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User Experience with Geodashboards Visualizing Preparedness and Response to Natural Hazards

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Abstract:

Management of natural hazards and associated risks requires access to multivariate information. Access to rich spatiotemporal data that contains information on all aspects of the hazardous event— e.g., factors that led to the event, what was affected by the event, impact of any previous (or planned) interventions—should support proper understanding as well as informed decision making for current and future actions (Gołębiowska et al., 2023). However, studying multiple variables and the interactions between them is cognitively demanding, and when it is not done right, it can impair human comprehension and decision making rather than improving it (Keskin et al., 2023; Cheng et al., 2024). In this context, we examine geodashboards that contain multiple linked visualizations (Figure 1), which offer opportunities for exploration and communication of spatiotemporal data from many perspectives through, e.g. maps, plots, graphs, spreadsheets, networks etc. (Golebiowska et al., 2017, 2020), though their complexity could lead to high levels of cognitive load (Nadj et al., 2020).

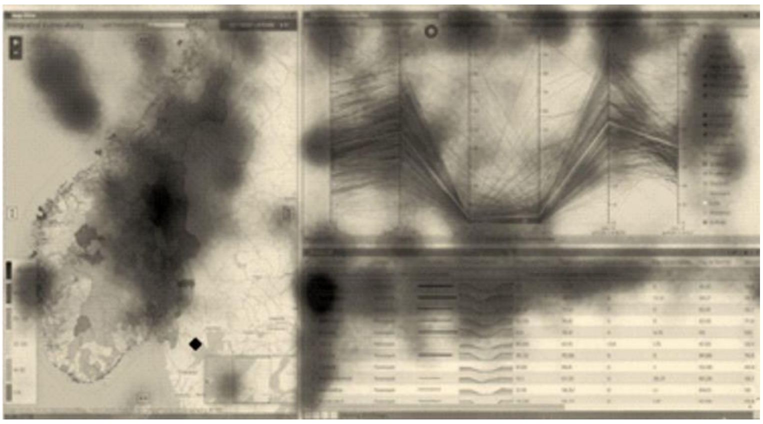

Fig. 1. Tested geodashboard with an overlaid heatmap showing average fixation times of study participants while learning the tool

We conducted several user experiments where participants are given natural hazard related sense making and decision making tasks with such complex dashboards as described above, and measure their performance as well as eye movements, from which we can surmise their cognitive load to some degree (Ke et al., 2023). Specifically, we investigated user experience and layout design related challenges; *i.e.*, inexperienced participants' process while learning the complex interface, their process of information retrieval from multiple-view tools, and the effect of different layouts of geodashboards (Figure 2). We asked participants a set of questions referring to different task types, e.g. reading value, localization, comparing, and detecting anomalies.

Fig. 2. Two layouts tested with users with different designs of explanatory elements

Combining usability performance metrics (efficiency, effectiveness and satisfaction), and eye tracking data (Çöltekin et al., 2009), we get insights into the users' reasoning and cognitive processes. The tested geovisualizations present data on preparedness, *i.e.*, vulnerability and exposure to natural hazards (floods, landslides, storms), as well as consequences of natural hazards in a form of insurance compensations due to natural hazards (storms, floods, landslides, storm surge, water intrusion). Participants were asked to carry out various task types using the presented geovisualization tools. Our results broadly suggest that despite the visual complexity of the tools, even the inexperienced participants find them convenient and helpful in exploring large sets of spatio-temporal data. We thus posit that properly designed geodashboards can be effective tools supporting users, enabling them access to complex data.

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