Assessing the intentionality of spatial organization. Cemetery of Župna Cerkev (Kranj, Slovenia) case study

Preučevanje namernosti prostorske ureditve. Primer grobišča Župna cerkev v Kranju

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Izvleček

Osnovni namen prispevka je poudariti pomen prostorske analize grobišč z orodji prostorske statistike. Naš pristop temelji na kombinaciji analize vzorca točkovne razmestitve ene spremenljivke (t. i. Ripleyjeva K-funkcija) z izborom tistih orodij prostorske statistike, ki upoštevajo vrednosti globalne in lokalne avtokorelacije. Uporabnost teh orodij v kontekstu arheoloških analiz grobišč smo preizkusili na primeru srednjeveškega grobišča Župna cerkev v Kranju. Natančneje, preverili smo, ali je prostorska ureditev grobišča naključna, in če ne, ali je namerna. Prepoznali smo namerno, kronološko dinamično izbiro prostora pokopavanja.
Ključne besede: Slovenija, arheologija, prostorske analize, srednjeveška grobišča

Abstract

This article is focused on highlighting the importance of assessing spatial patterns in archaeological analyses of cemeteries through a statistically driven approach. It is based on the combination of Ripley's K-Function and selected geostatistical tools that take into consideration the values of global and local autocorrelation. Their feasibility in funerary contexts is demonstrated on the mediaeval cemetery of Župna Cerkev in Kranj (Slovenia). The case study was used to test whether the spatial distribution of graves is non-random and, if so, whether it is intentional. The methods used made it possible to recognize an intentional, chronologically driven choice in grave placement.
Keywords: Slovenia, archaeology, spatial analysis, mediaeval cemeteries

INTRODUCTION

The mediaeval cemetery of Župna Cerkev is situated at the heart of the ancient town of Kranj (Slovenia). Its suitable location on a promontory overlooking the confluence of the Sava and Kokra Rivers encouraged the occupation from the Iron Age onwards (*Fig. 1*). The town gained regional importance in the late Iron Age/early Roman period, and under the Langobards in the late antiquity period and in the early mediaeval period. Due to the regional importance of the contemporary settlement and especially due to its size, the Župna Cerkev cemetery is deemed to be of regional importance for the archaeology of the early mediaeval period in the South-Eastern Alpine area.

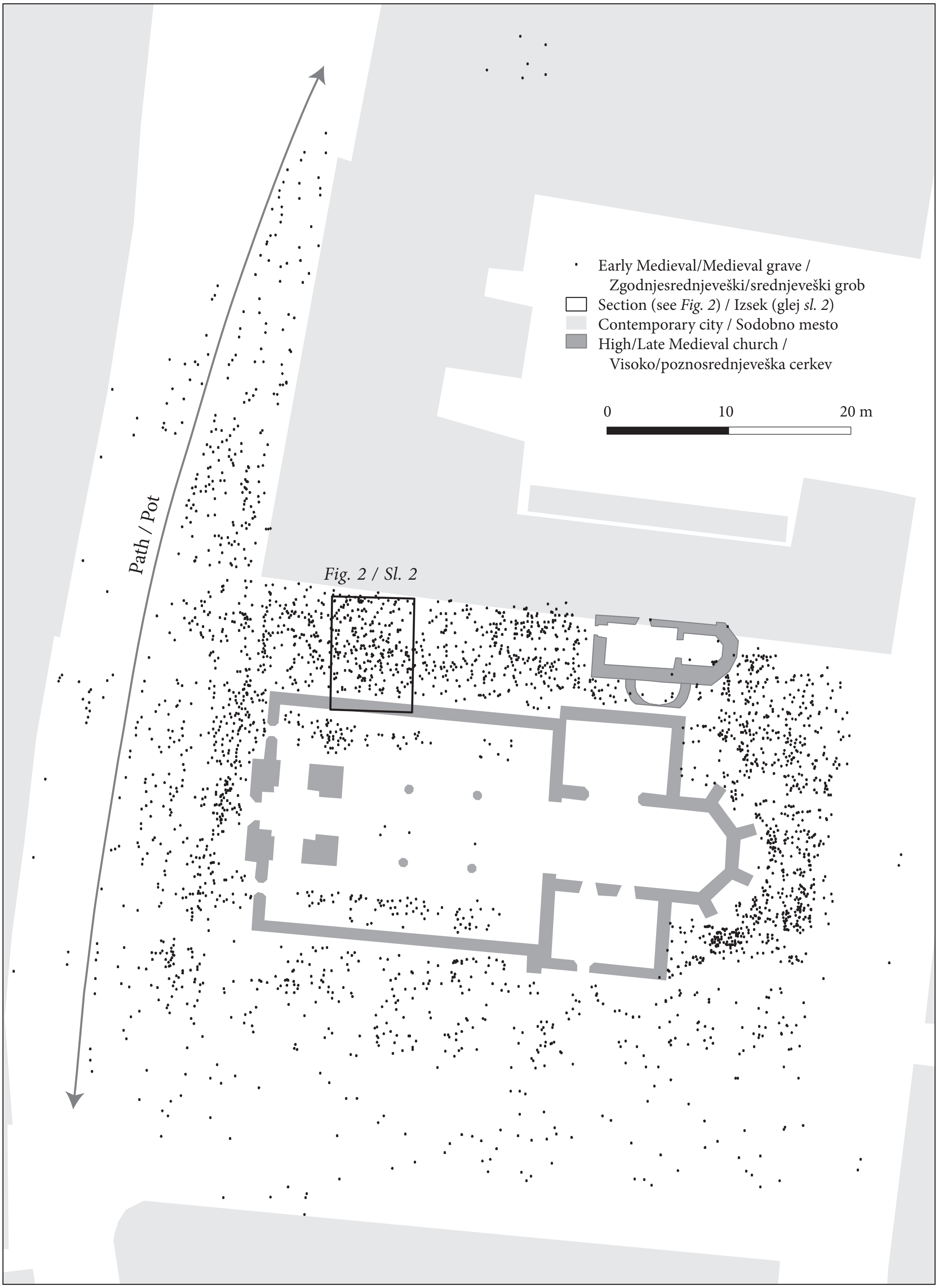

Fig. 1: Župna Cerkev in Kranj. Cemetery, the location of the site. Arrow represents the probable path as revealed by the gap in burials. Black square marks the extract presented in *Fig.* 2.
Sl. 1: Župna cerkev v Kranju, lega grobišča. Puščica prikazuje verjeten potek poti, ki jo dokazuje prazen prostor med grobovi. Črn pravokotnik označuje mesto izreza za *sliko 2.*

The cemetery was excavated between 1953 and 2013, spanning several vastly different excavation methods. In total, 2,936 graves dating from the 8th to mid-18th centuries have been excavated (Štular, Štuhec 2015, 34–42; Pleterski, Štular, Belak 2016, 7–25).

This article is part of an ongoing project that aims to catalogue, analyse, and document the site. The large number and especially the high density of burials – reaching up to 19 burials per square metre – requires a novel approach to the archaeological analysis of cemeteries. This article aims to present a toolkit of robust and versatile methods of spatial statistics that are executable in an off-the-shelf GIS environment and can be applied in the analysis of Župna Cerkev in Kranj and similar cemeteries.

