# MEASUREMENT AND EVALUATION OF ACOUSTIC MARINE POLLUTION

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**Abstract:** *During construction and during exploitation operations of the offshore objectives occurs, inevitably, noise pollution in the marine environment.This paper presents a system for measuring underwater acoustic field.Mobile polygon is described, which is used in noise measurements for the determination of sea noise.*

Keywords: *underwater noise, acoustic field, sound pressure measurement, hydrophone***.**

## 1. Introduction

Introducing noise into the ocean by construction activities, drilling, transportation, tourism is clearly a serious problem for marine mammals and must be properly analyzed and evaluated, taking into account that their installation is already taking place.

Underwater acoustic noise assessment gives the manager, first, the ability to predict the estimated noise values at each point of the water column, giving him the opportunity to create noise maps.[1]

Under ambient noise mapping is an important component part of the input of these modeling. The measurements described below were performed in an investigation initiated to determine noise levels, underwater ambient noise and acoustic transmission loss at the proposed location for the construction of an important port of Constanta.

For the prediction modeling noise levels with increasing distance from the drilling site, was used: noise levels of drilling operations, the description of the propagation of sound and noise influence of the sea.[2]

Results of the acoustic field are used to assess the potential impact of noise on marine organisms.

## 2. Ambient noise measurements

In order to determine ambient noise levels in the vicinity Constanta port were performed underwater ambient noise recordings from seven stations using a recording system installed in depth.[3]

Basic levels of noise were measured at seven locations in Constanta harbor, ship position: 44º 19'LatN and28º 65'LongE.

On board the research vessel was installed a mobile laboratory for measurements of underwater acoustic field parameters.

Measurements were made in an experimental context that includes:

- a mobile sound recording system, consisting of a network of three hydrophones located at different depths, equipped with a float and ballast to keep the system at desired locations in a vertical position,
- own design mobile acoustic polygon for field measurements, composed of data acquisition and processing system, power amplifier, submarine cables, specialized software for handling and processing of underwater acoustic field,
- powered boat to travel to the sites registration system.

Recordings were made on a period of time between 8 and 12 hours at each site sampling rate of 44.1 kHz. The acoustic system was anchored to the seabed with concrete weights. After each implementation the recording system is recovered.

Each implementation has been assigned a number for ease of reference. Were made seven deployments their position is represented in Fig. 1 and detailed in Table 1.


**Figure 1:** *Map region near Constanta harbor and holding location recording systems.*

Sound propagation to the site was estimated using the approach and removing noise from ships as a source of noise and measuring its loss with distance in steps of 1/3 octave and using samples that were above the relevant ambient noise.[4]

### 3. Data processing

To produce levels in 1/3-octave bands wavelength for recording ambient noise, power spectrum was calculated for each minute (60 s) data recording using a FFT (Fast Fourier Transform). Resulting power spectra were integrated over the frequency range of each 1/3-octave intervals wavelength between 10 Hz and 20 kHz.

### 3.1 Temporal variability

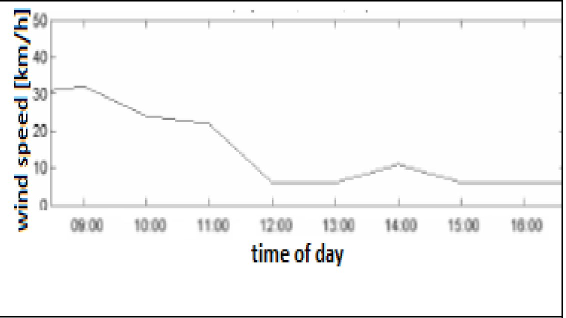
Noise levels recorded at seven locations while recording vary significantly as shown Figure 2. Is detailed how ambient noise levels were selected and processed for location 1.

Underwater noise fluctuation, highlighted in the bellow spectrograms Fig.2, can be caused by a number of factors, including biological, distant sea traffic, a ship passing nearby, sea state, wind, rain, and fluctuations in the currents associated with tidal cycle.

