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## Analysis of extent and spatial pattern change of mangrove ecosystem in Mangunharjo Sub-district from 2007 to 2017

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**Abstract.** This study aims to determine changes in the extent and spatial patterns of mangrove ecosystems in Mangunharjo Sub-district from 2007, 2012 and 2017. The main data source of this research is Digital Globe Imagery of Mangunharjo Sub-district and surrounding area. The extent and spatial pattern of the mangrove ecosystem were obtained from visual interpretation result of the time series image and accuracy tested with field survey data, and then the analysis was conducted quantitatively and qualitatively. The result of time series data analysis shows that there is an enhancement of mangrove forest area in Mangunharjo Sub-district from 2007-2017. In the first five years (2007-2012), the area of mangrove ecosystem increased from 9.01 Ha to 19.78 Ha, and then in the next five years (2012-2017), it was increased significantly from 19.78 Ha to 68.47 Ha. If analyzed from the spatial pattern, in 2007-2012 the mangrove ecosystems were distributed extends along the river border ponds, while in 2012-2017 it already clustered to form a certain area located at the estuary. The increasing of mangrove area in Mangunharjo Sub-district is a result of hard work with various parties, from the government institution, individual and company which launched mangrove ecosystem recovery program especially in the coastal area of Semarang City. With the better mangrove ecosystem is expected to help restore and prevent the occurrence of environmental damage in the coastal area of Semarang City due to abrasion, seawater intrusion, and tidal flood.

### 1. Introduction

Semarang is one of the municipality in Central Java Province which located in the coastal area. It has 36.63 km coastal line with total water area 10,048.80 ha. During Semarang Municipality development, coastal area has a strategic function related to economic and regional development. There is some vital transportation infrastructure (Tanjung Mas Port and Ahmad Yani Airport), electrical generator (PLTU Tambaklorok) and industrial areas (Tugu, Tanjung Mas, and Genuk). Based on creating integrated and sustainable coastal area management, Mangrove conservation is important to be done. Mangrove existence is crucial, especially related to following functions [1]: (1) the area of mangrove vegetation becomes a spawning ground for various types of fish, shrimp, and other marine biota and become a shelter for various types of animals, (2) the area of mangrove vegetation supports the diversity of flora and fauna species in coastal areas (various species of birds and other animals), and (3) mangrove area is a conservation area that protects the coast from the threat of coastal disasters, such as tidal flood,



seawater intrusion, tidal wave and tornado that is potentially harmful to various social, economic activities of the community [2]; (4) the existence of mangrove vegetation in the coastal area could absorb carbon and heavy metal that would help restore the polluted waters [3], [4]; and (5) coastal communities utilize a variety of mangrove products (wood, leaves and mangrove fruit) for various basic materials of economic value, including batik dyes, medicines, flour and others.

Based on administration area, the total area of Mangrove vegetation in the coastal area of Semarang is 94.39 ha [4]. The district with the widest mangrove vegetation is Tugu District with total area 46.19 ha (48.93%); the second largest is Genuk District of 22.72 ha (24.47%), third Semarang Barat District area of 13.40 ha (14.20%) and the smallest extent is found in Semarang Utara District of 12.07 ha (12.79%). The condition of mangrove vegetation in some locations in the World is generally uneven and tends to decrease due to land use needs in coastal area, the lack of law enforcement and the insistence of various interests in the use of residential/settlement area, industrial estates, basic facilities and infrastructure in coastal areas and others [5]–[8].

This research objective is to analyze the extent and spatial pattern change of Mangrove Ecosystem in Mangunharjo Sub-district, Tugu District of Semarang from 2007 to 2017. This location was chosen because there is a specificity regarding land ownership where Mangrove Ecosystems grow which are still private property. While in other Mangrove sites, the land is averagely already owned by private parties. Thus, in the Mangunharjo Sub-district, there is greater potential for successful conservation effort with an assumption that the community is more easily invited to participate in efforts to conserve the mangrove ecosystem.

