

## **Geovisualization Design for Epidemiology: A Framework**

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The development of new geovisualization methods poses a challenge to researchers interested in methods of assessing their use and usability. In the past, cartographers have relied on measures of performance, accuracy, and metrics of preference/confidence to test selected map variables and theories of perception and cognition. Traditional methods are ill-equipped to describe the use and usability of geovisualization tools that are targeted toward the nebulous tasks of data exploration and analysis. Therefore, there is a need for deeper understanding about users and how they conceptualize interaction and exploration. The research reported here has utilized multiple complimentary qualitative methods common in the field of interaction design, as well as selected metrics and methods used in usability research. Assessment methods from both domains are useful in combination when attempting to tailor a suite of tools to a specific application domain.

This research began with interest expressed by colleagues at the National Cancer Institute (NCI) to develop a geovisualization toolkit designed to explore multivariate health data. The resulting application, the Exploratory Spatio-Temporal Analysis Toolkit (ESTAT) is based on geovisualization tools from the open-source GeoVISTA *Studio* visual programming environment. ESTAT features a set of dynamically-linked tools, including a scatter plot, bivariate map, time series plot, and a parallel coordinate plot. It is intended to facilitate multivariate exploration and analysis of health outcomes and covariates.

From the beginning, users from NCI have been the central focus of the development of ESTAT. Often, geovisualization tools are developed without an audience in mind, and later adapted to specific work. In this case, ESTAT is the result of a human-centered design approach that set out from the onset to adapt tools for epidemiological needs.

Based on the iterative, user-centered development of ESTAT, this paper suggests a design framework for a geovisualization toolkit. This framework is based on a series of knowledge elicitation assessments with both geographers and practicing epidemiologists. Specifically, users have provided input through focus groups, verbal protocol analysis sessions, surveys, and collaboration through an in-depth case study. The design framework presented suggests the critical functions, linkages, sharing methods, and interface preferences that have been illuminated through triangulation of the multiple methods applied. Specific examples from the development of ESTAT will be used to describe these suggestions. While the proposed framework is the result of efforts to design for epidemiology, the general principles gathered from this work should be easily transferable to geovisualization applications in other domains.