

Impacts of Air Quality to the Environment of Kupang Harbor Port

*Sri Sumiyati¹, Martha Lucasnussy², Fransiscus F. G. Ray³

^{1,2} Department of Biological Education, Faculty of Teachers Training and Education Science, Nusa Cendana University, Kupang, Indonesia

³ Department of Electrical Engineering Education, Faculty of Teachers Training and Education Science, Nusa Cendana University, Kupang, Indonesia
Corresponding Author: Sri Sumiyati

Abstract: Tenau Kupang harbor plays an important role for the development of East Nusa Tenggara (ENT) Province, Indonesia. This is why it has to increase the quality of its services. Such an increase in quality services, however, needs to be balanced with an environmental management system adequate with the port area, one of which is related to air quality in the area. One of its impacts is air and noise pollution. This study was to measure and examine air and noise pollution caused by port activities in that harbour. It was conducted in two phases, the first phase was from April 30 to May 1, 2015, and the second phase from December 14 to 15 December 2015 in the four locations. Sampling of air quality includes concentrations of NO₂, SO₂, dust and noise. The results of the analysis suggest that the quality of NO₂ air, SO₂, and dust is still under environmental quality standards, except for average noise which is 80.91 db (A) showing that the level of ambient noise has exceeded the limit.

Keyword: Air Quality, Environmental, Impacts.

Date of Submission: 16-08-2017

Date of acceptance: 05-09-2017

I. Introduction

A port is a place or service facility to serve ships coming and going in the dock area, including waste handling facilities. According to Article 1 of Indonesian Government Regulation Number 61 Year 2009 on Port, a port is a place that consists of land and its surrounding waters with certain limits as a place for governmental and economic activities used as a vessel leaning, anchoring passengers up and down and/or loading and unloading goods equipped with shipping safety facilities and port supporting activities. It is also a place for intra- and inter-modal transport movement[1].

The Port of Tenau Kupang as the main port in ENT has a strategic role in connecting inter-island trading activities and other public transportation services. Currently, the Port of Tenau has proven itself as the entrance gate of basic necessities shipped with containers. The loading and unloading of the containers has increased from year to year. In 2009, 49,809 boxes entered the Port of Tenau Kupang, in 2010 it increased to 54,751 boxes, and in 2011 56,708 boxes. In 2012, there were 2,261 units of vessels with the total GT 3,2 million tons visiting the port, and in 2013 2,675 units.

In loading and unloading the containers, of course, some means of transportation in the forms of vehicles in operation makes noisy sounds like the sounds of machines through exhausted vehicles. At low levels, these sounds can still be tolerated in the sense that the resulting effect does not give negative impacts but at higher levels the sounds generated by the vehicles are noisy and, therefore, create noise interference.

This will certainly have bad impacts to the coastal ecosystem of the Port of Tenau Kupang. Among these impacts are noise and air pollutions and natural habitat degradation (flora & fauna). Degradation of natural resources and biodiversity due to port activities can alter coastal ecology structures and even decrease its aquatic biodiversity. Noise is an undesirable sound from business and other kinds of activities within certain levels and time that can cause public health problems and environmental discomfort. While vibration is the movement of alternating mass/weight through a balanced state to a certain point or all unwanted sounds created by certain means of production processes and or work tools which, to some extent, may cause hearing loss[2]. Among other environmental pollutions, pollution/noise pollution is considered special in terms of: 1) personal and subjective judgments which are crucial to recognize noise as noise pollution; 2) local and sporadic damage compared to air pollution and aircraft noise which is an exception.

Based on the definition, it is deemed necessary to calculate the noise level at the port to find out whether the noise level is tolerable or has exceeded the threshold so that an activity aimed to reduce the negative impact and noise by installing the insulation (Noise Insulation Treatment) as applied in the UK based on the

book "Calculation of Road Traffic Noise" is necessary [3]. In Indonesia, the noise threshold value is set at 85 db (A) based on the regulation of the Ministry of Labor, Transmigration, and Cooperatives No. 1/1978 [4]. The noise level standard for the area/environment of a special seaport is managed in accordance with the Decree of the State Minister for Environment No. KEP 48/MENLH/11/1996 set at the level of 70 db (A)[5].

