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THE INFLUENCE OF OCEAN CURRENTS TOWARDS DISTRIBUTION OF TOTAL SUSPENDED SOLIDS VERTICALLY IN CILALANANG ESTUARY, DISTRICT INDRAMAYU

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ABSTRACT

Cilalanangriver located in the village of EretanWetan, District Indramayu. There are Fishery Harbor Beach (PPP) and shipping activities in this region is quite high. Activities in the PPP could potentially lead to silting due to the material carried by the river flow. The purpose of this study to determine the concentration of total suspended sediment (TSS) and the influence of ocean currents on the TSS in Cilalanang Estuary, District Indramayu. The research is located at coordinates 1080 4' 53.400" EL -1080 5' 50.215" EL and 60 19' 26.709" SL - 6019' 26.720" SL. The method used in this research is quantitative method. Analysis of the TSS is done by making the TSS distribution maps using ArcGIS10.5 and modeling ocean currents using MIKE 21. The results showed that the concentration of TSS at low tide toward the high tide is worth between 286-888 mg / l whereas when the high tide towards low tide worth between 348-553 mg / l. Dominant ocean current direction at the time of low tide to the hightide leads to the southwest. This causes TSS concentration coming out of the mouth of the river converge toward the southwest near the shore. In conditions of high tide toward low tide the dominant current direction leads to the northeast. This led to the spread of TSS concentration coming out mouth of the river away from the shore.

Key words: Cilalanang River, IndramayuDistrict,Ocean Currents, Ocean Tides, Total Suspended Solids

INTRODUCTION

Indramayu is located in the northern districts of Java precisely in the province of West Java. Coordinates of Indrmayu is 1070 51' 00" EL - 1080 36' 00" EL and 60 15' 00" SL - 60 40' 00" SL, Cilalanang river in the village of Eretan Wetan, administratively located in District Kandanghaur. River estuary serves as a dispensing and disposal of river discharge that carries the material supplied from land erosion, riverbed erosion, degradation of living creatures, industrial and household waste. This material will be mixed in the water column and some of the material will settle to the river mouth and the rest will be forwarded to the sea. Suspended sediment is sediment material floating in the water moving in a certain time without touching the bottom of the water. Water circulation patterns such as streams and tidal currents is a factor that most influences the distribution of suspended sediment in estuaries (Chester, 1990 in Satriadi and Widada, 2004).

Sediment transport in estuaries occurs through the waters bedload and suspended load. Sediment transport in suspended load is strongly influenced by the flow velocity, which transports fine material. Trasnport changes with suspended sediment load in the river mouth and around the waters of the river estuary Cilanang, seen by the turbidity level of water in the river. River water has a turbidity level will flow towards the mouth of the river up towards the open sea.

The concentration of the material carried by the flow of river sediment in the estuary could potentially cause silting up because of delays in the river flow to the sea. Factors causing silting in the river is high activity in the Port of Coastal Fisheries. Activities that occur potentially causing silting due to source materials transported by the flow of the river. Disruption of shipping lanes of fishing vessels that affect the levels of suspended solids material through the mixing process (mixing) caused by the movement of ships as well as the flow of the river that carries it. Through these considerations, the need for further study to determine the effect of the concentration anddistribution of material suspended solids. Map of research sites are shown in Fig.1.

MATERIAL AND METHOD

Materials of Research

The main material used in this study is the MPT water sample data and the data of ocean currents. Supporting material used in this study is tide data in Cirebon published by Geospatial Information Agency (BIG) in September 2016, Topographic Indonesia Map (RBI) published by Geospatial Information Agency (BIG) in 1999 at a scale of 1: 25,000, bathymetry map of Tanjung Priok Up Cirebon Scale 1: 200,000 published by DISHIDROS Navy in 2013 and Landsat 8 published by United States Geological Survey (USGS) recorded on September 11, 2016.

