COMPARATIVE ANALYSIS OF LANDSAT, ASTER, ALOS DATA TO SUPPORT THE STUDY OF AGRICULTURAL LAND FRAGMENTATION SOME PARTS COASTAL AREA, EAST JAVA, INDONESIA

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ABSTRACT:

The Government of the Republic of Indonesia has established act number 41/2009 on the protection of sustainable agricultural land use. This act is intended as an effort to prevent further losses of agricultural land use for non agricultural purposes. This act has mandated that both the central and local government must make protection of agricultural land area. However, the implementation of this policy is still facing a very serious problem, particularly on social, demographic, economic, institutional, and technological aspects. These problems will affect the degradation, conversion, and fragmentation of agricultural land that threatens efforts to maintain the carrying capacity of national food security. This research combines methods of digital image analysis with the method of visual analysis and spectral analysis through geographic information system technology assistance. Data used in this study are the LANDSAT 1994, ASTER 2006 and ALOS 2009 imageries. This research through the study fragmentation level of non-natural wetlands (rice fields and ponds) due to settlement growth. In this analysis, sets of pixels on the raster map is processed by using the moving window size, eg 3x3, 5x5, 7x7, or even larger. This research will focus on wetland ecosystems in coastal areas of coastal regions of Gresik, Surabaya and Sidoarjo. The reasons for selecting the sites through the consideration that this region has particular characteristics of physical, economic and intensity changes in different agricultural land use

1. INTRODUCTION

1.1 Problem Identivications

Wetland ecosystem is one of the most productive ecosystems in the world. This ecosystem has benefited the economy and ecosystem services such as on agriculture, forestry, mining, transportation, recreation and tourism. In addition to having economic functions, the wetland ecosystem functioning is also very high ecological value. Cassel (1997), explained in terms of ecological standpoint, wetlands ecosystem functioning flood control, improve water quality, and provide habitat for wildlife. The same thing is described by Notohadiprawiro (1997) that the wetlands can provide a series of goods and services that are very important for humans in the use of direct and indirect, the welfare of wildlife, and maintenance of environmental quality. Biophysical processes that all depend provision of goods and services and also sustain important ecosystem functions and structure for men in the use of direct and indirect, the welfare of wildlife, and maintenance of environmental quality.

Dugan (1990), Maltby and Immirzi (1996), explained that the indifference to conservation, resulting in conversion of wetlands to continue by reason of use of wetlands ecosystems better. This was the one who encouraged wetland ecosystem continues to experience anthropogenic pressure tends to increase both the number and intensity. Gardier, (1994), Joes et.al, (1995) in Spencer et.al (1998) asserts that wetlands are the most degraded ecosystems, estimated to have lost 50 percent of the original wetland area in the world. Even Erez1at al (2002), suggests that degradation of wetlands have been heading toward a conflict of interest. Therefore a very serious effort in the management of wetland ecosystems in a broad sense is a natural wetland ecosystem and non-natural wetland ecosystem, very important to begin immediately.

Obstacles in efforts to manage wetland ecosystems because of the two main problems. First, it is perception or perspective of this ecosystem. Wetland ecosystems are considered as marginal ecosystems that are not beneficial and even have negative connotations as the value of the swamp where source of disease. This viewpoint has triggered the conversion of wetlands to other uses through the process of backfilling and drainage of wetlands ecosystems, Turner at.al. (2003). Conversion in this way obviously does not pay attention and consider aspects of the physical characteristics of the wetland ecosystem, causing damage and even has led to the disruption of wetland ecosystems. Secondly, the issue of controversy about the terminology that until this very moment are controversial, especially to understand the nature of this ecosystem, as a result of wetland policies in dealing with vague, uncertain fate of wetlands, and damage to wetlands is not solved, Natohadiprawiro (1997).

