Advances in Biology & Earth Sciences
Vol.2, No.3, 2017, pp.290-305

GEOINFORMATION MAPPING TECHNIQUES AT DOCUMENTATION OF THE HISTORICAL SACRAL MONUMENT IN EAST SLOVAKIA

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Abstract. Archaeological sites and historical monuments require accurate and detailed documentation. Surveying and geographic mapping methods provide a wide range of possibilities for creating documentation for various archaeological sites and historical monuments. The paper deals with application of some geoinformation mapping techniques and to documentation of the historical monument at the archaeological exploration in eastern Slovakia. In addition to the classic terrestrial geodetic methods, the advanced terrestrial scanning technique and unmanned aerial photo coverage were applied for mapping the restored historical monument, i.e. mapping the reconstructed rock ruins to the foundations of the stone walls of the early Gothic church Koscelek in the south-east of Slovakia. The output data obtained from mapping the renovated ruins of the foundations of the masonry perimeter walls of the medieval church Koscelek were be provided for GIS database of the archeologically very important and interesting region of the south-east region of Slovakia.

Keywords: *Sacral monument – surveying – mapping - laser scanning - aerial photo coverage.*

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Manuscript received*: 12 October 2017*

1. Introduction

Documentations of archaeological sites and excavations and historical monuments are a very important part at the whole archaeological investigation complex, renovation and restoration of many historically valuable monuments and artefacts of the national cultural heritage. Mapping archaeological sites and excavations and historical monuments of involves the complex of geoinformation techniques and methods to acquire the needed cartographic map documentation of the mapped historical artefacts in a classical printed paper or digital form [1, 8, 19, 24, 29].

Outputs of geodesy and also geography extend to almost everywhere, not only the technical areas of human activity. Geo-data, pointing to the localization of the object in question, are necessary and indispensable also in archaeology and in research of historical monuments where it is necessary to know the geographic location of archaeological sites or historical monuments and by 3D to determine these sites and to visualize historical buildings, monuments and so on [1, 29]. Geo-data also design for a dominant part of the database of GIS (Geographic Information Systems) which in recent years have also applied to archaeology and research of many historical sites [1, 15].

Possibility of the advanced mapping techniques as are terrestrial laser scanning (TLS) and unmanned aerial vehicle (UAV) at mapping the renovated church foundations ruins can be useful for determination of the historical architectonic styles, in which the church Koscelek was built. TLS and UAV technics complemented the extensive surveying activities carried out at the site Koscelek several years ago after renovation of the exterior wall foundations ruins of the church. From mapping this historically very important monument together with archaeological exploration, which is very intensive in this region of Slovakia for last period of over twenty years, it is possible to incorporate the church Koscelek into a group of village churches and so to find more analogies to this tangent church [20-22].

One historically very interesting archaeological site in eastern Slovakia is the remnants of the defunct early-Gothic small village church from the 13th century A.D. under the name of Koscelek near the municipality Nižná Myšľa about 17 km, south-east of the city of Košice (Fig. 1). Some geodetic measurements (surveying) significantly helped at the extensive archaeological research of this site at the turn of the 20th and 21st centuries [21, 22, 25-27]. In 2017 with purpose of obtaining more complete 3D geo-data from this sacral site the classic surveying and mapping have been also contributed by an up-to-date progressive and specific mapping technics such as the terrestrial laser scanning and unmanned aerial photo coverage.

