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(HERAUSGEBERINNEN)

GAMZIGRAD-STUDIEN I

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GERDA VON BÜLOW / SOFIJA PETKOVIĆ
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GERDA VON BÜLOW UND SOFIJA PETKOVIĆ

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GIS based topographical analysis in the surrounding of *Felix Romuliana*, Serbia

By János Tóth and Brigitta Schütt

INTRODUCTION

The ruins of the Late Roman emperor's palace *Felix Romuliana* are located in an isolated situation between the today small villages Gamzigrad and Zvezdan in east Serbia. With an analysis of topographical site characteristics this study intends to identify the outstanding and preferable site characteristics of the location where *Felix Romuliana* was built.

STUDY SITE

Felix Romuliana is located in east Serbia *(fig. 1)* in the Carpatho-Balkan Region. The Late Roman fortified palace is situated in the Black Timok Valley close to the city of Zaječar. It was built by Emperor Galerius in the small valley of Seliški Creek. Today it is situated between the villages of Gamzigrad and Zvezdan. *Felix Romuliana* was built as a retirement residence of the Emperor[1].

In spite of the fact that the ruins – which are today known as *Felix Romuliana* – are well known and mentioned by several sources[2] it was not known for a long while that these ruins belong to *Felix Romuliana*. Rather, older archaeological investigations suppose that *Felix Romuliana* might be located in what is today Bulgaria[3]. At first in the 1980s an ornamental carved stone block from the door lintel of the fortification's east gate was excavated[4] featuring the carved inscription '*Felix Romuliana*'. The discovery opened up new perspectives for further researches and since 2007 *Felix Romuliana* belongs to the UNESCO World Heritage List[5].

Opposite to the ruins, across the valley of the Seliški Creek and on top of the divide the burial-mounds and

Fig. 1. Location of the research area.

Fig. 2. Gamzigrad. Excavation of the mausoleums.

1 Živić 2003.
2 von Herder 1846; Kanitz 1861; Breithaupt 1861; Mačaj 1892.
3 Srejović / Vasić 1994.
4 Srejović 1985.
5 http://whc.unesco.org/en/list/1253 (Last access 07.06.2019).

Fig. 3. Gamzigrad. Burial-mounds and mausoleums of Galerius and Romula.

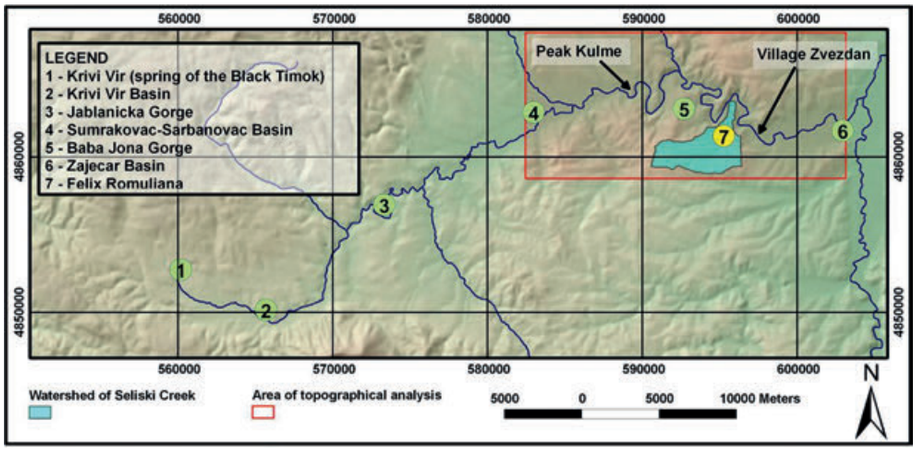

Fig. 4. Topographical overview map of the Black Timok river.

mausoleums of Emperor Galerius and his mother Romula can be found *(figs 2; 3)*. These gravesites were also excavated in the 1980s. Before the excavations started the area was covered widely with forest *(fig. 2)*. During the excavation of the late Roman mausoleums additional Bronze Age burial places were found which show that the hill called Magura was a long-time burial and sacral place. The burial-mounds which are visible at present on top of the hill are reconstructions.

The drainage basin of the Black Timok totals 1269 km^2 [6]. The Seliški Creek, the watercourse at which *Felix Romuliana* is located, is a tributary of the Black Timok and discharges in its lower course just upstream of the Baba Jona Gorge. The Baba Jona Gorge connects the Sumrakovac-Sarbanovac and Zaječar Basins *(fig. 4)*; the river segment between Peak Kulme and Zvezdan is 22.5 km long and has seven entrenched meanders[7].

