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Impact of ocean noise on mammalian life (case study: Samarinda waters)

Sri Ratih Deswati[1,*], Muhammad Syahrir[2], Mujiyanto[3]

[1] *Marine Science and Technology, Faculty of Fisheries and Marine Science, IPB University, Indonesia.*
[2] *PT EOS Consultants, Indonesia.*
[3] *Ministry of Marine Affairs and Fisheries, Republic of Indonesia.*

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ABSTRACT

Noise pollution, or unwanted sounds in the ocean, can have a negative impact on marine mammals, especially on their biological behaviour when hunting for prey and changes in diving habits when leaving their habitat. This noise study was carried out in the waters of Samarinda with the help of a passive system acoustic instrument, which captures the range of sound intensity in the water column and supporting data in the form of sound range and activity above sea level. The sound range of 38.10-78.60 dB (A) above the water surface is safe for both everyday activities and as a habitat for mammals. Similarly, the underwater sound intensity between 0.84 and 138.47 dB re 1 Pa falls within this range. The noise condition in the study area is still expected. It can be used as an initial reference for the tolerance of sound intensity that applies to living things around the research location. The noise of the sea in Samarinda's waters has no effect on the lives of animals.

Introduction

The primary concern expressed by marine noise research is its impact on marine mammals. Because marine mammals use sound to communicate, identify their surroundings, and protect themselves from harm, noise pollution can have a negative effect on them. Short-term impacts on marine mammals include disruptions in feeding and socialisation, as well as changes in diving behaviour and movement away from their natural habitat. Noise also interferes with the biosonar used by mammals to navigate, communicate, and watch prey. Noise varies in intensity, duration, and regularity and can also harm some marine animals (Bailey *et al*., 2010). Information received at various distances from the source and various levels can be compared to species hearing thresholds and ambient noise levels.

Several variables impact the modelling of underwater acoustic reflections from the sea surface blown by the wind, including bubbles near the surface and other things that appear on the surface (Jones *et al*., 2016). Sound propagation in the deep sea has been studied using an algorithm based on depth, sediment type, temperature, and salinity parameters. It is more complex in shallow water environments (at a depth of 200 m) (Urick, 1983). Surrounding environmental noise is related to noise originating, one of which is related to noise originating, and one of which comes from the movement of water around (Santoso, 2015).

Some shallow water noise is caused by exposure to anthropogenic noise in the marine environment, such as ship traffic, seismic surveys, and marine pipeline drilling, is the most significant contributor that can harm both people and wildlife, particularly marine mammals. Commercial ship activity significantly contributes to ocean noise (Bailey *et al*., 2010; Merchant *et al*., 2014; Halliday *et al*., 2017; Mikses-Olds, 2018). Ship noise is caused mainly by propeller cavitation, engine propulsion, hydraulic flow over the hull, and hull jerking.

* Corresponding author.
Email address: *sriratih@apps.ipb.ac.id*

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The importance of this research is to look at the characteristics of the sound in the sea, especially at the research location, as a baseline to see the noise intensity of the sound in the natural gas mining area at that location. In addition, the importance of soundscape analysis lies in ecology, which contributes information about the biological composition and environmental conditions (Buscaino *et al*., 2016).

Yayasan Konservasi RASI (2009) stated that the Irrawaddy dolphin, *Orcaella brevirostris*, is a marine and freshwater species with populations in three of Asia's major rivers. One is the Mahakam River in Indonesia, which flows into the Samarinda River. Irrawaddy dolphins are also susceptible to habitat modification and degradation (for example, due to noise and chemical pollution), and they compete for fish and other resources with humans.

The underwater noise measurement employs a passive hydroacoustic device to detect sound propagation through the water medium. Biota and human activities in the column and behaviours on the water's surface are all sources of sound.

The intensity of sound in a specific area, also known as landscape or soundscape acoustics, is highly dynamic and changes in response to sound sources in the surrounding environment. The existence of habitats and the species that inhabit them cause changes in underwater acoustics landscapes over time and space. Contributions from human (anthropogenic) activities such as cargo ships, fishing vessels, and seismic surveys, as well as natural sound sources originating from abiotic or geophysical processes (e.g., wind and rain), as well as acoustic contributions from biological sources (e.g., sounds produced by the movements and vocalisations of animals such as marine mammals, fish, and invertebrates), are all examples of underwater sound sources (Mikses-Olds, 2018). The sound intensity is recorded three times on the observation station. Because activities at sea level can influence the sound recorded in the water column, recording conditions above sea level are also considered a source of noise that contributes to the sound intensity in the water column, given the shallow depth of the water at the observation station.

