INTERNATIONAL MARITIME ORGANIZATION

E

MARINE ENVIRONMENT PROTECTION COMMITTEE
82nd session
Agenda item 9

MEPC 82/INF.31
26 July 2024
ENGLISH ONLY
Pre-session public release: ☒

REDUCTION OF UNDERWATER RADIATED NOISE FROM COMMERCIAL SHIPPING

Marine spatial planning for underwater radiated noise (URN) management

Submitted by India

SUMMARY	
Executive summary:	This document is based on the study carried out on underwater radiated noise (URN) by one of the research centres in India. It attempts to put in perspective the marine spatial planning (MSP) based approach, driven by the underwater domain awareness (UDA) framework for managing the low frequency ambient noise due to URN from commercial shipping. It describes a unique modelling and simulation based approach for MSP, particularly in the unique tropical waters of the Indian Ocean region (IOR).
Strategic direction, if applicable:	1
Output:	1.16
Action to be taken:	Paragraph 12
Related documents:	MEPC 82/9 and MEPC 76/INF.32

Introduction

1 The Committee had considered document MEPC 76/INF.32 (India), which sought to highlight the seriousness of acoustic habitat degradation due to shipping in the Indian Ocean region (IOR) and also proposed a digital monitoring tool, backed by the underwater domain awareness (UDA) framework, to manage the issue. India has since been designated as the lead pilot country (LPC) for the IMO GloNoise Partnership project in the IOR. This document, built upon a foundation set by the previous work of the Committee and Member States, is based on the study carried out on underwater radiated noise (URN) by the Maritime Research Centre, Pune, India. It brings in the modelling and simulation (M&S) based approach for marine spatial planning (MSP) as a governance tool, to uniquely manage the tropical waters.

2 The conventional digital transformation manifested as MSP is highly resource intensive in terms of deployment of sensors across the water bodies to cover the entire region. The tropical waters, with its known sub-optimal performance of the sonars deployed to cover the underwater space, requires at least six times more sensor deployment, making it unviable for the Global South to participate. A high technology M&S based approach backed by artificial intelligence and acoustic signal processing algorithms makes it possible to map the entire underwater space, with limited field experimental validation in select location.

Effective URN management

3 The low frequency (below 1KHz) noise due to URN from shipping is the major ubiquitous source of ambient noise in the ocean. The low frequency means that it experiences least attenuation due to acoustic propagation and thus its impact is seen at thousands of kilometres. However, this low frequency ambient noise is extremely harmful for the marine mammals, that use acoustic perception for multiple biologically critical functions like foraging, communication, navigation, finding mates for breeding and more. The increasing noise in the oceans is causing serious acoustic habitat degradation for big whales, manifesting as strandings along the shores and serious species degradation. The IOR is witnessing a large increase in the stranding incidents, as shown in figure 1 below. This could be attributable to low frequency shipping noise; however, it needs detailed investigation.

Figure 1: Recent marine mammal stranding along the Indian Coast.
Left: 42 ft Blue Whale Stranding off the Alibaug Coast (Jun 15).
Centre: 50 ft Bryde Whale Stranding off the Mumbai Coast (Jan 16).
Right: Over 90 Short-Finned Pilot Whales Stranding off Tuticorin (Sep 16).
Source: Author

4 Two critical publications give a clear understanding of the ground realities on URN, globally. Noisonomics by G V Frisk, presents the empirical model for ambient noise due to URN and establishes a direct link with the shipping traffic and global GDP data, as shown in figure 2, below. Another publication by Donald Ross, reports actual acoustic data recordings at two locations, globally and validates the trends proposed in the models by G V Frisk. Figure 3, below shows the recorded data at Point Sur and San Nicolas Island. Both figure 2 and figure 3, establish the 3.3 dB per decade increasing trend in low frequency ambient noise in the ocean, attributable to the URN from shipping traffic. It also provides the baseline data for URN due to shipping noise. However, this is not specific to the tropical waters of the IOR and does not give a real-time appreciation of the URN linked to the real shipping traffic movement.

