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Virtual tourism on the example of the defunct Koscelisko medieval church in the North-Western Slovakia

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Abstract

The primary objective of this paper is to present opportunities for creating virtual 3D models of defunct historical buildings, reconstructed on the basis of archival and field research, and the effective promotion and visualisation of such models through a thematic web application. The secondary objective is to increase the tourism potential and attractiveness of the various historical sites and the studied region. The comprehensive methodical processing of documents and the creation of 3D models of objects and other digital visualisation requires not only high-quality programmers and graphic artists, but especially scientists who create historically-relevant descriptive texts, real schemes, and historically acceptable models that can be computer-processed, visualised, and used as an effective tool for the development of tourism. Research and follow-up activities require an interdisciplinary approach, i.e. the cooperation of experts from various disciplines. The research processed in this study points out that even simple, now widely available modern means of communication, such as websites, can be effectively used for the promotion and publicity of this type of attraction. High-quality 3D models and visualisations of buildings and specific destinations, or cultural and technical monuments, can thus become available to tourists also outside museums. This paper introduces the opportunities of digital presentation of preserved, partially defunct and, especially, completely defunct historical buildings and sites that are often almost unknown to tourists. In many cases, only their shells or foundations remain. In terms of cultural heritage conservation and monument protection, these sites are often among the most important religious buildings from various historical periods. This study focuses on the Middle Ages and locations in Slovakia (former Hungary), and presents a methodology that is generally applicable for the research and visualisation of any similar cultural sites, and thus opening up their potential to tourists.

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1. INTRODUCTION

Slovakia is a country with a rich history and numerous cultural monuments, many dating to the early Middle Ages. A number are listed as UNESCO World Heritage, such as Bardejov town (since 2000), Levoča town (2009), Spiš Castle with Spišské Podhradie and Spišská Kapitula (1993), and Banská Štiavnica gold mining town with surrounding technical monuments (1993). The complete list of UNESCO sites in Slovakia also includes the wooden houses in Vlkolínec village (1993) and the Carpathian Mountain area wooden churches (2008). Seven other locations in Slovakia have applied for listing.

Furthermore, Slovakia has thousands of sites protected as national cultural monuments. Many locations and buildings have been preserved in good condition and are therefore popular tourist attractions. The Central List of the Monuments Fund of the Slovak Republic registers 9,807 immovable national cultural monuments. The district of Krásno nad Kysucou, where the studied area is located, includes 17 national cultural monuments (available online: http://www.pamiatky.sk), three of which in Radoľa village. These include the statue of St. John of Nepomuk at the Roman Catholic chapel, a manor house from the late 16th century, and the studied Koscelisko site (Figure 1).

The medieval Koscelisko site is a defunct cultural monument, and is therefore almost unusable as a potential tourist attraction. The ruins of buildings and foundations as potential tourist destinations are only interesting to a narrow and highly specialised type of "tourist".

The only possible and certainly most attractive form of presentation of such defunct sites to the wider general public is their professional historical reconstruction, 3D visualisation, and publication on the Internet. Many historical buildings in Slovakia have already been digitised (scanned) and are presented online, but most are existing monuments.

This paper aims to emphasise the opportunity of creating 3D models of defunct historical buildings, thereby increasing the tourism potential of the respective locations. This task, however, cannot be fulfilled only by professionals and experts scanning and digitising monuments. Instead it requires a comprehensive approach and cooperation among historians, architects, programmers, graphic and web designers because the result must be a historically relevant, architecturally realistic, and visually attractive model, effectively presented and accessible to every tourist.

