Preliminary Study of Ocean Acidification: Relationship of pH, Temperature, and Salinity in Ohoililir, Southeast Maluku

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Abstract. Changes in pH, temperature, and salinity in seawater can indicate the occurrence of ocean acidification. The purpose of this research was to study changes in acidity that occur in Ohoililir waters, Southeast Maluku, which is part of the Banda Sea. This research was conducted in March 2019 as a study of the prefix of oceanic equities in the Southeast Maluku region which is part of the Banda Sea which is currently one of the priority researches in Indonesia, and sampling at 10 points. The results obtained were pH average of 8.69, temperature average of 29.74°C, and salinity of 33.23. The correlation between pH and temperature is -0.097 and the correlation between pH and salinity is in the range of -0.054 which indicates a very weak relationship between pH and temperature and salinity. Besides, pH has a negative correlation to temperature and salinity. This shows the need for further research on the relationship between these three or more parameters to see the effect on the ocean.

1. Introduction

Climate change is a global threat that impacts on coastal and marine environment waters. Lately, the term global warming is very popular, especially in developed countries. This is very reasonable because some research results indicate a tendency for an increase in earth temperature which coincides with increasing concentrations of greenhouse gases (especially CO₂ and CH₄). Two effects that are often discussed because of the effect of global warming are the increase in the temperature of the air or the surface of the earth and the melting of ice in the polar regions. Both of these impacts also affect the marine environment because the atmosphere and the oceans are two environments that interact and control the climate on planet Earth. If there is an increase in air temperature, it will increase the surface temperature of the sea and affect mainly the patterns of current and air pressure in various oceans so that it changes the climate or weather patterns on the earth's surface [1]. Likewise, the impact of the melting of ice in the polar regions also has a direct effect on the marine environment, namely an increase in sea level or better known as sea-level rise, SLR [1][2].

Temperature is one parameter that is often used in physical, chemical and biological processes. Water temperature changes with times and places. Spreading temperature in the open water is mainly caused by water movements, such as currents and turbulence. Heating that occurs at sea level that occurs during the day it is not entirely absorbed by seawater because of the presence of clouds and the latitude position. Energy will be absorbed quite a lot when the sun is above the height of the sky and decreases when it is close to the horizon. The position of the sun in the tropics and subtropics which is always above the horizon throughout the season makes this area warmer than generally in the polar regions [3]. Decreasing seawater salinity due to run-off from rivers and high rainfall is...
thought to inhibit coral growth [4], causing an increase in nutrients and sediments which then lead to coral disease, algal, population explosion and seawater turbidity, thus inhibiting the penetration of sunlight in seawater [5][6].

Ohoililir is one of the villages in the small Kei archipelago, Southeast Maluku Regency, Maluku, Indonesia. A Kei Kecil Islands are part of the Banda Sea. Ohoililir has a well-preserved a coral ecosystem, but this area is also feared to experience the effects of ocean acidification due to global warming, so research is needed on the ocean acidification in this area. Changes in pH, temperature, and salinity in seawater can indicate the occurrence of ocean acidification. The purpose of this research was to study aim to study changes in acidity that occur in Ohoililir waters, Southeast Maluku, which is part of the Banda Sea.

2. Method
This research was conducted in March 2019 as a study of the prefix of oceanic equities in the Southeast Maluku region which is part of the Banda Sea which is currently one of the priority researches in Indonesia, and sampling at 10 points associated with coral reefs and seagrass ecosystems (Figure 1).

![Figure 1. Research Site in Ohoililir, Southeast Maluku, Maluku, Indonesia](image)

Data collection was carried out at each point at that time using the Water Quality Checker (WQC) and a CTD instrument. The data obtained is processed using the Ocean Data View (ODV) program to view distribution data while the correlation uses simple regression analysis. Data is presented in the form of distribution patterns and regression curves. Data collection was carried out at each point at that time using the Water Quality Checker (WQC) and a CTD instrument.

3. Result and Discussion

3.1 Acidity
Ocean acidification is a term given to the process of decreasing the pH level of seawater that is now occurring due to an increase in the absorption of carbon dioxide (CO₂) in the atmosphere resulting from various human activities. Figure 2 shows the distribution pattern of pH in Ohoililir waters.
Ohoililir waters pH is in the range of 8.56-8.85 with an average of 8.69. The pH value was higher than the pH value obtained [7] its cause the research site directly related to the Banda Sea which is undergoing an upwelling and down-welling process. The dissolution of CO$_2$ in the oceans can cause a rise in the concentration of hydrogen ions (H$^+$), thereby reducing the pH value and causing the ocean to be acidic. Besides that, according [8], since the start of the industrial revolution the pH of the ocean has decreased by approximately 0.1 units which is equivalent to an increase of 30% hydrogen ions and is expected to continue to decline to 0.3 to 0.4 units in 2100. This is due to the increasing amount of CO$_2$ gas that comes from various human activities absorbed by the ocean. Acidic waters also tend to cause a reduction in calcification for shell formation when exposed to rising CO$_2$ levels, for example in shellfish and shelled animals. The era of the industrial revolution caused many byproducts in the form of hazardous chemical waste and gas pollution which up to now is still in the spotlight of the problem of global warming, namely carbon dioxide (CO$_2$) emissions [9]. Researchers found that the sea has become one of the largest absorbers of CO$_2$ after forests, thus slowing the impact of CO$_2$ gas pollution on the Earth's atmosphere. Acidification or decreased pH in a solution to an acidic state is a phenomenon that occurs due to the reaction between seawater and CO$_2$ gas. The reaction between seawater and CO$_2$ gas will form carbonic acid which will reduce the pH of seawater, especially in areas near the surface [10].

