Dynamics land cover changes of Wulan Delta in 2003-2017 approach by remote sensing technology

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Abstract. Wulan Delta is a form of landscape in the coastal area of Wedung District, Demak Regency, which was formed due to sedimentation of the Wulan River estuary. Utilization of the delta region into a pond will have an impact on the environment and socio-economic surrounding communities. This study aims to look at the dynamics of land cover changes in Wulan Delta, Wedung District, Demak Regency. Multitemporal remote sensing technology can be used to see the dynamics that occur in the Wulan Delta region. Remote sensing imagery used by Quickbird imagery from 2003 and Worldview imagery from 2017. Based on the results of the interpretation of multitemporal imagery that most of the Wulan delta area is used as ponds. Along with the increase in the pond area, from the socio-economic aspects of the livelihoods of residents in the sub-district of Wedung as pond farmers increased from 2003 to 2017. So that the use of land in the form of ponds has a positive impact as the livelihood of the population. Changes in the area of Wulan Delta between 2003 and 2017 there are delta gain as large as 112,9 ha (7.9 %), delta loss area by 28,78 ha (2,01 %) and a fixed area of 1287.77 ha (90,09%). Delta area changes also affect land cover changes from mangroves into ponds 29,73 ha (2,08%) and pond to mangrove 8,81 ha (0,62%). The land cover dynamics changes of Wulan Delta also affect the socio-economic conditions of surrounding communities, most of whom work as pond farmer. Calculation of the production value of ponds in the study area is estimated at approximately IDR 39.422.252.670,-.

1. Introduction
Delta is a land formed by sedimentation of river estuaries that occur throughout the year, which is caused by various factors including river discharge, waves, tidal conditions, and other oceanographic physics parameters, so that it will form a separate morphological landscape [1]. In a number of areas such as the South Coast of Java, material that is carried by river currents will be eroded by very strong sea waves. Whereas in the North Coast of Java, the beaches have waves that tend to stagnate, making sedimentation material carried by river currents can settle [2]. Delta Wulan is one of the deltas formed in the northern coast of Java, located in the Wedung District, Demak Regency.

The area in the delta region consists of protected areas and cultivation areas. The protected area in the delta region is a coastal area that is overgrown by mangrove. mangrove as a tropical coastal vegetation community which is dominated by several types of mangrove tree vegetation that is able to grow and develop in muddy coastal tides [3]. Mangrove has an important role in maintaining water productivity, coastal protection and protection of aquaculture behind it or as a border area [4]. This border area is
important to maintain balance so that environmental damage can be prevented. The cultivation area in the delta region is the pond area. The construction of ponds in the mangrove area has several facilities including that of mangrove areas which are generally inundated at high tide and dry at low tide, making it easier to replenish and replace pond water [5]. The increase in the area of ponds is very much related to the socio-economic conditions of the communities around the Delta region, especially those whose livelihoods originate from ponds. The area of the pond can have a positive impact that is increasing the rate of economic growth of the community, but also can have a negative impact if the utilization does not pay attention to the environment.

The delta ecosystem balance is highly dependent on the development of protected areas and cultivation areas. Multitemporal analysis is needed to see the dynamics of land cover change that occurs in the Wulan Delta region. The dynamics of multitemporal land cover areas in the Wulan Delta region can be identified using the remote sensing imagery technology approach. Satellite remote sensing is the most common source of data for detecting land cover changes due to repeated data acquisition processes so that it is possible to see land changes regularly [6].

Procedure The use of remote sensing technology is the right choice in the detection of changes in land cover in coastal areas in an effective, fast and accurate manner [7]. In this study, researchers used multitemporal imagery in 2003 and 2017 to see the direction of the development of the Wulan Delta and changes in the region.

