

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

This chapter summarizes the findings obtained throughout the research, covering the comparison of the planar method with Karney's Algorithm, the development of a calibration model based on Support Vector Regression (SVR), and the testing of model consistency under various conditions. Finally, relevant recommendations for future researchers are presented.

5.1. Conclusions

Based on the research results and discussion presented, the following conclusions can be drawn:

1. A geodetic computational evaluation of the entire 400-sample dataset reveals that Karney's algorithm yields a MAPE of 6.89% and an MAE of 416.35 m², whereas the planar method records a MAPE of 8.41% and an MAE of 434.95 m². The mean difference between the two methods is 45.69 m² ranging from 0.79 to 706.33 m² indicating that the discrepancy between the methods widens as land parcel size increases. It should be noted that these figures represent the inherent deviation of each method based on the full dataset, whereas the performance evaluation of the SVR calibration model (yielding an SVR MAPE of 5.34%) was conducted separately on the test set derived from a 70:15:15 data split. This underscores that the ellipsoid-based geodetic approach, which accounts for the Earth's curvature, is more effective at minimizing distortion.
2. Using a linear kernel configuration ($C = 1000$, $\epsilon = 1.0$), the SVR model successfully reduced the MAPE to 5.34%, achieving an R^2 of 0.9997, an MAE of 35.99 m², and an RMSE of 78.25 m² on the test data. The Wilcoxon Signed-Rank test confirms that this performance improvement is statistically significant ($p = 0.0034$) rather than merely coincidental. The SVR's ability to handle outliers commonly found in unevenly distributed spatial data stems from the epsilon-insensitive loss mechanism that characterizes the algorithm.
3. When tested across land-size stratum, the Karney Algorithm + SVR combination recorded a MAPE of 8.39% for small parcels, 4.30% for medium parcels, and 1.37% for large parcels, resulting in a cross-stratum average

MAPE of 4.69%. The downward trend in MAPE as land area increases indicates that the model performs consistently across polygons with both complex and simple geometries. Stability testing across three data-splitting schemes (80:10:10, 70:15:15, and 60:20:20) yielded a MAPE Coefficient of Variation of 7.45% comparable to the 7.72% observed with the Karney Algorithm alone demonstrating that the performance of the Karney Algorithm + SVR model is robust against changes in training data composition.

Overall, the combination of the Karney Algorithm and SVR proved more effective at addressing digitization bias in land data than single-model approaches. Among the evaluated models, the Karney Algorithm + SVR outperformed the Karney Algorithm + Ridge Regression and Karney Algorithm + Random Forest Regressor. These findings are expected to serve as an empirical foundation for developing more accurate and reliable land area estimation methods for real-world geospatial data.

5.2. Recommendations

Based on the research findings and the limitations encountered, the following recommendations are made for future research:

1. The approach employed in this study was limited to the horizontal (2D) dimension. Future research should seriously consider integrating Karney's algorithm with Earth's surface topography data. Incorporating elevation components into area calculations has the potential to yield actual surface area estimates that more closely reflect real-world conditions.
2. The morphological features utilized in this study could be expanded. Attributes such as convexity, solidity, rectangularity, or fractal dimension may exhibit stronger correlations with digitization error patterns. Exploring these features in future studies also offers the opportunity to capture the influence of a wider range of geographic factors on digitization accuracy.