THEORETICAL BACKGROUND

Spatial analysis in archaeology has a venerable tradition from the late 1970s onwards. It was predominantly oriented to reconstructing either the relationship between humans and the landscape (inter-site scale) or the use of space and the arrangement of activities practised within archaeological and ethnoarchaeological contexts (intra-site scale) (for an overview, see e.g., Whallon 1973; 1974; Carr 1984; Hietala 1984; Aldenderfer 1987; Voorrips, O'Shea 1987; Blakholm 1991; Kroll, Price 1991). Since then, archaeologists have adopted a wide range of theoretical concepts, models and theory-dependent methods from various scientific fields, such as computer and social sciences, geography, geology, biology, and mathematics (Wheatley, Gillings 2002; Conolly, Lake 2006; Salisbury, Keeler 2007; Nakoinz, Knitter 2016). According to such inter-disciplinary theories, the archaeological data acquisition strategies are structured, the type of analysis chosen, and the interpretation of analysis results is influenced (Hodder, Hutson 2003).

Since the late 1980s, spatial analysis in archaeology has been characterized by an increasing application of GIS (Geographical Information System) for managing archaeological data and providing a fundamental tool for the interpretation of archaeological contexts (Zubrow 1990; Gillings, Sbonias 1999; Wheatley, Gillings 2002; Bevan, Conolly 2004). Ever more frequently, GIS is being applied on an intra-site basis, aimed at the interpretation of settlements and settlement activities (Peterman 1992; Pettitt 1997; Huggett 2000; Lavachery, Conelissen 2000, 153; Moyes 2002; D'Andrea, Gallotti 2004; Gallotti et al. 2011; 2012).

In a different vein, the archaeology of death and burials has not seen such a vigorous adoption of spatial analysis techniques.

Until the 1970s, the spatial component was all too often ignored (Goldstein 1981, 57). As an early example, the analysis of the Moundville (USA) cemetery – where monothetic-divisive cluster analysis using the information statistic was used for grouping the burials – can be cited (Goldstein 1981, 62–63; see bibliography cited). The work on the El Cigarralejo (Spain) cemetery is an early implementation of GIS in archaeology, focusing on intra-site mapping (Quesada, Baena, Blasco 1995). Two edited volumes in the early 2000s demonstrated a growing interest in the spatial analysis of funerary areas. However, most of the cemeteries analyzed were relatively small and low-density ones, and the prevailing method employed was a visual analysis of scatterplots or plan-drawings (Silverman, Small 2002; Šmejda, Turek 2004a). As a notable exception, the prehistoric cemetery at Holešov (Czech Republic) – where kernel density was used to map the distribution of artefacts and trend analysis of mean tin content – can be cited. Investigating the major concentration of specific archaeological markers, the author filtered the values of grid cells taking into account the input cell value (identified in the middle of the kernel) and the values of its immediate neighbours; in this way, it was also possible to identify and control the potential "false zero effect" that can arise close to site borders (Šmejda, Turek 2004b, 57–68).

Among the most advanced uses of spatial statistics in the study of cemeteries in archaeology is the application of Ripley's K-function analysis to determine the proximity of statistically significant clusters within four early Anglo-Saxon cemetery sites (UK); the statistically significant distance suggested by this method was used to apply kernel density analysis to data sets, in order to visualize and define the areas of clustering for the data (Sayer, Wienhold 2013).

Despite the above-mentioned studies, scatterplots (intended for visual examinations) remain by far the most common method employed for the spatial analysis of cemeteries (Goldstein 1981, 67; cf. Fotheringham 2002, 7; Bevan et al. 2013). The archaeology of large mediaeval cemeteries is no exception (e.g., Losert, Pleterski 2003; Filipec 2012; Sokol 2016).

Moreover, it is at large mediaeval cemeteries with an extremely high density of burials, such as Župna Cerkev, where the shortcomings of this

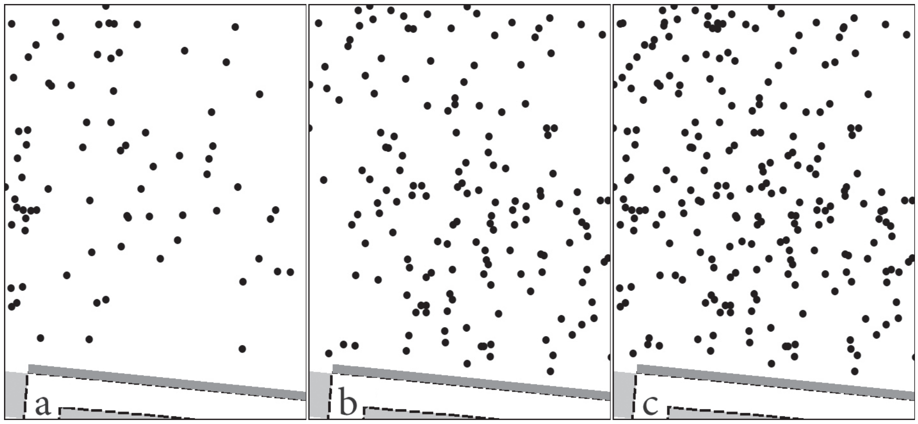

Fig. 2: Scatterplots of graves within the selected area: *a* – Early Mediaeval graves; *b* – Mediaeval graves; *c* – all graves. For the location see *Fig. 1*.
Sl. 2: Točkovni načrt grobišča, izsek: *a* – zgodnjesrednjeveški grobovi; *b* – po-zgodnjesrednjeveški grobovi; *c* – vsi grobovi. Za lokacijo glej *sliko 1*.

method become painfully obvious: the high density of burials prevents visual assessment and interpretation of data mapped as scatterplots (*Fig. 2*). Even the simplest of tasks, reliable delineation of the highest density areas, is all but impossible. Instead, some form of isopleth map is needed (cf. Banning 2000, 28–30). Most of this article deals with creating meaningful isopleth maps through the use of spatial statistics.

MATERIALS AND METHOD

Materials

The documentation of the Župna Cerkev cemetery in Kranj stems from six decades of archaeological excavations; therefore, it varies significantly in both quantity and quality. For method testing, the interference caused by this circumstance must be minimized. To this end, we are employing only the lowest-common-denominator data, i.e., data that are for all excavations from 1953 onwards in comparable qualities and quantities. The chosen datasets are location and a rough chronology.

Our primary analysis of spatial distribution is based on xy point data for each recorded burial. In order to ingest the data (stemming from six different *ad hoc* projected coordinate systems, e.g., xy measured from the corner of the church building, and four different recording systems) into the unified state plane coordinate system, we have adopted the following procedure:

– reconstruction of each *ad hoc* projected coordinate system;
– mapping of each *ad hoc* projected coordinate system to the state plane coordinate system (GK D96);
– mapping of archaeological data – derived from either xyz measurements or archaeological drawings – to the state plane coordinate system.

This approach differs from the most commonly used one, in which archaeological drawings are directly georeferenced to the state plane coordinate system using ground control points. The chosen approach was necessary (i) due to the lack of surviving ground control points, and (ii) in order to minimize the impact of errors made by surveyors at the time of data acquisition (e.g., mistakes made by laying down the grid using a simple tape measure) and the error introduced during the georeferencing process; while the two cannot be avoided, by using our approach the mistakes are added, whereas using GCPs mistakes are multiplied and distorted.