The drainage basin area of the Seliški Creek totals 14 km^2 *(fig. 4.)* and extends 4.5 km in N-S direction and

6 Zhivković 1992.
7 Dukić 1975.

Fig. 5. Gamzigrad. Excavation in 1954.

Fig. 6. Gramzigrad. Crack lines in the tower 19.

6 km in E-W direction. The highest elevation reaches 456 m.a.s.l. while the lowest elevation is located at the Seliški Creek-Black Timok confluence at approximately 144 m.a.s.l. The drainage basin of the Seliški Creek is cultivated all over the slightly undulating lowlands while forests can be found on the steep slopes and as riverine forests along the creek.

The area of the Black Timok valley was a settled and fortified way across the Serbian Carpathians (E-W: Kostol-Zaječar, *Felix Romuliana*, Savinac, Sumrakovac, Lukovo)[8]. The two fortifications neighbouring *Felix Romuliana* are Savinac in the west, located in the Sumrakovac-Sarbanovac Basin, and Kostol in the east, located in the Zaječar Basin close to the city of Zaječar. The Baba Jona Gorge connects both basins and approximately on the half-way *Felix Romuliana* is located in the tributary valley of the Seliški Creek.

Felix Romuliana was built on a fan dumped into the valley and pushing the Seliški Creek to the east. The historical landscape is reworked by gullying and mass wasting since the Roman Period *(fig. 7)*. Gully erosion is generally associated with accelerated erosion and landscape instability[9]. The accelerated erosion is in many cases related to heavy rainfall and land degradation. North of the palace the slopes and affiliated fan deposits are dissected by well developed gullies each more than 100 m in length with depths up to 3–4 m. At present they are inactive with their channel beds and flanks covered by woods and shrubs. North of the fortification buried ruins were found below the present day cropland. A group of late Roman columns arranged in a circle with 33–34 m in diameter belong to these structures. As the circle is cut through by a gully some of the columns are missing. Consequently, the gullying is younger than late Roman Period. A geomagnetic survey by order of the Romano-Germanic Commission of the German Archaeological Insitute (DAI-RGK)[10] points out that the settlement area during Roman time totaled approximately twice as much as it appears from the present day superstructure. It is assumed that the course of the gullies shows the course of historical pathways.

At present mass wasting occurs around the palace as downhill creep. It is connected with the volumetric changes of the soil through shrinking and swelling corresponding to the change between dry and wet periods[11]. Downhill creep is a slow mass movement of the upper soil on slopes below 5° inclination[12] without damaging the vegetation cover.

In the area of *Felix Romuliana* the most characteristic soil is the vertisol, locally also called *smonica*[13]. The pedoturbation of vertisols is a consequence of adsorption processes and in a long term causes a mixing of the soil[14] and a dislocation of surface elements. The effects of pedoturbation are documented in the photos in the monuments of *Felix Romuliana*, indicating horizontal as well as vertical movements *(figs 5; 6)*. These processes explain the dislocation of the trigonometrical points around *Felix Romuliana*.

8 Petrović 1997.
9 Morgan 2005.
10 von Bülow / Schüler 2007.
11 Szabó 1998b.
12 Butzer 1976.
13 Sekulić / Hadžić 2005.
14 Scheffer / Schachtschabel 2002.

