Stanislava Bönde Gogová* orcid.org/0000-0001-9703-5514
Peter Chrastina** orcid.org/0000-0001-7051-438X
Daniel Bešina*** orcid.org/0000-0002-6068-9159

3D Visualisation of a Section of the Imperial-Royal Postal Road in the Landscape of the Dudváh Wetland in Western Slovakia

Wizualizacja 3D odcinka cesarsko-królewskiej drogi pocztowej w krajobrazie mokradeł rzeki Dudváh na Słowacji Zachodniej

Keywords: imperial-royal road, late Middle Ages, S. Mikovíni, reconstruction, 3D visualization, virtual reality

Słowa kluczowe: cesarsko-królewska droga, późne średniowiecze, S. Mikovíni, rekonstrukcja, wizualizacja 3D, wirtualna rzeczywistość

Introduction

Humans have always been connected to nature, they are part of it. They have been reshaping and adapting their living space since time immemorial, and individual changes in the landscape are influenced by their civilizational progress. It is through this intervention that cultural landscapes change and emerge, reflecting man's purposeful impact on nature in a particular area. The end of the last century saw the emergence of the so-called Anthropocene concept, which was based on the extent and impact of humans/humanity on the environment and the formation of the global ecosystem [Pokorný and Stoch 2020]. This is a direction that is graspable not only in the natural sciences, but also in the humanities and philosophical studies. Gradually, the existing cultural landscape, which was created by the long-term symbiosis of nature and civilization, is being reborn to the development of intensively used areas (industrial parks, housing areas, transport infrastructure, etc.). Recent changes in the landscape are often rapid and destructive, hence the growing importance of relics of historic landscapes, which allow us to better understand the significance of transformative processes and environmental changes in the natural environment at a local or regional level.

The aim of the study is to characterize and visually interpret the historical-geographical aspects of the no-longer-existing imperial-royal postal road between Trakovice and Leopoldov (Leopoldov toll) in the district of Hlohovec (Trnava region, Western Slovakia) (Fig. 1). The reconstruction and modernization of the local castle was based on a design by Samuel Mikovíni (1686/1698?–1750), an associate of Matthias Bel. It is no coincidence that the road was situated in an ancient region with numerous archaeological sites and a long

* *D.Sc. Ph.D., PhDr., Faculty of Arts, University of Constantine the Philosopher in Nitra*
** *Prof. Ph.D. RNDr. Peter Chrastina, Faculty of Arts, University of St. Cyril and Methodius in Trnava*
*** *Ph.D. PhDr. Daniel Bešina, Faculty of Arts, University of Constantine the Philosopher in Nitra*

* doc. dr, Wydział Sztuk Pięknych, Uniwersytet Konstantyna Filozofa w Nitrze
** prof. dr hab., Wydział Sztuk Pięknych, Uniwersytet Świętych Cyryla i Metodego w Trnawie
*** dr, Wydział Sztuk Pięknych, Uniwersytet Konstantyna Filozofa w Nitrze

Cytowanie / Citation: Bönde Gogová S. Chrastina P. Bešina D. 3D Visualisation of a Section of the Imperial-Royal Postal Road in the Landscape of the Dudváh Wetland in Western Slovakia. Wiadomości Konserwatorskie – Journal of Heritage Conservation 2022, 72:80–88

Otrzymano / Received: 6.07.2022 • Zaakceptowano / Accepted: 28.08.2022 **doi: 10.48234/WK723D**

Praca dopuszczona do druku po recenzjach *Article accepted for publishing after reviews*

settlement tradition, in an area significance in terms of transport and that captures to a significant extent civilizational movements from different directions. In addition to the European significant Palaeolithic findings, the exposure of this area is also evidenced by intensive settlement from the Early and Late Stone Age (several settlements) and numerous medieval finds [Hladký and Vondrovský 2009; Kuzma and Bartík 2011; Urminský 2013; Gálik 2013]. The dominant feature of the region in the Middle Ages was Hlohovec castle, which was built on the old trade route along the Váh River and was an important fortress of mountain-wide importance [Gálik 2013, p. 355]. The intensity of medieval trade and the building of roads supported a specific organization of the transport infrastructure [Daňová and Daňová 2019, p. 142]. During the Middle Ages, the Považská road played an important communication role in western and north-western Slovakia; it led from Komárno along the Váh River via Šintava, Hlohovec, Trenčín to Žilina and from there on to Poland and Spiš [Fridrichová 2017, 70-76; Ivanič and Husár 2019, 1030]. In addition to archaeological sources, written, pictorial (vedutas, panoramas of towns) and cartographic sources (especially maps from the period of the First Military Survey, 1782–1785) form an important category in the territory under study; [Ivanič and Husár 2019, p. 1030].

In terms of information database and research methodology, written sources, old maps, and the literature were used in combination with field research procedures (m. observation) and computer processing of documents in GIS (including 3D visualization of the castle and selected watercourse bridges).

