International Cartographic Association
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So who wins on this map? A user study on the persuasiveness of selected design solutions for presenting dominance on thematic maps

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Keywords: persuasive cartography, information distortion, thematic maps, user study

Abstract:

Cartographic design has an impact on the perception and interpretation of data on maps. Some map design solutions can even lead to information distortions, causing the representation to diverge from reality (Tyner, 1982). The choice of a specific cartographic solution can support the creation of persuasive maps that intentionally incorporate certain manipulations (Monmonier, 1991). By comparing the differences and similarities between persuasive maps and scientific geovisualizations, researchers can investigate how persuasive maps communicate information in contrast to scientific representations (Muehlenhaus, 2013). Multiple decisions of map makers can affect the resulting image that is perceived by a map user, among them are: selection of aggregation level for enumeration units (Kuby et al., 2013; Karsznia et al., 2021), map type selection (Monmonier, 1991; Słomska-Przech & Gołębiowska, 2021), as well as color scale choice (Brewer, 1996; Borkin et al., 2011).

Information distortion in the form of propaganda maps has received attention in cartography (Quam, 1943; Waktola, 2022). However, there were not many studies investigating the specific case of showing dominance of one category over the other and the effectiveness of design solutions of influencing this image on thematic maps. This issue commonly arises while presenting e.g. results of political elections. There are multiple ways to present such data, showing rich diversity of thematic mapping (Field, 2022). In this context, gerrymandering becomes relevant. This solution in enumeration units aggregation aims at distinguishing areas to strengthen the influence of one group at the expense of another, thereby affecting the interpretation of spatial data and its distribution (Wu et al., 2020).

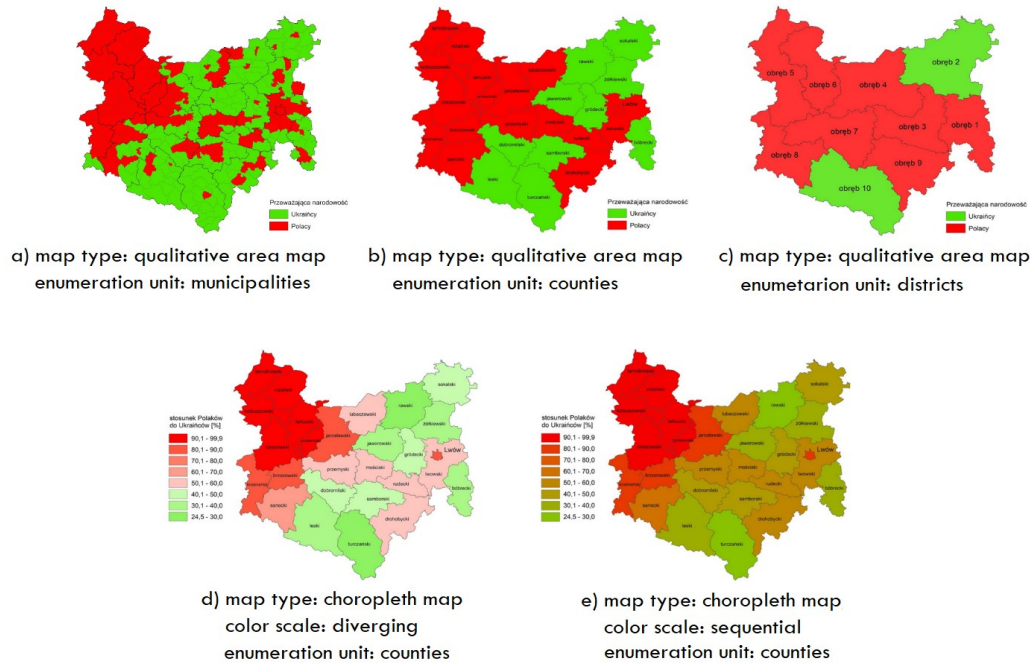

Figure 1. Tested maps presenting the same input data with different design solutions: aggregation levels of enumeration units (a, b, c) for qualitative area maps, and two color scales (d, e) for choropleth maps.

However, there are also other map design solutions that can be considered and empirically tested for their effectiveness. In the study reported here, the following solutions were selected for empirical evaluation: map type, aggregation level, and color scale. Both qualitative and quantitative map types showing data with two categories presented over a mapped

territory were tested. For qualitative area maps, the effects of different enumeration unit aggregation levels (municipality, county, district) were compared, whereas for quantitative maps: map types (qualitative area map, choropleth map), and color scales (sequential and diverging) for choropleth maps. Two social phenomena were presented on the tested maps: ethnic diversity (Fig. 1) and the results of the presidential elections. In all cases, only two categories were presented. The choice of data was based on the criterion of the size of the advantage between categories. For ethnic diversity maps, the dominance was significant (62.8% for one category versus 37.2% for the second category). In contrast, in the election data, the difference between categories was small (51.03% versus 48.97%). In total, 151 participants took part in the study. The participants solved map-based tasks. They were asked to assess which category (out of two) dominate in the presented area and estimate the size of the dominance. The accuracy of responses and the subjective rating of the difficulty of the question were measured.

The results showed statistically significant differences in responses between users employing the tested design solutions. The findings indicated that a phenomenon dominating in larger units with lower population density was more clearly perceived by participants when using qualitative area maps with the smallest spatial units—municipalities, i.e., low aggregation (Fig. 1a)—than when using maps with higher aggregation levels, such as counties and districts (Fig. 1b, 1c). Enlarging enumeration units "spreads" a phenomenon concentrated in a smaller area, thus enhancing its perceived dominance. The use of either a sequential or a diverging color scale did not affect the identification of the dominant phenomenon or the perceived difficulty of the task. However, the sequential color scale more effectively conveyed the magnitude of dominance than the diverging scale. In the task of estimating dominance across the entire mapped area, participants using quantitative map types were more effective than those using qualitative maps. Participants also strongly preferred quantitative maps over qualitative area maps. Among qualitative area maps, those with moderate spatial unit sizes (Fig. 1b) were preferred over maps with small or large spatial units (Fig. 1a and 1c, respectively).

Koch (2004) argues that a map is always an expression of the author's vision, and that the reader will never interpret it in exactly the same way. The tested design solutions significantly influenced the interpretation of a phenomenon's dominance—affecting the identification of the dominant category, the perceived magnitude of dominance, and participants' preferences for specific design choices. The selected method of visual presentation can substantially alter how the dominance of a phenomenon is perceived, demonstrating that map design may be subjectively manipulated to achieve desired outcomes—such as in political contexts—thereby turning maps into tools for shaping public opinion. However, the choice of an appropriate visualization method should be closely aligned with the map's intended purpose. It is essential to consider factors such as the complexity of the represented phenomena, the expectations of the target audience, and the interpretative context. These considerations support the optimization of the cartographic message and contribute to its effectiveness and credibility (Brewer, 2003). Carefully adjusting these elements improves the efficiency of spatial communication and reduces the risk of data misinterpretation, thereby enhancing the overall usefulness and reliability of the map.

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https://doi.org/10.5194/ica-abs-10-270-2025