## 2. Methods

### 2.1. Research Location

The research location of this study was Mangunharjo Sub-district, Semarang (Figure 1), which has total area 467,69 ha. Land use distribution of Mangunharjo Sub-district could be seen in Table 1.

### 2.2. Data Source

The data of extent and spatial pattern of the mangrove ecosystem were obtained from visual interpretation result of the high-resolution time series image, i.e. Digital Globe Imagery. Then team conducted accuracy tested of the data using field observation method.

### 2.3. Analysis Method

The analysis was conducted quantitatively and qualitatively. The land use and mangrove vegetation distribution were obtained from visual interpretation result of digital globe image. The interpretation was done on three images with different recording year to know land use change and distribution of mangrove ecosystem in the coastal area of Mangunharjo Sub-district. A similar method has been done by some researchers, but by using different image data sources, i.e., Landsat Image [9]–[12]. The image processing phase has begun with geometric correction on three digital globe images with different recording years, i.e., 2007, 2012 and 2017. This revision aims to provide coordinates on each image. The next step was visual interpretation to get the land use condition in each year so it could compare to know the land use and distribution change of mangrove ecosystem in Mangunharjo Sub-district. Accuracy test of land use interpretation from digital globe image was conducted by confusion matrix. It was done by comparing area training data and interpretation result of existing land use. Based on interpretation result, land use in research site could classify into 6 (six) classes. There was open space, mangrove ecosystem, built land, non-mangrove vegetation, rice field, and fishpond. Sampling pattern used stratified random sampling technic. Sample location selection conducted randomly dispersed through the whole study sites. The approach used was the larger land use classes then more samples taken.

According to [13], [14], total area of study site less than 404.700 ha and land use classes less than 12 (twelve), then total samples were taken was less than 50. Based on accuracy test through all six

classes of land use, showed that interpretation which performed has an accuracy level of 90%. Refer to [15]–[17], that accuracy percentage which permitted at the minimum level of 80-85%. So that the interpretation result of study site's land use fulfilled the criteria and could use for further analysis.



**Figure 1.** Research location in Mangunharjo Sub-district, Semarang  
(Source: Digital Globe Imagery, 2017)

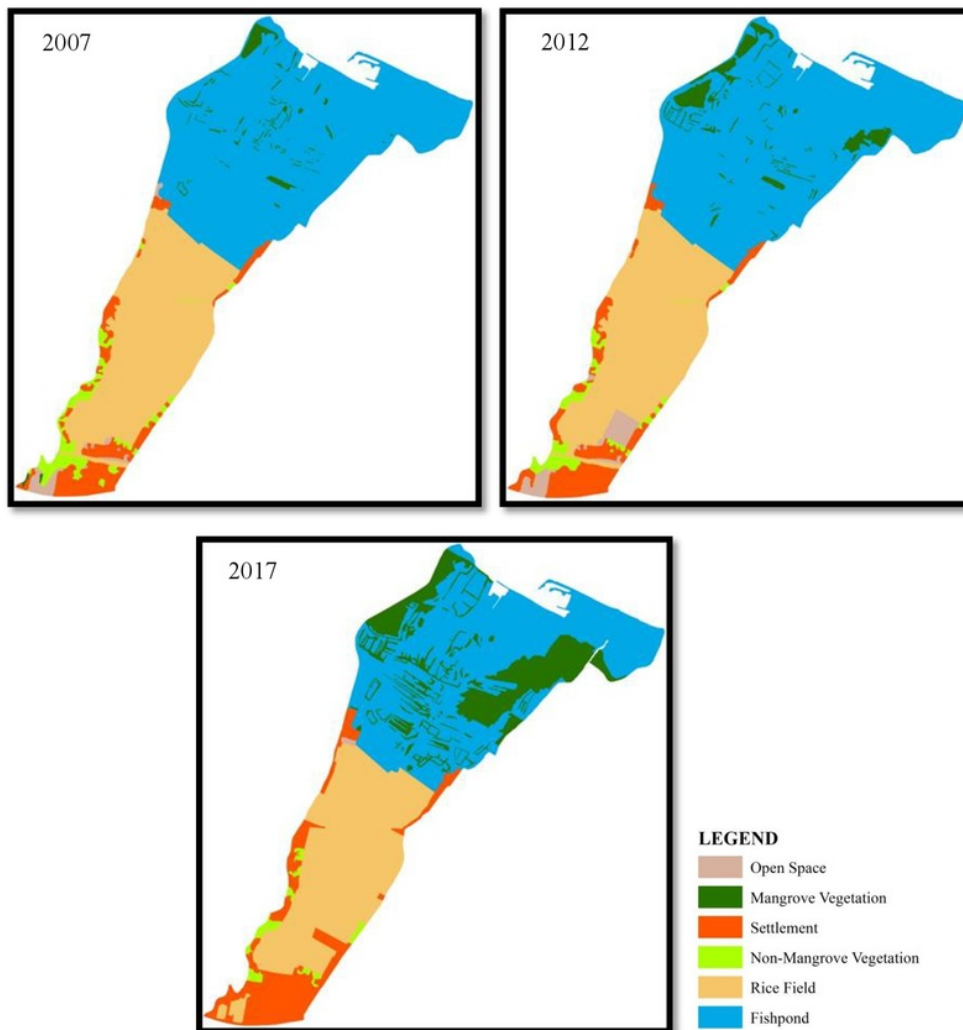
**Table 1.** Land Use Distribution in Mangunharjo Sub-district 2017

