Identification of changes mangrove areas toward shoreline changes in East Coast of Surabaya 2004-2017

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Abstract. Changes in the mangrove area is the crucial cause for the shoreline changes, it happens since that vegetation stores sediments which lead to accretion and if that vegetation is reduced or damaged, it will cause abrasion. This research aims to identify the changes in the mangrove area and the shoreline of the east coast of Surabaya (Purmabaya) during 2004-2017. This research uses Landsat image 7 ETM + and Landsat image 8 OLI by applying overlay method which is spatial analyzed. During 2004-2017, there was a reduction on mangrove area for 167,701 Ha and the width was increasing for 374,183 Ha. At the same time, there was an abrasion for 12,1 Ha and an accretion for 314,661 Ha. In Kalisari, the widest accretion was 233,833 Ha which was followed by the increasing width of the mangrove area, while in Keputih had the widest abrasion, 6,87 Ha. The conclusion is the changes of the mangrove area Purmabaya keep increasing likewise the shoreline changes, especially the accretion width or the increasing width which keep changing during 13 years (2004-2017).

1. Introduction
Mangrove is an ecosystem that grows and develops in estuary land and on the beach. Mangrove has an important aspect which is a transition area between land and sea have an important role to maintain ecological systems and maintaining biodiversity. One of the physical function of mangrove area, they can keep the shoreline stable. Mangrove ecosystem is one of the factors causing shoreline changes that include abrasion and accretion. The beach is the part of the earth that is the imaginary line where the land and waters meet from the lowest average sea level to the highest mean sea level [1]. The shoreline is the boundary line between land and sea level, where its position is unstable and can move in accordance with tidal sea water and coastal erosion that occurs [2]. Increase of mangrove area can change the shoreline, because the mangrove root can precipitate the sediment (sludge) and slow the flow of water from the river so that it will cause sedimentation which will eventually expand the shoreline edge or accretion [3]. Abrasion is a process of coastal erosion caused by destructive ocean waves and ocean currents [4]. The cause of the decrease of mangrove area is the change of shoreline causing the mangrove area to decrease [5].

Mangrove forest areas commonly spread throughout the Indonesian coast. East Coast Surabaya (Pamurbaya) is one of the mangrove areas that received special attention related to the decrease of green open space in Surabaya [6]. Pamurbaya is located at 7 ° 16' 03" LS - 112 ° 50' 31" BT. The east coast

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of Surabaya is a beach with a dominant precipitation process, so shoreline changes are frequent, this could lead to changes in land area. In this research we need spatial data and information about the picture of mangrove area. Spatial data and information can be obtained one of them by utilizing remote sensing technology [7]. Remote sensing technology for mapping and monitoring of resources becomes useful for wide area coverage and spatial information [8]. Remote sensing is defined as the measurement or acquisition of information of some nature of the object or phenomenon, using a physically unrecognized tape recorder or interconnected with the object or phenomenon under research [9]. This research used Landsat 7 ETM + for 2004 and Landsat 8 OLI for 2017. The purpose of this research to identify changes in mangrove area toward the shoreline changes in East Coast Surabaya (Pamurbaya) in 2004–2015.

2. Materials and Methods
The research area is located in East Coast of Surabaya, East Java Province. Surabaya is the capital of East Java Province located between 07 ° 9’ s 07 ° 21’ S and 112 ° 36’ s.d 112 ° 54’ E. East Coast of Surabaya (Pamurbaya) is located at coordinates 7 ° 16’ 03” S - 112 ° 50’ 31 ” E. East Coast Surabaya is a coast located in eastern part of Surabaya, Pamurbaya longways from Mulyorejo, Sukolilo, Rungkut and Gunung Anyar. Mangrove Pamurbaya spread along coastline, along the river and near the ponds. There are 41 species of mangroves on the east coast of Surabaya. 22 species of which include true mangrove species and 19 species are an associated mangrove species [10]. In Pamurbaya Avicennia spp. and Rhizophora spp, are the dominant mangrove species, their live along shoreline in Pamurbaya.

Data that used in this research is Landsat 7 ETM+ for 2004 and Landsat 8 OLI for 2017. The images were downloaded from the USGS (United States Geological Survey) of path 118 and row 65. All imageries were geo-referenced to UTM (Universal Transverse Meractor) map coordinate system. Do the atmospheric correction to removes the scattering and absorption effects from the atmosphere to obtain the surface reflectance characterizing (surface properties). (Figure.1) The composite image that use in this research to see the mangrove area using 4-5-3 bands for Landsat 7 ETM+ and 5-7-3 for Landsat 8 OLI. Layer stacking all combination of the bands. Then digitization the shoreline to see the phenomenon of accretion and abrasion during 2004 – 2017.

Analyzed data in this research is classify area into six areas namely Kalisari, Kejawan Putih Tambak, Keputih, Wonorejo, Medokan Ayu and Gunung Anyar Tambak (Figure.2). The changes of mangrove area and shoreline change using overlay methods then the data will be analyzed by spatial descriptive.

Figure 1. The composite for Landsat 7 ETM+ and 8 OLI
3. The Change of Mangrove Area 2004 – 2017

Mangrove vegetation grows along the shoreline of Pamurbaya. During 13 years, there was a change of area of mangrove that caused the change of shoreline. The result of the data processing of landsat using the composite band 753 in Landsat 8 and 453 in Landsat 7 resulted the distribution and extent of mangrove area in 2004 and 2017. Using overlay method between mangrove area in 2004 and 2017 to see the change of mangrove area decreasing and increasing area of mangrove and produce a map of change of mangrove area year 2004 - 2017. Mangrove area which have purple color is mangrove area which decrease, mangrove area which has light green color is an unchanged mangrove area and mangrove area with dark green color is mangrove area increased for 13 years (Figure 3).

