



Study of Nitrate Distribution in the Waters of the Wedung River Estuary, Demak Regency, Central Java, Indonesia

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ABSTRACT

The Wedung River is one of the rivers in Demak Regency which flows directly into the North Java Sea. The mouth of the Wedung River is widely used by local communities as a fishing port, fish auction place, fishing location, and as a place to dispose of waste from residential areas. Nitrate concentration is an indicator used to determine water quality, where if the nitrate concentration is too high it can cause eutrophication which triggers phytoplankton blooms. This research aims to determine the distribution and concentration of nitrate at the Wedung River Estuary, Demak Regency. Field data in the form of water samples, current measurements, and physicochemical water parameters carried out on March 11 2023 in the east monsoon were used to determine the concentration and distribution of nitrate using the cadmium reduction column method. Nitrate concentration values range from 2,806 – 6,424 mg/l. The distribution of nitrate concentrations is highest in the waters closest to the river mouth compared to offshore waters. Nitrate concentrations decrease as we head towards offshore waters.

Keywords: Estuary, Horizontal Distribution, Nitrate, Ocean Current, Wedung River

1. Introduction

Nutrients are elements that influence the development of aquatic organisms in increasing primary productivity (Ramadhan et al., 2020). One of the important nutrients in water is nitrate. Nitrate is one of the nitrogen in water which can be used as an indicator of environmental pollution and water fertility (Setyorini and Maria, 2019). The concentration of nitrate in waters comes from ammonium which enters rivers through domestic waste. The positive impact of nitrate levels under normal conditions is that they are the main nutrient source for algae growth. However, if the nitrate concentration exceeds normal limits, it will cause a decrease in oxygen levels in the waters which will trigger the emergence of dangerous types of phytoplankton, namely Harmful Algal Blooms (Risamasu and Prayitno, 2011).

The waters of the Wedung River Estuary are waters that are widely used by the community for various activities. There are places for catching and auctioning fish, agriculture, and livestock which can affect the quality of the water, apart from that around the Wedung River there are residential areas that are quite densely populated which throw waste into the waters of the Wedung River which will affect the quality of the water. With the current, waste that enters the river body will be carried by the current towards the river mouth where it will then be released into the open sea. The problem that exists in the waters of the Wedung River Estuary is that many community activities around the river body can pollute the waters directly or indirectly. The concentration of nitrate in waters under normal conditions functions as the main source of nutrients for plant and algae growth, however, if the concentration of nitrate exceeds normal limits it will result in environmental pollution where eutrophication will occur (Megawati et al., 2014).

This research aims to determine the concentration and horizontal distribution of nitrate in the waters of the Wedung River Estuary.

2. Material and Method

Materials

The material used in this research is main and supporting data. The main data is the nitrate concentration, samples were taken directly from the waters of the Wedung River Estuary and analyzed in the laboratory. Supporting data in the form of surface current data observed in the field and physical-chemical parameters of waters, namely salinity, DO, pH, and temperature, as well as maps of the Indonesian landform which come from the Geospatial Information Agency.

Research Method

The method used in this research is a descriptive method that combines quantitative and qualitative approaches. The qualitative approach used in this research is assessing the results of nitrate distribution analysis based on descriptive consideration of station points in the field. Meanwhile, the quantitative approach in this research was used to calculate the nitrate concentration value taken from the research location and processed in the laboratory.

Location and Timing Selection Method

Determining the location of research stations uses a purposive sampling method where station points are determined based on consideration of the researchers' targets and objectives (Sugiyono, 2014). Determining the research location using GPS (Global Positioning System) aims to make it easier to see the research station on the research map. The sampling locations were determined by 10 station points, where station 1 represented the river area, stations 2 and 3 represented the river estuary area, and stations 4, 5, 6, 7, 8, 9, and 10 represented the open sea area. Sampling was carried out on Tuesday, March 11 2023 in the East Season during high tide conditions at coordinates $6^{\circ}43'26''$ - $7^{\circ}09'43''$ South Latitude and $110^{\circ}27'58''$ - $110^{\circ}48'47''$ East Longitude. The location of the sampling points can be seen in Figure 1.

