Changes in the west Delta of Ci Manuk in 2002 - 2018

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Abstract. Ci Manuk Flow Area is one of the river basins in Java Island. The Ci Manuk Delta changed from 1963 to 2002. Changes that occurred in the Ci Manuk delta were moved by extensive accretion. The reason for choosing Ci Manuk Delta is because the Ci Manuk flow has a high sedimentation rate compared to other flow areas, besides that, Sumedang Regency has built a dam to hold the sediment flow and repair floods. How this is done as a problem and research can be done to determine the delta-forming factors and changes in the delta region that occurred temporally from 2002 to 2018 after the dam was built. The method used in this research is spatial analysis and quantitative descriptive analysis. Spatial analysis is used to describe the spatial change in the temporary area and quantitative descriptive analysis is used to explain the results of the calculation of changes in delta area. The results of this study are the dynamics of delta changes that occur in the west are dominated by the addition of delta (accretion) with an area of 522.3 ha and undergo a change in shape from cuspate to birdfoot. The factors that support the addition of the area comes from internal factors, namely the high value of sediment and the low external factors originating from the marin.

1. Introduction

The surface of the earth that we live in today is the result of a process of combining labor, that is the building or building forces and destructive forces that have lasted a long time [1]. The process of formation of the earth naturally can occur through: a process of diastrophism, a gradation process, a process of aggression, volcanism, an atoll formation process [2,3]. The aggression process is a process that forms a delta because the sediment material carried is greater than the sediment transport capacity [3]. The aggression process is of course caused by erosion. Erosion is a natural event, which occurred since the earth was formed. Many factors can cause erosion, but the main factor that causes erosion is water. In general, erosion caused by water is divided into two, namely normal erosion and accelerated erosion [4]. Normal erosion is slow, so the rate of soil formation can withstand the process of loss of surface layers of the soil. Whereas accelerated erosion can be divided into four other groups, namely splash erosion, sheet erosion, groove erosion and valley erosion [4].

Regional Flow is a complex system built on physical systems (physical systems), biological systems (biological systems) and human systems (human systems) that are interrelated and interact with each other. Each component in the system / sub-system has unique characteristics and its existence is related to the others. The components that make up an integrated ecological system (ecosystem). So if there is interference or imbalance in one component it will have a chain effect on other components [7]. Ci Manuk is one of the major rivers in the province of West Java. DA Ci Manuk is one of the main pillars of water resources in West Java. Administratively, Ci Manuk is located in four districts, namely Garut, Sumedang, Majalengka and Indramayu. This river has a length of 337.67 km and is the second longest river in the province of West Java which is able to provide 2.2 billion m3 of water per year,
which is mostly used to irrigate agricultural land. Ci Manuk Berhulu in Garut and Hilir Regencies are located in Indramayu Regency [7].

The amount of mud deposited by several rivers in Java Island, averaged 939 - 5,520 mg per liter, while outside of Java 67 - 2,790 mg per liter. While the amount of river mud transportation on the island of Java is 3.79 - 25.0 million tons per year and the amount of river mud transportation outside Java is 0.17 - 1.40 million tons per year. This explains that rivers in Java have high sediment transport capacity, this shows that the intensity of erosion in Java tends to be high [5]. The highest amount of mud sediment is found in the Amazon river, where 8.3 x 10^8 T settles at the mouth of the Amazon river [6].

Based on the statement above, the purpose of this research is to find out the dynamics of changes in the delta to the west of the cimanuk coastline due to reservoir construction. The use of remote sensing is used to see the dynamics of spatial change in the Delta west of Ci Manuk which is considered to be expanding due to land degradation in the upstream area. In this study the images used were Landsat 5TM, 7 ETM + and 8 OLI in the period of 2002 - 2018 with a gap of 4 years. The analysis used in this study is the Spatial Analysis and Quantitative Descriptive Analysis which was conducted to see the surface area of Ci Manuk Flow Area and to know the amount of river mud transportation in Ci Manuk in the period of 2002 – 2018.