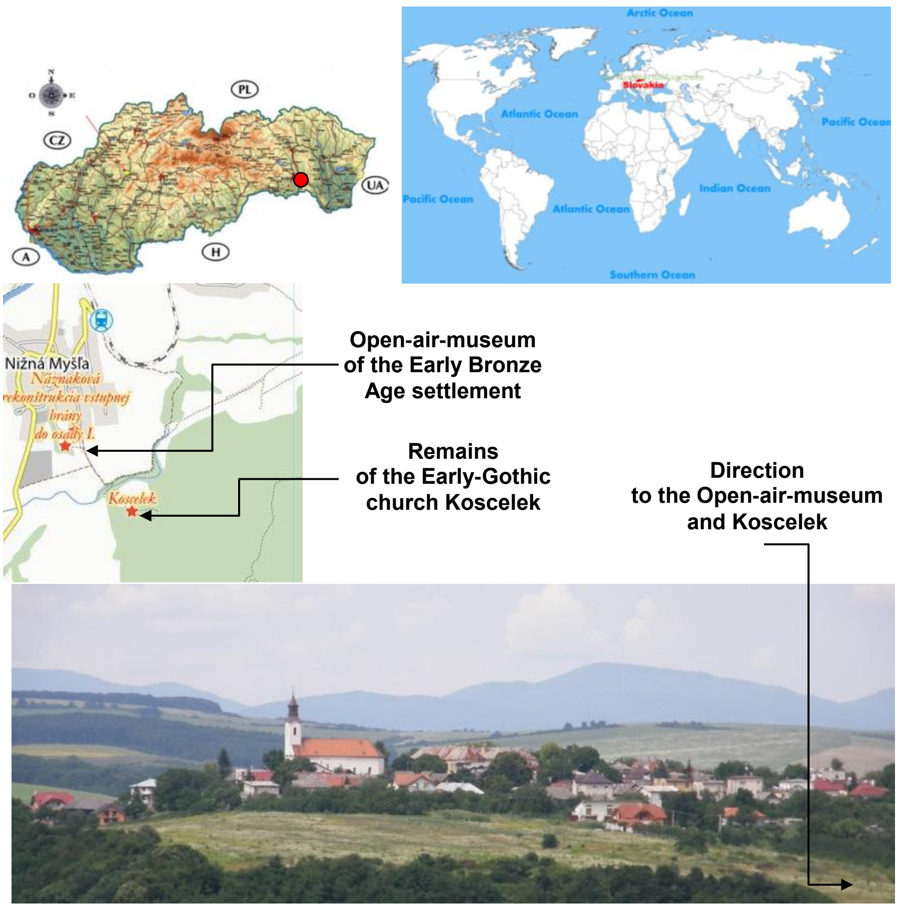

Fig. 1. View of the today's municipality Nižná Myšľa from the south-west. Slanské vrchy (the Saline Mountains) in the background.

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2. Research basis and methodology

a. Nižná Myšľa – history

The beginnings of settlement in the region of the municipality Nižná Myšľa are dated back to prehistoric ages. More specifically, the oldest monument coming from the younger section of the Early Stone Age - Palaeolithic, dated between 35000 to 10000 B.C. [4, 9, 12, 16]. These historical monuments belonged to hunters of the Aurignacian culture who left the stone tools. In the 5th millennium B.C. the territory of the present land area of Nižná Myšľa is settled by people of the Beech-Highland culture. This era was come under the New Stone Age, i.e. Neolithic Age. Other traces of the settlement are till from the Stone Age – Eneolithic[2, 7, 21].

Important role of the municipality Nižná Myšľa came up in the late Bronze Age, when it became part of the settlement area of Ottoman culture. Ottoman community is settled here between 1200 till 1000 B.C. In the next century (900 B.C.) residential complex of a younger fortified settlement was created in the space above the burying-ground.During the Iron Age (from the 4th century B.C. until the turn of our era) this territory was occupied by Celts. However, the most intensive settlement was shown from the Roman period. The recent studies have brought monuments that argue continuous settlement in 11th to 12th century A.D. The historical settlement findings from the archaeological site from the locality Pod Ždánskym Brehom (in English: Under Ždaňa Shore) and Moľva and locality nearness to Koscelek prove the existence of a number of settlements in this period. It is not excluded that the today's municipality Nižná Myšľa was developed from an earlier settlement, which the first written mention about the municipality with the name Nižná Myšľa was mentioned in the historical source in 1270 [6, 21].Currently on the site of the archaeological excavations near the village Nižná Myšľa is accessed to the public the open-air museum of the settlements (Settlement I and Settlement II) dates from the Early Bronze Age (1700-1400 B.C.) (Fig. 2) [2, 6, 20, 21].

The extensive prehistoric complex near the municipality Nižná Myšľa is not yet archaeologically still by far completed. Regarding this decided historical sites, which expressively exceeds an ambit of the history of Eastern Slovakia, it is expected to continue even several years of next archaeological research work. The results of the archaeological investigation indicate that this part of Europe was in its time on a high cultural and social level, and that in Slovakia too are the roots of pan-European civilization in Slovakia [7, 31].

Fig. 2. Open-air-museum: "Settlement I" from the period of the Early Bronze Age. Views to the settlement entrance (A), primeval abode outside (B), primeval abode inside (C),archaeological excavations in the Open-air-museum "Settlement I" with the municipality Nižná Myšla in the background (D).

b. Koscelek – history

In the years 1996-1998 uncovered the archaeological research on a wooded hill above the river Olšava south of the municipality Nižná Myšľa remains of the extinguished Early Gothic small church from the 13th century A.D. (Fig. 3 and Fig. 4) [6, 20-22]. The church belonged to the medieval settlement that existed in these places according to the findings in the period of the12th to 15th century A.D. and it was probably destroyed by the beginning of the second half of the 15th century A.D. during the fighting with Bratriks.

The walls at least 1 m high are maintained of this object (Koscelek) with plaster fragments, altar refectory relicts, stone altar refectory and fragments of brick floors. The church has two entrances, southern and western, the remains of which remained conserved. A vestry was annexed later from northern side. According to the ground plan it is the Early Gothic medieval church. The building is east-west orientated (like any Christian sacred building), with moderate deviation to the south.