The purpose of this study is to measure and examine air pollution and noise level caused by the activities in the port. By minimizing air pollution and noise, it is possible to achieve a safe, convenient, smooth and economical transportation system now and in the future.

The results of this study are expected to contribute data information in order to influence port activities and air quality of the Port of Tenau Kupang, and to provide a definite picture of air pollution and noise increase as well as analysis of prevention, mitigation and restoration of noise and air quality problems as well as environmental conservation of the Port of Tenau Kupang.

II. Materials And Method

As described in the Decree of the Minister of Communications no. 53 of 2002 the port is a place comprising land and waters surrounding it with certain limits as a place of government activity and economic activity used as vessel leaning, anchored, up and down passenger and / or loading and unloading Goods equipped with shipping safety facilities and port supporting activities and as a place for intra and inter-mode transport[6].

The port is the place where the movement of goods and passengers from and to the territorial waters and land. In addition, the port can be regarded as a gateway for entry into a certain area and as a liaison infrastructure between regions, between islands, even between countries [7].

The port is also an economic unit, a place that provides terminal services for transport operators and nodes in the transport network, in support of port activities as well as places to dock to be docked at the port, there must be a building called a dock [8]. The dock is a port building that is used to dock and moor the ship loading and unloading of goods and up and down passengers[9].

Increase of harbor loading activities in the Port of Tenau Kupang has an impact on the environment around Petikemas Port which has air pollution and noise Air pollution at the port arises from emissions from ships, trucks, loading and unloading equipment and freight trains at the port. Pollution or environmental pollution occurring in the majority port area occurs in water and air areas. Air pollution at the port arises from emissions from ships, trucks, loading and unloading equipment, and freight trains at ports

Pollution is defined as the entry/inclusion of living creatures, substances, energy, and / or other components into the environment by human activities so that the quality drops to a certain level that causes the environment can not function in accordance with its intended[10]. Simply put, pollution is a pollution that causes the quality of the environment down to a certain level and causes the environment not to function properly.

Air pollution at the port is caused by the main engine and vessel auxiliary engines, boilers, and exhaust gases accumulated due to ship traffic in ports. The main engine is a major resource for ships when moving in the waters. Auxiliary machines are used at sea and when docked at the port to generate electrical equipment or to heat the system on board. Emissions at the harbor occur when the ship is docked at the harbor. The vessel generates emissions when docked at the harbor while powering their auxiliary machine to produce electricity on board. If there are many ships that dock at the harbor and do the same, there will be an accumulation of emissions at the port and will have adverse health and environmental impacts. Emissions from burning combustion engines generally contain carbon dioxide (CO₂), carbon monoxide (CO), Nitrogen Oxide (NO_x), Sulfur dioxide (SO₂), and particles[11]. If incomplete combustion, it will produce Hydrocarbons (HC) that are not burned. Emissions are air pollution generated by the combustion process of motor fuel[12].

Noise is an undesirable sound and interferes with the health and comfort of the environment expressed in decibels (dB). Noise is caused by a vibrating sound source. The vibration of the sound source disturbs the surrounding air molecules so that the molecules come vibrating. The vibration of this source causes a wave of mechanical energy propagation in the air medium according to the longitudinal propagation pattern. At the Port, noise is generated by ships, trucks, loading and unloading activities, construction and maintenance activities. The noise level of ship auxiliary machinery when at the port can reach 80 - 120 dB). Noise at the port can cause hearing loss and increased blood pressure[7].

This study was conducted in two stages. The first phase was from 30 April to 01 May 2015 and the second phase from 14 to 15 December 2015 in several places. Air quality is taken as follows: stage one includes Alak, the front part of the Customs Office, Pier I, and the PNMP Dock; stage two includes the same places, that is, Alak, the front part of the Customs Office, Pier I, and the PNMP Dock.

The tools used for air sampling for primary data at each location were *Impingel* tool, sound level meter and pump suction. Sample analysis methods used for each parameter are as follows: SO₂ using Pararosaniline method, NO₂ using Saltzman method, and Dust using Gravimetri method. Samples taken as primary data at each location were further analyzed at the Chemical Laboratory of the School of Science and

Engineering of the University of Nusa Cendana, and the results were compared with the Decree of the Ministry of Environment No. 48/MENLH/11/1996 on Noise Level[5] and the Regulation of the Government of Indonesia No.41 of 1999 on Ambient Air Quality Standard[13].

