Watershed Analysis and Risk Assessment Using Global Mapper

by Jenna Nelson

Humans typically conceptualize land based on administrative boundaries—such as countries, states, and municipalities. However, physical features like ridgelines and drainage basins often provide more ecologically relevant demarcations. Tools like Global Mapper® allow users to move beyond political borders and analyze the topographical and hydrological characteristics of landscapes.

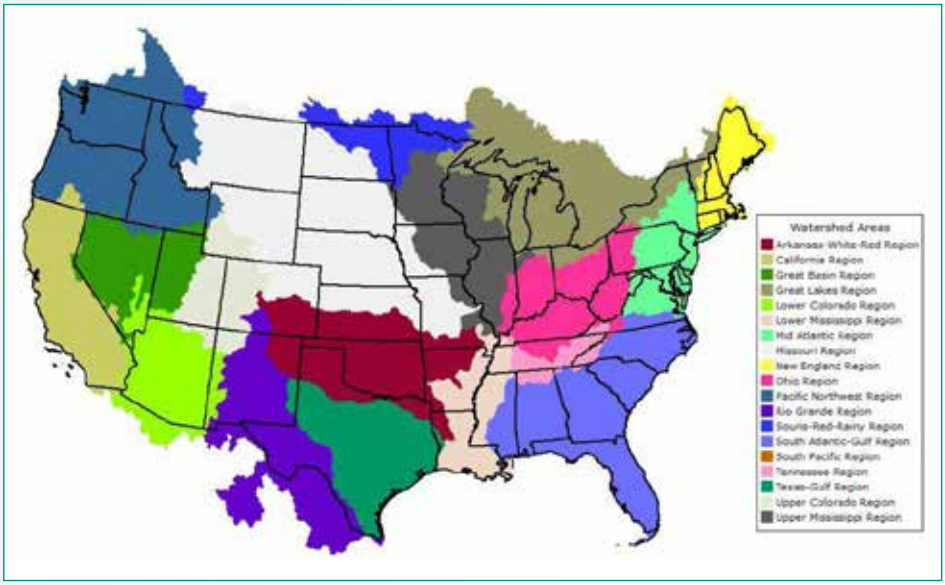

Fig. 1 From a publicly available national dataset, large watershed areas for the continental United States are shown. Each watershed covers portions of multiple states, with the watershed boundary not conforming to state lines.

Introduction

Watershed analysis is especially important in identifying flood risks, managing stormwater, and understanding the potential for contamination from point sources such as landfills. This study focuses on the Tennessee Region watershed and illustrates how Global Mapper's suite of spatial and hydrological tools can be used for watershed delineation, area measurement, and environmental risk modeling.

Methods

Watershed Delineation and Spatial Operations

A publicly available national watershed dataset was loaded into Global Mapper to visualize large watershed areas across the continental United States. Each watershed spans multiple states, often without adhering to state boundaries. A specific focus was placed on the Tennessee Region watershed, which crosses nine state lines.

To isolate the regions of each state that fall within this watershed, a Spatial Operation was performed using the Intersection function. This operation created a new layer containing only the overlapping portions of each state and the Tennessee watershed.

To quantify area by state, Global Mapper's Digitizer Tool was used to measure the size of the intersecting polygons. States with multiple disjointed features (e.g., Georgia) were grouped into multipart polygons, enabling accurate calculation of total watershed area per state.

Sub-Watershed Generation

Using a national terrain dataset, the Watershed Generation tool in Global Mapper was employed to delineate micro-watersheds. Parameters such as stream flow length, stream size, and depression fill depth were adjusted to control the resolution and scale of the output.

- Larger stream thresholds resulted in broader watershed areas.
- Smaller stream parameters identified finer sub-basins,

capturing localized water flow.

Environmental Risk Modeling
Environmental hazards, particularly those affecting water quality, were analyzed using landfill location data. The Search Vector Data tool identified currently open solid waste management facilities within the Tennessee watershed.
Selected landfills were used as starting points in the "Trace Flow from Selected Point(s)" analysis, which generates streamlines from each location to show surface water flow across the terrain. These streams were then intersected with watershed or municipal boundaries to determine the potential impacted area.

Results

Watershed and State Overlap
The Tennessee Region watershed was successfully isolated from the national dataset and intersected with nine state boundaries. Unique colors were applied to each state's portion within the watershed. Area calculations produced a quantitative breakdown, enabling watershed management planning by state.