No	Land Use	Area (ha)
1	Settlement	47.25
2	Rice field	75.20
3	Fishpond	230.48
4	Open space	15.75
5	Mangrove Veg.	68.47
6	Non-Mangrove Veg.	30.54

Source: Digital globe imagery processing, 2017

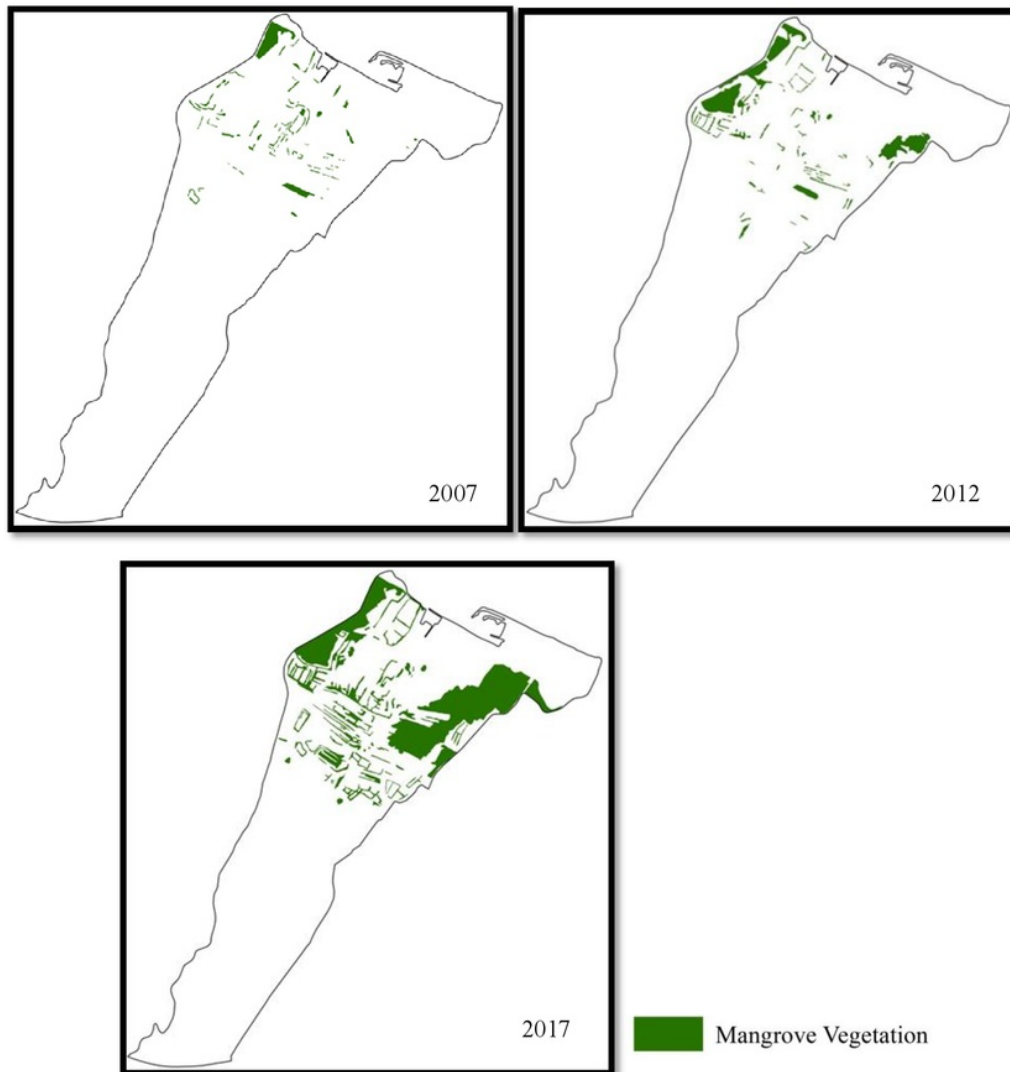
### 3. Result and Analysis

Mangrove ecosystem in Mangunharjo Sub-district had various change. In 1998-2000 was the worst condition that occurred in Mangrove ecosystem, which the damage reached 80%. This mangrove forest destruction due to abrasion, which gradually eroded the land on the north coast of Semarang City. The condition then prompted the Local Government to initiate repair and conservation action of mangrove forests in 2002-2005. These efforts ultimately appear to result in the period 10-15 years later (Figure 2).



**Figure 2.** Land use change in Mangunharjo Sub-district  
(Source: Digital Globe Imagery Visual Interpretation, 2017)

Based on satellite imagery analysis, the trend of mangrove area changes between 2007-2012 was positive. In 2007 total area of mangrove in Mangunharjo Sub-district was 9.01 ha with a fragmentary distribution along streams that limit the community fishponds. In 2012, mangrove area increased to 19.78 ha with similarly distribution condition as the previous five years. Significant changes were evident between 2012-2017. The extent of the mangrove area increased significantly to 68.47 ha with some mangrove vegetation has been clustered to form a lush mangrove forest ecosystem (Figure 3).



**Figure 3.** Mangrove vegetation change in Mangunharjo Sub-district  
(Source: Digital globe imagery visual interpretation, 2017)

