medium density category (Table 2).

Table 2. Result of NDBI on 1998 and 2018 in capital province of Sulawesi island

Years	NDBI						Total (Ha)
	LOW		Medium		HIGH		
	Ha	%	Ha	%	Ha	%	
1998	**3296**	**17.85**	**8331**	**45.11**	**6840**	**37.04**	18467
2018	**3606**	**19.53**	**7834**	**42.42**	**7027**	**38.05**	

Same as NDVI, from three samples which each of them has been zoomed in within same location but different years, changes of built-up area index value can be observed (Figure 3).

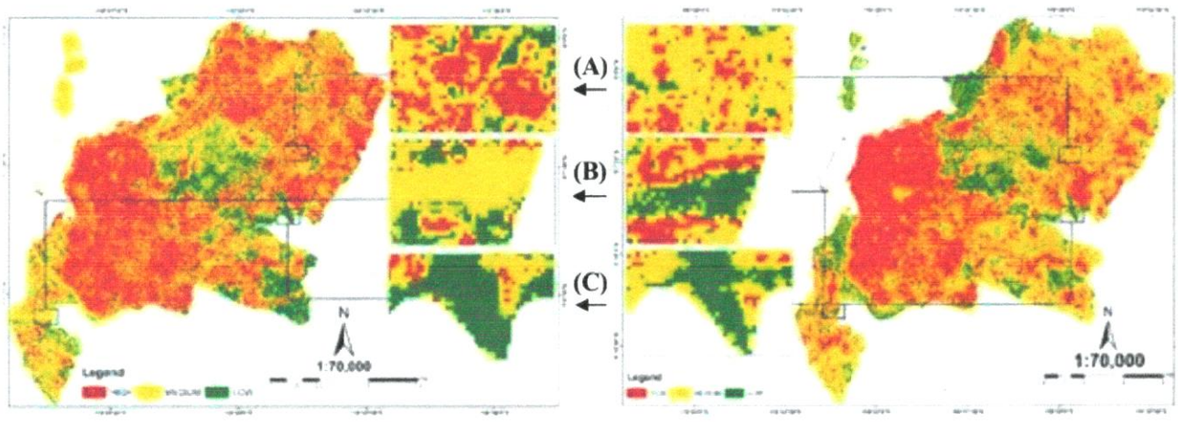

Figure 3. Results of NDBI classification in 1998 using Landsat-5 imagery with acquisition on August 8, 1998 and OLI Landsat-8 imagery for 2018 with acquisition on August 15, 2018. (A) arrow describes that in 1998 the location had built-up area extend with dominantly Medium classification, marked with Yellow colour. Meanwhile by the year 2018,that area has been experiencing increase in built-up area extend into High level, which marked with Red colour. For the direction of (B) arrow, it can be seen that land which previously had very low built-up area index value in 1998 (marked with thick Green colour), has been change into Medium built-up area index value, marked with Yellow. (C) arrow has different result with the previouses, whre land with Low built-up area index (marked with thick green), has been increase in 2018, instead.

Figure 4. Imagery of high resolution from google earth in 2018. A). Urban built-up area dominant, B). less of urban built-up area, C). less vegetation, D). Vegetation area dominant

Validation of vegetation and built-up area

The Normalized Difference Built-up Index (NDBI) has been an effective technique to map built-up areas with accuracy of 92% (Zhang et al. 2013). For assessing accuracy between NDVI and NDBI for Landsat 8 OLI image, defining 3 classes by varying the training pixels, they are low, medium, and high density. The position of each object is also recorded using the *Global Possitioning System (*GPS) with an accuracy of 3 m. Whereas sampling points of objects on the base cover in NDVI of Makassar are 145 sampling and 150 sampling for NDBI. The accuracy of NDVI area is 77.72% and NDBI area is 70.75%.

3.2 Discussion

Remote sensing technology can be used as a method to identify the development of vegetation and built-up area in short time with accountable result accuracy in Makassar city. Extraction of vegetation and built up area transformation from Landsat imagery as moderate spatial resolution have some spectral confusion between other landuse types. There are some missclassification that identified base on ground truth. In fact, There are only 1.01% expansion of the built up area change and 13% of vegetation area has been lost in the capital city between 1998 to 2018 periods. Many forms of development that have been and currently on progress today, mainly the increase of physical development are often related to land limitation. This has become the cause of land use change dynamics from vegetation covered land to built-up land. The increasing demand on land, leads to conflict of interest in land use.

4. CONCLUSIONS

The spatial vegetation cover in Makassar city is decreases continuously for 20 years (1998 to 2018). The use of NDVI shows a low accuracy and ability to classify and discriminate built-up area. Urban industrial, commercial and residential areas are unable to be separated. So in area Makassar city where there is a combination of both industries, commercial and residential area.

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