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In the Footsteps of the Gods:
The use of computational methods to explore the role of mobility in the religious landscape of 2nd century AD Ostia

by

Katherine Ann Crawford

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IN THE FOOTSTEPS OF THE GODS: THE USE OF COMPUTATIONAL METHODS TO EXPLORE THE ROLE OF MOBILITY IN THE RELIGIOUS LANDSCAPE OF 2ND CENTURY AD OSTIA

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ABSTRACT

This thesis assesses how temples contributed to the religious landscape of Ostia, Rome's ancient port, through the practice of processional rituals. A novel computational approach is developed for the study of ritual movement that combines space syntax, urban network analysis, and agent-based modelling to evaluate where processional routes may have travelled within Ostia's urban landscape. The modelling and visualisation of hypothetical processional routes, associated with specific temples, provides a heuristic approach for looking at how temples structured individual rituals and their wider cultic impact upon the surrounding cityscape. The quantity of evidence relating to Ostian religion presents an ideal opportunity to consider how religious and ritual practices extended beyond temple precincts to impact the wider cityscape.

Processional routes are explored within the 2nd century AD city as one way to study the role that temples played in structuring religious landscapes. While scholars acknowledge the regularity of processional activity, studies have traditionally focused upon major processions, such as the Roman triumph, rather than considering the wider occurrence of religious processions within urban contexts. The nuances of how a procession traversed a city's streets and its urban impact are not easily revealed due to the paucity of information from ancient literary sources and their near invisibility within the archaeological record. In terms of Ostia, processions are assumed to have occurred but no attempts have been made to assess their contribution to Ostia's religious environment. This thesis aims to address this gap in both processional scholarship and approaches to religious landscapes more broadly by developing a new method that questions how urban architecture and social activity helped to structure ritual movement within the city of Ostia. Three case studies are used to illustrate how processional movement created a complex ritual environment: the *Campo della Magna Mater,* the *Serapeum,* and the *forum* temples. It will be argued that the analysis of these routes contributes new understanding into how the urban community of Ostia interacted with these temples through virtue of their rituals.

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Electronic Supplements

The electronic supplements includes a PDF version of Volume II and the NetLogo model which are included within a USB at the back of this thesis. The PDF contains all of the betweenness centrality graphs and agent-based model simulations specific to each of the three case studies.

The 'Ostia_ABM' folder contains the NetLogo agent-based model and accompanying GIS shapefiles. In order to run the model, you will first need to download and install NetLogo 6.0.2: https://ccl.northwestern.edu/netlogo/download.shtml. To adjust the size of the model's view window, select settings along the top toolbar and change 'view patch size' to 0.6. The model is run by first clicking the 'setup' button. Once the model has loaded, click the 'reset-parameters' button and then the 'Display-agents' button. To start the model, press the 'Go' button.

Academic Thesis: Declaration Of Authorship

I, Katherine Ann Crawford

declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research.

In the Footsteps of the Gods: The use of computational methods to explore the role of mobility in the religious landscape of 2nd century AD Ostia

I confirm that:

1. This work was done wholly or mainly while in candidature for a research degree at this University;
2. Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
3. Where I have consulted the published work of others, this is always clearly attributed;
4. Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;
5. I have acknowledged all main sources of help;
6. Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
7. None of this work has been published before submission

Signed: .....

Date: .....

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Definitions and Abbreviations

AE	*L'Année Épigraphique*
CIL	*Corpus Inscriptionum Latinarum*
IE	*Die Inschriften von Ephesos*
RICIS	*Recueil des Inscriptions concernant les cultes isiaques*

Abbreviations for ancient sources follow the Oxford Classical Dictionary:

This thesis uses the Italian names for Ostia's buildings and streets in order to conform with other Ostian publications.

Chapter 1: Introduction

Religious practice permeated Roman urban life, its existence recognisable from the presence of private household shrines and monumental temples to the noise of ritual practices. The visual recognition of religion within the archaeological record, however, is predominantly confined to static representations of religion such as religious structures, sculpture, and epigraphic evidence. These sources of evidence provide only a partial view into how religion was integrated within the urban fabric of a cityscape. The ways in which religion impacted urban life and enabled it to create its own unique religious landscape can only be understood within the context of the city.

Studies of the Roman cityscape have traditionally addressed either the development of the city in terms of its urban organisation and different building typologies (Ward-Perkins, 1974; Owens, 1991; Zanker, 2000), or the various theoretical approaches aimed at understanding a city's construct (Finley, 1977; Hopkins, 1980; Whittaker, 1995). However, an important shortcoming of these previous approaches was a disregard for the people that formed these cities. Recognition of this prompted the structuralist approach that sought to determine how urban architecture could be 'read' in order to provide insight into different forms of urban activity (Rykwert, 1964; MacDonald, 1986). Interested in developing alternative ways for understanding the Roman city, scholars, predominately focused upon Pompeii, developed various integrated approaches that combined textual and archaeological evidence in order to understand the meaning of different urban spaces and buildings (Laurence, 1994; Wallace-Hadrill, 1994).

The relationship that existed between the buildings that gave structure to a city and the people that occupied it has resulted in new ways of understanding their relationship (Rapoport, 1977; Giddens, 1984). An important contribution is Zanker's (1998) idea of 'townscape' (*Stadtbild*) at Pompeii, which he states describes a city's appearance which is inclusive of buildings and their function. More importantly, this concept illustrates how changing attitudes of the urban population over time is reflected in the architectural development of the city. However, one aspect that is not addressed by the concept of a 'townscape' are the social activities or people that gave meaning to the city. In an attempt to build upon this, the idea of 'cityscape' encompasses the place where people live and its ultimate form, as evident through various architectural structures, is directly bounded by the different forms of social practices that occurred within it.

