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CONTENTS **PAGES**

Salvatore Basile*

The funerary landscape of late antique and early medieval Lucca through Point Pattern Analysis

1. Introduction

The inclusion of cemetery areas within cities starting from the Late Antique period has been the subject of numerous studies that tried to contextualise its causes and proportions (Meneghini, Santangeli Valenzani 1995; Cantino Wataghin, Lambert 1998; Lambert 2003; Chavarría Arnau, Giacomello 2014, 2015). Despite the extreme potential given by the numerous burials located within the walled city from the 5th century, only rare studies (Degasperi 1995) investigated this phenomenon in Lucca.

This study uses a part of a larger dataset created for a research project that aims to study Lucca's ancient territory from the 2nd century BC to the late 6th century (Basile 2021; Basile, Carrer 2022). It proposes a novel methodology for inspecting the development and distribution of sepulchral areas within the urban space and in the suburb between the 5th and the 7th centuries AD. The main focuses of these analyses are to evaluate the aggregation and interaction criteria among burials and to assess the role of urban and suburban features in the development of the funerary landscape.

Point Pattern Analysis, a research method increasingly employed in archaeological studies (Orton 2004; Eve, Crema 2014; Visentin, Carrer 2017; Brandolini, Carrer 2020; Costanzo *et al.* 2021), will be used to provide a reliable statistical estimation of these dynamics. Nevertheless, this method of investigation is applied mainly to the study of settlement patterns related to environmental and landscape features. To the best of my knowledge, this study represents the first application of this technique in studying the late antique and medieval urban funeral landscape.

After a short overview of the city's historical background, a brief dataset presentation will describe Lucca's funerary contexts during the 5th-7th century

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timespan. Subsequently, I will explore the relationship between child and adult tombs to evaluate whether the latter influenced the distribution of the former. Secondly, the pattern of burials will be analysed against a series of spatial covariates to measure how urban and suburban features determined the development of cemeteries.

This study will thus provide objective criteria to evaluate the relationship between child and adult burials (Vitale 2015), understand how cemetery areas were structured, and assess which factors played a decisive role in choosing where to bury the dead.

2. Historical background: the formation of the Christian landscape

In the city of Lucca, complex urban dynamics developed from the 2nd century AD; these led to the contraction of the urbanised area and the formation of what Giulio Ciampoltrini effectively defined as a "fluid state" city (Ciampoltrini 2006d). In this panorama, the Early Imperial Period urban landscape crumbled and the boundaries among public, private, productive, and commercial spheres became increasingly blurred. Garden areas, scattered burials, and dumps began to occupy large portions of the walled city (fig. 1). Even the forum area, the centre of the social and political life of the previous phases, was occupied by landfills and lay in partial disuse (Ciampoltrini 1998, p. 90). Moreover, the 'sub-urbanisation' of the city led to early burials within the walls. Two female pit burials in the north-western corner of the city date to the 2nd century AD (Abela, Bianchini 2006, p. 43; fig. 2a), while two other burials found among the ruins of the so-called "Archivio Notarile *domus*" (fig. 2b) date to the following century (Ciampoltrini *et al.* 1994, p. 608).

In the second half of the 3rd century AD, Lucca became a strategic military outpost to protect the Apennine routes from *Aemilia* to *Etruria* due to the empire's complicated political and social situation (Ciampoltrini 1995b, pp. 566-567; 2003, p. 213). The late republican city walls were heavily restored (Ciampoltrini 1995a, p. 6; 2006d, pp. 61-64), and an imperial *fabrica* of *spathae,* known by the *Notitia Dignitatum,* was established in the city (Ciampoltrini 2006d, p. 65). Consequently, iron production structures settled all along the western part of the city (fig. 2c-e), within areas that had already assumed typical characteristics of *suburbia*.

As already mentioned, the old forum lost its original role, and it seems that part of its functions – at least the representative ones – were assumed by the south-eastern sector of the city, that of the public baths (fig. 2f). The discovery in this area of two imperial dedications to emperors Constantine and Licinius and Julian the Apostate indeed validate this hypothesis (Ciampoltrini 2006d, p. 69; fig. 2g).

