

Intisari

Survei batimetri menggunakan *Multibeam Echosounder* (MBES) mampu menghasilkan model batimetri dasar perairan dengan cakupan data yang rapat dan detail. Namun, kualitas data MBES dipengaruhi oleh ketepatan penerapan profil kecepatan suara dan koreksi *patch test*. Dalam pelaksanaan survei, profil kecepatan suara hasil pengukuran tidak selalu merepresentasikan kondisi kolom air pada seluruh waktu dan lokasi akuisisi. Selain itu, pemilihan area dan lintasan *patch test* yang kurang sesuai dapat menghasilkan parameter koreksi orientasi yang tidak tepat. Kondisi tersebut berpotensi menimbulkan perbedaan kedalaman, distorsi model batimetri, dan penyimpangan estimasi volume. Penelitian ini bertujuan menganalisis pengaruh variasi penerapan koreksi kecepatan suara dan koreksi *patch test* terhadap hasil kedalaman MBES, perubahan model batimetri, dan penyimpangan estimasi volume di perairan Maumere.

Data yang digunakan merupakan data hasil survei MBES di perairan Maumere, Kabupaten Sikka, Nusa Tenggara Timur, menggunakan MBES Norbit Winghead i77h. Model batimetri dibentuk dalam bentuk *Digital Terrain Model* (DTM) menggunakan *rectangular grid* berukuran 0,85 m. Analisis dilakukan pada tiga area utama, yaitu A1, A2, A3, P dan S yang merepresentasikan morfologi dasar perairan berbeda. Pengaruh penerapan profil kecepatan suara dianalisis melalui skenario *no SVP correction* (NS), yang tetap menggunakan kecepatan suara konstan 1500 m/s tanpa menerapkan profil kecepatan suara hasil pengukuran. Pengaruh koreksi *patch test* dianalisis melalui skenario *no patch test correction* (NP), sedangkan pengaruh gabungan dianalisis melalui skenario *no SVP and no patch test correction* (NC). Uji sensitivitas *patch test* dilakukan pada area A2 dengan menyisipkan kesalahan residual $\pm 0,5^\circ$ pada parameter *roll*, *pitch*, dan *heading* secara terpisah. Nilai $\pm 0,5^\circ$ dipilih sebagai kesalahan terkontrol di antara kesalahan orientasi kecil yang dapat memengaruhi berkas tepi dan kesalahan 1° yang menghasilkan penyimpangan lebih besar. Model batimetri *full correction* (FC) digunakan sebagai model acuan. Setiap model skenario dibandingkan terhadap model acuan melalui analisis *difference surface*, *Mean Absolute Error* (MAE), *Root Mean Square Error* (RMSE), profil penampang, uji-t satu sampel satu arah berbasis blok spasial terhadap selisih MAE blok dan batas *Total Vertical Uncertainty* (TVU) blok, serta perhitungan penyimpangan estimasi volume.

Hasil penelitian menunjukkan bahwa pengaruh tidak diterapkannya SVP hasil pengukuran relatif kecil pada data penelitian ini. Pada area kajian utama, skenario NS terhadap FC menghasilkan RMSE sebesar 0,016 m pada A1, 0,027 m pada A2, 0,016 m pada A3, dan 0,016 m pada S. Sebaliknya, tidak diterapkannya koreksi *patch test* menghasilkan perubahan model batimetri yang lebih besar, terutama pada area A2 dan P. Pada A2, skenario NP dan NC menghasilkan RMSE masing-masing sebesar 1,289 m dan 1,294 m. Pada area P, skenario NP dan NC menghasilkan RMSE masing-masing sebesar 1,879 m dan 1,883 m. Hasil uji signifikansi menunjukkan bahwa secara rata-rata MAE blok pada skenario NP dan NC melebihi batas TVU blok secara signifikan pada area A2 dan P. Pada area lainnya serta seluruh skenario sensitivitas $\pm 0,5^\circ$, belum terdapat bukti statistik bahwa secara rata-rata MAE blok melebihi batas TVU blok. Penyimpangan estimasi volume terbesar juga terjadi pada skenario NP dan NC, terutama pada A2, dengan *gross volume* masing-masing sebesar 1.762,21 m³ dan 1.774,73 m³. Hasil tersebut menunjukkan bahwa tidak diterapkannya koreksi *patch test* memberikan pengaruh lebih dominan dibandingkan tidak diterapkannya SVP. Meskipun demikian, seluruh koreksi tetap diperlukan untuk menghasilkan model batimetri yang andal.