Personality and work of Samuel Mikovíni in the context of the problem

The life and work of S. Mikovíni continues to inspire researchers in the field of cartography and mapmaking [Hirčák 2016, p. 93–94], geodesy, architecture, civil engineering or engineering education [Purgina 1958, Bendefy 1976, Deák 1995, Dobos 2000, Forgách 2003, Hájek and Melicher and Bartaloš 2005, Hirčák 2016, Kamenický 2002, Sokáčová 2005, Török 2011]. He was an associate of M. Bell, a Hungarian (in the broader sense of the word Slovak) polymath in the Baroque period. Mikovíni created maps of the Turčianska (1736), Zvolen (1736) and Novohrad (1742) counties for the needs of Bela's homeland studies *Notitia Hungariae novae historico-geographica* (1735–1742). The quality and technical maturity of Mikovíni's cartographic work and his achievements in the pedagogical field were reflected by his position as imperial-royal engineer of mining towns. In 1735, Charles VI entrusted him with the establishment and management of the Mining Academy in Banská Štiavnica, which is considered to be the first higher technical school in Europe [Čižmár 2013, p. 9].

S. Mikovíni also engaged in road design and watercourse modifications. Based on the study of floods and their causes, he also proposed sustainable ways of routing and building roads in river landscapes [Pišút et al. 2016; Pišút 2019, p. 64–67]. An example is the reconstruction of the castle between Trakovice and Leopoldov toll, which is approached from the point of view of historical geography in the manuscript of P. Chrastina [2021].

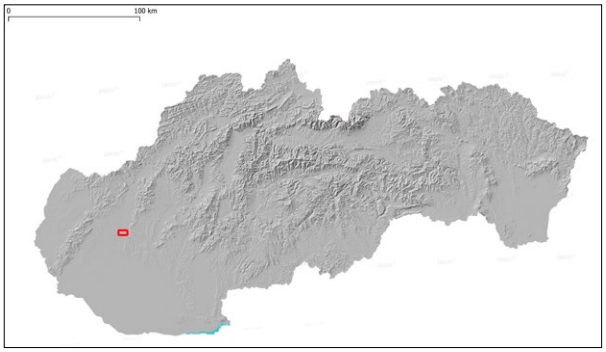


Fig. 1. Location of the road section on the map of Slovakia; by D. Bešina.
Ryc. 1. Położenie odcinka drogi na mapie Słowacji; oprac. D. Bešina.

Brief characteristics of the study area and historical context of the issue

The investigated section of the extinct imperial-royal postal road is located between the villages of Trakovice and Leopoldov in the district of Hlohovec (Trnava region, Western Slovakia). In the middle of the eighteenth century, this section was an important link between Považie and Ponitrie, or Bratislava and Nitra [Chrastina 2021]. The body of the road was built in the first half of the eighteenth century in the marshy landscape of the Dudváh Wetland (part of the landscape sub-unit of the Dolnovážska Niva), between the Váh River and the edge of the Trnava Tableland [Pišút 2016, p. 22, 32; Hromádka 1943, p. 150; Lukniš 1972, p. 155; Chrastina 2021].

Traffic on the original road, as well as toll collection and access to the Leopoldov fortress from the west (from Trnava) were affected by the flooding of the Váh and Dudváh rivers. The technical condition of the road was dealt with in the 30 years of the eighteenth century by central and regional institutions, the Hungarian Royal Chamber and the General Congregation of the Nitra County, respectively. S. Mikovíni was entrusted with the construction of the land road, which crossed the wet and often impassable Dudváh wetland with makeshift dike bridges [Chrastina 2021].

Mikovíni had already dealt with the situation in the local landscape in 1725 - 1726, when he studied the causes of the floods in the area at that time. In his report of 10 August 1726, he stated that "all the floods in this region have their cause in the Váh, which pours out from its banks not only in the territory of the Bratislava but also in the Nitra Comitatus" [Purgina 1958, p. 33; Lehotský 2019, p. 66]. In the spring of

Fig. 2. Landscape between Hlohovec (Galgótz), Leopoldov Fortress (Leopold) and Trakovice (Karkótz) on a section of Mikovíni's map from 1735, the section of the road under study is marked by a dashed line; source: www.maps.hungaricana.hu.
Ryc. 2. Krajobraz pomiędzy Hlohovcem (Galgótz), Fortecą Leopoldov (Leopold) i Trakovicami (Karkótz) na fragmencie mapy Mikovíniego z 1735, badany odcinek drogi oznaczono linią przerywaną; źródło: www.maps.hungaricana.hu.

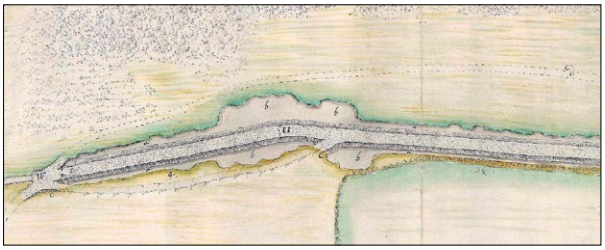


Fig. 4. Detailed section from the map of the viarum Karkotzensium… showing the road embankment together with the exploitation pits and secondary routes used during the drier periods of the year; source: www.maps.hungaricana.hu.
Ryc. 4. Szczegółowy wycinek mapy viarum Karkotzensium… ukazujący wał drogowy wraz z dołami wyrobiskowymi i pomniejszymi drogami wykorzystywanymi w suchszych porach roku; źródło: www.maps.hungaricana.hu.