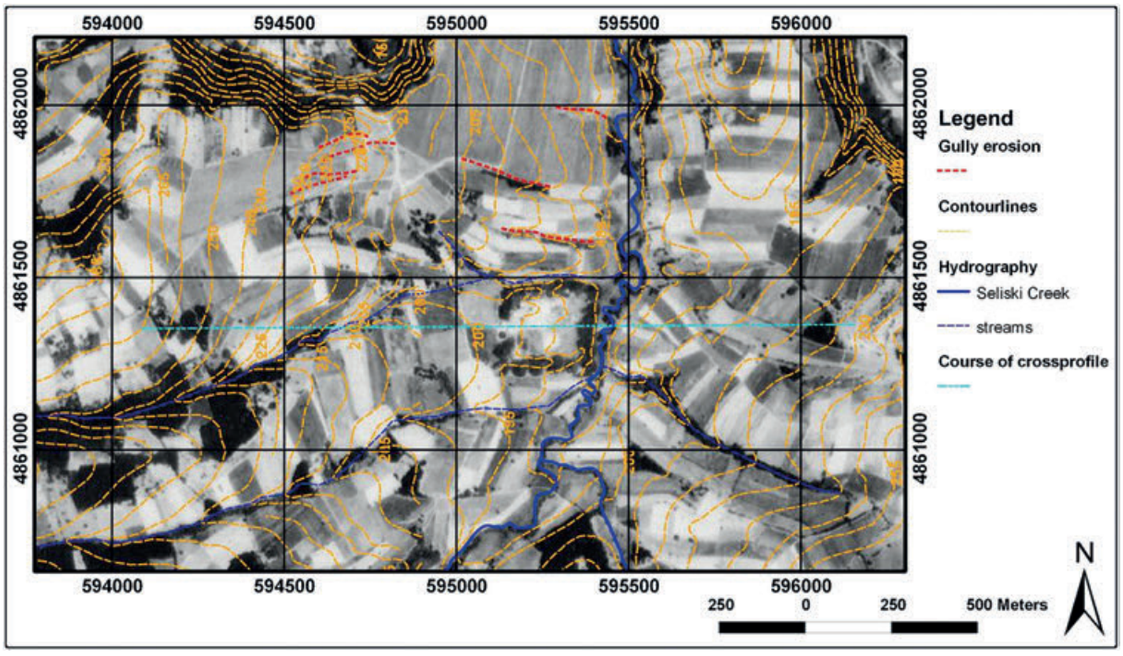

Fig. 7. Topography and marked relief elements of the close surrounding of *Felix Romuliana*. On the background of a panchromatic orthorectified air-photograph of the area the Seliški Creek is marked in blue and contour lines are dashed and marked in orange. *Felix Romuliana* is located in the center of the map, clearly identifiable by its rectangular structure.The E-W-striking light blue line marks the position of the topographical profile displayed in *fig. 8*. Dashed red lines mark the location of gully structures.

METHODS

Data processing

Determination of the site characteristics and the topographical analysis are based on the 1 : 10 000[15] and 1 : 50 000[16] scale topographic maps and the digital elevation data provided by the Shuttle Radar Topography Mission (SRTM) with a ground resolution of 90 × 90 m[17]. Additionally, data from the 1 : 100 000 geologic map[18] are included. All map series were edited in Gauss-Krüger Projection. For mapping and further work they were converted to UTM (Universal Transverse Mercator). The georeferencing and the reprojection of the maps were carried out applying Erdas Imagine 8.6.

The SRTM data based digital elevation model was corrected in the 3DEM software. Voids included in the SRTM datasets were corrected applying the 'Patch missing data' operation in 3DEM. This operation corresponds to a calculation of the missing data by linear interpolation from the surrounding pixels[19]. After the correction the DEM was exported to GRID format in UTM.

Determining site characteristics of the fortification and the area of the topographical analysis

The site characteristics of the fortification *(figs 7; 8)* like geomorphological conditions and its geometrical attributes such as gradient and aspect of slopes were determined from the topographic maps, SRTM DEM and from the derivatives of the DEM (slope, aspect) applying ArcGIS 9.2. The extension of the area for the GIS analysis was delineated based on topographical deduction concerning to the three neighbouring fortifications *Felix Romuliana*, Savinac, and Kostol. The extent of the analysed area totals 193.75 km^2 *(fig. 4)*.

15 Military Geographical Institute, Belgrade, Serbia, 1967/68.
16 Military Geographical Institute, Belgrade, Serbia, 1955.
17 http://dds.cr.usgs.gov/srtm/ (Last access 19.01.2012).
18 Osnovna Geoloska Karta SFRJ, Belgrade, 1989.
19 www.megwrm.aun.edu.eg/sub/workshop5/pdf/3dem.pdf (Last access 19.01.2012). *Operating Instructions, 3DEM Software for Terrain Visualization and Flyby Animation, Version 20.*

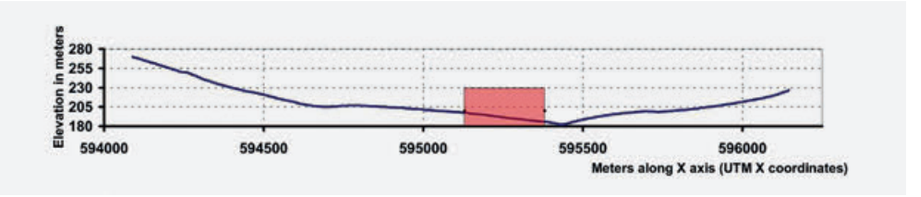

Fig. 8. Topographical W-E cross profile through the close surrounding of *Felix Romuliana* (marked with rectangle) across Seliški Creek. Location of the cross profile is marked in *fig. 7*.