III. Results And Discussion

The results of the analysis of the four samples conducted in both the first and the second stages, in the field and in the laboratory, are presented in Table 1 and Table 2.

1. Noise Level Parameters

The noise level parameters can be seen in Table 1 below.

Table 1: Noise Level

No	Parameter	Unit	Measurement Location				Mean	Quality standards
			K-1	K-2	K-3	K-4		
Stage1	Noise	dB(A)	67.7	79.9	90.7	82.0	80.07	55-70
Stage 2			69.4	78.9	90.5	88.2	81.75	
Mean							80.91	

Source: Primary data

Remarks: Quality Standard based on the Decree of the Minister of Environment No. Kep-48/MENLH/11/1996. Noise Level Standards: K-1 = Alak, K-2 = Customs, K-3 = Dock, K-4 = PNMP Dock

Based on the Decree of the Minister of Environment No. Kep-48/MENLH/11/1996[5], the result of air quality testing on noise level, concentration at four measurement sites in the first stage shows the average noise level of 80.07 ± 9.48 db (A) and noise level of 81.75 ± 9.64 db (A). Average concentration on the three sampling sites at K-2 (Front Part of Customs Office), K-3 (Pier), and K-4 (PNMP Docks) is 80.91 db (A) for noise parameters which has exceeded the upper limit noise level for an industrial region, that is, 70 db (A). While at K-1 location, Alak, the noise parameter concentration has exceeded the lower limit noise level a settlement area, that is, 55 db (A).

Differences of noise at each location in ambient air are generally due to the heavy contribution of vehicles during loading and unloading activities at the container ports (especially large vehicles such as trucks, passenger cars and other vehicles) as well as the activity of belting of passenger ships/freight vessels (sea transportation vessels), heavy equipments used in the port area, industrial activities around the port, and activities Pertamina (Indonesian Fuel Mining). Noise that occurs in the Port of Tenau Kupang is short-lived because the source of noise occurs during pier operational activities and land transportation activities around the pier.

The impact of noise on humans can damage their hearing devices. Psychological effects include increased blood pressure, nausea, insomnia, and restlessness. The effects of emotional change as an expression of disturbance can even lead to mental disability. In addition, excessive noise can also decline one's power of communication and sharpness of his/her mind.

2. Air Quality Parameters

The environmental parameters in the Port of Tenau Kupang area related to air quality components as listed in Table 2 below have gone through laboratory analysis. Air quality analysis results are presented in Table 2.

Table 2: Air Quality

No	Para meter	Unit	Measurement Location Phase 1				Mean	Method	Quality standards
			UD-1	UD-2	UD-3	UD-4			
1	NO ₂	($\mu\text{g}/\text{Nm}^3$)	48.94	61.17	76.12	47.22	58.363	Saltzman	400
2	SO ₂	($\mu\text{g}/\text{Nm}^3$)	177.17	188.98	165.36	141.74	168.31	Pararosnilin	900
3	Dust	($\mu\text{g}/\text{Nm}^3$)	58	63	54	65	60	Gravimetry	230
No	Para meter	Unit	Measurement Location Phase 2				Mean	Method	BM
1	NO ₂	($\mu\text{g}/\text{Nm}^3$)	45.96	75.77	76.35	78.89	58.363	Saltzman	400
2	SO ₂	($\mu\text{g}/\text{Nm}^3$)	142.24	188.56	175.97	177.17	168.31	Pararosnilin	900
3	Dust	($\mu\text{g}/\text{Nm}^3$)	60	58	66	65	60	Gravimetry	230

Source: Primary data

Remarks:

Quality Standard based on the Regulation of the Government of Indonesia No.41 of 1999 on Ambient Air Quality Standard; UD-1 = Alak, UD-2 = Customs, UD-3 = Dock, UD-4 = PNMP Dock

The result of testing ambient air quality parameters from four air sampling sites, for all parameters, has not passed the national ambient air quality standard threshold based on the attachment of the Government Regulation No. 41/1999 on Air Pollution Control[13].