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World public awareness about the ecological functions of wetland ecosystems on the already increasing, this is reflected in the conversion rate decreased symptoms whether natural wetlands or non-natural including productive agricultural land to other uses. National Land Agency of Japan (2000), reported that in the year 1970 conversion 5.8 million hectares of land area while in the year 1999 have been reduced to 4.9 million hectares. But in Indonesia the other hand, precisely at that period both the natural conversion of wetlands (swamps, mangrove forests) and non-natural wetlands (ponds, rice fields) to the increasing use of other symptoms. Based on data RePPProT (1985) in Poniman, et al, (2006), area of wetlands in Indonesia approximately 41,706,105 hectares or about 20 percent of the land area in the period 1985-2003, by Haryani (2003), Indonesia has done conversion of wetlands more than 50 percent, so that current wetland area of 22.158 million hectares, or stay about 10 percent of the total land area. Indonesia belongs to the seven countries in Asia Pacific that have wetland ecosystems are supported by extensive wetlands.

Java Island is an area that experienced the conversion of artificial wetlands (rice fields, freshwater ponds and brackish water) to other uses a very different nature, with the highest growth rate, compared with other islands in Indonesia. Urban development process resulted in increased conversion of wetlands on the island of Java. Kustiwan (1997) explains that in the period between 1983 to 1994 agricultural land, especially in wetland ecosystem on the island of Java, an area of 104 581 hectares less, most of which 35.58 per cent took place in the area of the North Coast of Java. Another study conducted by Pakpahan et al (2006) that the conversion of farmland to other uses in Java, an area approximately 23 140 hectares per year. Housing sector, industry, and infrastructure that most land conversion, approximately 16.500 hectares per year or 44.23 percent. In the period of five years ie 1981-1986, East Java Province has the largest conversion of 43.947 hectares or 8.798 hectares per year. Central Java Province of 40.327 hectares or 6,721.2 hectares per year. West Java Province 37.033 hectares or 7,406.6 hectares per year, and Yogyakarta Special Region 223.8 2.910 hectares or acres per year. Indonesian government efforts to prevent the conversion of productive agricultural land is increasingly out of control really gone on long enough. The Indonesian government has rules and regulations governing the use 1ahan.

This study aimed to examine the level of fragmentation of wetland ecosystem in Indonesia. This study focused on settlement growth an urgent review of wetland ecosystem "cultural wetland" in Indonesia with a case study in Gresik, Surabaya and Sidoarjo. Determining the location of the study was based on the consideration of the following things: (1) the study area are typical of wetlands in Indonesia under the influence of river regime in this regard is the Solo and Brantas River that form the "landscape morphology" typical of river estuaries in the region; (2) extensive wetlands in East Java province, amounted to approximately thirty percent of the total area, the current ecosystem is increasingly threatened by land conversion process, (3) the level of urbanization in this region is very high this will encourage the utilization of space, especially in wetlands increasingly out of control, (4) the current agglomeration of urban development corridor of the Surabaya-Sidoarjo has threatened the preservation of wetlands and ponds, especially paddy fields to other uses in the future will certainly occur due to changes Suromadu bridge.

Based on the above conditions, hence in wetland ecosystem fragmentation studies of non-natural research question is formulated as follows, (1) how the distribution of non-natural wetlands (rice fields and ponds) in terms of shape and dynamics of the years before 1960 until years after 2005 in Gresik, Surabaya and Sidoarjo? (2) how the process of changing the non-natural wetlands (rice fields and ponds) to residential use and what factors are most influential? (3) how the prospect of necessity non-natural wetlands (rice fields and ponds) and the impact of the fragmentation of non-natural wetlands and the efforts to prevent it?

