[CV-06-023] Map Analysis

Abstract

Map analysis is commonly listed as one of three aspects of user interaction with a map, along with map reading and map interpretation. Map reading is generally categorized as using the basic functions of the map – matching symbols to the legend, using the scale and directional indicator, and so forth (Buckley & Kimerling, 2021; Tyner, 2015). Map interpretation is typically considered to be a complex exploration of the data in the map, often with reference to other maps or data sources, to understand and explain patterns (Kimerling et al., 2016; Kraak & Ormeling, 2010; Tyner, 2015). Map analysis lies somewhere in the middle, defined variously by scholars (Field, 2018; Kimerling et al., 2016; Tyner, 2015), but essentially a description, whether general or precise, of what's in the map. Analysis utilizes the basic tools of map reading to describe patterns or calculate characteristics, and questioning the assumptions and biases that may have influenced the map's creation. Map analysis is sometimes conflated with map critique, but a full analysis moves beyond critique to a larger assessment of the map's messaging.

Keywords: map use

Author & citation

Rock, A. E. (2024). Map Analysis. Geographic Information Science & Technologies Body of Knowledge (2024 Edition). John P. Wilson (Ed.). DOI: 10.22224/gistbok/2024.1.24.

Explanation

1. Definitions
2. Map Analysis: Beyond Critique
3. Analysis of the Map Metaphor
4. Analysis of the Spatial Information
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1. Definitions

Map Audience: the people for whom the map is intended, to include their needs and experience with maps

Map analysis: evaluating the effectiveness of the map's communication (map critique) and describing the geographic information contained within it.

Map critique: an evaluation of the design and development of the map, meant to provide insight on map user response and map maker intent.

Map interpretation: recognizing/describing patterns, drawing geographic connections, and compiling information (including from other sources) to study the map.

Map reading: understanding the map as a representation of the real world, and using the

tools of the map (scale, directional indicator, legend) for wayfinding, position finding, and recognition of symbols.

2. Map Analysis: Beyond Critique

Maps are the cartographer's interpretation of the geographic environment, as presented to the map reader (MacEachren, 2004). The evolution of the cartographer's craft from art to something bounded by objective rules for functionality (Edney, 2005) has given rise to a similarly structured process of map analysis based on objective review. The "rules" of graphic literacy ("graphicacy") and cartographic visualization outlined by Robinson, Imhof, Bertin, and others are presented to introductory students as the backbone of good design and effective graphic communication. The development and comprehension of the map as a metaphor are core components of analysis that not only inform the iterative process of design but will also determine the utility and proliferation of the map after publication. For analysis to be useful, it must not only leverage the question-and-resistance methods of critique (Crampton, 2010), but also of more objective, quantifiable tools of evaluation (Kimerling et al., 2016).

Map analysis can be broken down into a two-pronged approach to evaluating how and what the map communicates: critique and description. The first part consists of an analysis of the map metaphor itself, looking at data management and communication, as it relates to understanding or evaluating the map. This is sometimes described as map critique, and done properly, is an interactive process to understand the goals of the map and generate feedback for the mapmaker. The second, more geographic, description of the map can be part of the design process but is also done long after the map is created, as map readers seek to uncover the full message of the map. Depending on the purpose of the analysis, these two components may be equally detailed, or critique may be brief in favor of more detailed description.

3. Analysis of the Map Metaphor

Analyzing the map metaphor examines three primary components: the data within the map, the method by which it is communicated, and the overall effectiveness in reaching the intended audience. When conducted as part of a larger analysis, critique should not be overlooked, but may be a brief assessment of these key points. The most beautiful map in the world is reduced to a work of art rather than an effective map if the data underneath cannot be verified or is proven to be of poor quality. Likewise, a sound map based on good quality data is less useful if the design interferes with its ability to communicate, or if the map is designed for the wrong audience. The map metaphor must balance data quality, design, and purpose.

