Analysis of Air, Water and Noise Level Quality Due to Industrials Activities in Aceh Province

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Muhammad Zaki[1,2,*], Mahidin[1,2,♣], Mariana[1,2], Asri Gani[1,2], Muhammad Nasir[1,3], Muhammad Irham[1,4], Erdiwansyah[1,5,♦], Ichwana[1,6], Safarul Aufa[1,7], Nasrullah[1,8]

[1] Research Center for Environmental and Natural Resources, Universitas Syiah Kuala, Banda Aceh 23111, Indonesia
[2] Department of Chemical Engineering, Universitas Syiah Kuala, Banda Aceh 23111, Indonesia
[3] Department of Biology, Universitas Syiah Kuala, Banda Aceh 23111, Indonesia
[4] Faculty of Marine and Fisheries, Universitas Syiah Kuala, Banda Aceh 23111, Indonesia
[5] Faculty of Engineering, Universitas Serambi Mekkah, Banda Aceh 23245, Indonesia
[6] Department of Agricultural Engineering, Universitas Syiah Kuala, Banda Aceh 23111, Indonesia
[7] Sekolah Tinggi Ilmu Ekonomi Indonesia (STIEI), Banda Aceh 23244, Indonesia
[8] Graduate School of Environmental Management, Universitas Syiah Kuala, Banda Aceh 23111, Indonesia

ARTICLE INFO	ABSTRACT
	Air pollution throughout the world, in general, has been at a very alarming rate with the increase in industrial and human activities. In Indonesia, the level of air pollution caused by various industries, especially from motor vehicles, is no longer a secret. Particularly, in the province of Aceh, air, water, and air noise quality in recent years have resulted in deteriorating health for humans and living things. This research analyzed air quality, water odor, and air noise level in the Aceh Province. The results for air quality analysis show an increase in emissions. The noise level of the three regions analyzed is still below the thresholds set. Meanwhile, the results of water odor analysis show its level has exceeded the thresholds set by the Ministry of Environment. Therefore, industrial activities can have an impact on the environment when they are not managed appropriately.

1. Introduction

In the last few decades, the surrounding air has been polluted by various activities, including multiple industries and motor vehicles. Air pollution has occurred throughout the world, and Indonesia is one of them. Air pollution has now reached a very alarming level. The primary sources

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* *Corresponding author.*
E-mail address: m.zaki@unsyiah.ac.id

♣ *Corresponding author.*
E-mail address: mahidin@unsyiah.ac.id

♦ *Corresponding author.*
E-mail address: erdi.wansyah@yahoo.co.id

of air pollution are private vehicles, public transportation, industry, etc. [1]. In several scientific works that have been reported show that air pollution has an impact on the health of humans and other living things. Research on reducing air pollution to improve human health caused by vehicles has been discussed by Schmid *et al.,* [2]. Handling climate change and air pollution can correctly and adequately drive the transition to society to reduce carbon. Analysis of air pollution in India in 2016 was carried out by Kanawade *et al.,* [3]. The average PM2.5 concentrations in New Delhi before, during, and after SAPE reached $142\mu g/m^3$, $563\mu g/m^3$ and $240\mu g/m^3$, respectively. Meanwhile in China, analysis of air pollution is carried out to develop metrics based on social media, city-level for insomnia, and support causal claims by instructing pollution with variations in wind patterns that make sense [4].

Furthermore, research on air pollution from the combustion of biomass that has affected air pollution, human health, and global climate was studied by Zhou *et al.,* [5]. Variations were made every hour with the characteristic of criteria for air pollutants (PM2.5, PM10, SO_2, NO_2, CO, and O_3). Chemical components and sources of PM2.5 were given before, during, and after regional air PE. The results of their research show that the combination of intensive pollution from biomass burning, stable meteorological conditions, and basin topography caused severe local PE in the southern Sichuan Basin (SSB). Investigations regarding the relationship between air pollution and deaths of children <5 years old in Beijing, China, was carried out by Wang *et al.,* [6]. Besides, their research explored the impact on age and sex and causes of death specifically at this association. An evaluation of the environmental impact of noise and air pollution on surrounding traffic was studied by Klompmaker *et al.,* [7] and Yazid *et al.,* [8]. The results of their investigation show that environmental exposure, air pollution, and traffic noise cannot be linked to specific non-accident mortality or causes. Some researches on air pollution have also been done with different problems and different locations and places [9–13]. From numerous researches that have carried out show that air pollution caused by various factors was very detrimental to health and had an impact on death.