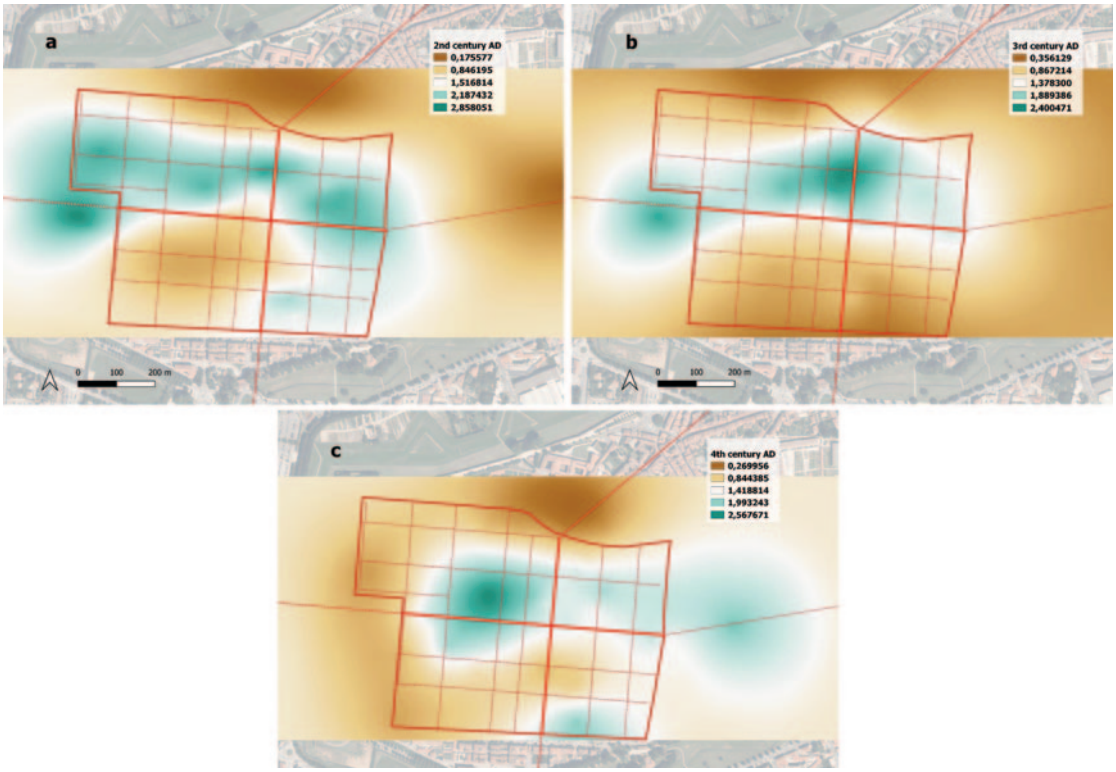

Fig. 1. Kriging of 'suburbanised' and abandoned areas in Lucca during the 2nd (a), 3rd (b) and 4th (c) centuries AD.

From an archaeological point of view, the 4th century AD is characterised by the construction of the first ecclesiastical building of the city, the cathedral of Santa Reparata. The church was built in the middle of the century upon the levelled ruins of the demolished public baths (fig. 2f), highlighting the authority that the bishop assumed in the city's administration (Cantino Wataghin *et al.* 1989, pp. 44-45; Grig 2013, p. 556).

According to a model widely attested in *Etruria*, the baptistery was built shortly after adjacent to the cathedral (Cantino Wataghin *et al.* 1989, p. 86). Furthermore, the location of the cathedral along the *cardo maximus*, close to the southern gate of the city, could have a symbolic and functional meaning of maintaining a privileged relationship with the population of the suburban and rural areas, who referred to the city church for the baptismal function (Chavarría Arnau 2009, p. 129).

The construction of the cathedral led to the reorganisation of the neighbourhood that developed around it: just in front of the church, the *domus* of Piazza San Giusto (fig. 2h) was restored with new structures and mosaic floors

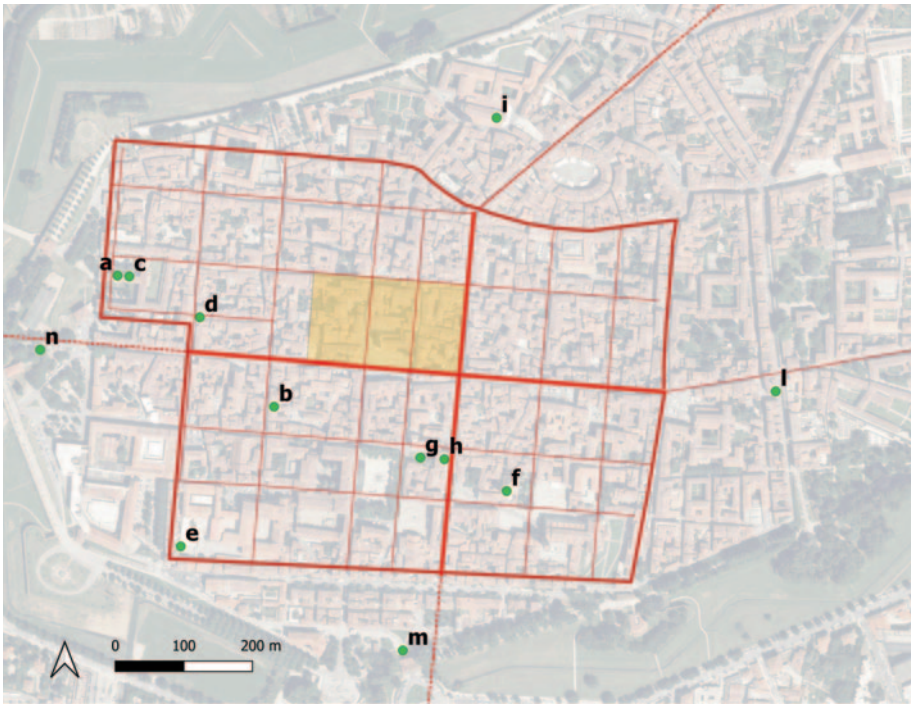

Fig. 2. Sites mentioned in the historical background paragraph. The orange area represents a hypothetical extension of the Roman forum.

(Ciampoltrini *et al.* 2005, pp. 326-327). Perhaps, this is just one of the many interventions necessary for the organization of the *insula episcopalis*. The restoration works of the wealthy *domus* could also refer to the construction of the *episcopium* right in front of the cathedral (Castiglia 2018, pp. 102-103).

