ANALYSIS OF UNDERWATER ACOUSTICS RAY TRACING USING BELLHOP PROPAGATION MODEL IN SUNDA STRAIT

RAKHMATULLAH IBNU SALAM

DEPARTEMENT OF MARINE SCIENCE AND TECHNOLOGY
FACULTY OF FISHERIES AND MARINE SCIENCE
IPB UNIVERSITY
BOGOR
2026

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Rakhmatullah Ibnu Salam
C5401221802

ABSTRACT

RAKHMATULLAH IBNU SALAM. Analysis of Underwater Acoustics Ray Tracing using Bellhop Propagation Model in Sunda Strait. Supervised by HENRY MUNANDAR MANIK and STEVEN SOLIKIN.

Sunda Strait which links the Java Sea with the Indian Ocean, divides the Indonesian islands of Java and Sumatra and is situated at 6.0°S, 105.0°E, the strait serves as the westernmost point of entry for waters from the Pacific and Indonesian Seas into the Indian Ocean. Underwater acoustic communications and networking technologies are essential for national defense operations, subsea resource extraction, and undersea exploration which is why acoustic propagation modelling is very useful. Underwater acoustic models are regularly utilized in the forecasting of acoustic condition for planning experiments at sea, optimizing sonar system design, to predict the performance of sonars and its generally the cost much less than experiments at sea. This research aims to analyze the acoustic propagation of Sunda Strait in 3 stations with a length of 5 km at 3 different depths while using frequency of 5 kHz, 50 kHz, and 100 kHz. Environmental data was collected using CTD cast and sound speed was processed using Leroy empirical model for sound speed using temperature, salinity, depth and latitude. Bathymetry empirical model from Hamilton and Bachman was used to determine the type of sediment used in the model. Resulting simulation shows that 5 kHz frequency travels the farthest beyond 5 km in all three stations, 50 kHz frequency generally only travels about 2 km before reaching a transmission loss of >80 dB, 100 kHz frequency is on average the shortest covering less than 1km before reaching a transmission loss of > 80 dB.

Keywords: bellhop, frequency, model, propagation, Sunda Strait

ABSTRAK

RAKHMATULLAH IBNU SALAM. Analisis Ray Tracing Akustik Bawah Air Menggunakan Model Propagasi Bellhop di Selat Sunda. Dibimbing oleh HENRY MUNANDAR MANIK and STEVEN SOLIKIN.

Selat Sunda yang menghubungkan Laut Jawa dengan Samudra Hindia, memisahkan pulau Jawa dan Sumatra di Indonesia, serta terletak pada koordinat 6,0° LU, 105,0° BT, berfungsi sebagai titik masuk paling barat bagi perairan dari Samudra Pasifik dan Laut Indonesia ke Samudra Hindia. Teknologi komunikasi dan jaringan akustik bawah air sangat penting untuk operasi pertahanan nasional, ekstraksi sumber daya bawah laut, dan eksplorasi bawah laut, itulah sebabnya pemodelan propagasi akustik sangat berguna. Model akustik bawah air sering digunakan dalam peramalan kondisi akustik untuk merencanakan eksperimen di laut, mengoptimalkan desain sistem sonar, serta memprediksi kinerja sonar; dan umumnya biayanya jauh lebih murah daripada eksperimen di laut. Penelitian ini bertujuan untuk menganalisis propagasi akustik Selat Sunda menggunakan model bellhop di 3 stasiun dengan panjang 5 km pada 3 kedalaman berbeda sambil menggunakan frekuensi 5 kHz, 50 kHz, dan 100 kHz. Data lingkungan dikumpulkan menggunakan pengukuran CTD, dan kecepatan suara diproses menggunakan model empiris Leroy untuk kecepatan suara berdasarkan suhu, salinitas, kedalaman, dan lintang. Model empiris batimetri dari Hamilton dan Bachman digunakan untuk menentukan jenis sedimen yang digunakan dalam model. Hasil simulasi menunjukkan bahwa frekuensi 5 kHz menjangkau jarak terjauh melebihi 5 km di ketiga stasiun, frekuensi 50 kHz umumnya hanya menjangkau sekitar 2 km sebelum mencapai kehilangan transmisi >80 dB, sedangkan frekuensi 100 kHz rata-rata memiliki jangkauan terpendek, kurang dari 1 km, sebelum mencapai kehilangan transmisi >80 dB.

Kata kunci: bellhop, frekuensi, model, propagasi, Selat Sunda

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RAKHMATULLAH IBNU SALAM

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DEPARTEMENT OF MARINE SCIENCE AND TECHNOLOGY
FACULTY OF FISHERIES AND MARINE SCIENCE
IPB UNIVERSITY
BOGOR
2026

Examiner's Committee:

1. Prof. Dr. Ir. Indra Jaya., M.Sc
2. Dr. Ir. Totok Hestirianoto., M.Sc

Title of Undergraduate Thesis : Analysis of Underwater Acoustics Ray Tracing Using Bellhop Propagation Model in Sunda Strait
Name : Rakhmatullah Ibnu Salam
Student ID : C5401221802

Approved by

Supervisor 1:
Prof. Henry Munandar Manik S.Pi., M.T., Ph.D

Supervisor 2:
Dr. Steven Solikin, S.I.K., M.Si.

Acknowledged by

Head of Marine Science and Technology Department:
Dr. Syamsul Bahri Agus, S.Pi., M.Si.
NIP 197207262005011002

Exam Date:
25 May 2026

Completion Date:

PREFACE

The author offers praise and thanks to Allah, subhanaahu wa ta'ala, for all His blessings, which have enabled the successful completion of this scientific work. The topic chosen for this research, conducted from October 2025 to June 2026, is Marine Acoustic Propagation Modeling, with the title "Analysis Of Underwater Acoustics Ray Tracing Using The Bellhop Propagation Model In The Sunda Strait."

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May this scientific work be of benefit to those in need and contribute to the advancement of science.

Bogor, June 2026

Rakhmatullah Ibnu Salam

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