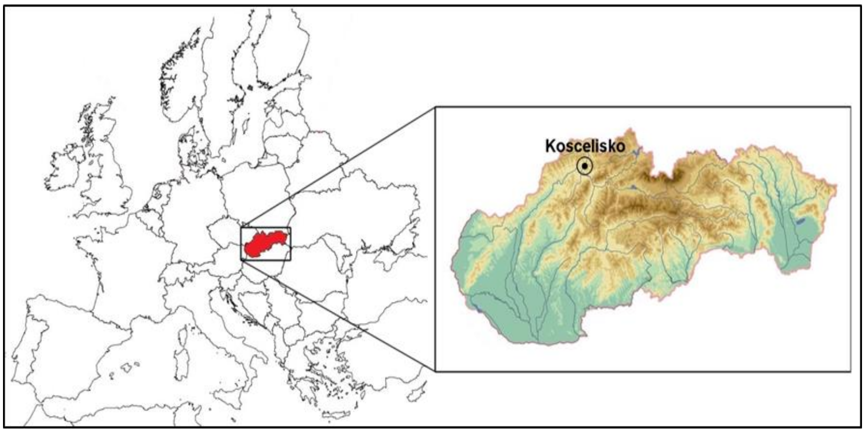

Figure 1. Location of o church within Slovakia and Europe

2. BACKGROUND

We consider the set of methodologies within the transdisciplinary field of environmental history (Worster 1988; Hughes 2009) to be the most appropriate for the identification of defunct historic monuments (both specific buildings and the surrounding landscape), and their subsequent historically-relevant reconstruction in written- and computer-form. Environmental history can be understood as a complex and systematic transdisciplinary research of internal components (Masný & Zaušková 2014, 2015), interactions, and associations in the landscape (environment), including human society (i.e. their culture, thinking, lifestyle, and technology), in space and time (Hronček 2015; Weis & Hronček 2017). The research of such a (complex) scientific approach to the topic at hand will allow us to create scientifically correct documents (van Dam & Verstegen 2009; Myllyntaus 2011; Hronček 2014; Péterfi & Sümeghy 2018) for future use in tourism by utilising modern information technology. Methodology for creating 3D models for geotourism and mining tourism in Slovakia has been long overseen by the BERG Faculty of the Technical University of Košice (Rybár & Hvizdák 2009, 2010; Rybár et al. 2010; Hvizdák & Molokáč 2012; Hvizdák 2013). The modelling, visualisation, and presentation of technical monuments as web applications and map portals is the subject of current publications by the Faculty of Natural Sciences, Matej Bel University in Banská Bystrica (Fuska et al. 2017; Weis et al. 2015; Kubinsky, Lehotsky & Weis 2014; Weis & Kubinsky 2012).

When approaching this topic using the example of Koscelisko church (Slovakia), we proceeded along the lines of environmental history and used historical research methods (archival research), critical analysis of expert reports and literary sources, field research and landscape mapping, text synthesis, and subsequent 3D modelling using SketchUp Pro 2017, Surfer 11, and Voxler 4 software tools. On top of this wide-ranging research, computer reconstruction videos and models have been made available to interested parties from tourist industry through modern computer technology (Google Earth tools and our own programmed web map application) to enable easy virtual time travel using the models of defunct buildings (virtual reality). Virtual reality is understood as a computer-mediated sensory experience that facilitates access to the visual and/or sound dimensions of a destination (Good & Sambhanthan 2013).

Generally, as the first step in processing a case study when conducting historical research in archives, it is necessary to proceed according to established and proven methodical procedures (Gerber 1974; Best & Kahn 1998; Dvorak et al. 2014). After determining the research objective, historical sources need to be collected, sorted, and critically analysed, with an emphasis on original documentary material, which in the case of the medieval period is in Latin. Such sources are then studied and logically arranged, followed by final synthesis into text (Holec 2013). In our case, we reconstructed the history of the church building and surrounding medieval landscape. In such ancient historical periods, the deductive and comparative historical method is also indispensable (Avenarius 1999; Kratochvíl 1999; Kuzmíková & Javošová 2002) for the reconstruction of monuments if no drawings remain. Their visual appearance and dimensions (or even functions) must then be compared with similar buildings in the region within the respective time frame.

After completing the historical research, the most important part of 3D model processing is to obtain accurate dimensions of defunct buildings. The easiest approach is to get dimensions from their historical depictions, if available. In the case of historical paintings, the subjective view of the painter is an important factor contributing to inaccuracy. Scaled technical (construction) drawings significantly facilitate progress, but are only preserved from the modern period. From the late 19th century, historical postcards (photos) are also a good starting point. It is necessary to consider the lack of genuine scale as well as the central projection of the image, but a skilled interpreter should be able to derive several directionally oriented scales for selected objects in a scene, even in a perspective view.