Despite the grounding in objectivity, the assessment of data representation and audience connection are somewhat subjective. Evaluation of data quality is less so, however, there can still be some flexibility in determining data to be "good enough" for the task at hand. In this way, the three components are interlinked, as a map for scientific purposes must of necessity contain more accurate and more precise data than a map of local tourist destinations, which may eschew precision in favor of design, and less accurate data may be deemed "good enough" for the purpose. Brewer (2016) notes that the mapmaker should plan for analysis through design choices by linking layout to purpose, valuing experimentation and critique, and choosing projections to minimize distortion in accordance

with map purpose. The role of critique then is to determine whether the three legs of the stool -- data, design, and purpose -- are working together in balance.

3.1 Data quality and manipulation

As the saying goes, garbage in, garbage out. The data displayed in the map must be analyzed for accuracy, relevance, and effective use of any statistical techniques. As Monmonier (1991) and others have frequently pointed out, all maps lie, as the nature of generalizing the earth at scale on a flat sheet requires some amount of misrepresentation, but it is important not to commit more egregious falsehoods. Although it may sometimes be challenging to determine what (if any) manipulation of the data has occurred prior to its presentation in the map, it is still important to check a few key points.

1. Is the source reliable?
2. Is the source relevant and timely to the map's purpose?
3. Are the statistical techniques appropriate to the data and purpose?

While it is possible to answer all of these in the affirmative and still have poor data quality, asking these questions will weed out some of the most egregious and basic of data issues. Foster (2019) provides an easily digestible overview of statistical techniques, and a quick assessment of classification and normalization methods can often reveal poor data management, which should lead one to further question the relevance and reliability of the map. A data quality rubric may be helpful for more detailed review, or visual comparison to another map or data source may suffice for simpler applications.

3.2 Effective design

A map's principal function is to communicate geographic data, but the design of a map can help or hinder this communication. Tyner (2015) notes that the selective nature of maps and inherent distortion can impact analysis, and poor design can exacerbate this. Every introductory cartography textbook discusses the impact of design on communication, and the need to adapt the design to suit the map's purpose. Analysis of the design should focus on how well these goals are met, rather than the analyst's personal taste – critique is not criticism (Crampton, 2010; Huffman, 2021), but about assessing how well the map works within its context.

A checklist for evaluating the design of a map may be useful for the novice analyst, to ensure careful review of compilation, data sources, and design (Field, 2012). Sample checklists may be found at various online sources and can be used as is or adapted by the analyst as they become more fluent in the process. In a brief critique, the basic questions that should be asked are:

1. Do I understand what this map is trying to tell me? If not, where does the message break down?
2. Is the map visually balanced?
3. Is the map aesthetically pleasing?

The analysis of design is by nature rather subjective, based largely on intuition and judgment, which is conditioned by training and experience (Field, 2018). Both can be developed through repeated exposure to maps and the analytical process of others.

3.3 Connection to audience

Audience refers to the intended map user, and the associated parameters, such as map purpose, delivery format, and expected map reading skills. The map maker plans for analysis through design choices: linking layout to purpose, valuing experimentation and critique, choosing projections to minimize distortion related to purpose (Brewer, 2016). We ask key questions about what is being mapped and who will read it to make sound design choices. These may include adjusting the map for educational level of the audience, intended publication format, or setting a tone for the map through design choices. This development for audience may range from the benign (using bright colors and bold fonts for children, for example) to the potentially malignant (propaganda maps designed to deliberately persuade). What is important to the analyst is to review how the map maker has adapted the map for the audience, which can be assessed with a few questions.

1. Who is the audience for the map? (e.g., children, scientists, the general public)
2. What is the purpose for the map? (e.g., to inform, guide, entertain)
3. What adjustments to accuracy and/or design may have been made to meet these goals?

This last question may be fairly simple, but may also require some inquiry into the context of the map, to understand the broader historical, social, and political factors that influence the map's creation and interpretation. For example, we may look at Mitchell's 1755 map of British colonies in North America and see broad stripes of British dominion, but it is important to understand that these were claims made strictly as rebuttal to conflicting French claims in the region, rather than strict, governed boundaries, and did not reflect actual colonial settlements.