2. Methods

Ci Manuk flow area is administratively located in West Java Province includes four districts namely Garut, Indramayu, Majalengka and Sumedang with an area of 358400 Ha where 116582 Ha is in Garut Regency, 39906 Ha located in Indramayu, 101860 ha is in Majalengka and 105877 Ha located in Sumedang. Variables of this research are the factor internal and external who can change the shape of west delta in Indramyu coastline. Internal Factors are factors that can affect changes in delta from erosion in the land area (mud transport) and external factor are factors that can affect changes in delta from the sea area.

In this study using various types of research data which is then grouped into primary data and secondary data. Primary data is data obtained directly such as surveys or direct data collection. Secondary data is data obtained indirectly as data obtained from institutions, previous research and other information. The primary data used in this study is the sampling of mud deposits in the Range Weir in Majalengka Regency. Here is the sampling location of the water flow at Ci Manuk flow area (Figure 1).

![Figure 1. Sampling Water Flow Location](image_url)
For secondary data, the previous processing has been performed. The secondary data used in this study is the boundary data of Cilutung River basin, the daily rainfall of the Cilutung River basin in 2018 to 2019, and the time of the hours of the Cilutung River basin discharge data from 2018 to 2019 (Table 1).

| Data                              | Data Types                              | Sources                                           |
|-----------------------------------|-----------------------------------------|---------------------------------------------------|
| Boundary of Ci Manuk flow area    | Shapefile (shp)                         | Balai Besar Wilayah                               |
|                                   |                                         | Sungai Cimanuk-Rabat Bibir                       |
| Daily rainfall flow area Ci Manuk | Annual rainfall in table                | Balai Besar Wilayah                               |
| River year 2002-2018              | Form                                    | Sungai Cimanuk-Rabat Bibir                       |
|                                   |                                         | Cisanggarung and Pusat                           |
|                                   |                                         | Penelitian Sumber Daya                           |
|                                   |                                         | Air Kabupaten                                    |
| Ci Manuk River Month - Time (2002 | Monthly Debit in table                 | Majalengka                                       |
| - 2018)                           | Form                                    | Balai Besar Wilayah                               |
|                                   |                                         | Sungai Cimanuk-Rabat Bibir                       |
|                                   |                                         | Cisanggarung and Pusat                           |
|                                   |                                         | Penelitian Sumber Daya                           |
|                                   |                                         | Air Kabupaten                                    |
|                                   |                                         | Majalengka                                       |
|                                   |                                         | Geospatial Information                           |
| Ocean Currents, Waves and Tides   | Shapefile (shp)                         | Agency                                            |
|                                   |                                         | Geospatial Information                           |

The results of data collection and processing are carried out using descriptive-quantitative analysis and spatial analysis. Descriptive-quantitative analysis was carried out for processing debit data using logarithms derived from the flow of the river basin $Q_s = a \cdot (Q_w)^b$ where $Q_s$ were sediment discharges, $a$ of 13.33, $Q_w$ was the flow of rivers and $b$ of 0.96. Descriptive analysis is used to see the relationship between the existing flow rate and the erosion process that occurs which causes sedimentary transport as an internal factor that forms the delta. Whereas spatial analysis is used to see the dynamics of the change in the western Ci Manuk delta by processing data within a span of four years and then overlaying techniques is performed to see the large magnitude of abrasion and accretion that occurs in the western Ci Manuk delta.

3. Result

Based on the history of the formation of the Ci Manuk delta, the delta formed west of Indramayu is a delta due to the main Ci Manuk river crossing. This change gradually became significant because the main Ci Manuk river experienced a very large sedimentation so that the river banks began to overgrow the land used as agricultural land by the surrounding community. In addition, there was also a change in river flow due to the breaking of the Ci Manuk river embankment in 1947 and caused a new river flow direction so that it was made a northwestward direction. In addition to overcoming the broken embankment, the sodetan was made to cope with the flood that occurred in the main downstream of Ci Manuk in 1988. However, over time, the Sodetan region heading to the northwest grew. The direction of the flow that was originally directed directly to the north of Indramayu (downstream of Ci Manuk) but now branching and delta growth that occurs in the west is more dominant. The following is an illustration of the changes in the Ci Manuk delta from 2002 - 2018 with data processing carried out every four years.
Based on (Figure 2) above, delta formation in the west occurs in stages, delta changes that occur in the range 2002 - 2018 in the western part of the Ci Manuk delta are more dominated by the delta accretion process (area addition) compared to delta abrasion (wide reduction). Changes that occur are influenced by Internal and External Factors. Internal factors in delta changes affect changes in delta area (addition of sedimentation), this can be seen in the (Table 2) below.