Air pollution in Indonesia, especially in the province of Aceh, is the same thing that is happening throughout the world. Investigations regarding air pollution in the environment that have an impact on the health of humans and living things have been investigated by Budiyono [14]. By-products from various industrial and human activities have presented heavy metals, NOx, SOx, CO, Ox, TSP and Pb which have a terrible impact on the health of humans and other living things. An analysis of the effects of air pollution on the environment has also been evaluated by Raharjo [15]. Spread of pollution gases such as (sulfur dioxide, nitrogen dioxide, hydrogen chloride and other minor compounds) due to various forest fires and other causes. Meanwhile, the analysis of air pollution pollutants consists of CO, CO_2, NO, NO_2, SO_2, SO_3, particulates and ozone from the effects of air pollution and acid rain [16]. One of the sources of problems for the survival of living things on earth is due to air pollution as examined by Abidin and Hasibuan [17]. Humans and other living things need clean air. Studies on anticipation of air pollution that have an impact on health have also been studied by Basri [18]. Their research specifically analyzed pollution such as O_3, CO, CO_2, SO_2, SO_3, and NO, NO_2, dust, acids and pesticides. The results reported that air pollution is alarming for the health of humans and living things in general.

Research on air pollution has been widely reported in various scientific publics. In Indonesia, the problem of air pollution has made the issue very worrying for the community. This research was carried out in several different regions in Aceh province. The main objective of this investigation is to analyze environmental conditions (notably air, water, and air noise pollution) in certain areas.

2. Material and Methodology

2.1 Material

Materials used in this study include Hi-Volume Sampler and Gas Sampler for air quality analysis. Meanwhile, the content for water analysis used water samples and 1 to 2-liter sample bottles. Air noise analysis used Sound Level Meter to get the sound pressure level with the dBA unit. The locations for analysis of environmental conditions on air quality, water quality and air noise levels consisted of three different places, as shown in the map in Figure 1. The point of analysis of environmental conditions in detail are described in Table 1, based on the area shown in Figure 1.

Fig. 1. Map of location data analysis

2.2 Analyses

Data analysis in the study was based on thresholds as determined by the Minister of Health regulation No. 416 of 1990 as well as requirements for water quality control. Whereas for the analysis of air noise levels, the analysis was carried out using noise threshold levels set by the Minister of Environment No. 48 of 1996. Air quality was analyzed using SNI No. 41 of 1999.

3. Results

This research was conducted to analyze air quality, water odor, and noise levels caused by various industrial activities that are currently running or developed. The investigation carried out at several different places located in the Aceh province regions as shown in Figure 1. The analysis was carried out on emission from the air caused by industrial activities that were found in the study area to determine the extent of air pollution caused by industrial activities and other daily human activities. The analysis used several measurement methods required by the established SNI. The results of the

study show that SO_2, NO_2, O_3, and Pb had exceeded the thresholds set for the Blah Dayah Blang region in Pidie Regency. While the results of the analysis found in the Teungoh Pidie Jaya village area show that only SO_2, NO_2, and PB passed the permitted thresholds. Whereas in Cut Ulim Village, Bireuen Regency, NO_2, O_3, and Pb exceeded the specified thresholds as shown in Table 1. These results indicate that ongoing industrial activities and human activities have an impact on air pollution. It needs various parties to be sensitive to the air in the environment so that the health of humans and other living things can be maintained in a healthy atmosphere.

Various investigations and analysis of air noise in multiple regions and even countries have been carried out. However, each different area shows different noise level since there are various factors both from industrial activities and other human activities. Several studies in scientific publications on air quality have been reported [19–21]. Where the results show that the average benzene level in ambient air in Asian countries ($371 \mu g/m^3$) was about 3.5 times higher than the level of benzene in the room ($111 \mu g/m^3$).

