THE SPATIO-TEMPORAL DYNAMIC IN WATER NEAR PALABUHAN RATU COAL FIRE PLANT, SUKABUMI, WEST JAVA

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Abstract

Indonesia Power PLTU Jabar 2 Palabuhanratu's activities have an impact on the quality of the surrounding river water and ocean. Monitoring the quality of the water thereafter became an important factor. Using remote sensing technologies, the spatial and temporal sea surface temperature and chlorophyll-a of water can be determined. This study aims to (1) determine water quality near Palabuhan Ratu Coal Fire Plant, Sukabumi, West Java; (2) determine water quality near Palabuhan Ratu Coal Fire Plant, Sukabumi, West Java based on Health Ministerial Regulation No. 32/2017 and Government Regulation No.22/2021; and (3) determine the spatio-temporal dynamic of sea surface temperature near Palabuhan Ratu Coal Fire Plant, Sukabumi, West Java. River water and ocean quality, including physical parameters (total dissolved solids, electrical conductivity, and temperature) and chemical parameters (pH and salinity). (1) River water and saltwater quality in the Cimandiri Downstream River and Batu Bintang Beach are suitable with regard to physical parameters (total dissolved solids, electrical conductivity, and temperature) and chemical parameters (pH and salinity). (2) According to Health Ministerial Regulation No. 32/2017 and Government Regulation No.22/2021, the river and seawater quality in the Cimandiri Downstream River and Batu Bintang Beach for clean water is adequate in terms of physical characteristics (total dissolved solids, electrical conductivity, and temperature) and chemical parameters (pH and salinity). (3) The average sea surface temperature time series from 1980 to 2020 was 20.0°C and 31.5°C.

Keywords: *spatial-temporal, river water quality, seawater quality, palabuhanratu*

1 INTRODUCTION

The built-up land, which is increasing yearly, affects river water quality (Ly et al., 2020). The more the built-up land increases, the lower the river water quality (Yeanny et al., 2021). Built-up land in Palabuharatu sub-district such as PLTU Palabuhanratu, residential land, agricultural land, farmland, sand mining land, and tourism place, as well as domestic activities that dominate downstream of the Cimandiri River and Batu Bintang Beach. The number of buildings causes environmental damage (Singh et al., 2021). The communities around Batu Bintang Beach dispose of domestic waste such as bathing, washing, and toileting (MCK).

Activities carried out by the community include power plants industry, farmland, and domestic waste such as bathing, washing, and toilets (MCK) in Cimandiri Downstream and Batu Bintang Beach. Pollutants from PLTU Palabuhanratu will flow down the Cimandiri Downstream River and Batu Bintang Beach. Power generation has the potential to affect dissolved nutrients and metal concentrations and impact water quality and the ecological functions of marine systems (Kim et al., 2022). Communities around the Cimandiri River and Batu Bintang Beach dispose of domestic waste such as bathing, washing, and toilets (MCK). Domestic pollutants will flow down in the Cimandiri Downstream River and Batu Bintang Beach. Build-up land harms water quality (Yeanny et al., 2021). The impact of PLTU Palabuhanratu and community activities around the river and the seawater result in water pollution downstream of Cimandiri river and Batu Bintang Beach. The Cimandiri Downstream River becomes murky and brown. River water remains unclear in the rainy and dry seasons. However, the communities around the river utilize river water for farming and agriculture for irrigating rice fields. If preventive measures do not follow this, more complex environmental and health problems will occur.

The communities around the river also do not know information on the water

quality in Cimandiri Downstream River and Batu Bintang Beach in more detail through testing the quality of river water and seawater. Testing the quality of river water and seawater is necessary to identify the quality of river water and seawater for the community around the river and seawater. The spatial-temporal quality of river water and seawater by providing data supports monitoring the quality of river water and seawater (Ghuvita Hadi et al., 2021). Monitoring river water quality with spatial-temporal analysis is crucial to determine changes in river water and seawater quality in Cimandiri Downstream River and Batu Bintang Beach. Using remote sensing can determine the water's spatial and temporal salinity and determine how significant the change in river water and seawater quality in Cimandiri Downstream River and Batu Bintang Beach is. The spatial data of river water quality is based on Sentinel 2 Level 2A through Google Earth Engine in Cimandiri Downstream River and Batu Bintang Beach.