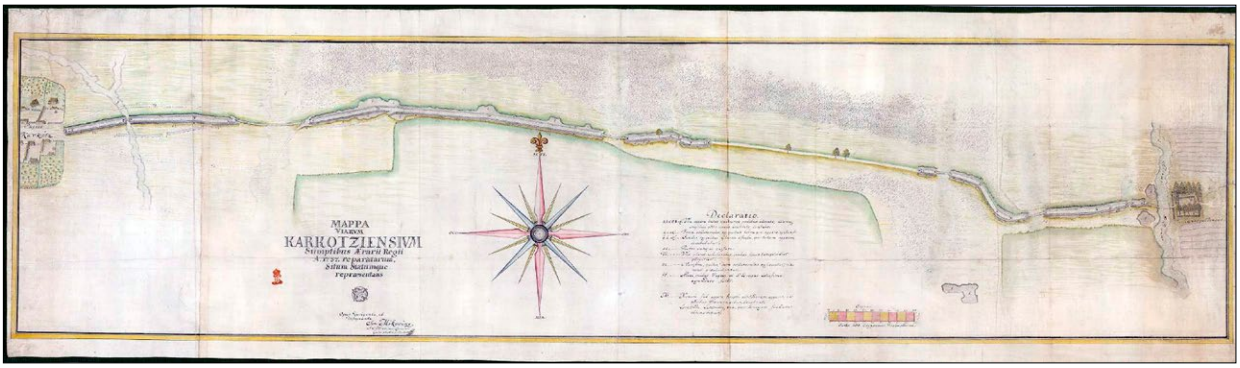


Fig. 3. Mappa viarum Karkotziensium Sumptibus Aerarii Regii A. 1737 reparatarum Situm Statumque repraesentans by Samuel Mikovíni; source: www.maps.hungaricana.hu.
Ryc. 3. Mappa viarum Karkotziensium Sumptibus Aerarii Regii A. 1737 reparatarum Situm Statumque repraesentans Samuela Mikovíniego; źródło: www.maps.hungaricana.hu.

1735, the Hungarian Royal Chamber commissioned Mikovíni to survey an important link between the Bratislava and Nitra provinces - the road from Trnava to Hlohovec, where the most critical section was the Trakovice–Leopoldov (Leopoldov toll) road, crossing the Dudváh depression [Pišút 2019, p. 66].

On June 20, 1735, S. Mikovíni reported to the Hungarian Royal Chamber in Pressburg (Bratislava), in which he described the progress of the construction of the new road. He proposed not only to do earthworks, but also to build two new bridges over the marshy bed of the Dudváh [Purgina 1958, p. 232–233; Pišút 2019, p. 66]. He recorded the situation in the local landscape in maps; only *Mappa minor generalis* (Fig. 2) has survived, in which he discussed the possibilities of flood prevention as well as the way of modifying the river landscape of the Dudváh. Mikovíni also proposed a budget for the construction of new bridges and the materials, earthworks and cost of individual works [Pišút 2019, p. 66].

After the final approval of Mikovíni's proposal, the repair and modification of the road was carried out between the second half of June and November 20, 1737. The course of the reconstruction work was personally directed by S. Mikovíni according to his own project [Pišút et al. 2016, p. 68; Chrastina 2021].

Computer visualization of a section of the Imperial-Royal Postal Route

The potential of virtual imaging of historical landscapes or selected objects (architectures) or structures is obvious [Rábik et al. 2013, p. 5]. The landscape environment is a mosaic of natural and anthropogenic structures that dynamically evolve in space and time. Interactions and correlations of physical-geographical and human-geographical phenomena in the past can be converted into the form of digital data and interpreted in a completely new "artificial" environment. These entities can be very plausibly captured in the form of virtual representations in spatial and temporal contexts. The disappearance of many humano-geographical features in the landscape is reconstructed mainly on the basis of historical and archaeological sources.

The research of sources on the topic under study and the study of the transport relics in question in the local landscape enabled the virtual reconstruction of the object in the environment of the marshy landscape of the Dudváh Wetland. It is the availability of knowledge that is essential for a qualitatively valuable virtual reconstruction of the selected landscape structure. The knowledge from historical and especially spatial sources had to be converted or modified into digital form in a GIS-enabled soft-

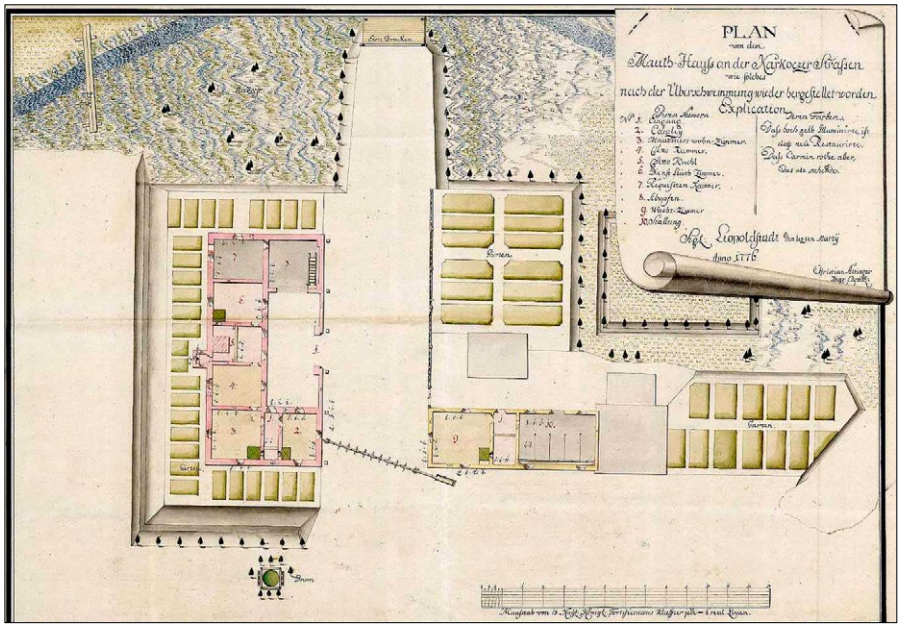


Fig. 5. Detailed depiction of the Leopold toll on a plan from 1776; source: https://maps. hungaricana.hu/en/MOLTerkeptar/2577/view/.
Ryc. 5. Szczegółowe przedstawienie płatnej drogi Leopolda na planie z 1776; źródło: https://maps. hungaricana.hu/en/MOLTerkeptar/2577/view/.

