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# Application of JONSWAP Method for Analyzing Wave Height and Period on the Coastal of Poso, Tomini Bay, Poso Regency

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**ABSTRACT**

Poso Regency has great potential to be developed into a marine tourism and fisheries city due to its 64.6 km coastline, extending from Tumora in North Poso Pesisir District to Malei in Lage District. For the development of a marine tourism and fisheries city in Poso Regency, data related to wave height and period are required. One method for measuring wave height and period in a body of water is the JONSWAP (Joint North Sea Wave Project) method, an advancement of the Pierson-Moskowitz (1964) method. The JONSWAP method incorporates fetch length and wind speed parameters for calculating wave height and period, whereas other methods only use fetch length. This study aims to analyze wave height and period in Tomini Bay, using the JONSWAP method. The results show that the wind direction dominantly from the north, with most wind speeds (67.71%) being below 0.5 m/s. Wind gusts from the southeast were not detected on the wind rose because the area is located in the Verbeek Mountains; thus, southeast winds can be deflected. The average wind speed is 1.533 m/s, the significant wave height is 0.09 m, the peak wave period is 3.603 seconds, and the wave type is non-fully developed sea.

**Keywords:** Wave Height, Wave Period, Poso Coast.

## 1. INTRODUCTION

The development of the coastal area of Poso Regency for marine aquaculture currently only contributes approximately 4.2% of the total marine fishery production in Central Sulawesi Province, which amounts to 165,404 tons [1]. For the development of coastal areas to support the tourism and fisheries activities, data related to wave height and wave period, in addition to other supporting data, are essential. Wave height and wave period data are crucial for coastal area development as they influence various aspects of planning, design, and management of infrastructure and activities in coastal regions.

One method to measure wave height and wave period is the JONSWAP (Joint North Sea Wave Project) method [2] [3]. The JONSWAP method is an extension of the Pierson Moskowitz method (1964), and the method commonly used today for the measurement of wave height and wave period. Pramita et al and Haiyqal et al measured wave height using the Wavewacth-III model [4] [5] , Setiawan et al, and Satriadi used the SMB method for wave measurement on Pabelokan Island [6] [7], Arianty et al used the STWAVE model to analyze wave characteristics in Palu Bay [8], Rumsarwir et al used Darbyshire and SPM methods for wave forecasting in Sindulang Manado [9], Sari et al used the Wilson method to analyze wave height on Kijing beach [10], Kurnianto et al used quantitative methods to study wave characteristics on Kejawanan beach, Cirebon [11], Latimba et al used CG WAVE simulation model for forecasting height and wave period on Tinobu Lasolo beach, North Konawe [12]. Priska used shoaling equation for analyze wave height on Tablolong Beach Tourism Area [13]. The research that will be carried out is different from previous research in terms of the method and location. Thus, this study aims to analyze the height and wave period of Poso coastal in Tomini Bay using the JONSWAP method.

## 2. METHODOLOGY

### 2.1. Location

This research was conducted on the coastal of Poso in Tomini Bay, located in Poso Regency at coordinates of 120°05'96” – 120°52'4.8” E and 1°06'44.892” – 2°12'53.172” S [14] (Figure 1). Furthermore, the wind speed and direction data used in this study were obtained from Ogimet.com. The data used for analysis were dated from March 2024.

*Figure 1. Research Site (Source: Google Maps)*

### 2.2. Stages of Wave Height and Period Analysis

The stages of wave height and period analysis were carried out as follows:

a. The wind data used in this wind rose analysis were not measured directly from the field, but were downloaded from Ogimet.com by entering the WMO (World Meteorological Organization) station index corresponding to the research location [15] [5]. The wind data utilized were 3-hourly wind speed and direction data from 2024.

b. Wind speed was calculated using Equations (1) and (2). The relationship between sea and land wind speeds was illustrated by Figure 2 [11] [12] [15].