The increasing of Mangrove area in Mangunharjo Sub-district was not apart from the various efforts that have been done by the Government together with the community. One of the efforts which undertaken by the Government of Semarang City was issued Regional Regulation (Perda) number 23 in 2011 about coastal area management. The regulation is explained about the plan to develop mangrove conservation area in the coastal area of Semarang City, coastal zone zoning plan, coastal zone rehabilitation, reclamation, and disaster mitigation implementation in the coastal area. Also, it also regulates the implementation of education, training, and extension of coastal regions.

#### 4. Conclusion

The result of time series data analysis shows that there is an enhancement of mangrove forest area in Mangunharjo Sub-district from 2007-2017. In the first five years (2007-2012), the area of mangrove ecosystem increased from 9.01 Ha to 19.78 Ha, and then in the next five years (2012-2017), it was increased significantly from 19.78 Ha to 68.47 Ha. If analyzed from the spatial pattern, in 2007-2012 the mangrove ecosystems were distributed extends along the river border ponds, while in 2012-2017 it already clustered to form a certain area located at the estuary. The increasing of mangrove area in Mangunharjo Sub-district is the result of hard work with various parties, from a government institution, individual and company which launched mangrove ecosystem recovery program especially in the coastal area of Semarang City.

#### Acknowledgement

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