International Cartographic Association
Association Cartographique Internationale

Cartographic generalization for multi-scale thematic maps

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Keywords: generalization, multi-scale maps, thematic maps

Abstract:

Nowadays thematic maps on the web portray data across a range of scales. Although, the successful design of multiscale web maps depends on the application of cartographic generalization, in most cases generalization is absent. Generalization includes basemap generalization (e.g. rivers, lakes) and thematic layers generalization (e.g. administrative units, number of classes in a choropleth map). Basemap generalization is akin to topographic map generalization and can be therefore handled efficiently. In contrast, thematic layers generalization requires the cartographer's attention as it is a neglected aspect (Raposo et al., 2020).

In a well-designed map, complexity should diminish as the scale decreases. Map complexity (MacEachern, 1982) is the degree to which the combination of map elements results in an intricate pattern. Usually, statistical offices visualize on thematic maps data that refer to administrative units. Administrative units follow a hierarchical schema e.g. NUTS for EU by Eurostat. Complexity measures, based on Muller's application of graph theory, take into account the faces (administrative units), the edges (boundaries), and the vertices (edges intersections). The hierarchical organization of administrative units in levels supports the use of an appropriate level for each map scale. Several statistical offices (Stolte et al., 2002) apply generalization in thematic maps, by adopting the change of the administrative units' level by map scale. Administrative units at a higher-level lead to lower map complexity since the number of faces decreases. In addition, the polygons of the administrative units should be generalized e.g. simplified considering map scale.

If one accepts the change in the level of administrative units as a generalization tool, the question arises as to the implementation of the chosen thematic symbolization method across scales. For example, should a choropleth map keep the same classification or apply a new one when administrative units and scales change? From another perspective, the complexity of a map is not only related to the nature of distribution mapped, but also to the symbolization method. According to MacEachern (1982), isopleth maps are visually less complex than choropleth maps. Therefore, an isopleth map can be used to represent a statistical index in a small-scale map when the administrative units are too small to be portrayed on a choropleth map. The symbolization method is thus also a tool for generalization.

In this context, a web application was created with thematic maps at multiple scales, using the following practices:

- The thematic data is presented at an appropriate level of administrative units in relation to scale, in combination with the generalization of the geometry of the polygons of the administrative units.
- Fixed Symbolization is applied in the same way at all scales.
- Adapted Symbolization changes with the scale, e.g. choropleth map: data classification, proportional symbols: the sizes and reference values of the smaller and larger point symbols, dot map: the size and reference value of the dot. At small scales, the symbolization method may also change, i.e. a choropleth map is replaced by an isopleth map.

In this app, the level of administrative units changes with the change of scale (Figure 1a, 1b). For each statistical index, e.g. population density, two multi-scale maps are displayed in two adjacent windows, which present both symbolization alternatives. Fixed symbolization (Figure 1a, 1b left) can help the user to study a phenomenon across different levels of administrative units / scales in a constant visualization framework and draw conclusions based on a comparison. Adapted symbolization (Figure 1a, 1b right) can show specific patterns that become apparent when the symbols are adapted to the analysis and the values of the individual administrative units or scales.

The user's adaptability and ability to obtain information from this web app is examined with specific questions about the data presented. It is estimated that multiscale thematic maps with variable enumeration units and synchronous side-by-side display with fixed and adapted symbolization can be used in the geoportals of statistical offices, in geovisualization and in explorative visualization for Big Data.