1.2 Objectives

Objective of the study divided into three classes according to the research questions that have been formulated that is,(1) image analysis of LANDSAT, ASTER and ALOS by using the supervised method, (2) evaluate the accuracy of image analysis of LANDSAT, ASTER and ALOS

1.3 Teoritical Approach

This research is to integrate digital image processing in multispectral classification, object-based segmentation by visual interpretation and other spatial analysis in environmental geographic information system (GIS). Multispectral classification applied to Landsat Enhanced Thematic Mapper Plus (ETM +) with a spatial resolution of 30 meters, and from the Terra satellite ASTER image with spatial resolution of 30 meters for short-wave infrared (SWIR). In addition, this study also using ALOS image. Visual interpretation was done by on-screen (heads-up) digitisation in particular to the spatial dimensions of the existing land use. Alternatives for the way this is through object-based segmentation. In the same way is applied to obtain information and landform terrain units, which will be integrated with multispectral classification results to derive land use information.

In order to characterize landscape at different spatial resolutions, we used three multi-spectral satellite data sets. A Landsat-TM subscene (pixel size of 30m) acquired on June 1994, an ALOS image with a pixel size of 15 m sensed on July 2009. From the spectral point of view, whereas TM sensor has 3 additional channels (b5 and b7 in the swir and b6 in the thermal infrared). The land cover maps of the studied area were obtained by using a supervised classification (Maximum Likelihood algorithm) based on training areas identified by unsupervised preclassification (ISODATA) and fieldwork information (Richards, 1994). The final land cover maps from the TM, ASTER and ALOS. The TM classification has one class (called mixed vegetation/wet soil) more than ASTER and ALOS maps due to soil hydrological conditions present during the Landsat acquisition that highly conditioned vegetation and soil signatures. No data class is mainly generated from shadowed pixels.

2. DATA AND METHOD

For this study we used a rule base object oriented classification approach to derive non-natural wetland (rice field and ponds) and buildup area (setlement) land cover classes from high spatial resolution imagery. Post classification comparison was applied to detect significant changes in cover characteristics linked to urbanization processes. Landscape metrics were derived from land cover classes in each date and compared to establish relationships with potential alterations to the structure and function of landscape.

2.1 Study Area

The location of this research is part of lowland ecosystem in East Java with the regime influence the development and dynamics of the Solo and Brantas River. Naturally, this region is influenced by the fertile volcanic material as the basis for intensive agriculture. In addition this region also has hiterland region very susceptible to denudation and erosion, which results in every rainy season will receive an overflow of water and sediment are very big into the Java Sea and the Strait of Madura, which form the development of Delta Delta Solo and Brantas. Economically Region Gresik, Surabaya, Sidoarjo is Gerbangkertasusila development area. Administratively, which is a research location Gresik, Surabaya and Sidoarjo. While the astronomically located between 112°22'39,00"- 112°52'39;00" east longitude and 06°50'9;00"- 07°35'39;00"; south latitude as shown in Figure 1.