This study aims to identify sounds that exist in nature as initial quantitative information on sound intensity and as initial data to create policies regarding sound intensity tolerance that pertain to living things around the research location. Is it having an effect on the animals in the area of the study?

Materials and Methods

Location and time of research

Sound observations were carried out in the Samarinda seas on the 17 and 20 February 2021. Table 1 shows the station positions, and Figure 1 shows the observation areas. The observations were obtained in shallow water at depths ranging from 5 to 15 meters. The study is being conducted in the waters of Samarinda, which are directly linked to the Makassar Strait on the west side (Prasetiyo *et al.* 2019). The Mahakam River's water input has a significant impact on these waterways.

The observation post is on the traditional boat trade route to the upper Mahakam River and the villages surrounding the river mouth. Barge activity is within 5 to 15 nautical miles of the study location.

The sound intensity was measured at sea using a hydrophone (Seaphone SQ26-H1B) placed 1 meter below sea level with an adequate sensitivity of -169 dB at 1V/Pa and a frequency range 0.020-45 kHz. Using the Android-based SmarterNoise program, record the sound intensity on the water's surface as a control of the sound character in the water. In this experiment, we used the Doogee S60Lite smartphone gadget. Observation of environmental factors around the station with two cameras on opposite faces. Position of the observation point as determined by the Garmin Oregon 750.

Table 1. The position of three stations in the study site.

Station Names	Positions
Station 1	S 0°46’42.4” and E 117°40’2.6”
Station 2	S 0°37’41” and E 117°37’11.8”
Station 3	S 0°43'29.6" and E 117°39'27.4"

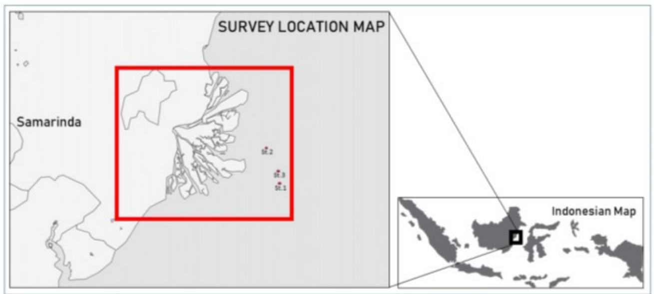

Figure 1. Observation locations (red dots) in Samarinda waters.

Three (three) observation sites around Samarinda waters were monitored from 17 to 20 February 2021. The location of observations is determined by a random technique that can reflect the northern, central, and southern areas of the research site, which are natural gas exploration areas.

Depik Jurnal Ilmu-Ilmu Perairan, Pesisir dan Perikanan
Volume 12, Number 1, Page 35-39

Data analysis

The signal analysis employs time and frequency regions (time-frequency analysis). In the time domain, the signal is represented as a wave reflecting the amplitude's time and magnitude (wave height). The waveform is transformed into a spectrum to determine the magnitude of the sound, allowing each frequency component to be visible. The FFT (Fast Fourier Transport) output is a spectrum that shows a frequency magnitude graph.

The Audacity software is used to analyze recorded spectrograms and sound waveforms. Using octave software, the FFT technique was used to convert sound intensity characteristics in the time domain to the frequency domain.

Furthermore, the Short Time Fourier Transform (STFT) is used to acquire the spectrogram of the voice signal. The sound pressure level is calculated by converting sound strength into decibels (SPL). The average squared pressure expressed in decibels is the sound pressure level (SPL) compared to the reference pressure.

The noise intensity in the marine environment was calculated using the standard SST (dB re 1 Pa). As an underwater acoustic measure, sound pressure is used. Maximum, minimum, and average sound pressure levels are determined (Sakurada *et al.*, 2013; Bailey *et al.*, 2013).