Geomorphological mapping

Geomorphological field survey was carried out in August 2008 following the mapping guidelines of Hartmut Leser and Gerhard Stäblein[20]. The resulting geomorphological map *(fig. 10)* is based on 1 : 50 000 scale topographic maps and was edited applying the software ArcView 3.2. After all different features mapped were joined into a single polygon vector layer with different ID numbers in the attribute table except the stream network which is a polyline layer.

Map Calculations

For the map calculation merged GIS layers were required. To receive the correct layer structure all raster data were classified and reclassified and ongoing converted to polygon vector layers. The slope and aspect data were generated as derivatives of the SRTM digital elevation model applying the Spatial Analyst tool of ArcGIS 9.2. Both datasets, available as raster data, were classified with a focus on the site characteristics of *Felix Romuliana*: Slope data were classified into the categories < 2.16° and ≥ 2.16°.The aspect data were classified into the classes east exposition (45–135°) and the other exposed areas (135–45°). Successional new values were allocated to the classes: [slopes < 2.16°] = 1 and [slopes ≥ 2.16°] = 0, [east aspect] = 1 and [non-east aspect] = 0. The resulting layers were converted into vector layers (polygons) applying ArcGIS 9.2. From the vector layers, areas attributed by classes with 0 values were removed. From the geomorphological map, the valley sides were extracted and also got the value 1. The different polygon layers were blended by multiplication using ArcView 3.2. The remaining areas with values > 1 indicate sites with similar site characteristics to those known for *Felix Romuliana*. Finally, as the construction of a fortification has a minimum extent and thus requires a defined area, only complex areas with more than 4.5 ha were selected.

RESULTS

The area analysed can be geographically divided into three large areas: the Sumrakovac-Sarbanovac Basin in the west, the Baba Jona Gorge in the central, and the west part of the Zaječar Basin *(fig. 10)*. The relief reflects the different geological conditions of the area *(figs 9; 10)*.

	Sumrakovac-Sarbanovac Basin	**Baba Jona Gorge**	**Zaječar Basin**
Valley density [km × km^{-2}]	North: 1,24 South: 2,08	North: 2,18 South: 1,67	North: 1,99 South:1,08
Slopes [°] (average)	North: 3,24 South: 6,67	North: 7,85 South: 6,35	North: 5,23 South: 4,11

Table 1. Valley density and average of slopes gradients in the analysed area.

In the north of the Sumrakovac-Sarbanovac Basin and in the Zaječar Basin Miocene sediments (sandstones, clay, sand and gravel conglomerates) occur. In contrast, in the south of the Sumrakovac-Sarbanovac Basin Upper Cretaceous volcaniclastics and sedimentary rocks (claystone, sandstone, and marl)[21] are deposited. Correspondingly, in the southern part of the Sumrakovac-Sarbanovac Basin and the Zaječar Basin the valley density is higher and the slopes are steeper than on the north part of the Sumrakovac-Sarbanovac Basin *(tab. 1; fig. 11)*.