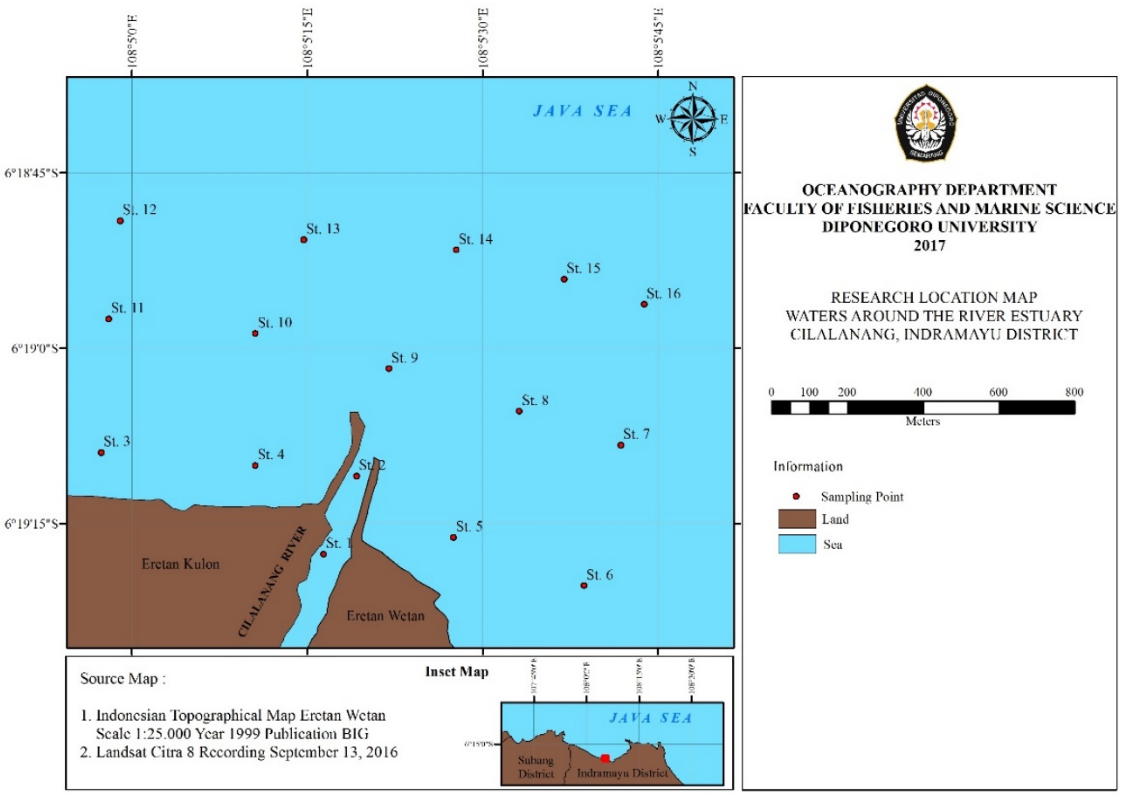

Figure 1. Research Location

Method

The method used in this research is quantitative method. According Sugiyono (2009), quantitative methods are methods used to examine the population or a particular sample, data collection using research instruments as well as data that has been obtained is processed into the form of numbers. Location research using purposive sampling. Purposive sampling method is a method in which the sample collection point or station based on certain considerations are made to represent the condition of researchers and research areas (Sugiyono, 2009). Sampling of suspended sediment in the waters around the mouth of the River Cilalanang, Indramayu regency determined with particular consideration at which point a determination to represent the overall condition of the area under investigation using the Global Positioning System (GPS) at each station, the number of research stations totaling 16 points. In consideration of 1,2,9,14 station is a station that is located perpendicular to the river mouth, 3,4,10,11,12,13 station is a station located west estuary and 5,6,7,8 station, 15.16 is a station located east estuaries.

Sea Current Measurement

Measurements of ocean currents in this study using lagrange method. Lagrange method using a ball to measure the speed and direction of ocean currents. Compass viewfinder is used to determine the current direction.

Sampling MPT

TSS samples were taken using Nansen bottles that have been linked with a string, and then inserted into the Nansen bottle waters. If the Nansen bottle has reached a certain depth. Iron ballast is dropped into the water that has been linked with a string. Nansen bottles will automatically trap samples of sea water into the Nansen bottle. Nansen bottle is pulled to the surface and sea water samples were transferred into the sample bottle.

TSS Analysis Method

The method used in analyzing samples of SST using gravimetric analysis. The methods used for analysis of substances (solid) is suspended gravimetric analysis method.

Tidal Analysis Method

According to Djaja (1989), the tidal measurement data in the field then carried tidal harmonic analysis methods in order to obtain constant Admiralty tidal harmonics ie M2, S2, K2, N2, K1, O1, and P1.

Flow Model Analysis Method

The pattern of ocean currents gathered from data processing using software models MIKE21. Before the tide data input derived from the supporting data modeling flow pattern. The results of field measurements will produce data such as speed, direction and the coordinates of the current total. The speed and direction of ocean currents will be described as component of U (east-west) and V (north-south).

TSS Concentration Analysis Method

Map of the TSS concentration distribution in the estuary of the Cilalanang created using ArcGIS
software 10.5 using topo to raster method by inserting TSS concentration of each station.3.

RESULT AND DISCUSSION

Result

Ocean Currents

Results of field measurements showed that the dominant ocean current leads westward at low tide toward the maximum current speed of 0.192 m / sec while the minimum flow velocity of 0.028 m / sec. While the dominant flow during ebb tide toward leads to the north with a maximum speed of 0,287 m / sec while the minimum flow velocity of 0,037 m / sec.
Rose current picture can be seen in Figure 2 and Figure 3.

Based on the data processing speed that has been done indicates that when the current flows closer to land diminishing value of the current velocity at high tide or low tide heading towards the tide receded. Measurement data speed and direction of currents are presented in Table 1.

Tide

Results of data processing is done using admiralty method tidal component values obtained as shown in Table 2. And based on the value obtained tidal component can be seen that the territorial waters of the river estuary tidal Cilalanang has type double daily skewed mix with Formzahl value (F = 0.929 cm), face surutan (Z0 = 27.283 cm), the mean sea level (MSL = 90.386 cm), the lowest sea level (LLWL = 42.538 cm), and the highest sea level (HHWL = 138.235 cm).