Micro-Watershed Delineation
Adjusting stream size thresholds resulted in two types of watershed outputs:

- Macro-watersheds, which illustrated general drainage regions.
- Micro-watersheds, showing detailed local catchment zones that feed into larger systems.

These layers provided the groundwork for linking terrain analysis with environmental impact assessments.

Landfill Contamination Risk
Using landfill location data, open sites were identified within the Tennessee Region watershed. The water drop analysis generated flow paths from each landfill, showing potential contamination trajectories.
Intersecting these flow paths with watershed boundaries highlighted areas at risk for pollution from leachate. This model allows planners to focus mitigation efforts on high-risk zones.

4. Discussion

The findings demonstrate the capability of Global Mapper to conduct in-depth watershed analysis across multiple spatial and thematic layers. While administrative boundaries remain critical for governance, watershed-based planning offers a more ecologically sound framework, particularly for managing shared water resources and environmental risks.
The ability to simulate water flow and quantify areas at risk from point-source pollution is invaluable for proactive resource management.
With increasing pressure on water systems from climate

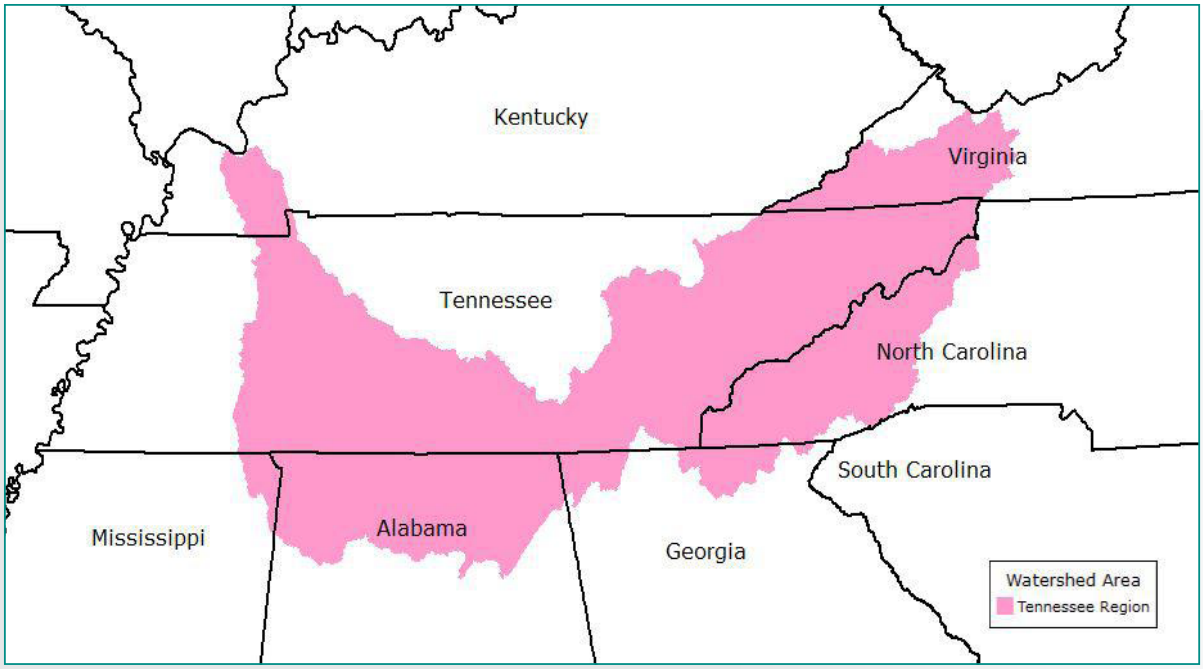

Fig. 2 - From a publicly available national dataset, large watershed areas for the continental United States are shown. Each watershed covers portions of multiple states, with the watershed boundary not conforming to state lines.

