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From Works of the Cartographic Heritage to the Digital 3D Model and Presentation of the Riverine Landscape

Tomáš Janata [a,*], Vojtěch Cehák [a], Jiří Cajthaml [a], Jiří Krejčí [a]

[a] *Czech Technical University in Prague, FCE, Tomáš Janata – tomas.janata@fsv.cvut.cz; Vojtěch Cehák – vojtech.cehak@fsv.cvut.cz; Jiří Cajthaml – jiri.cajthaml@fsv.cvut.cz, Jiří Krejčí – jirikrejci@fsv.cvut.cz*

* Corresponding author

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Abstract:

Archival sources of spatial data (maps, aerial photographs) allow performing reconstructions and 3D visualisations of the extinct landscape. This contribution deals with the reconstruction of a 300-km-long "pre-dam" valley of the Vltava river in Central and Southern Bohemia flooded by a system of water reservoirs in the total extent from the Vltava spring in the Bohemian Forest to the confluence with the Berounka, which takes place within the project solved at CTU in Prague by the Department of Geomatics.

For the purpose of reconstruction of the extinct georelief, methods based on archival aerial photographs and old maps were tested in detail. The reconstruction of such a large area is relatively exceptional, as the total area that is the subject of the reconstruction is 1670 sq. km. Based on trial processing of various types of archival data, from which it is possible to derive elevation, maps of the first edition of the so-called State Map Derived 1 : 5,000 (SMD-5) were chosen to reconstruct the original river valley. This is the oldest map set, which completely covers the entire Czech Republic and contains elevation information in the form of contours and elevation dimensions (with a contour interval of less than 50 m). The first edition of these maps includes papers published between 1950 and 1959.

Great emphasis was placed on accurate contour digitisation. The total length of the digitised contours exceeds 25,000 km – therefore, the method of semi-automatic vectorisation was chosen. The digitised contour lines come from the oldest comprehensive map series, which covers the entire area of interest. Although the individual map sheets come from one map series, they contain contour lines with different intervals, which is due to the state of elevation data in the then post-war Czechoslovakia – the altimetry was derived from various elevation maps and other data sources. With this in mind, the whole area is not covered by contour lines with a homogeneous interval, but the contour interval varies from 1 m (the most detailed) to 20 m in the least accurate areas, for which no better and more precise elevation was available than the maps of the last edition of the so-called Third Military Survey, which contained contour lines of a low accuracy only as a supplement to the hatching.

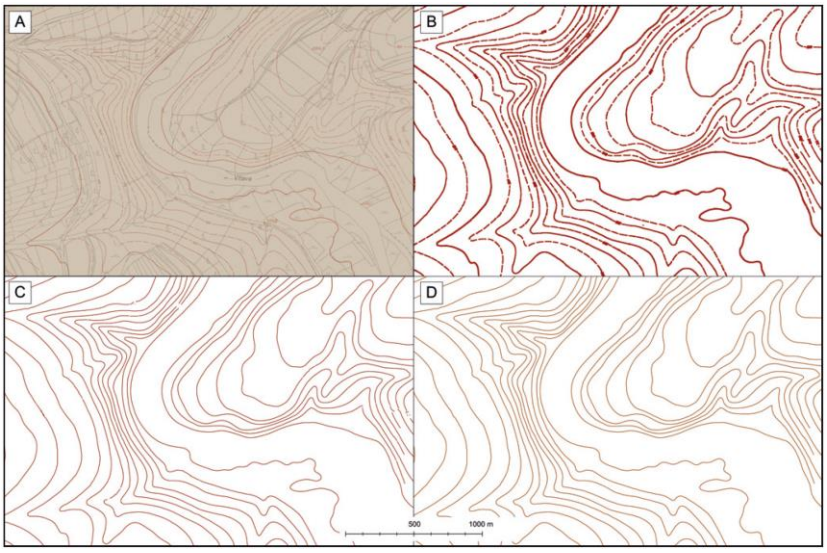

Figure 1. Semi-automatic vectorization of contour lines. A – input map. B – conversion to bi-colour and modified in ArcScan. C – raw vector data. D – manually cleaned vector data.

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The resulting DTM primarily serves as a basis for 3D printing in the project, but was also used as a basic elevation data layer for procedural modelling of scenes depicting large sections of terrain and also as a basis for creating sub-areas presented by virtual reality. The essential requirement was that the water level of the Vltava River was flat, with a slope corresponding to the surrounding terrain. This requirement is not feasible only with the use of vectorised contour lines; thus another data set was included in the creation of the DTM data set – elevation points of the longitudinal profile of the Vltava, derived from an accurate measurement performed in 1940 and rendered as a strip map. The DTM formation was split into two steps – the watercourse and its surroundings were created as a triangulated network (so-called TIN), which maintains a flat river level, and the rest of the area, which was derived by raster interpolation. The DTM is then formed by combining these two approaches.

The resulting DTM was used as a layer representing the original shape of the landscape in the environment of the map application, for the visualisation of the historical area in the form of virtual models – where equipped with textures, it formed the basis of the entire 3D scene –, and as a basis for creating physical 3D models. One of the other uses of the terrain data was also to create a realistic 3D scene presented in virtual reality. This technology allows the user to explore a vanished landscape and view the scene in an immersive, life-size way. The content created in Unreal Engine includes ground materials, vegetation, buildings, or water level in a very high level of detail. Also, some interactive elements (for the use of controller buttons), such as basic motion controls, a map with the current location, or the ability to toggle the current water level visibility (in flooded areas) were implemented. The disadvantage of such technology can be high hardware requirements (for a project of this scale). The resulting application is available for the Oculus Rift S VR headset and shows a fly-through above a vanished landscape in the areas of selected water reservoirs on the Vltava river.

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