Results

During noise recording, the Beaufort scale is used to watch the weather. During the recording, the weather ranged from sunny to heavy rain, with moderate to strong winds. During high winds, measurements are still taken despite a shift in the point and time of observation, with the safety element and excellent data acquisition in mind.

The frequency and intensity of sound are obtained between 20 and 450 Hz, with sound intensities of 0.84-138.47 dB re 1 Pa (recorded under the sea) and 0-20 kHz with 38.01-79.16 dB (A) (recorded over the sea) based on observations of sound intensity using two devices, namely a hydrophone and SmarterNoise (Figure 2 and Figure 3).

The sound around the observation location influences the results from recordings with various sound intensity ranges. The range variation is also determined by the sensitivity of the hydrophone receiver, which captures sound in milliseconds. Because sea conditions vary constantly, the sound range varies from recording to recording. Due to the impact of wind and weather on the surface, the condition of the observation site in shallow water is also an impediment.

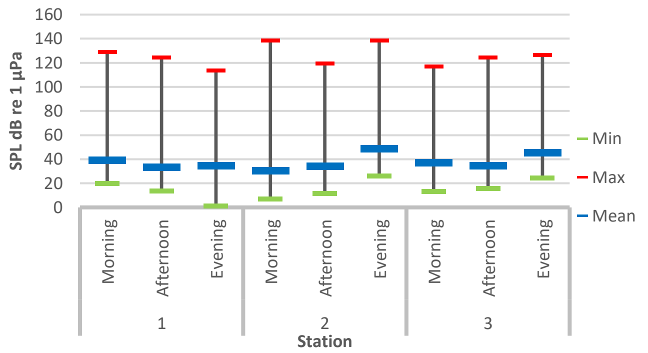

Figure 2. Range of sound intensity under the sea using a hydrophone.

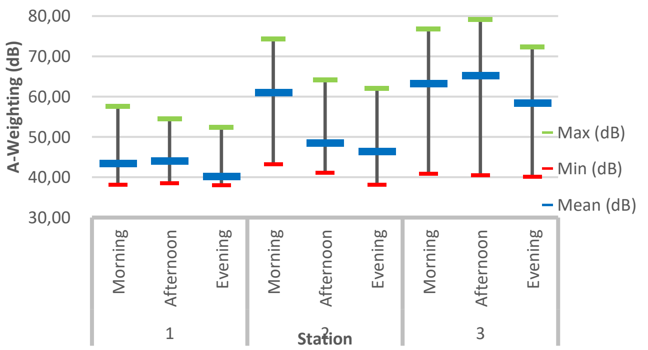

Figure 3. Range of sound intensity above the sea using a SmarterNoise.

In general, weather conditions such as rain and wind blowing on the sea surface, producing ripples on the sea surface, dominate high sound intensity in shallow water. Furthermore, ocean currents that move water masses add sound, but they were not equipped with a current meter to determine current speed and were only based on visual observations at the time of recording, so they were not included in the data analysis.

The average sound intensity number during recording is compared to reference data. Due to the brief duration of the observations, no mammals were seen at the time of observation. Dolphins in the Mahakam River, however, are seen between 180 and 480 kilometers upstream, are found on the coast about 20 kilometers upstream, and reach the delta at low tide, so they are thought to belong to a different coastal population than the river population (Kreb, 2004). Soede *et al.* (2019) also proclaimed the existence of other mammals, such as Bryde's Pope in East Kalimantan.

Discussion

The average sound intensity number recorded during the recording is compared to the standard data. No mammals were observed at the time of observation due to the short length of the observations. Kreb (2004) stated that dolphins in the

Mahakam River are seen between 180 and 480 kilometres upstream, are found on the coast about 20 kilometres upstream, and reach the delta at low tide, so they are believed to belong to a different coastal population than the river population. Soede *et al.* (2019) also declared the presence of other mammals, such as Bryde's Pope, in East Kalimantan. Commercial ship activity significantly contributes to marine noise (MMC, 2007; Bailey *et al*., 2010, Merchant *et al*., 2014; Halliday *et al*., 2017). The primary noise sources in vessels are propeller cavitation, engine propulsion, hydraulic flow over the hull, and hull jerks. Ships generate noise at low frequencies (5-100 Hz), as well as at higher frequencies. Weak sound levels from ships vary from 198 dB re1 Pa2/Hz @ 1 m for fast-moving cargo ships (20 knots) to 156 dB re1 Pa2/Hz @ 1 m for small boats (MMC, 2007; Kipple and Gabriele, 2003).