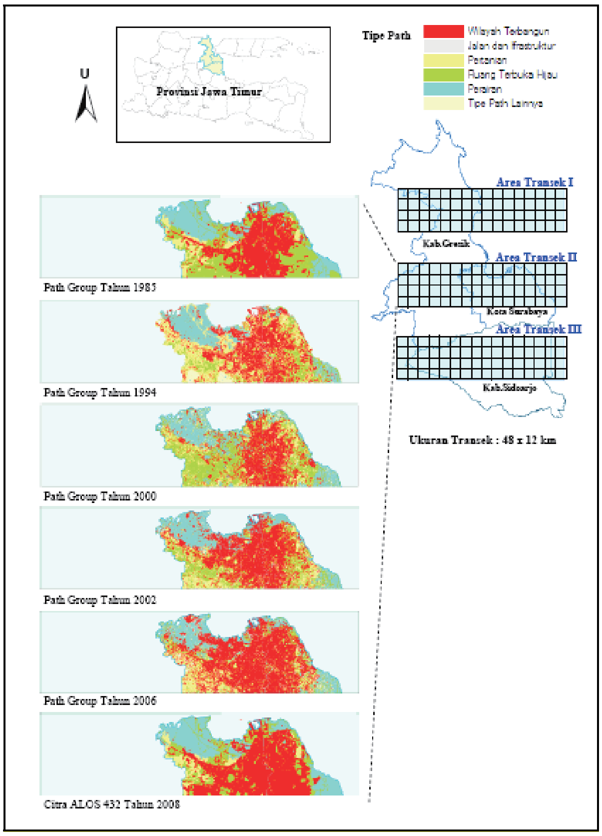

Figure 1. Location of Study

2.2 Data

This study using satellite imagery Landsat ETM +, ASTER and ALOS by the consideration that the two kinds of spatial resolution was relatively high (15 and 30 m) to describe the variety and fragmentation of existing land use in Surabaya and surroundings. In addition, Landsat ETM, ASTER and ALOS is relatively easy to obtain, as well as covering the spectral channels that are sensitive to the phenomenon of land cover on land. The three types of imagery will also be evaluated using different kernel sizes, to obtain information about the optimal size for evaluating the level of observation of land fragmentation in the study area.

2.3 Analysis Prosedure

2.3.1 Image Pre-processing

Medium-resolution image first before being processed to standardize the scene for the classification. Given the location and extent of the study area, we first create a mosaic to unify the two spaces for each date for both panchromatic and multispectral scenes. We decided to apply the patch illumination difference histogram matching process. Because there is no atmospheric parameters are available for absolute atmospheric correction, we apply the generic convolution inverse point spread with dehaze multispectral images. Panchromatic and multispectral mosaics in 2009 and then co-registered to each other apply the first order polynomial transformation with a RMSE of 0.084 m. After the first geometric correction, we use the pan sharpening function (King and Wang 2001) to improve the spatial resolution of multispectral scene in 2009. This mosaic samples returned up to 30 m. to be consistent with spatial resolution 1994. Because no IR is available for 1994, we created a natural color composite images for 2009. Both composites finally co-registered to one another with RMSE of 0.153m

2.3.2 Land Cover Classification and Change Detection

For this study, we use the supervised object-oriented approach to classifying land cover classes of natural and man-made in some areas in Surabaya test using feature extraction software ENVI. For this purpose, we first tested the level of segmentation of different scale and choose the 45.9 for the second date. This parameter gives a good description of the individual objects that represent the major classes of land cover in the area. Given the medium spatial resolution images, the object that was originally extracted using the threshold value of 75.7 coupled λ iteratively merge adjacent segments based on a combination of spectral and spatial information (Robinson et al., 2002). This step allows to integrate the small objects to reduce over-segmentation. We calculated the spatial, spectral, and textural attributes of the object is extracted to serve as a basis for land cover classification based on the information scale RBI Map Data 1:25.000,

2.3.3 Landscape Metrics Computation

Classified datasets were generalized to eliminate spots with the smaller area of 60 square meters but still the size of two pixels. This allows metrics landscape is less affected by misclassification comes from the high information content in the high spatial resolution. In preparation for the calculation of landscape metrics, datasets were converted into 8-bit binary format. Landscape metrics computed by Fragstats (McGarigal and Marks, 1995), a spatial pattern analysis program categorical raster data. Given the extent and nature of the test area of land cover classes are extracted, we chose to only calculate the metric 8 representation which provides an overview about the influence of urbanization on landscape structure and function in areas of Surabaya and sekitraanya (Table 1).

Table 1. Selected Fragstats landscape metrics (McGarigal and Marks, 1995)

Metric Type	Level	Metric	Key	Description
Area/ Density/ Edge	Class	Path Density	PD	Measure the number of pacthes per 100 hectares
		Largest Path Index	LPI	Quantity the percentage of total landscape are comprised by the largest patch
	Landscape	Number of Patches	NP	Measure the extent of subdivision or fragmentation of landscape
Shape	Path/ Class/ Landscape	Contiguity index	CONTIC	Assesse the spastial connected ness or contiguity of cells within patch
		Shape index	SHAPE	Measures shape complexity
Contangion/ Intersppersion	Class/ Landscape	Contangion	CONTAG	Measures the level of compatness
		Landscape Division Index	DIVISION	Measures the Probability that two randomly chosen pixels in the landscape are not located in the same path
Connectivity	Class/ Landsape	Connectance Index	CONNECT	Represents the percentage of the maximum possible functional joins between patches of the corresponding patch type based on a 100 m threshold distance