This study aims to determine water quality near Palabuhan Ratu Coal Fire Plant, Sukabumi, West Java; (2) determine water quality near Palabuhan Ratu Coal Fire Plant, Sukabumi, West Java based on Health Ministerial Regulation No. 32/2017 and Government Regulation No.22/2021; and (3) determine the spatio-temporal dynamic of sea surface temperature near Palabuhan Ratu Coal Fire Plant, Sukabumi, West Java. This research focuses on observing, studying, collecting, and understanding the spatial-temporal quality of river water and seawater and the results of field tests and the spatial-temporal on river water and seawater quality in the Cimandiri River Downstream and Batu Bintang Beach. This research can provide information on changes in river water and seawater quality to the local government of Sukabumi Regency, regional planning, and other communities. The research results drive governments' decision-making in protecting and predicting river water and seawater quality.

2 MATERIALS AND METHODOLOGY

2.1 Study Area

This research area was in the Cimandiri Downstream River and Batu Bintang Beach. Cimandiri Downstream River and Batu Bintang Beach are located in the Palabuhanratu district. The coordinate of Cimandiri Downstream River and Batu Bintang Beach is 2481300E – 929100S and 2483700E – 931800S on the map. The research area has four villages (Palabuhanratu, Jayanti, Cidadap, and Loji village). Research time in the field for three days from October 30, 2022 - November 1, 2022.

2.2 Research Method

The research design is descriptive with a quantitative method. The research variables are river water and seawater quality, such as physical parameters (total dissolved solids, electrical conductivity, and temperature) and chemical parameters (pH and salinity), river suitability for clean water, and the spatial-temporal distribution of salinity. The research sample is 30 river water and seawater samples with stratified area sampling. Collecting 30 sample points of river water and seawater quality is determined based on a grid of 300 x 300 metre each to obtain points in Cimandiri Downstream River and Batu Bintang Beach near the PLTU. Research data collection is observation, field test of water quality using Hanna Combo and portable refractometer, spatial-temporal water quality, and documentation. Data analysis of research is to (1) identify and match river water quality and seawater based on Health Ministerial Regulation No. 32/2017 and Government Regulation No.22/2021, (2) descriptive analysis, and (3) the spatial-temporal distribution of sea surface temperature.

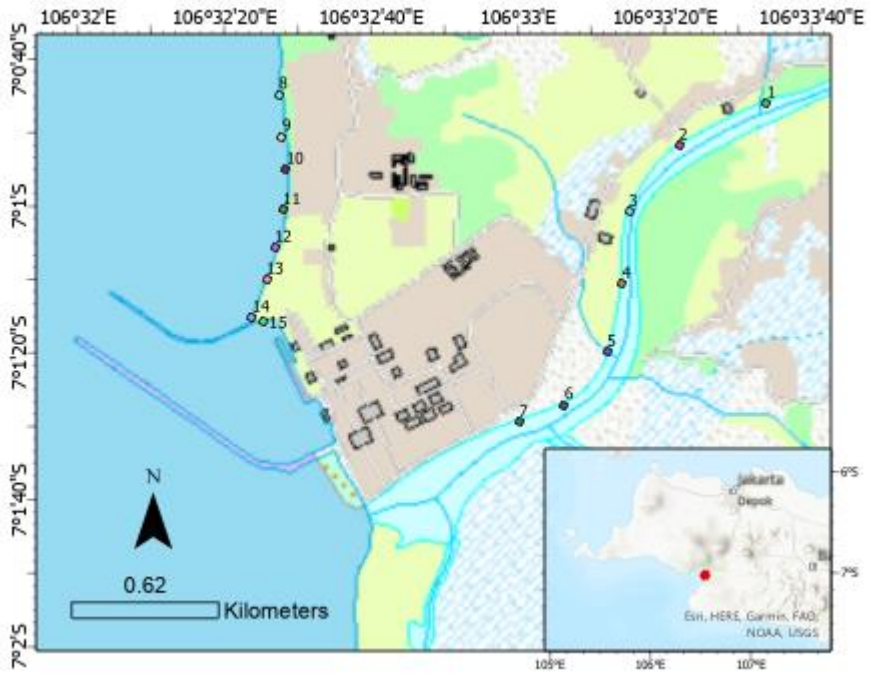

Figure 2-1: Research area (measurement station shows in point).

