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Visualizing map intuitiveness to support map design

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Abstract:

Producing geoscience maps for non-experts can be challenging because the maps are based upon information that is usually not straightforward. These maps are often produced for a specific purpose and comply with various standards, methods, scales and degrees of uncertainty across time and space. The difficulty for the reader to follow expert interpretations of non-tangible geology, should not be underestimated. The risk of misinterpretation and poor decision-making among map users can be decreased if care is taken during the simplification and production of 'easy-to-use' maps. For the map development team, much effort is used to simplify complex data without excluding important information. Map design is an area where most project team members, sometimes also stake-holders, engage with personal preferences and expert opinions. Empirical evidence on what works and not to ensure the maps are perceived the intended way are missing.

This study describes the experience gained from graphical data processing of test results from a map experiment. The aim was to find methods to explore and present map intuitiveness visually, e.g., find the better map alternatives. Firstly, there was an exploratory phase to find the nature of the statistical differences to find possible explanations of these. Secondly came the process of selecting graphs that most effectively communicate map intuitiveness. The map experiment aimed to test the intuitiveness of three geoscience thematic maps: Possibility of clay and marine limit, Radon and InSAR measurements. Multiple map alternatives were made to analyse the effect that different designs had on correct answers, confidence, and uncertainty. Of these four map types, 5-8 design alternatives were tested. 450 participants were given the task of matching sample areas in a map with thematic categories without a legend present. They were also asked about their confidence and uncertainty as well as personal information. The map experiment returned a significant amount of data with ample opportunities for data analyses.

ANOVA analyses and T-tests were performed to detect statistical significance, and only the significant differences were pursued for discussion and used in the conclusions. The statistical results were complemented with visualizations to reveal the nature of and explanations for the statistical differences. Both SPSS and R were used in statistical analysis, data processing and to produce graphs. The large number of maps required automation with scripts to make it easier to produce and reproduce graphs.

The distribution of answers for a single variable were compared between each map alternatives. However, this did not give any information about the combination of answers, for example, was the darker colour perceived as higher risk than the lighter colour? In addition, it was relevant to compare the categorization task answers with confidence and uncertainty.

Data were processed to analyse the combination of answers and to simplify data. For example, participants with the same set of answers on the categorization task were grouped (width of paths in Figure 1) for further analyses and visualization.

After graphical processing had revealed pros and cons of each map alternative, graphs were selected to communicate and discuss the results in team meetings and map design discussions. The line graphs in Figure 1 communicate on three levels. Firstly, the overall image: A graph with a thick green line, fewer alternative paths and fewer outliers be argued to be more intuitive. On the intermediate level it is possible to read where categorization task was difficult and to study the pronounced alternative paths. Lastly, details can be extracted and analysed, for example what the participants answered when they were wrong. Combined with graphs for frequencies of answers, uncertainty and confidence, these gave a complete image of map intuitiveness. For example, paths combined with participant uncertainty, revealed whether errors were made with high or low confidence.

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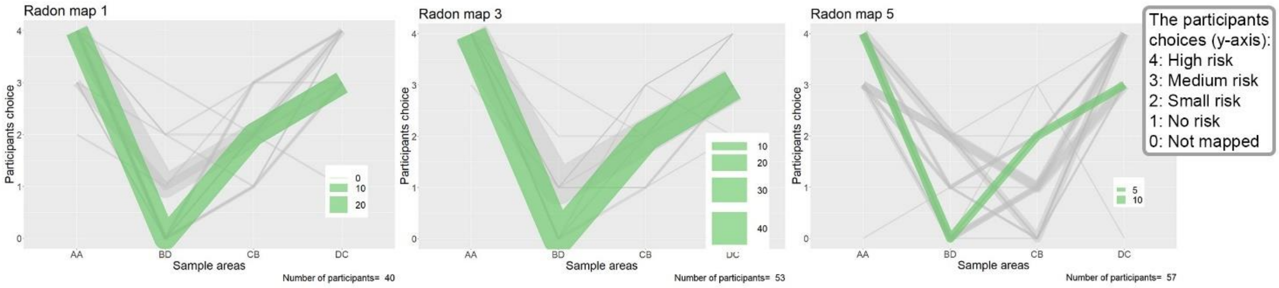

Figure 1. Line graphs showing the percentage of participants understanding alternative Radon maps the same way. The green line represents the group that had all the categories correct. The middle map represents higher map intuitiveness.

In conclusion, graphical data processing of the map experiment results was crucial for extracting knowledge, but also for communicating the intuitiveness of different map design choices. Furthermore, visuals like the line graphs in figure 1 made the experiment results more available for analyses and discussion in plenum. Experimenting with data processing and visualizations lead to new knowledge that easily could be missed if only analysing independent variables.

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