The result is a geodatabase of 2,881 individual burials with known location data, each represented with an xy point located at the occiput of the skeletal remains. This robust dataset is intended for quantitative analyses only.

Since the analysis of the site is on-going, a detailed chronology is not yet available. However, a classification of burials in two chronological phases has been made *in situ*: the early mediaeval and post-early-mediaeval phase (high mediaeval, late mediaeval, and post-mediaeval graves could not be readily distinguished). This division, recognized by different excavators independently of each other, was based on the following criteria: burial depth, the colour of the bones (a proxy for the state of decay of organic substances), the general state of burial preservation, and grave goods (if present).

Although such a crude method does not adhere to modern standards, a preliminary stratigraphic analysis on the subset of 158 burials already implemented (Rihter 2016) confirmed the original estimation as 100% accurate: a Harris matrix has been produced based on the available stratigraphic data, and all of the burials marked as Early Mediaeval by the excavators proved to be the earliest. We, therefore, assume that the *in situ* chronological division suffices for the method development and testing, which is the purpose of this article. Alas, the preliminary *in situ* dating was not recorded in the 2011–2013 excavation campaign that re-excavated the entire cemetery in the search for burials that went undetected by older excavations, e.g., because archaeologists were not allowed to cut down the trees or remove portions of pavement. This means that preliminary dating is only available for 79.3% of burials, but the burials missing this information are, in the majority, dispersed throughout the cemetery.

Visual analysis of the scatterplot of all burials (*Fig. 1* and *Fig. 2*) reveals that the cemetery is spread around the church buildings contemporary to each phase. Burials are most dense in the W, N and E sectors outside as well as in the NW corner inside the present-day church building built soon after 1430. A relatively high density can also be observed in the NW extension of the cemetery. In the S sector, the density is visibly less and is fading away from the church. Towards the W, the density is relatively uniform up to the linear gap that is presumably a path contemporary with the cemetery; across the linear gap, only sporadic burials have been excavated. Visual analysis of the early mediaeval phase scatterplot reveals the concentrations in the W and S sectors as well as in the NW and SW corners inside the present-day church. Burials of the later phase are concentrated in the N and E sectors, as well as immediately adjacent to the western church wall.

Method

In order to develop methods, a starting hypothesis was set: the millennia of burials at the Župna Cerkev cemetery was characterized by a dynamic burial practice; this is reflected (among others) in burial density, i.e., the frequency of burial instances within a predefined grid.

As a null hypothesis, a random spatial distribution of burials was assumed. The rejection of the null hypothesis would be proof of an intentional dynamic spatial organization of the cemetery.

Therefore, first, the non-randomness of the spatial distribution of the burials was established. This was achieved by fitting a spatial distribution to different theoretical models of distribution using SPSS Statistics 22.0. The models used are Poisson, Geometric, Binomial, and Exponential. Except for the first model, associated with a random distribution, all the others mirror the existence of intentionality in their distribution (Achino 2016; Revelles et al. 2017).

The spatial pattern that characterizes the graves was explored by applying the following mathematical tools: Multi-Distance Spatial Cluster Analysis (Ripleys K-function), Spatial Autocorrelation (Global Moran's I), Optimized Hot Spot Analysis (Getis-Ord G*) and Optimized Outlier Analysis (Local Moran's I), implemented in ArcGis 10.3. They make it possible to identify whether graves are spatially distributed according to a) a regularly dispersed model, b) randomness, or c) clusters.

Ripley's K-function

This statistical test, successfully utilized in numerous other archaeological spatial analyses (Bevan, Conolly 2006; Crema et al. 2010; Vanzetti et al. 2010; Winter-Livneh et al. 2010; Sayer, Wienhold 2013; Duncan, Schwark 2014; Markofsky 2014;

Thacther, Milne, Park 2017, as examples), has proved to be an effective measure of the spatial relationship between point data. Specifically, it is a way to measure statistically significant clustering or aggregation and regularity or segregation of point data at multiple scales, regardless of the shape of the area being studied (Conolly, Lake 2006, 166; Sayer, Wienhold 2013, 77). Within the ArcGis environment, it is a particularly effective analytical function because the tool combines a commonly used transformation (L(d)) (Winter-Livneh et al. 2010, 288; Cable 2012, 148; Sayer, Wienhold 2013; Carrer 2015; Thacther, Milne, Park 2017) of Ripley's K-function with Monte Carlo simulation. Monte Carlo simulation randomly generates a distribution of points equal to the number of input points, which creates the confidence intervals or envelopes according to the number of permutations (Winter-Livneh et al. 2010, 288; Sayer, Wienhold 2013, 78). This simulation makes it possible to verify whether the data fall above the high-confidence envelope created by it and consequently guarantees that the data are clustered in a statistically significant way; if the data fall below the confidence interval, they are dispersed in a statistically significant way. In contrast, when they fall between the lower and upper boundaries of the confidence interval created by simulation, the distribution does not statistically differ from randomness. In this case, 999 permutations were run in the Ripley's K-function tool to create such a confidence level.

Spatial Autocorrelation: Global and Local Moran's I

In order to better characterize the broader spatial distribution of graves, the Global Moran's Index for Spatial Autocorrelation was first calculated. It quantifies the magnitude, extent and intensity of autocorrelation, as spatial dependence between the frequencies of the graves within the analysed area, when the null hypothesis of spatial randomness can be rejected; I values range from -1 (perfect dispersion) to +1 (perfect correlation) and a zero value indicates a random pattern (Cliff, Ord 1973; Moran 1950). If spatial dependence was certified, it was then determined from which distance the clustering occurs. The use of Moran's I statistic is quite common in archaeological research (Kvamme 1990; Premo 2004; Carrer 2015; Achino 2016). In addition to the Global Moran's I index, the local spatial autocorrelation was also calculated; it identifies the local regions of strong autocorrelations, that is, concentrations in a particular zone of the global space, such as unusually high/low values of a variable, more than the expected mean value. Local indices of spatial association (LISA, Anselin 1995; Levine 2013) allow the local level of spatial autocorrelation to be examined, in order to identify areas where values of the variable are both extreme and spatially homogeneous; this leads to the identification of so-called hot spot areas, where the considered phenomenon is extremely pronounced across localities – as well as spatial outliers. In other words, this index highlights, in this case, the spatial distribution of similar and dissimilar values of autocorrelation between the frequencies of graves within the analysed area.

For this case study, Outlier Analysis as well as Hotspot Analysis, available within the ArcGIS environment, were applied. They identified statistically significant spatial clusters of high values (hot spots), low values (cold spots) and spatial outliers using the Anselin Local Moran's I statistic and the Getis-Ord G* statistic, respectively. The program provides z-scores and p-values, i.e., measures of statistical significance that mirror whether or not to reject the null hypothesis of randomness. Such values indicate, for Cluster and Outlier Analysis, whether the apparent similarity (a spatial clustering of either high or low values) or dissimilarity (a spatial outlier) is more pronounced than one would expect in a random distribution. In the same way, the z-score and p-value indicate, for Hot Spot Analysis, whether the observed spatial clustering of high and low values is more pronounced than one would expect in a random distribution of those same values. Both tools are applied for this study in their optimized version since a sufficiently numerous sample of graves is available.