Table 2. Sediment Transport Discharge

| No | Month | Sediment Transport Discharge (ton/month) |
|----|-------|-----------------------------------------|
|    |       | 2002         | 2006         | 2010         | 2014         | 2018         |
| 1  | Jan   | 86.895,31    | 66.422,01    | 58.704,90    | 66.046,78    | 34.953,42    |
| 2  | Feb   | 38.070,60    | 75.265,53    | 93.828,97    | 53.536,89    | 60.668,75    |
| 3  | Mar   | 58.458,64    | 37.284,80    | 86.893,82    | 83.178,96    | 87.180,70    |
| 4  | Apr   | 56.935,33    | 36.850,25    | 63.500,21    | 67.261,59    | 40.799,60    |
| 5  | Mei   | 15.209,89    | 29.820,76    | 83.364,17    | 25.754,73    | 19.240,53    |
| 6  | Jun   | 24.881,46    | 7.491,54     | 33.890,56    | 19.438,33    | 16.560,80    |
| 7  | Jul   | 9.168,17     | 4.075,45     | 22.701,20    | 19.484,83    | 16.600,77    |
| 8  | Aug   | 4.446,90     | 2.845,35     | 21.709,51    | 7.805,63     | 14.103,27    |
| 9  | Sep   | 2.427,44     | 1.878,80     | 57.823,39    | 3.464,49     | 6.318,06     |
| 10 | Oct   | 2.036,23     | 1.520,69     | 39.047,11    | 3.470,38     | 2.326,31     |
| 11 | Nov   | 9.993,53     | 2.176,02     | 63.867,92    | 11.538,27    | 11.699,61    |
| 12 | Des   | 34.156,62    | 34.156,62    | 84.814,33    | 72.521,23    | 22.998,42    |
|    | Amount| 342.680,13   | 299.787,84   | 710.146,09   | 433.502,10   | 333.450,22   |
|    | Average| 28.556,68   | 24.982,32    | 59.178,84    | 36.125,18    | 27.787,52    |

Based on the table above, it can be seen that mudflow discharge every year has fluctuating values, in 2010 sediment transport discharges have a large value compared to other sediment transport, this is because in 2010 there was a large rainfall so that the sediment transport discharge in that year even big. Average mud transportation in Ci Manuk is around 26,000 per month. To further clarify the picture from the above table, the following is a picture of the change in the western Ci Manuk delta from 2002 - 2018. (Figure. 3).
Based on Figure 3, it is the result of delta changes that occurred in the period 2002 - 2016, 2006 - 2010, 2010 - 2014 and 2014 - 2018 in the western delta Ci Manuk. In the Ci Manuk delta in the west with a period of 2002 - 2006, it was dominated by the accretion process in the east and south of the delta. While the abrasion process that occurred in the 2002-2006 period only occurred in the north. In the Ci Manuk delta in the west with a period of 2006 - 2010, it was dominated by the accretion change process found in the north and south and in the east. While the abrasion process that occurred in the period 2006 - 2010 only occurred in the south and north but did not dominate.
In the Ci Manuk delta in the west with a period of 2010 - 2014 dominated by the accretion process found in the north, west and south. While the abrasion process that occurred in the period 2010 - 2014 only occurred in the east and dominated but not too broad. While the Ci Manuk delta in the western part with a period of 2014 - 2018 is dominated by an accretion change process which is almost present in all parts of the western Ci Manuk delta. While the abrasion process that occurred in the period 2014 - 2018 only occurred in the south but did not dominate. The extent of the delta changes are as follows

| Period of Time | Changes Delta (ha) | Abrasion | Accretion |
|---------------|--------------------|----------|-----------|
| 2002 - 2006   | 68.31              | 94.96    |
| 2006 - 2010   | 23.16              | 64.18    |
| 2010 - 2014   | 24.42              | 158.89   |
| 2014 - 2018   | 12.77              | 204.26   |