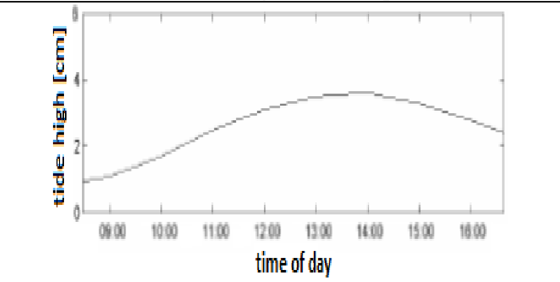
**Table 1**. Location details regarding sound recording implementation

| *Nr impl* | *Area* | *System location* | *Total recording* | *Latitude N* | *Longitude E* | *Water depth [m]* |
|---|---|---|---|---|---|---|
| 1 | Constanta | CB-1B (200m away from | 8:10:06 | 44°19.426’ | 28°65.335’ | 27 |
| 2 | Consta nta | CB-2B (300m E by ship) | 9:03:00 | 44°19.412’ | 28°65.335’ | 28 |
| 3 | Constanta | CB-5 (500m NE by ship) | 11:56:00 | 44°19.432’ | 28°65.360’ | 29 |
| 4 | Constant a | CB-4 (700m SE by ship) | 12:22:00 | 44°19.389’ | 28°65.420’ | 32 |
| 5 | Constanta | CB-3 (harbor entrance-50m V by ship) | 8:46:00 | 44°19.420’ | 28°65.334’ | 26 |
| 6 | Consta nta | DFO-3 (100m V-NV by | 09:58:00 | 44°19.428’ | 28°65.334’ | 27 |
| 7 | Constanta | IR-W (150m S-SV by ship) | 11:49:57 | 44°19.425’ | 28°65.335’ | 27 |

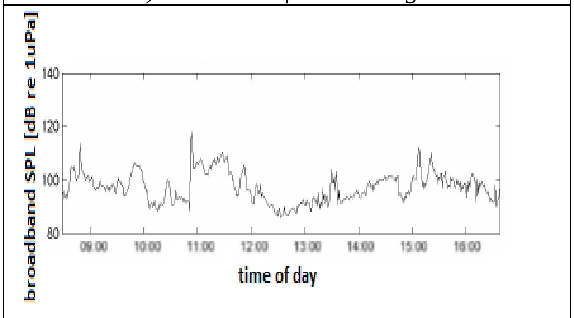
Acoustic characteristics of each of these types of sources are discussed below.



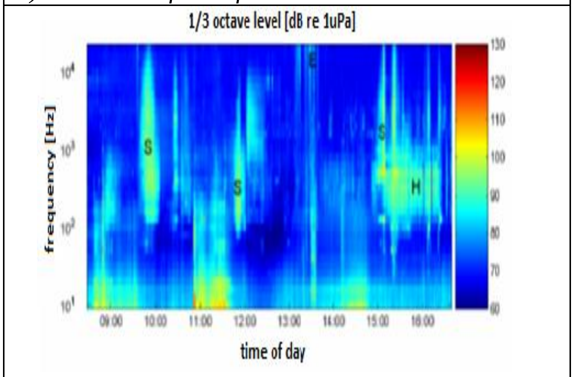

*a) variation of the wind speed,*




*b) Variation of the tide hight*




*c) Variation of the of the broadband noise levels*



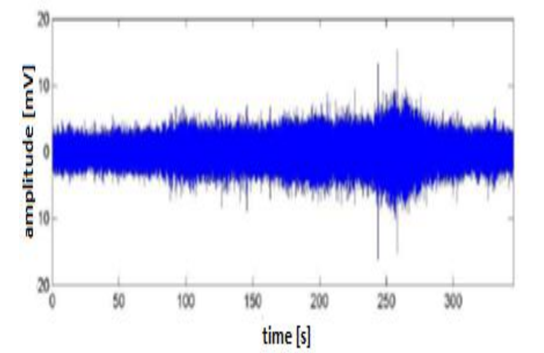

*d) power spectrum of the broadband noise levels S-ship, E-electric noise, H- air-cushion ships, B-speed boat*

**Figure 2:** *Implementation 1 –Variation of the ţime, wind speed, tide hight.*

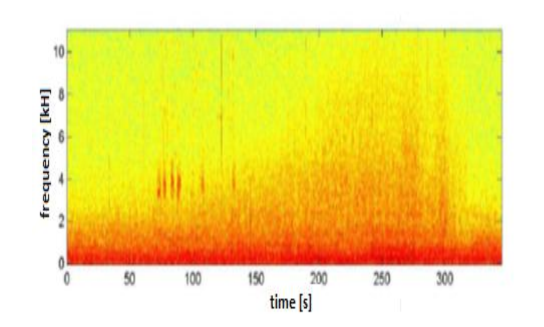
### 3.2 Shipping and anthropogenic noise

Occasionally more distant ships suspected of contributing to noise levels - traffic noise - higher frequency under 50Hz. Ships marked on spectrograms with the letter S.