ware. GIS-based view analysis is beneficial to show the absolute upper and lower bounds of the view [Ghadirian and Bishop 2008]. The extent of such a broad spectrum of imagery allows virtual reconstructions of landscapes to be explored and helps to interpret representations of past environments [Winterbottom and Long 2006]. Historical maps usually already contain spatial reference and thematic content, which often makes them easier to process than raw satellite imagery or aerial photographs [Fuchs et al. 2015, p. 11]. The primary source of knowledge was spatial sources (maps and plans) available in digital form on several internet portals. The starting point for the creation of the computer visualization was the *Mapa Viarum Karkotziensium Sumptibus Aerarii Regii*... (Fig. 3) from 1737 by Samuel Mikovini available in the digitized Hungaricana database [www.hungaricana.hu]. The cartographic source shows a road body on an embankment with bridges over the main course of the Dudváh River and its side branches. The embankment shows in detail the gates apparently used for seasonal road closures. The map (or plan) also records the height of the embankment in Viennese feet (roughly 30 cm). Alongside the road section can be seen the excavation pits from which earth material was extracted to build the embankment (Fig. 4). To the plotted objects on the road can also be associated bridges of various lengths and the object of the Leopoldov toll with the development surrounded by a regular earthen embankment.

We do not know the architecture of the toll and its internal layout at the end of thirty years of the eighteenth century. A detailed depiction of the whole area dates back to 1776, when it was reconstructed after an ice flood (Fig. 5). According to the concrete plan, the area of the Leopoldov toll was to have the shape of a rectangle. It was surrounded by a moat with a grove of trees, which was surrounded by gardens on the inside. The toll office building with offices was situated on the southern edge of the courtyard; the guardhouse with stables for five horses was on the northern side. The entrance to the area from the east (from the Leopoldov fortress) was regulated by a barrier. From Trakovice (from the west), carriages and stagecoaches with a team could only reach the tollhouse via a bridge over the marsh, through which the main stream of the Dudváh flowed (walkers occasionally used the wooden footbridge). In 2010, the buildings of the Leopoldov toll were demolished.

The clearly delineated Dudváh floodplain with indications of vegetation cover has marked road sections that were probably used in drier periods when there was no need to move along the embankment. The above source has good numerical and spatial data for reconstruction.

Maps from the middle of the twentieth century and the present day can be assigned to the map bases used in the creation of the virtual reconstruction. On an aerial photograph from the 1950s [www.mapy.tuzvo.sk], the original course of the historical road is still visible, even with the relatively unchanged course of some arms of the Dudváh. The road changed its course in the early 1990s when the new II/513 road was built in this corridor [Chrastina 2021]. The embankment of the extinct road is well visible on the digital elevation model (5.0) obtained by laser airborne radar (LIDAR) (Fig. 6). Even today, the embankment has a height of 30 to 70 cm on the 709 m long section. The LIDAR images [ÚGKK SR] contributed to the elevation modeling of the terrain in the virtual reconstruction. All the acquired map data were compared with each other in Global Mapper. The result was an accurate georeferencing of the historical road (Fig. 7) in the form of a custom map output used for reconstruction purposes.

Fig. 6. Remains of historical transport layout on the map extracted by LIDAR method, source of LLS products: ÚGKK SR, map edited by D. Bešina.
Ryc. 6. Pozostałości historycznego układu komunikacyjnego na mapie uzyskanej metodą LIDAR, źródło produktów LLS: ÚGKK SR, edycja mapy D. Bešina.

When creating the virtual reconstruction we also used information from contemporary written sources, namely from Mikovíni's transcripts of reports to the Hungarian Royal Chamber from 1735 to 1737 published by P. Chrastina [2021]. The reports provide factual information about the condition of the floodplain, the method of construction of the road body, the materials used and the labor force. Particularly relevant for the reconstruction were the references in Mikovíni's proposal from June 20, 1735, in which he listed the recommended embankment heights as one to three Viennese feet (roughly 30–95 cm) and a width of four Viennese fathoms (approximately 7.6 m). Mikovíni also calculated the total length of the embankments, which amounted to 910 Viennese fathoms (c. 1730 m) [Chrastina 2021].

