

# Integrated Cartographic Visualization Method for Analyzing the River Valleys in Mountain Topography – an Application for the Dunajec Gorge

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## Abstract:

We would like to address a problem related to mountain cartography, namely proposing a dynamic way of visualizing a river valley. Herein, the innovative component is the dynamic synopsis of partly unconventional visualisation techniques. From such combinations using multiperspective visualization (Medyńska-Gulij et al., 2015), we expect a more comprehensive understanding of the landscape in focus. The expected positive effect can be attributed to complementary and partly more specific and explicit presentation of geo-content. They can reveal regular dependencies between geo-components (in particular soil, hydrology, land use) and relief properties. This old geographic principle has been treated extensively in literature under the term ‘Catena’ or Catena principle (summarized e.g. by Opp, 1983).

The goal of our case study is to develop such an advanced cartographic visualization combining 2D maps, 2.5D visualizations, and thematic cross-sections. We illustrate the spectacular and diverse topography of the Dunajec River Gorge, located on the Polish-Slovak border. The study area is distinguished by its exceptional landscape value and high tourist appeal, further emphasizing the importance of the visualizations being developed. They all share a common dynamic spatial centre, which can be located at any point along the river channel (e.g. at a position indicated by the user). The approach enables comparisons of different visualization forms, can transport more detail, and assist analysis of terrain features.

The project utilizes, among others, advanced tools and powerful plugins available in the QGIS application (e.g. various geoprocessing tools). Additionally, Python programming capabilities are employed to automate certain analytical and visualization processes. The usefulness and potential of free software and open data in creating high-quality maps of mountain areas have been demonstrated in the studies by Gröbe et al. (2022). Well accessible data, such as digital elevation models (DEMs with 1-meter resolution), orthophotos, OpenStreetMap data, topographic databases (BDOT10k), and the National Register of Geographic Names, form the data base. An extension to geo-referenced objects of particular relevance to the portrayed area, is of course possible.

The limitations stem from the level of detail and the volume of data that can be efficiently rendered in a web browser. This necessitates the use of appropriate solutions—for instance, in the case of terrain profiles, a choice must be made between dynamically loading data from a file or script (e.g., using Plotly.js), and displaying a pre-generated SVG graphic created through automated processing (e.g., using Python). It may also be necessary to divide the river into sections.

The resulting visualization could be delivered to users such as researchers, tourists, or spatial planners as a tool for gaining deeper insights into the Dunajec Gorge's unique terrain (Figure 1). Apart from the educative potential of integrated visualization techniques and themes, our approach may as well direct a tourist's attention to the beauty and individuality, and to the particular highlights one can encounter on a way through the valley. By employing a multilayered approach, the study allows for a more comprehensive understanding of landscape properties, genetics and their impact on the actual state. The final product may be useful for both research and promotional purposes, contributing to the region's tourism development.

Once the application reaches full functionality, an evaluation involving end users is planned — for example, through surveys (cf. Halik and Wielebski, 2023). This will allow for a realistic assessment of the usefulness of the proposed solutions.

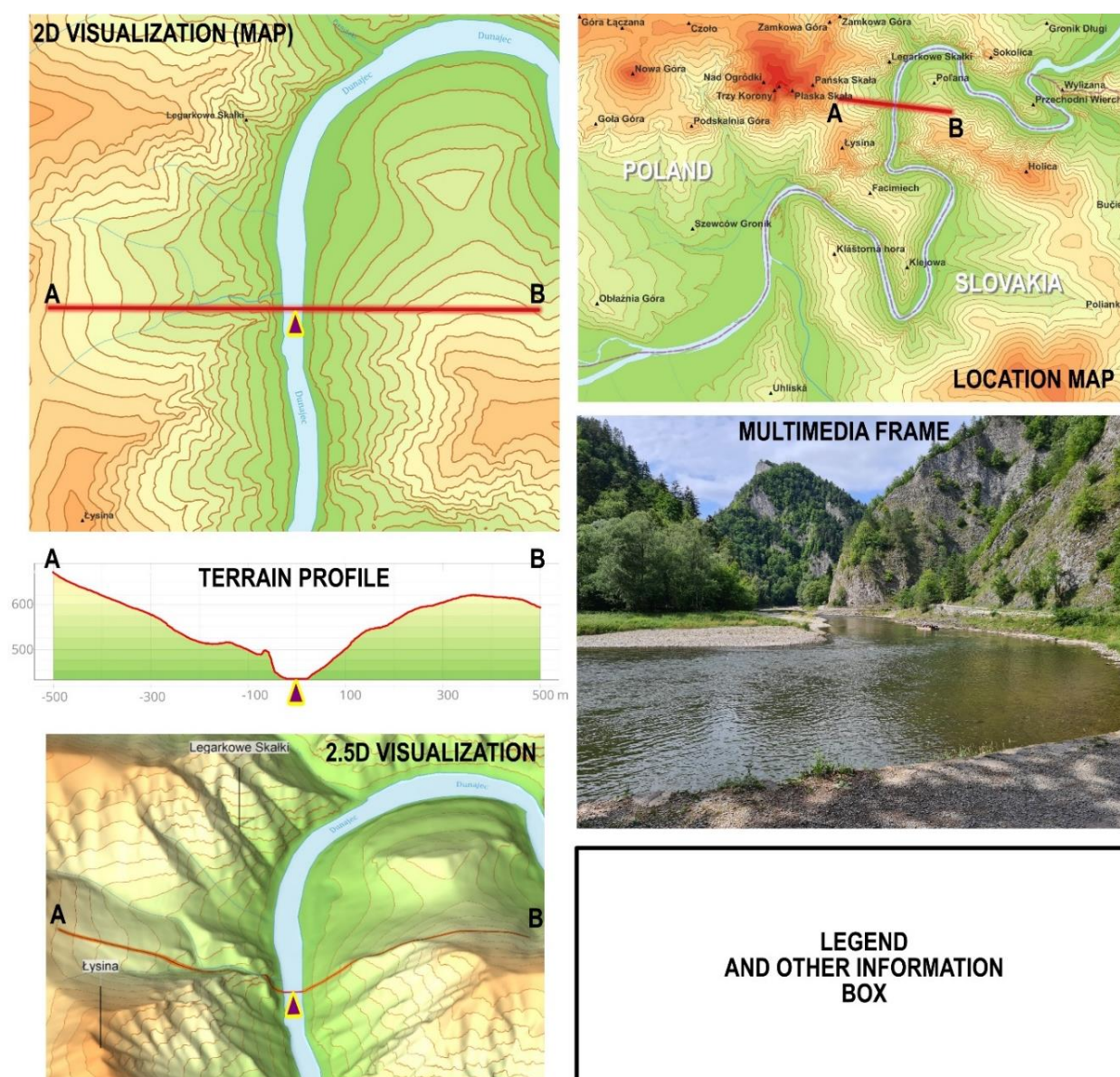


Figure 1. Frames in the Application of Integrated Cartographic Visualization Methods for Analyzing the Topography of the Dunajec Gorge on the Polish-Slovak Border.

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