Georeferenced and interpreted orthophotos acquired via Trimble UX5 UAS have also been used, and the data further interpreted in the AGISOFT PhotoScan application.

When dealing with the oldest monuments, or in the absence of the above bases for the acquisition of dimensions, it is necessary to continue research in the field. Field research allows information to be gained about the surrounding historic landscape regarding time and space, the studied building and its relationship to the surrounding relief, and its gradual transformation. Fieldwork can be greatly facilitated by previously undertaken archaeological research. Regarding our case study, detailed archaeological research on Koscelisko was carried out in 2012 - 2013 (Samuel, Majerčíková & Furman 2014). Following the archaeological research, we conducted field research of the uncovered church foundations in the summer of 2016. The research objective was to accurately identify the position and dimensions of the building in the floor plan and to determine the orientation of the building's cardinal points. For fast and accurate measurements, two GNSS Stonex S9III PLUS rovers (IP67 certification) with Stonex S4H controllers in the Carlson Surf CE software application were used. To achieve high measuring accuracy outside the GSM signal, both devices were connected through a UHF radio modem. High measuring precision in real time was achieved using the SK-POS service via the GSM network (Real Time Kinematic). Besides the ground plan of the building, we also positively identified and analysed relics of the medieval landscape.

During the field research, we used classic geomorphological research methodology (Demek 1987), as well as the methodology developed for the research of historical landscapes (Hronček 2014). An important methodology in identifying historical montane relics is the process of identifying montane relief relics and historical landscape structures according to Slámová (2013).

The final step of the first stage – the summarization of documents about the defunct cultural or technical monument – is to create a true digital model in the selected application (volume object modelling tools, digital terrain model (DTM), and composition of the entire scene, or GIS). The final research step is the subsequent visualisation of the resulting model, the scene, and their publishing and promotion using modern technology through web applications, or through thematic online map portals.

The defunct Koscelisko church was modelled with the SketchUp Pro 2017 application. A contemporary visualisation of the relief around the church, with estimated moat and earth mound, was modelled in the real position and elevation coordinates in the Surfer and Voxler applications, while the DTM was created using the vectorised contours of the topographic state map ZM 1:10,000 series. The building was also visualised in the Google Earth application.

A modern and potentially very appropriate solution seems to be the publishing of any results of historical or montane research through a thematic web map portal. For the purpose of this research, a process according to the methodology of Weis et al. (2015) was chosen.

3. ANALYSIS

The opportunities of using 3D models in tourism will be presented using the example of the early-Gothic Koscelisko church, where we conducted comprehensive environmental history research. The Koscelisko site belongs to Radoľa village (district Kysucké Nové Mesto) in the Kysuce region of north-western Slovakia. It is located near the border of three countries – Slovakia, the Czech Republic, and Poland. The historical region of Kysuce belonged politically and administratively to the Kingdom of Hungary since the early 11th century until 1918, when it became part of Czechoslovakia (since 1993 Slovakia). With regard to the aim of the study, we only present a very brief history of Koscelisko church and a basic description of the building parameters obtained through research as a basis for 3D modelling.

The first written mention of Kysuce dates to 3 December 1244, when a region called Kysuca is mentioned (*terra Kis Zudcze*), and based on a description of the medieval landscape it is known to be the geographical area around Koscelisko (Fejér 1829). Another document from 11 December 1244 (Marsina ed. 1986) also mentions the Kysuca river (*fluvium Kiszucza*), again in the geographical area of Koscelisko. The medieval landscape around the Koscelisko site is also recorded in a document from 24 October 1254, which mentions a region called Jesesín (*quandam terram Yesesin nomine*), i.e. the neighbouring Kysucké Nové Mesto (National Archives of Hungary Budapest in archivo familae Balassa DL 65697; Marsina ed. 1986). The region around Koscelisko is also mentioned in documents from 1285 (National Archives of Hungary Budapest in archivo familae Balassa DL 66072; Wenzel 1864), 1321 (Sedlák 1987), and 1325 (Fejér 1844).

