Wave height and period on 16 March, 21 April, and 22 September 2019, in the Ujung Batee coastal waters and Lampanah coastal waters, Aceh Besar District, Indonesia

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Abstract. Waves are one of the sea parameters that affect the rate of retreat of the coastline. This research investigation was carried out in the coastal waters of Ujong Batee and Lampanah, Aceh Besar District on 16 March, 21 April, and 22 September 2019, with the aim of examining wave parameters, namely wave height and period. Then the wave measurement data sampled at the research station location was carried out by purposive random sampling method. Sea wave data were taken using a scale board that has been labeled with numbers and a stopwatch. Wave measurements were carried out approximately 1000 times. Then the sea wave data is processed to obtain the wave height and period and then analyzed. The results obtained that the wave heights on 16 March, 21 April, and 22 September 2019 were 67 cm, 83 cm, and 80 cm in Ujong Batee and 55 cm, 67 cm, and 66 cm in Lampanah. While the wave period is 12 seconds on March 16, April 21, and September 22 in Ujong Batee and Lampanah. Thus, the wave height and period at both locations ranged from 50 cm to 80 cm and 12 s.

1. Introduction
Ocean waves are natural phenomena in the ocean that affect the safety and efficiency of marine activities, so information about the behavior of ocean waves is certainly needed. Coastal damage and changes can be caused by wind movements, currents due to waves that cause shoreline changes. Coastline changes in general are not only caused by natural factors but also human activities, including the destruction of coastal vegetation, aquaculture, port development activities, mining, dredging, coastal protection, coastal reclamation, and coastal tourism activities. Among the many waves of concern in marine meteorological information, there are three types of service waves, namely wind, tsunami, and tidal waves [1], and [2].

The waves can vary, this is influenced by the season or the wind. Based on this, it is very important to conduct research on wave measurements in the coastal waters of Ujong Batee and Lampanah based on time. In general, these ocean waves are ocean waves caused by wind. In the area where the wind blows, known as the fetch, there is a transfer of energy from the wind to energy from the waves over a
broad spectrum of frequencies. In other words, in the wind area a mixture of waves of various frequencies is formed [3], [4], and [5]. When compared with the research of Tagayaki et al. [3], James et al. [4], and Wang et al. [5], this study and the obtained wave parameters. In this study, the wave parameters were measured directly, while the research [3], [4], and [5] were obtained from wind forecasts.

Therefore, this study aims to examine the waves that occurred in the Ujong Batee coastal waters and Lampanah coastal waters on 16 March, 21 April, and 22 September 2019. Furthermore, this wave study can be recommended for coastal protection and tourism development.

2. Materials and Methods

This wave study was measured on 16 March, 21 April, and 22 September 2019 in the coastal waters of Ujong Batee (Station 1) with coordinates 95.54° East Longitude, 5.66° North Latitude and coastal waters of Lampanah (Station 2) with coordinates 95.7° East Longitude, 5.6° North Latitude, Aceh Besar District (Figure 1). The sea wave parameters in the form of the measured wave height and period were processed and analyzed.

![Figure 1. Research locations.](image)

The location of the wave research station was done by purposive random sampling method [6], [7], [8], [9], and [10]. Then the location was recorded using the Global Positioning System (GPS) as a record of the coordinates. At the measurement stations shown in Figure 1, the depth is less than 2-3 meters.

The sampling of wave height measurement data is determined in coastal waters using a labeled scale board. The bottom of the scale board sticks to the bottom of the water in an upright position before the wave breaks. As a wave arrives, the highest and lowest peak values are recorded to obtain the height of one wave. Calculations were carried out for 1000 replicates each on 16 March, 21 April, and 22 September 2019. While the measurement of the wave period is done by observing the first wave and the second wave by recording the time using a stopwatch.

In addition, that The wind speed and direction when measuring the waves on 16 March, 21 April, and 22 September 2019 were 5 m/s Northeast, 2.5 m/s North, and 2.5 m/s North, respectively.
3. Results and Discussion
The results of measuring the height and average period of sea waves in the coastal waters of Ujong Batee and Lampanah are shown in Table 1. Based on wave observations that have been collected from the coastal waters of Ujong Batee on 16 March, 21 April, and 22 September 2019, the results of the average wave height are 67 cm, 83 cm, and 80 cm and then 55 cm, 67 cm, and 66 cm in Lampanah coastal waters. While the period of the waves at the two locations is all 12 s. Based on WaveWatchIII (WW3) Global Wave Model [12] that on 16 March, 21 April, and 22 September 2019, the average wave height are 68 cm, 35 cm, and 37 cm and the average wave period are 13 s, 15 s, and 15 s in Ujong Batee. Then in Lampanah coastal waters, the average wave heights are 41 cm, 18 cm, and 11 cm and the average wave period is all 4 s. The difference between the results of this wave research and the WaveWatchIII (WW3) data is due to the lower data resolution.

| Table 1. Average height and period of sea waves in the coastal waters of Ujong Batee and Lampanah |
|-------------------------------------------------|-----------------|-----------------|-----------------|
| Month                           | Ujong Batee     | Lampanah        |
|                                 | Average wave height (cm) | Average wave period (s) | Average wave height (cm) | Average wave Period (s) |
| 16 March                        | 67              | 12              | 55              | 12              |
| 21 April                        | 83              | 12              | 67              | 12              |
| 22 September                    | 80              | 12              | 66              | 12              |

Based on the results of Table 1, the difference in sea wave height in the coastal waters of Ujong Batee is higher than Lampanah with a range of 10 cm to 15 cm. The difference in wave height is because the two coastal waters are in the Malacca Strait, namely Ujong Batee towards a widening strait and Lampanah towards a narrowing strait.

In general, the smaller wave heights are located in narrow straits compared to wide straits. And when compared to the wave height in the Ocean, the wave height in the Strait is also smaller [13], [14], and [15].

4. Conclusion
Based on the results and discussion of this study, it is concluded that the range of wave heights measured on 16 March, 21 April, and 22 September 2019 in the coastal waters of Ujong Batee and Lampanah is 55 cm to 83 cm and the wave period is 12 s. Meanwhile, based on data extraction of the Global WaveWatchIII (WW3) Wave Model, the wave height ranges from 11 cm to 68 cm and the wave period is 4 to 15 seconds.

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