2. Research Method

2.1 Description of Research Areas
Wulan Delta is a land that forms broadly along the Wulan River. This delta from year to year continues to experience land expansion. This condition is caused by a high sedimentation process. This high sedimentation rate is due to the supply of dissolved material from the mainland through the Wulan River. High sediment deposition causes the waters around the delta to have a low diversity of marine flora and fauna. However, with the expansion of the delta due to high sedimentation, land use in the area is increasingly for fish pond cultivation, settlement, and mangrove forests this has happened gradually since 1892 [8]. The topography of the Wulan Delta region which has a low altitude makes the area widely used as pond aquaculture land, due to physical and mechanical properties that are able to benefit the pond construction and hold water in the pond, low elevation by not reducing the cost of extracting and supplying water [9]. In general, land use in Wulan Delta is dominated by aquaculture ponds and mangroves [10]. The addition of pond area and mangrove damage in Wulan delta has also occurred between 2000-2010 [11]. Wulan Delta morphology is a land that extends following the flow of the Wulan River in which part of the delta is branched to follow the flow of the tributary. As mentioned by, sediments that are built like dykes on the banks of a river are delta types of bird’s foot [12].

2.2. Tools and materials
The tools used are computer hardware and ArcGis 10.3 software to digitize land use and analyze land use changes that occur. The material used is in the form of remote sensing imagery maps of Wedung District, namely Quickbird imagery in 2003 and Worldview imagery in 2017.

2.3. Data Analysis
The analysis used in this research is descriptive qualitative development over time. Land use maps obtained from multitemporal image interpretation are then overlaid on the old land cover map (2003) and the newer land cover map (2017). Analysis and evaluation of land resources are calculated in unit area (hectares) and in percentage calculations (%) [13]. The results of the analysis can be used to see changes in mangrove land and ponds that occur in the Wulan delta. The results of the land cover change map will be linked to the community’s economy, in this case the livelihoods of the people of Wedung sub-district as pond farmers.
2.4. Data Processing
Multitemporal remote sensing imagery is performed radiometric and geometric corrections. Radiometric correction is used to improve the visual quality of the image, which corrects the pixel value that does not match the reflectance value or the actual spectral beam of the object. Radiometry correction is performed on each band used from multitemporal images [14]. After radiometry correction, the stacking image is then performed geometric correction for each image. Geometric correction of images is in principle carried out to correct the position of satellite imagery against the actual location on the surface of the earth [15]. Correction of geometry using the image to map method, using a map of Indonesia Rupabumi scale of 1: 25,000. Whereas image sharpening is done to improve the visual interpretation of images by increasing the apparent differences between features. This process is best used for visual analysis, while the original image is used for automated analysis [16,17].

The results of multi-temporal images that have been carried out radiometric and geometric corrections are ready to be carried out the process of land cover classification on the images in 2003 and 2017. Land cover classification is done by visual interpretation by referring to several key interpretations such as hue / color, texture, pattern, and association. Visual land cover classification has the advantage of better accuracy due to the process of identifying objects using several key interpretations and image pixel values, while the weakness of this method is high subjectivity [18]. In this study visual analysis was chosen because the object to be interpreted in high resolution imagery in the study area is quite easy to recognize. Higher resolution or large-scale image data displays higher levels of information detail, but higher levels of detail also refer to more complex features in spectral values [19]. The image composite used is a visible color (true color). Multitemporal maps of the results of land cover classifications will be overlapped to overlay changes in land cover and area change so that the direction of development of the Wulan River delta in 2003 - 2017 is obtained.

Figure 1. Research Flow Chart
3. Results and Discussion
The ongoing process of sedimentation in the Wulan River resulted in the dynamics of the shape of the delta which generally causes changes in the area of the delta. The analysis shows that in the period from 2003-2017 there was an increase and decrease in the delta area as shown in Figure 2 and Table 1. In addition to Wulan Delta growth, Wulan Delta is also experiencing abrasion in the north, where there is a decrease in mangroves and ponds in the region. In the southern part of the Wulan river there is a significant growth of mangrove and pond areas.

![Figure 2. Wulan Delta Change from 2003 to 2017](image)

| Delta Area Change  | Area (Hectare) | %   |
|-------------------|----------------|-----|
| Area Gain         | 112,9          | 7,90|
| Area Loss         | 28,78          | 2,01|
| Not Change        | 1287,77        | 90,09|
| **Total**         | **1429,45**    | 100 |