$$U_W = R_L \, . U_L \quad (1)$$

$$U_A = 0.71 U_W{}^{1.23} \quad (2)$$

In Equation (1) and (2), $U_L$ refers to wind speed on land (m/s), $U_W$ refers to wind speed at sea (m/s), $R_L$ refers to relationship between sea and land wind speeds, and $U_A$ refers to corrected wind speed (m/s). The effective fetch length was calculated using Equation (3) [5] [9] [10] . In Equation (3), $F_{eff}$ is the effective fetch (km), $X_i$ is the fetch length (km) and $\alpha$ is the deviation (°).

$$F_{eff} = \frac{\sum X_i \cos\alpha}{\sum \cos\alpha} \quad (3)$$

c. The JONSWAP method provides two equations for calculating significant wave height and period. First, with the effect of fetch length, Equations (4) and (5) were used; second, without fetch length, Equations (6) and (7) were used. From the results of calculating wave height and period, the relationship between the dimensionless number, wave height, wave period, fetch length, and effective fetch length can be analyzed using Equations (8), (9), (10), and (11) [2] [17].

$$H_s = \frac{U_A{}^2 \, x \, 0.0016 \left(\frac{gF_{eff}}{U_A{}^2}\right)^{1/2}}{g} \quad (4)$$

$$T_p = \frac{U_A \, x \, 0.286 \left(\frac{gF_{eff}}{U_A{}^2}\right)^{1/3}}{g} \quad (5)$$

$$H_s = \frac{0.243 U_A{}^2}{g} \quad (6)$$

$$T_p = \frac{8.13U_A}{g} \quad (7)$$

$$H_s{}^* = \frac{gH_s}{U^2} \quad (8)$$

$$T_p{}^* = \frac{gT_p}{U} \quad (9)$$

$$F^* = \frac{gF_{eff}}{U^2} \quad (10)$$

$$F^*{}_{eff} = \left(\frac{t^*}{68.8}\right)^{3/2} \quad (11)$$

In Equation (4) to (11), $H_s$ is the significant wave height (m), $T_p$ is the peak wave period (seconds), $H_s{}^*$is the dimensionless wave height number (m), $T_p{}^*$ is the dimensionless wave period number (seconds), $F^*{}_{eff}$ is the dimensionless effective fetch (km), $F_{eff}$ is the effective fetch length (km), and $g$ is the acceleration gravity (m/s²). In Equation (11) the value of $t^*$ equals to 71500.