Figure 2. Distribution of pH in Ohoililir Water, March 2019

3.2 Temperature
Ohoililir water temperature ranged from 29.29°C – 30.28°C with an average of 29.74°C (Figure 3). Time of data collection is a transition season from the west to the east monsoon following these conditions occur. Sea surface temperature of the Banda Sea in general ranges from 23 to 33°C, accordingly with the results of several previous studies [11] - [14]. From the picture, it can be seen that farther from the coast the lower water temperature. Refer to [15] stated that in the waters of the archipelago, seawater temperatures generally ranged from 28°C- 38°C. Indonesia’s sea surface temperature (SPL) ranges between 19°C-26°C. Because Indonesian waters are affected by monsoons, the distribution of the SPL follows seasonal changes. The temperature at sea is a very important factor for the life of an organism [16]. Furthermore, [17] stated that temperature is a very important physical factor in the sea. Temperature changes can have a major influence on the properties of other seawater and for marine biota. Temperature affects the solubility of gases needed for photosynthesis such as CO$_2$ and O$_2$, these gases are easily dissolved at low temperatures than at high temperatures resulting in photosynthetic speeds being increased by low temperatures. The heat received by the sea surface from sunlight causes
the temperature on the surface of the waters to vary based on time. This temperature change can occur on a daily, seasonal, annual or longterm basis.

Figure 3. Distribution of temperature in Ohoililir Water, March 2019

Rising sea temperatures due to an increase in carbon dioxide in the atmosphere has raised temperatures in the ocean, causing coral is bleaching to occur more often. The temperature of seawater even increases 1-2 degrees Celsius above the temperature that can cause coral bleach. Temperature tolerance is very specific because corals have adapted to local conditions for long periods (hundreds or thousands of years). However, global warming has significantly increased the temperature of the most coral locations so that corals bleach very quickly compared to their previous historical range.

3.3 Salinity
Salinity in Ohoililir waters ranged from 33.0-33.3 with an average of 33.2 (Figure 4). Ohoililir waters salinity is high because it is related to the ocean and does not have rivers which can reduce the salinity. Contrast to the temperature, the salinity of Ohoililir waters is higher if it is further away from the coast. The relation of the salinity to the life of aquatic biota depends on the ability of biota-regulated biota, namely the ability of biota to regulate the balance of differences in salt solutions in the body with the environment in which it lives.

The salinity at sea varies between 33 — 38 with an average of 35. Salinity seawater experiences differences due to the effects of evaporation and precipitation, run-off from rivers, cooling and melting ice. In areas with high evaporation salinity can reach 40. In general, high salinity occurs at the equator. Salinity waters vary depending on the depth. Large changes in salinity occur between 100 to 1000 meters. In this zone, fast salinity variations are called halocline layers. Rapid changes in salinity are related to temperature and dissolved oxygen. Ocean waters are mixed well and the abundance of essential components is relatively constant, this condition makes chemical measurements of salinity simple. With a constant composition, it is important to measure the concentration on one in the salinity of the water sample.
3.4 Correlation pH and temperature
In this study it is known that the value of the correlation coefficient between pH and Ohoililir water temperature -0.097. This value indicates that the relationship between pH and salinity is negative and has a very weak correlation. According to the results of the discussion [16], daily and annual temperature variations are the result of solar radiation and evaporation. Besides, the condition of the temperature at pH 8 obtained is classified as optimal for the growth and development of marine biota.

3.5 Correlation pH and salinity
The correlation coefficient between pH and Ohoililir water temperature is -0.05494. This value indicates that the relationship between pH and salinity is negative and has a very weak correlation. In this preliminary study, a negative challenge was found if the pH increased in salinity with a very weak weakness. This means that changes in pH are not so important by changes in salinity.
Figure 6. Correlation pH and salinity, Ohoililir, March 2019

4. Conclusion

The results obtained were pH ranging from 8.567 – 8.851, temperatures ranged from 29.285 – 30.281°C, and salinity ranged from 33.041-33.333 ‰. The correlation between pH and temperature is -0.097 and the correlation between pH and salinity is in the range of -0.054 which indicates has no relationship between pH and temperature and salinity. Besides, pH has a negative correlation with temperature and salinity, with a very weak correlation, that’s means that changes in pH are only slight changes by salinity and temperature. This shows the need for further research on the relationship between these three parameters to see the effect on ocean acidification.

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