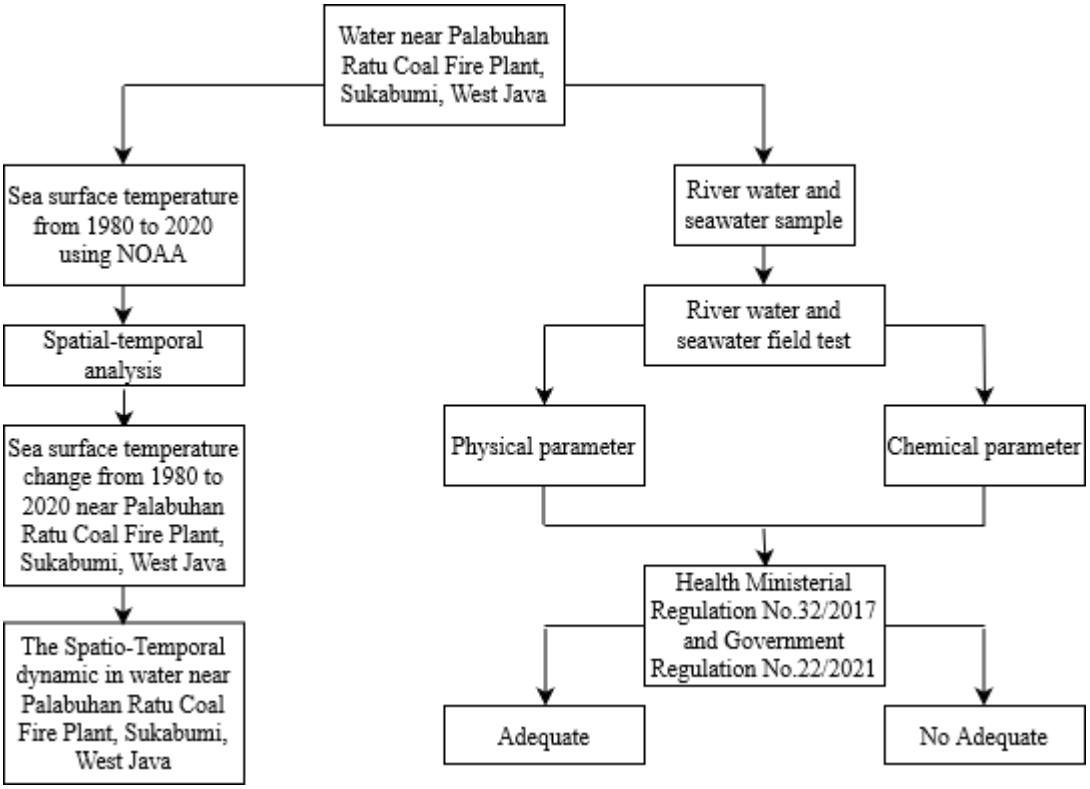

Figure 2-2: Research flow-chart.

3 RESULTS AND DISCUSSION

3.1 River water and seawater in Cimandiri Downstream River and Batu Bintang Beach

The Cimandiri Downstream River and Pantai Batu Bintang Beach can be identified using measurement tools. The value of the physical and chemical parameters can be detected by measuring river and seawater quality in the Cimandiri River Downstream and Batu Bintang Beach, near PLTU. The physical parameters include total dissolved solids (TDS), electrical conductivity (EC), and temperature. The chemical parameters

are pH and salinity. The total of physical and chemical parameters is five parameters.