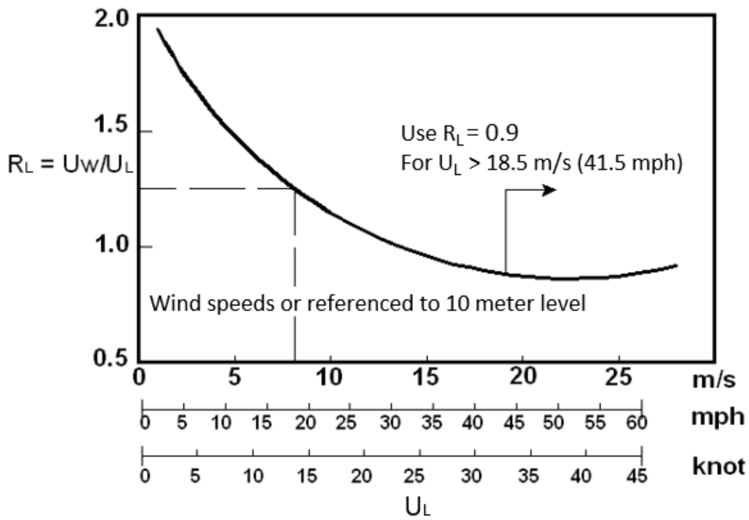


*Figure 2. Relationship between Sea and Land Wind Speed*

## 3. RESULTS AND DISCUSSION

### 3.1. Windrose Analysis

To illustrate the wind rose on the coast of Poso, the WRPLOT program was used with wind speed and direction data from Ogimet.com. The wind rose analysis results show that the predominant wind direction is from the North, with 161 occurrences (44.01%) and a maximum wind speed of 8.8 m/s, while 40 occurrences (16.25%) of wind come from the Northeast with a maximum speed of 5.7 m/s. The coastal of Poso tends to be calmer, dominated by wind speeds of 0.5 m/s with 168 occurrences (67.71%). This condition is due to Poso's location in Tomini Bay, which protects it from strong winds. The wind rose also indicates no wind blowing from the southeast on the coast of Poso, as there is land that is a part of the Verbeek Mountains to the southeast side (1), causing winds from this direction to deflect. The shape of the wind rose, and the percentages of wind speed and direction can be seen in Figure 3, Table 1, and Table 2.

