Space as a Metaphor – Design Guidelines and Evaluation of Map Imitation

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Abstract:

Map imitation is a type of data visualization in which individual data items are displayed on a visualization resembling a map. Although map imitations have been created since the 17th century, examples of complete map imitations are rare – the inspiration for this research is the atlas by Hermann and Leuthold, 2003. No complete map imitation has ever been tested in a user study, although there is research on individual layers of map imitations (Hogräfer et al., 2020). By complete, it means a visualization with multiple layers and visual elements of a conventional map. Therefore, this research contributes to the field by providing a comprehensive procedure for the production of a complete map imitation, as well as testing user perception and understanding.

Because of the lack of a common term, a new definition of map imitation is given. For this research, a map imitation is defined as a map-like visualization of non-geospatial data, or geospatial data, created by plotting individual data items onto non-geospatial coordinates, and designed to resemble a map using cartographic elements.

An example of map imitation is created (Figure 1) and a design procedure is presented. Three main steps are necessary. First, preliminary considerations must be taken, as this type of visualization is suitable for the simultaneous display of a large number of variables of certain types. Second, the selected data must be processed in order to create the main layers. In order to reduce potential confusion regarding the interpretation of the axes, it is decided to employ a different technique than spatialization for this research. Instead of using a spatialization technique, which is the foundation of this research, the position of the data items on the plane is directly determined by two variables, as proposed by Hogräfer et al. (2020). A weighted density surface is generated, that can be used as a Digital Elevation Model (DEM) in a GIS. Then, different steps must be performed in a GIS, such as the creation of the colored areas using Thiessen polygons and the creation of the shaded relief using the generated DEM. Third, important effort in graphic design aspects must be taken, in particular regarding label placement, shaded relief, color choices, symbol design, and all individual layers, as well as the overall visual hierarchy. Making the visualization resemble a map is a crucial aspect of map imitation.
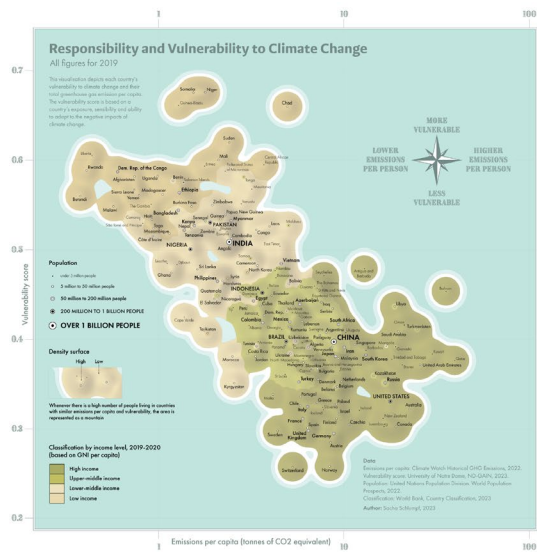
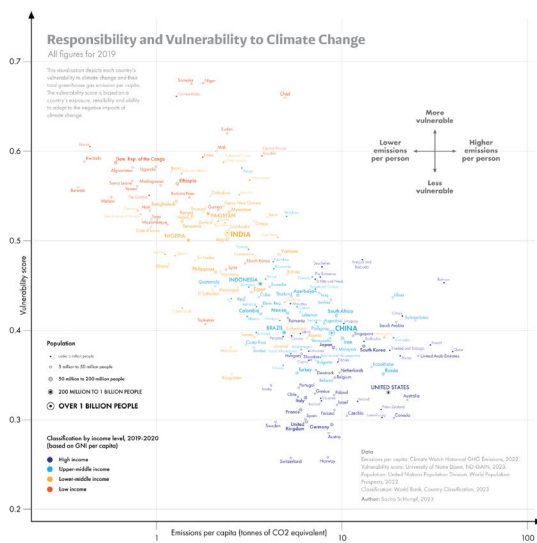Figure 1. Proposed map imitation

Figure 2. Scatter plot version

The map imitation is then tested. Two parallel surveys were conducted, one with the map imitation, and the other with a scatter plot showing the same information (Figure 2). Both surveys asked the same questions, and the participants were randomly assigned to one of the surveys, without being informed that two surveys co-existed. By comparing the results, it is possible to determine how the map-likeness of the visualization affects user performance.

Although the results were mostly similar for both visualizations, when there was a statistically significant difference, it was in favor of the graph (Figure 3). The map imitation was perceived as confusing by a significant number of participants, led to more errors of understanding than the graph, and caused some participants to forget one important variable when asked to summarize the main message of the visualization. The layer that caused the most problems was the relief, which unnecessarily increased the cognitive load of the map imitation and probably contributed to making the visualization confusing and difficult to understand.
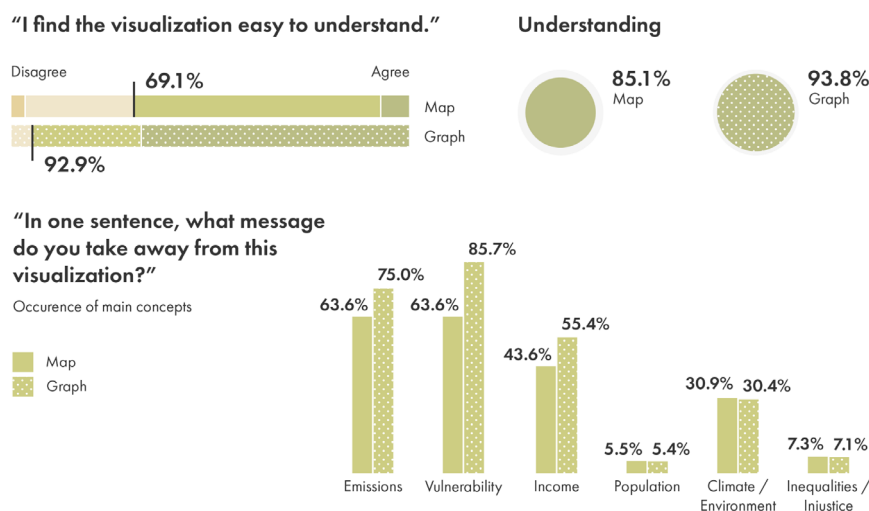

Figure 3. Selected results of the surveys

The research had limitations. The participants in the surveys were mostly young and educated in fields related to this study, which may have influenced the results. The visualization tested is a single map imitation, and other map imitation designs could lead to different results. Moreover, different user study methods may lead to different results and findings. In this regard, future research is encouraged. Different map imitations could be created using different techniques, especially for positioning the points in the plane and generating the relief, which are two steps for which various techniques exist. Additionally, different user studies could be conducted, in particular using eye tracking to test whether map imitations increase curiosity to explore. There is still much to be discovered in the field of map imitation, and researchers are invited to join this exploration and contribute to its growth.

References

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