2P6-4

Spatial Mapping of Underwater Radiated Noise from Passing Vessels Using Automatic Identification System (AIS) data

Sungho Cho[1†], Donhyug Kang[1], Ji Sung Park[1], and Jooyoung Hahn[2] ([1]Korea Institute of Ocean Science and Technology; [2]Agency for Defense Development)

1. Introduction

Ship radiated noise caused by vessel traffic is a major contributor to underwater noise sources in the ocean. Over the past four decades, since the mid-1960s, the number of ships in the world has more than doubled due to increased global trade. Over the same time, the total gross tonnage (GT) of ships nearly quadrupled from 160 to 605 million GT. As a result of the increase in maritime traffic, it is reported that the noise level has increased by 0.3 dB/yr slope at 40 Hz and approximately doubled in every 10 years according to the data measured in the Pacific Northwest region.[1)]

Recently, the International Maritime Organization (IMO) has declared increased shipping noise to be a deleterious influence on marine organisms; the IMO has also declared their intention to strengthen shipping noise regulations to protect marine ecosystems. However, to regulate noise levels for ecosystem protection, it is essential to have information on the wide spatial distribution of underwater noise caused by ship traffic. This is especially true of port areas, which exhibit high noise levels in time and space due to high cargo volume, and heavy ship traffic involving diverse vessels. It is therefore important to characterize the spatial distribution of underwater noise in areas of high shipping density as baseline data for developing regulations to protect marine life.

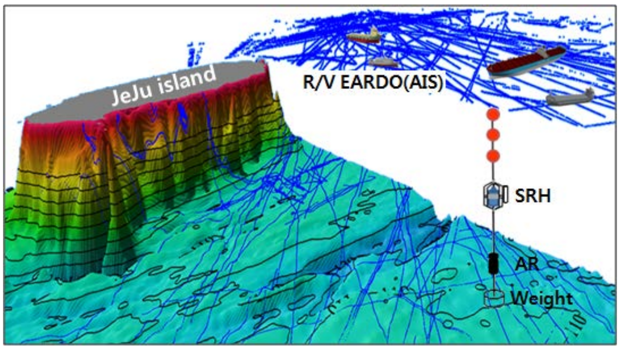

Fig. 1 Experimental layout for measuring the underwater radiated noise from passing vessels.

The goal of this study is to investigate the spatial distribution of underwater radiated noise originating from ships using Automatic Identification System (AIS) data.

e-mail: jspark@kiost.ac.kr

2. Field Measurements

2.1 Automatic Identification System data

The AIS is a device adopted by the IMO to automatically provide shipping information among ships and between ship and shore to enhance ship safety and avoid marine collision. AIS transmissions were logged by a portable receiver installed on the bridge of the offshore support vessel R/V EARDO to obtain both the vessel's dynamic data (position, speed, course, etc.) and static data [Maritime Mobile Service Identity (MMSI), name, call sign, type, dimension, etc.] around the experimental area (**Fig. 1**).

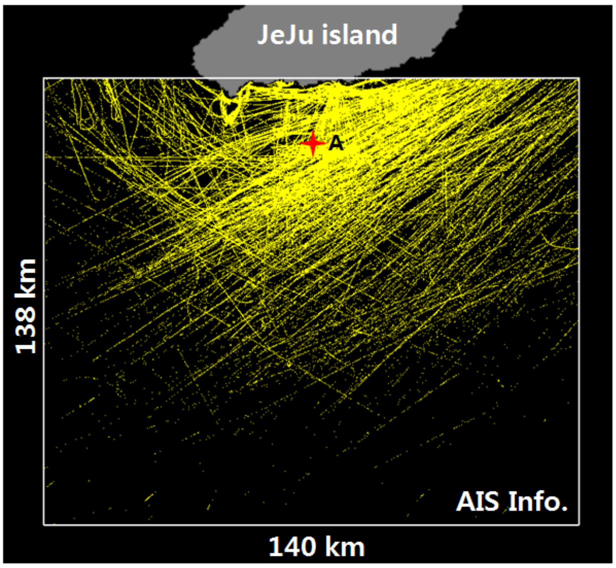

Fig. 2 Map of shipping lanes in the study area. A : position of hydrophone to measure shipping noise.

Figure 2 shows the AIS data measured inside the study area (140 x 138 km) during the period between July 15th and 26th, 2016. An estimated 630 unique vessels were identified, of which approximately 73% were relatively large-sized cargos, tankers and passager ships [**Fig 3**. (a) - (c)], mostly moving from the southwest to the northeast. About 23% of those included fishing boats, pleasure crafts, tug boats, etc. [Fig 3. (d) - (e)] typically moved around the coastal area. The ships were divided into seven categories according to their size information retrieved from AIS static data.