20 Leser / Stäblein 1975.
21 Osnovna Geoloska Karta SFRJ, 1989.

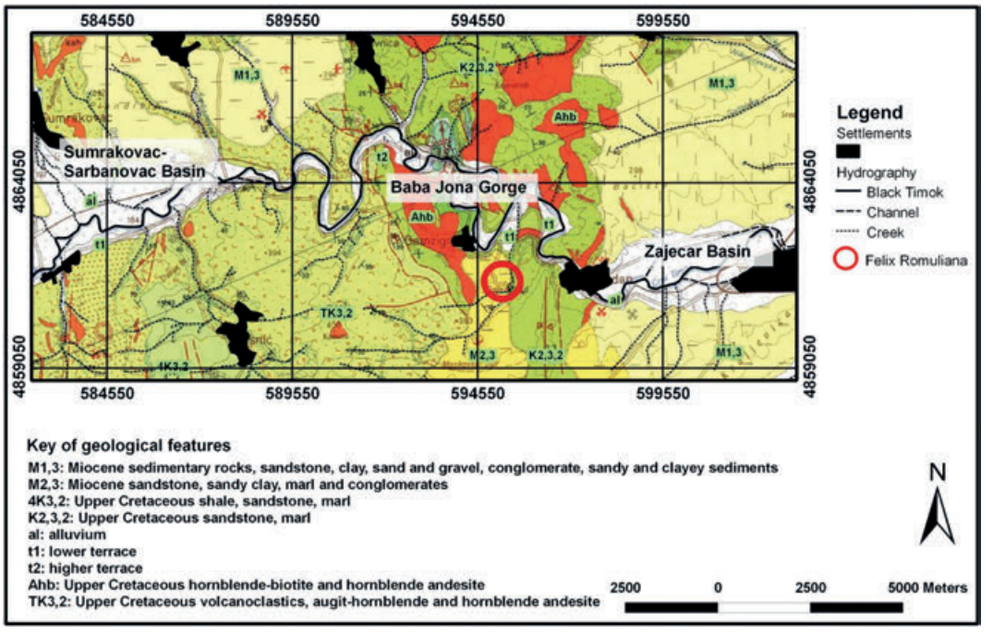

Fig. 9. Geological map in the surrounding of *Felix Romuliana*. Data source: Osnovna Geoloska Karta SFRJ, Belgrade, 1989.

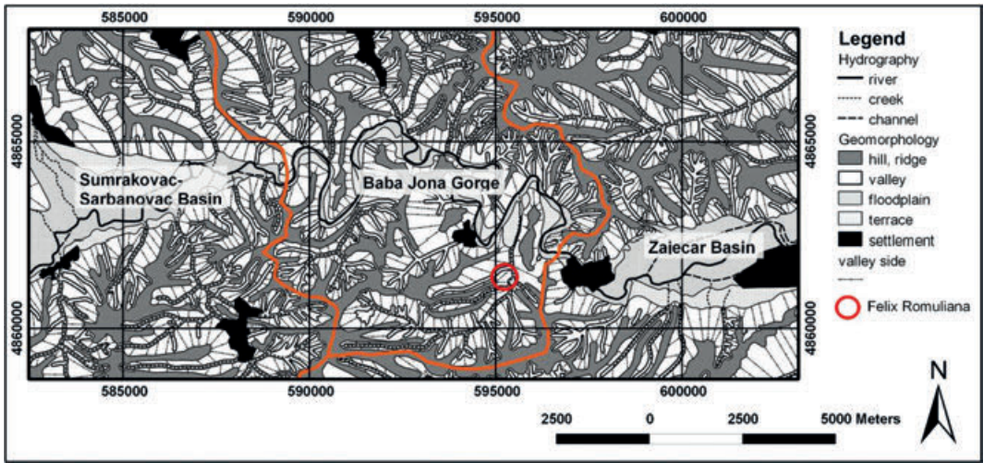

Fig. 10. Geomorphological map in the surrounding of *Felix Romuliana*.

Landscape characters in the Baba Jona Gorge also differ between its northern and southern part: In its northern part, where Upper Cretaceous magmatic rocks (andesites), sandstones and marls occur, the valley density is higher and the slopes are steeper than in its southern part where large areas are covered by Upper Cretaceous volcaniclastics and Miocene sandstones, marls and conglomerates[22] *(tab. 1, fig. 11)*. In general, the landscape characters of the southern Baba Jona Gorge are similar to those of the southern Sumrakovac-Sarbanovac Basin except the center of the area where Miocene sedimentary rocks are located. The relief is more gentle than in the surrounding area and the slopes are lower than 5°. *Felix Romuliana* is placed here in a distinctive bowl shaped part of the valley surrounded by gentle slopes.

