The field study of hydro-oceanography of Krueng Teunom estuary

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Abstract. Hydro dynamic of estuarial area has great effect on how river flow influence on the dynamic of sea coast. The study of hydro-oceanography of Krueng Teunom estuary was done by observing and retrieving data directly from the field. The study aims to understand how the dynamic of flow, waves and tides in the estuary of Krueng Teunom work in the area as knowledge base of hydro-oceanography dynamic in the coastal zone. The method used in this study was a direct measurement in the field with several sample points as a purposive sampling. The results showed that the condition of the waters dynamics was more influenced by upstream currents while the influence of waves in the estuary area was not dominant.

1. Introduction

Krueng Teunom estuary is located in Aceh Jaya. The estuary is used as a place of residence, small fishing vessel lanes and a source of livelihood for the local community. In addition, the Krueng Teunom estuary is also a habitat for organisms such as benthos but also vulnerable to pollution [1, 2] and [3]. Krueng Teunom estuary is influenced by fluctuations in currents, waves and tides. According to Irham et al. [3], tides that occur in an estuary can cause water quality both at high tide and at low tide, this is due to the tidal dynamics that cause fluctuations in the mass transfer of water [4]. Mass water transport occurs from the sea to the river or vice versa which can carry polluted material. Therefore, knowledge of tides, wave and circulation patterns of tidal currents in coastal waters can provide an indication of the movement of water masses [5, 6, 7] and their relation as factors that can affect the distribution of a material in the water column [8]. Thus, the study of hydro-oceanography in the estuary area needs to be done to determine the characteristics of these waters. By knowing the characteristics of hydro-oceanography, the analysis of the waters and their relevance to aquatic geomorphology can be described scientifically. This is because the waters in the form of fluids do not recognize administrative or ecological boundaries, so if the waters in a location are polluted, the impact will spread to the surrounding area [9, 10, 11].

Several studies on estuary hydrodynamics have been conducted by several researchers to determine sediment transport [7, 11], the distribution of polluted matter [12, 13], fluvial systems and oceanographic
dynamics [14, 15, 16, 17]. These studies have used direct field measurement [18], 19], physical models [20] and numerical models [21, 22, 23]. None of the hydrodynamic studies, however, conducted in the Krueng Teunom estuary. Even though some of the studies that have also been led in the Krueng Teunom area are more focused on living things in the waters and several environmental studies [24, 25], unfortunately, there has never been a study of hydro-oceanography at the Krueng Teunom estuary. Therefore, a field measurement study as the initial basis for hydro-oceanographic dynamics is important in this area. Hence, the purpose of this study was to determine the hydro-oceanographic dynamics in the Krueng Teunom estuary, Aceh Jaya. It is expected that the results of this study will be preliminary information about hydro-oceanographic conditions, especially the dynamics of the waters at the Krueng Teunom estuary. The result of this preliminary study can be a reference for further research in describing hydro-oceanographic conditions at the Krueng Teunom estuary, Aceh Jaya.

2. Method
This research will be conducted in Teupin Ara Village in Teunom Subdistrict, Aceh Jaya in April 2018. While data analysis from hydro-oceanography is carried out at the Marine Sciences Laboratory of Marine and Fisheries Faculty of Syiah Kuala University. The location map of the research can be seen in Figure 1 below.

![Map of study area located the estuary of Krueng Teunom, Aceh Jaya District](image)

2.1 Tidal measurement
Tides were measured using a prepared pole. The way to do this is:
1. The tool was installed in the tidal area which is still submerged in water with the lowest ebb
2. The height of the sea surface was initialized as $T_0$.
3. Within an interval of 15 minutes, the sea level (as $T_i$) was recorded.
4. The results obtained were copied in the table provided.
5. Measurement of tides was done at station 5 only.
2.2 Wave measurement
For wave measurements, the same device from tidal measurements is used. The way the instrument works is:
1. Scale board was installed in the water
2. The wave height was measured the same as tidal measurements but the period wave measurement is very short
3. The height of the wave peak to the next wave peak was recorded as the time interval period. This treatment was continuously made until it was produced 1000 waves.
4. Wave height measurements were also carried out at station 5.