Based on the map, thirty water samples in Cimandiri Downstream River and Batu Bintang Beach were taken in the morning and afternoon. The number of river water samples in the Cimandiri Downstream River is seven. The number of seawater samples is eight in Batu Bintang beach. Thirty water samples were taken downstream from the Cimandiri River and Batu Bintang Beach using field tests. The water quality measurement tool is the Hanna Combo with four parameters: total dissolved solids (TDS), electrical conductivity (EC), temperature, and pH. The portable refractometer is used for measuring water salinity in the Cimandiri Downstream River and Batu Bintang Beach.

3.2 The feasibility of river water and seawater in Cimandiri Downstream River and Batu Bintang Beach

The Cimandiri Downstream River and Pantai Batu Bintang Beach can be collected in the morning and afternoon. The results of field tests of thirty samples of river water and seawater are in Table 7. Field data results compare to the Regulation of the Minister of Health of the Republic of Indonesia No.32/2017 and Government Regulation No.22/2021 concerning clean water quality requirements. Parameters for river water quality include physical and chemical parameters such as the total dissolved solids (TDS), electrical conductivity (EC), temperature, pH, and salinity. The total dissolved solid is in Figure 2.

3.2.1 Total Dissolved Solids (TDS)

The total dissolved solid (TDS) consists of inorganic and organic materials such as water ions (Wang, 2021). The results of thirty river and seawater samples with field tests of the river and seawater quality showed that the total dissolved solids (TDS) in the Cimandiri River Downstream and Batu Bintang Beach was 0.07 to 10 ppt in the morning and afternoon. The lowest total dissolved solids (TDS) in samples 3, 4, and 5 was 0.07 ppt in the Cimandiri Downstream River. The highest total dissolved solids (TDS) in samples 8 to 15 was ten ppt at Batu Bintang Beach. The maximum dissolved solids (TDS) parameter value must comply with the guidelines for clean water quality in the Regulation of the Minister of Health of the Republic of Indonesia No.32/2017 and Government Regulation No.22/2021, which is 1000 mg/l for river water and 10.000 – 100.000 mg/l for seawater. The parameter value for the total dissolved solids (TDS) in samples at Cimandiri Downstream River and Batu Bintang Beach is by the guidelines for clean water quality in the Regulation of the Minister of Health of the Republic of Indonesia No.32/2017 and Government Regulation No.22/2021 with a clean water quality standard of 1000 mg/l for river water and 10.000 – 100.000 mg/l for seawater.

3.2.2 Electrical Conductivity (EC)

Electrical conductivity (EC) is the capacity of water to carry electrical current or electrons, where all dissolved ions are the conductors (Naser et al., 2019). The results of thirty river water samples with water quality field tests found that the electrical conductivity of river and seawater in the Cimandiri Downstream River and Batu Bintang Beach is between 0.15 to 20 mS in the morning and afternoon. The lowest electrical conductivity in samples 3, 4, and 5 is 0.15 mS in the Cimandiri Downstream River. The highest electrical conductivity in samples 8 to 15 is 20 mS in Batu Bintang Beach. The maximum water electrical conductivity parameter value must comply with the clean water quality guidelines in the Regulation of the Minister of Health of the Republic of Indonesia No.32/2017 and Government Regulation No.22/2021, which is 15 mS for river and 150-500 mS for seawater. The value of the electrical conductivity parameter in the Cimandiri River Downstream and Batu Bintang Beach is by the clean water quality guidelines in the Regulation of the Minister of Health of the Republic of Indonesia No.32/2017 and Government Regulation No.22/2021 with a clean water quality standard of 15 mS for river water and 150-500 mS for seawater.

