The assessment of water quality by STORET method in the northern waters of Banda Aceh

The assessment of water quality by STORET method in the northern waters of Banda Aceh

S Afriani[1,2], S Agustina[1,2,*], S Karina[1,2], I Irwan[1,2] and C S M Kazrina[1]

[1]Department of Marine Science, Faculty of Marine and Fisheries, Syiah Kuala University.
[2]Laboratory of Marine Chemistry and Fisheries Biotechnology, Faculty of Marine and Fisheries, Syiah Kuala University.
[*]Corresponding Author : sri_agustina@unsyiah.ac.id

Abstract. The STORET method is one of the methods commonly used to determine water quality. This water quality status can indicate the waters are in a polluted condition or in good condition referring to the predetermined water quality standard. This study aims to obtain an overview of the status of water quality in the northern waters of Banda Aceh. Activities in the area such as the transportation route of ships, port activities, tourism, aquaculture and disposal of household waste are source of pollutan in the waters. Water sampling was carried out at 10 points (stations) around the waters of Ulee Lheu, Krueng Aceh and Alue Naga. The parameters used are: ammonia content, sulfide, cyanide, phenol, surfactant, and fatty oil. The results showed that the water quality in Ulee Lheu classify into Class C (score –16), which was medium polluted, with ammonia and phenol content 1.1 mg/L and 0.014 mg/L, respectively. Meanwhile, the estuary of Krueng Aceh and the waters around of Alue Naga are categorized in Class A (score 0), that means both are still in accordance with water quality standards.

1. Introduction

The northern waters of Banda Aceh are bordered by Sabang waters in the north, Malacca Strait in the east, and the Indian Ocean in the west. These waters receive a supply of fresh water from Krueng Aceh river, Alue Naga river, and several other small estuaries in Banda Aceh. Economic and transportation activities are very dense in this area, especially in the Ulee Lheu port and Samudera Fishing Port (PPS) Lampulo. The impact of the entry of fresh water and economic activities around the waters tends to produce waste which can reduce the waters quality in this region [1]. Marine pollution is a change in sea water conditions caused by human activities or the entry of other components which have the impact for reducing the waters quality, so that waters cannot function properly [2]. Activities that pollute the waters of Ulee Lheu can come from land or sea waters, such as ship activities in ports, ship entry and exit routes, and tourism activities. Pollutants in Alue Naga estuary come from waterways of ponds and household waste.

Waste from pond and household activities provides several pollutants such as ammonia (NH_3), sulfide (H_2S), cyanide (CN), phenol, surfactants, and fatty oils. Ammonia (NH_3) in waters is thought to come from aquaculture activities. Meanwhile, sulfide (H_2S), cyanide (CN), phenol, surfactant, and fatty oil are assumed to come from household waste [3]. The entry of organic and inorganic substances into the waters excessively are bad for the sea waters and causes a decrease the quality of sea waters physically, chemically and biologically. This condition resulting in environmental degradation in the coastal area and surrounding ecosystems [4]. Accordingly, this research was conducted to determine the

condition of the northern waters of Banda Aceh in order to provide information on water pollution conditions with these chemical parameters.

Analysis of water quality in this study using the STORET (Storage and Retrieval of Water Quality Data System) method. This method compares the water quality data from the analysis results with water quality standards to determine the status of the waters [5]. Water quality classification is based on Environtmental Protection Agency (EPA) standards [6].

2. Material and Methods

2.1. Time and places

Seawater sampling in this study was conducted in September 2019 at 10 points along the northern waters of Banda Aceh. Sample analysis was carried out in October 2019 at laboratory of Banda Aceh Industrial Research and Standardization Center (BARISTAND).