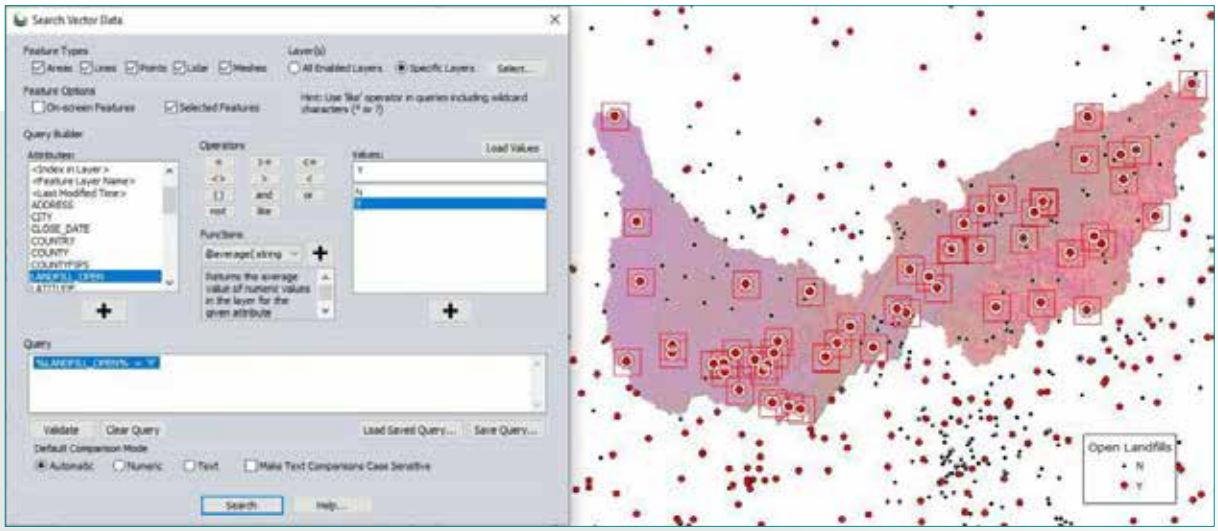

Fig. 3 -Left: A simple Spatial Operation is set up to isolate the areas where specific states and the Tennessee Region watershed intersect. Right: Colored uniquely, areas from each state in the watershed are seen.

change, urbanization, and waste mismanagement, tools like Global Mapper provide essential support for evidence-based environmental planning.

Conclusion

Watershed analysis using Global Mapper® offers a robust methodology for understanding and managing hydrological systems beyond administrative borders. The Tennessee Region watershed case study highlights the tool's strength in spatial operations, terrain modeling, and environmental risk assessment. By integrating terrain data, landfill locations, and flow simulations, stakeholders can better predict, visualize, and respond to watershed-scale threats, ensuring sustainable management of land and water resources.

Implementation Extension: COAST for Coastal Risk and Damage Assessment

As a further extension of Global Mapper's capabilities, the COAST (COastal Adaptation to Sea Level Rise Tool) provides a purpose-built interface to evaluate the economic impacts of sea level rise and coastal flooding. Developed by Blue Marble Geographics in partnership with the New England Environmental Finance Center (NEEFC) and Catalysis Adaptation Partners, COAST is built using the Global Mapper SDK and is available as a free, standalone tool.

COAST assists stakeholders in planning for future climate-related threats by modeling expected damages under various storm and sea-level scenarios and comparing the costs and benefits of mitigation strategies. Two key outputs are generated:

- Damage visualization maps that show flood extent and asset loss in a given scenario.
- Cumulative damage charts that assess long-term impacts across different planning horizons.

For example, in a modeled scenario for downtown Portland, Maine, with 1.8 meters of sea level rise and a 100-year flood event by 2100, COAST projected losses exceeding $500 million, with single-parcel damage reaching over $54.1 million. Alternative strategies—such as levees or surge barriers—can then be evaluated for their effectiveness and return on investment. Adaptation options modeled in COAST include both hard infrastructure (e.g., levees) and soft strategies (e.g., rezoning, flood-proofing). Outputs can be exported to Google Earth and used for cost-benefit analysis, allowing community leaders to make informed decisions about how and where to invest in resilience. Importantly, COAST allows for scenario modeling across a range of sea level rise projections and storm intensities, giving planners the flexibility to evaluate risk under uncertainty and test both "action" and "no-action" outcomes.