The first written mention of Koscelisko church appears in this well-documented period - in 1332-1337 (Archivio Segreto Vaticano, Camera apostolica, Collectoriae decimarum, fasc. 184; Sedlák 2008). The church is mentioned in the records of papal tithe collectors. The papal tithe collector Rajmund from Bonofatto noted that Peter, a pastor from Radoľa parish, paid six groschen as tithe from his annual church office income (*Petrus de Radola, solvit VI grossos*). Although Radoľa parish paid only six groschen (which at that time was paid only by poorer parishes), that fact in no way diminishes its status in Kysuce. We can say with certainty that it was not only the first parish, but also the first church in Kysuce.

No written documents about the church's existence have survived. According to written documents from neighbouring Kysucké Nové Mesto, during the mid-to-late 14th century, Koscelisko and Radoľa were gradually declining as the centre of medieval Kysuce and losing their privileged status in favour of the rapidly growing Kysucké Nové Mesto. A definite change in this status occurred from 1440. Archaeological research suggests that at some point during this period Koscelisko church was suddenly destroyed by fire. This is evidenced by a significant layer of cinder and burnt soil in the interior and exterior of the building. The burnt soil layer of red and black colour in the church interior contains burnt pieces of wood, as well as melted metal (Samuel, Majerčíková & Furman 2014). This catastrophic event in the church's history was probably related to Hussites raids from Moravia and Silesia through the Jablunkov Pass down the Kysuca river valley in 1328 (Petrovský & Šichman 1963) or 1431 (Marsina ed. 1986a).

The stone building of Koscelisko church, towering at the edge of a 30 m high left-side terrace of Kysuca river, dominated the whole geographic area for more than a century. The building must have made a strong impression on the medieval merchants, pilgrims, and travellers passing along the old road along the right Kysuca bank (Figure 2). Although by today's standards the church was small, its enchanting position in the medieval landscape was enhanced by its white walls and brick-red window linings contrasting with the surrounding landscape. Its visual appearance was unique far and wide. Typical buildings in Kysuce at that time were simple wooden houses with shingle roofs and colours that matched the environment.

The early-Gothic church was a simple single-nave building with a rectangular ground plan, 15.13 m long, 8.65 m wide, and estimated height of 11.8 m. The entrance to the church nave was on the west side, or rather the northwest side as the longer church axis is deflected by 34 degrees. In the first construction phase, together with the main nave (external dimensions 9.30 - 9.70 m × 8.65 m), a slightly tapering square sanctuary on the eastern side (internal dimensions 4.53 - 4.80 × 4.50 m) and a square vestry (internal dimensions 3.45 × 3.45 m) were built. The church wall foundations were 40 to 100 cm deep and built mostly from locally-mined flysch sandstone.

Based on historically-relevant documents obtained from complex archaeological, historical, geographical, geological, and landscape research with an emphasis on the environmental history of the landscape and its digital rendering, we created a 3D model of the early-Gothic Koscelisko church (Figure 3).

We used the SketchUp Pro application, which allows the modelling of all external and internal dimensions of objects with sufficiently high accuracy (cm).