An important component of the larger cityscape are the different religious rituals practiced by a city's inhabitants. However, studies of Roman religion have largely focused upon what is visible within the archaeological record or literary texts (Woolf, 2000). Monumental temples comprise of some of the most visible and widely recognisable forms of evidence for the occurrence of religious practices within Roman cities. These attest to the presence of individual deities within a city as well as affording insights into the presence of different religious communities. Furthermore, temples

provided a venue for the practice of different rituals[1] (Revell, 2009; Revell, 2013, p. 21). These rituals, which ultimately gave meaning to individual cults, tend to be largely discounted when study is focused upon monumental architecture alone.

Transitioning emphasis away from the architectural evidence of religion, the larger religious landscape of a city can be addressed which is inclusive of a city's rituals, cultic mythology, and cultural practices (Horster, 2010, p. 437). More importantly, these rituals were a fundamental component of a city's organisation, providing important insight into how a city's religious landscape was constructed. Processions enabled ritual practices to move from a temple precinct into a city's liminal space. As they wound through the city's streets, they connected disparate spaces while enabling people to become temporary participants within a shared ritual experience.

The focus of this PhD thesis is concerned with studying the ritual landscape constructed by temples through the practice of processional rituals. The primary aims of this thesis are the following:

1. To develop a new framework for assessing how temples structured ritual activity within an urban environment.
2. To understand how the spatial dynamics of processional rituals created a unique religious landscape.
3. To question how the human component of processional rituals can be incorporated within spatial focused methodologies.

These research aims will be addressed by looking at the city of Ostia, Rome's ancient port. Ostia's religious life remains one of the site's most debated areas of scholarship (Pavolini, 2016). Evidence for over 100 different cults and 40 identified religious structures makes Ostia an ideal case study for moving attention towards questioning how temples structured ritual activity within the port town. In order to evaluate how temples constructed a religious landscape, study is focused upon the practice of religious processions. Despite the range of evidence relating to religious life at Ostia, Ostia's ritual practices have seen limited consideration, especially in terms of how they would have intersected with the city's urban population.

In order to more fully address how Ostian temples helped to create a religious landscape, three case studies are developed in this thesis relating to different temples located within the late 2nd century AD city. This temporal focus is driven by the corpus of archaeological and historical evidence that is most prevalent for this period. The three case studies are: the *Campo della Magna Mater,* the *Serapeum,* and the *forum* temples. The temples of the Magna Mater and Serapis were chosen due to their known deity associations as well as having sufficient comparative evidence about the practice of processional rituals. The final case study is centred around Ostia's two *forum* temples,

[1] The term ritual is used throughout this thesis to refer to specifically religious rituals unless otherwise stated.

the *Capitolium* and the *Tempio di Roma e Augusto.* Unlike the first two case studies, accurate identification of the associated deities and festivals of these temples are less well formulated. Therefore, this case study presents an exploratory approach to show how processional movement study can provide a more nuanced understanding of the ritual landscape structured around temples with tenuous cultic associations.

1.1 Research Objectives

In order to address the research aims discussed above, several research objectives are asked to provide a more nuanced understanding about Ostia's religious landscape:

1. How far did the location of temples at Ostia contribute towards the construct of a broader religious landscape across the cityscape as a whole?
2. How have scholars approached processions and to what extent can we study processions within the archaeological record at Ostia?
3. What is the best methodology for modelling and visualising religious processions at Ostia?
4. How far might processions have played an active role in defining social and religious practice across urban space at Ostia?
5. Does the modelling of processional routes rooted at temples help us better understand the broader ritual landscape at Ostia?

The results of this thesis will present several new contributions to both Ostian studies and Roman processional research which are grounded in a new computational approach. First, a new ritual movement framework is developed that merges spatial approaches and ritual studies to address how processional routes were structured and can therefore be studied within a given urban landscape. Due to the paucity of literary evidence for urban processions in cities outside of Rome, this framework allows research to move beyond focusing upon the written record to looking at alternative ways of approaching processional studies. Questioning how the paths taken by processions were structured by the urban landscape provides us with insight into the creation of specific ritual areas that were determined by a temple's spatial position within the city. Favro in an article entitled, "The Festive Experience: Roman Processions in the Urban Context" begins by addressing the reciprocal relationship that existed between the built environment and ritual processions (Favro, 2008, p. 10). Scholars have long recognised that a close relationship existed between the built environment and urban activity, but these concepts have yet to be readily applied to the study of processions (Rapoport, 1982; Lawrence and Low, 1990; Lefebvre, 2014). Favro's (2008) statement, therefore, serves as the starting point for the present work in which I argue that processional rituals can be studied by focusing upon how the built environment, which is indicative of social activity, structures urban movement.

Second, in order to assess processional movement, a multi-layered computational approach is developed in order to visualise possible processional routes at Ostia. This contributes to the growing corpus of scholarship focused upon the study of movement within the ancient city. The combination of network analysis methodologies and agent-based modelling presents the first attempt at studying moving rituals at Ostia. It is argued that despite the limited evidence for processional activity in the city, this multi-layered methodology can provide insight into how processions may have traversed Ostia's cityscape when considered within a ritual movement framework. The resulting processional routes developed in these models do not reflect actual processions, but rather, it enables us to look at how possible routes may have create a defined ritual movement area structured around different temples. This approach aims to bring to life Ostia's rich religious environment beyond an architectural driven focus while addressing the human interactions that gave meaning to the city's urban and religious fabric.

Third, the analysis of processions provides new insight into the broader significance and function of processional rituals that can be applied to both Ostia and other Roman cities. More specifically, it addresses the multi-faceted nature of processional rituals. The engagement of processions with a city's religious and socio-political environment provides insight into topics that extend beyond the city's religious landscape. The outcome of this study ultimately prompts a re-evaluation of both previous processional assumptions as well as how they can and should be studied within ancient urban contexts.