The outside church dimensions are approximately 14.5 x 8.8 m. The entrance from the west side is 1.6 m wide. Crack in the southern wall points out that there existed an older, later walled-in, southern entrance. The thickness of walls is in average 1.1 m. Statics of the western facade was consolidated by the corner supporting pillars, which later added by another pair of pillars along the west entrance side wall. Building of the church survived the destruction of the settlement and served its purpose in the coming centuries. At the church cemetery on the south-west side of the church a few dozen graves have been discovered until since the 18th century A.D. Older graves (from the Middle Ages) were probably destroyed by later burials [6, 27]. The church had been in an administration under the Jesuits from the city of Košice and Sacrifice Masses are held twice a year.

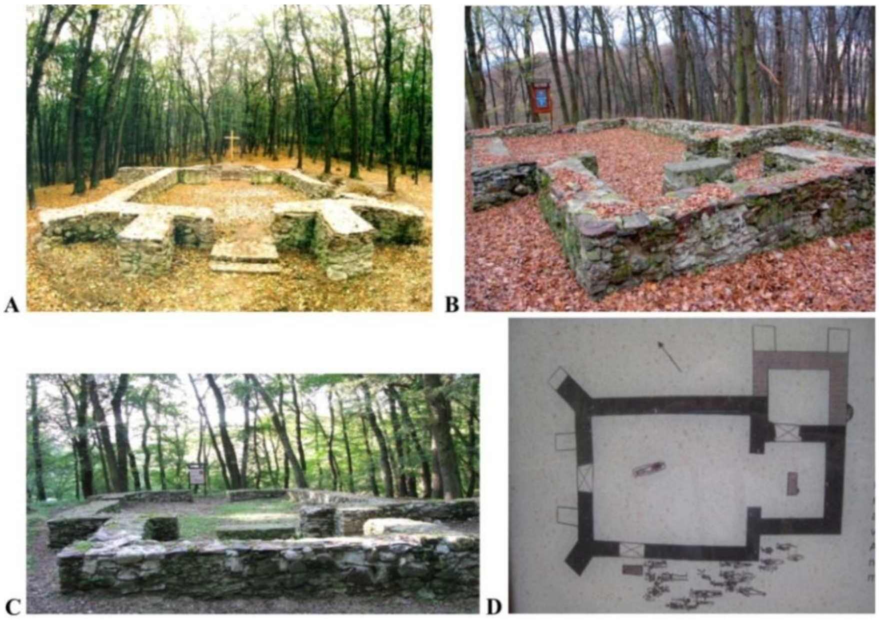

Fig. 3. Uncovered and renovated foundations of masonry perimeter walls of the former church Koscelek. Views from the south-west (A), south (B), south-easts (C), renovated vision of the original church foundations with the adjacent cemetery (D).

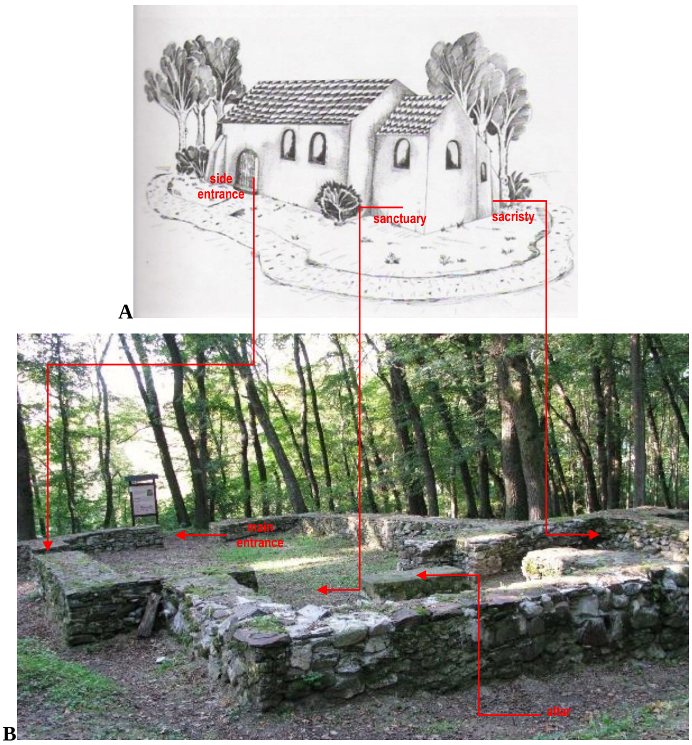

Fig. 4. Koscelek: Renovated vision of the former church Koscelek (A) and view of the uncovered and renovated stone foundations of its masonry perimeter walls from the east (B).

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The archaeological research and renovation works were made of whole object of Koscelek. A lot of ceramics from 12th to 14th century A.D. and many metallic items were found during the renovation as such. The part was explored simultaneously of so-called churchyard. People were buried irregularly, in storeys and rows. In the church, exactly in its centre, there was just one tomb with a woman buried in it. According to the latest evidences, except the Koscelek area, more extensive ruins of a former sacred building were situated on this place. Further archaeological research of the archaeological site Koscelek was stopped after 1998. Renovated vision of the church according to the historical documents and archaeological excavations is presented in Fig. 4.After archaeological research thanks to the efforts of archaeologists it was successful to present the uncovered foundations of masonry perimeter walls. At the present the information board and cross are mounted beside the church. From the municipality Nižná Myšľa leads to it a marked trail [2, 20, 21, 27].

c. Research methodology

Methodology of measurement and mapping many archaeological sites and historical monuments offers a wide range of technologies and techniques to obtain 2D or 3D visualization of the examined objects. From long-term practical and theoretical knowledge in graphic documentation of an examined archaeological site or historical monument results the priority use of geodetic methods in the design of classical terrestrial surveying or satellite geodesy.

