River Network Line Generalization at Small Scales: A Comparative Approach

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Introduction

Line generalization is a core problem in GIS, especially when working with natural features like rivers. Rivers are messy, irregular, and change significantly depending on scale, which makes it difficult to simplify them without losing important shape details or making them harder to read on a map. This project examines how river networks can be generalized to retain as many features as possible while remaining legible, visually clear, and reasonably true to their real-world shape (Buttenfield, 1989).

This research focuses on smaller-scale mapping (e.g., ~1:1,000,000), where higher levels of generalization are required compared to more commonly studied larger scales (e.g., 1:100,000). At these smaller scales, the challenge of balancing geometric accuracy and visual clarity becomes more pronounced, requiring careful selection of generalization techniques and parameters.

Method

This methodology will be applied to National Hydrography Dataset (NHD) stream features for the state of Illinois, filtered to main stem flow volume greater than 9 cubic feet per second for display at approximately 1:1,000,000 scale (Clark, 2025). Rather than focusing on a single method, this research takes an exploratory approach by testing and comparing multiple line simplification techniques in ArcGIS. Established algorithms approach simplification in different ways, including distance-based, area-based, and shape-based methods. Previous research has shown that these approaches can produce significantly different results depending on parameter selection, and that positional error tends to increase as simplification becomes more aggressive (Veregin, 2000).

The general workflow involves applying multiple simplification methods to the same river datasets using a range of tolerance values. As the lines are simplified, the results are compared to the original data to evaluate how much they change. Evaluation is based on a set of quantitative and visual metrics, including positional accuracy, average and maximum displacement, number of vertices retained, and angularity (i.e., the introduction of sharp angles that may reduce realism in river features).

This study is currently in progress, and results are not yet available. The focus at this stage is on developing a consistent framework for comparing generalization techniques and understanding how different parameter choices influence outcomes.

Discussion and Conclusion

A key objective of this research is identifying when simplification begins to break down. In other words, at what point does removing detail start to noticeably distort river shape or reduce readability? A constraint-based approach will be taken to determine the optimal combination of algorithms and parameters to maximize legibility without exceeding distortion limits. This reflects a broader issue in GIS, where generalization is not just about reducing data, but about balancing accuracy, clarity, and usability in a consistent and meaningful way (Lee & Hardy, 2005).

Ultimately, this research aims to better understand the trade-offs involved in river generalization and to identify which methods, or combinations of methods, produce the most useful results. The findings are expected to contribute to more effective and practical approaches to simplifying river networks for mapping and analysis, particularly at smaller scales where generalization challenges are most pronounced.

References

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