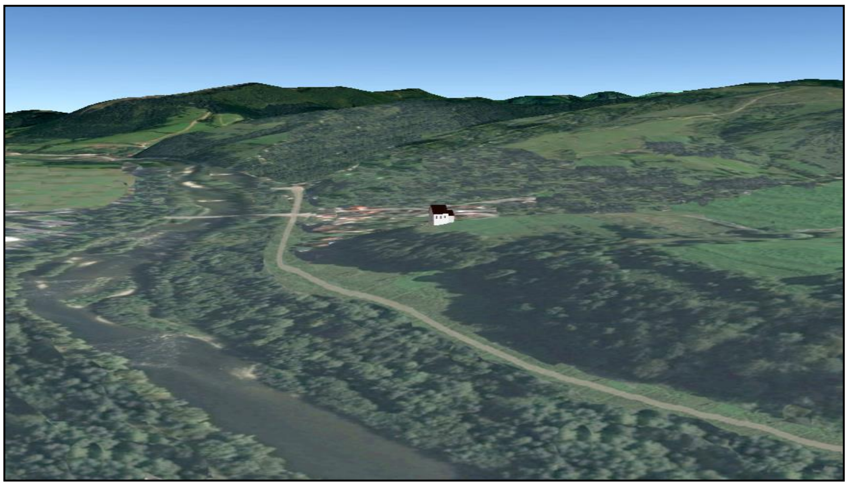

Figure 2. View of Koscelisko church from floodplain level

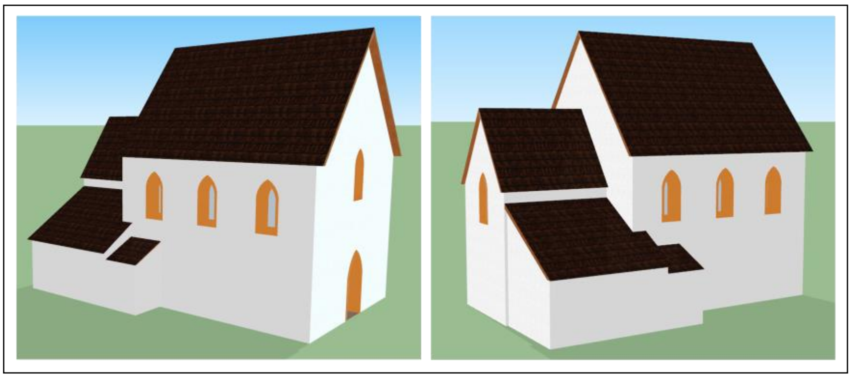

Figure 3. A detailed view of volume/mass 3D model of the church in SketchUp Pro application

In addition to the external dimensions of the main nave of the church, we also modelled the thickness of bearing perimeter walls as well as subsequently added walls, taking into account the foundation widths and the total mass and stability of the building. According to data obtained by the field research, the thickness of the church perimeter walls ranged from 91 to 104 cm. The wall foundation stones of individual annexes (sacristy, charnel house) were 59 to 82 cm thick.

A specific task was the contemporary interpretation of the building's roofing material (wooden shingle) and material visualization (structure and texture) of walls and doors, while preserving the assumed original material and colors. The used elements were consulted with experts and selected with reference to the historical period, the available materials, and similar buildings in the area. For the purposes of the final composition, we created a unique material library with materials such as travertine, sandstone, glass, smoke preserved wooden shingle, oak slabs, red and orange sandstone window and doors linings, etc.

The resulting dimensional and mass-volume model enabled to conduct further analysis and derive other characteristics of the building, such as the calculation of the volume of displaced construction material and the definition of the expected nature and properties of the building materials. The volume of external walls and the estimated amount of stones needed for the main church nave construction was almost 270 m^3, and the volume of the sanctuary was over 50 m^3. According to calculations, the sacristy on the northern side of the sanctuary together with the charnel house required about 40 m^3 of building stone.

Since the church building stood on a relatively oval platform on the left-bank river terrace, which rises high above the valley floodplain (395 m above sea level), it was necessary to create a DTM of the immediate surroundings of the building as well as the wider area of the river floodplain, formed during the Quaternary by the deep and mainly lateral erosion of the easily erodible flysch bedrock. This distinct geomorphological elevational structure provided the ideal conditions for locating a building of a similar nature. Predicted disposition of the building towards the defensive mound (Figure 4) was also estimated. In the south and partially south-west, there was a relatively flush platform, probably protected by an earth mound. By precisely modelling the mound course and height above the terrain, the volume of displaced material and total extent of terrain adjustments was determined to be about 1,500 m^3.