Conventional traverse and tacheometric measurements were applied in a frame of terrestrial surveying to preparation of the topographic map of the renovated rock foundations from the former medieval church Koscelek and its surrounding area. TLSand aerial photo coverage using UAV were applied into mapping processes of the foundations of the church Koscelek. TLS and UAV belong to the current advanced mapping techniques which operatively provide 3D mega-data of mapped objects. Obtained 3D mega-data centralized into geo-databank can be flexibly used anytime to 3D modelling for a space variable virtual visualization of mapped object. Despite the fact that TLS and UAV and LiDAR (Light Detection And Ranging) and others not mentioned here mapping techniques belong to the current top mapping techniques, traditional surveying procedures continue to be as the most important methods among geoinformationmapping technologies for a wide range of engineering works archeology and restoration exception [5, 15, 17, 26].

3. Geoinformation mapping techniques at documentation of the church of Koscelek

a. Surveying

As it was already stated in the introduction as well as in the abstract of this paper, to create the detailed map documentation of the renovated ruins of the external walls foundations of the church Koscelek and its surroundings, there were carried out the extensive geodetic measurements (surveying). These were carried out immediately after the intensive archaeological research of the locality Koscelek (1996-1998) and after renovation of the foundations ruins of the church (the beginning of this century).For the reasons already earlier presentation of the results of geodetic measurements at the site Koscelek [25-27], there is only a brief overview of the achieved outputs of these measurements in this chapter.

For the needs of a numerical and graphic documentation of any archaeological sites, historical monuments and renovated historical artefacts, in the majority of cases it is necessary to identify all three coordinates (3D) *x*, *y*, *z* of the geodetic network points founded at a site of interest. It means that to calculate them, it is necessary to measure all geometric elements: angles, lengths and heights (difference in elevation). Surveying keeps a basic in mapping methods for a documentation of many archaeological sites and historical monuments. Due to this reason, the most effective surveying equipment was used, i.e. the electronic tacheometer (total station) – Leica TC600 to determination of 3D coordinates of the traverse point as well as to localization of 3D position of the detailed (object) geodetic points (in number 122) placed on the renovated foundations and their close surroundings. 3D position of the object points was realized by means of using tacheometric technology. The main objective of all geodetic measurements for archaeological purposes was preparation of the planimetry and hypsometry (i.e. tacheometric map) of the renovated foundations ruins of the old historic village church - Koscelek, located in the rural zone of Nižná Myšľa (in the forest) about 400 m south from the village. The one-sidedly connected and oriented traverse was used with a starting orientation to the point No. 7101-1, i.e. the tower of current church in the municipality of Nižná Myšľa. It is the point of ŠTS (in Slovak: Štátna trigonometric kásieť, in English: State Trigonometric Network) [1] numbered within the relevant triangulation sheet. The traverse was connected to the point No. 7101 of ŠTS. The traverse point No. 5001 was additionally oriented to the point No. 7001-6 (under the title "Dringáč") of ŠTS. The traverse measurement was very complicated by very broken and inaccessible terrain with a dense forestation along the river Oľšava across which the traverse was measured. The traverse measurement was carried out twice (baseline and control measurements). All detailed measurement procedures with numerical and graphic outputs have been described in the papers [25-27]. Fig. 5 presents the traverse measurement planimetry outline in S-JTSK. Each surveying works (planimetry and hypsometry) with cartographic outputs in Slovakia must be realized in

[1] Geodetic points of ŠTS represent GZ points (physical points of the Basic Point Field) that were taken from the original Czechoslovakian Trigonometric Network (ČSTS) and Czechoslovak Astronomical Geodetic Network (ČSAGS) from the territory of Slovakia and these points have designated position coordinates in the implementation of the JTSK of the Coordinate System of the Unified Trigonometric Cadastral Network (S-JTSK).

the national geodetic systems, which are S-JTSK and Bpv (in Slovak: Baltskývýškový system povyrovnaní, in English: Baltic Vertical Datum - After Adjustment).