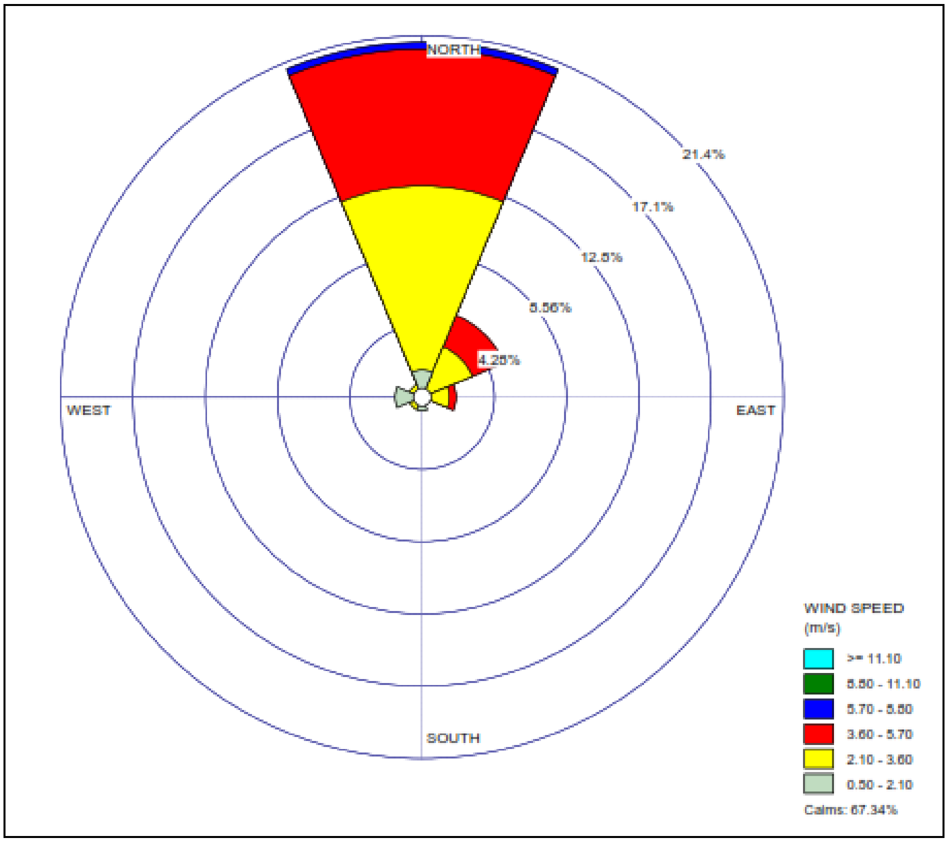


*Figure 3. Wind Rose of the coastal of Poso*

*Table 1. Classification of Wind Speed and Direction on the coastal of Poso*

| **Wind Direction** | **Wind Speed (m/s)** | | | | | | **Number of Occurrences** |
|---|---|---|---|---|---|---|---|
| | **0.0 – 0.5** | **0.5 – 2.1** | **2.1 – 3.6** | **3.6 – 5.7** | **5.7 – 8.8** | **8.8 – 11.1** | |
| North | 109 | 4 | 27 | 20 | 1 | 0 | 161 |
| North East | 27 | 1 | 7 | 5 | 0 | 0 | 40 |
| East | 10 | 0 | 4 | 1 | 0 | 0 | 15 |
| South East | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| South | 4 | 2 | 0 | 0 | 0 | 0 | 6 |
| South West | 4 | 0 | 2 | 0 | 0 | 0 | 6 |
| West | 8 | 4 | 0 | 0 | 0 | 0 | 12 |
| North West | 4 | 0 | 2 | 0 | 0 | 0 | 6 |
| Total | 168 | 11 | 42 | 26 | 1 | 0 | 248 |

*Table 2. Percentage Classification of Wind Speed and Direction on the coastal of Poso*

| **Wind Direction** | **Wind Speed (m/s)** | | | | | | **Total %** |
|---|---|---|---|---|---|---|---|
| | **0.0 – 0.5** | **0.5 – 2.1** | **2.1 – 3.6** | **3.6 – 5.7** | **5.7 – 8.8** | **8.8 – 11.1** | |
| North | 44.01 | 1.61 | 10.90 | 8.07 | 0.40 | 0.00 | 65.00 |
| North East | 11.00 | 0.40 | 2.83 | 2.02 | 0.00 | 0.00 | 16.25 |
| East | 4.23 | 0.00 | 1.61 | 0.40 | 0.00 | 0.00 | 6.25 |
| South East | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| South | 1.69 | 0.81 | 0.00 | 0.00 | 0.00 | 0.00 | 2.50 |
| South West | 1.69 | 0.00 | 0.81 | 0.00 | 0.00 | 0.00 | 2.50 |
| West | 3.39 | 1.61 | 0.00 | 0.00 | 0.00 | 0.00 | 5.00 |
| North West | 1.69 | 0.00 | 0.81 | 0.00 | 0.00 | 0.00 | 2.50 |
| Total | 67.71 | 4.44 | 16.95 | 10.49 | 0.40 | 0.00 | 100.00 |

### 3.2. Wave Height and Period Analysis

The initial step in wave height and period analysis using the JONSWAP method involves considering the fetch value. If F* < F eff, then the wave is based on the fetch length, and Equations (3) and (4) are used. If F eff < F*, then the wave is based on its duration; for the analysis, the smaller value of F*and F*eff is used [17]. This value is defined as follow. Substituting Equation (10) into (11) gives:

$$F^*_{eff} = \left(\frac{71{,}500}{68.8}\right)^{3/2} = 33{,}502.44 \text{ km}$$

The fetch length measurement resulting in this study shows the $F_{eff}$ of 205.05 km, with the lowest and highest wind speeds (UA) being 0.86 m/s and 2.76 m/s, respectively, as shown below.

$$F^*_1 = \frac{9{,}81\ x\ 205.05}{0{,}86^2} = 2{,}730.96 \text{ km} < F^*_{eff} = 33{,}502.44 \text{ km}$$

$$F^*_2 = \frac{9{,}81\ x\ 205.05}{2{,}76^2} = 264.70 \text{ km} < F^*_{eff} = 33{,}502.44 \text{ km}$$

The resulting data from the analysis of Hs and Tp using Equations (3) and (4) above are shown in Table 3.