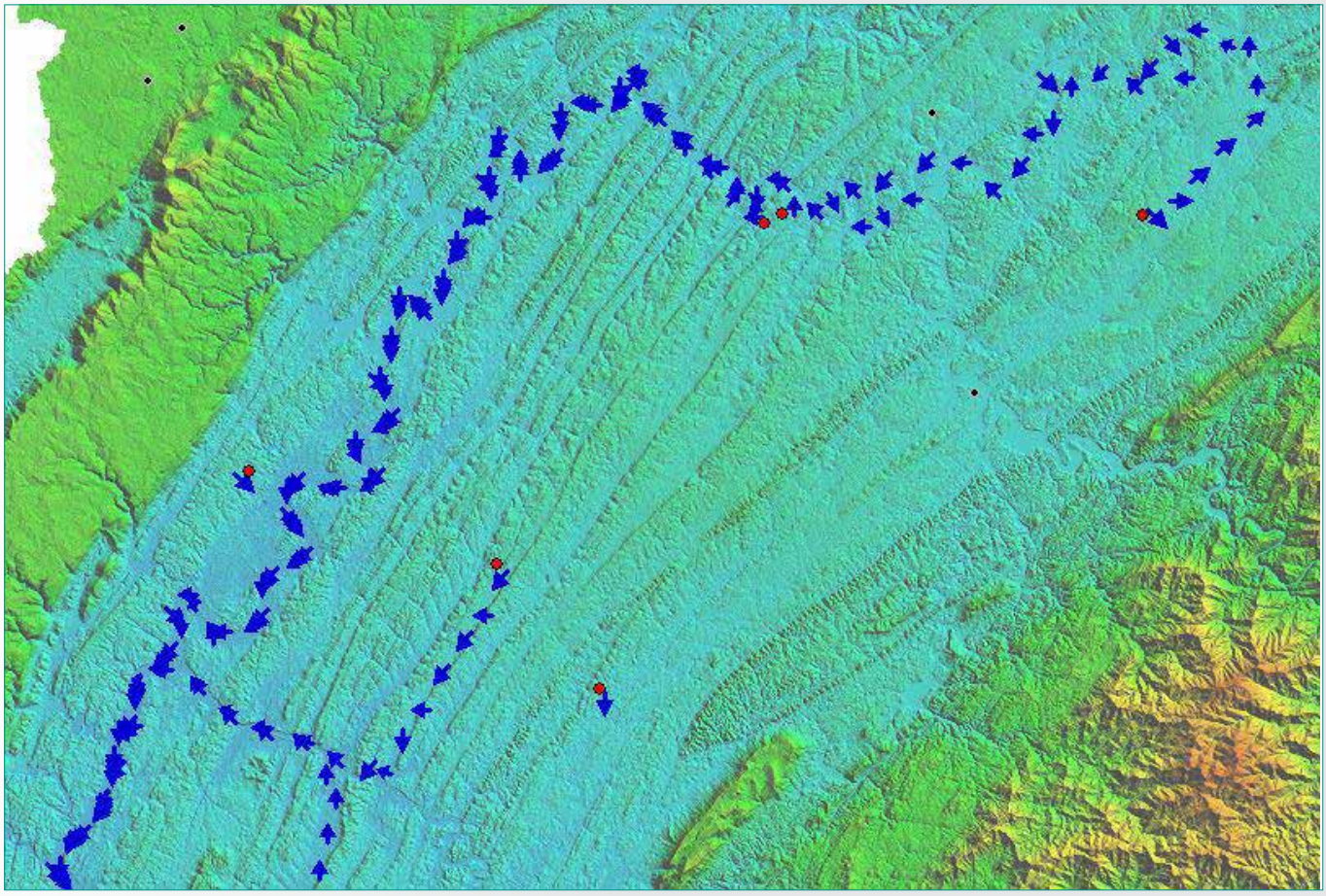

Fig. 4 - With the water drop analysis, only streams are generated, showing the flow from the selected landfill points over the terrain.

REFERENCES

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KEYWORDS

GIS; Global Mapper; watershed analysis; environmental risk; infrastructure; land use; COAST

ABSTRACT

Watershed analysis provides critical insights into the natural flow of water across landscapes, helping to identify environmental risks and inform land-use and infrastructure planning. This paper explores how Global Mapper®, a geographic information system (GIS) tool, can be used to delineate watersheds, analyze topographic boundaries, and assess environmental threats such as landfill contamination. Through a case study of the Tennessee Region watershed, the paper demonstrates how spatial operations, watershed generation tools, and terrain analysis can support data-driven watershed management and risk mitigation. The paper also presents COAST, an extension of Global Mapper developed for coastal adaptation planning, as an advanced implementation that enhances watershed and coastal flood risk analysis through economic impact modeling.

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