2.3 Flow measurement
Because of the limitations of the equipment, the current was measured manually using a very simple method. This simple method is a combination of floating tools tied to raffia straps as measuring distances. Current measurements were carried out using floating balls that the movements are affected by the movement of the mass of water so that the velocity of the floating object is considered to be the same as the velocity of the water surface. Speed was measured based on the distance of the rope that has been determined the size of the length with the unit time of the rope trajectory. The direction of the current seen from the direction of the floating ball stops. Each measurement is done five times so that the resulting size is more accurate.

3. Result and Discussion

![Figure 2. Wave height signals measured](image)
Figure 3. The signal of wave period measured

The results of the hydro-oceanographic data analysis at Muara Krueng Teunom, Aceh Jaya in April of 2018 can be seen in Figures 2, 3 and 4. The wave height measurement result (Figure 2) shows the highest wave was 1.95 m and the lowest wave was 1.00 m. While the wave period (Figure 3) shows the fastest incoming waves was 2 seconds and the slowest was 24 seconds with the average wave period was 9.83. Tidal measurements for 24 hours measurement (Figure 4) indicate that the tides in the Teunom region are a semi-diurnal tide.

Table 1 shows the results of current measurements carried out in each station. The results show that the smallest flow occurred at station 9 with a value of 0.03 m/sec, while the largest flow occurred at station 1 with a value of 0.93 m/dt. While the direction of the current (Table 1) is relatively dependent on the shape and the curve direction of the river. The measurement data of flow and its direction can be seen in the following Table 1.

Table 1. The data of flow magnitude and flow direction

| Station | Flow (m/s) | Direction (°) |
|---------|------------|---------------|
| 1       | 0.9333     | 105           |
| 2       | 0.3629     | 81            |
| 3       | 0.3561     | 95            |
| 4       | 0.7095     | 82            |
| 5       | 0.5095     | 91            |
| 6       | 0.0496     | 79            |
| 7       | 0.0511     | 89            |
| 8       | 0.0391     | 91            |
| 9       | 0.0302     | 86            |

From the results of wave measurements, it shows (Figure 2) that the waves that occur are classified as moderate, even though the estuary is directly facing the Indonesian ocean. The medium wave height is likely to be caused by the east monsoon (when the data was taken in April), where the small wind speed results in wave height quite moderate. It is known that the areas directly facing the Indian Ocean have an average wave height of 1.5 m and a certain time such as the western season, waves can reach 2.5 m or more [26].
The measurement results of the wave period (Figure 3) shows that the average wave period is 9.83 seconds. These results indicate that the ripples of water moving towards the land are relatively slow. It is also strongly influenced by the speed of the wind blowing in the research area. Because the data collection carried out during the east season (east monsoon) where the wind blows from the land to the ocean, it causes the wave movement to slow down. Irham et al. [20] in his paper on water dynamics state that the wave currents that occur during the eastern monsoon have a small magnitude compared to the western monsoon which is caused by the influence of the wind blowing at that time.

Measurements of flow in the Krueng Teunom Estuary (Table 1) show that the currents are greater at stations 1 and 2 (upstream areas) while those in closed areas are considered small (Stations 6, 7, 8, and 9). Estuary currents (Stations 4 and 5) produce medium flow. Large currents occur at stations 1 and 2 due to the influence of upstream river flow. The effect of river flow in this station is not much influenced by the dynamics of the sea originating from the river estuary. While at stations 4 and 5 the flow is more influenced by ocean currents entering the estuary of the river, on the other hand, the speed of the flow from the river begins to decrease due to being blocked by the incoming seawater discharge. Relatively small currents occur in closed areas (stations 6, 7, 8, and 9) caused by small water flows entering the area. The current that enters through station 3 in this closed area is not circulated so that the circulation of water in this area is highly dependent on the tides.

The tidal measurements produce diurnal tides (Figure 4). It is seen that the highest tide at the time of measurement is 180 cm and the lowest low tide is 150 cm. The tides that occur when the measurement is considered high which is caused by the current state of data collection that is a full moon (April 14, 2018, at 13:00 Hours).

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