Table 1
The results of air quality analysis in different regions

Location	Testing Parameter	Result	Threshold	Unit
Pidie	Sulphur Dioxide (SO_2)	<12.55	900	$\mu g/Nm^3$
	Carbon Monoxide (CO)	664.21	30000	$\mu g/Nm^3$
	Nitrogen Dioxide (NO_2)	<19.48	400	$\mu g/Nm^3$
	Oxidant (O_3)	<20.33	235	$\mu g/Nm^3$
	Lead (Pb)	<0.0232	2	$\mu g/Nm^3$
	Hydrocarbon (HC)	25.35	160	$\mu g/Nm^3$
	PM10 (Particle <10 mm)	33.78	150	$\mu g/Nm^3$
	PM2,5 (Particle < 2.5 mm)	16.89	65	$\mu g/Nm^3$
	TSP (Total Dust)	97.28	230	$\mu g/Nm^3$
	Wind velocity	5.10	N/A	m/det
	Temperature	33.00	N/A	°C
	Humidity	51.30	N/A	%
Pidie Jaya	Sulfur Dioxide (SO_2)	<12.55	900	$\mu g/Nm^3$
	Carbon Monoxide (CO)	572.60	30000	$\mu g/Nm^3$
	Nitrogen Dioxide (NO_2)	<19.48	400	$\mu g/Nm^3$
	Oxidant (O_3)	141.73	235	$\mu g/Nm^3$
	Lead (Pb)	<0.0232	2	$\mu g/Nm^3$
	Hydrocarbon (HC)	25.06	160	$\mu g/Nm^3$
	PM10 (Particle <10 mm)	50.59	150	$\mu g/Nm^3$
	PM2,5 (Particle < 2.5 mm)	33.73	65	$\mu g/Nm^3$
	TSP (Total Dust)	65.77	230	$\mu g/Nm^3$
	Wind velocity	1.60	N/A	m/det
	Temperature	32.10	N/A	°C
	Humidity	45.00	N/A	%
Bireuen	Sulfur Dioxide (SO_2)	129.22	900	$\mu g/Nm^3$
	Carbon Monoxide (CO)	664.21	30000	$\mu g/Nm^3$
	Nitrogen Dioxide (NO_2)	<19.48	400	$\mu g/Nm^3$
	Oxidant (O_3)	<20.33	235	$\mu g/Nm^3$
	Lead (Pb)	<0.0232	2	$\mu g/Nm^3$
	Hydrocarbon (HC)	16.13	160	$\mu g/Nm^3$
	PM10 (Particle <10 mm)	67.37	150	$\mu g/Nm^3$
	PM2,5 (Particle < 2.5 mm)	50.53	65	$\mu g/Nm^3$
	TSP (Total Dust)	82.53	230	$\mu g/Nm^3$
	Wind velocity	1.60	N/A	m/det
	Temperature	31.30	N/A	°C
	Humidity	49.70	N/A	%

The level of air noise from the three sites analyzed shows that Gampong Cot Ulim Bireuen Regency was the highest at 53.02 dBA as shown as in Figure 2. The height of the noise level can be influenced by various factors, especially vehicles that pass for 24 hours inside the City. Meanwhile the lowest noise was recorded in the Gampong Daya Blang area of Pidie Regency. The center of Gampong Daya Blang is far away from the center of the crowd and the beach. Besides, the air noise is reduced compared to those are close to the beach and the center of the city. The lowest noise level was 49.01 dBA in Pidie Regency Blang Village. However, the results of the analysis in the three regions show that the noise level was still below the standard set. Researches on the study of air noise levels have also been carried out by several previous researchers [22]. In their research, the analysis was carried out on the highway using a traffic signal. The combined noise level analyzed was 67,615 dB (A). The results of the investigation show that the noise level was still at a safe point based on the results determined by the Minister of the Environment ($\leq$ 70 dB). This research analyzed the noise level caused by everyday industrial and human activities.