Total Suspended Sediment

Results of processing of Landsat 8 shows the dominant direction of suspended solids material distribution at sea level to move westward and value TSS concentration range 26-207 mg / l. In Figure 2 the concentration of TSS is based on Landsat 8 is shown in Table 3. Based on the results of field measurements and laboratory analysis of samples of TSS in the waters around the mouth of the river when the flood tide Cilalanang TSS concentration values ranging from 295-475 mg / l in depth 0,2d; 286-771 mg / l in depth 0,6d; 295-888 mg / l in depth 0,8d. Meanwhile, when the ebb tide toward TSS values ranging from 387-515 mg / l in depth 0,2d; 348-553 mg / l in depth 0,6d; 383-544 mg / l in depth 0,8d. TSS concentration value at all observation stations and all the depth can be seen in Table 4 and in the TSS distribution maps and flow pattern can be seen in Figure 3 to Figure 8.

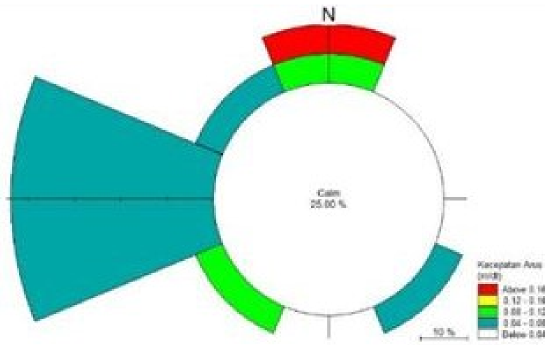

Figure 2. Current Rose When Flood Tide

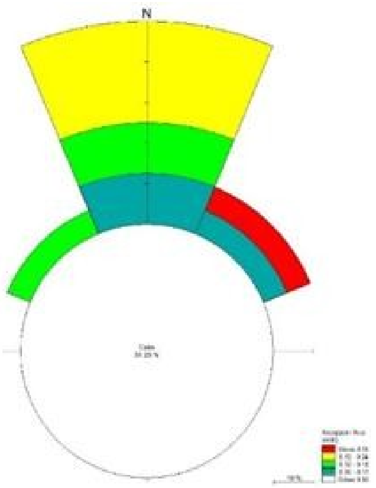

Figure 3. Current Rose When Ebb Tide

Table 1. Velocity and Direction of Ocean Currents Filed Data

Station	Date	Flood Tide			Ebb Tide		
		Current Velocity (m/sec)	Direction (degree)	Direction	Current Velocity (m/sec)	Direction (degree)	Direction
1	15/09/2016	0,091	219	BD	0,053	2	U
2	15/09/2016	0,028	218	BD	0,067	5	U
3	15/09/2016	0,089	346	U	0,045	76	T
4	15/09/2016	0,192	346	U	0,073	352	U
5	15/09/2016	0,038	310	BL	0,217	9	U
6	15/09/2016	0,045	311	BL	0,037	138	TG
7	15/09/2016	0,034	304	BL	0,287	23	TL
8	15/09/2016	0,066	283	B	0,193	5	U
9	15/09/2016	0,070	120	TG	0,151	17	U
10	15/09/2016	0,067	269	B	0,037	240	BD
11	15/09/2016	0,062	260	BD	0,166	330	BL
12	15/09/2016	0,073	259	BD	0,050	290	B
13	15/09/2016	0,062	279	B	0,085	29	TL
14	15/09/2016	0,074	280	B	0,208	356	U
15	15/09/2016	0,041	271	B	0,182	13	U
16	15/09/2016	0,029	270	B	0,154	7	U

Table 2. Tidal Component Values

Component	Amplitude(cm)	Phase(g^0)
S0	90,39	-
M2	12,80	57,25
S2	12,00	338,11
N2	7,19	347,50
K1	16,94	305,53
O1	6,11	31,61
M4	2,12	319,21
MS4	0,98	324,52
K2	2,76	698,11
P1	5,59	665,53

Table 3. TSS concentration Surface Based on Landsat 8

Station	Coordinate		TSS concentration Surface Based on Landsat 8 (mg/l)
	Latitude	Longitude	
1	6^0 19' 17,636"	108^0 5' 16,390"	84,271
2	6^0 19' 10,949"	108^0 5' 19,213"	84,415
3	6^0 19' 8,915"	108^0 4' 57,363"	52,049
4	6^0 19' 10,045"	108^0 5' 10,546"	55,578
5	6^0 19' 16,197"	108^0 5' 27,494"	63,191
6	6^0 19' 20,340"	108^0 5' 38,668"	48,744
7	6^0 19' 8,287"	108^0 5' 41,807"	36,779
8	6^0 19' 5,400"	108^0 5' 33,144"	36,779
9	6^0 19' 1,759"	108^0 5' 21,970"	53,330
10	6^0 18' 58,746"	108^0 5' 10,546"	71,362
11	6^0 18' 57,490"	108^0 4' 57,991"	45,314
12	6^0 18' 49,079"	108^0 4' 58,996"	45,468
13	6^0 18' 50,711"	108^0 5' 14,689"	36,613
14	6^0 18' 51,590"	108^0 5' 27,746"	36,017
15	6^0 18' 54,092"	108^0 5' 36,963"	34,894
16	6^0 18' 56,252"	108^0 5' 43,823"	35,632