Finally, the Christian urban and suburban landscape was completed in the 5th century with the construction of four suburban churches at each city gate. Of these, the only one known from an archaeological point of view is the funerary basilica of San Vincenzo (fig. 2i) in the northern suburbs. In contrast, the other three are known only through place-name studies and early medieval sources (Belli Barsali 1973, pp. 464–474): these are the churches of Santi Gervasio and Protasio (fig. 2l) to the east, San Pietro (fig. 2m) to the south and San Donato (fig. 2n) to the west. The construction of suburban churches, often with funerary connotations, is one of the significant activities of the bishops of the early Christian age and is documented in different areas of the empire according to often very similar models (Chavarría Arnau 2009, pp. 146-147; Fiocchi Nicolai 2013, pp. 222-224, 2016). The case of Lucca is a perfect example of the application, on a smaller scale, of the grand scheme applied by Bishop Ambrose in Milan, with

churches arranged outside the gates. In this scheme, the *cardo* and *decumanus maximi* form a cross that assumes a symbolic Christian meaning with four churches at the ends as in a Christogram (Lusuardi Siena 1997, pp. 34-36).

3. Materials and methods

3.1. Dataset

As already mentioned, the data used for this analysis represent a small portion of a larger dataset created for a research project that aims to study Lucca's whole ancient territory from the 2nd century BC to the late 6th century. To conduct this research, I thus collected all the available archaeological data for this territory, which derive from published and archival material. All the data were stored in the Pisa University MAPPA Project database (Anichini *et al.* 2012; Fabiani, Gattiglia 2012) and geo-localised in QGIS. The dataset used for this research comprises 427 archaeological interventions, with 1196 finds in total, and was recently published in the open access repository of the Pisa University's MAPPA laboratory (Basile 2022). A significant percentage of these finds – 669 out of 1196 – comes from the urban and suburban areas of Lucca (Basile, Carrer 2022, p. 68).

Many of these data refer to cemeteries dating to the late antique and early medieval periods. Unfortunately, the frequent lack of archaeological documentation made sometimes impossible to determine the exact number of burials. Moreover, the complex stratifications of the urban context and the rarity of grave goods have not allowed an absolute dating of many of them. Indeed, these often refer to broad chronological horizons covering from the 5th to the 7th century. Nevertheless, I tried to distinguish between necropolises that developed from the 5th century and those whose formation began during the 6th and 7th centuries AD, providing, whenever possible, a more detailed chronology.

Despite all these issues, the quantity of data allowed to perform the analysis with an acceptable degree of accuracy. Considering Lucca's urban and suburban areas, 126 burials were found; 96 out of the total refer to adults, while 30 refer to children.

The 5th century

The cemetery areas identified during the excavations of Palazzo Lippi (Ciampoltrini, Notini 1990, p. 571; fig. 3a), Via dell'Anguillara 2 (Ciampoltrini 2006d, p. 64; fig. 3b), Piazza San Frediano (Ciampoltrini, Notini 1990, p. 574; fig. 3c), Piazza Santa Maria *forisportam* (fig. 3d), and Piazza San Giusto[1] (fig. 3e)

[1] Both Piazza Santa Maria *forisportam* and Piazza San Giusto excavations are unpublished.

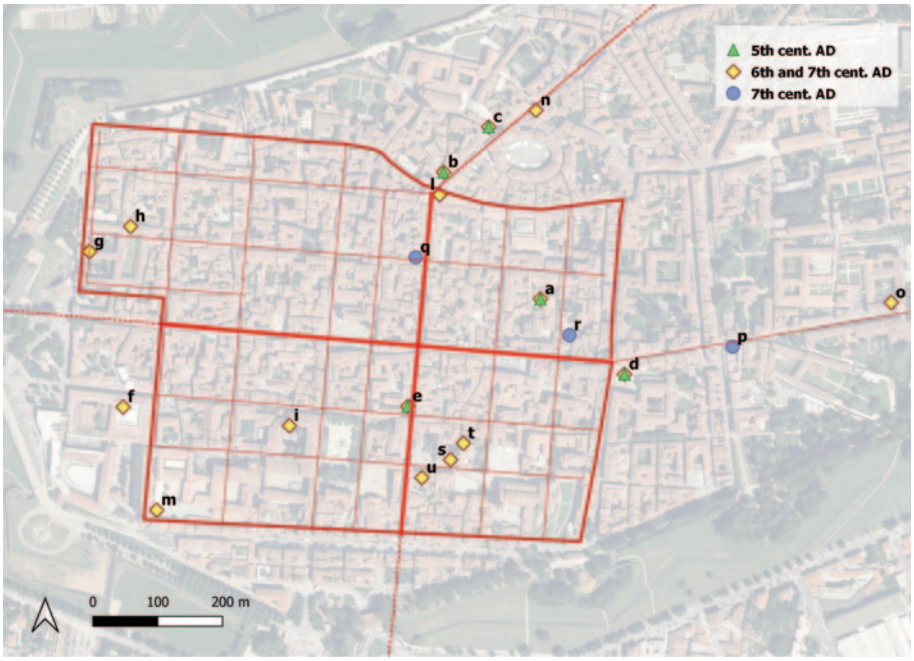

Fig. 3. Cemeteries within the urban and suburban area from the 5th to the 7th century AD.

date to the 5th century AD. The two areas of Piazza San Frediano and Via dell'Anguillara are probably connected to the nearby suburban church of San Vincenzo, built in this period. In the eastern suburb, the cemetery of Santa Maria *forisportam* probably refers to the burial church of Saints Gervasio and Protasio (fig. 2l). Three simple pit burials were excavated within the urban perimeter in the dump layers found in Palazzo Lippi, while two children were buried in Piazza San Giusto.