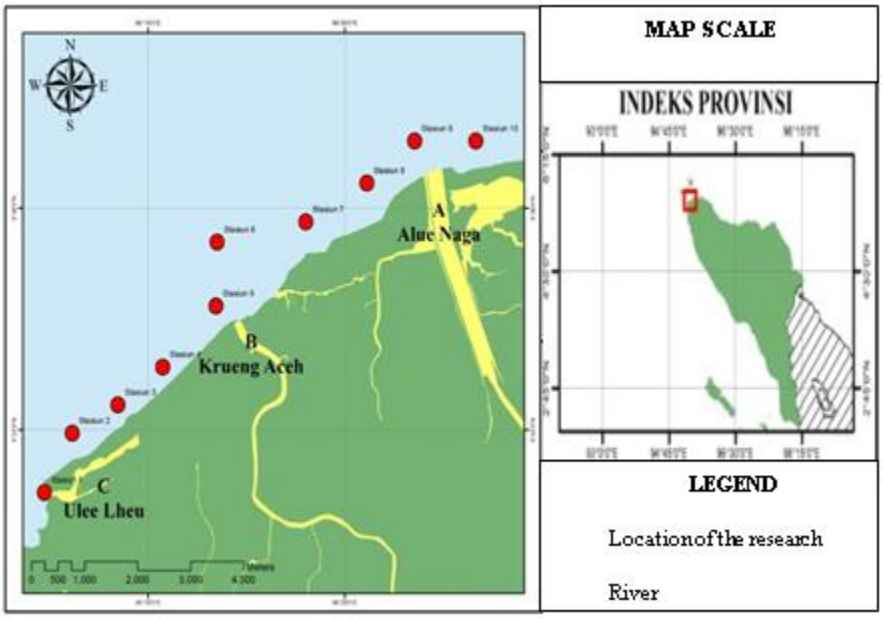

Figure 1. Map of research location

2.2. Materials and equipment

The materials in this study are seawater samples (from several stations) and chemical solutions for the analysis of ammonia, sulfides, surfactants and oil fats. The tools are camera, jerry cans 5 L, markers, styrofoam box, Global Positioning System (GPS), Atomic Absorption Spectrophotometer (AAS), erlenmeyer, pipette volume, beaker glass, water sampler, volumetric flask, watch glass, glass funnel, water bath, vacuum filter, spray flask, and filter paper.

2.3. Procedure of research

2.3.1. Determinations of stations

The stations are determined using purposive sampling method. This method is a non-random sampling method, it is determined by determining special characteristics in accordance with the research purposes. Retrieval of coordinates for 10 stations using Global Positioning System (GPS) [7].

Sampling was carried out at 10 points, spread from the waters of Ulee lheu, Krueng Aceh to Alue Naga. Samples were taken using a water sampler. In this study, water samples were taken at a depth of 1-2 meters, with a volume of 4,2 liters. Water samples were taken 2 times to fill the jerry can 5 L.

All seawater samples that have been taken from each station were placed in jerry cans 5 L and are named according to the station. After that, it was put into the styrofoam box. These samples will be analyzed at laboratory of Banda Aceh Industrial Research and Standardization Center (BARISTAND).
Procedur of analysis
Sample of seawater 25 mL was piped and put into a 50 mL Erlenmeyer. 1 mL of phenol and sodium nitroprusside solution are added and homogenized. Then, added 2.5 mL of oxidizing solution, cover the erlenmeyer with plastic or paraffin film, left for 1 hour to see the color formation. This solutionis placed into a cuvette on a spectrophotometer, then read and record the absorption at a wavelength 640 nm [7]

Sample of seawater 7,5 mL was put into 50 mL erlenmeyer. Then, added with 0,5 mL of amine sulfuric acid reagent respectively: 0,15 mL $FeCl_3$ and 1,6 mL of solution $(NH_4)_2HPO_4$. The solution is homogenized slowly. The absorption is measured with wavelength 665 nm with a time span of 8-24 minutes. Then, sulfide levels were calculated in the test sample [8].

2.3.2. Cyanide
The seawater sample 10 mL was put into sample bottles. Added one of *pillow reagen cyaniver* 3, 4 and 5 which were shaken for 30 seconds then let stand for 30 minutes. The cyanide concentration in sample can be read by a tool equipped with a standard curve system at wavelength 612 nm [9].

2.3.3. Phenol
The solvent of methylene chloride was evaporated using a rotary evaporator to obtain phenol extract. Then added 10 mL of distilled water and vortexed for 30 seconds. Folinciocalteau reagent 0,2 mL and 2 mL carbonate tartrate were added. The solution was vortex and left in room temperature for 30 minutes. This experiment was carried out twice and analyzed using UV-Vis (Brand Perkin Elmer Lamda 25) with wavelength 740 nm [10].

2.3.4. Surfactants
A standard solution of surfactants, a solution of 0.3% methylene, a washing solution, a calibration curve was made (Greenberg et al, 1985). A calibration curve was created using standard detergent solutions: 0,05 mg/L, 50 mg/L, 75 mg/L, and 100 mg/L. NaOH 1 N was added, then added phenolphthaline until it turned pink, and decolored with $H_2SO_4$1 N. Added $CHCL_3$ and 25 mL of methylene blue solution, shaken for 30 seconds until the solution separated. This solution was collected and extraction was carried out 3 time. The solution is transferred into measuring cup100 mL and filtered using glass wool so that a clear liquid is obtained. Then, added $CHCL_3$ to 100 mL, measured the absorbance of the suspense using a spectrophotometer with a wavelength of 652 nm [11].

Solvents of C_2Cl_4 and S316 were measured on IR absorption with Oil Meter POC 100, then 250 mL sample (containing oil) was put into a separating funnel and extracted using 50 mL solvents of C_2Cl_4 and S316, then left to stand. After two solvent layers have been formed, the extract is filtered with filter paper containing 10 grams of Na_2SO_4. The extract of solvent is read on an oil Content Meter POC 100 [12].