Before we proceeded to the virtual reconstruction, it was necessary to choose a suitable method of visualization and possible presentation potential of the output. The objectives were based on the verification of our own scientific conclusions in a virtual environment, as well as with the possibilities of presentation and popularization of this landscape-technical work. The virtual reconstruction depicts a specific time, that is, it was necessary to choose a time period of the functional existence of the object. The period chosen was after 1737, i.e., shortly after Mikovini's modification of the road. In the process of creating the virtual reconstruction of the building and the surrounding landscape, we followed the methodological approach of M. Forte [2008, p. 266]. The principle of this methodological procedure is based on the location of the site in the landscape, either in its original geocontext or in its relations with the ecosystem which multiplies the factors of contextualization of the connection with other elements of the environment, natural or artificial. The value attributes of a site are generally linked to the structure of the environment. The applied approach is based on the creation of models and scene based on its individual components, such as models created using virtual anastylosis, evocative models, hybrid models, holistically reconstructed models. The dynamics of the scene is completed by the simulation (behavior) of organisms and artificial structures fully integrated into the virtual landscape environment (vegetation cover and ecological relationships).

Spatial models and landscapes were created in Blender, which since version 2.9 has a plugin that allows working with GIS data. Blender's capabilities are currently at a very high level and the program thus also meets the requirements for outputs for research purposes. Initially, we proceeded to model a road embankment based on Mikovini's plan from 1737. The known dimensions of the object allowed the modeling of the road embankment in relatively accurate dimensions. In Blender, we inserted the 1737 plan georeferenced with the current terrain at a scale of 1:1. We then plotted the profile of the road embankment in real scale and progressively modeled the object on the surface of the base map (Fig. 8). In the same way, all the embankments of the road between Trakovice and Leopoldov toll were modelled. Once the embankments were completed, models of the barriers, road bridges of different lengths and the Leopoldov toll were created. The individual segments of the scene had to be inserted into the landscape scenery. The landscape model was based on the background obtained by laser airborne radar (LIDAR). In Blender, we created a 1:1 scale landscape model in a three-dimensional view based on the GEOTIFF map. The *Displace* modifier was applied, which has an algorithm that distinguishes the elevation position according to the colors in shades of gray. The rule of thumb is that the greater the bit depth of the image, the more the fidelity of the landscape morphology corresponds to reality. The result was a geomorphologically accurate terrain of the Dudváh floodplain. The scanning data had to be adjusted as it contained existing landscape structures such as road embankments, industrial area, regulated hydrological channels, etc. Additional modification of the scanned data is necessary in the creation of virtual reconstructions, as point clouds, despite their high accuracy, do not allow accurate visual interpretation of certain terrain structures, such as perpendicular rock ravines, etc. Manual modeling of missing terrain data is not the most appropriate way of completing or modifying a digital model. This risks distortion and the creation of large deviations. Ideally, these segments should be supplemented with other accurate methods such as photogrammetry or terrestrial laser scanning [Cherkes and Linda 2022, p. 30; Pierdicca et al. 2016]. After editing we proceeded to apply the road model together with small architectural elements to the virtual landscape relief. At this point, the original hydrological situation was created in the scene according to the georeferenced map data. The basic virtual scene was ready to be completed with textured materials and vegetation cover. The realistic look of the virtual landscape scene is given by the material based on the principle of Phys-

Fig. 7. Map of the reconstructed section of the Road in the landscape of the Dudváh Wetland based on aerial photography; maps source: ÚGKK SR, reconstruction by D. Bešina.
Ryc. 7. Mapa zrekonstruowanego odcinka drogi w krajobrazie mokradeł Dudváh, na podstawie fotografii lotniczych; źródło mapy: ÚGKK SR, rekonstrukcja D. Bešina.

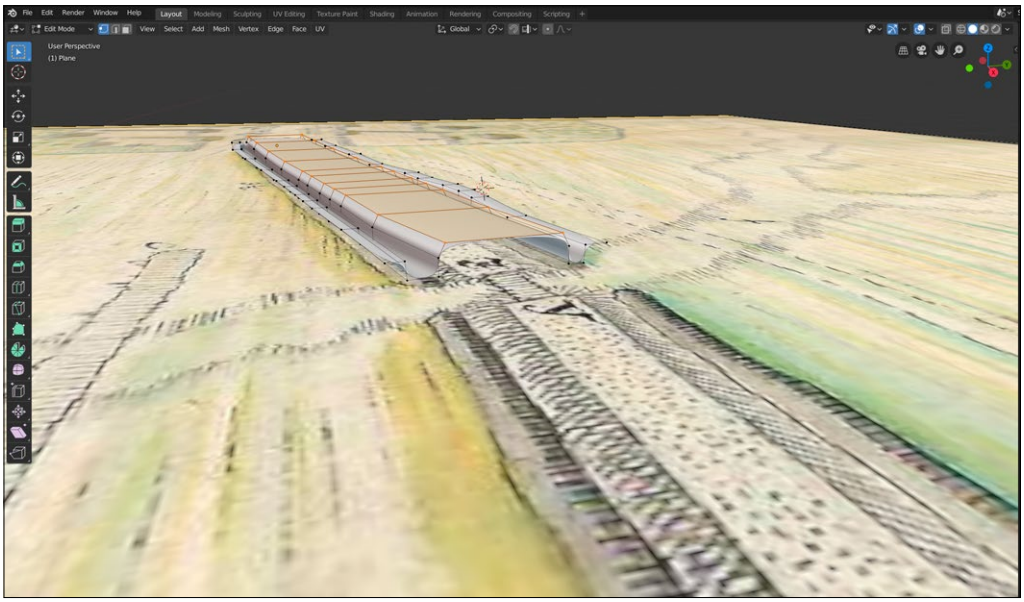
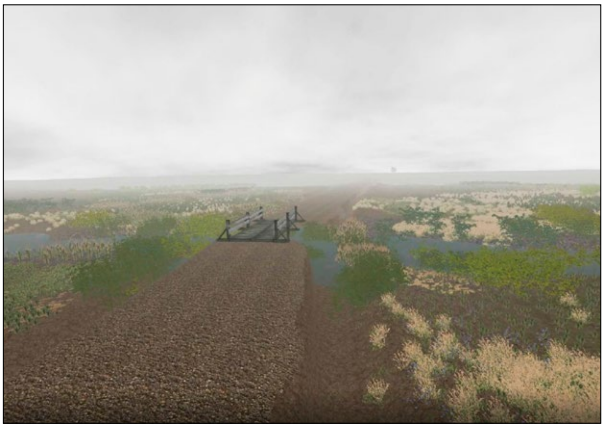