Ship noise is highlighted in noise spectrograms and increases short (30 minutes or less) like acoustic energy between 100 Hz and 1 kHz, as shown in Figure 3.




*a)Noise amplitude variation in time*




*b)Frequency variation in time*

**Figure 3:** *Noise amplitude and frequency domain representations of a ship in transit.*

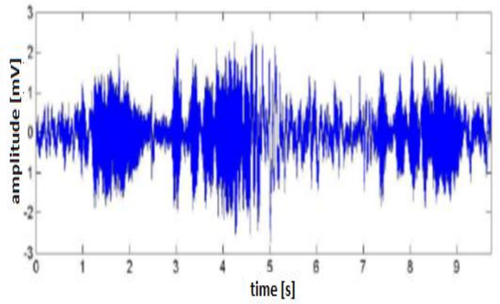
**Noise generated by equipment.** A short electronic noise was observed during the implementation 1. This is the only occurrence of a static sound, and is marked with an E in the spectrogram shown in Figure 2.

**Noise generated by wind and waves.** Sea state during the measurement program of implementation 1 ranged from 0 to 3 corresponding wind speeds from 0-10 knots (0-19 km / h).

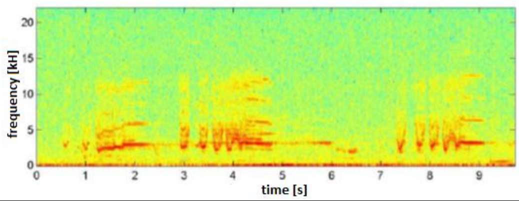
**Noise generated by sea tide.** An increase in noise below 50 Hz is observed, there is very little, most of the implementation 1.

### 3.3 Biological noise.

Sounds produced by dolphins were recorded at an average frequency of 3.6 kHz frequency of dolphin whistles were dominant in the range of 2 to 5.9 kHz and other types of vocalization between 1-8 kHz. Echolocation sounds can be 40-60 kHz and 100-120 kHz. Whistles produced by dolphins were recorded in ambient noise data in the range of 2-3 kHz as shown in Fig. 4.




*a)Amplitude variation in time*




*b)Frequency variation in time*

**Figure 4:** *Amplitude and frequency domain representation of dolphin whistles.*

## 4. Spatial Variability

Sound pressure levels averages and standard deviations for one minute levels of broadband noise for each implementation (Table 2) were calculated making media a minute of broadband noise levels and the quietest hour of every implementation that when ships are not other obvious sources of noise observed in spectrograms[5].

Ambient noise levels at location 1 ranged from 89 dB - 102 dB.

**Table 2.** Average sound pressure levels and standard deviations (dB re 1 μPa) at each location

| Implementation | SPL (sound presure level) during the quietest period of the day | |
|---|---|---|
| | Average (dB re 1μPa) | Standard deviation (dB re 1μPa) |
| 1 | 89,6 | 1,8 |

## 5. Conclusions

Measurements have shown that ambient noise levels do not exceed the maximum allowable level, of 120dB, for living creatures. However, the sound pressure is added to produced noise at construction or mining activity that will take place with major noise pollution effects.Acoustic measurements made in the marine environment have shown different ways of producing natural and anthropogenic noise, clearly defined seasonal and diurnal. The experimental context is original and allows measurements at different depths hydroacoustic parameters on three levels.Mobile polygon to measure the acoustic field comes to fill a gap in the measuring and hydroacoustic data processing. It can be used both: on special platforms designed for hydroacoustic measurements and the oldest ship without a special need for investment. Acoustic sensors integration in existing devices could be an economical solution which will improve the data collected for both purposes.It takes a passive monitoring underwater sound from all sources.

Recommendations after conducting this study:

- conducting noise studies on the areas that are planned for activities with acoustic impact on the marine environment. If possible, relocation should be taken into consideration in those places where there is less marine life,
- conducting studies on marine mammals and their behavior and their auditory responses to different types of noise and data should be subject to modeling to determine thresholds of confidence in the scientific community,
- there is a need for a system in order to use the framework as a guide to making decisions in the management of noise. This is important in that there is a discontinuity between the various elements of the system and the difficulties that arise during the decision making process.
- it is obvioust the need to achieve a database of temporal history of shipping containing estimates of the density of ships in sectors with an accuracy of less than 1 º longitude and 1 º latitude.

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