Wright *et al.* (2007) conducted several studies on marine mammals' physiological stress reaction to noise. When seismic guns emit sounds at 1-3 kHz, bottle dolphins (*Tursiops truncatus*) and Belugas' blood hormone levels shift. Because this number has a low frequency that can interfere with mammalian behaviour, it could be a noise limit.

Because the study area is shallow water, the observed noise is affected by sea-level wind and rain. In this research, the SmarterNoise application was used to capture sound sources above the water surface that can affect the character of sound intensity in the water column. (Figure 2). This is an essential factor because wind and rain impact water movement on the surface. The movement of the water surface in shallow waterways affects the layers of water below. The lower the energy is due to the movement of the water surface, the less energy there will be due to absorption by the water mass. Because the waters in the study region are shallow, the sound generated by the water surface's movement strongly impacts the sound's intensity in the water column.

Sound intensity underwater varies from 0.84 to 138.47 dB re 1 pa, with an observed average of 37.34 dB re 1 pa. High sound intensity values are recorded at observation sites with strong winds and rain (Figure 3). The primary impact of rainfall noise is that it raises the overall sensor noise level. The bursting of bubbles produced by the impact of small and medium-sized raindrops on the sea surface causes the noise. According to this study, wind and rain can influence the movement of the water surface, causing sound and resulting in sound in the layers beneath the surface (Ashokan *et al*., 2015).

The SmarterNoise application is used in conjunction with a hydrophone to acquire sound on the surface of the water and underwater using a hydrophone. SmarterNoise collects sound from the breeze, rain, and other activities on the water's surface. In contrast, the hydrophone collects sound from the movement of water in the column and sounds in the surrounding area.

The outcomes of SmarterNoise and visual observations at the station site There are boat activities from residents near the research site to transport coal and daily necessities, but they are pretty far from the observation station, about 1 to 3 nautical miles, so transportation activities do not cause noise or disturbance at the observation point.

When compared to the effect of wind and surface waves, the activity of barges carrying coal can also be seen, but the distance from the observation point is 5-15 nautical miles, so the activity of cargo ships does not make a significant contribution to hydrophone recording (validated by SmarterNoise video recording). Further research is needed to ascertain sound intensity from various sources, including boats and barges.

Wind and rain at sea level dominate the noise that influences the sound recording results. The SmarterNoise application is used as a reference in this study for sound sources on the water's surface that influence the character of the sound intensity in the water column. This is due to the shallowness of the waters in the study area, which significantly influences the sound intensity in the water column.

Because the observation location is in shallow water, surface conditions play a significant role. A sound intensity greater than 220 dB can increase stress markers in a beluga whale's blood (MMC, 2007). In contrast, a moderate level of 153 dB produces no evidence of stress. Marine mammals make noise when subjected to high-intensity noise with a range of more than 195 dB at 1 Pa2 for 1 second.

Bailey *et al.* (2010) stated that ship activity has the highest sound intensity at 138 dB re 1 Pa, while port activities can approach noise levels of 160 to 200 dB re 1 Pa. According to known references, the findings of this activity's observations remain at a safe and sound intensity level for marine mammal activities.

The sound recording results below and above sea level indicate intensity values within normal limits for activities at sea (TMSC, 2012). Above sea level, the sound intensity ranges from 38.10 to 78.60 dB(A), with an average of 52.24 dB(A) in zone E, indicating that the area is safe for daily activities without ear protection or earplugs due to the absence of activities such as fishing, routine community transportation traffic, and cargo transport ships.

Conclusion

Because the observation region is shallow water with depths ranging from 5 to 15 meters, the findings of noise observations at the research location in Samarinda waters are influenced by activities above sea level, such as surface winds. The noise condition in the study area is still expected. It can be used as an initial reference for the tolerance of sound intensity that applies to living things around the research location. The noise of the sea in Samarinda's waters has no effect on the lives of animals.

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