RESULTS

As a first step in the analysis of the Župna Cerkev cemetery in Kranj, the non-randomness of the spatial distribution of the burials was established by the rejection of the null hypothesis of a Poisson distribution. The data fitted mainly an exponential distribution, which mirrors an intentional spatial distribution of the variable under analysis. Furthermore, the Global Moran's Index for Spatial Autocorrelation indicates that the spatial organization of graves is clustered, and there is a less than <1% likelihood that this pattern could be the result of random chance. According to the results of the Ripley K-function (*Fig. 3*), from a distance of 4 metres the observed K value is larger than the expected K value; then, from this particular distance, the distribution is more clustered than random.

Optimized Outlier Analysis (LISA) shows the presence of areas that are positively spatially autocorrelated (*Fig. 4*); in the N sector of the cemetery, this means that high values surrounded by high values are concentrated. They are surrounded by some of the least dense squares (low values surrounded by high values, outliers). The S sector and northern extension of the cemetery are characterized by positive autocorrelation, with low values surrounded by low values.

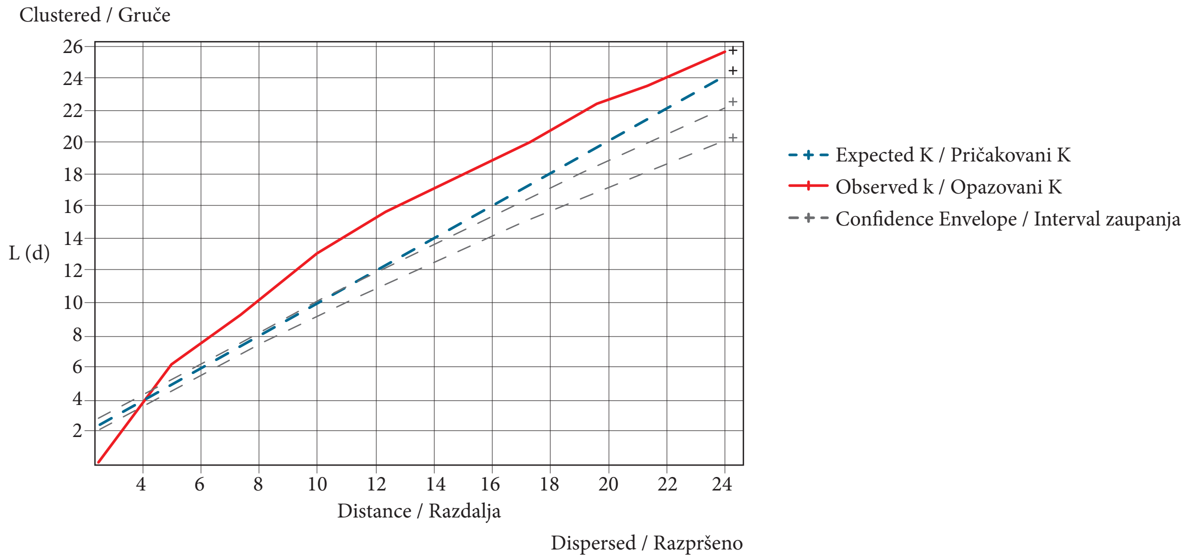

Fig. 3: Ripley's K-function analysis graph showing local distribution – L (d) –, i.e. significance from the distance of 4 meters onwards.
Sl. 3: Rezultat analize vzorca točkovne razmestitve ene spremenljivke (t.i. Ripleyjeve K-funkcije) kaže statistično pomenljivost za opazovane razdalje – L (d) – 4 metre in več.

Predictably, the Hot Spot Analysis (Getis-Ord G*) results adhere to an almost identical scenario: hot spots in the N, E and W sectors, in the NW corner inside the church and in part of the northern extension of the cemetery; the only noticeable cold spot, other than the fringes of the cemetery and the interior of the church, is a gap in the centre of the N sector where a mediaeval burial chapel stood (*Fig. 5*).

In continuation, the overall spatial distribution is compared to both chronological phases, the early mediaeval and post-early-mediaeval. The null hypothesis of a Poisson distribution was rejected for each chronological phase individually. Similarly, the Global Moran's Index for Spatial Autocorrelation indicates, in both cases, that there is a less than <1% likelihood that the spatial patterns could be the result of random chance.

Optimized Outlier Analysis (LISA) and Optimized Hot Spot Analysis (Getis-Ord G*) provided invaluable insight into the spatial pattern. Early mediaeval graves exhibit a very well-defined hot spot in the NW and a cold spot in the SE sector (*Fig. 6*).

The later phase exhibits an almost exactly opposite spatial distribution with a hot spot in the SE and a cold spot in the NW and S sectors. There is an additional smaller hot spot in the N sector (*Fig. 7*). The impression is, therefore, that while the two phases largely overlap, the focal areas of each are on the opposite sides of the church building.

DISCUSSION

The above analysis was designed to confirm or refute the hypothesis that the burial practice in Župna Cerkev cemetery in Kranj was dynamic and that this dynamic is reflected, among others, in spatial patterns. The hypothesis is confirmed since the chronological dynamics in the spatial pattern has been demonstrated.

There are further archaeological interpretations to be drawn.

(1) The non-randomness of the spatial distribution was clearly established, both for the entire cemetery and for each chronological phase individually. In the context of mediaeval and post-mediaeval burial practices (e.g., Steuer 1982; Parker Pearson 1999, 11–17; Podpečan 2006, 19–20; Petts 2007; Eichert 2010; 2013), this can only be explained by intentional human choice governing the placement of individual graves. The spatial distribution of the Župna Cerkev cemetery in Kranj, therefore, exhibits statistically relevant intentional human choices in grave placement.

Although this inference may, at first, seem self-evident and, as such, pointless, an overview of the relevant literature reveals its importance. At least as far as archaeological explanations of spatial patterns in Central European early mediaeval cemeteries are concerned, for the most part, spatial patterns are not even discussed (Pleterski

Fig. 4: Result of Optimized Outlier Analysis representing outliers and clusters within the cemetery.
Sl. 4: Rezultat optimizirane analize izstopajočih vrednosti prikazuje osamelce in gruče na grobišču.