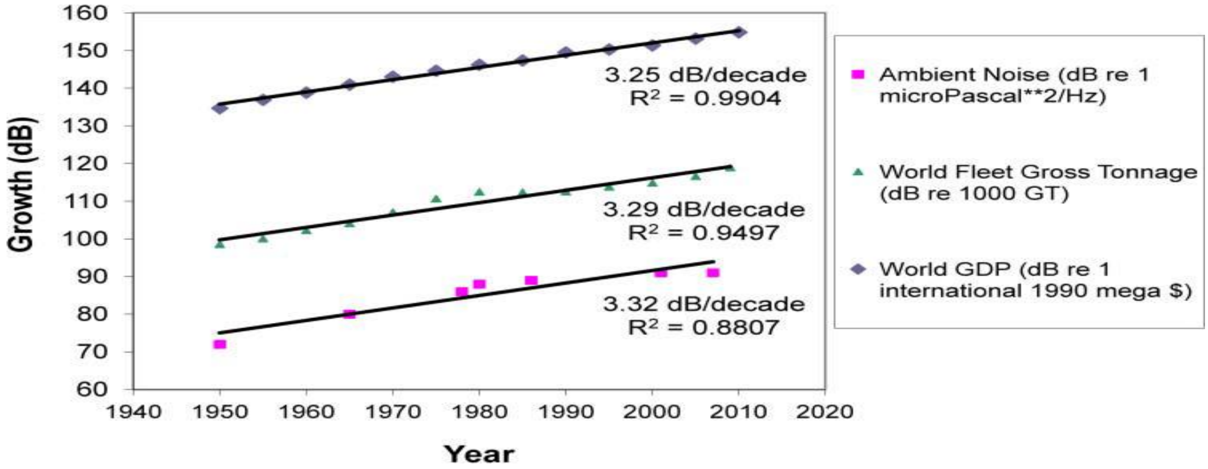

Figure 2: Noisonomics by G V Frisk

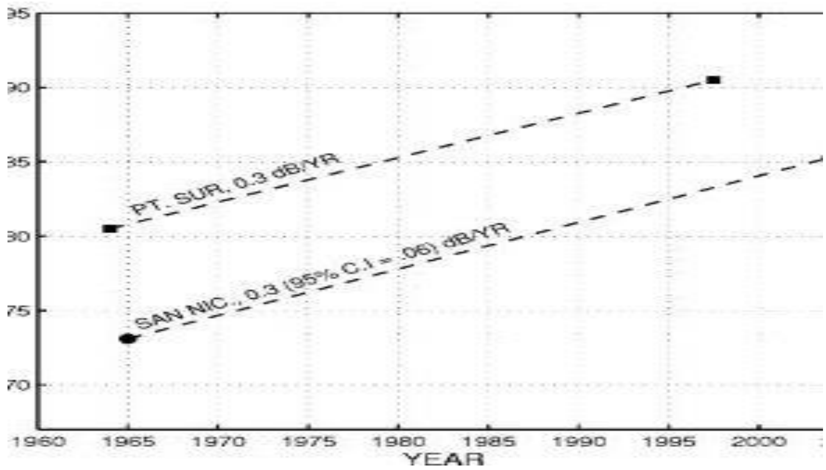

Figure 3: Recorded data at two locations globally

Modelling and simulation (M&S) based marine spatial planning (MSP)

5 The M&S based MSP, followed by field experimental validation, will be a game changer to manage the challenges and opportunities of the new global order. The UDA modelling will provide us the backbone to generate synthetic data for any kind of variation in the underwater space. The tropical waters with their unique characteristics can be mapped using signal processing algorithms. As an example, we can consider the low frequency ambient noise MSP mapping using the varied databases. The low frequency ambient noise is known to be generated by the shipping traffic. The following points present the entire process:

.1 The entire space is divided into grids of 1^0 latitude and longitude. Each grid is treated as a unit of M&S.

.2 The Automated Identification System (AIS) inputs are drawn for each grid to extract the static and dynamic inputs of the ships in the region. Artificial intelligence (AI) based algorithms are used to clean the corrupted AIS data.

.3 This real-time AIS input is then corroborated with the Classification Society database to derive the machinery details of the specific ships in the grid.

.4 The AIS and the classification society data is used to compute the source level URN in each grid. The computed URN is then brought to the center of the grid and referred as the noise at source. These high-end URN models are specifically customized for tropical conditions. The AI based algorithms are used to minimize the computational load and also enhance accuracy and precision.

.5 The real-time underwater medium parameters are drawn from the ETOPO1 database to compute the underwater channel model referred as path. Signal processing algorithms backed by AI algorithms are used to build the customized underwater channel model for the tropical waters that are able to account for the acoustic propagation.

.6 The signal at source and the path are combined to extract the signal at the receiver. The entire process is presented schematically in figure 4 below.