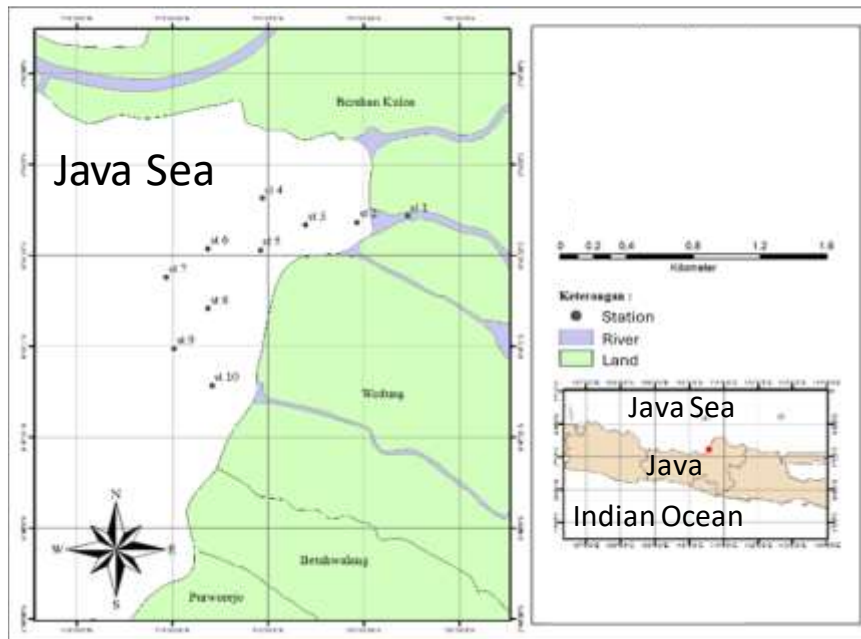


Fig 1. Area of Interest

Data Collection and Processing Method

Sampling and Conducting Ocean Physical and Chemical Parameters

Water samples were taken from the surface layer using a sterilized 1000 ml sample bottle, and then placed in a coolbox. Physicochemical parameter data measured in situ include surface temperature measurements using a thermometer, measuring dissolved oxygen levels using a DO meter, refractometers used to measure salinity levels, and measuring water pH using a pH meter.

Surface Current Data Retrieval

Surface current data was measured directly using the Lagrange method using a measuring ball, a stopwatch to calculate the travel time of the measuring ball, and a compass to determine the direction of surface currents.

Nitrate Analysis

Nitrate concentration measurements were carried out using a UV-Vis spectrophotometer with a wavelength of 543nm. The first step is to create a calibration curve for the standard solution that has been created. then after the absorbance value was obtained, a calibration curve was created using Excel. The value obtained is the equation that will be used to calculate the concentration value of the nitrate sample.

Data Processing Methods

Nitrate distribution data processing was carried out using ArcGIS 10.8 software. Flow data is obtained through direct measurements in the field, and then presented in map form with ArcGIS 10.8.

3. Results and Discussion

Nitrate Concentration

Based on the results of laboratory analysis, the nitrate concentration ranges from 2,806 – 6,424 mg/l. with an average concentration of 4.553 mg/l. The highest nitrate concentration is at station 2 and the lowest concentration is at station 9. More details on the distribution of nitrate concentrations are in Table 1. A map of the nitrate distribution pattern is presented in Figure 2.

Table 1. Nitrate Concentration Value in Wedung River Estuary

No	Station	Nitrate Concentration (mg/L)
1	1	5,988
2	2	6,424
3	3	5,419
4	4	5,185
5	5	5,238
6	6	4,37
7	7	3,584
8	8	3,292
9	9	2,806
10	10	3,219