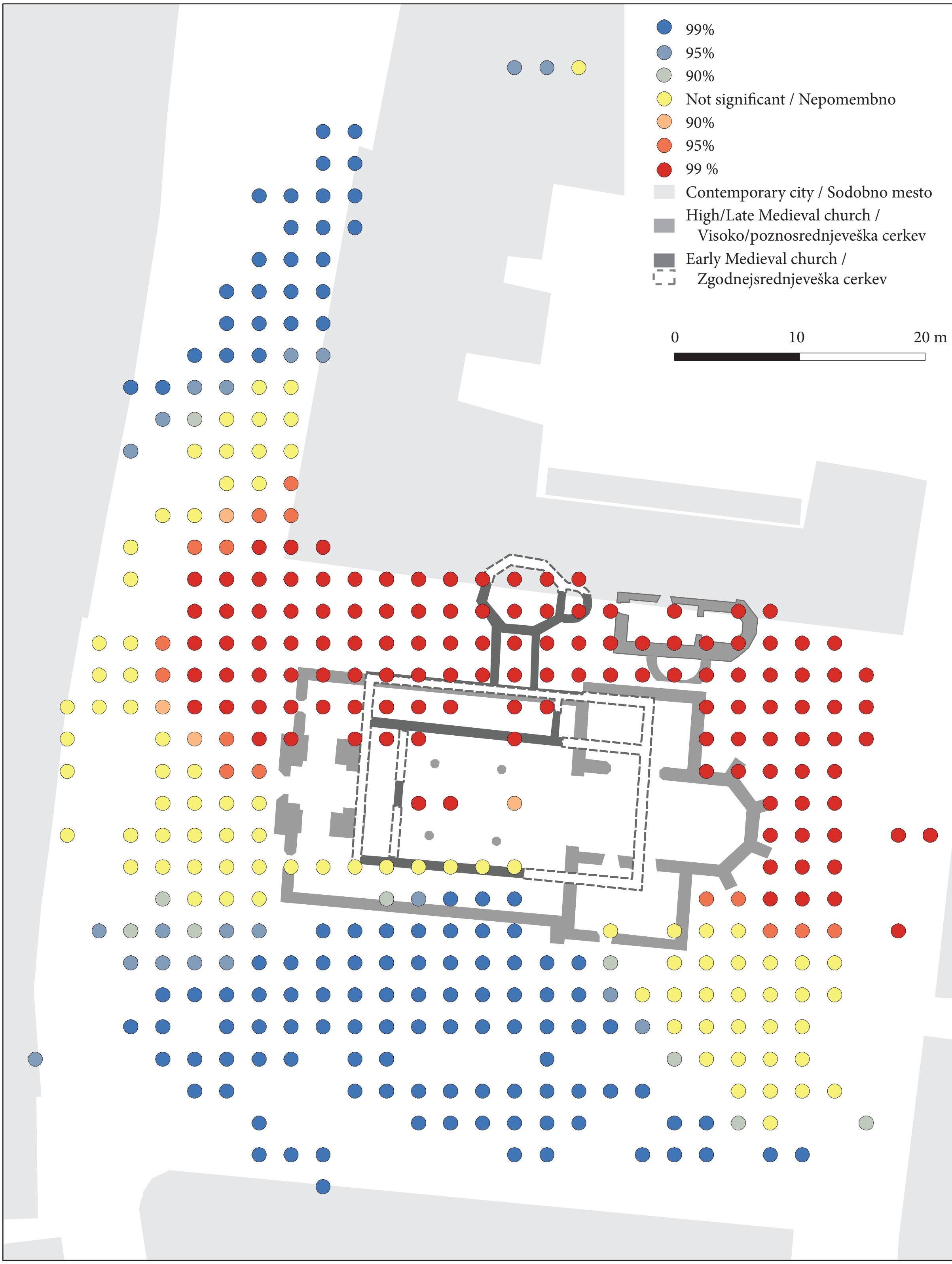

Fig. 5: Result of Optimized Hot Spot Analysis representing cold (blue), neutral (yellow) and hot (red) spots within the entire cemetery. Confidence level in percentage.
Sl. 5: Rezultat analize hladnih (modro), nevtralnih (rumeno) in vročih (rdeče) točk na celotnem grobišču. V odstotkih je izražen interval zaupanja.

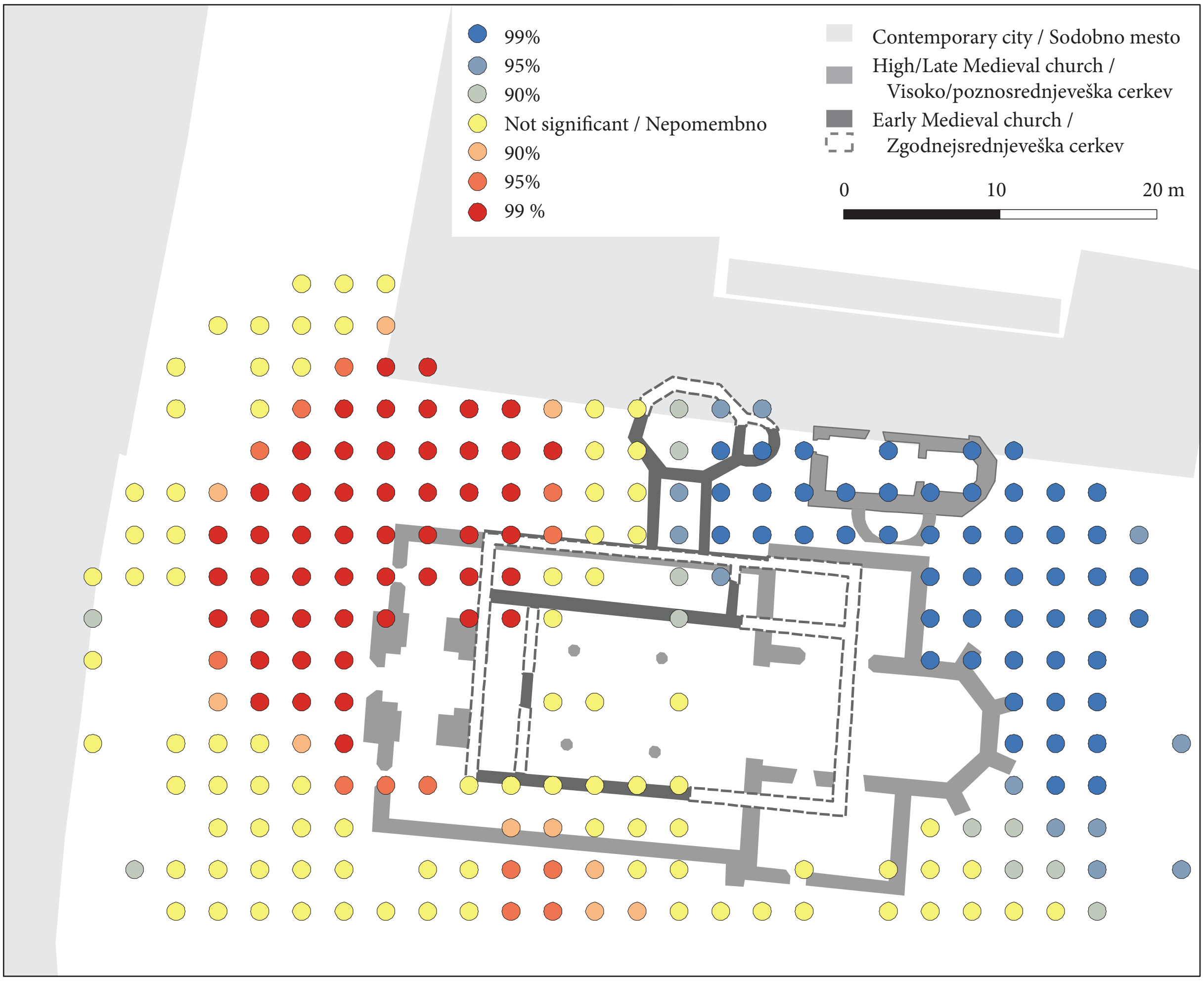

Fig. 6: Result of Optimized Hot Spot Analysis representing cold (blue), neutral (yellow) and hot (red) spots for Early Mediaeval graves. Confidence level in percentage.
Sl. 6: Rezultat analize hladnih (modro), nevtralnih (rumeno) in vročih (rdeče) točk za zgodnjesrednjeveške grobove. V odstotkih je izražen interval zaupanja.