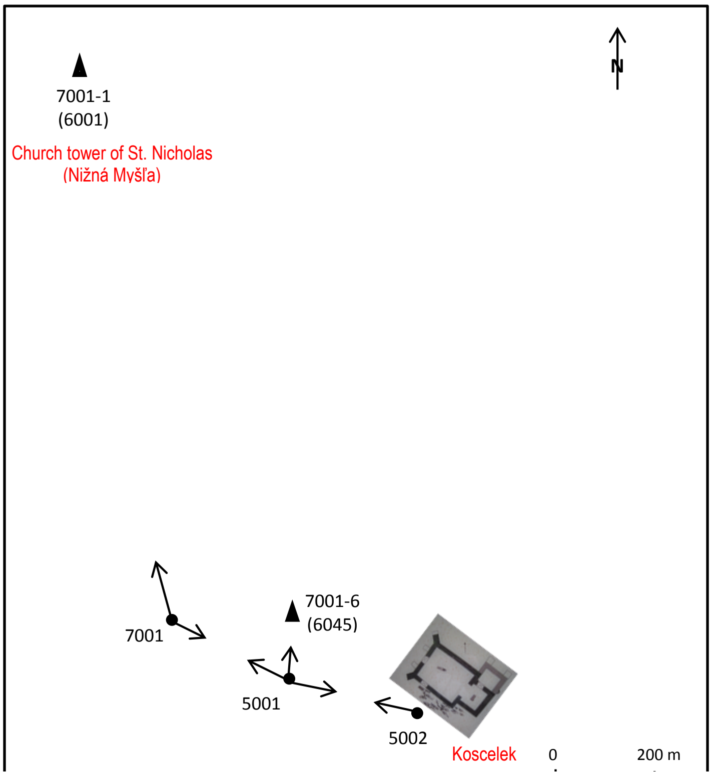
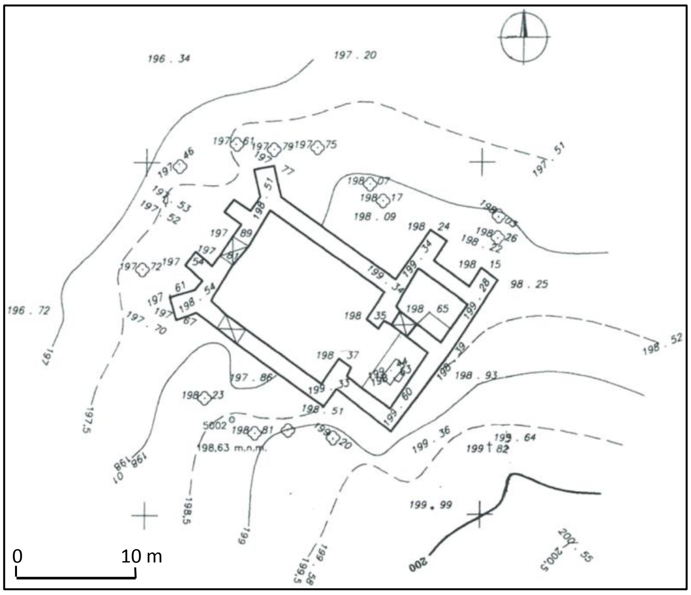


Fig. 5. Traverse measurement outline (in S-JTSK). Notice: Dimensions of the church Koscelek are not in scale.

All numerical calculations of 3D geodetic data with their adjustment were processed by the software GEUS and the graphic outputs by software KOKEŠ in the scales (S) 1:100, 1:200 and 1:300 with the plotter output and GEUS software calculation listing (segment) with the traverse points coordinates (in Slovak) (Fig. 6). For organizational and administrative reasons related to the activities of the co-operating group of archaeologists as well as for the needs of the GIS database from the tangent locality Koscelek, some points were renumbered in the calculations, namely point No. 7101-6 corresponds to point No. 6045 and point No. 7101-1 corresponds to point No. 6001.

Global test on congruence of the geodetic points

Additionally, in connection with the presentation of the application of other geoinformation mapping techniques (TLS and UAV) to the graphic documentation of the archaeological site Koscelek, additional calculations were performed for the congruence of geodetic points of the measured traverse. The congruence presents a quality in determining 3D position of the traverse geodetic points and thus also a quality of the entire geodetic measurements. The procedures for calculating the congruence of the traverse geodetic points are shown in the following subhead.

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Výpočet súradnic Koscelka.
Pridať body
    6045   254948.06   1251854.23   178.85
    6001   255233.57   1250782.90     0.00
Polárna metóda:
Č.bodu     dĺžka   výš. cieľa    vod. uhol     zenit. uh
6045                 1.30
6001        0.00                   0.0000       95.2380
Orientácia : 183.4194
Str.chyba orientácie :  0.0000   Dop.str.chyba :  0.0800
Podrobné body:
5001   386.00 2  1.30  142.1575  98.5240
Polárna metóda:
5001                 1.41
6001        0.00                  0.0000    96.5130
6045      386.00     1.41       356.3095   101.4475
Orientácia :169.2642
Str.chyba orientácie:  0.0019   Dop.str.chyba :  0.0800
Podrobné body:
5002      151.39     1.41       240.0020    95.4410
Polárna metóda:
5002                 1.57
5001      151.40                  0.0000   104.5390
Orientácia :209.2662
Str.chyba orientácie :  0.0000   Dop.str.chyba :  0.0800