.7 The low frequency ambient noise in the tropical waters of the IOR has been generated as shown in the figure 5. The figure shows a sample of the ambient noise levels in the IOR at 500 Hz. The algorithm has the capability to generate at all frequency (till 1KHz) and in real time with required spatio-temporal resolution.

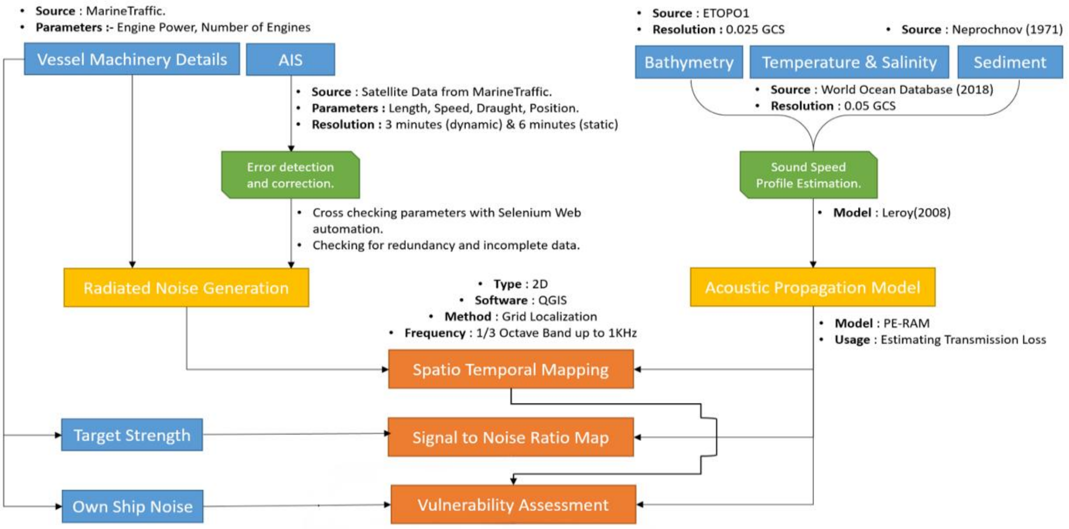

Figure 4: Schematic diagram of the M&S based MSP implementation

6 The following aspects merit attention that defines the uniqueness of the proposed M&S based MSP implementation, presented above:

.1 The model has the capability to map the entire globe with the above water database, which will bring down the cost. The area and domain coverage and the spatio-temporal resolution that can be achieved is significant.

.2 The local site-specific tropical characteristics can be captured in real-time and with high resolution.

.3 The pooling of resources and synergizing of efforts across the multiple stakeholders, will optimize the resource deployment and make it economically viable for the global south.

.4 The AI based data analytics will assure the global south that their classified data will not be compromised and misused.

.5 Meaningful jobs can empower those in developing nations to tackle global challenges. The UDA framework will provide a nuanced regional way ahead for policy & technology intervention, along with acoustic capacity & capability building.