3. Sulfur Dioxide (SO₂)

Measurement result in the first stage for sulfur dioxide (SO₂) parameters at UD-1 station was 177.17 µg/Nm³, at UD-2 station 188.98 µg/Nm³, at UD-3 station 165.36 µg/Nm³, and at UD-4 station 141.74 µg/Nm³. While the second stage measurement for sulfur dioxide (SO₂) parameter at UD-1 station was 142.24 µg/Nm³, at UD-2 station 188.56 µg/Nm³, at UD-3 station 175.97 µg/Nm³, and at UD-4 station 177.17 µg/Nm³. This indicates that SO₂ gas in the four sampling sites is still below the environmental quality standard set at 900 ug/Nm³[13].

SO₂ gas can be formed when the golden-yellow powder sulfur contained in coal and burning fuel comes from motor vehicle fumes and burning of waste, from heating in factories/industries and from domestic heating. SO₂ will form very fine particles (sulfate) and can interfere with human health if it penetrates the deepest part of the lungs, which is a chronic irritation of the respiratory tract, causing bronchitis and pulmonary and epiphysima. If SO₂ reacts with water in the atmosphere, it will result in acid rain that will affect the plants and animals. In plants, the green color changes on their leaves turn into yellow color which can also create white patches on the leaves. The effects to the animals are the same as those to humans.

4. Nitrogen Dioxide (NO₂)

The result of measurement of first phase of Nitrogen Dioxide (NO₂) parameter at UD-1 station was 48.94 µg/Nm³, UD-2 station 61.17 µg/Nm³, UD-3 station 76,12 µg/Nm³, and at UD-4 station 47.22 µg/Nm³. At the second stage, the result of measurement of the parameters of Nitrogen Dioxide (NO₂) at UD-1 station was 45.96 µg/Nm³, at UD-2 station 75.77 µg/Nm³, at UD-3 station 76.35 µg/Nm³, and at UD-4 78.89 µg/Nm³. By referring to the Governmental Regulation No.41 Year 1999 about Ambient Air Quality Standard[13], it shows that all categories of air quality monitoring results are still below environmental quality standards.

The concentration of NO₂ in air can come from motor vehicle fumes, garbage burning and heating in factories/industries, whereas the amount of NO₂ concentration in air depends on sunlight, air temperature, humidity, air pressure, wind, and rainfall. NO₂ emission in the atmosphere was about 3 days; NO gas accumulated in the air when mixed with water will cause acid rain. NO₂ gas can cause lung and respiratory disorders as well as other effects in other parts of a person's body when it enters his/her bloodstream.

5. Dust

Based on the results of air quality testing in the area of Tenau Port, it can be seen that the dust concentration at the four sampling sites in the first stage at the UD-1 station was 58 µg/Nm³, at UD-2 station 63 µg/Nm³, at UD-3 station 54 µg/Nm³, and at UD-4 station 65 µg/Nm³. The second measurement result for dust parameters at UD-1 station was 60 µg/Nm³, at UD-2 station 58 µg/Nm³, at UD-3 station 66 µg / Nm³, and at UD-4 station 65 Mg/Nm³. The four measurement sites are still below the established standard of 230 ug/Nm³ as stated by the Governmental Regulations No.41 of 1999 on Ambient Air Quality Standard[13].

There are three effects of dust on one's health, namely, entry of dust from the air to a human's body through inhalation, ingestion, and skin penetration. Inhalation of air pollutant materials to the lungs can cause disruption in the lungs and respiratory tract of a person, although pollutant materials which are large enough cannot frequently enter one's digestive tract. However, cough reflex releasing any pollutant materials from one's lungs when ingested can also enter his/her digestive tract. Air pollutants can also enter one's body when eating or drinking. Skin surface can also be the entrance of air pollutants, especially organic materials that can penetrate one's skin and can cause systemic effects[14]. Damage to health due to dust depends on length of contact, concentration of dust in the air, and type of dust itself and other pollutant materials [15].