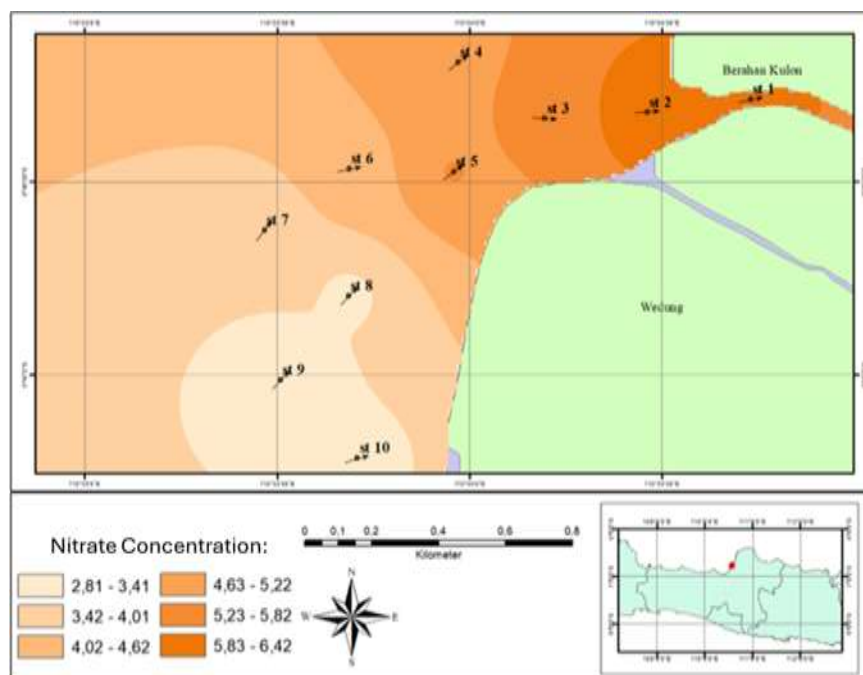


Fig 2. Nitrate Distribution Map in Wdung River Estuary

Based on **Table 1**. The highest nitrate concentration is at station 2 which is at the mouth of the Wedung River Estuary. The high concentration at station 2 is due to its location at the mouth of the River Estuary, which is the first place to obtain nutrients that come from the land and are carried by river currents to the river mouth. Meanwhile, the lowest nitrate concentration was found at station 9 which was in the open sea. The low concentration at station 9 is due to its location far from the river mouth where according to Regita et al. (2015), stated that the further away from land influence the nitrate supply will decrease, resulting in low nitrate concentrations.

Based on laboratory results, the waters of the Wedung River Estuary can be classified into the mesotrophic water class which has a nitrate concentration of between 2,806 – 6,424 mg/l (Arizuna et al., 2014). From this classification, the nitrate concentration found in the waters of the Wedung River Estuary is included in the medium class where there is an increase in nitrate levels in the waters but is still within normal limits.

Surface Current

Based on the results of measuring the direction and speed of surface currents, it shows that the speed of surface currents in the waters of the Wedung River Estuary ranges from 0.05 – 0.16 m/s. The highest speed is at station 8, while the lowest speed is at station 1. The direction of surface currents is east and northeast with an average current speed of 0.11 m/s. The complete speed and direction of surface currents are in **Table 2**.

Table 2. Surface Current Speed and Direction in Wedung River Estuary

Station	Current Speed	Current Direction
1	0,05	East
2	0,11	East
3	0,12	Northeast
4	0,1	East
5	0,08	Northeast
6	0,12	East
7	0,13	Northeast
8	0,16	Northeast
9	0,08	Northeast
10	0,11	East

Ocean Physical Chemical Parameters

Based on in situ measurements of water physical-chemical parameters in the form of temperature, salinity, DO and pH values, the temperature values range between 31° - 32°C, with the highest temperature at station 3 and the lowest temperature at station 9. Water salinity values range from 0 – 9ppm, with the highest salinity found at station 9, and the lowest salinity value found at stations 1 and 2. The dissolved oxygen value ranges from 5.2 to 6.5, with the highest DO value found at station 5, while the lowest DO is at station 1. The pH value of the water ranges from 7.27 – 8.19, with the highest pH value at station 10, while the lowest pH value is at station 1. In full, the physical and chemical parameters of the waters of the Wedung River Estuary, Demak Regency are in **Table 3**.

Table 3. Physical Chemical Parameters in Wedung River Estuary

Station	DO	pH	Temperature	Salinity
1	5,27	7,27	31,4	0
2	5,5	7,9	31,9	0
3	5,62	7,88	32	4
4	5,47	7,99	31,6	3
5	6,57	8,11	31,8	3
6	5,5	7,86	31,4	7
7	6,17	8,08	31,5	5
8	6,49	8,06	31,7	5
9	6,19	8,11	31	9
10	5,75	8,19	31,6	8

4. Summary

Based on the results of research in the waters of the Wedung River Estuary, it can be concluded that the Nitrate concentration ranges from 2,806 – 6,424 mg/l where the highest concentration is found in the river estuary area, this is because it is close to land where the concentration of nitrate is greater than on land which is carried by currents towards the estuary. The waters of the Wedung River Estuary are in the medium category so public awareness is needed to maintain these waters. The horizontal distribution of nitrate leads to the east or the river mouth with a current speed of 0.05 – 0.16 m/s.

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