The data analysis points out that several locations exist, where site characters comparable to those of the *Felix Romuliana* site are partly available. Restrictions appear as most of these areas are much smaller than the 4.5 ha *Felix Romuliana* occupies. After extracting those sites which are

22 Osnovna Geoloska Karta SFRJ, 1989.

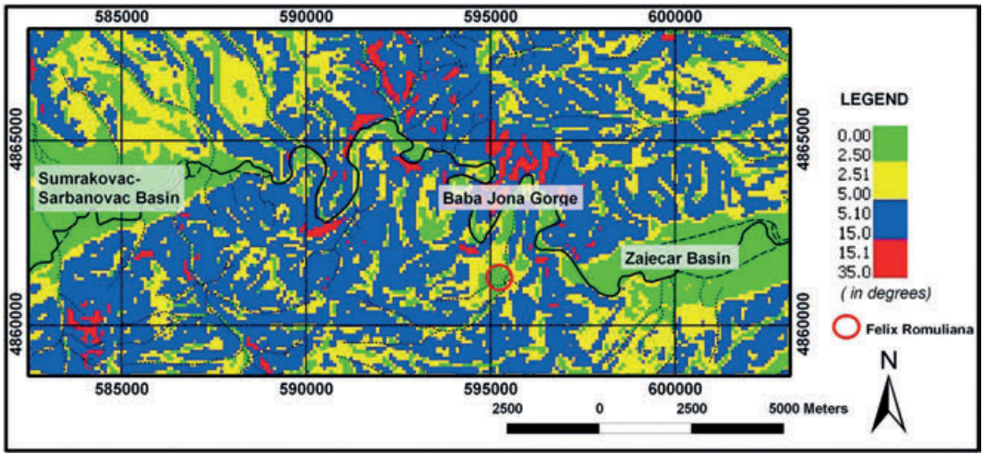

Fig. 11. Slope gradients in the surrounding of *Felix Romuliana*. Classification after Pécsi / Ádám 1985.

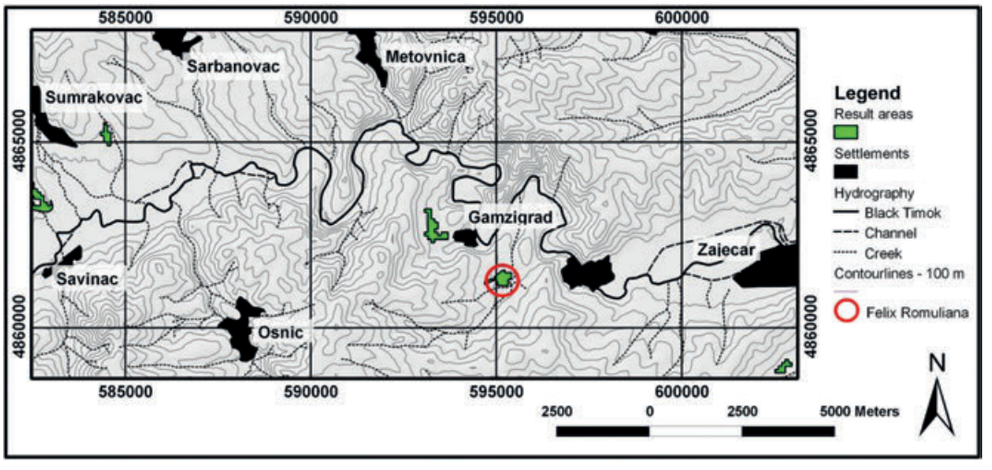

Fig. 12. Topographic map of the surrounding of *Felix Romuliana*-Gamzigrad highlighting the areas in green which have similar topographic characters with gentle slopes <5° and a size larger than 4.5 ha as available at the location of *Felix Romuliana*.

larger than 4.5 ha and which are located on east exposed slopes, four locations remained *(fig. 12)*. One of these sites is nearby *Felix Romuliana* west of the village Gamzigrad, two other sites are in the vicinity of Sumrakovac, one site is located south of Zaječar.

DISCUSSION

The topographical analysis points out that the site characteristics of *Felix Romuliana* are unique in its surroundings. There is no other site with the same character in a neighbouring area of at least 200 km^2. The inclinations of less than 2.5° are an outstanding precondition for the identification of a building ground[23]. At the *Felix Romuliana* site an alluvial fan complex deposited from a minor tributary in the alluvial plain of the Seliški Creek provides moderate inclining slopes and sufficient space. The genuine Miocene sedimentary bedrock allows the development of a low mountain range landscape with slightly rolling plains in the central part of the basin and bowl-shaped tributary valleys. In contrast, in the neighbouring areas, especially in the north outcropping Andesites are of high petrographic hardness and prefer the development of plunging slopes and steep incised valleys. Additionally, low permeability

23 Pécsi / Ádám 1985.

of the Andesites faciliates concentrated runoff coinciding with a relatively high valley density compared to the areas with Miocene sedimentary bedrock[24]. In consequence, due to the steep slopes and the dissected plains, a suitable terrain for settlements is missing.