    Podrobné body:
      1   7.95       1.57    358.9045        108.1935
      2   6.69       1.57    356.2570        109.1470
      3   6.53       1.57    368.6085        108.3420
      4   5.30       1.57    379.2265        108.2710
      5   4.35       1.57    394.2115        110.0915
      6   5.50       1.57     82.6080        101.7660
      7   6.44       1.57     73.4010         99.8010
      8   9.50       1.57     95.4645         98.3275
      9  13.46       1.57     72.9350        101.1625
≈
    114   2.10      1.57    331.0885        112.1245
    115   6.54      1.57    265.2630        106.0740
    116   9.70      1.57    154.9725         93.7625
    117  21.92      1.57    112.3960         94.4150
    118  26.17      1.57     80.7715        100.2665
    119  24.00      1.57     49.3520        102.9690
    120  21.73      1.57     12.5935        104.2035
    121  20.76      1.57    378.9505        107.0300
    122  13.63      1.57    320.2195        108.9410
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Fig. 6. Koscelek: Planimetry (in S-JTSK) and hypsometry (Bpv) and listing (segment)/GEUS.

Significant "stability or instability"[2] of the geodetic points is rejected or not rejected by verifying the null-hypothesis H_0 respectively, also other alternative hypothesis [18]

$$H_0 : d\hat{\bar{\mathbf{C}}} = 0; \quad H_\alpha : d\hat{\bar{\mathbf{C}}} \neq 0 \tag{1}$$

where H_0 expresses an insignificance of the coordinate differences $d\hat{\bar{\mathbf{C}}}$ of the final adjusted coordinates of the geodetic network (traverse in our occasion) points according to the Gauss-Markov model between both epochs of the traverse measurements, i.e. the epoch $t_{(Bas)}$ of the baseline traverse measurement and the epoch $t_{(Contr)}$ of the control traverse measurement. To testing can be use e.g. test-statistics T_G for the global test

$$T_G = \frac{d\hat{\bar{\mathbf{C}}}\, \mathbf{Q}^{-1}_{d\hat{\bar{C}}}\, d\hat{\bar{\mathbf{C}}}^{\mathbf{T}}}{k\, \bar{s}_0^2} \approx F(f_1, f_2) \tag{2}$$

where $\mathbf{Q}_{d\hat{\bar{C}}}$ is the cofactor matrix of the final adjusted coordinate differences $d\hat{\bar{\mathbf{C}}}$, k is the coordinate numbers entering into the network points adjustment (k = 3 for 3D coordinates) and $\bar{s}_0^2$ is a posteriori variance factor common for both epochs $t_{(Bas)}$ and $t_{(Contr)}$.

The critical value T_{KRIT} is searched in the tables of F-distribution (Fisher–Snedecor distribution tables) according to the degrees of freedom $f_1 = f_2 = n - k$ or

[2]In the sense we coordinate differences between the measurements at different epochs.

$f_1 = f_2 = n - k + d$, where n is number of the measured values entering into the network points adjustment and d is the network defect at the network free adjustment.Through the use of methods MINQUE is $s_0^{2_{t(Bas)}} = s_0^{2_{t(Contr)}} = \bar{s}_0^2 = 1$. The test-statistics T should be subjugated to a comparison with the critical test-statistics T_{KRIT} . T_{KRIT} is found in the tables of F-distribution according the network stages of freedom. Two occurrences can be appeared:

1. $T_G \le T_{KRIT}$: The null-hypothesis H_0 is accepted. It means that the coordinate values differences between both traverse surveying are not significant.
2. $T_G > T_{KRIT}$: The null-hypothesis H_0 is refused. It means that the coordinate values differences between both traverse surveying are statistically significant.

Table 1 presents the results of the global testing of the geodetic network (traverse) congruence.

Table. 1.Test-statistics results of congruence of the traverse points Nižná Myšla-Koscelek

Point	$T_{G(i)}$	$< \le >$	***F***	**Notice**
7001	2.153	$<$	3,628	coordinate differences are not significant
5001	3.019	$<$		
5002	3.6277	$\le$		

b. TLS and UAV techniques

Currently in the mapping archaeological sites are getting more and more the progressive scanning and mapping techniques. The non-contact scanning techniques in mapping geo-space offer highly effective mapping methods and techniques not only in geo-disciplines, but also within the archaeology. Such progressive scanning techniques in mapping include TLS (Terrestrial Laser Scanning), ALS (Aerial Laser Scanning), LiDAR (Light Detection And Ranging) and UAV (Unmanned Aerial Vehicle) [3, 5, 11, 13, 14, 17, 19, 24, 28].

To increase accuracy of the geodetic/surveying mapping of 3D position of the renovated stone foundations of the former church Koscelek was used now highly advanced and effective mapping technique, such as TLS. The V-Line 3D Terrestrial Laser Scanner RIEGL VZ-1000 was applied at TLS and DJI Phantom GoPro Hero3 Professional with Hero camera was applied at UAV.