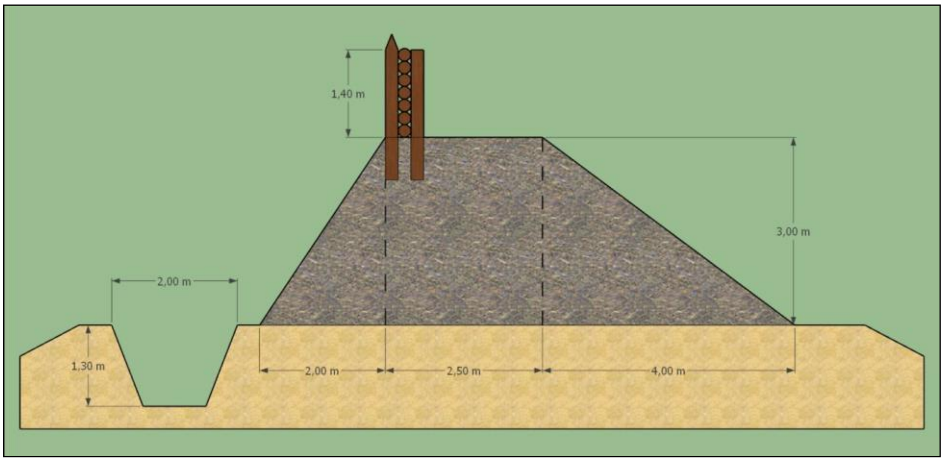

Figure 4. A view of the defence mound model with wooden structure and a water moat

In recent decades, digitisation has been an unstoppable phenomenon that has penetrated all spheres of our life. It is becoming an integral part of cultural and historical heritage, as well as tourism. Classical forms of information are converted into digital formats, which generally makes it more accessible. The situation is different with defunct monuments, and those that have been preserved only as archival documents. We must therefore, on the basis of scientific research, collect information about such monuments and by modelling plot new, hitherto unknown information. Modern computer technology allows us to virtually visit places that would otherwise remain inaccessible, and to see objects that would otherwise remain unseen. This advantage can also benefit tourism, since it allows interested parties to "virtually" move both in space and time.

Today, we are flooded by a huge amount of (digital) information that can be troublesome to navigate. Virtual tourism allows tourists to seamlessly deal with a specific and professionally processed high-quality 3D model or other visualisation. It is therefore clear that digital technologies have wide application opportunities in the field of tangible as well as intangible cultural heritage, in the visualisation of existing and especially defunct buildings. This process allows defunct buildings to be preserved for humanity as digital heritage.

The 3D model we created provides an example of the new presentation opportunities in tourism. Through internet technology, such models allow tourists to virtually visit and see both existing and defunct cultural sites and features in the "real historical" landscape. These opportunities will enable the development of tourism not only at major tourist destinations (where 3D visualisation is rather only a trend or where reasons for digitisation are motivated by protecting and archiving data about current site status), but also in small localities (where visualisation is essential for promoting tourist attractions). Small sites with limited opportunities for offering attractive buildings in situ, or with defunct buildings, will get new impulses for using their cultural and historical potential to promote education, tourism development, and employment growth.

3D models enable tourists to view defunct cultural and technical monuments from every side and angle, move around their immediate vicinity, and even enjoy a bird's eye view. In the case of underground sites, virtual visitors can also visit otherwise inaccessible and dangerous places. Tourists can experience all this from the comfort of their home as well as directly in situ, gaining the impression of looking back into time. By correctly aligning an image, the models enable a landscape and its features to be seen from the viewer's perspective. Another advantage is that the landscape, underground, and various features can be viewed in different timeframes, if so enabled by the models' technical and content processing.

Another advantage of 3D computer models is the ability to obtain derived, hidden, or invisible characteristics and measurable parameters of a landscape and its features. From a digital model, it is possible to derive secondary features and elements that cannot be obtained from historical materials. However, the implementation of research requires expertise and experience. Therefore, 3D models are also used in precise scientific investigation, particularly in geoscience disciplines, classical and anthropogenic geomorphology, the study of mining and metallurgy, history, environmental history, etc.

The research results were published on a thematic web map portal, whereas the content of the thematic layer with virtual models of defunct sacral buildings will be gradually filled with advancing research in the broader area and region (Figure 5).

Modelled sacral and votive architecture buildings will form a separate, thematically uniform layer of the portal. The programmed environment lets anyone quickly search sites and attractions, and filter them according to selected criteria or search a text string in the description. The portal is well-structured in that objects can be categorised into layers, and individual features can be grouped according to certain commonalities or characteristics. Regular tourists can therefore quickly search required information online, orientate themselves in an unknown area, and choose optimal routes for a trip with regard to availability and length.