1.2 Structure of the Thesis

The research aims and objectives are fully developed in the following chapters.

Chapter 2 begins with a discussion about how Roman processions have been studied and in particular their routes (§2.2). The methodological challenges and problems in Roman movement-based studies are then addressed (§2.3) to illustrate the need for a more methodologically rigorous approach for studying processional movement. A detailed overview is then provided of the current computational approaches that can be applied to the study of urban movement, addressing possible directions for the study of processional movement (§2.4). The chapter concludes with a discussion about how processional research needs to be reassessed and how the application of a movement-based framework that questions how processions moved through the city is one way to address this issue (§2.5).

Chapter 3 is a background chapter that provides a historical overview of Ostia (§3.1). A detailed review of how religion and cults have been studied at the port positions the present study within its Ostian religious context (§3.2). The chapter concludes with a discussion of our present understanding of the rituals that occurred at Ostia and how this facilitates a study of processional activity (§3.3).

Chapter 4 describes the model that is created for undertaking a movement-based study of processions within Ostia's urban environment. The first part discusses how the model was created applying a specific temporal dimension within ArcGIS (§4.1). The second half of the chapter explains the classification of different types of buildings based upon spectatorship and urban activity, which is informed by the ritual movement framework (§4.2). These classifications serve as the influencing factors that are subsequently used to study how the built environment helped to structure ritual movement.

Chapter 5 is the methodology chapter that details the multi-layered methodology that is applied to the study of processional movement at Ostia within the context of each case study. Space syntax measures are used to assess the spatial position of temples as well as allowing for the creation of a delineated area for movement study (§5.3). Urban network analysis provides a way of studying the movement potential of processions along Ostia's street network, which is structured by the surrounding built environment (§5.4). The final section describes the agent-based model that is used as a comparative method to visualise processional movement as well as to question the validity of the ritual movement framework as a whole (§5.5).

Chapter 6 is the first case study, focused upon the *Campo della Magna Mater*. The chapter begins by providing an introduction to the cult of the Magna Mater (§6.1) and its presence at Ostia (§6.2). The evidence for studying the cult's processional activity at Ostia is then detailed (§6.3). The next sections apply the methodology of space syntax (§6.4), urban network analysis and agent-based modelling (§6.5) for the visualisation of processional movement along the city's street network. These potential routes are then considered within a larger framework of areas of the city important to the cult of the Magna Mater (§6.6).

Chapter 7 is the second case study, which focuses upon the cult of Serapis. The first half of this chapter introduces the Roman cult of Serapis (§7.1) and Ostia's *Serapeum* (§7.2) as well as addressing the evidence that exists for processions associated with the cult (§7.3). The next sections apply the multi-layered methodological approach to visualise areas of movement associated with this temple (§7.4–7.5). These routes are subsequently assessed within the context of our understanding of Egyptian processional practices (§7.6).

Chapter 8 is the final case study of this thesis. The two *forum* temples are used as an exploratory case study to assess how the study of a religious landscape that is structured by a temple can provide insight into temples with questionable cultic affiliations. The chapter begins with an overview of what is known about the two temples, the *Capitolium* and the *Tempio di Roma e Augustus* (§8.2). The second half of the chapter applies the methodology to question how processions associated with these two temples may have occurred on a citywide scale (§8.3–8.4). The significance of these potential routes and how it further informs our understanding about the ritual influence of these temples is subsequently considered (§8.5).

Chapter 9 begins by discussing the extent to which the present methodology has provided insight into possible processional routes, especially providing certain limitations within the dataset (§9.1). The chapter then proceeds to consider the significance of the case study results and how they provide a narrative about how ritual activity at Ostia was integrated within the cityscape (§9.2). The chapter concludes with a discussion about how the study of processional rituals provides new understanding into Ostia's religious and socio-economic environment (§9.3).

Chapter 10 draws the thesis to a close by summarising its conclusions, discussing its broader contributions to the study of religion at Ostia and Roman religion more generally, and raising future avenues of research.

Appendix A consists of relevant literary passages referred to throughout this thesis. **Appendix B** contains the classification database created in ArcGIS in relation to individual building identifications. **Appendix C** presents the annotated code used to create the agent-based model.

Appendices D–F form Volume II of this thesis and are included in a supplementary digital format. These comprise of additional urban network analysis graphs and visualisations of the agent-based model runs specific to each of the three case studies. The full agent-based model created for this thesis is also included in a separate file.

Chapter 2: Placing Religious Processions within a Landscape of Movement

2.1 Introduction

The aim of this chapter is to review how scholars have approached the study of Roman processions and processional routes. I begin with a review of the ways in which the principal processions have been studied, focusing attention upon current discussions about how specific routes through the urban landscape can be identified. This is then placed within a larger context of how the study of processional movement needs to move beyond trying to recreate routes based upon a fragmented literary and archaeological record. I argue that movement-focused methods can inform our understanding of processional routes because they are in part structured by pedestrian movement. I then discuss the ways in which pedestrian movement has been studied within Roman cities. However, current approaches are insufficient for similar studies at Ostia as well as for the study of non-random pedestrian movement. An overview of the different computational approaches that can be used to study pedestrian movement shows the potential of applying a more methodologically rigorous approach to the study of processional movement at Ostia. The chapter concludes with a discussion about how the assumption that the built environment helped to structure processions provides a novel approach to studying urban religious movement.

2.2 Roman Processions

Religious processions are complex multi-sensory rituals. Defined by the *Oxford English Dictionary* (3rd edition) as "the action of a body of people going or marching along in orderly succession in a formal or ceremonial way," they vary considerably between time and place. Despite the differences among processions, one consistent feature is the way in which they interact with the surrounding urban environment, bridging and incorporating otherwise disparate spaces.