Fig. 8. The process of modeling the embankment of the road according to Mikovini's plan of 1737; by D. Bešina.
Ryc. 8. Proces modelowania skarpy drogi według planu Mikovíniego z 1737; oprac. D. Bešina.

ically Based Rendering (PBR). The textured material created in this way can mimic the flow of light and achieve a realistic appearance. The indisputable advantage of PBR rendering is its ability to mimic the texture of real materials along with gloss, reflectivity and microfacets on a small scale. This type of material is composed of multiple texture types that combine with each other to visualize the reality of the material. For the pertracted scene, we selected materials corresponding to the environment of waterlogged floodplains and floodplain forests. The choice of textures of silty soils, fine sedimentary sands and coarser gravel best corresponded to reality. For the barrier and bridge models, we chose a texture of older wetter wood. Vegetation cover consisted of models of smaller and larger grasses, longer rushes, shrubs, and trees occurring primarily in riparian habitats. We textured the water surface of the tributaries of the Dudváh at six channels. We visualized the remaining two in a regime of moderate waterlogging by texturing wet soil overgrown with dense vegetation. To reconstruct the water regime in the scene, we relied on Mikovini's plan (1737), where the water level is plotted in the channels.

The creation of the scenic atmosphere formed the final stage of the virtual scene creation. The settings of the sky light and visibility in the landscape were equally based on real values. We chose a drizzly and foggy weather as our intention was to present a scene with a higher water regime. The light can be adjusted in Blender according to real physical quantities. For cloudy and foggy weather, we chose a cold light value of 8,000 °K which corresponds to the value of the morning phase of a cloudy day (Fig. 9). The landscape horizon is shrouded in fog. The last step was to insert



Figs. 9. Virtual reconstruction of the road with the Dudváh bridges; by D. Bešina.
Ryc. 9. Wirtualna rekonstrukcja drogi z mostami przez rzekę Dudváh; oprac. D. Bešina.

Fig. 10. Virtual reconstruction of the hypothetical form of the Leopoldov toll in the first half of the eighteenth century before the ice flood; by D. Bešina.
Ryc. 10. Wirtualna rekonstrukcja hipotetycznej formy płatnej drogi Leopoldov w pierwszej połowie XVIII wieku przed powodzią lodową; oprac. D. Bešina.

two cameras into the scene. One camera was designed to output a dynamic animation and the other to output a static display. The outputs from the scene have an audiovisual form.

Conclusion

The aim of the study was to characterize and visually interpret the historical-geographical aspects of the extinct imperial-royal postal road between Trakovice and Leopoldov (Leopoldov toll) in the Hlohovec district (Trnava region, Western Slovakia). The reconstruction and modernisation of the road was carried out on the basis of a project by S. Mikovíni (1686/1698?–1750), an associate of Matthias Bel.

The virtual reconstruction of the road in the landscape of the Dudváh Wetland provided a number of insights and opportunities for further use of selected findings. First and foremost, the reconstruction contributed to visualization of a very accurate representation of the possible appearance of this engineering work. Realistic measurements of the landscape and the body of the road allow experimental verification of the driveability of the route at a certain period of the year or water level. The bridges of the road embankments, modelled according to Mikovini's plan, illustrate an interesting situation concerning the crossing. The bridges were clearly narrower than the total width of the body of the road which suggests that only one carriage could pass over the bridges at any single time. The situation was further complicated by the fact that the bridges did not have railings. The reconstruction confirmed the importance of the road embankment during the rise of the water level in the more rainy periods of the year. Simulations showed that when the water level rose up to 1 m in the floodplain, the western and eastern parts of the road section were flooded. Even at such a raised level, passage along the road was possible.

The presented reconstruction can be used very prospectively in the area of presentation of cultural heritage. Cultural heritage has been confronted with the phenomenon of digitization as well as visualization for several decades. Modern technologies are becoming a common part of cultural and cultural memory institutions and bring very wide possibilities for utilization [Formanek et al. 2020, p. 48]. The potential of digital cultural heritage can be used for various purposes. The main forms include popularization, research and development objectives. An important aspect of the existence of a digital heritage model is also its existence or disappearance status. In most cases, digital cultural heritage is identified with popularization. In this case, they are commonly referred to as virtual reconstructions visualized in various forms [Koszewski et al. 2021]. Virtual tours can be carried out in the field or in the interior of an institution. They can be enhanced with interactive elements consisting mainly of basic knowledge on the subject [Paar 2006]. The practical application of the project still needs to be completed for the purpose of presentation as well as setting up distribution management for users.