The elevated location of *Felix Romuliana* on top of the vertex of a fan tributary to the valley floor of Seliški Creek reinduces that the palace is protected from the seasonal flood events of the Seliški Creek. Additionally, the proximity of *Felix Romuliana* to the valley floor was probably playing an important role for the location decision considering the water supply of the palace: Next to the availability of surface water from the Seliški Creek the high groundwater table in the alluvial plain allows easy groundwater access by shallow wells. Presumably the east slope aspect was not determining the construction and location of *Felix Romuliana*. During the data analysis the filtering potency of this parameter was not really strong in the calculations.

Baba Jona Gorge builds the wider surrounding of *Felix Romuliana*. This area is located half-way between the two other fortifications Kostol-Zaječar and Savinac. Several fortifications, and Antique settlements, and mines are located along the Black Timok Valley to Horreum Margi in the Morava Valley: (from East to West) Kostol, *Felix Romuliana*, Savinac, Valakonje, and Lukovo[25]. According to the equal distances, the location of *Felix Romuliana* corresponds to the settlement network. Its construction in the Baba Jona Gorge is double-sided: The territory of the gorge can be watched from *Felix Romuliana* but also *Felix Romuliana* is shielded. The subtending hill is also an important advantage of *Felix Romuliana*. From the hilltop where the *Tetrapylon* is located the whole Zaječar Basin can be overlooked. Previously, this area was also called 'Straza' which means watchpost[26].

By the topographical and morphometrical data analysis four sites with comparable site characters to that of *Felix Romuliana* are identified. In general, the shapes of these four other sites are irregular. Most likely it would have been necessary to rework the landscape to receive a total construction area of 4–5 ha. Additionally, their location is less in the approximate middle between Kostol-Zaječar and Savinac than closer to one of them. In the northwestern part of the Baba Jona Gorge the landscape is similar to that of *Felix Romuliana* considering geomorphological conditions and topographic situation; anyhow, slopes incline 2.5–5° and thus are less suitable for the construction of larger buildings[27]. Another location with similar site traits like *Felix Romuliana* is located west of the village Gamzigrad. This area is an old and 'hanging' meander of the Black Timok River[28]. The favorable slope gradients can be measured along the old riverbed. At all, this site is located in a higher elevation above the river bed and it is in more exposed situation compared to the site of *Felix Romuliana*. Because of its position the water supply is relatively weak as nearby creeks are lacking and the groundwater table is relatively deep. Due to exposition and higher elevation the site is also highly wind exposed. All in all, the complexity of the different favorable parameters are giving an outstanding character to the site where *Felix Romuliana* was built.

CONCLUSIONS

The topographic and morphometric analyses point out that the site where *Felix Romuliana* is located is unique in its surrounding area. The different suitable characteristics of the site can be found in several locations of the surroundings, but at *Felix Romuliana* all preferable physical conditions are combined with the favourable environmental conditions. The outstanding character of the site is based on the complexity of favourable features such as the type of bedrock, relief, and topography.

24 Szabó 1998a.
25 Petrović 1997.
26 Mačaj 1892.
27 Pécsi / Ádám 1985.
28 Petrović 1970.

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ABSTRACT

A topographical analysis is carried out to comprehend the situation of the Late Antique emperor's palace *Felix Romuliana* in the surrounding area. Major focus is the identification of locations with comparable site characteristics and highlighting the outstanding traits of the location where *Felix Romuliana* is built. The local topographical and morphometrical attributes were used as criteria for the site analysis and characterisation. Data analysis points out the unique site characteristics of *Felix Romuliana* in the broader surrounding area.

ZUSAMMENFASSUNG

Eine topographische Analyse wird durchgeführt, um die Situation in der Umgebung des spätantiken Kaiserpalastes *Felix Romuliana* zu erfassen. Schwerpunkt sind die Identifizierung von Standorten mit vergleichbaren Standortmerkmalen und die Beschreibung der herausragenden Merkmale des Ortes, an dem *Felix Romuliana* gebaut worden ist. Die lokalen topographischen und morphometrischen Merkmale wurden als Kriterien für die Analyse und Charakterisierung des Standortes verwendet. Die Datenanalyse zeigt die einmaligen Standorteigenschaften von *Felix Romuliana* im Vergleich mit der weiteren Umgebung auf.

(Übersetzung: J. Gier)