Furthermore, this study analyzed the level of water odor in three different regions to determine the level of water quality caused by industrial activities. This analysis is essential for human health in consuming water. The analysis used the thresholds determined by the government or SNI 19-719.1:2005 or other methods such as SMM-AAS and NIOSH. The results of this analysis show that the water odor has exceeded the threshold set, except for NH_3 ammonia as shown in Table 2. The height of water odor is an adverse impact which can be caused by various industrial activities and other human activities.
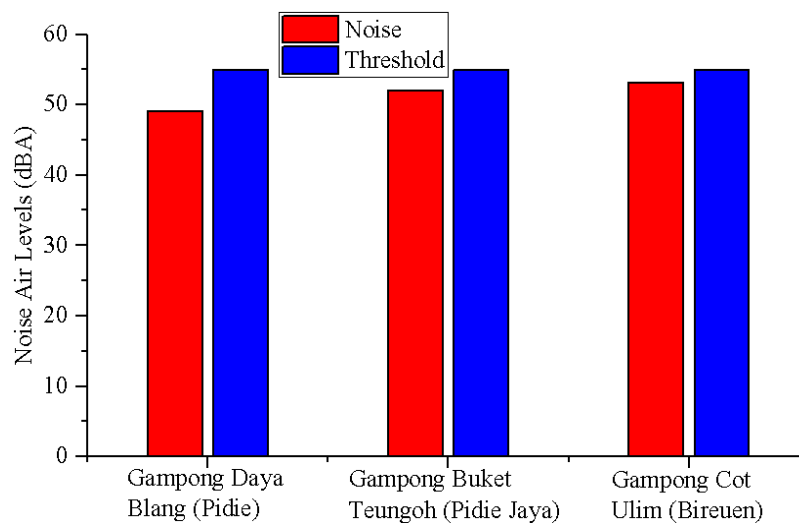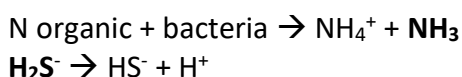

Fig. 2. Effect of noise air levels for different area

In the environment, the onset of odor can be caused by several chemical reactions including ammonia, methyl Mercaptan, hydrogen sulfide, methyl sulfide, and styrene which are odor compounds that cause a negative impression.

N organic + bacteria $\rightarrow$ NH_4^+ + **NH_3**
H_2S^- $\rightarrow$ HS^- + H^+

Methyl Mercaptans, with chemical reactions that cause odour, are as follows

Cysteine (-S-S) $\rightarrow$ Cysteine (-SH-SH-) $\rightarrow$ CH_3SH

Table 2
The results of the analysis of water odour from different regions

Location	Testing Parameter	Result	Threshold	Unit
Pidie	Ammonia (NH_3)	0.24	2	ppm
	Hydrogen Sulfide (H_2S)	<0.004	0.02	ppm
	Methyl Sulfide	<0.0032	0.01	ppm
	Methyl Mercaptant	<0.0004	0.002	ppm
	Stirena	<0.002	0.1	ppm
Pidie Jaya	Ammonia (NH_3)	1.63	2	ppm
	Hydrogen Sulfide (H_2S)	<0.004	0.02	ppm
	Methyl Sulfide	<0.0032	0.01	ppm
	Methyl Mercaptant	<0.0004	0.002	ppm
	Stirena	<0.002	0.1	ppm
Bireuen	Ammonia (NH_3)	1.80	2	ppm
	Hydrogen Sulfide (H_2S)	<0.004	0.02	ppm
	Methyl Sulfide	<0.0032	0.01	ppm
	Methyl Mercaptant	<0.0004	0.002	ppm
	Stirena	<0.002	0.1	ppm

The results of ambient water quality analysis carried out at the location are shown in Figure 1, indicating that it was still safe overall. However, the ambient water quality for SO_2 showed an increase of $12.55 \mu g/Nm^3$ from the standard quality set by SNI 19-7119.7-2005 as shown in Table 3.

Table 3
The result of ambient air quality

Testing Parameter	Result	Threshold	Unit
Sulfur Dioxide (SO_2)	<12.55	365	$\mu g/Nm^3$
Carbon Monoxide (CO)	229.04	10000	$\mu g/Nm^3$
Nitrogen Dioxide (NO_2)	36.36	150	$\mu g/Nm^3$
Oxidant (O_3)	34.55	235	$\mu g/Nm^3$
Lead (Pb)	0.01	2	$\mu g/Nm^3$
Hydrocarbon (HC)	84.56	160	$\mu g/Nm^3$
PM10 (Particle <10 mm)	65.57	150	$\mu g/Nm^3$
PM2,5 (Particle < 2.5 mm)	40.06	65	$\mu g/Nm^3$
TSP (Total Dust)	96.87	230	$\mu g/Nm^3$
Wind velocity	1.70	N/A	m/det
Temperature	29.20	N/A	°C
Humidity	56.90	N/A	%
Air Pressure	758.90	N/A	mmHg