Additionally, the last question also implies accommodations made for accessibility. Visual impairments can impact the ability to distinguish colors, detect or interpret small or intricate symbols, or even see the map at all. Color acuity and impairments which impact interpretation can be addressed through color choices and symbol design. The ColorBrewer tool has provided improved selection for color acuity and colorblind-safe palettes, which may differ from traditional colors used in certain disciplines (Harrower and Brewer, 2003). Blind or low vision readers may benefit from tactile maps which feature the inclusion of braille text and raised symbols, and map design may need to be simplified to adapt to this method. When considering a map for a web audience with visual impairment, the cartographer must also consider how to describe the map effectively for assistive technology tools.

4. Analysis of the Spatial Information

The critique phase is important to help the analyst avoid the pitfalls of assuming the map is objective and factual. A proper map analysis should not stop at critique, however, but move toward using the map beyond the basics of measuring and identifying features.

The inherent value of a map is its ability to communicate spatial relationships. Patterns and interactions that were not previously apparent may be revealed, and this alone is often sufficient for the purpose of analysis. Training and practice will improve the analyst's skill and produce more consistent results (Field, 2018; Tyner, 2015).

4.1 Qualitative description

The initial analysis of a map is quite often purely visual – the map analyst may describe an area's topography, or the general distribution of features. Visual inspection is much like critique in that it can be highly subjective – what looks sparsely distributed to one person may be determined by another to be frequent occurrence. Topographic map users are taught to recognize steep slopes and gently rolling plains, but at what point should it be described as a cliff face? Descriptions of closeness are hindered by a lack of standardization for "close", and visual analysis is subject to significant variations in conclusions (Kimerling et al., 2016).

Visual inspection is not wholly without value, however, as it can focus on the presence or absence of features, the arrangement within the geographic space, and relationship between elements. It is still possible to pull more information from the map than from simply looking at the underlying data tables, hence the utility of a map. Some questions the analyst can answer with visual descriptions include:

1. Is there a pattern, or is it random?
2. Does there appear to be a relationship between features?
3. Is there contextual information that shaped the results?
4. What can be inferred from the spatial information? (e.g. access to other features, limitations of the data)

The analyst might further describe things in terms of "nearness" or clustering, lines which lead to or from other features, or transitions (e.g., gradual or abrupt changes in density). Qualitative assessment may also include descriptions of the pattern or proximity using categorical or ordinal values, grouping similar descriptors in some fashion. Context may shape the interpretation, as noted in the section above, along with identification of any potential bias in the representation of features.

4.2 Quantitative description

To achieve more systematic and consistent analysis, some quantitative measures must be applied. Kimerling et al. (2016) include distance, direction, and position finding in these measures, but beyond the basic level of map reading. At the analysis level, these measures must include understanding of the inherent distortions of the map projection, calculation of error, and more sophisticated non-Euclidean measures, such as travel time or other functional distances. Wayfinding and position calculation are generally considered to be advanced map reading skills, but the analyst map use these tools to predict paths of travel, generate topographic profiles, or determine viewsheds.

Understanding the structure and function of the topography may come from visual analysis, but the quantitative measure can add valuable information. For example, a visual inspection of a river might provide information about whether it flows quickly through steep terrain, or meanders across a gentle valley. The quantitative counterpart might be calculation of the actual flow rate through a watershed based on the stream length, topography, and land cover. The questions in quantitative analysis may be similar to visual analyses, but with a measurable component:

1. What is the frequency of the feature within a constrained boundary (grid, hexbin, etc.)?

2. What is the slope of the terrain in this area?
3. What is the compactness or complexity of the object?
4. What areas are visible from a particular point?

Quantitative analysis allows for specific answers to questions such as these, but also for descriptive statistics related to the presence or absence of features. A simple quantitative analysis of proximity might involve the use of a distance measure from a given point, but a more in-depth analysis might include measures of slope, landcover, road networks, and other variables.

5. Conclusion

Map analysis is the process of looking beyond the basic map interface to describe the geographic relationships of the map. This description of the spatial messaging contained in the map must also contain some evaluation of the conditions that led to the map's creation. Understanding the context, purpose, and design choices of the map maker to at least a basic level will provide the analyst with a more robust understanding of the information expressed in the map. Without evaluation of the map metaphor, the analyst may be able to describe where, but not why or what. The analyst must understand how maps work (MacEachren, 2004) to understand how to put the map to work.

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