Based on Table 3, in the period 2002 - 2006 the western part of Ci Manuk delta experienced an abrasion process of 68.31 ha and an accretion process of 94.96 ha. This indicates that the delta deformation process in 2002 - which occurred in the western part of the Ci Manuk delta, the deposited sediment material process is more dominant compared to the erosion process by external factors that occur on the coast, so that in the process of forming the delta on the west Ci Manuk in 2002 - 2006 experienced extensive changes in the north experiencing abrasion and in the south experiencing accretion, the shape of the western delta in the 2002-2006 period did not change. originally the Cuspate type delta became the Bird-foot type.

Whereas in the period 2006 - 2010 the western part of the Ci Manuk delta experienced an abrasion process of 23.16 ha and an accretion process of 64.18 ha. This indicates that the delta deformation process in 2006 in the western part of the Ci Manuk delta, the deposited sediment material process is more dominant compared to the erosion process by external factors that occur on the coast, so that in the process of forming the delta on the west Ci Manuk from 2006 to 2010 experienced a change in shape from the original Cuspate type delta because it has a coastline resembling the letter V to be a Bird-foot type that resembles a bird's foot.

Whereas in the year 2010 - 2014 the process of delta changes that occurred in the western Ci Manuk delta experienced an abrasion process of 24.42 ha and an accretion process of 158.89 ha. This also indicates that the delta deformation process in 2010 in the western part of Ci Manuk delta, the process of sediment material deposited in the estuary is more dominant when compared to the erosion process by external factors that occur on the coast, so that the formation proces the western part of Ci Manuk delta in 2010-2014 did not change its shape but only experienced the accretion of the delta.

Whereas in 2014 - 2018 the process of delta changes that occurred in the western Ci Manuk delta experienced an abrasion process of 12.77 ha and an accretion process of 204.26 ha. This also indicates that the delta deformation process in 2014 - 2018 occurring in the Ci Manuk delta in the western part of the process of sediment material deposited in the estuary is more dominant compared to the erosion process by marine factors that occur on the coast. the western part of Ci Manuk delta in 2014 - 2018 did not change its shape but only experienced the accretion of the delta.
Based on Figure 4 above, it gives a picture of the speed, direction of currents and tides that occur on the north coast of Java, especially Indramayu Regency with the same coordinate location. Sea currents have different values and directions, because monthly data collection is done according to the conditions of the image taken to process data. Based on this, ocean currents have an important role that can form waves. Sea currents are influenced by wind that blows so that when the wind crosses the north coast of Java island, the wind makes a shock to the water so that the water forms waves. In the process of changing the delta, ocean currents play a role in carrying sediment material that results from erosion that occurs along the delta coast and settles when the current gets reflected from the coastline so that it loses the ability to transport the sediment material contained therein. While the tidal data that
occurred in the coastal areas of Indramayu Regency did not have any elevation below 0, this indicates that the land area on the Indramayu coastline was experiencing land subsidence.

Tides that occur on the coast have a role in the process of delta deformation. Where the process of changing the delta that is affected by tides is the frequency of tides that rise and fall (tides and tides) in one day causing land on the coast to experience two different conditions. At high tide, the land area that is submerged by tidal flood will experience humid or wet conditions and the movement of currents and waves that cross the affected land area will be eroded because indirectly at the time of the tide the coastline will retreat and cause Delta areas that are submerged by ocean tides will erode due to the texture of the sediments which tend to be smooth. Meanwhile, during low tide, the coastal conditions will dry up so that air can enter the soil particles and cause the land to have a cavity when the tide occurs again.

4. Conclusion
Based on the results of the discussion above, changes in the Ci Manuk delta in the west are influenced by internal factors compared to external factors. Internal factors influence the formation of deltas, which cause changes in the delta in the west from cuspat type to elongate type. This form of change occurred in the period 2006 - 2010. In 2002 - 2006 it only expanded and there was a change in flow, whereas in 2010 - 2014 the delta was expanded and in 2014 - 2018 the delta was expanded followed by land use in the west delta area.

5. References
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