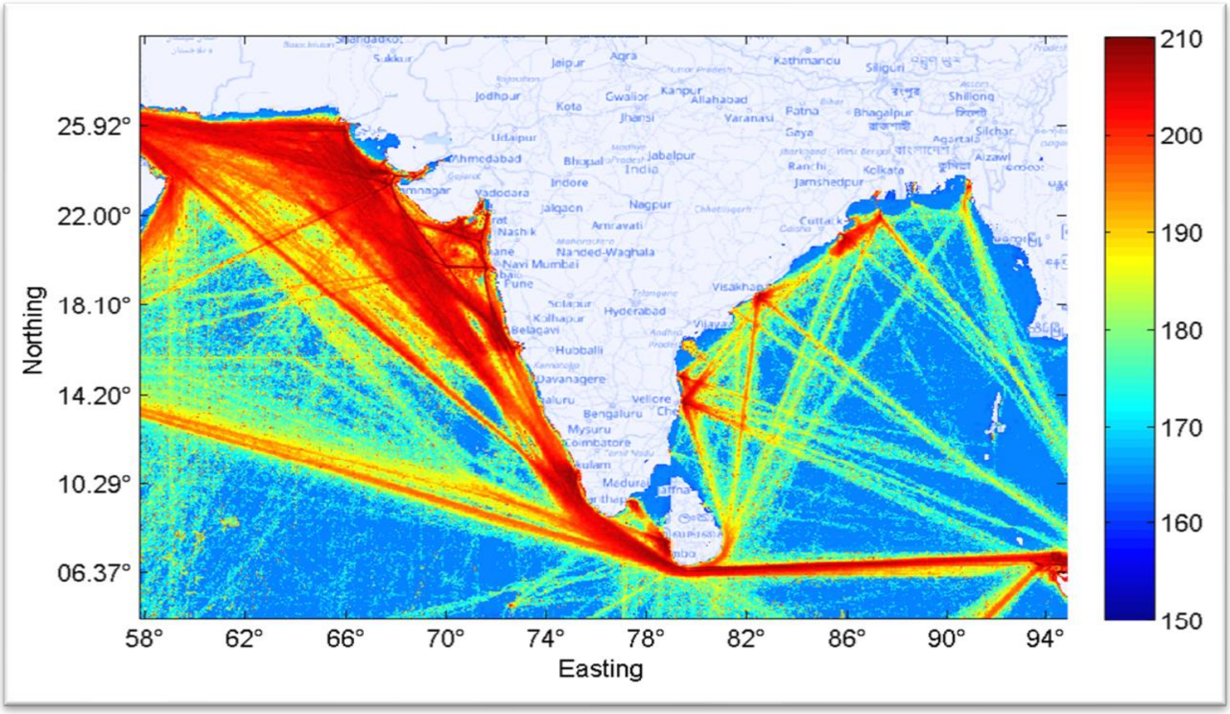

Figure 5: MSP due to shipping traffic in the IOR. Source Author

7 The proposed methodology can also be concentrated to specific regions like special protected areas (SSA). It is also understood that ocean parameters like temperature, salinity, and depth play a major role in underwater noise propagation and are highly variable from region to region. The same would be addressed with respect to URN at various depth. As indicated, the present approach is a unique way ahead to manage URN and a tool for forecasting, especially for region specific requirements on acoustic capacity and capability building.

8 The M&S, once validated in the field experimentally in select locations, would give maximum effectiveness in closing the gaps. The field validation will have to be planned using the three-step formulation:

.1 **To see:** will include the sensors and the platform that will carry the sensors to the required location. Acoustic and non-acoustic sensors mounted on static (buoys) and dynamic platforms like autonomous (surface and sub-surface) vehicles are some examples.

.2 **To understand:** is the core data analytics including pre-processing, application specific processing and post processing.

.3 **To share:** pertains to making the processed actionable inputs available to the user in real-time and in a format that is easy to act upon. This will require varied displays and user-friendly formats for users ranging from policy makers to stakeholders. This will require massive customization and multiple levels.

Acoustic capacity and capability building

9 The human resource mapping will require three categories:

.1 ***High-end technology and data analysts*** will handle the hardware and software for M&S and signal processing requirements. They will conceptualize the entire technology intervention and design the implementation strategy. The AI based algorithms and the high-performance computing infrastructure will be designed and developed.

.2 ***Domain specialist*** will form the backbone of the entire effort. Multi-disciplinary experts will look at the sustenance of the projects across varied domains. Policy intervention backed by technological support. Maintenance of the infrastructure, data analysis across varied dimensions, management and administration and more will be the core responsibility.

.3 ***Field deployment specialist*** will be the front-end team in the water fronts for deployment of sensors and platforms and sample collection across applications. These could be the coastal and riverine community people, fully conversant with the water bodies and equipped with the traditional knowledge to handle the water fronts across freshwater and marine systems.

10 A well-defined talent strategy, including stakeholder mapping, skills gap analysis, job descriptions, and a clear career path, will streamline skilling and knowledge transfer initiatives.

Conclusion

11 The following conclusions of the study are submitted for consideration by the Committee:

.1 Marine spatial planning (MSP), backed by the underwater domain awareness (UDA) framework, is an effective method for URN management globally. Modelling and simulation based MSP implementation could be very effective, particularly for the Global South.

.2 A structured, comprehensive and inclusive UDA framework will allow policy and technology intervention along with acoustic capacity and capability building.

.3 Outreach, engage and sustain will be the optimum way ahead to manage such a global initiative with unique regional diversities.

.4 Tropical IOR led by India can provide the unique way ahead to manage URN at a global scale.

.5 E-Learning modules on UDA and URN will provide online tools for mass outreach.

Action requested of the Committee

12 The Committee is invited to note the methods presented in this document and consider them in the future development of guidelines and regulations for URN management as per document MEPC 82/9 (Secretariat).