*Table 3. Wave Height and Period Using the JONSWAP Method for the coastal of Poso*

| No | $U_A$ (m/s) | $F_{eff}$ (km) | Hs (m) | Tp (s) | F* | Hs* | Tp* |
|---|---|---|---|---|---|---|---|
| 1 | 0.858 | 131.731 | 0.050 | 3.018 | 1.754.49 | 0.670 | 34.494 |
| 2 | 0.960 | 131.731 | 0.056 | 3.132 | 1.402.68 | 0.599 | 32.015 |
| 3 | 1.074 | 131.731 | 0.063 | 3.252 | 1.120.38 | 0.536 | 29.704 |
| 4 | 1.181 | 131.731 | 0.069 | 3.357 | 926.53 | 0.487 | 27.882 |
| 5 | 1.306 | 131.731 | 0.077 | 3.471 | 757.25 | 0.440 | 26.068 |
| 6 | 1.559 | 131.731 | 0.091 | 3.682 | 531.44 | 0.369 | 23.166 |
| 7 | 1.890 | 131.731 | 0.111 | 3.926 | 361.76 | 0.304 | 20.378 |
| 8 | 2.211 | 131.731 | 0.130 | 4.137 | 264.37 | 0.260 | 18.356 |
| 9 | 2.757 | 131.731 | 0.162 | 4.453 | 170.05 | 0.209 | 15.845 |
| Average | 1.533 | 131.731 | 0.090 | 3.603 | 809.884 | 0.430 | 25.323 |

Table 3 shows that as wind speed ($U_A$) increases, both wave height (Hs) and wave period (Tp) also increase. Wind speed also affects the dimensionless fetch number (F*); as wind speed increases, the value of F* decreases. The relationship between the dimensionless fetch number (F*), wave height (Hs*), and wave period (Tp*) indicates that as the fetch (F*) increases, both wave height (Hs*) and wave period (Tp*) will also increase. The relationship among these three dimensionless numbers can be seen in Figure 4.

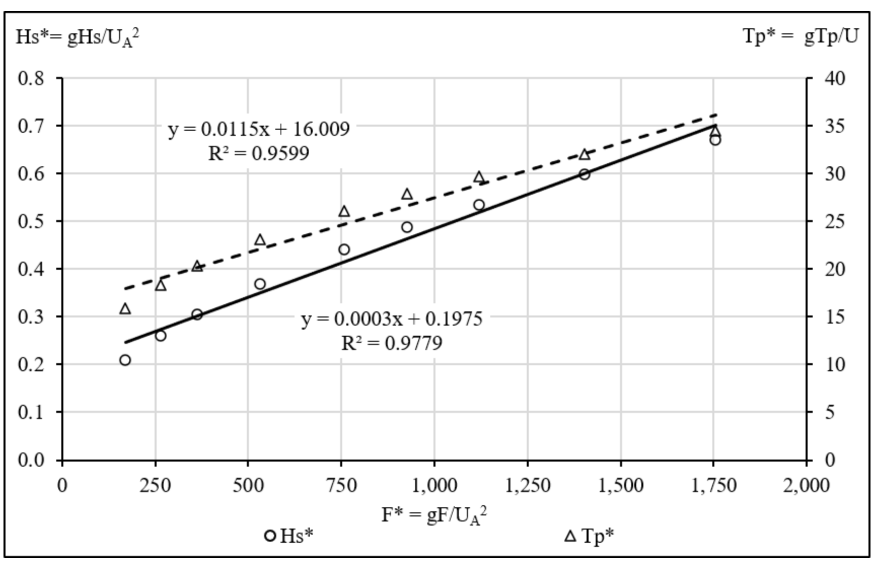


*Figure 4. Relationship between fetch, wave height, and wave period in Poso Coastal*

## 4. CONCLUSION

Poso Coastal is located in Tomini Bay, where the dominant wind blows from the North, with most (67.71%) wind speeds below 0.5 m/s. Wind blows from the Southeast are not detected in the windrose due to the presence of a land area, which is part of the Verbeek Mountains, causing winds from the Southeast to be deflected. Analysis of Poso coastal using the JONSWAP method yields an average wind speed of 1.533 m/s, a significant wave height of 0.09 m, and a peak wave period of 3.603 seconds, with the wave type still developing and not yet reaching dynamic equilibrium (non-fully developed sea).

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