Kata kunci: MBES, SVP, *patch test*, penyimpangan estimasi volume.

Abstract

Bathymetric surveys using a *Multibeam Echosounder* (MBES) are capable of producing detailed seafloor bathymetric models with dense data coverage. However, the quality of MBES data is influenced by the accuracy of sound velocity profile application and *patch test* correction. During survey operations, the measured sound velocity profile may not fully represent water-column conditions throughout the acquisition period and survey area. In addition, inappropriate selection of the *patch test* area and survey lines may produce inaccurate orientation correction parameters. These conditions may cause depth differences, distortion of the bathymetric model, and deviations in volume estimation. This study aims to analyze the effects of variations in sound velocity and *patch test* correction application on MBES depth results, bathymetric model changes, and volume estimation deviations in Maumere waters.

The data used in this study were obtained from an MBES survey conducted in Maumere waters, Sikka Regency, East Nusa Tenggara, using a Norbit Winghead i77h MBES. The bathymetric model was generated as a *Digital Terrain Model* (DTM) using a rectangular grid with a cell size of 0.85 m. The analysis was conducted in three main areas, namely A1, A2, and A3, as well as areas P and S, which represent different seabed morphologies. The effect of sound velocity profile application was analyzed using the *no SVP correction* (NS) scenario, in which the measured SVP was not applied and a constant sound velocity of 1500 m/s was retained. The effect of *patch test* correction was analyzed using the *no patch test correction* (NP) scenario, while the combined effect was evaluated using the *no SVP and no patch test correction* (NC) scenario. A *patch test* sensitivity analysis was also conducted in area A2 by separately introducing residual errors of $\pm 0.5^\circ$ into the *roll*, *pitch*, and *heading* parameters. The value of $\pm 0.5^\circ$ was selected as a controlled error level between smaller orientation errors that may affect outer beams and a 1° orientation error that may produce larger deviations. The *full correction* (FC) bathymetric model was used as the reference model. Each scenario model was compared with the reference model using *difference surface* analysis, *Mean Absolute Error* (MAE), *Root Mean Square Error* (RMSE), cross-sectional profiles, a block-based one-sample right-tailed t-test of the difference between block MAE and block *Total Vertical Uncertainty* (TVU), and volume estimation deviation calculations.

The results show that the omission of the measured SVP had a relatively small effect on this dataset. The NS scenario against FC produced RMSE values of 0.016 m in A1, 0.027 m in A2, 0.016 m in A3, and 0.016 m in S. In contrast, the omission of *patch test* correction produced larger changes in the bathymetric model, particularly in areas A2 and P. In A2, the NP and NC scenarios produced RMSE values of 1.289 m and 1.294 m, respectively. In area P, the corresponding RMSE values were 1.879 m and 1.883 m. The significance test showed that the mean block MAE values for the NP and NC scenarios significantly exceeded the block TVU limits in areas A2 and P. In the other areas and in all $\pm 0.5^\circ$ sensitivity scenarios, there was insufficient statistical evidence that the mean block MAE exceeded the block TVU limit. The largest volume estimation deviations also occurred in the NP and NC scenarios, particularly in A2, with gross volumes of 1,762.21 m³ and 1,774.73 m³, respectively. These results indicate that the omission of *patch test* correction had a more dominant effect than the omission of the measured SVP. Nevertheless, all corrections remain necessary to produce a reliable bathymetric model.

Keywords: MBES, SVP, patch test, volume estimation deviation.