3. RESULTS AND DISCUSSION

3.1 Classification and Land Cover Change

Aggregation objects are segmented and supervised classification of non-natural wetland (rice field and fish pond) and buildup area class generated includes two models. In 1994, 85.24% of the test area is classified as non-natural wetland ground cover, which can be patched landscape changed. Only 15.73% of the area is classified as settlement land cover (Fig. 3a). In 2009 the class cover classification of non-natural wetlands (rice fields and ponds) is 66.45% of the test area, whereas the wake of land classes representing 47.91% (Figure 3b). Map of the difference in fact, describe and 31.78% increase in the artificial land cover between 1994 and 2009 (Figure 3c). This means that the estimated growth rate of 65 ha per year, far below the estimated growth rate for the entire city. However, because they stop the distribution of the urbanizing areas of new shows a clear fragmentation of the landscape units of natural consolidation.

(a) (b) (c)

Figure 3. Object based supervised classification results from the 1994 (a) and 2009 (b) images, and land cover change (c).

Overall accuracy for image classification in 1994 to 86.22% from, the user accuracy (UA) of 88.45% for non-natural wetlands and 77.78% for residential areas the cover classes. Higher commission errors (CE) in the class settlement is because many small land area located in the interstitial bare cluster housing. In contrast, M is lower in the class might be due to widespread nature and compactness. When compared with spectral classification based on a typical supervised, the overall accuracy dropped to only 65.34%. Year 2009 based on the classification of objects, the overall accuracy of 83.95%, which is 25.63% above the overall classification accuracy based on the spectral test of the same year. UA base object classification from 76.68% reported for non-natural wetlands and 86.21% for class residential area. Fragmentation would be higher in natural ground cover and ground cover causes an artificial increase in CE is higher for the second class in the classification of land cover in 2009.

We observed several advantages in using object-based classification of this research. Because we have only seen the band is available, we can not fully utilize the spectrum difference between resistance and plant surfaces. Segmentation is based not only on the spectrum of the object but the spatial and textural attributes ensure better identification of land features. In addition, sample selection allows classifying interactive features such as regional development in the class of man-made. Because many of the items only bare soil, the use of spatial segmentation based on object attributes and application criteria for the location by the operator to avoid this feature will be assigned automatically to a class of fish ponds or rice fields (figure 3) and (table 3).

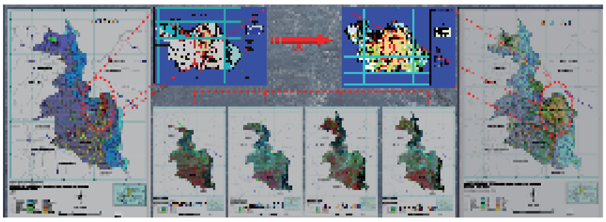

Figure 3. Object based supervised classification results from the 1985, 1994, 2000, 2002, 2006, 2008 images, and land cover change

Table 3. Landcover changes results from the 1985, 1994, 2006, and 2009 images

Reclassified patch type	MSS (1985)	TM (1994)	ASTER (2006)	ALOS (2009)
Agriculture	**65,09**	**54,587**	**41,601**	**39,28**
Greenspace	**107,473**	**70,856**	**95,107**	**62,274**
	4,715	7,791	30,289	35,714
	11,187	8,237	10,819	4,514
	7,657	2,915	7,762	4,307
	45,576	26,63	21,755	14,032
	38,338	25,283	24,482	3,707
Buildup Area	**120,504**	**122,428**	**123,82**	**167,529**
	6,812	0	0	0
	113,692	122,428	123,82	167,529
	63,29	**67,678**	**55,024**	**46,043**
Water/Swamp	5,505	0,019	0,068	0,129
	3,141	17,308	7,891	1,323
	34,369	10,588	29,565	30,726
	19,286	39,763	17,5	12,267
	0,989	0	0	1,598