A major difficultly in studying Roman processions is that their existence was only held in the memories of those that attended, heard, saw, or learned about it from someone who had been present (Connelly, 2011, p. 314). While scholars tend to associate processions with the majority of Roman rituals, they are not regularly mentioned by literary sources or depicted within the iconographic record (Price, 1984, p. 110; Fless, 2004, p. 34). The assumption about their routine occurrence and the difficulty of identifying their presence has shaped the direction of processional research.

Studies of specific Roman processions have relied predominately upon literary accounts. However, minimal surviving evidence has resulted in a fragmented understanding about the extent to which processions occurred in the Roman world as well as their more nuanced characteristics (Fless, 2004). This is in part due to the fact that like many other Roman daily activities, descriptive explanations of processions were not necessary as ancient authors assumed their audience was familiar with the topic (Flower, 1996, p. 97). Another issue concerns how processions were described by ancient authors. There is no generic term used to identify the range of different processions that occurred (Fless, 2004, p. 33). The largest processions are typically identified by the term *pompa,* such as the *pompa circensis, pompa funerbris, pompa triumphalis,* but these represent just one type of processional ritual. Minor processions are more complicated to identify due to their vague literary descriptions.

More often than not, processions have to be inferred from literary accounts. Examples include references to the movement of cult statues, such as Dio's narrative about a boy falling while carry a statue of Victory in a procession with soldiers (Dio 47.40.8). The context of this passage remains unclear; it refers to a *pompa*, but neither the nature of the procession nor the point at which the incident occurred within the ritual are specified. Alternatively, a procession may be commented upon explicitly but without supporting details. One of Cicero's letters contains a brief complaint about the occurrence of a procession, but observations or details about the particulars of the ritual are not included (Cic. *Att.* 13.44.1). In other instances, spatial references within the city may be provided. Plutarch's account of the *Lupercalia* procession states that it begins its "course around the city at the point where Romulus is said to have been exposed" (Plut. *Vit. Rom.* 21.48).[2] The starting point of the procession is referenced in terms of a person's mythological and historical understanding of the city, while further details about the procession are not offered. Processional activity is largely alluded to by ambiguous references to movement that formed a component of a larger ritual. These literary examples clearly show the occurrence of distinct processional rituals, but the provided details for each of the processions is extremely limited. In most cases, understanding of the literary reference would have been reliant upon a person's cultural and historical understanding of the rituals at the time.

Iconographic depictions of processional rituals are even more problematic to understand, raising issues of artistic representation and viewer reception (Elsner, 1996; Hölscher, 2004). Processions depicted upon reliefs and wall paintings portray selective elements of a single procession, providing a representative illustration of the overall ritual, which could easily differ from reality (Holliday, 2002). While processions likely passed a wide range of urban structures, only those directly relevant to the ritual are depicted by artists (Kellum, 1999; Favro, 2008, p. 18). Each procession was unique with different intentions and characteristics, which further complicates any attempt at studying

[2] Translation by Perrin, 1914.

individual rituals. As a result, the examination of individual processions tends to focus upon a singular ritual aspect rather than the total spectacle event (Fless, 2004).

The study of processions within the archaeological record is complicated by their ephemeral nature. Evidence of their occurrence may survive in the form of commemorative architecture or by the dedication of a monumental temple, but these architectural structures only provide partial insight into the ritual. Therefore, much of the research surrounding processions has focused upon the ritual meaning, individual literary descriptions, and religious or cultural differences in processional practices (Turner, 1969; Jacobsen, 2008). From an archaeological perspective, attention has been placed upon the buildings associated with a procession in isolation from the ritual rather than discussing how the overall processional ritual was staged (Friese and Kristensen, 2017, p. 2). As a result, processional studies have not seen extensive consideration within archaeological studies of Roman religion, which have focused predominantly upon extant evidence of ritual practice, such as ritual deposits (Wilkins, 1996).

In terms of the processional routes, the limited amount of existing information has shaped how scholars have approached the issue of movement, focusing predominately on processions with detailed literary descriptions (Favro, 2008, p. 10). Despite the inherent difficulties in studying processions, the ways in which buildings interacted with the urban landscape presents one way of looking at how a particular religion was able to construct a religious landscape within the ancient cityscape. More limited consideration has been given to processions in the context of a moving ritual, a topic that has focused upon determining the exact route of a particular procession (Rogers, 1991; Östenberg, Malmberg and Bjørnebye, 2015).

A comprehensive and systematic study of processions in the Roman Empire has yet to be undertaken (Fless, 2004, p. 35). Our understanding about the range of processions that occurred comes predominantly from the annual events and festivals documented within the Roman calendar, or *fasti* (Fless, 2004, p. 34).[3] There are twenty-two known calendars surviving from the Roman Empire (Beard, North and Price, 1998, pp. 322–339). Most of these calendars date to the Late Republic or Early Empire, whereas documentation of later Imperial festivals comes predominately from select documents such as the Severan period *Feriale Duranum*[4] and different painted calendars (Graf, 2015, p. 65).

The few surviving Imperial calendars means that our understanding of individual festivals, let alone processions, is extremely limited during this period. These calendars were syncretized with the

[3] The *fasti* were organised around the twelve calendar months of the year, documenting juridical days, assemblies, foundation of temples, and festival days. These were manifested as either publicly displayed inscriptions or as wall paintings found predominantly within elite dwellings (Rüpke, 2011, p. 8).
[4] This calendar survived on papyrus in Dura Europous and recorded the main festivals celebrated by the army (Fishwick, 1988).

calendar of events that occurred at Rome, which meant that local cult festivals were not generally recorded. But as Rüpke argues, the lack of variation indicates that the purpose of the *fasti* was to maintain the Roman Imperial calendar rather than a city's individual festivals (Rüpke, 1995, p. 163; Iddeng, 2012, p. 18). This does bring to light questions concerning the extent to which Roman festivals were celebrated within other localities of the Empire versus more localised traditions. The same held true for the *fasti Ostiensis* (Ostia's calendar), which included only nine years with specific reference to Ostian rituals, discounting the elections to the *pontifex Volkani*, over a total of 79 years (Bruun, 2009, p. 135).