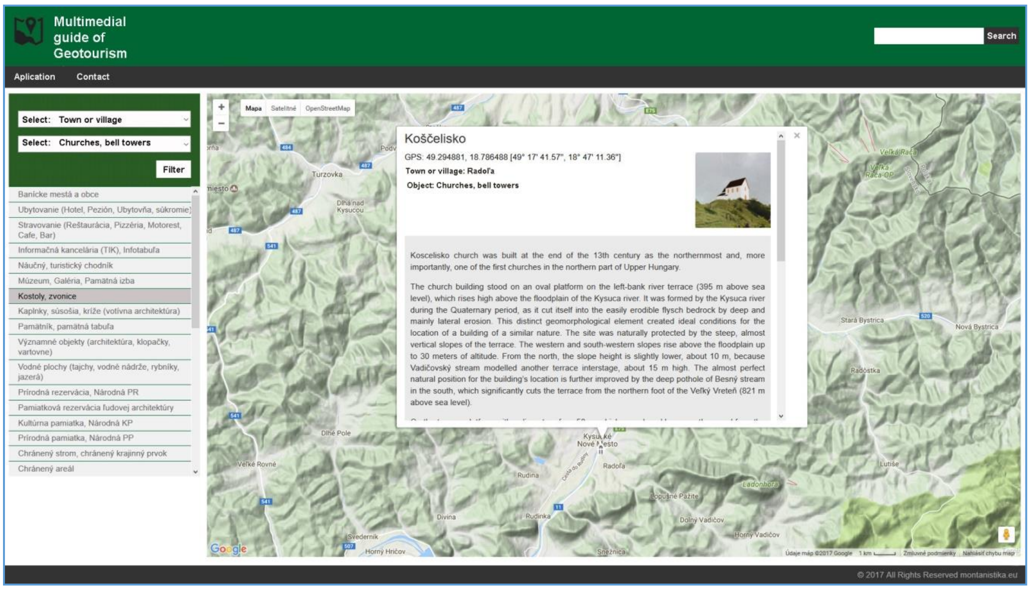

Figure 5. Thematic layer view options in a web-based map portal

Another way to provide tourists with a number of research results is the creation of information boards on educational tourist trails. They can be used to introduce tourists to a large amount of collected unique archival, text, and graphic material. Currently, boards displaying QR codes are an inexpensive solution for educational trails - they can show graphics and texts, and link to a thematic web map portal with additional information. This solution is also beneficial in view of the unfinished research in the regions, and the ongoing need to update and add information to the information boards without the need to renew and reprint expensive large-formats. An important benefit is the relatively very low cost of repairing damaged information boards with only QR codes.

4. CONCLUSIONS

Undeniably, digital modelling based on comprehensive scientific (mostly historically-oriented) research and different scientific disciplines that are best linked by transdisciplinary environmental history (Chrastina 2009; McNeill & Mauldin eds. 2012; Hoffmann & Richard 2014) brings a wealth of historically relevant information. With the proper scientific evaluation of models, we can gain information and knowledge that cannot be obtained by means other than digitally. This "digital information" has an ever wider and irreplaceable place in the scientific and social sphere. It is currently protected as a UNESCO World Digital (Virtual) Heritage (UNESCO 2003). Computer modelling in graphics applications and GIS, based on the relevant historical documents and maps, as well as high-quality systematic historical and field research, provide new attractive display options as various 3D models, animations, and short educational videos.

In recent years, professional computer reconstructions have become increasingly indispensable in tourism. With visualisations in the form of images, 3D models, and even films and holograms, tourists can get into a real historical period, i.e. digital computer modelling allows them to virtually travel in time and space.

Such models can be used to support new trends in tourism, a sector that is an important source of sustainable development in Europe, and the models also find application in education and making tourist attractions barrier-free. Experiential and visually appealing, modern ways to present historical buildings have high potential to reach and attract the young generation and stimulate their interest in this type of tourism and the history of their surroundings. In such a way they might be able to identify with their hometown or region, and be proud of their country's history.

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