3.2 Landscape Dynamic Characterization

Landscape level metrics show increasing fragmentation of land cover in the test area (Table 4). The number of patches (NP), in fact, increased by 250% between the three dates. This indicates an ongoing process that intenspembukaan desert shrub lands to urbanization. Many of these man-made recently emerged a small patch in the image 2009 has been identified as a campground, paved roads, and landfills associated with the development of new housing development. Patch density (PD), accordantly, rose 82.42 to 262.54 patches per 100 ha, which agrees with the trend of fragmentation in the area. Regularity in shape (SHAPE), the soil covering the patch with the maximum value of 1 for compact patches, also noted a small increase. This increase is expected to be higher, but there seems to be a strong influence from a small patch on the third date.

Table 4. Landscape level metrics computed from the 1994, 2006 and 2009 land cover classifications

Year	NP	PD	SHAPE	CONTIG	CONTAG	CONNECT	DIVISION
1994	375	82.42	2.09	0.89	70.61	9.14	0.69
2006	593	232.55	2.18	0.62	44.84	3.35	0.83
2009	854	262,54	2.32	0.59	39.81	3.12	0.65

The contiguity index (CONTIG), representing the spatial connectedness of cells within a patch and measured between 0 and 1, decreased in 22.89%. This might confirm the opening of small manmade areas in the desert scrub patches and reveal limitations in the classification protocol to assign correctly small patches within large buildup area patches. The level of compactness, measured by the contagion index (CONTAG) with a range from 0 to 100 shows an even large decrease, mostly because the two large desert scrub patches in 1994 were split into several small patches in 2009. Connectance index (CONNECT) representing the percentage of functional joining between patches of the same type was in fact very slow in both dates; in part due to the existence of only two classes, but is even lower for 2009. When looking at the probability of two random pixels not occurring in the same patch, the landscape division index (DIVISION) increased 14% due to the larger number of patches and increased fragmentation.

Most metrics at the class level (Table 5) coincide with the pattern showed at the landscape level. The only exceptions are a decrease in SHAPE and DIVISION metrics for the manmade class between 1994 and 2009. The first difference can be interpreted as decrease in the complexity of the manmade patches due to the large residential and industrial regular patches that appeared in 2009, which might help also to understand the lower probability of random locations not occurring in the same patch.

Table 5. Class level metrics computed from the 1994 and 2009 land cover classifications

Year	Class	PD	LPI	SHAPE	CONTIG	CONNECT	DIVISION
1994	1*	68.47	54.73	1.91	0.85	9.24	0.65
	2**	23.59	11.25	2.12	0.81	13.14	0.91
2009	1*	242.37	24.56	2.41	0.69	4.21	0.96
	2**	49.27	45.28	2.61	0.75	5.22	0.80

**1 = non natural wetland, ** 2 = buildup area*

4. CONCLUSION

Development of the city of Surabaya, Gresik and Sidoarjo changed dramatically between 1994 and 2009. Increased urban land cover in the third related area. This increase occurred in both large and regional compact patch a small hole which causes fragmentation of the landscape is marked, mostly on farms and fisheries. This trend has been confirmed by the most selected landscape metrics for analysis. Some of these effects more than fragmentation may be associated with environmental risk for developing new urban areas and important ecological functions subtle changes to the provision of critical environmental services. Housing and industrial development is an important determinant in the spatial configuration of land cover changes in the study area. This study shows an approach of integrated ecological-landscape of remote sensing to understand the relationship between changes in land cover and landscape structure and function in Surabaya and surroundings. The time period of analysis and more detailed field data is needed to confirm the results of future studies. Further necessary to build a stronger relationship between the character of the new urbanization processes and landscape dynamics in the study area

Major headings or section headings are to be centered, in bold capitals without underlining, after a triple line space (two blank lines) and followed by a double line space (one blank line). Latter is done automatically when using the provided Word template file.

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