The results of noise level measurements for 24 hours at the study site are shown in Table 4. The noise levels were analyzed at different hours divided into seven retrieval sections, and each analysis was represented by L1 Noise to L7 Noise. The highest noise level was recorded at 17:00 to 22:00 at 49.90 dBA with maximum noise reaching 50.00 dBA. Meanwhile, the lowest sound was recorded at 00:00 to 3:00 at 44.50 dBA. Then, the average noise reached 46.70 dBA during the day and 44.50 dBA at night, while the average noise level for 24 hours was 46.95 dBA. The results of the noise level

analysis conducted in this study are shown in Table 4. Previous research on air noise analysis has also been carried out by several researchers [23,24]. The noise level reported in their study reached 92 dBA, while the lowest was 62 dBA. The results in their study were higher than those stipulated by KepMenaker No. 51/1999 (85 dBA. However, the differences between these studies was the location and causes of noise, i.e. aero plane. Meanwhile, the locations in this study are the distant sea and land from the airport.

Table 4
The result of noise in 24 hours

Testing Parameter	Leq Result	LMax	Unit	Measurement Method
L1 Noise	47.90	48.90	dBA	Time 06.00 – 09.00
L2 Noise	46.70	47.50	dBA	Time 09.00 – 11.00
L3 Noise	47.90	48.90	dBA	Time 14.00 – 17.00
L4 Noise	49.90	50.00	dBA	Time 17.00 – 22.00
L5 Noise	45.10	46.30	dBA	Time 22.00 – 24.00
L6 Noise	44.50	46.00	dBA	Time 00.00 – 03.00
L7 Noise	44.60	45.90	dBA	Time 03.00 – 06.00
Daytime Leq	46.70	N/A	dBA	
Night Leq	44.50	N/A	dBA	
Leg 24 hours	46.95	N/A	dBA	

The results of the water odor analysis carried out in full research are shown in Table 5. The analysis of the water odor level focused on (NH_3), H_2S, methyl sulfide methyl Mercaptan and styrene. The measurement method was carried out referring to the national standards SNI 19-7119.1: 2005, SMM-AAS and NIOSH. The highest level of water odor was recorded in NH_3 of 0.34 and followed by H_2S and styrene, respectively, <0.004 and <0.002. However, the results of water level analysis obtained in this study were still below the specified thresholds. These results indicate a safe level that needs to be maintained and needs awareness from various groups to conserve the environment. Thus, the future health can always be managed with a clean and healthy environment. Analysis of the water odor and air has also been carried out by several previous researchers [25,26]. Those studies included industrial and agricultural activities such as urban reliable waste handling, crumb rubber factory production, intensive livestock farming, wastewater treatment plants, and oil refineries. Meanwhile, this study analysis was carried out on the industries that are currently running or developed in the regions of Pidie, Pidie Jaya, and Bireuen districts in Aceh Province.

Table 5
The result of odour

Testing Parameter	Result	Threshold	Unit
Ammonia (NH_3)	0.34	2	ppm
Hydrogen Sulfide (H_2S)	<0.004	0.02	ppm
Methyl Sulfide	<0.0032	0.02	ppm
Methyl Mercaptant	<0.0004	0.002	ppm
Stirena	<0.002	0.2	ppm

4. Conclusions

This study was conducted to estimate environmental conditions on air quality, water odor, and air noise levels caused by various industrial activities and other human activities. The results of the analysis of environmental conditions found in several regions in Aceh Province carried out in this study can be drawn as follows

i. Air quality caused by various industrial activities in the area studied shows an increase in overall emissions rather than the threshold set.

ii. The level of air noise in the three areas studied is still below the threshold set, so that the sound is still safe for the area caused by various industrial activities and other human activities.

iii. The overall ambient water quality is still below the threshold set by the government and the measurement methods used.

iv. Overall, this shows an increase in the threshold of water odor as specified thresholds.

Acknowledgement

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