The 6th and 7th centuries

New cemetery areas developed from the 6th century AD. At the then 'Manifattura Tabacchi' (fig. 3f), located in the western suburb, two pit graves relating to an adult and a child were recently found (Abela *et al.* 2015, pp. 69-70). Two groups of burials were identified in the central and northern pavilions of the Galli Tassi building (fig. 3g-h): in the first case, seven children's tombs lay on the layers that obliterate some 4th-century production structures (Abela, Bianchini 2006, pp. 51-56); in the second area, archaeologists found six adults buried inside tombs built with reused materials. In both cases, the disposition of the graves in parallel rows along a wall allowed the excavators to hypothesise the presence of a building, perhaps a sacred one, within which the tombs may have been placed (Ciampoltri-

ni 2006b, pp. 13-24). Further south, within the so-called Carrara courtyard (fig. 3i), ten east-west oriented burials were identified: despite the lack of grave goods, the stratigraphic context dates them to the end of the 6th century (Ciampoltrini 2011, pp. 38-57). Finally, at the intersection of Via Fillungo and Via Streghi (fig. 3l), a single adult burial was found inside an abandoned structure connected to the northern gate of the city (Ciampoltrini, Notini 1990, pp. 564-567).

Despite developing from the 6th century AD, other necropolises refer to a broader horizon that includes the 7th century. In the south-eastern corner of the city, the excavation of the San Romano complex (fig. 3m) led to the discovery of two burials, which the excavators cautiously referred to as the construction of the San Romano and San Ponziano *in Placule* churches, both known from written sources from the 8th century (Abela *et al*., 2013, pp. 6-7). Two other necropolises are in the northern and eastern suburbs in Via Fillungo (fig. 3n) – four tombs (Ciampoltrini 2011, p. 59) – and under the San Ponziano church (fig. 3o). The latter comprises three different groups of six burials, each partially excavated on the Roman age *via publica Luca-Florentiam.* To the first group belong children between the ages of zero and six with an east-west orientation; on the contrary, the second and third groups are composed of adults whose ages range from twenty to fifty.

Finally, the use of three other cemeteries began in the 7th century. In the suburban site known as "Casa Betania" (fig. 3p), six burials were excavated inside a building that probably had a funeral function also during the first Imperial period (Giannoni 2011). Within the urban space, one tomb was found near the Roman forum in Via Buia (Ciampoltrini 1998, pp. 84-86; fig. 3q), while three other individuals were buried inside tombs built with reused materials under the Santa Giulia church (Degasperi 1995, p. 542; fig. 3r).

The cathedral and the baptistery

The description of the cemetery areas of the baptistery (fig. 3t) and church of Santa Reparata (fig. 3s) – the city's first cathedral – deserves a separate discussion. The church was built in the mid-4th century AD, and a few decades later, the construction of the adjacent baptistery began (De Marinis 1992). Nevertheless, a century and a half later, the area inside the baptistery was uncommonly used for funerary purposes: here, archaeologists identified about thirty-one people buried, of which twenty-one adults, nine children, and one adolescent, placed inside box tombs in bricks or in simple grave pits (De Marinis 1992, pp. 114-118). It is probably in the same period that the funeral use of the cathedral started. At least seventeen burials occupy the area near the solea and the southern transept; most of them are burial pits with walls covered with reused stone materials, while only one has a slate slab roof (Fichera *et al*. 1992). Despite the difficulties of dating these graves, scholars hypothesised the contemporaneity of the cathedral and baptistery burial grounds (Degasperi 1995, p. 539; Fichera *et al*. 1992, p. 200). Letizia Pani Ermini (1992, p. 52) proposed that the use of the

church as a funerary area began by the 6th century, combining an examination of the written sources with the stratigraphic analysis of the complex. This fits perfectly with what is known for other cases of northern Italy such as Turin, Verona, Mantua and Cividale, where the custom of burying inside cathedrals occurred from the second half of the 6th century and became particularly frequent during the 7th century (Chavarría Arnau, Giacomello 2014, p. 213).

Finally, four adults and a child were buried on the layers covering some demolished Roman age structures in Via del Duomo (fig. 3u), just a few metres south of the cathedral (Degasperi 1995, p. 539; Mencacci, Zecchini 1982, p. 125).

3.2. Kernel density estimation

Despite all the difficulties related to their dating and interpretation, the data presented outline some of the main criteria of formation, distribution, and aggregation of the urban and suburban cemetery areas in Lucca between Late Antiquity and the Early Middle Ages.

A first exploration of the data was carried out using kernel density analysis (Nakoinz, Knitter 2018, pp. 77-81). The analyses were carried out on R, using the *density* function (Venables, Ripley 2002); the bandwidth was calculated using the *bw.diggle* function (40 m).

A comparison of the kernel density analyses shows how, during the 5th century AD (fig. 4a), *coemeteria* were mainly located immediately outside the northern and eastern city gates and distributed alongside the roadways. At the same time, burials occupied only two sectors of the urban area. On the contrary, during the two following centuries (fig. 4b), intramural burials represent the most significant part of the analysed sample: although these are mainly located in the cathedral and baptistery area, it is easy to notice the funerary use of other parts of the city, such as the north-western, north-eastern, and south-western corners, or the southernmost part. At the same time, new necropolises developed in the western suburbs.

Other interesting observations emerge by examining infant and adult burial distribution. During the 6th and 7th centuries, infant burials are primarily distributed in three nuclei in the north-western corner of the city, in the area around the cathedral, and the eastern suburb (fig. 5a); on the other hand, burials of infants outside these areas are sporadic. Despite having a more widespread distribution, adult cemeteries (fig. 5b) are also organised in nuclei, and isolated burials are rare.

