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Towards cartographic xR representation – case topobathymetric hypsometric colouring

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Abstract:

Virtual, extended and mixed reality (VR/XR/MR = xR) technologies coupled with tangible user interfaces are proceeding edges of development for the cartographic and geovisual communication (e.g., see Çöltekin et al. 2020). They have all potential to provide natural and immersive user experiences for exploring and understanding geospatial data for location-born insights like never before. However, geospatial utilisation of these environments has widely concentrated on photorealistic digital replicas of the world as well as on graphically polished immersion in fictional environments, such as video games. These applications often provide local navigable first-person views rather than spatial insights over geographically interesting scales.

Development of abstracted, generalised and symbolised cartographical xR displays for real-world data and tasks has remained as an emerging area of application. Barriers have not been in the technological capacity of the physical devices nor in the willingness to put efforts in technical software development but rather in finding the methods of visualisation, animation and interaction that would optimally support humans to conceive the represented abstract geospatial information meaningfully. For example, abstracted 2D projections of reality, that is, cartographic 2D maps, are still often the most efficient means for conveying many spatial terrain and environmental information for practical use due to the ease of their reading for many users, for instance, while mobile with smart phones (e.g., see Oulasvirta et al. 2009).

An example of a cartographic visualisation paradigm to be transferred to the xR views is hypsometric colouring. Hypsometric colouring depicts elevation levels with dedicated colours and is generally considered to allow for facilitated interpretation of elevations locally and also over wider spans on maps (e.g., see Patterson and Jenny, 2014).

In order to understand reading efficiency of hypsometric colouring embedded in three-dimensional map views, we conducted a static table-top and screen-based eye-tracking experiment on hypsometrically geovisualised topobathymetric maps that depict both elevations on land and depths in water (Figure 1). A within-subject experimental design among four map types was used, testing usage effects of both 2D versus 3D and hypsometrically coloured versus contour-only maps. Two tasks assignments were given: A) “Select the point pair (A, B, C) with the greatest elevation difference.” and B) “Select the bridge (A, B, or C) that is highest above the ground or the bottom of the water it crosses over, considering the lowest point beneath it.” Utilised behavioural measures were correctness of answers, response time as well as eye fixation count and duration. 37 participants with academic geoinformatics background took part in a half-an-hour session each. The results reveal less measured differences between the map types than expected by their differences in visual appeal. They will be presented in the conference for providing insights on how this classical cartographic method can function in three-dimensional displays and what it means for xR use.

xR will also provide a novel platform for dynamic geovisualisations, such as view-adaptive hypsometric colouring that keeps the colour scale constant over the terrain being displayed each moment (Kettunen et al. 2025). We are studying usability of such solutions and considering how eye-trackers of xR glasses can support comfort of use as well as measurement of performance with these kinds of quite complicated abstract cartographic geovisualisations. Preliminary results from a trial case with xR eye-tracking will be presented in the conference.

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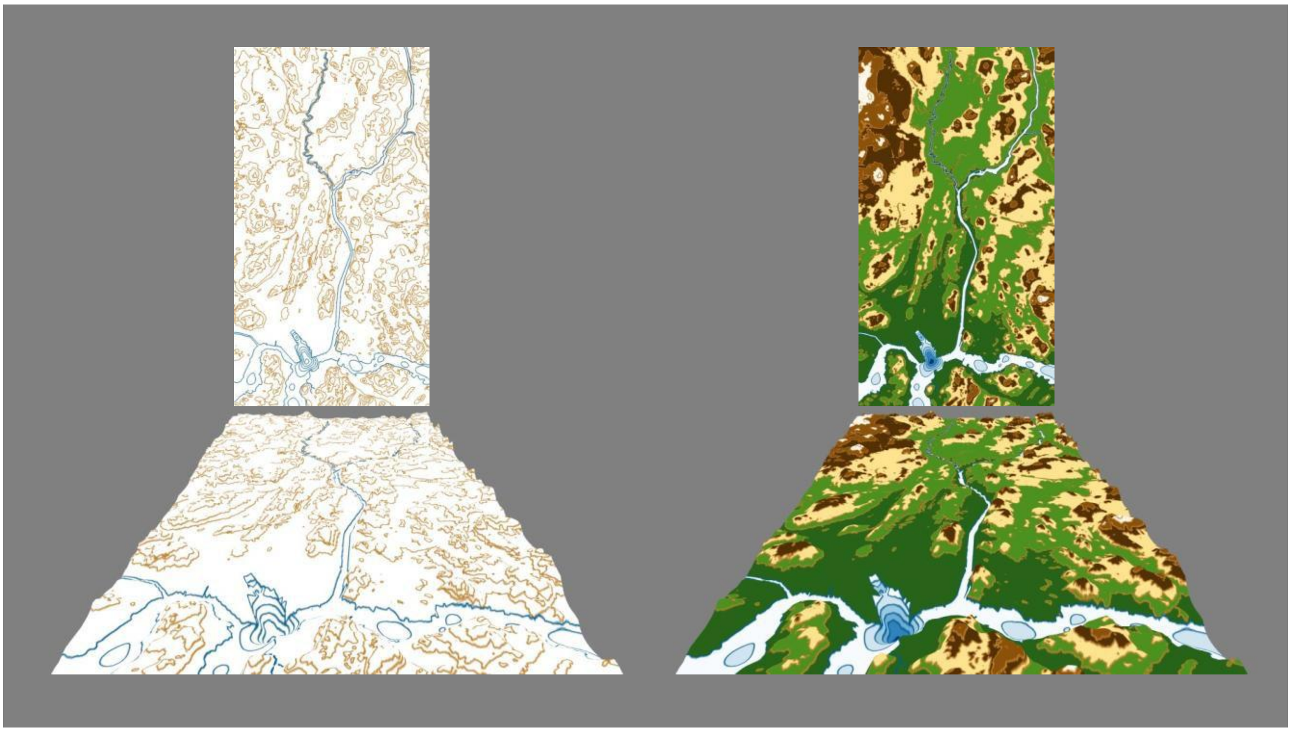

Figure 1. The four map types tested in the eye-tracking experiment.

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