2010, 127). Where the topic is raised, it is most often limited to being descriptive – e.g., burials in rows, *reihengräberfeld* (Steuer 1982, Abb. 95.1) – or focused on detecting the so-called horizontal stratigraphy (e.g., Knific 1974; Alajbeg 2015; Sokol 2016). Notable exceptions addressing spatial patterns have not received the attention they deserve (Stadler, Von Freeden, Wieczorek 1997; Macháček 2001; Losert, Pleterski 2003).

(2) Hotspot analysis of all graves offered glimpses into this intentional human choice: the N, E, and W sectors were preferred. Observing the chronological dynamics is more insightful, however.

Firstly, the area inside the post-1430 church is, as expected, dominated by early mediaeval graves. These predate the post-1430 church and were buried adjacent to and outside the contemporary church. Burials made within the existing church, i.e., post-1430, are expectedly rare, since the area inside the church was reserved for clerics and the most affluent individuals (cf. Aries 1989, 32–33; Makarovič 1995, 162; Daniell 1997, 108–109).

Secondly, early mediaeval graves are concentrated in the NW sector, i.e., between the early mediaeval church building and the path leading towards the settlement (*Fig. 1*). It would seem that the choice of placement was governed by a duopoly, the church building on the one side and the path/settlement on the other.

Thirdly, later phase graves exhibit two focal areas. The focus SE from the late mediaeval church building can be readily explained by the desire to be buried as close to the church altar as possible (cf. Aries 1989, 32–33; Podpečan 2006, 20; Meier,

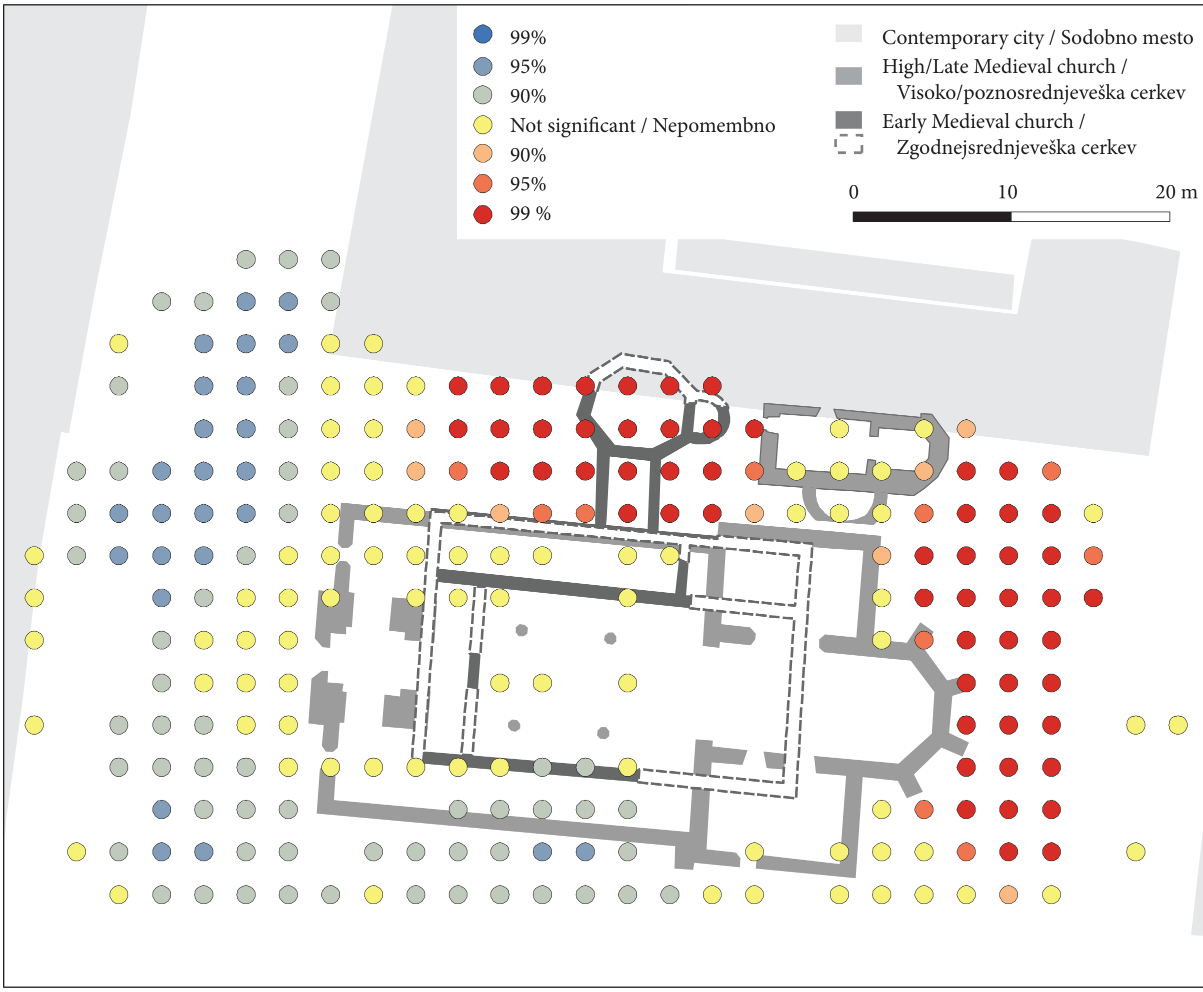

Fig. 7: Result of Optimized Hot Spot Analysis representing cold (blue), neutral (yellow) and hot (red) spots for post-Early Mediaeval graves. Confidence level in percentage.
Sl. 7: Rezultat analize hladnih (modro), nevtralnih (rumeno) in vročih (rdeče) točk za po-zgodnjesrednjeveške grobove. V odstotkih je izražen interval zaupanja.

Graham-Campbell 2007, 434). The concentration N of the late mediaeval church is located exactly in front of the entrance to the burial chapel, an obvious second focal area. It can be expected that finer chronology will be revealed as meaningful for explaining the two. The avoidance of the S sector cannot be fully explained at this time. One can conjecture that the explanation could be found in the desire of late mediaeval citizens to maintain an open space S of the church, e.g., to be used as an open marketplace (Žontar 1982, 36–38; cf. Makarovič 1995, 145); in addition, the mystical symbolism in urban forms cannot be excluded (cf. Sattler 1983; Lilley 2004). However, at this point of the research, it is just as likely that the described anomaly is simply the consequence of the different methodology used in this area excavated in 1953.

CONCLUSION

The study of patterns within cemeteries is not a new topic of enquiry. However, for very large cemeteries with a high burial density, a predominant method of visual interpretation does not suffice. This article originates from the need to replace visual interpretation with statistically relevant methods employed for understanding and interpreting the patterns within funerary space.

The increasing advances in computer analysis and statistical techniques applied to archaeological contexts in an attempt to identify statistically significant clustering or regularity for different types of data drive the choice of the approach presented in this analysis. It consists of a combination of statistical and geostatistical techniques that have proved to work particularly well for cemetery analysis.