3.3. Spatial interaction of infant and adult burials

Given the high density of the sample, I attempted to investigate the methods of aggregation and formation of the necropolises to both other burial areas and different elements of the urban system.

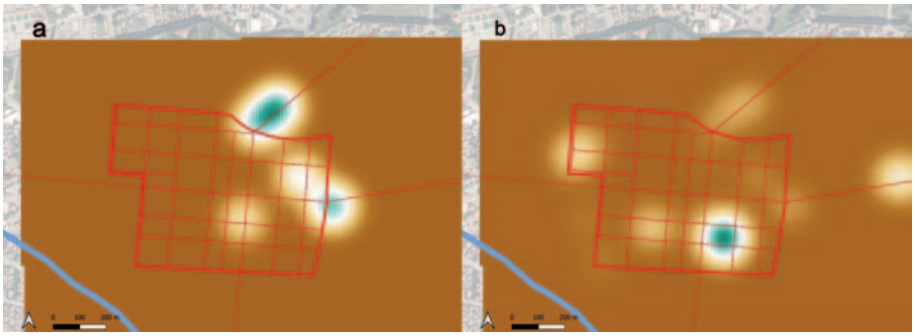

Fig. 4. Kernel Density Estimation of burials during the 5th century AD (a) and the 6th and 7th centuries AD (b).

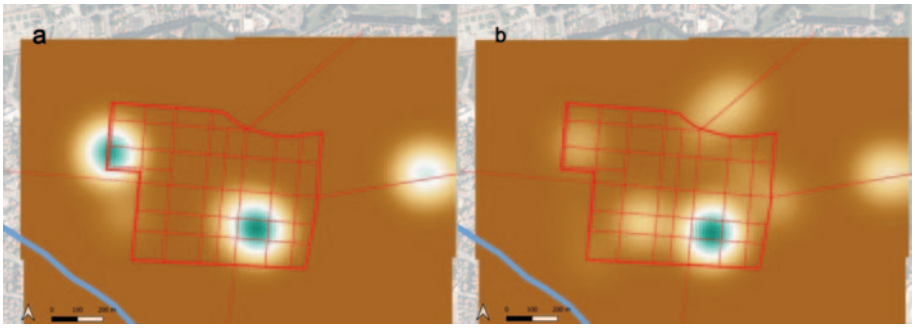

Fig. 5. Kernel Density Estimation of infant (a) and adult (b) burials.

As the first step in this process, the level of aggregation between burials of infants and adults was analysed through Point Pattern Analysis. This method was recently tested to assess the relationship between Roman and medieval settlement in the Po area (Brandolini, Carrer 2020). The investigation of the so-called second-order properties in the distribution of points determines whether the position of a point is somehow dependent on the presence of others (Nakoinz, Knitter 2018, p. 130). This is determined by the L-function, which measures the number of points at different distances from each point of the analysed sample (Biagetti *et al.* 2016, p. 4; Ripley 1977). Therefore, using the bivariate version of the L-function on R, it is possible to assess the level of spatial interaction between the two types of burials. It means that if the burials of adults did not play an attractive role towards those of children, then the L-function will not show any level of aggregation (Biagetti *et al.* 2016, p. 5; Brandolini, Carrer 2020, p. 9).

Firstly, I verified the inhomogeneity of the point distribution using the *quadrat.test* function of the *spatstat* package available on R; subsequently, I used a kernel density-based method (Brandolini, Carrer 2020, p. 9) to evaluate

the intensity of the point distribution, which is a necessary condition for the application of the Inhomogeneous L-function. According to this method, three different kernels were produced using bandwidth corresponding to the 10th, 20th and 30th percentile of the distance among the analysed sites. After a visual estimation of the three kernels, the latter percentile was chosen to estimate the intensity of the process (sigma= 250 m for adult burials; sigma= 110 for infant burials) since the first two produced overly clustered maps.

The L-Function was then computed from the children's graves (*i*) to the adults' ones (*j*) and for 999 bivariate point patterns randomly simulated[2] within the analysed area.

3.4. Assessing how urban and suburban landscapes affected necropolises distribution

As a second step, I tried to assess which urban and suburban features affected the distribution of cemetery areas in the city, regardless of whether they refer to children or adults. To do so, first-order properties of the distribution of points were inspected (Nakoinz, Knitter 2018, pp. 131-134). The analysis of the published material highlights how the main urban factors that have an influence on the distribution of funeral areas during Late Antiquity and the early medieval period are: the proximity to the primary urban and suburban road network (Ciampoltrini 2006d, p. 64; Degasperi 1995); the contiguity to ecclesiastical buildings (Chavarría Arnau, Giacomello 2015, p. 130); the presence of Roman period funerary areas (Cantini 2012, p. 170); the closeness to abandoned Roman period public spaces (Citter 2001, p. 28; Costantini 2010); finally, the proximity to areas of the city which are partially or entirely 'suburbanised' (Degasperi 1995, p. 544).

By using the *r.grow.distance* tool for GRASS a series of raster maps were created (fig. 6): distance from the main road axes (*dist_strade*), distance from ecclesiastical structures (*dist_chiese*), distance from Roman necropolises (*dist_necr_imp*), distance from Roman period public areas and buildings (*dist_pub*), distance from 'suburbanised' urban areas (*dist_abb*). Furthermore, since these covariates are not directly comparable, they have been standardised using the *r.recode* function. Since the function allows the recoding of categorical raster maps, the range of values of each covariate was set on a scale of 0:800 values.

