Seasonal variations of water quality at Doreri Gulf, Manokwari, West Papua

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Abstract. The character of Manokwari City's coastal waters is strongly influenced by activity on the mainland. The degradation in Sawaibu Gulf's water quality has an impact on water quality nearby, as well as the waters of the Field Work Center (BLK), Lemon Island, and Tanjung Manggewa, which is part of Doreri Gulf. The purpose of this study was to determine the water quality in Doreri Gulf according on location and season. In February-April (rainy season) and August-October (dry season) 2020, the research was carried out within Doreri Gulf, Manokwari, West Papua. Turbidity, salinity, pH, temperature, and dissolved oxygen are amongst the variables analyzed. Its statistical analyses were performed descriptively using standard deviation and ANCOVA to correlate seasons and locations. Temperature, DO, and pH were highest at location 2; salinity showed highest at location 3; and turbidity were highest at location 1. Low concentrations of DO, pH, and salinity were measured at location 1; temperature showed highest at location 3; and turbidity were highest at location 1. The dry season would have the highest temperature, DO, pH, and salinity concentrations, meanwhile the rainy season had enough highest turbidity. The study confirms that there are no variations in water quality between location of each variable and that seasonal factors comprise the majority of differences in water quality.

1. Introduction
Manokwari City's coastal water quality is strongly influenced by mainland activities. These activities include the Sanggeng market, Wosi port, PLTD (Diesel Fired Power Plant), hotels, offices, hospitals, and residential areas located on the Doreri Gulf coast, Manokwari City [1]. Moreover, the decrease in water quality and the environment's aesthetic value was due to the accumulation of organic and inorganic waste in Sawaibu Gulf from the negative impacts of various human activities [2]. The water quality decline of Sawaibu and Doreri Gulf had an overall effect on the Manokwari City coast.

The decreased water quality in Sawibu Gulf can have an impact in other places, such as the waters of the Field Work Center (BLK), Lemon Island, and Tanjung Manggewa which is part of Doreri Gulf. As this condition continues, there is a decrease in water quality and ecological changes.

Water quality of the marine area is important to be monitored and to be managed. Many studies related to physico and chemical factors related to water quality in many parts of Indonesian
Archipelago has been done, for example in the Bangka Island [3] and in Borneo [4] meanwhile, monitoring of water quality in Papua is urgent to be explored. The purpose of this research was to assess water quality by location and season in Doreri Gulf.

2. Material and method
This research was conducted in Doreri Gulf, Manokwari, West Papua from February to April (rainy season), and August to October (dry season) 2020. The water sampling location consisted of 3 locations (Figure 1), namely: around the waters of the fieldwork center (Location 1), very close to settlements, Lemon Island (Location 2) was a bit far from settlements, and Tanjung Manggewa (Location 3). The determination of the three locations was based on the characteristics of Doreri Gulf.

Every month, 6 sides water sampling were performed at each location.

![Figure 1. Location of Research on Water Quality in Doreri Gulf, Manokwari, West Papua.](image)

Water sample analysis was performed at the Unipa Aquatic Resources Laboratory. Parameters analyzed include turbidity, salinity, pH, temperature, and dissolved oxygen. Measurement refers to *Standard Methods for the Examination of Water and Wastewater* [5]. The data were analyzed
3. Result

The measurements of seawater quality at the three locations (figure 2) indicated that the highest temperature was found at location 2, which was 30.71 °C, and the lowest was at location 3 at 29.85 °C. In the measurement of dissolved oxygen (DO) location 2 had the maximum concentration of 6.61 mg/l, and location 1 was the lowest with 5.88 mg/l. The highest seawater pH was at location 2, which was 7.72, and the lowest was at location 1, 7.14. Furthermore, location 3 had the highest salinity of 31.45‰, and the lowest was location 1 with 30.69‰. Location 1 had the most turbidity results of 2.24 NTU and the lowest was at location 2, which was 0.82 NTU.

Figure 2. Water quality concentration (a) temperature, (b) DO= dissolved oxygen, (c) water pH, (d) salinity, (e) turbidity based on location. Data are presented in mean ± SD (n = 36).
The seasonal results of water quality measurements (Figure 3) showed that seawater temperature in the dry season is higher at 30.73 °C compared to 29.72 °C in the rainy season. Dissolved oxygen (DO) in the dry season was 6.25 mg/l and lower in the rainy season with 6.38 mg/l. The dry season’s pH was higher at 7.45 compared to 7.41 in the rainy season. Furthermore, the dry season’s salinity at 31.25‰ was higher compared to 31.03‰ in the rainy season. Turbidity in the dry season was lower at 1.18 NTU compared to 1.45 NTU in the rainy season.

**Figure 3.** Water quality concentration (a) temperature, (b) DO=dissolved oxygen, (c) water pH, (d) salinity, (e) turbidity based on rainy and dry season. Data are presented in mean ± SD (n = 54).