Oil analysis using gravimetric method was carried out in several varieties based on the extract level and sample volume. In addition, the type of oil was also investigated for effect on the quality of the method [12].

3. Result and Discussion

3.1. Chemical parameters analysis
The STORET method assessment in this study is based on water quality standards by the Ministry of Environment Decree. No. 115/2003. The results of chemical parameters analysis from water pollutants in seawater samples at 10 stations are presented in Table 1. The seawater sample test was obtained using the AAS.

Table 1. The results of sample analysis

Chemicals parameters	Concentration at each station (mg/L)									
	Ulee Lheu waters			Krueng Aceh rivers				Alue Naga rivers		
	St.1	St.2	St.3	St.4	St.5	St.6	St.7	St.8	St.9	St.10
Ammonia	1,1	0,002	0,08	0,01	0,02	0,01	<0,001	<0,001	0,01	0,02
Sulfide	<0,001	<0,001	<0,001	<0,001	0,001	<0,001	0,002	<0,001	0,002	0,001
Cyanide	<0,001	0,001	<0,001	<0,001	<0,001	<0,001	0,001	<0,001	<0,001	<0,001
Phenol	<0,001	<0,001	0,014	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001
Surfactants	<0,001	0,023	<0,01	<0,01	0,015	0,012	0,042	<0,01	0,016	<0,01
Fatty-Oil	0,016	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1

Table 1 shows that the ammonia at station 1 has the highest concentration. Station 1 is on Ulee Lheue, this location is also taken as station 2 and 3. All three stations show the concentrations of ammonia exceeds the water quality standard. The other seven stations have ammonia concentrations within the quality standard tolerance. Ammonia concentration in the mouth of the Krueng Aceh (Station 5) and the estuary of Alue Naga (Station 9 and 10) is close to the threshold.

The highest sulfide concentrations at Station 7 and 9, both are still within the threshold. The highest cyanide concentration was at station 7 and 2. The surfactant concentration had the highest value at Station 2, while the fatty oil could not be determined which station had the highest concentration. The results of the chemical parameter analysis also showed that the phenol concentration had a value that passed the threshold at Station 3. However, the other stations were still below the phenol threshold.

In general, the chemical parameter conditions at Station 1, 2, and 3 have the highest concentration compared to other observation stations. The significant results can be seen at Stations 5 and 9, the concentrations of ammonia, sulfides and surfactants that reach the quality standard threshold.

3.2. The water quality of northern waters of Banda Aceh using the STORET method

The STORET method assessment in this study is based on water quality standards by the Ministry of Environment Decree. No. 115/2003. The results of water quality analysis using the STORET method are presented in Table 2.

Water quality classification with the STORET method is classified into 4(four) classes based on the provisions published by the Environmental Protection Agency (EPA):

1. Class A: very good, score = 0 is still in accordance with the water quality standards
2. Class B: good, score = -1 to -10 light polluted
3. Class C: moderate, score = -11 to -30 moderate pollutant
4. Class D: poor, score > - 31 severely polluted [13]

Table 2. The results of water quality analysis using the STORET method

Around Ulee Lheu waters (St. 1, 2 and 3)

Chemicals parameters	Max. Value	Score	Min. Value	Score	Average	Score	Total
Ammonia	1,1	-2	0,002	0	0,394	-6	-8
Sulfide	<0,001	0	<0,001	0	<0,001	0	0
Cyanide	0,001	0	<0,001	0	<0,001	0	0
Phenol	0,014	-2	<0,001	0	0,005	-6	-8
Surfactants	0,023	0	<0,001	0	0,011	0	0
Fatty Oil	<0,1	0	0,016	0	0,072	0	0

Around Krueng Aceh river (St. 4, 5, 6 and 7)

Chemicals parameters	**Max. Value**	**Score**	**Min. Value**	**Score**	**Average**	**Score**	**Total**
Ammonia	0,02	0	<0,001	0	0,394	0	0
Sulfide	0,002	0	<0,001	0	<0,001	0	0
Cyanide	<0,001	0	<0,001	0	<0,001	0	0
Phenol	<0,001	0	<0,001	0	0,005	0	0
Surfactants	0,042	0	<0,001	0	0,011	0	0
Fatty Oil	<0,1	0	<0,1	0	0,072	0	0

Around Alue Naga river (St. 8, 9 and 10)

Chemicals parameters	**Max. Value**	**Score**	**Min. Value**	**Score**	**Average**	**Score**	**Total**
Ammonia	0,02	0	0,002	0	0,01	0	0
Sulfide	0,002	0	<0,001	0	0,001	0	0
Cyanide	<0,001	0	<0,001	0	0,001	0	0
Phenol	<0,001	0	<0,001	0	0,001	0	0
Surfactants	0,016	0	<0,01	0	0,012	0	0
Fatty Oil	<0,1	0	<0,1	0	0,1	0	0