A null hypothesis will be tested through Point Pattern Analysis to address the analysis:

> nH = The distribution of the tombs is homogeneous, so the intensity of the point pattern is isotropic and homogeneous.

[2] Using the *envelope* function.

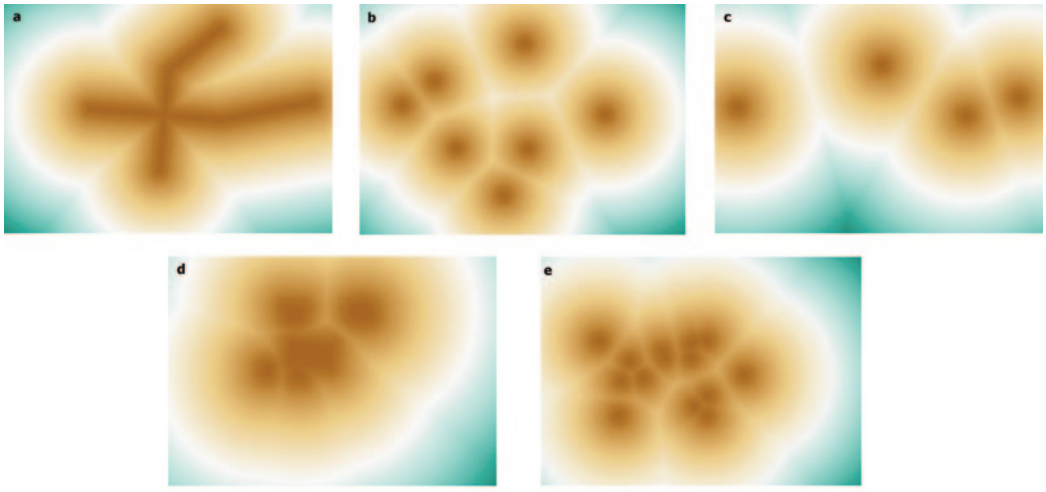

Fig. 6. Spatial covariates of the Point Pattern Analysis. The value of all maps varies from 0 (dark brown) to 800 (dark green). a) distance from the main road axes; b) distance from ecclesiastical structures; c) distance from Roman necropolises; d) distance from Roman period public areas; e) distance from 'suburbanised' urban areas.

Therefore, the association among cemetery areas and the selected covariates would be considered valid by rejecting the null hypothesis.

Furthermore, three different models were created to assess the incidence of the variables in the distribution of cemetery areas. The first one (*Model1*) combines all the spatial covariates with the burials point pattern. As discussed in the next paragraph, the model shows a direct correlation between distance from abandoned public areas of the Roman period (*dist_pub*) and the presence of tombs; since this datum collides with what is usually claimed in literature (Costantini 2010; Degasperi 1995), a second model (*Model2*) was created without this variable. Finally, a third model (*Model0*) combines a constant variable to the point pattern of the burials. If the analysed sample were to be uniformly distributed and therefore not influenced by the variables used in models 1 and 2, *Model0* would be considered more performing than the first two, and the null hypothesis *nH* would be valid.

4. Discussion

The L-Function (fig. 7) shows a significant aggregation – beyond the range of points simulated by the *envelope* function – of infant and adult burials within the first 50 metres; on the other hand, beyond a 150 metres radius from each infant burial, fewer tombs of adults than predicted were found. These results highlight

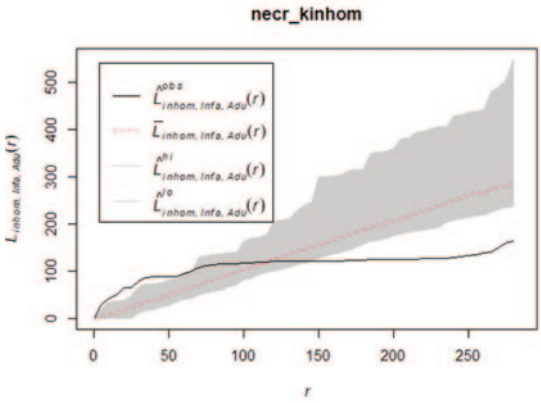

Fig. 7. Spatial aggregation between infant and adult burials. Inhomogeneous L function measurement.

a substantial aggregation of burials rather than single scattered graves; therefore, it is possible to claim that a significant spatial relationship between the two categories exists. Thus, the distribution of infant tombs is strongly conditioned by the near presence of tombs of adults. The strong aggregation of infant tombs close to adult necropolises – such as in Galli Tassi and San Ponziano areas (§ 3.1) – suggests the existence of reserved sectors for children at the margins of cemetery areas (Vitale 2015).

Point Pattern Analysis suggests that in both *Model1* and *Model2* (fig. 8) burials distribution does not correlate with the proximity to Roman necropolises (*dist_necr_imp*). At the same time, a strong inverse correlation exists with distance from churches (*dist_chiese*), distance from main road axes (*dist_strade*) and distance from 'suburbanised' areas (*dist_abb*). As already indicated, in *Model1*, burials distribution directly correlates with the distance from abandoned public areas (*dist_pub*): hence, the greater the distance from an abandoned Roman period public area, the greater the number of burials found.

