Distribution patterns of redox potential in intertidal zone of Blanakan coast and their implication on the coastal ecosystem

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Abstract. The intertidal zone of Blanakan Coast has an area of approximately 15 ha. The Blanakan Coast itself is important fishing ground. Correspondingly, a study to assess the water quality in the coastal ecosystem is important. One of important water quality parameters is reduction and oxidation (redox/Eh) potential since it can indicate the anoxia condition. Nevertheless, the detailed spatial variation of Eh is poorly understood, especially in intertidal zone where anoxia may be a significant environmental constraint for marine organism. The Eh data were recorded from 7 sampling points in intertidal zone. Based on the result, the mean value of Eh is ranging from -20.0 to -50.67 mV. The poorest intertidal zone was found in the sampling point closed to the river mouth with mean value of Eh is -50.67 mV. Another poor intertidal zone was found in the eastern part of intertidal zone closed to the coast with mean value is -46.16 mV. The better condition of intertidal zone was found in the northern and western part of intertidal zone with mean value is -25.16 mV. The study also found that value of Eh is significantly correlated with the value of dissolved oxygen (DO). The DO is high when the value of Eh is high and the DO is low when the value of Eh is low. For example, the -50.67 mV redox potential significantly reduced the DO in the intertidal zone as low as 1.56 mg/l. Thereby, this Eh can cause anoxia condition in ecosystem of intertidal zone especially near river mouth and east side.

1. Introduction

Recently, redox (reduction and oxidation/Eh) potential has been acknowledged as one of important environmental parameters in evaluating the water quality [1]. Basically, Eh is a measurement based on electron activity and it indicates the relative tendency of a solution to accept or transfer electrons. The Eh reactions control the behavior of many chemical constituents in the natural waters and sewage. Respectively, the reactivity and solubility of critical elements in living systems is strongly dependent on Eh conditions.

Eh has been used widely as important parameters to monitor water quality. The polluted river has been observed has Eh value closed to -300 mV. The poor (negative) Eh values which is observed in Diyala River was correlated positively with the low dissolved oxygen closed to 1 mg/l [2]. In polluted Attoyac river basin, the Eh value can be low as -370 mV. This poor condition is caused by effluents from anthropogenic influence nearby [3].
The Eh to assess the water quality has also been used in marine environment. Eh with value as low as -206 mV was known has negative effect on marine organisms [4]. The Eh has also been used to assess the environmental quality of marine and coastal ecosystem as well. In Banten, Java Island, the coastal ecosystem with high Eh value has been mapped to select the suitable sites for shrimp culture pond [5].

Intertidal zone in Blanakan coast in Subang district, West Java province is an important ecosystem. This zone act as a barrier from water coming from the river and from the sea. Respectively, this zone functioning to filter and control the water quality before entering the Java Sea. The Java Sea is also important fishing ground for people living in Subang district. Therefore, it is important to investigate the water quality in this area using the most reliable method, which is Eh measurement. Thus, this research aiming to study the distribution patterns of Eh in intertidal zone of Blanakan coast and their implication on the coastal ecosystem.

2. Methodology
The samples were collected from 7 stations that located in intertidal zone across Blanakan coast and offshore. The sample collection activities were conducted in April 2019. The samples that collected and measured directly from the stations were Eh, dissolved oxygen (DO), pH, salinity, temperature and turbidity [6].

2.1 Study Site
The Blanakan coast is located in northern part of Subang district, West Java province. The 7 stations coordinates were located from western part at latitude: -6.22691, longitude: 107.66431 (station 4) to eastern part at latitude: -6.23, longitude: 107.67953 (station 7) Figure 1. Each station has unique characteristics. The station 1, 2 and 3 are located in river mouth, station 4 and 6 are located in western part, 7 is in eastern part and station 5 is offshore.

![Figure 1. The locations of 7 stations across intertidal zone in Blanakan coast](image)

2.2 Physico-chemical Parameters
The parameters including Eh, dissolved oxygen (DO), pH, salinity, temperature and turbidity were
measured directly in the field. DO and temperature measured by using DO meter, pH and Eh with pH and ORP meter, salinity with refractometer and turbidity with turbidity meter respectively.