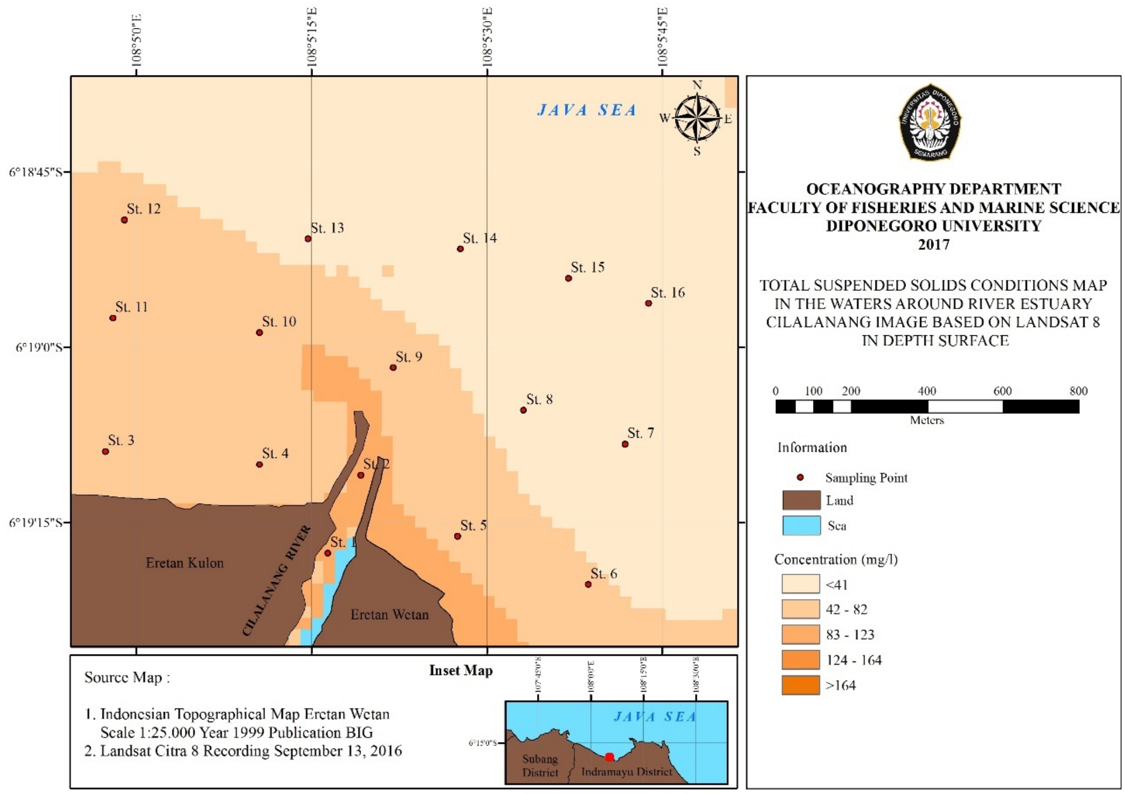

Figure 4. TSS concentration Surface Based on Landsat 8

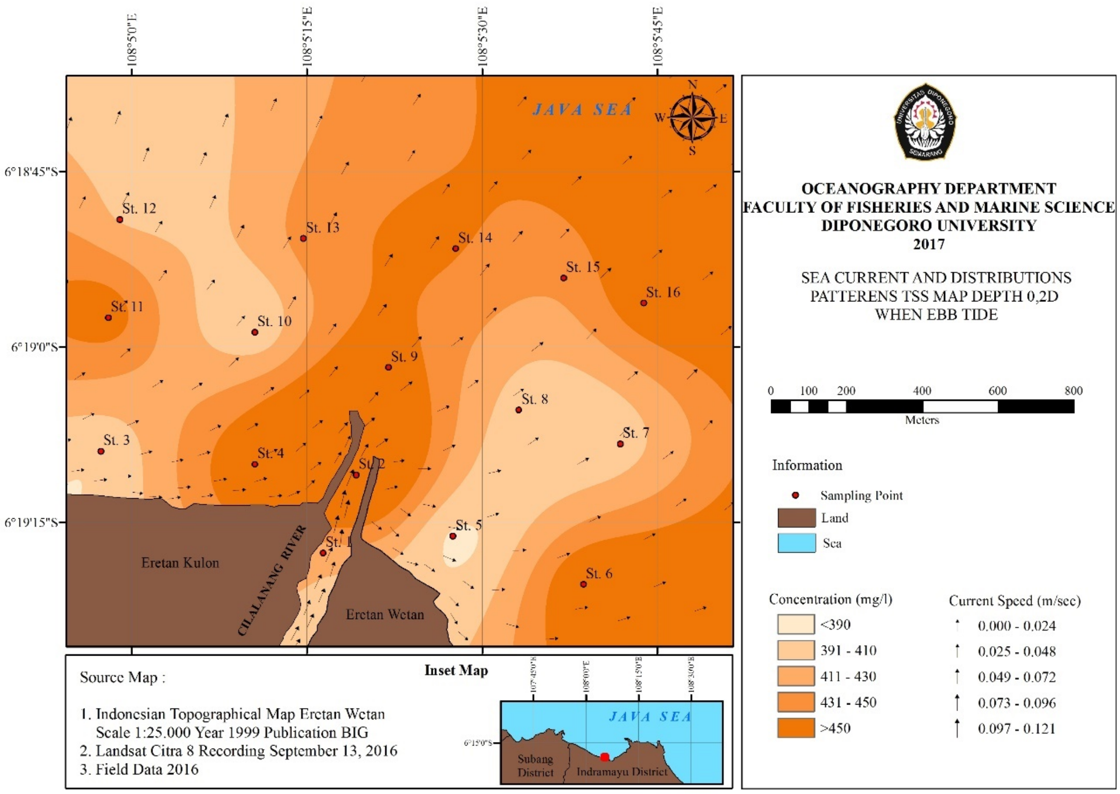

Figure 5. Sea Currents and distribution patterns TSS Depth 0,2d When Ebb Tide

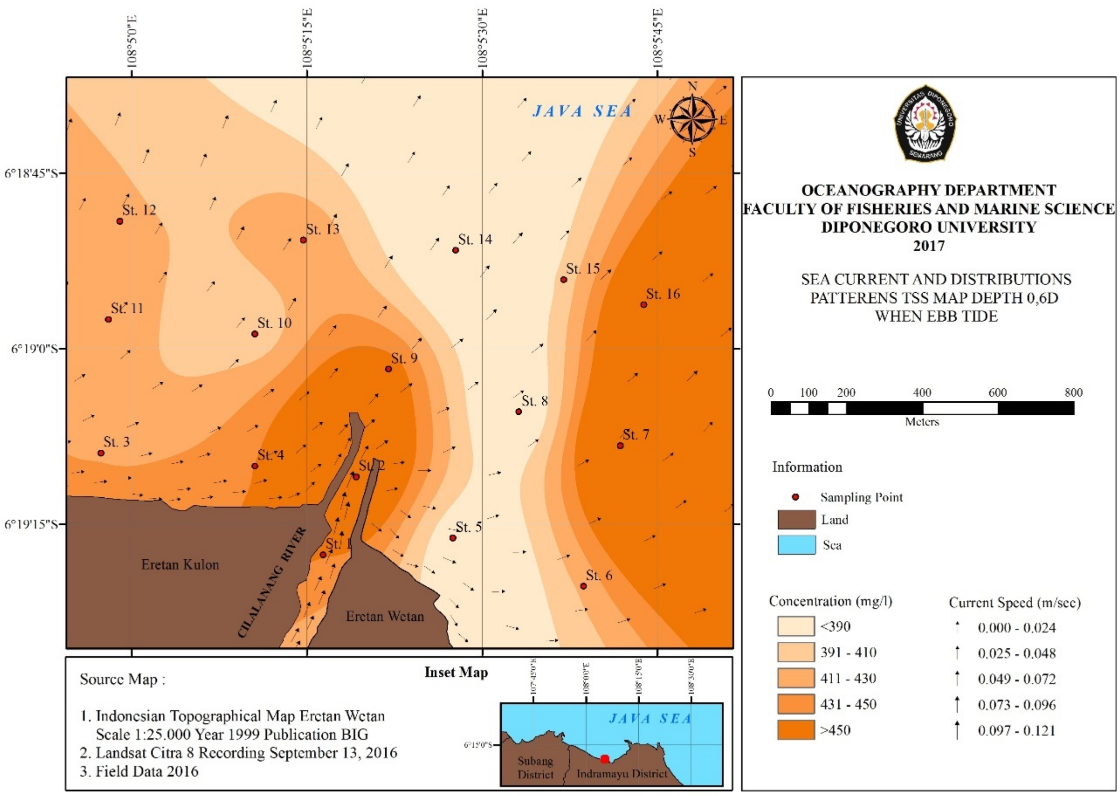

Figure 6. Sea Currents and distribution patterns TSS Depth 0,6d When Ebb Tide

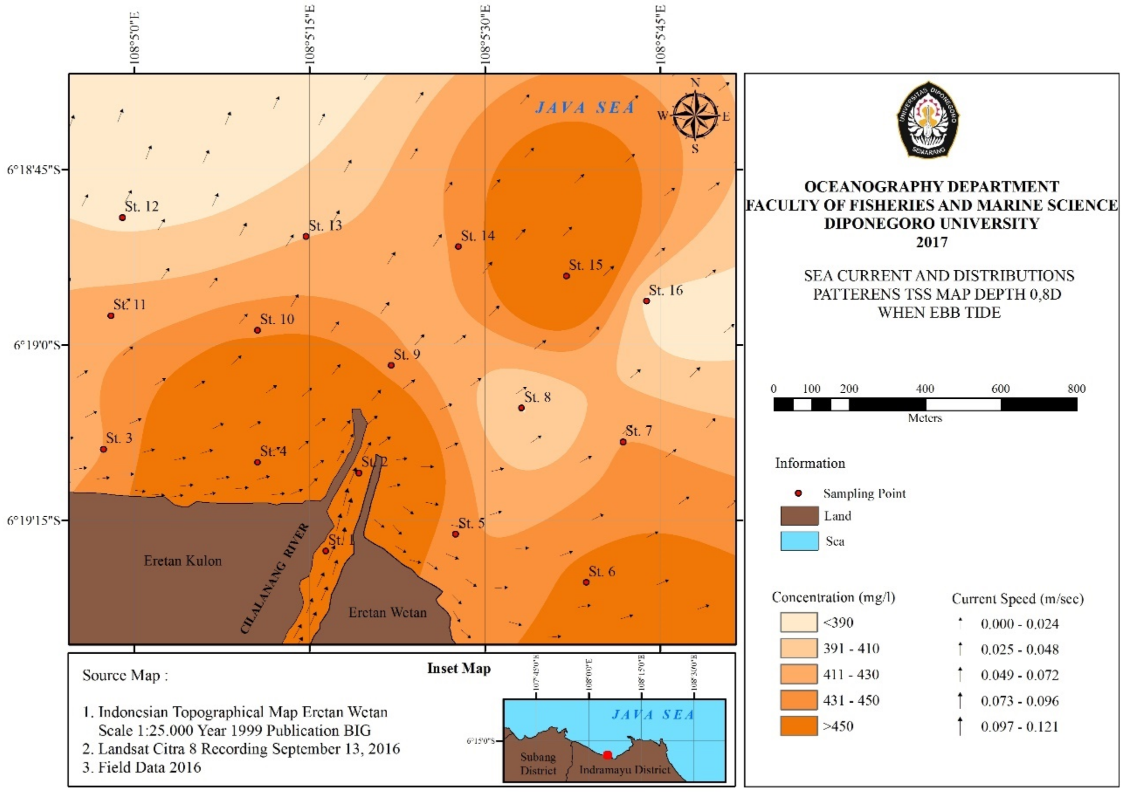

Figure 7. Sea Currents and distribution patterns TSS Depth 0,8d When Ebb Tide

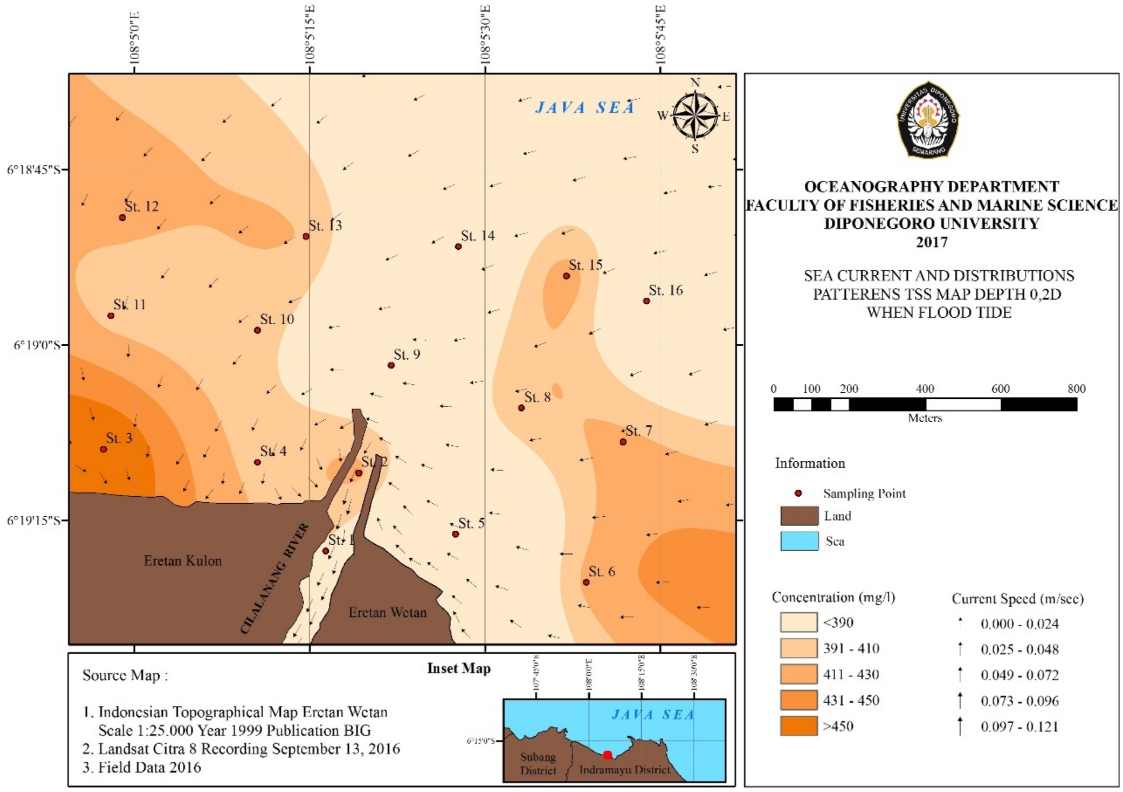

Figure 8. Sea Currents and distribution patterns TSS Depth 0,2d When Flood Tide

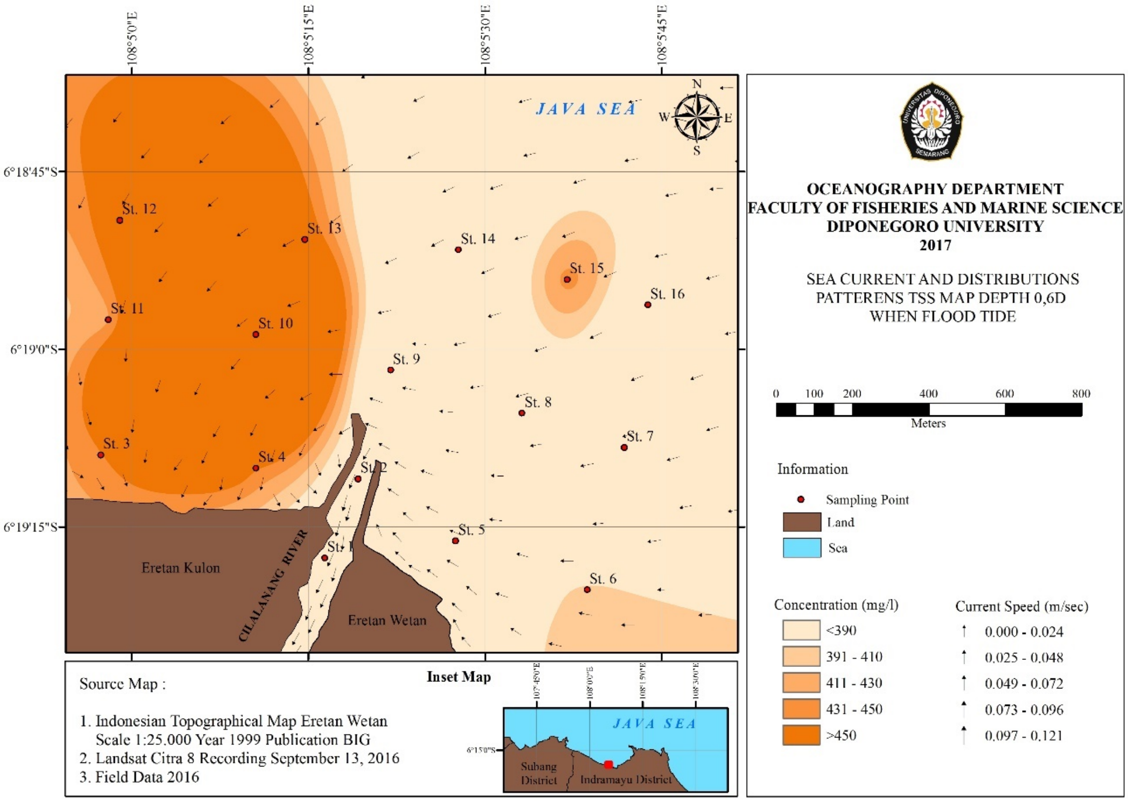

Figure 9. Sea Currents and distribution patterns TSS Depth 0,6d When Flood Tide

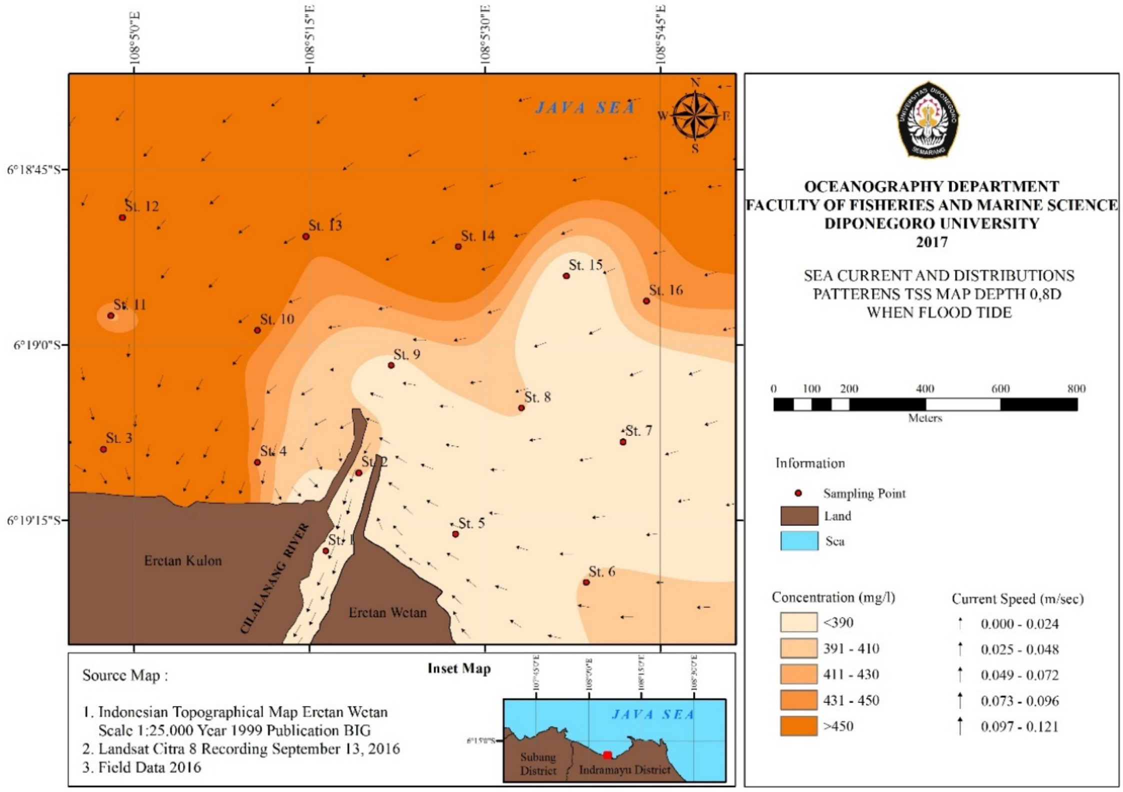

Figure 10. Sea Currents and distribution patterns TSS Depth 0,8d When Flood Tide

Field Data Verification and Model Data

Based on the simulation results of the current pattern is modeled using software MIKE 21. Fromthe verification results obtained CF values the model with field data in the U direction 0.092 and V direction of 0.160 with an excellent classification.

Discussion