Delta Wulan experienced an increase in the area of one side and also experienced a reduction in area on the other side. This also contributed to changes in cover and land use in the delta area. The dynamics of changes in land cover in Delta Wulan occur quite high. The factors causing the dynamics consist of natural and artificial factors. Natural factors occur because of sedimentation, resulting in the addition of land towards the sea. In addition, the dynamics of the coastline caused by abrasion, the occurrence of abrasion is caused by artificial factors, namely the conversion of land which was originally a mangrove which is used as a protected area that naturally functions as an abrasion barrier is converted into a pond. Analysis of changes in delta development and land use using remote sensing imagery. The Quickbird image of 2003 is used as preliminary data. In 2003, mangrove areas were located along the coastline and rivers, while most of the delta area had already been cultivated as ponds. Worldview imagery of 2017 is used as final data. In 2017 there was a development of protected areas, especially in the western part of the Wulan delta. For more details can be seen in Figure 3 and Figure 4.
Figure 3. 2003 Quickbird Imagery and Land Cover Map

Figure 4. 2017 Worldview Imagery and 2017 Land Cover Map

Table 2. Land Cover Change Area in Delta Wulan

| Land Cover | Area (Hectare) |
|------------|----------------|
|            | 2003           | 2017           |
| Mangrove   | 138,80          | 171,58          |
| Pond       | 1097,37         | 1148,70         |

Changes in the area of land cover that occurred in the Wulan delta area are an increase in pond area by 32.78 hectares and an increase in mangrove land by 51.33 hectares, so that this area has increased land area.
Figure 5. Wulan Delta Land Cover Change Map from 2003 to 2017

Table 3. Wulan Delta Land Cover Area Change from 2003 to 2017

| Land Cover Change (2003 – 2017) | Area (Hectare) | %  |
|---------------------------------|----------------|----|
| Mangrove > Pond                 | 29.73          | 2.08|
| Mangrove > Water Body           | 20.52          | 1.44|
| Pond > Mangrove                 | 8.81           | 0.62|
| Pond > Water Body               | 8.26           | 0.58|
| Water Body > Mangrove           | 74.23          | 5.19|
| Water Body > Pond               | 38.67          | 2.71|
| Not Change                      | 1249.23        | 87.39|
| **Total**                       | **1429.45**    | **100.00**|

The dynamics of land cover that occurred in Delta Wulan experienced a change of 13%, while 87% did not change. Land cover change of mangrove to a pond by 29.73 hectares, mostly located in the main flow of the Wulan river, which does not pose a risk of abrasion by waves, so that most of the banks of the Wulan river have land cover as ponds. Land cover changes that is large enough is water body into mangroves by 74.23 hectares. This change occurred in the southern part of the delta, where mangroves experienced growth in one of the Wulan tributaries.

The development of fishponds in the Wulan Delta Region greatly affects the economy of the community, especially the people of the Wedung District. At very least 1,133 residents of Wedung District are pond farmers or 1.41% of the entire population, pond area is 2,601.20 ha with production of 409,175 kg with production value IDR 4,418,215,000.00 [20]. There are also 1,658 residents of Wedung District were pond farmers or 2.74% of the total population, pond area 3,699.39 ha with production of 4,219,800 kg with production value IDR 127,168,557,000,- [21]. Wedung Subdistrict
has the most extensive area of ponds in Demak Regency, and the community of Wedung Subdistrict utilizes the area of ponds as a place to grow milkfish, which is the main commodity in the region. The large number of farmer ponds in the Subdistrict of Wedung is followed by the use of land as a fairly large pond in this sub-district. The study area itself represents 31% (1148.70 ha) of the entire area of the ponds located in Wedung District, and the change in the area of the ponds from 2003 to 2017 was only 4.6% which was the result of the growth of the Wulan River Delta. Then the calculation of the production value of ponds in the study area is estimated at around IDR 39,422,252,670.

4. Conclusion
Coastal monitoring can be done using satellite image processing to see the dynamics. Besides that, it can also be used to see developments and land cover changes. The study results show that the delta shape changes from 2003 to 2017 due to the high Wulan River sedimentation activity. Addition of land due to sedimentation results in the use of new land, namely pond cultivation and the growth of mangrove areas. Wulan Delta land cover change mapping can be used for the government as a consideration in making a decision to limit and even stop to grant a permit to open a pond area by considering environmental conditions and their impact on the socio-economic community in a sustainable manner. In the case of Delta Wulan, changes in land cover still consider the existence of protected areas by maintaining existing mangroves and also helping to improve the community's economy by increasing the area of ponds due to delta growth due to sedimentation.

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