The religious year was documented in a variety of ways within the *fasti* (Stevens, 2017, p. 158). The foundation date of temples or altars were often commemorated with the establishment of a festival (Balsdon, 1969; Rüpke, 2011). Although the records contained within the different *fasti* vary, many of the temples frequently commemorated corresponded to those found in the city of Rome (Rüpke, 2011, p. 11). Public holidays were noted as *feriae publicae*, which occurred annually on a fixed day. While the occurrence of festivals can be noted, it is not possible to reconstruct the total design of the processions that occurred as part of various festivals. There are three general types of processions, those associated with large public spectacles (e.g. *ludi*),[5] processions that occurred as part of a specific festival for a deity (e.g. *Megalensia*, *Lupercalia*),[6] and minor rituals like sacrifices that were preceded by a procession (Fless, 2004, p. 39). The remainder of this section addresses the most well-known processions as a way to illustrate how scholars have approached the study of processional routes.

2.2.1 Roman Triumphal Processions

The Roman triumph, *pompa triumphalis*, constitutes one of the largest and most elaborate processional rituals that occurred in the Roman world. As a celebration of a victory won by a Roman General, the spectacle contained elements such as the display of spoils and captives, all of which were later commemorated by the creation of triumphal monuments. The grandeur and complexity of the Roman triumph has resulted in over 150 years of scholarship (Gibbon, 1796; Fowler, 1916; Payne, 1964; Brilliant, 1999; Pittenger, 2008; Beard, 2009; Popkin, 2016). While early

[5] *Ludi* were a series of games ranging from chariot races to gladiatorial games and dramatic performances that occurred throughout the year. Within Rome, the late Republic saw almost three months of *ludi* a year (Scullard, 1981; Veyne, 1990; Dunkle, 2014). Examples include: *Ludi Ceriales*, April 12–19; *Ludi Apollinares,* July 6–13; *Ludi Vitoriae Caesaris,* July 20–30; *Ludi Romani,* September 4–19; *Ludi Plebei,* November 4–17; *Ludi Saeculares* (Balsdon, 1969, pp. 68–70). One of the features of *ludi* was the occurrence of *pompae* where images of deities were carried in a procession from temples to their temporary placement in the circus or theatre (Livy *Ab. Urb.* 40.59.6–8; Dion. Hal. *Ant. Rom.* 7.72.13; Ov. *Am.* 3.2.43–64).

[6] The *Megalensia* was a festival associated with the cult of the Magna Mater, occurring April 4–10, that consisted of a series of games preceded by processions (see Chapter 6). The *Lupercalia* occurred 15 February and consisted of a procession of young men, wearing skins of previously scarified animals, around the Palatine Hill (Beard, North and Price, 1998; Graf, 2015, pp. 163–183; Vuković, 2017).

research into the triumph focused upon the origins and meaning of the ritual (Beseler, 1909; Fowler, 1916; Wallisch, 1955; Payne, 1964; Versnel, 1970), more recent scholarship has approached the procession as a performative ritual, looking at the ways in which it can inform our understanding of various aspects of Roman culture (Brilliant, 1999; Beard, 2009; Östenberg, 2009).

Reconstruction of the triumphal route through Rome, and the degree to which it may have varied between different processions, remains one of the most contested aspects of the ritual among scholars today (Popkin, 2016, p. 24). Itgenshorst contends that the procession cannot be reconstructed and focuses attention instead upon the function of the ritual and its relationship to the participants (Itgenshorst, 2005). In contrast, Coarelli believes that the triumph had a fixed route that was followed from its establishment in the Republic until the 6th century AD (Coarelli, 1968). An alternative view on the fixed route is offered by Favro, who proposes that the triumph passed certain nodes that remained constant, but that the route between these nodes likely varied (Favro, 1994, pp. 154–157). Beard takes a less stringent approach that views the triumph as a continually evolving ritual, where the route was probably structured by specific architectural parameters rather than always following the same itinerary (Beard, 2009). This adapts a more ritualistic view of the triumph, where certain components changed over time while retaining recognisable characteristics so the public could understand the performance (Popkin, 2016, p. 33).

Recent questions regarding the triumphal route and how it should be studied have resulted in new ideas regarding the importance of determining specific routes. Popkin's recent book, *The Architecture of the Roman Triumph* (2016) adopts a new approach that investigates how monuments helped to shape the route of the triumph. Building upon spatial studies that recognise the reciprocal relationship between architecture and urban action, Popkin illustrates how certain types of urban architecture affected the route chosen for the triumph (Favro, 2008; Popkin, 2016). Similarly to Favro's (1994) discussion of nodes, Popkin states that the path of the procession should be considered in terms of nodes, where "the precise means by which triumphs passed between each set of nodes shifted at different performances of the ritual, the relative order of these nodes remained constant" (Popkin, 2016, p. 44). A comparable premise has previously been suggested by Gisborne who argues that processional routes should be considered in terms of 'blueprints', where the appearance and actual route may vary overtime but the total ritual retained a standard structure (Gisborne, 2005, p. 10).