Ripley's K-function demonstrated its applicability to these contexts in the previous analysis (Sayer, Wienhold 2013) thanks to its flexibility in operating on multiple scales and at complex, heterogeneous sites. In the same way, statistical techniques that into account values of global and local autocorrelation have proved their effectiveness in their application to the mediaeval cemetery at Župna Cerkev. Indeed, these methods made it possible to recognize an intentional, chronologically driven choice in grave placement.

Thus, in this analysis, a robust and versatile toolkit for spatial analysis using off-the-shelf GIS software, tested in its application to cemetery contexts, is proposed. Furthermore, this research confirms that the archaeological explanations related to spatial patterns of Central European early mediaeval cemeteries deserves more attention; this application will hopefully stimulate an increase of the research in this direction.

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Preučevanje namernosti prostorske ureditve. Primer grobišča Župna cerkev v Kranju

Povzetek

Uvod

Srednjeveško grobišče Župna cerkev leži v osrčju srednjeveškega Kranja, ki je nasledil prazgodovinsko, rimskodobno in poznoantično naselbino. Glede na regionalni pomen srednjeveške naselbine in predvsem zaradi številčnosti pokopov sodi obravnavano grobišče med najpomembnejša zgodnjesrednjeveška grobišča jugovzhodnoalpskega prostora (*sl. 1*).

Izkopavanja, ki so potekala s presledki med letoma 1953 in 2013, so razkrila 2936 grobov, ki jih preliminarno datiramo v čas od 8. do 18. st. (Štular, Štuhec 2015, 34–42; Pleterski, Štular, Belak 2016, 7–25).

Teoretična izhodišča

Prostorske analize v arheologiji imajo bogato tradicijo (pregled npr. Whallon 1973, 1974; Carr 1984; Hietala 1984; Aldenderfer 1987; Voorrips, O'Shea 1987; Blakholm 1991; Kroll, Price 1991), ki je v zadnjih desetletjih prevzemala metode iz različnih področij znanosti (Wheatley, Gillings 2002; Conolly, Lake 2006; Salisbury, Keeler 2007; Nakoinz, Knitter 2016). Tudi geografske informacijske sisteme (v nadaljevanju: GIS) v arheologiji uporabljamo že od poznih osemdesetih let prejšnjega stoletja (Zubrow 1990; Peterman 1992; Pettitt 1997; Gillings, Sbonias 1999; Huggett 2000; Lavachery, Conelissen 2000, 153;

Moyes 2002; Wheatley, Gillings 2002; Bevan, Conolly 2004; D'Andrea, Gallotti 2004; Gallotti et al. 2011, 2012).

Vendar te metode z nekaterimi izjemami (Goldstein 1981, 62–63; Quesada, Baena, Blasco 1995; Silverman, Small 2002; Šmejda, Turek 2004a, 57–68; Sayer, Wienhold 2013) niso našle mesta v arheologiji smrti in arheologiji grobišč. Tako na tem področju vizualno preučevanje načrtov grobišč ostaja najpogosteje uporabljena metoda prostorske analize (Goldstein 1981, 67; prim. Fotheringham 2002, 7; Bevan et al. 2013; za srednji vek npr. Losert, Pleterski 2003; Filipec 2012; Sokol 2016). Vendar ta metoda ni primerna za analizo najdišč z izjemno količino in gostoto pokopov, kakršno je grobišče Župna cerkev v Kranju (*sl. 2*).

Podatki in metode

Podatki

Analiza arheoloških podatkov grobišča Župna cerkev v Kranju je še v fazi primarnega vrednotenja gradiva. V prispevku uporabljamo enega od dosedanjih rezultatov, prostorsko podatkovno zbirko. Ta že vsebuje natančno lego posameznih grobov (Pleterski, Štular, Belak 2016, 25–26).

V analizo smo vključili tudi primarno kronološko opredelitev, ki so jo izkopavalci določili *že in situ*, ko so ločevali zgodnjesrednjeveške grobove od mlajših, po-zgodnjesrednjeveških. Gre za zelo grobo kronologijo, ki pa se je pri stratigrafski analizi izkopavalne sezone 1984 že potrdila kot zanesljiva (Rihter 2016). Žal so ti podatki na voljo samo za 79,3 % grobov, a je njihova razporeditev v prostoru razmeroma enakomerna.

Vizualna analiza načrta grobišča (*sl. 1; 2*) kaže, da so grobovi razporejeni okoli vsakokratne sočasne cerkvene stavbe. Zgodnjesrednjeveški pokopi so najgostejši zahodno in južno od današnje cerkvene stavbe ter v severo- in jugozahodnem delu notranjosti te.

Metoda

Naše izhodišče pri razvoju metod prostorske statistične analize grobišča je bila naslednja hipoteza: za tisočletje pokopavanja na grobišču Župna cerkev v Kranju je značilna dinamika v pogrebnih praksah; ta dinamika se izraža, med drugim, v gostoti grobov, tj. v frekvenci posameznih pokopov, opazovanih znotraj vnaprej določene mreže.

Kot ničelno hipotezo smo predvideli naključno razporeditev grobov v prostoru; z ovrženjem te lahko postavimo alternativno hipotezo: prostorska ureditev grobišča je bila nenaključna.

Vzorec prostorske ureditve grobišča smo analizirali z uporabo naslednjih matematičnih orodij:

– analiza vzorca točkovne razmestitve ene spremenljivke (t. i. Ripleyjeva K-funkcija: za metodo v arheologiji glej Conolly, Lake 2006, 166; Sayer, Wienhold 2013, 77; primeri uporabe v arheologiji npr. Bevan, Conolly 2006; Crema et al. 2010; Vanzetti et al. 2010; Winter-Livneh et al. 2010; Sayer, Wienhold 2013; Duncan, Schwark 2014; Markofsky 2014; Thacther, Milne, Park 2017);

– ocenjevanje prostorskega razporejanja (Moranova I-globalna statistika: za metodo glej Moran 1950; Cliff, Ord 1973; primeri uporabe v arheologiji npr. Kvamme 1990; Premo 2004; Carrer 2015; Achino 2016);

– optimizirana analiza vročih in hladnih točk (Getis-Ord G*);

– optimizirana analiza izstopajočih vrednosti (Moranova I-lokalna statistika: Anselin 1995; Levine 2013).

Vse metode smo implementirali v programskih okoljih SPSS Statistics 22.0 in ESRI ArcGIS 10.3. S temi metodami lahko ugotovimo, ali je prostorska razporeditev grobov skladna z (a) modelom pravilne razpršenosti, (b) naključno ali pa se pojavlja (c) v skupkih oziroma gručah.

Rezultati

V prvem koraku smo ovrgli ničelno in dokazali alternativno hipotezo, da so grobovi nenaključno razporejeni v prostoru. Podatki večinoma kažejo eksponencialno distribucijo, ki odseva namerno urejanje grobiščnega prostora. Ocena prostorskega razporejanja kaže, da so grobovi urejeni v gruče, pri čemer je možnost naključne razporeditve manjša od 1 %. Analiza vzorca točkovne razmestitve ene spremenljivke kaže, da je razporeditev bolj nagnjena h gručam kot k naključnosti, ko razdalja opazovanja preseže 4 metre (*sl. 3*). Optimizirana analiza izstopajočih vrednosti kaže pozitivno prostorsko avtokorelacijo v severnem in južnem sektorju grobišča (*sl. 4*). Skladno s pričakovanji te rezultate potrjuje tudi optimizirana analiza vročih in hladnih točk z vročimi točkami v severnem, vzhodnem in zahodnem sektorju ter v severozahodnem vogalu v notranjosti današnje cerkvene stavbe; edino hladno mesto je v osrednjem delu severnega sektorja, kjer je stala srednjeveška kapela (*sl. 5*).