Abstracts of the International Cartographic Association, 7, 153, 2024.
European Cartographic Conference – EuroCarto 2024, 9–11 September 2024, TU Wien, Vienna, Austria.
https://doi.org/10.5194/ica-abs-7-153-2024

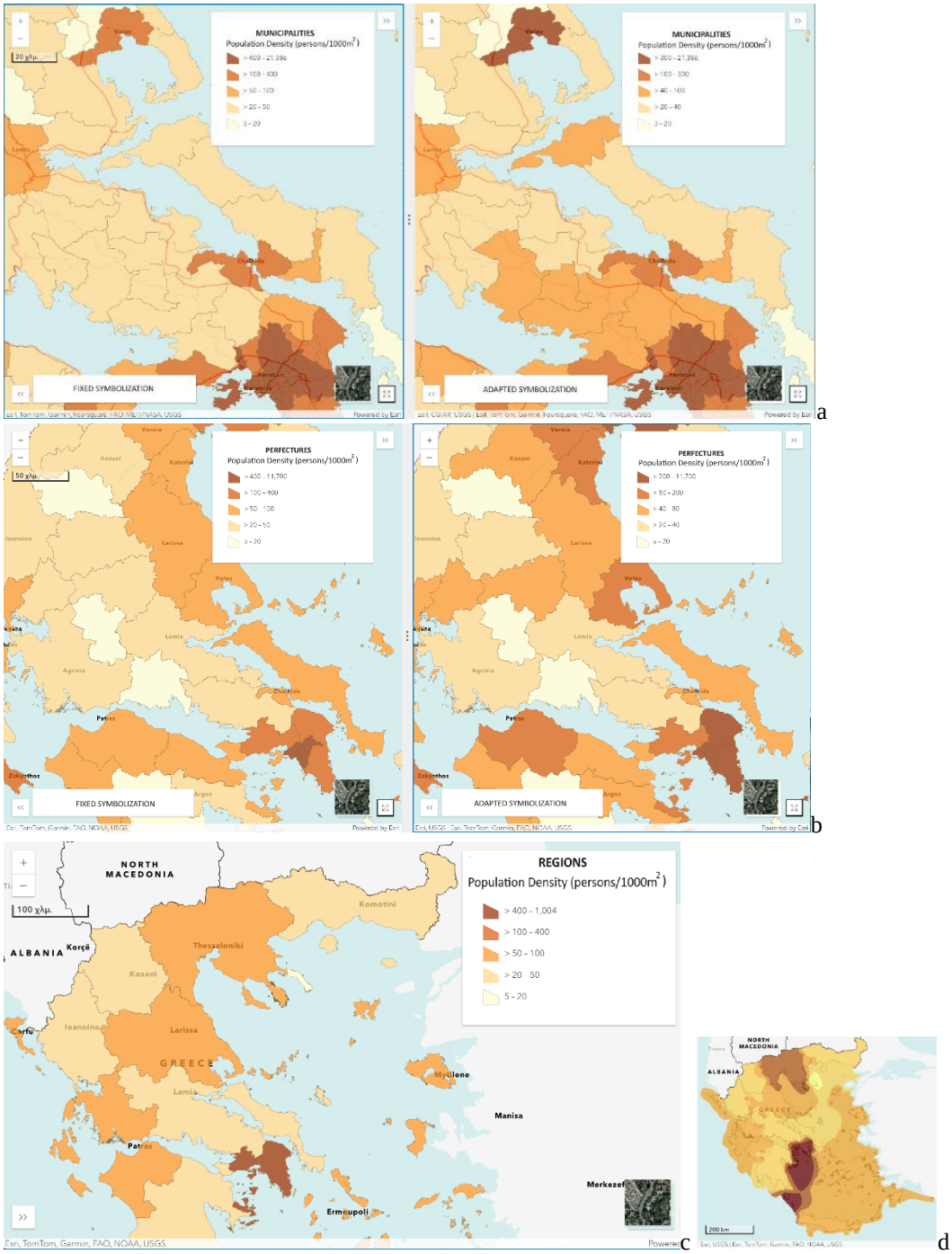

Figure 1. The level of administrative units changes with the scale, i.e. municipalities (1a), prefectures (1b) and regions (1c). Two multiscale maps are displayed side by side, with fixed (1a and 1b - left) and adapted symbolization (1a and 1b - right). An isopleth map can replace the choropleth map at a smaller scale (1d).

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