A recurrent issue in many attempts to reconstruct the triumphal route lies in the fragmentary nature of literary accounts in addition to the dismissal of archaeological evidence (Beard, 2009, p. 101). Scholarship tends to focus upon specific aspects of the route; debating topics that range from identifying where the triumph assembled to specific monuments that it may have passed (Payne, 1964; Tuck, 2008). Refocusing attention towards how certain monuments shaped the *pompa* moves the focus of attention away from attempting to define the route with limited surviving evidence, to

questioning alternative ways of studying the procession's itinerary.

2.2.2 Circus Processions

Circus processions, *pompae circenses*, occurred several times during the year at Rome in conjunction with festival games (Bernstein, 2007, p. 222). Sponsored by the *praeses ludorum,* the procession began at the Temple of Jupiter Optimus Maximus on the Capitol. Statues of the gods were carried from there through the city and placed within the Circus Maximus in preparation for the start of the games. Early scholarship focused upon the *pompa circensis* in relation to the triumph. Mommsen argues that the circus processions were a continuation of the triumph's ending point (Mommsen, 1859). His theory assumes that the triumph was the main factor motivating other spectacles within the city, a spectacle that did not occur regularly (Latham, 2016, p. 33). Despite scholars recognising the regular occurrence of circus processions in the city of Rome, it has received considerably less attention in comparison to the triumph.

Study of the processional route focuses predominately upon the transition between the Republican and Imperial periods as this is when the fullest account of the procession is detailed (Dion. Hal. *Ant. Rom.* 7.72). Arena addresses the development of the route in the 1st and 2nd centuries AD, specifically in relation to important temples and significant locations for the imperial family (Arena, 2009, p. 91). While presenting insight into the ways in which imperial ideology shaped the route, the study still does not integrate how urban factors may have influenced the route. An important point that is raised is the idea that the procession effectively linked Rome's urban spaces with the political and religious ideology of the empire (Arena, 2009, p. 93). Latham, alternatively, views the processions as a form of way-finding, where an understanding of the city is constructed based upon the route taken and its regular occurrence (Latham, 2016). His attempt to present an analysis of the procession and the monuments passed based upon a range of evidence does not fully answer the question as to why certain areas, in relation to the surrounding cityscape of Rome, were included within the ritual. Although striving to avoid excessive simplification of the route, he reconstructs the procession following the combination of various literary accounts (Latham, 2016). The study of a circus procession's route remains the focus of scholarly enquiry, however, none of the present scholars have adequately addressed the route and its course through Rome. Rather, the procession is used as a proxy for asking larger questions about Roman ideology.

2.2.3 Funerary Processions

Roman funerary processions, *pompae funebres,* would have regularly occupied the streets of Rome. They became an important occasion for the elite to display their power and influence as they wound through the city (Polyb. 6.53; Cass. Dio 75.4.2–6). The overall funerary ritual has been approached from a variety of perspectives ranging from the symbolic meaning to considering specific ritual

components such as the carrying of death masks (Toynbee, 1971; Hopkins, 1983; Flower, 1996; Bodel, 1999). Despite being a relatively common event during the Roman Republic and Empire, which concluded in one of the most public spaces in Rome, the *Forum Romanum,* it has very few detailed descriptions (Flower, 1996, p. 97). The only aspects of the route addressed by ancient authors includes its arrival at the Roman *Forum* in preparation for the *laudatio*, or funerary speech (Dion. Hal. *Ant. Rom.* 5.17.2; 11.39.5–7; Hor. *Sat.* 1.6.43). As a result, research into this particular processional route is focused almost exclusively upon the concluding point rather than its movement through the streets of Rome. Bodel's seminal article "Death on Display" considers the choreographed nature of the ritual, which includes the relationship between the procession and the crowd, but emphasis remains upon the procession's goal of reaching the *Forum* rather than the route as a whole (Bodel, 1999).

The route's concluding point at the *Forum* is addressed through a phenomenological analysis in Favro and Johanson's article 'Death in Motion' (Favro and Johanson, 2010).[7] Considering three different processions from the mid-Republic and Imperial periods, they demonstrate how the processions changed over time based upon their entrance to the *Forum* and their use of urban space (Favro and Johanson, 2010). Using a combination of comparative studies drawn from triumphal processional routes and digital reconstructions of the *Forum* over different time periods, they highlight the connection between the *Forum* and buildings passed by the procession. Their innovative approach addresses many of the issues implicit with studying funerary processions, but they focus upon one specific aspect of the ritual rather than the entire route prior to its entrance to the *Forum*. However, the constantly changing starting point that would have begun at the deceased's house means that a set route would not have existed therefore making a complete study of the route unfeasible. Despite a narrow focus that considers only the concluding point of the procession, due to the ephemeral nature of a funerary procession's route, their work is an important contribution to looking at the way urban space affects the processional ritual through the use of computer visualisations (Favro and Johanson, 2010, p. 31).

2.2.4 Urban Processions

In comparison to the *pompae* discussed above, urban processions constitute one of the least studied processions but probably accounted for the majority of processional activity within Roman cities. The general regularity of processions within daily life meant they did not merit much attention by literary sources (Boatwright, 2009). The processions that occurred within the city of Rome are inevitably the most well-known due to their greater frequency of literary documentation and iconographic depictions. Apuleius, however, argues that processions retained their form in cities

[7] This article follows Johanson's doctoral thesis which applies digital modelling of the *Forum Romanum* to look at different choreographic entrance possibilities of the funerary procession (Johanson, 2008).

outside of Rome while assimilating with the local traditions of a city (Apul. *De deo Soc.* 14).[8] While this may have been true to an extent, we have to be careful about assuming that processional rituals remained constant throughout the empire. It is more likely that important festivals associated with a deity were celebrated, but within the guise of local traditions.