V nadaljevanju smo prostorsko razporeditev preverjali še za vsako kronološko fazo posebej, tj. za zgodnjesrednjeveške in po-zgodnjesrednjeveške grobove. Ničelna hipoteza je bila ovržena za vsako fazo posebej in tudi ocena prostorskega razporejanja kaže < da je možnosti naključne razporeditve manjša od 1%. Posebno dragoceni pa so rezultati optimizirane analize izstopajočih vrednosti in predvsem analize vročih in hladnih mest za zgodnjesrednjeveške grobove. Zgodnjesrednjeveški grobovi izkazujejo izrazito vroče območje v severozahodnem in izrazito hladno območje v jugovzhodnem sektorju (*sl. 6*). Po-zgodnjesrednjeveški grobovi izkazujejo skorajda zrcalno podobo: vroče območje v jugovzhodnem in hladno v severozahodnem in južnem sektorju z dodatnim manjšim vročim območjem v severnem sektorju (*sl. 7*). Prostora pokopavanja obeh kronoloških faz se torej prekrivata, a imata žarišča na nasprotnih si straneh današnje cerkvene stavbe.

Diskusija

Namen analize je bil potrditi ali ovreči hipotezo, da so bile pogrebne prakse na grobišču Župna cerkev v Kranju dinamične in da ta dinamika, med drugim, odseva v prostorskih vzorcih. Hipotezo smo potrdili s tem, ko smo dokazali kronološko dinamiko nenaključnih prostorskih vzorcev.

Rezultati pa omogočajo dodatne interpretacije.

1 – Nenaključnost prostorskih vzorcev oziroma urejanja prostora grobišča je bila potrjena za grobišče v celoti ter tudi za vsako kronološko fazo posebej. V kontekstu srednjeveških in po-srednjeveških pogrebnih praks (npr. Steuer 1982; Parker Pearson 1999, 11–17; Podpečan 2006, 19–20; Petts 2007; Eichert 2010; 2013) to lahko razložimo samo z namerno izbiro mesta posameznega pokopa. Slednje je torej za grobišče Župna cerkev v Kranju statistično relevantno dokazano.

Sklep se na prvi pogled zdi samoumeven in zato nesmiseln, vendar pregled relevantne literature pokaže drugače. Vsaj v srednjeevropski arheologiji zgodnjesrednjeveških grobišč se raziskovalci s prostorskimi vzorci najpogosteje sploh ne ukvarjajo (Pleterski 2010, 127). V redkih primerih, če je tema že omenjena, so avtorji najpogosteje zgolj deskriptivni – npr. grobovi so v vrstah (Steuer 1982, sl. 95.1) – ali osredotočeni na t. i. horizontalno stratigrafijo (npr. Knific 1974; Alajbeg 2015; Sokol 2016). Izjeme (Stadler, Von Freeden, Wieczorek 1997; Macháček 2001; Losert, Pleterski 2003) so ostale izolirani primeri.

2 – Analiza vročih in hladnih točk nam je omogočila vpogled v zavestno umeščanje grobov: priljubljeni so bili severni, vzhodni in zahodni sektor. Bolj izpovedna je kronološka dinamika.

Prvič, v današnji cerkveni stavbi, ki stoji v tem obsegu od leta 1430, po pričakovanju prevladujejo zgodnjesrednjeveški grobovi. Ti so bili vkopani zunaj vsakokratne sočasne cerkvene stavbe. Pokopi znotraj sočasne cerkve so po pričakovanju redki in izjemni (prim. Aries 1989, 32–33; Makarovič 1995, 162; Daniell 1997, 108–109).

Drugič, koncentracija zgodnjesrednjeveških grobov v severozahodnem sektorju leži med sočasno cerkveno stavbo in potjo (*sl. 1*). Zdi se, da je bil prostor grobišča zamejen na eni strani s cerkvijo in na drugi s potjo.

Tretjič, po-zgodnjesrednjeveško grobišče kaže dve zgostitvi. Tisto jugovzhodno od današnje cerkve lahko pojasnimo z željo biti pokopan čim bliže oltarju (prim. Aries 1989, 32–33; Podpečan 2006, 2; Meier, Graham-Campbell 2007, 434). Zgostitev severno od cerkve je tik pred vhodom v sočasno grobiščno kapelo, katere bližina je bila očitno zaželena. Podrobnejša kronologija grobov bo v prihodnosti zagotovo omogočila natančnejšo interpretacijo teh opažanj. Izogibanja južnemu sektorju za zdaj še ne moremo natančneje pojasniti. Ena od možnih razlag bi bila, da so meščani v nekem obdobju predel južno od cerkve – ena glavnih prečnih komunikacij med mestnimi predeli (Žontar 1982, 36–38; prim. Makarovič 1995, 145) – namenili komunikaciji. Trenutno ne moremo izključiti niti uporabe mističnega simbolizma v urejanju mestnega prostora (prim. Lilley 2004; Sattler 1983). Vendar se na tej stopnji raziskave zdi enako verjetna razlaga tudi da, da je manjša gostota zgolj posledica drugačne metode izkopavanja leta 1953.

Zaključek

Analiza prostorskih vzorcev na grobiščih ni nova tema v arheologiji. Vendar za zelo velika grobišča z visoko koncentracijo grobov običajna metoda analize, opazovanje načrta grobišča, ne zadostuje. Pričujoči prispevek je nastal iz potrebe po nadomestitvi te vizualne analize s statistično relevantnimi metodami, ki omogočajo analizo in interpretacijo vzorcev pogrebnega prostora. Pot, ki smo jo izbrali, je tlakovana z napredkom računalniških tehnologij in statističnih analiz v arheologiji. Želeni cilj je prepoznati statistično relevantne vzorce in vzorce. Končna metoda je kombinacija statističnih in geostatističnih orodij, ki se je izkazala za prav posebej primerno za analizo grobišč.

Analiza vzorca točkovne razmestitve ene spremenljivke, ki je že bila uporabljena za analizo srednjeveškega grobišča (Sayer, Wienhold 2013), je zelo primerna zaradi prilagodljivosti in zmožnosti analize v različnih merilih. Podobno so se kot zelo primerna pokazala statistična orodja, ki temeljijo na globalni in lokalni avtokorelaciji. Aplikacija teh metod na grobišču Župna cerkev v Kranju nam je omogočila, da smo prepoznali namerno, kronološko dinamično izbiro prostora pokopavanja.

V prispevku torej predstavljamo robusten in raznovrsten nabor orodij za prostorske analize grobišč, ki ga lahko uporabimo znotraj že obstoječih programskih paketov GIS. Dodatno s prispevkom opozarjamo, da v prihodnosti analizam urejanja prostora srednjeveških grobišč, ki odseva v prostorskih vzorcih grobov, kaže nameniti več pozornosti.

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