To estimate the effectiveness of each model, I used Schwarz's Bayesian Information Criterion (BIC), which makes a comparison among them and returns a value from 0 to 1, indicating their respective efficiency (Zimmerman 2010, pp. 50-51). The results show how *Model1* is the best performing model[3] and highlight the inhomogeneity of the analysed sample, thus allowing to reject the null hypothesis (*nH*).

The inhomogeneous L function (fig. 9) shows that the principal aggregation factor of the tombs is the presence of other tombs within a range of 150 m. Spa-

[3] AIC weight *Model1*= 0.9162431; AIC weight *Model2*= 0.0837569; AIC weight *Model0*=0,000000.

```
Model 1:

Fitted trend coefficients:
  (Intercept)  dist_chiese  dist_strade     dist_abb    dist_pub
 -5.620057175 -0.010851301 -0.010245813 -0.007483082 0.003313664

                Estimate         S.E.      CI95.lo       CI95.hi Ztest       Zval
(Intercept) -5.620057175 0.3200554766 -6.247354382 -4.992760e+00   ***  -17.559634
dist_chiese -0.010851301 0.0013399468 -0.013477548 -8.225053e-03   ***   -8.098307
dist_strade -0.010245813 0.0013075879 -0.012808638 -7.682988e-03   ***   -7.835659
dist_abb    -0.007483082 0.0013959418 -0.010219078 -4.747086e-03   ***   -5.360597
dist_pub     0.003313664 0.0010968618  0.001163854  5.463473e-03    **    3.021040


Model 2:

Fitted trend coefficients:
 (Intercept)  dist_chiese  dist_strade     dist_abb
-5.204019016 -0.012129496 -0.009897637 -0.005698344

                Estimate         S.E.      CI95.lo       CI95.hi Ztest       Zval
(Intercept) -5.204019016 0.2998911818 -5.791794932 -4.616243e+00   *** -17.353024
dist_chiese -0.012129496 0.0012922147 -0.014662190 -9.596801e-03   ***  -9.386595
dist_strade -0.009897637 0.0013338650 -0.012511965 -7.283310e-03   ***  -7.420269
dist_abb    -0.005698344 0.0012783247 -0.008203814 -3.192873e-03   ***  -4.457665
```

Fig. 8. Selected spatial covariates for *Model1* and *Model2*.

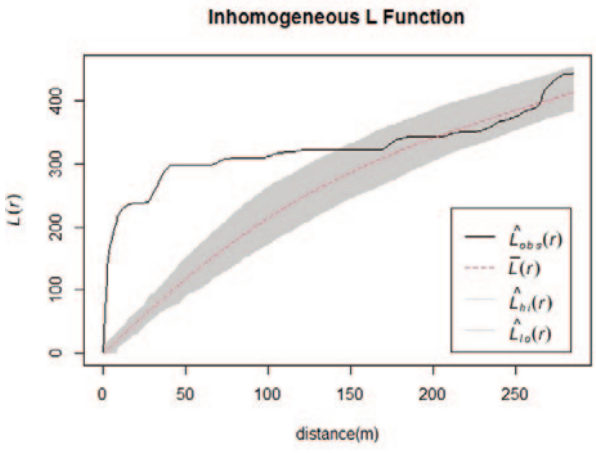

Fig. 9. Inhomogeneous L function measurement.

tial covariates explain the distribution of cemeteries only after a 150 m radius. Hence, churches, 'suburbanised' spaces, and proximity to main roads attract more groups of burials, leading them to arrange themselves in the same area. It is thus possible to hypothesise the existence of groups of tombs for members of the same family or individual tombs that played a role of attraction towards others: among the various possible examples, this could be the case of burial *ad sanctos*, which were common in these centuries, especially in the suburbs (Chavarría Arnau, Giacomello 2015, p. 157).

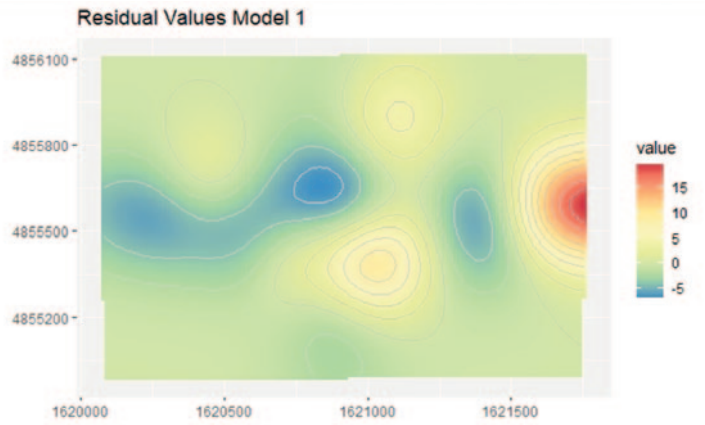

Fig. 10. Residual value map for *Model1*.

To further inspect this pattern, residual values of the Poisson Process were analysed (Baddeley *et al.* 2016, ch. 11). The residual map (fig. 10) allows the observation of the model prediction: positive residual values indicate that the model underestimated the actual intensity of the point pattern; on the contrary, negative values indicate an overestimation of the real density. The map shows how the model performs well in approximately the entire area. It overestimates the real intensity in the city's central area and the western suburb, probably due to the lack of archaeological research. On the other hand, the high density of burials in the San Ponziano and Santa Reparata areas produced and underestimation of the intensity in the southern part of the city and the westernmost sector of the analysed area. It is not a surprise that these are two among the few urban contexts extensively excavated in the whole area.