Based on the model results in ocean currents, ocean currents moving north (towards the sea), whilethe current was far away from the mouth of the River Cilalanang current direction moving toward the northeast. Ocean currents near the beach during ebb tide headed east. This is due at the time of ebb tide conditions, the current direction heading north because of a low water level due to experiencing the lowest ebb. When the flood tide conditions, the current direction toward the south due to a high water level. The cause of this is due to the high water mark is based on the results of the supporting data. When conditions ebb tide, the dominant current direction towards the south. When the condition of flood tide, the dominant current direction heading west.

Based on modeling results using software MIKE 21 is the maximum current speed of 0.144 m / sec during the flood tide. While at ebb tide, the maximum current speed is 0.121 m / sec. The current direction during ebb tide models dominant leading to the northeast, while at flood tide dominant direction toward the southwest. The maximum field current speed is 0,287 m / sec at ebb tide conditions. While the maximum field current speed of 0.192 m / sec at flood tide conditions. Difference value when flood tide flow velocity greater than the speed of the current flow when the ebb tide. Differences occur in the direction of flow of the sea turned almost 1800 when the current ups and downs also proved that the flow of the waters are tidal currents (Triatmodjo, 1999).

Based on the data processing that has been done, the results of the analysis showed the depth 0,2d TSS around the station when the flood tide, the highest TSS concentration value at station 3 with a value of 475 mg / l. While the ebb tide when the highest concentration value at station 2 with is 515 mg / l. TSS analysis on the depth 0,6d throughout the station as flood tide, the highest TSS concentration value obtained at station 10 with the concentration of 771 mg / l. Meanwhile, when the ebb tide conditions TSS concentration highest values obtained at station 7 with a value of 553 mg / l. The results of the analysis on the depth 0,8d TSS around the station when the flood tide, the highest TSS concentration values in the station 3 with a value of 888 mg / l. While the ebb tide when the highest concentration values obtained at station 2 with a value of 544 mg / l. Station 2 in the depths of time ebb tide 0,2d located at the mouth of the river mouth has a high concentration of TSS and the point at which the meeting between the mass of sea water and river water masses, each of which carries materials. At this location there mixing sediments resulting in these areas have suspended solid