2.3 Spatial Mapping
All the coordinates of physico-chemical parameters were recorded by using GPS. GIS software was used to map the physico-chemical parameters in the intertidal zone of Blanakan coast. The map of physico-chemical parameters then overlayed with the Blanakan coast.

2.4 Statistical and Factoral Analysis
Factorial analysis were used to analyze the differences of physico-chemical parameters influenced by intertidal zone of Blanakan coast.

3. Result and Discussion
The results have provided a clear distribution pattern (Figure 2) of Eh and other physico-chemical parameters in various parts of intertidal zone in Blanakan coast. The Eh has poor value (negative value) especially in the stations located near the edge of Blanakan coast. For example, in the eastern part of Blanakan coast, the Eh value was -46.16 mV. This similar Eh value was also observed in river mouth. The pattern of Eh value was correlated with the turbidity value (Table 1, Figure 3). Respectively, the turbidity in the eastern part of Blanakan coast was 218.03 NTU and in the river mouth was high as well. The poor aquatic condition is indicated by negative Eh value and positive turbidity value.

From the factor analysis (Figure 3), the station 7 was influenced significantly by the turbidity and Eh value. This condition is related to the geo position of this station. This station is located inside the intertidal zone and very closed to the coast. The tide wave has mixed the sediment in the water and causing the water becoming murky. In Gyeonggi bay, a tide can mix a sediment of tidal flat up to 0.023 kg/m² [7]. Correspondingly, in intertidal zone of Blanakan coast, the reference minimum and maximum tides were 38 cm at 14.00 and 82 cm at 06.00 [8]. During observation, the minimum tide was recorded 42 cm at 11.00. Moreover, this station is also receiving more sediments either flushed from the land or transported from the river. The Blanakan coast shape was similar to U shape. This shape has caused the Blanakan can trap more sediment.

If Eh and turbidity have positive correlation, in contrast the Eh has negative correlation with dissolved oxygen. In the station 7, the significant Eh value was followed by decreasing of dissolved oxygen. When the Eh as low as -46.16 mV, it was observed that the DO can be low as 1.1 mg/l. Correspondingly, the station 7 does not have significant value of dissolved oxygen and has experienced anoxia. The anoxia or a condition when oxygen cannot be detected has been reported when the Eh value was closed to -173 mV [9].

The station 5 in offshore is characterized by DO and salinity parameters (Figure 3). The salinity was high because the station 5 was located far away from the coast. Since located in offshore, this station receives less sediment. As a result, there is no influence of turbidity and Eh parameters. With the absence of turbidity and Eh effects, this station has high DO value up to 5.7 mg/l.

In this result, when the Eh was increasing from -51 to -20 mV, the DO was also increasing from 1.1 to 5.7 mg/l. This finding is comparable with other researches. In oxidated water, when the EH is increasing from -100 to 100 mV, the DO is also increasing from 0 to 100% [10]. The DO was found higher especially in the river mouth areas (Figure 2), especially in station 1 and 5 compared to other stations. This high DO was presumably related with the turbulence that usually happens in river mouth [11]. The DO observed was ranging from 1.1 to 5.7 mg/l. This value is within the value of DO in the tropical river mouth [12].
**Figure 2.** The patterns of Eh and physico-chemical parameters in intertidal zone of Blanakan coast

**Table 1.** The factor analysis of physic-chemical parameters

| Physico-chemical parameters | Factor 1 | Factor 2 |
|-----------------------------|----------|----------|
| Salinity                    | 0.8      | 0.024    |
| Turbidity                   | 0.736    | -0.117   |
| pH                          | 0.959    | 0.119    |
| Temperature                 | -0.196   | -0.821   |
| DO                          | 0.056    | 0.95     |
| Eh                          | 0.318    | -0.73    |

**Figure 3.** The physico-chemical parameters in 7 stations located in intertidal zone of Blanakan coast
5. Conclusions

The eastern part of intertidal zone in Blanakan coast can be categorized as the poor ecosystem because it has high turbidity and significant value of EH but low DO. The Eh was observed to be correlated with the turbidity but contrasted with DO. Conversely, the river mouth, western part and offshore of intertidal zone are having better conditions since it has less turbidity and Eh but more DO.

5. References

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