Attention towards the transportation of cult images in a procession is one of the more commonly employed methods for considering the range of ancient processional activity that existed apart from the standard *pompae.* Elkins (2014) addresses the procession of imperial cult images at Rome and their final placement within the Colosseum. Analysing the evidence of cult statues, he argues for the regularity of processional activity associated with the amphitheatre and other public venues at Rome and throughout the empire (Elkins, 2014). While the article brings together a range of evidence for imperial cult processional statues, the procession itself is not addressed. A broader perspective is adopted by Madigan in *The Ceremonial Sculptures of the Roman Gods* (2012), which looks more generally at the role played by statues in ceremonies and rituals of the Roman world. Building upon Stewart's approach that moves the study of statuary beyond the realm of art history and consider them within their social and physical contexts, Madigan questions the role that statues played within festivals (Elsner, 1996; Stewart, 2008; Madigan, 2012). Analysed upon the basis of literary and iconographic depictions, the work provides a relatively comprehensive overview of the different ways in which statues could be used for religious ceremonies. Despite Madigan's attempt at advancing understanding of the ways in which statues were used in ceremonies, statuary is not considered within the context of the larger processional ritual (Madigan, 2012). Without considering the wider social function or visual emphasis of the statues, the participant and spectator component is discounted.

Study of individual processional routes has been attempted predominantly for well-documented urban religious processions, not counting the Roman *pompae*. One of the most comprehensive accounts is the procession of Artemis at Ephesos, which is detailed in a 568-line dedicatory inscription donated by C. Vibius Salutaris in the 2nd century AD (*IE* 27). The Artemisia processional route, a circular procession that travelled between the temple of Artemis and the Theatre, is considered in detail by Rogers following details provided in the inscription (Rogers, 1991). He aims to associate specific urban spaces within Ephesos with sites mentioned by the inscription, thereby describing the circular route (Rogers, 1991, pp. 80–112). While specifying the spaces passed, his study does not adequately account for chronological variation in the existing archaeological record or engage with the urban context of the procession (Cole, 1993). He effectively connects-the-dots

[8] Apul. *De deo Soc.* 14: "So also in the matter of rites there is a great diversity by region—in the formation of processions, the silence of mysteries, the duties of priests, the rules of sacrifice, and similarly in the images and ornaments of gods, the liturgy and placement of temples, the blood and the color of sacrificial victims. All these things are traditional and determined according to the custom of each place." (Translation by Jones, 2017).

between identified spaces within the city to construct the processional route without questioning why certain areas were passed and what they contributed to the total ritual. Such an approach is not unlike previous scholarship on *pompae* that reconstructed routes by stitching together various pieces of literary evidence. The symbiotic relationship that existed between a procession and the urban landscape necessitates further study.

The past couple of years have seen a growth in movement focused studies within Roman cities. The edited volume, *The Moving City* (2015), presents several articles about religious movement, which begins to shift the focus of research away from topographic studies of space to questioning how topography influenced movement. Despite the volume's interest in movement, the essays specific to processions do not go much beyond traditional approaches. One article considers the relationship that existed between different cult and urban spaces and their location along processional routes between the city and the suburbs, however, the study does not surpass basic conclusions into their routes' importance (Iara, 2015). Various urban pilgrimage routes at Rome are likewise considered by several scholars, but the reason certain religious spaces were passed and their contribution to an overall religious experience are not addressed (Andrews, 2015; Mulryan, 2015). While the collected articles provide a welcome change of focus towards considering urban topography by looking at movement, they do not contribute much in terms of developing a more rigorous approach to studying processional movement within the city.

2.2.5 Advancing Roman Processional Studies

Despite the number of studies aimed at reconstructing possible routes, the previously mentioned studies suffer from a problem with their methodological limitations. Processions were highly interactive events that engaged with both participants and spectators to create a shared ritual experience (Favro and Johanson, 2010; Lange, 2015; Popkin, 2016). Graf highlights the complexity of studying processional routes:

> A procession is not just a journey from A to B; it matters where A and B are located, and who is doing the journey. But to properly be able to elicit what the purpose of a procession is, one must consider not only the form, but the total ritual context to which it belongs. (Graf, 1996, p. 64).

Roman processions were not straightforward rituals. Their transient nature and the variation among even the same annual procession further complicates their study (Flower, 2004, p. 393). Research into processional routes needs to move away from a 'connect-the-dot' approach that is focused solely upon the combination of literary evidence with an interest in urban topography, to questioning which urban and social factors shaped the route. While such scholars as Popkin (2016) are beginning to adopt methods that address how the presence of selective buildings might have conditioned the specific routes taken by a procession, this approach can be taken further. The

kinetic aspect of processions merits further attention in terms of how it structured interactions within the ritual. As Favro states: "every component of a festival procession gained, or lost, significance depending upon its placement in the processional sequence" (Favro, 2008, p. 24). A procession's movement arguably facilitated both how urban populations interacted with a procession, and its broader impact within an urban environment. The ways in which people moved through the ancient city presents an alternative perspective for studying processional routes by turning attention towards movement. The next section addresses how the topic of movement has been studied in regards to various Roman cities and the ways it can be applied to processional studies.

2.3 Study of Movement within Roman Towns

Prior to looking at how to more rigorously study processional movement, it is necessary to address how movement has been approached within Roman studies. Developing out of the Roman 'spatial turn', there has been a growing trend of looking at how movement can be studied within ancient Roman cities (Cosgrove, 2004; Ballet, Saliou and Diudonné-Glad, 2008; Laurence and Newsome, 2011; Östenberg, Malmberg and Bjørnebye, 2015). Despite a variety of approaches being adopted, this review shows that the present studies do not offer adequate methods for studying processional movement when there is limited literary evidence about their character.

