International Cartographic Association
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# Large-Scale Phenomena and Small-Scale Heterogeneous Data: Cartographic Challenges in a Cross-Border Comparison of Healthcare Systems

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**Keywords:** health cartography, cross border, accessibility analysis, data normalisation, visual analytics

**Abstract:**

European policies allow citizens to access healthcare across borders. Although subject to limitations and barriers, this possibility holds potential for people living in border regions. According to Schwettmann et al. (2023), such barriers manifest themselves in differences regarding the organisation of health care at the system level (macro level), at the level of organisations (meso level) and at the level of individuals and providers (micro level). These structural levels correspond to different spatial scales that cartographic approaches to comparative health systems research need to anticipate. The limited data available at the meso and micro levels is a major challenge for health researchers.

This work reflects insights into such a multidisciplinary research endeavour in the northern Dutch-German border region from a cartographic perspective. These insights result from qualitative interviews with researchers, a cartographic and data science-based design process for prototypes embedded in cross-border research (Hall et al., 2020), and a data-based study of the cross-border potential for general inpatient care using methods from the Floating Catchment Areas (FCA) family. The identified cartographic challenges fall into four groups: geometry, algorithms, data operationalisation and data classification.

Most public health data are only available for administrative areas, and both health services researchers and epidemiologists tend to work on relatively large administrative areas. Data are generally available from national sources and are only provided for national regions only, and there are few sources of harmonised cross-border data. However, local or regional models of accessibility require a more detailed distribution of the population than administrative regions. Cartographic grids of population have been used to alleviate some of these problems (Specht et al., 2022). Due to their regular geometric representation and their temporal stability, they played an important role in the project. Both aggregation and disaggregation methods could be successfully applied to bridge the polygon-raster transitions for different national administrative structures.

The objective of a cross-border comparison not only influences the cartographic presentation of the data, but is also present in the early stages of data collection, data generation and data analysis. The prototyping process involved the challenge of collecting comparable data on both sides of the border. In addition, the FCA algorithm had to be modified to make it suitable for cross-border comparison. The algorithms had to be adapted at the level of both spatial data (cartographic grids) and statistical data (normalisation to national means / medians).

The last two cartographic challenges of a cross-border cartography of health system mapping are related to the treatment of statistical data within maps. Cross-border comparison of health system outcomes, for example in conjunction with socio-economic data, requires indicators with the same or at least similar operationalisation. Very little harmonised data exists, and when it does, it is only available at higher levels of administrative region, which is not appropriate for studying the micro-level of health systems. To produce large-scale maps of a border region with such heterogeneous data, statistical standardisation and normalisation techniques were used in conjunction with distribution-based map classification (quantiles / percentiles, standard deviation-based classification). This choice had implications for the interface design of the prototypes, the choice of map symbolisation and colours, and especially the design and typography of the legends.

For the last two aspects, data operationalisation and data classification, a curation process for each indicator pair (one indicator source for Germany and the Netherlands) was identified as unavoidable. The role of the curator is to examine the operationalisation of each national indicator and decide on the possible degree of comparison (e.g. identical


https://doi.org/10.5194/ica-abs-7-162-2024 

operationalisation, similar operationalisation, loosely related operationalisation), the statistical transformation and the appropriate map classification (method and number of classes). Once again, the cartographic communication of these additional editorial processes had implications for the interface design of the legend and the display of data source metadata. For example, the map legend adapts its layout and colour scale according to the level of operationalisation.

The cartographic support of research processes in the context of cross-border health research aimed to provide researchers with the necessary tools for spatial hypothesis generation, despite the numerous data-related challenges that were encountered. The results demonstrate the potential of cartographic methods to enable the visualisation of heterogeneous data and to provide visualisation tools that promote scientific transparency and honesty.

**Acknowledgements**

This study was conducted in partnership with the Cross Border Institute of Healthcare Systems and Prevention (CBI), Groningen/Oldenburg and was funded by the Ministry of Science and Culture of Lower Saxony (MWK) as part of the 'Niedersächsisches Vorab' Program (Grant Agreement No. ZN3730).

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