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Method Article

Method for the simplistic modelling of the acoustic footprint of the vessels in the shallow marine area☆

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A B S T R A C T

The definitions of the 11th descriptor of the EU Marine Strategy Framework Directive (MSFD) "Underwater noise and other forms of energy" outlines the standards for the continuous noise evaluation and monitoring in the European seas. Long lasting fluctuations of the continuous underwater noise at the shallow marine areas in the low frequency bands (<1 kHz) are mostly associated with the shipping noise, where these fluctuations are sensitive to changes in the spatial distribution of human activities, or changes of environmental and climatic variables. Underwater noise modelling is usually considered as a supplement to noise measurements, where models increases the utility of the measurement results. Noise mapping is considered as a form of spatial modelling, providing a convenient and accessible way to visualise models. Therefore, underwater noise models and maps can be used in management and evaluation of environmental state. There are number of freely available widely used noise source and sound propagation models. Still the simplistic logarithmic rules purposed for the sound propagation loss computations do not account for the number of factors in the marine environment, i.e. sediment type, water depth or frequency. On the other hand the sophisticated physical models purposed for the description of the footprint of noise sources such as ships are complex and their programing requires very specific knowledge. In this paper the details of the method purposed for modelling of the ship noise footprint in shallow seas is presented. Proposed method allows to compute:

- depth dependent ship sound transmission losses in 1 Hz frequency bands;
- sound propagation losses during different seasons (summer/winter);
- acoustic footprint accounting for vessel noise directivity.

☆ The contents of this manuscript are the sole responsibility of the authors and can in no way be taken to reflect the views of the European Union, the Managing Authority or the Joint Secretariat of the South Baltic Cross-border Cooperation Programme 2014–2020.

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Method name	*Simplistic modelling of the vessels acoustic footprint in the shallow marine area*

Method details

The research area and the hydro-acoustic properties

Lithuanian marine area is located at the Eastern part of the Baltic Sea coast in the Gotland basin [1]. Lithuanian marine areas borders with the Russian Federation in the southern part, in the North with Latvia, and in the West with Sweden. At the centre of the Lithuanian EEZ the Nemunas Palaeo opens to the inside of the Gdansk Peninsula [2]. A Klaipeda–Ventspils Plateau gradually slopes through the Gdansk sill to the West forming the deeper areas having the depths of >60 m reaching ~125 m at the West [3], where the downslope from the East to West has no any steep ridges or cliffs forming favourable sound propagation paths. The bathymetry of the Lithuanian EEZ depicted in the Fig. 1A.

For description of sound propagation conditions and determination of winter ducting period at Lithuanian EEZ the SVP's were computed using TS data for the year of 2015. The TS data were acquired from the EU Marine Environment Monitoring Service database (Baltic Sea Physics Reanalysis From SMHI 1989–2015 HIROMB model, [4]), acquired at the location 55°43′8.32″N; 20°36′40.31″E (see Fig. 1A), using the equation:

$$C_w(z) = 1449.2 + 4.6T - 0.055T^2 + 0.00029T^3 + (1.34 - 0.01T)(S - 35) + 0.016H \quad (1)$$

Where *Cw(z)* – depth dependant sound velocity (m/s), *T* – temperature, *S* – salinity, *H* – water depth [5].

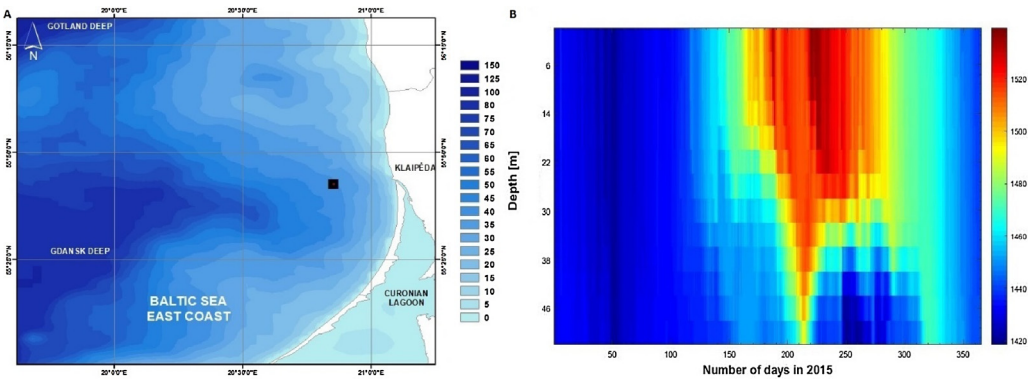

Fig. 1. A – Bathymetry of the Lithuanian Baltic Sea area (black square marks the location of the data acquisition from the hydrodynamic model); B – daily sound velocity profile for the period of 2015, acquired from the hydrodinamic model, colour bar marks SVP in m/s.