The results of anyazing air quality and noise as stated above show that they are still below environmental standard for air quality, yet the average noise measurement result was 80.07 db (A) in the first stage and it has increased to 81.75 db (A) at the second stage of measurement. The measurement results indicate that the noise level has exceeded the ambient limit standard based on the Attachment I of the Minister of Environment Decree No. 48 Year 1996 about Noise Level ranging from 50 to 70 db (A)[5].

So, several ways can be done to prevent and overcome increased noise and decreased air quality. They are, among others, as follows: 1) based on the results of observation of land/flora/vegetation in the Port of Tenau, it is necessary to broaden green and open space in the area as suggested by the Regional Regulation of the Government of the City of Kupang No.7 in 2000[16]; 2) workers on duty of loading and unloading goods in the port need to be equipped with work protective equipment; 3) a health care unit for routine health care workers needs to be established in the port; 4) general plan of navigation facility network, scouting and delaying of vessels, security facilities and infrastructure, rescue and provision facilities as well as infrastructure in marine areas be available beyond 12 (twelve) miles; and, 5) determination of dock management standards for inter-provincial/international port interests be implemented.

IV. Conclusion

Based on the result of measurement analysis on environmental quality for noise and air component in Tenau Kupang Port area, it can be concluded that: 1) the result of the noise level measurement has exceeded the ambient standard limit of noise quality standard, a comprehensive prevention and controlling activity is required by Pelindo III Company, its Kupang Branch and the community to reduce noise increase; and, 2) air quality parameters in the port area of Tenau Kupang for dust, Sulfur Dioxide and Nitrogen Dioxide concentrations in ambient air are still below the Standards of Environmental Quality Standards.

Acknowledgements

The authors express gratitude to the rector and dean of the faculty of teacher and education who have supported the financing of this research.

References

- [1]. Government Regulation of Indonesia, Number 61 of 2009 on Port (Jakarta:Transportation Department, 2009)
- [2]. Decree of the Ministry of Labor No. 51 of 1999 on Environmental Pollution (Jakarta: Ministry of Labor, 1999)
- [3]. Department of Transport, Noise Insulation Treatment (HMSO: Welsh Office, 1988)
- [4]. Ministry of Labor, Transmigration, and Cooperatives No. 1/1978 on the Noise Standard Level (Jakarta: Ministry of Labor, Transmigration, and Cooperatives, 1978)
- [5]. Decree of the State Minister for Environment No. KEP 48/MENLH/11/1996 on the Noise Standard Level Jakarta: Ministry of Environmental, 1996)
- [6]. Decree of the Minister of Communications no. 53 of 2002. Port as place of government activity and economic activity. (Jakarta: Minister of Communications, 2002)
- [7]. Talley, W.K., *Port Economics* (New York: Routledge, 2009)
- [8]. Triatmodjo, B. *Port Planning* (Yogyakarta: Beta Offset, 2010)
- [9]. Fung, F. *Prevention and Control of Shipping and Port Air Emissions in China* (China: Natural Resources, 2014)
- [10]. Constitution RI no 32 of 2009 on Management of Environmental (Jakarta: Ministry of Environmental, 2009)
- [11]. Ericsson, P., Fazlagic, I. *shore-side power supply a feasibility study and a technical solution for an onshore electrical infrastructure to supply vessels with electric power while in port.* (Goteborg: Chalmers University of Technology 2008)
- [12]. Santoso, A. *Marine Power Plant and Emissions.* (Solo: JTSP – ITS, 2009).
- [13]. The Regulation of the Government of Indonesia No.41 of 1999 on Ambient Air Quality Standard (Jakarta: Ministry of Environmental, 1999)
- [14]. Aditama, Tj. Y. *Mayo Clinic Hipertensi.* (Jakarta : PT. Duta Prima, 2005)
- [15]. Miftahur, Rohim..Risk Factor Analysis of Particle Dust, Noise, Increased Air Temperature and Vibration from the Cement Industry on Worker and Community Health. (Cikarang: Bapelkes, 2012)
- [16]. The Government of the City of Kupang No.7 in 2000 on Broaden Green and Open Space (Kupang: Kupang City Government, 2000)

Sri Sumiyati. "Impacts of Air Quality to the Environment of Kupang Harbor Port." IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT) , vol. 11, no. 8, 2017, pp. 39–43.