Fig. 3 Representative ship types of AIS data that are received in the study area.

2.2 Acoustic Measurements

Acoustic measurements were made in July 2016 to investigate the characteristics of ship-radiated noise in shallow water of the South Sea of Korea. A self-recording hydrophone was deployed at a depth of approximately 50 m for 10 days to measure the shipping noise passing through the study area (Fig. 2 A pos.). **Figure 4** shows acoustic data as a spectrogram (in dB re 1 μPa^2/Hz) during the 20 minutes when a large cargo ship (16 kGT) of Cyprus nationality passed by the hydrophone. The closest point of approach (CPA) time from ship to the hydrophone was identified at 550 seconds. Two general features of ship noise shown are tonal lines around 300 Hz and a broadband interference pattern that occurs in the entire frequency band (< 1 kHz). The shipping noise has a major energy component below 200 Hz and affects noise levels up to and beyond the 1 kHz band when passing CPA time.

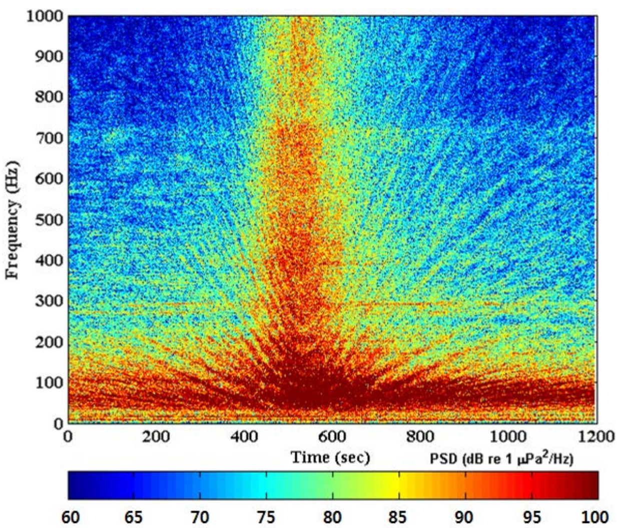

Fig. 4 Spectrogram of the received level during a 20-minute passage of a cargo ship.

3. Results

Received levels (RL) from the ships generally varied according to the ship's physical size (e.g., length and tonnage) and speed. The length and speed information of each ship were extracted from AIS data, and the corresponding source levels (SL), referenced to dB re 1 μPa^2/Hz at 1 m, were calculated using a modified Ross model.[2] The SLs for vessels identified within the study area range from 120 dB at 100 Hz for fishing boats to 175 dB for large cargo ships. **Figure 5** shows the spatial distribution of cumulative SL from vessel traffic on a 2 km x 2 km grid. The value at each grid point was incorporated with the SL information for all ship classes, taking into account the shipping density over time and the SL corresponding to each ship class. In addition, the spatial distribution of ship noise levels in the study area can be calculated at each cell by incoherently summing RLs considering the tranmission losses emitted from all source cells.

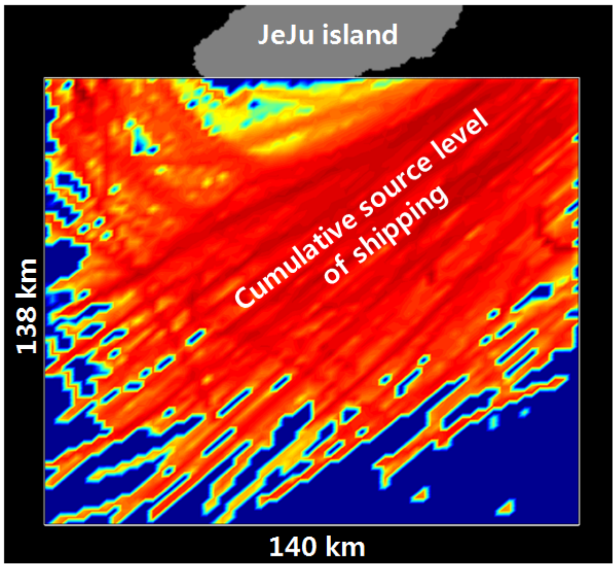

Fig. 5 Cumulative source level SL from vessel traffic in the study area.

Acknowledgment

This work was supported by the "Development and Field application of Prototype Hydrophone for Detecting Directivity" grant (PE99575) promoted by the Korea Institute of Ocean Science and Technology (KIOST).

References

1. M. F. McKenna, D. Ross, S. M. Wiggins, and J. A. Hildebrand, J. Acoust. Soc. Am. **131** (2012) 92.
2. J. E. Breeding, L. A. Pflug, M. Bradley, M. H. Walrod, and W. McBride: *Research Ambient Noise Directionality (RANDI) 3.1 Physics Description*, Planning Systems Incorporated 1996.