There was a decreased on mangrove area for 167,701 Ha or 15%, unchanged mangrove area 374,183 Ha or 34% and the width was increased for 374,183 Ha or 50%. The increasing mangrove location dominates along the shoreline in Pamurbaya while the decreased mangrove sites predominate in the surrounding ponds. The area that experienced the largest decreased of mangrove area is Keputih with the area of 48,761 Ha and for the area with the biggest increased of mangrove area is Kalisari with an area of 238,502 Ha (Table 1). Mangrove growth areas are located along the shoreline in Kalisari, Kejawan Putih Tambak, Medokan Ayu dan Gunung Anyar Tambak.
Table 1. The width decrease, increase and unchanged area of mangrove 2004 – 2017

| Unit Analysis                  | Decreased (Ha) | Increased (Ha) | Unchanged (Ha) |
|-------------------------------|----------------|----------------|----------------|
| Kalisari                      | 23,246         | 238,502        | 28,164         |
| Kejawan Putih Tambak          | 10,697         | 48,127         | 12,629         |
| Keputih                       | 48,761         | 137,159        | 140,446        |
| Wonorejo                      | 20,798         | 64,124         | 69,182         |
| Medokan Ayu                   | 22,515         | 32,041         | 63,254         |
| Gunung Anyar Tambak           | 41,684         | 28,674         | 60,508         |
| **Total**                     | **167,701**    | **548,627**    | **374,183**    |

4. The Change of Shoreline 2004 – 2017

The length of shoreline in Pamurbaya in 2017 has a length of 15,627 Km and in 2004 has a length of 14,503 Km. To know the occurrence of accretion and abrasion phenomena in Pamurbaya, using overlay methods between 2004 and 2017 shoreline. Kalisari has increased large accretion area, in this area overgrown with mangrove vegetation so that the addition of land caused by beach sediment trapped in mangrove root. Accretion area which have red color and the abrasion area which have blue color (Figure 4).

Table 2. Width abrasion and accretion area 2004 - 2017

| Unit Analysis                  | Abrasion (Ha) | Accretion (Ha) |
|-------------------------------|---------------|----------------|
| Kalisari                      | 0             | 233,833        |
| Kejawan Putih Tambak          | 0             | 40,18          |
| Keputih                       | 12,804        | 9,571          |
| Wonorejo                      | 5,23          | 4,834          |
| Medokan Ayu                   | 0             | 16,905         |
| Gunung Anyar Tambak           | 0             | 9,338          |
| **Jumlah**                    | **18,034**    | **314,661**    |

Figure 4. Abrasion and accretion area in Pamurbaya 2004 – 2017
Kalisari has width accretion area of 233,833 Ha, Kejawen Putih Tambak has width accretion area of 40.18 Ha, Medokan Ayu has width accretion area of 16.905 Ha, Keputih has width accretion area of 9.571 Ha, Gunung Anyar Tambak has width accretion area of 9.338 Ha and Wonorejo has width accretion area of 4,834 Ha. There are only 2 areas that have abrasion of Keputih and Wonorejo, Keputih has the widest abrasion area of 12,804 Ha and Wonorejo has a width abrasion area of 5.23 Ha.

5. The Changes Mangrove Areas Toward Shoreline Changes 2004-2017
The mangrove area that caused change of accretion area has a width of 299.0 Ha or 99% and the mangrove area that caused change of abrasion has width 12.1 Ha or 4%, it can be said that the shoreline changes occurred due to the addition of mangrove area in Pamurbaya (Table.3). Table.3 explains the phenomena of shoreline changes, caused by mangrove area changes in each area of the unit of analysis. Kalisari has the widest accretion area, mangrove Kalisari has a function as a sediment trap, so increasing the extent of mudflats located in front of the open zone (near to the ocean)[10]. Kalisari has width accretion area caused by changes of mangrove area of 233,88 Ha. There are only two unit analysis that have abrasion in their shoreline, the widest abrasion area happened in Keputih, has width of 8,3 Ha (Table.4) . (Figure.5) For 13 years Pamurbaya have shoreline changes dominated by accretion phenomena caused by increase mangrove area grow toward the ocean, in accretion area there are live Avicennia spp. and Rhizophora spp. the root can trap the sediment.

| Change | Area (Ha) | Area (%) |
|--------|-----------|----------|
| Mangrove → Akresi | 299 | 96% |
| Mangrove → Abrasi | 12.1 | 4% |

6. Conclusion
Mangrove vegetation grows along the shoreline of Pamurbaya. There was a decreased on mangrove area for 15%, unchanged mangrove area 34 % and the width was increased for 50%. During 13 years, there was a change of area of mangrove that caused the change of shoreline. The changes of mangrove area caused the changes of shoreline in Pamurbaya. The accretion phenomena dominate the shoreline, the widest accretion area happen in Kalisari has width of 233,88 Ha, because mangrove Kalisari has a function as a sediment trap, so increasing the extent of mudflats located in front of the open zone (near to the ocean) and there are live Avicennia spp. and Rhizophora spp., the root of those kind can trap the sediment. The widest abrasion area happened in Keputih, has width of 8,3 Ha.

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Figure 5. Changes Mangrove Areas Toward Shoreline Changes 2004-2017

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