The visualization of the imperial-royal postal route together with the Leopold toll (Fig. 10) in the Dudváh Wetland will be included in the Terra Beliana cultural route together with other sites as one of the outputs of the project APVV-18-0196 entitled "M. Bela's Knowledge of the Nitra Area (interpretation and application)." Within the project, specific methodological procedures are used to identify and reconstruct selected regional specifics of the territory of the former Nitra Stolica dated back to the first half of the eighteenth century. The visual look of the historical landscape will be illustrated by a conventional and virtual cultural itinerary. The virtual outputs can be used in situ via mobile devices or in fondo during popularization-educational activities in cultural or cultural memory institutions.

The article was published within the framework of the Agency for Research and Development (APVV) project number 18-0196 "Vedomosti Nitrianskej stolice M. Bela (interpretation and application)."

Bibliografia / References

Secondary sources / Opracowania

Bendelfy László, *Mikoviny Sámuel megyei térképei, különös tekintettel az Akadémiai Könyvtár Kézirattárának Mikoviny-térképeire*, 1. köt, Budapest 1976.

Čižmár Jozef, *Samuel Mikovíni – významný slovenský inovátor*, Bratislava 2013.

Deák Antal András, *Mikoviny Sámuel* és *a Tata környéki „posványságok" lecsapolása*, "Hidrológiai Közlöny" 1995, vol. 75, p. 289–294.

Daňová Klaudia, Daňová Miroslava, *Significant Crossroads at the Lower Reaches of the River Váh*, "Światowit Supplement Series U: Underwater Archaeology" 2019, vol. II, p. 133–152, Warszawa.

Dobos Irma, *Mikoviny Sámuel mérnöki munkája Pozsony* és *Komárom vármegyében,* "Hidrológiai Tájékoztató"2000, p. 62–65, Budapest.

Forgách Péter, *Samuel Mikovíni ml. a vojenské mapovanie (⋆ 1700(?)–† 1750),* Trenčín 2003.

Fridrichová Darina, *Mestské brány a ich napojenie na cestnú sieť* v *stredoveku*, "Dejiny cestnej dopravy na Slovensku II" p. 69–82, Žilina 2017.

Fuchs Richard et al., *The potential of old maps and encyclopaedias for reconstructing historic European land cover/use change*, "Applied Geography" 2015, vol. 59, p. 43–55.

Gálik Zdenko, *Dejiny Hlohovca po páde Veľkej Moravy do roku 1275 s osobitným zreteľom na polohu hradu Szolgagyőr*, "Historický časopis" 2013, vol. 61, No.2, p. 263–287.

Ghadirian Payam, Bishop D. Ian, *Integration of augmented reality and GIS: A new approach to realistic landscape visualisation,* "Landscape and Urban Planning" 2008, vol. 86, No. 3, p. 226–232.

Hájek Milan*,* Melicher Ján*,* Bartaloš Július, *Bratislavský poludník Samuela Mikovíniho – historická pamiatka,* "Historické mapy, Zborník z vedeckej konferencie, ed. Ján Pravda", p. 48–54, Bratislava 2005.

Hirčák Juraj, *Kremnica a jej okolie na Mikovíniho miestopisných mapách. Sonda do obrazu minulej krajiny s dôrazom na cestnú sieť*, "Zborník Kremnického múzea - Národná banka Slovenska - Múzeum mincí a medailí", p. 93–113, Kremnica 2016.

Hladký Juraj, Vondrovský Ivo, *Sta viator. Kapitoly z dejín Leopoldova*, Leopoldov 2009.

Hromádka Ján, *Všeobecný zemepis Slovenska*, "Slovenská vlastiveda" 1943, vol. I, ed. Ľudovít Novák, p. 83–333, Bratislava.

Cherkes Bogdan, Linda Svitlana, *Graphical 3D Reconstruction of the Tustan Rock Fortress, Ukraine, in the Study and the Promotion of Architectural Heritage Sites*, "Wiadomości Konserwatorskie" 2022, vol. 69, p. 26–35.

Chrastina Peter, *Cesta rozumu* v *krajine Dudvážskej mokrade,* (manuscript), 2021.

Formánek Matúš, Filip Vladimír, Hnat Adam, *Komparácia moderného a tradičného spôsobu percepcie informácií o vybraných objektoch kultúrneho dedičstva*, "Slovenský národopis" 2020, vol. 68, p. 47–67.

Forte Maurizio, *Cyber-archaeology: an eco-approach to the virtual reconstruction of the past,* "Digital Heritage" 2008, p. 261–268.

Ivanič Peter, Husár Martin, *Prechody cez dolný* a *stredný tok rieky Váh vo vrcholnom* a *neskorom stredoveku* v *kontexte písomných* a *hmotných prameňov*, "Archaeologia historica" 2019, vol. 44, No. 2, p. 1029–1055.

Kamenický Miroslav, *Samuel Mikovini a banícka* škola *v Banskej* Štiavnici, "Historický časopis" 2002, vol. 50, p. 483–492.

Koszewski Krzysztof, Franczuk Jakub, Argasiński Karol, *Architectural Heritage Virtual Models in Conservation Practice,* " Wiadomości Konserwatorskie" 2021, vol. 68s, p. 17–25.

Kuzma Ivan, Bartík Martin, *Letecká prospekcia na Slovensku v roku 2008*, "Archeologické výskumy a nálezy na Slovensku v roku 2008" 2011, p. 147–160.