material which is higher than the other stations. This is in accordance with the opinion of Triatmodjo (1999) which states that the mouth of the river serves as the drain of the land, so in the near shore area has a high concentration of TSS. Based on the analysis TSS values obtained the highest concentrations in the waters around the mouth of the river Cilalanang occur when the flood tide at the station 3 at a depth of 0,8d. Results of TSS concentration difference is caused by the depth of the waters and tidal waters around the mouth of the River Cilalanang. Besides the oceanographic parameters are ocean currents that can go deep enough into the water bodies resulting in an engaging TSS has occurred, even before the river water into the sea. Stirring causes the high value of TSS concentrations in water bodies before heading out to sea this was confirmed by Satriadi and Widada (2004), which explains that the high tide could bring water and sediment particles farther upstream so directly affect the TSS concentration in the area.

Based on the processing of Landsat 8, TSS distribution in the depth direction surface concentration between 26-207 mg / l. Landsat 8 is used for comparison with observational data field. The results show the differences in results between the concentration of Landsat 8 and with the field data. Directions distribution of TSS shows the results of the dominant westward estuaries. This is caused by the time difference between Landsat 8 with field data. Landsat 8 is recorded on 11 September 2016 whereas when the observations were made on 15 September 2016, with the highest concentration value MPT at station 2with TSS concentration was 84.415 mg / l and the lowest at 15 stations with TSS concentration was 34.894mg/l.

CONCLUSION

Based on the data processing TSS concentration results obtained with the highest value at flood tide conditions with TSS concentration value is 888 mg / l at station 3 0,8d depth. At ebb tide conditions with TSS concentration value is 554 mg / l at Station 2 0,8d depth. Dominant ocean current direction during flood tide leads to the southwest that causes TSS concentration coming out of the mouth of the river raised to the southwest approaching the shore. At ebb tide conditions, the dominant current direction leads to the northeast and distribution of TSS concentration coming out mouth of the river away from the shore. The diversity of the concentration of suspended solids material in Cilalanang River estuary waters affected by tides.

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