Several single variable models were created to understand which of the covariates attracted cemeteries the most: distance from main roads is the variable of *ModelV*; distance from churches is used on *ModelC*; *ModelA* uses the distance from abandoned areas; finally, distance from Roman period public spaces is the variable of *ModelP*.

The comparison of the models clearly shows that *ModelC* is the most performative among all the possible models[4]. Although all these variables explain the spatial distribution of cemeteries, in this specific case study ecclesiastical buildings thus constitute the principal nucleus of attraction around which the necropolises arranged.

[4] ModelV_AICweight= 0.0249121; ModelC_AICweight= 0.9750879; ModelA_AICweight= 0.00000; ModelP_AICweight= 0.00000.

Finally, the presence of numerous tombs, including nine children (De Marinis 1992, pp. 114-118), inside the baptistery of Santa Reparata is worthy of consideration. While the funerary function of the areas around baptisteries finds some comparison in other cities such as Mantua, Milan, and Padua (Chavarría Arnau, Giacomello 2015), the cemetery use of the inner area of a baptistery is, to my knowledge, unknown. Furthermore, the funerary areas of the three cities mentioned above date from the 8th to the 9th century[5]. In this case study, the numerous burials of the baptistery probably refer to a phase of abandonment or an interruption of the baptismal function. Indeed, during the excavation of the building, Giuliano De Marinis found layers that could indicate a period of abandonment from the mid-6th century AD; these are the layers on which burials were excavated (De Marinis 1992, p. 113). This phase ends with the construction of the so-called "pillared baptistery" in the early medieval period (De Marinis 1992, p. 118; Piancastelli Politi Nencini 1992b, pp. 133-138). It is hard to understand the possible reasons for this period of abandonment. Causes may indeed range from a collapse of the building to something related to the arrival of the Lombards at the end of the 6th century: in fact, Letizia Pani Ermini suggests that the arrival of an Arian bishop may have caused the transfer of the Catholic episcopate and, thus, of the baptismal function (Pani Ermini 1992, p. 52).

It is important to note that in this case study, two of the variables that usually affect the position of cemeteries – the proximity to Roman necropolises and the funerary use of former public structures (theatre, amphitheatre, forum) – do not affect the formation of the funerary landscape. Although the density of research may influence this evidence, the latter case suggests a possible reuse of Roman public spaces that the archaeological data does not, at least at the moment, permit us to identify.

5. Conclusion

This study aimed to test a novel methodology for assessing the role of urban and suburban features in the distribution of late antique and early medieval cemeteries. Field research intensity, research strategy biases, discrepancies of information related to each funeral context might have affected the accuracy of the analysis. Moreover, the lack of information regarding burials typology, grave goods, and sex of the buried did not allow for a social and hierarchic reading of cemeteries. Nevertheless, according to the results, it was possible to identify some specific funerary landscape patterns in Lucca. This study indeed updates

[5] Only one tomb in Mantua dates to the 7th century AD (Chavarría Arnau, Giacomello 2015, p. 145).

that of Angelica Degasperi (Degasperi 1995) and provides further solid objective considerations to her observations.

Firstly, the existence of specific areas for children's tombs emerges. These appear to have a strict connection with those of adults since they are usually located within 50 m of them. Secondly, some of the factors usually reported as elements of attraction for burials, such as Roman necropolises and public areas, did not play a significant role in the location on cemeteries in Lucca. Although the location of some burials corresponds to those of the Imperial period, it seems that the positioning of the latter did not affect the distribution of Late Antique cemeteries. Hence, we might suppose that other factors determined burials' location, such as the presence of funerary *basilicae* near the city gates.

City and suburban burials are not scattered as non-comprehensive analysis of the data might show; instead, their organisation allows us to suggest that family groups buried their members together or that specific individuals attracted other groups of tombs. The distribution of groups within the city and suburban space is mainly affected by the proximity to churches, 'suburbanised' areas, and primary roadways.

Despite the large amount of research conducted in the last 40 years, GIS-based studies and spatial analysis of Lucca's territory are still rare (Basile 2021; Basile, Carrer 2022), and their application for this area was recently criticised (Ciampoltrini 2020, p. 11). However, this study demonstrates that broader use of cutting-edge spatial analysis techniques may help to explore archaeological data from different perspectives and add new pieces to the intricate picture of antiquity.

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Abstract

Located in northern Tuscany, the city of Lucca represents a perfect case study to understand the development of the late antique funerary landscape. Although numerous burials are known for the 5th-7th century timespan, few studies have explored the factors that led to the formation of several cemetery areas within urban and suburban spaces. This study thus aims to investigate spatial interactions among burials and assess the role of urban and suburban elements in creating funerary landscapes through Point Pattern Analysis.
Keywords: Lucca, Late Antiquity, Early Middle Ages, Point Pattern Analysis, funerary landscape.

La città di Lucca, nella Toscana settentrionale, rappresenta un perfetto caso studio per comprendere lo sviluppo del paesaggio funerario tardo antico. Nonostante siano note numerose sepolture datate tra il V e il VII secolo, pochi studi hanno analizzato i fattori che hanno portato alla formazione di parecchie aree cimiteriali all'interno degli spazi urbani e suburbani. Il presente studio dunque vuole investigare, attraverso la Point Pattern Analysis*, le interazioni spaziali tra le sepolture e valutare il ruolo degli elementi urbani e suburbani nella creazione dei paesaggi funerari.*
***Parole chiave:** Lucca, tardo antico, alto medioevo, Point Pattern Analysis, paesaggio funerario.*

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