3.2.3 Temperature

Season, latitude, altitude above sea level, time of day, air circulation, cloud cover, and flow and depth of water bodies affect water temperature (Bachmann et al., 2019). The results of thirty river and seawater samples with field tests on the river and seawater quality revealed that

the temperature of the river and sea water was between 25.6 to 29.8 ºC in the Cimandiri River Downstream and Batu Bintang Beach in the morning and afternoon. The lowest water temperature in samples 2 and 6 is 25.6 ºC in the Cimandiri River Downstream. The highest water temperature in samples 8, 10, and 15 is 29.8 ºC in Batu Bintang Beach. The maximum water temperature parameter value must comply with the clean water quality guidelines in the Regulation of the Minister of Health of the Republic of Indonesia No.32/2017 and Government Regulation No.22/2021, which is 30 ºC for river water and 28 - 32 ºC for seawater. Temperatures that are not by the guidelines for the quality of clean water increase toxicity, solubility of pollutant materials, and pathogenic microorganisms that infect diseases in humans (Daud et al., 2017). The water temperature parameter values of the Cimandiri Downstream River and Batu Bintang Beach are by the guidelines for clean water quality in Health Ministerial Regulation No.32/2017 and Government Regulation No.22/2021 with a clean water quality standard of 30 ºC for river water and 28 - 32 ºC for seawater.

3.2.4 pH

pH is the intensity of an acid or base state in a solution (Sundaresan & Bohn, 2020). The results of thirty samples of river water and seawater with field tests on the quality of river water and seawater showed that the pH of the river and seawater was between 7.53 and 7.88 in the Cimandiri Downstream River and Batu Bintang Beach in the morning and afternoon. The low water pH in sample 1 is 7.55 in the Cimandiri River Downstream. The high-water pH in sample 3 of sample 15 was 7.88 at Batu Bintang Beach. The maximum water pH parameter value must comply with the clean water quality guidelines in Health Ministerial Regulation No.32/2017, with clean water quality standards being 6.5 to 8.5. The pH parameter values of samples in Cimandiri Downstream River and Batu Bintang Beach are by the clean water quality guidelines in the Health Ministerial Regulation 32/2017, with clean water quality standards being 6.5 to 8.5.

3.2.5 Salinity

Water salinity is measured as electrical concentrations (Naser et al., 2019). The results of thirty samples of river water and sea water with field tests on the quality of river water and sea water can be seen that the salinity of river water and sea water is between 0 and 33 ppt in the Cimandiri River Downstream and Batu Bintang Beach in the morning and afternoon. The lowest water salinity in samples 1 to 7 is 0 ppt in the Cimandiri River Downstream in the morning and afternoon. The highest water salinity in samples 8 to 15 was 33 ppt at Batu Bintang Beach in the morning. The value of Salinity in Batu Bintang Beach varied in the afternoon. The maximum water salinity parameter value must comply with the clean water quality guidelines in the Government Regulation No.22/2021 is 33 ppt for seawater and 0 ppt for river water. The value of the water salinity parameter in the Cimandiri River Downstream and Batu Bintang Beach is to the clean water quality guidelines in the Government Regulation No.22/2021 with a clean water quality standard of 33 ppt for seawater and 0 ppt for river water.