Table 2 shows that based on the calculation of the STORET method, the ammonia score is obtained from the maximum and average concentration assessment, as well as the phenol score. The maximum concentration was given a score of -2 and the average concentration was given a score of -6. The minimum, maximum, and average concentrations of sulfide, cyanide, surfactant, and fatty oil parameters have a score of 0. The total score for all parameters is -16 (around Ulee Lheu waters) and is in the medium polluted category (class C). The ammonia concentration at station 1 passed the quality standard limit of 1,1 mg/L. Meanwhile, the required quality standard value for ammonia is not more than 0,02 mg/L. Ammonia concentration is due to the fact that the station is a tourist place, close to the ship port and residential areas. The source of this pollutant is in the form of organic and inorganic waste such as plastic waste, ship oil spills at the port, and household waste. Ammonia in water comes from urine and feces, oxidation of organic substances microbiologically, and wastewater from community activities[14]. High ammonia concentration in water causes a decrease in dissolved oxygen which can interfere with metabolism and respiration [15]. In addition, the presence of ammonia compounds can affect the size of the chloroplasts to be small, thus inhibiting the photosynthesis process [16].

Phenol concentrations that exceed the quality standard can be observed at station 3. The specified quality standard value is not more than 0,001 mg/L. While the phenol concentration value obtained from the data is 0.014 mg/L. The source of phenol compound pollution in marine waters comes from industrial waste, oil spills, and the use of phenol-containing materials in marine bodies. Materials containing phenols are often used to anesthetize fish such as tobacco. Phenolic are also toxic organic compounds. In certain concentrations can cause the death of organisms in the water [17].

4. Conclusion

The results of this study showed that the water quality in Ulee Lheu classify into Class C (score –16), which was medium polluted, with ammonia and phenol content 1,1 mg/L and 0,014 mg/L. Meanwhile, the estuary of Krueng Aceh and the waters around of Alue Naga are categorized in Class A (score 0), that means both are still in accordance with water quality standards.

References

[1] Irnawati I, Manaf S A, Suhartono, Rusyana A, and Idroes R 2019 *IOP Conf. Series: Earth*

Environment Science 348 012068
[2] Menteri NegaraKependudukan dan Lingkungan Hidup1988 *Surat Keputusan Nomor: Kep–02/MENKLH/I/1988*
[3] Suyasa W B 2015 *Pencemaran Air & Pengolahan air Limbah* (Denpasar: Udayana University Press)
[4] Hamuna B, Tanjung R H R, Suwito, Maury H K, and Alianto 2018 *Jurnal Ilmu Lingkungan* **16(1)** 35-43
[5] Sugiyarto, Hariono B, Destarianto P, and Nuruddin M 2017 *Journal Physic.: Conf. Ser. 953 012126*
[6] Saraswati S P, Sunyoto, Bambang A K, and Suwarno H 2014 *Jurnal Manusia dan Lingkungan*, **21(2)** 129-142
[7] Ningsih S 2019 *Skripsi* (Program Studi ilmu Kelautan Universitas Syiah Kuala)
[8] Setiani L, Hanifah T A, Anita S *2015 JOM FMIPA* **2(2)** 1-9
[9] Sultan S N, Abidjulu, Koleangan H S J 2015 Jurnal Ilmiah Sains **15(1)** 1-6
[10] Sukandar D, Tri H P, Ai F H 2009 *Jurnal Valensi* **1(4)** 1-7
[11] Sulistiyawati I 2018 *Prosiding Seminar Nasional "Pengembangan Sumber Daya Perdesaan dan Kearifan Lokal berkelanjutan VIII. Unsoed* **8(1)**
[12] Hardiana S S and Mukimin A 2014 *Jurnal Riset Teknologi Pencegahan Pencemaran Industri* **5(1)** 1-6
[13] Purnamasari D E 2017 *Tugas Akhir* (Institut Teknologi Sepuluh Nopember Surabaya)
[14] Putri W A E, Purwiyanto A I S, Fauziyah, Agustriani F, and Suteja Y 2019 *Jurnal Ilmu dan Teknologi Kelautan Tropis* **11(1)** 65-74
[15] Zhang J Y, Ni W M, Zhu Y M, and Pan YD 2012 Aquatic Ecology **47(11)** 25-35
[16] Kivimäenpää M, Riikonen J, Sutinen S, and Holopainen T 2004 *Journal of Environtmental Pollution* 137 (3) 66-75
[17] Asuhadi S, Arafah N, and Amir A B 2019 Jurna Ecogreen **5(1)** 1-8