The V-Line 3D Terrestrial Laser Scanner RIEGL VZ-1000 provides high speed, non-contact data acquisition for ranges more than 1,400 m using a narrow infrared laser beam and a fast scanning mechanism (Fig.7) [23]. High-accuracy laser ranging is based upon RIEGL’s unique echo digitization and online waveform processing, which allows achieving superior measurement capability even under adverse atmospheric conditions and the evaluation of multiple target echoes. The line scanning mechanism is based upon a fast rotating multi-facet polygonal mirror, which provides fully linear, unidirectional and parallel scan lines. The RIEGL VZ-1000 is a very compact and lightweight surveying instrument, mountable in any orientation and even under limited space conditions.

The DJI Phantom GoPro Hero3 Professional represents the next generation of DJI quadcopters (Fig. 7) [10]. It is capable of capturing 4K video and transmitting an HD video signal out of the box. The DJI Phantom GoPro Hero3 Professional includes 12 MP photo camera and integrated 3-axis stabilization gimbal. UAV apparatus has intelligent flight system, dedicated remote controller and powerful mobile app w/auto video editor allowing live HD views. The DJI Phantom GoPro Hero3 Professional can be used not only for outdoor flights but also for indoor flights. The built-in camera has an integrated gimbal to maximize stability while minimizing both weight and size. Even when no GPS signal is available, the vision positioning system allows the device to hover accurately in place.

A B

Fig. 7. V-Line 3D Terrestrial laser scanner RIEGL VZ-1000 (A) and microUAVDJI Phantom GoPro Hero3 Professional with Hero camera (B).

TLS by means of using the V-Line 3D Terrestrial Laser Scanner RIEGL VZ-1000 was carried out of the eight stations that were deployed along the outside of the stone foundation of the church and as well as inside it (Fig. 8). The easy small targets made additionally in conditions of the Institute of Geography of the Pavol Jozef Šafárik University in Košice were used to simplification of a compilation of the scanned clouds of points between individual scans from the stations. RiSCAN PRO software was used for the processing of 3D clouds of points of TLS. 3D visualization of the renovated stone foundations of the former church Koscelek as a final output of TLS is presented in Fig. 9.

TLS of the renovated stone foundations of the former church Koscelek was complemented by an aerial photo coverage using UAV technology. The DJI Phantom GoPro Hero3 Professional was flying over the stone foundations of Koscelek and took the snaps of the foundations of the former church by the Hero cameras from different heights of about 4-20 m (Fig. 10). Some samples from the UAV aerial photo coverage are in Fig. 11. A flying space was limited by high and thick vegetation of surrounding trees. Also very clear and sunny weather to some extent distorted the clear contours of the stone foundations, i.e. alternation of the mapped of sunny and shaded areas makes it difficult to locate the exact contours of the stone foundations of Koscelek.

Fig. 8. Koscelek (July 2017): Demonstrations of scanning the renovated stone foundations of the former church by the V-Line 3D TLS RIEGL VZ-1000 from seven stations outside of the foundations (A) and one station inside of the foundations (B).

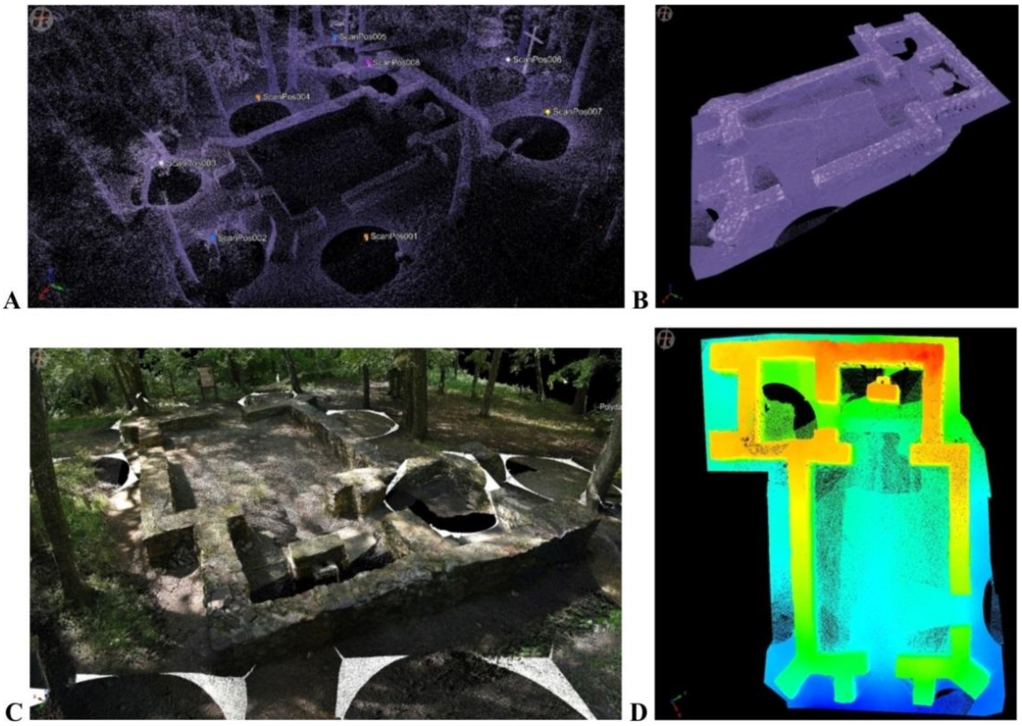

Fig. 9. Koscelek (July 2017): 3/2D visualizations of the renovated stone foundations of the former church from TLS processed by RiSCAN PRO software; 3D visualization with the scan positions localization (A), without surrounding vegetation (B), with surrounding vegetation (C) and 2D visualization (D).