### 4. Discussion

The time of data collection, weather conditions, and light intensity contributed to the varied temperature conditions, which is one of the most important factors in regulating life processes and the spread of organisms [6]. Although the locations’ characteristics were different, the time of data
collection and light intensity contributed to the temperature difference in the three locations. Also, the differences in water temperature were due to topography or depth associated with variations in sunlight penetration on the surface and deeper layers. These changes in seawater temperature can disrupt the growth and life of aquatic biota [1], [2], [6], [7].

The dry season’s high water temperature was due to high light intensity and wind influence on the distribution of seawater masses [8]. When the light intensity is increased, heat absorption by the water causes the water temperature to rise. Similarly, decreased temperature during the rainy season is closely related to the reduced sunlight intensity entering the waters. Also, an increased rainfall reduces the light intensity resulting in reduced heat absorption by water [7].

Air diffusion and photosynthesis by plant organisms, such as phytoplankton and aquatic plants in the euphotic zone provide oxygen in the waters [9]. The presence of dissolved oxygen in water is very important for aquatic biotas’ life because most aquatic organisms cannot directly utilize free oxygen [10]. In addition, previous research conducted in Doreri Gulf [5], [2], [1], showed that the range of dissolved oxygen fluctuates greatly due to differences in time, temperature, salinity, rainfall, and biota (Figure 2, 3).

The locations differences were due to the time of collection and characteristics of the location. Additionally, the low oxygen level in location 1 was due to the proximity to a densely populated area, and the high levels of inorganic and organic waste around the waters. This can cause a decrease in dissolved oxygen concentration in the waters [11]. According to the research results, the type of substrate around location 1 was silt to medium sand. When water movement occurred, the substrate can be transferred into the water column, resulting in cloudy waters [12]. Turbidity is a factor that can affect the distribution of dissolved oxygen levels in the waters [4].

The dry season’s low dissolved oxygen was caused by the amount of heat absorption by water resulting in a lot of evaporation. Lower temperatures and higher salinity will increase seawater oxygen levels[13]. The dry season results obtained showed high temperatures and salinity resulted in low dissolved oxygen. Other factors such as turbidity, currents, waves, and tides contributed to this condition. According to the seawater quality standard for marine biota, which is > 5 mg/l, the Doreri Gulf’s condition was favorable for the growth and development of aquatic biota, [14].

The pH was relatively homogenous irrespective of location and season and previous results in Doreri Gulf [5], [2], [1], showed similar ranges. Seawater has a relatively more stable pH in a narrow range of 7.7–8.4. The pH value was influenced by the buffer capacity, namely the presence of carbonate and bicarbonate salts [9]. According to the seawater quality standard for marine biota, namely 7 – 8.5, the pH conditions of the waters around Doreri Gulf were relatively good for the growth and development of aquatic biota [14].

The seawater salinity fluctuates depending on the season, topography, temperature, tides and the amount of freshwater input. Salinity is a description of the amount of salt in water [9]. Furthermore, the low salinity at location 1 was due to the inflow of the river freshwater, while the high salinity at location 3 is due to the distance from freshwater and river inputs. The dry season’s high salinity was due to the high light intensity which raised the water temperature resulting in evaporation and increased salt content. [12].

Dissolved and suspended solids in the water column affect the level of water turbidity. High turbidity at location 1 was due to silt to medium sand type substrate. When there was water movement, the substrate can be transferred to the surface resulting in cloudy water. Also, river inputs from that location can contribute to the condition. The low turbidity at location 2 is due to a larger type of substrate, namely from medium to coarse sand which was difficult to transfer into the water column when there was water movement. Furthermore, the content of dissolved materials and suspended particles such as microorganisms, mud, organic matter, clay, colloids, and floating objects that did not settle immediately resulted in turbidity of the water layer [4]. Turbidity affects fish respiration, photosynthesis, and productivity [13], [15]. Turbidity and other anthropogenic compounds in polluted environment also altered fish DNA through micronuclei in cells [15].
Turbidity is lower in the dry season than in the rainy season due to the rainfall factor. Heavy rainfall increases freshwater input through rivers that carry organic and inorganic particles. Therefore, cloudy waters result from the sieving or stirring of water from the substrate on the beach. According to the seawater quality standard, most of the marine biota were still below the water quality standard <5 NTU [14].

ANCOVA results proved that the season had a significant effect (F=22.022; p=0.000) or there were differences in water quality between seasons, while each location (F=0.415; p=0.661) had no significant effect or shows no differences between locations in water quality. According to this analysis, the difference in water quality was mostly explained by seasonal factors. Other studies stated that lower water quality may influenced on the lower immunity of invertebrates [16] and fishes [17].

5. Conclusions
The highest concentration of temperature, DO, and pH was discovered at location 2, salinity at location 3, and turbidity at location 1. Meanwhile, the lowest concentration of DO, pH, and salinity was at the location, with the temperature at location 3 and turbidity at location 1. Additionally, high concentrations of temperature, DO, pH salinity occurs in the dry season while high turbidity occurs in the rainy season. The results showed that there was no difference in the location of each variable, and seasonal factors mostly explained the difference in water quality. According to the Ministry of Environment Number 51 of 2004, the quality of Doreri Gulf’s waters was still below the quality standard for marine biota.

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