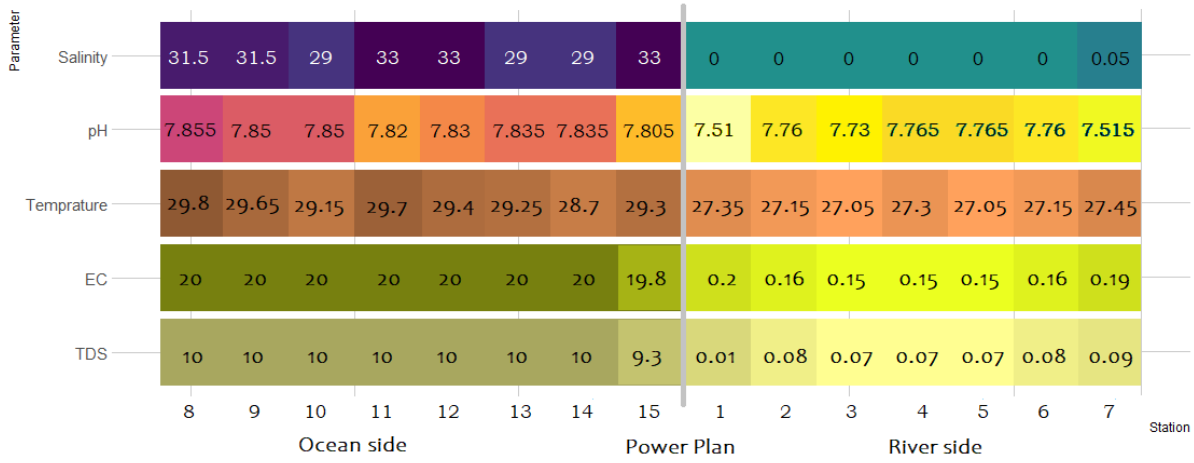

Figure 3-1: List of 15 samples of water quality parameter.

3.3 Time series of Sea Surface Temperature

The plot includes sea surface temperature time series that tend to vary each year at Batu Bintang Beach. This plot displays the sea surface temperature time series calculated based on 1980-2020. Time-series of sea surface temperatures over 40 years averaged using the NOAA satellite at Batu Bintang Beach. The average sea surface temperature time series fluctuated between 20.0°C and 31.5°C from 1980 to 2020.

The plot shows green before PLTU construction from 1980 to 2008. Sea temperature surface time series shows with red during PLTU construction from 2009 to 2012. The sea temperature surface time series is green during PLTU operation. During the pandemic in 2020, the PLTU was not operated, so the sea surface temperature dropped. In 2022, the PLTU works, resulting in high sea surface temperatures.

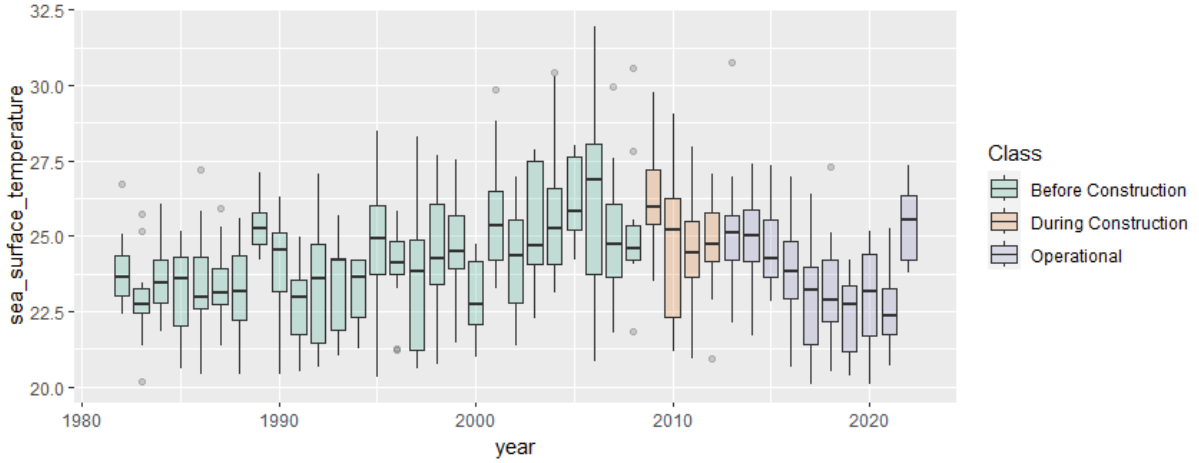

Figure 3-1: Sea surface temperature in 1980 - 2020.

4 CONCLUSION

River water and saltwater quality in the Cimandiri Downstream River and Batu Bintang Beach are suitable with regard to physical parameters (total dissolved solids, electrical conductivity, and temperature) and chemical parameters (pH and salinity). According to Health Ministerial Regulation No. 32/2017 and Government Regulation No.22/2021, the river and seawater quality in the Cimandiri Downstream River and Batu Bintang Beach for clean water is adequate in terms of physical characteristics (total dissolved solids, electrical conductivity, and temperature) and chemical parameters (pH and salinity). The average sea surface temperature time series from 1980 to 2020 was 20.0°C and 31.5°C.

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