A  B 

Fig. 10. Koscelek (July 2017): Demonstration of the preparation (A) and aerial photo coverage (B) of the renovated stone foundations of the former church by the DJI Phantom GoPro Professional Hero 3 of around 9 m above the ground.

A  B 

C 

Fig. 11. Koscelek (July 2017): View at the renovated stone foundations of the former church from UAV Hero camera DJI DJI Phantom GoPro Hero3 Professional from the height of 5 m (A), 7 m (B) and 15 m (C).

The maximum altitude, from which it was possible to identify more distinct contours of the foundations of the church, was 7-8 m. At higher altitudes due to nearby high forest cover and by it also striking shadow-casting all mapping area of Koscelek by UAV technics, the foundations of the church were difficultly identifiable (Fig. 11/C).

4. Conclusions

The renovated stone foundations of the old historical and archeologically very interesting church – Koscelek were located, both height and location wise in the national geodetic systems valid for Slovakia. The surveying outputs were complemented by TLS and UAV techniques. From the planimetry it could be identified that Koscelek was a single nave church built in early gothic style and is west-south orientated with a slight swing to the south. There was also a burial-place at Koscelek, where an additional archaeological investigation was made in the years 1996-1998. A number of human bones together with metallic and ceramic items were found in the uncovered tombs, dating back to 13th century A.D.

In terms of accuracy, it is sufficient for archaeological and historical landmarks research to use the classical terrestrial geodetic methods. Very proven method, especially in focusing rugged complex of historic buildings is also terrestrial photogrammetry and now unfortunately for economic reasons are still expensive 3D scanning. Some geophysical methods are used to locate the tombs or other underground historical formations too.

The paper confirms the necessity of surveying data for archaeologists in a case of the geographic localization of archaeological finds and historical monuments and for conservators and scientists in restoration and research of historical landmarks, especially when determining the architectural style and last, but not least the creation of GIS databank of the given archaeological or historically interesting locality. The surveying methods complemented by TLS and UAV together with map outputs and GIS databank in archaeology and historical landmarks research are important from the point of view of further possible archaeological excavations or historical landmarks survey in the given area. Despite the efficiency of technologically highly productive mapping techniques TLS and UAV, the conventional terrestrial surveying systems have still a given priority at mapping of archaeological sites and historical and cultural monuments. This is primarily due to the achievement of the required accuracy in 2D respectively 3D location mapped the archaeological site and its surroundings, which allows almost all traditional terrestrial and satellite surveying techniques. The conventional surveying methods (traverse and tacheometry) and the processing of measured data required approximately three-day work (thirty-thirty two hours of work). TLS and UAV mappings and 3D data processing were more time-consuming (approximately five to six-hour work). Processing of 3D data from TLS and UAV was realized directly in the field. The conventional surveying techniques clearly declare greater precision in determining 2D (also 3D) position of the Koscelek object (mean square error of measurement is 25 mm) than the TLS and UAV techniques (mean square error is 56-89 mm). TLS and UAV techniques allow multiple-variability in 3D modelling the mapped object with its visualization, which the used conventional surveying techniques do not allow.Applications of the high current advanced mapping techniques, such as TLS, or ALS, and UAV are useful additional mapping techniques complementing surveying processes. The great advantage of techniques TLS, ALS and UAV is possibility to obtain a huge amount of data and thus the ability to create a wide variability in 3D modelling of the scanned archaeological objects or other historical and cultural monuments.

Output data obtained from mapping the renovated ruins of the foundations of masonry perimeter walls of the former medieval church Koscelek near the village Nižná Myšľa are included in the database of GIS at the field office of the Archaeological Institute of the Slovak Academy of Sciences in Košice realizing a long term extensive the archaeological investigation of the prehistoric settlements by the river Hornád in the urban area of Nižná Myšľa and its surroundings.

Acknowledgement

The article followed out from the projects KEGA No.: 007UPJŠ-4/2017 and VEGA No.: 1/0474/16 and ESA No.: AO/1-8224/15/NL/Nde researched at the Institute of Geography of the Faculty of Science of the Pavol Jozef Šafárik University in Košice, Slovakia. The research was supported in part by the Cultural and Educational and Scientific Grant Agencies of the Ministry of Education, Science, Research and Sport of the Slovak Republic and European Space Agency.

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