Lukniš Michal et al., *Reliéf*, "Slovensko 2. Príroda" 1972, p. 124–202.

Paar Philip, *Landscape visualizations: Applications and requirements of 3D visualization software for environmental planning*, "Computers, Environment and Urban Systems" 2006, vol. 30, No. 6, p. 815–839.

Pierdicca Roberto et al., *Virtual reconstruction of archaeological heritage using a combination of photogrammetric techniques: Huaca Arco Iris, Chan Chan, Peru*, "Digital Applications in Archaeology and Cultural Heritage" 2016, vol. 3, p. 80–90.

Pišút Peter et al., *Vývoj koryta Váhu pri Leopoldove v 17. – 20. storočí a odozva rieky na zásahy* človeka, Bratislava 2016.

Pišút Peter, *Príklady rukopisných latinských máp* a *ich interpretácia (Prípadové* štúdie*),* "Geomorphologia Slovaca et Bohemica" 2019, vol. 2, p. 64–67.

Pokorný Peter, Storch David, *Antropocén*, Praha 2020.

Purgina Ján, *Samuel Mikovíni (1700–1750).* Život *a dielo*, Bratislava 1958.

Rábik Vladimír, Labanc Peter, Tibenský, Martin, *Historická geografia*, Trnava 2013.

Sokáčová Patrícia, *Samuel Mikovíni – „slovenský Leonardo da Vinci*", Historické mapy. Zborník z vedeckej konferencie, ed. Ján Pravda, p. 209–212. Bratislava 2005.

Török Enikõ, *Mikoviny Sámuel*, Budapest 2011.

Sandra. J. Winterbottom, D. Long, *From abstract digital models to rich virtual environments: landscape contexts in Kilmartin Glen, Scotland*, "Journal of Archaeological Science" 2006, vol. 33, p. 1356–1367.

Urminský Jozef, *Hlohovec naše mesto*, Hlohovec 2013.

Electronic sources / Źródła elektroniczne:

Historická ortofotomapa Slovenska, https://mapy. tuzvo.sk /hofm/default.aspx?pcx=-535403&prx=-534501&pcy=-1257038&pzl=23&pamap=0&fbclid=IwAR1gs Cqm-549WH5JacKNLU6YiDD1r83CSWfjaKW1mgeW5ujAdCCLMlDvMIyE (accessed: 24 I 2022).

Hurngaricana – Hungarian Cultural Heritage Portal, https://hungaricana.hu/en/ (accessed: 23 II 2022).
Úrad geodézie, kartografie a katastra Slovenskej republiky, http://www.skgeodesy.sk/sk/ (accessed: 24 I 2022).
Altringer Christian. *Plan von dem Mauth-Hauss an der Karkoczer Strassen wie solches nach der* Überschwemmung *wieder hergestellet worden.* [Mierka 1 : 140]. S. l., 1776. National Archives of Hungary, sign. [S 11 – No. 1055],
https://maps.hungaricana.hu/en/MOLTerkeptar/2577/view/ (accessed: 24 I 2022)
Mikoviny Sam[uelis]. *Mappa viarum Karkotziensium Sumptibus Aerarii Regii A. 1737 reparatarum Situm Statumque repraesentans.* [Mierka 1 : 1 500]. S. l., 1737. National
Archives of Hungary, sign. [S 11 – No. 269]. https://maps.hungaricana.hu/en/MOLTerkeptar/1701/view/ (accessed: 23 II 2022).

Abstract

This paper presents the application of 3D (or 2.5D) visualization methods in relation to the verification and interpretation of the spatial (technical and landscape) contexts of the no-longer-existing road between Trakovice and Leopoldov (Leopoldov toll) in the Hlohovec district of Western Slovakia. The critical condition of a particular section of the imperial-royal postal road was focused on in S. Mikovíni's design dated back to the first half of the eighteenth century. The written and cartographic documents of the project documentation, supported by data gathered during the field research, enabled creating a model of the historical cultural landscape of the Dudváh Wetland with the road in question. For the purpose of thematic visualization, software using GIS environment as well as 3D modeling programs were used, enabling the representation of the observed phenomena. In addition to basic research, the achieved results can be utilized in the planning and decision-making processes of public administration, as well as education or tourism.

Streszczenie

Artykuł przedstawia zastosowanie metod wizualizacji 3D (2.5D) w weryfikacji i interpretacji przestrzennych (technicznych i krajobrazowych) kontekstów nieistniejącej drogi między Trakovicami i Leopoldovem (posterunek mytniczy Leopoldov) w powiecie Hlohovec w zachodniej Słowacji. Krytyczny stan konkretnego odcinka cesarsko-królewskiej drogi pocztowej był przedmiotem projektu S. Mikovínia, datowanego na pierwszą połowę XVIII wieku. Dokumenty pisane i kartograficzne stanowiące dokumentację projektu, wsparte danymi pozyskanymi w trakcie badań terenowych, pozwoliły stworzyć model krajobrazu historycznego i kulturowego mokradeł rzeki Dudváh wraz z przedmiotową drogą. Na potrzeby wizualizacji tematycznych zastosowano oprogramowanie wykorzystujące środowisko GIS oraz programy do modelowania 3D, pozwalające na prezentację zaobserwowanych zjawisk. Oprócz badań podstawowych wyniki mogą być wykorzystane przez administrację publiczną w procesach planistycznych i decyzyjnych, a także w edukacji i turystyce.