Methodologies for studying patterns of movement have developed predominately out of Pompeian studies due to the city's well-preserved street network. Early research was undertaken by Tsujimura, who addressed the circulation of traffic based upon using wheel ruts and street depth as an index of the intensity of street usage at Pompeii (Tsujimura, 1991). Poehler expands upon this topic by examining Pompeii to produce a detailed study of possible movement patterns and vehicle directionality by assessing evidence of traffic wear and restrictions to movement (Poehler, 2006, 2017). While 'movement-wear' approaches illustrate an innovative attempt at merging archaeological data with larger questions of vehicular traffic, there are many limitations. First, research is restricted to cities with well-preserved streets, which means that a similar approach cannot be applied at Ostia which does not have a preserved street surface.[9] In terms of looking at ritual movement, traffic wear is indicative of a street's importance as reflected by its intensity of use, not necessarily the reason for the movement that generated the wear. Also it cannot incorporate pedestrian movement that leaves no visible trace, which constituted the majority of processional movement. A final issue is that street-wear studies cannot account for chronological changes in street use and functionality.

[9] Surviving paving stones were displaced when archaeologists excavated below street level, which were then replaced. The random replacement of paving stones is shown by wheel ruts running horizontal to the street.

Pedestrian movement, alternatively, has been approached by questioning how certain urban structures helped to configure movement patterns. Ellis addresses the relationship between pedestrian movement and the spatial location of *tabernae* at Pompeii to infer that they corresponded to high traffic areas (Ellis, 2004). Although the supposition that access to food held the same importance as today represents a slight cultural bias, Ellis strives to present an alternative way of analysing movement within the built environment. Following a similar idea, Hartnett examines areas of movement based upon the presence of street-side benches at Pompeii. He argues that these benches were active participants within the urban environment, impacting both people and surrounding buildings (Hartnett, 2008b, p. 117). These types of approaches have influenced further research that has addressed the spatial location of different urban structures following the reconstruction of movement patterns (Ling, 2005; Hartnett, 2008a; Kaiser, 2011). While these types of studies are less empirical, they have refocused movement studies towards questioning what affected movement, recognising that evidence of pedestrian movement is often invisible within the archaeological record.

The ways in which visibility informed individual perception of the ancient city has developed as a more common avenue for the study of urban movement patterns. Influenced by Lynch (1960), literary evidence has been used as a way to produce different narratives about how specific movement routes were perceived by fictitious characters. An early study undertaken by Purcell recreates how a viewer would have witnessed Rome during Nero's reign as a person walked from the city to the countryside (Purcell, 1987, pp. 187–189). Taking a more focused approach, Yegül reviews one of Ephesos' primary streets to detail how the surrounding architecture informed ancient pedestrians' understanding of the city's historical and religious traditions (Yegül, 1994). Favro assumes a similar albeit more detailed method that builds upon Lynch's framework (Lynch, 1960; Favro, 1996). Focusing upon theoretical walks through the city 52 BC–AD 14, she tries to address how Rome's Augustan transformation informed people's perception of the city and what types of messages were elicited (Favro, 1996, pp. 238–357; see however Coarelli, 2009). However, the limited detail we have about the street layout from Early Imperial Rome means that much of this analysis is fabrication. Pilgrimage studies have adopted similar perspectives for the study of routes through sanctuary settings. Recent work by Jürgens (2017) assesses the Hellenistic Leukophryena festival at Magnesia-on-the-Meander. The sanctuary's architectural layout is used to inform the likely processional route based upon the general visibility of passing individual monuments (Jürgens, 2017).

Phenomenological approaches offer limited insight into different ways in which the perception of Rome shaped pedestrian experience. The same issues found in Lynch's model are reiterated within these studies that follow a subjective view of the ancient city by attempting to understand a person's visual perception (Lynch, 1960; Kaiser, 2011). The ways in which routes were chosen does not present a believable representation of a city's street interactions, appearing sterile or mechanical.

As a result, the modelling of narrative walks has received heavy criticism from both classicists and archaeologists (Favro, 1996; Jaeger, 1997; Haselberger, 2000; Stöger, 2011a, p. 201). Although attempts have been made to discover how ancient authors perceived movement following descriptions of different urban environments, they leave much to be desired in terms of understanding the full complexity of features that affected urban movement patterns (Laurence, 1994; Larmour and Spencer, 2007; Newsome, 2011a). Any study of processional movement following this type of framework would encounter the same issues. Visibility-based approaches present insight into different perceptions of the urban environment, but they are not grounded in a strong methodological approach for studying movement. While presenting what could be considered a pretty story about how a city was viewed, there remains significant room for further consideration into the nature of pedestrian movement and what role the built environment played. Likewise, for the study of processions these approaches do not afford sufficient methods for studying possible routes apart from fabricating their itinerary in order to undertake a visibility based study of different monuments.

In recent years, computational methods have gained ground as a useful tool for studying movement patterns within ancient cities. By focusing attention towards how movement can realistically be studied and modelled for individual urban environments, these methods present a more-robust way of approaching processional movement when applied in combination with studies of the archaeological record. The following section considers the primary methods that can be applied to ancient pedestrian movement and their suitability for the present study.

2.4 Computational Approaches for the Study of Urban Movement

While movement formed a central component of ancient life, it has not seen the same degree of attention as has been afforded to spatial studies. There has been a growth in scholarship the past decades related to studies of movement and computational methods within the ancient world more generally (Bell, 1992; Häussler, 1999; Melfi, 2010; Connelly, 2011). In particular, the use of models presents an alternative way to investigate urban movement when compared to the methods described above (§2.3). As defined by Clarke, "models are pieces of machinery that relate observations to theoretical ideas" (Clarke, 1972, p. 1). A model can aid researchers in addressing questions and looking at the validity of theories in order to gain a better understanding of the system in study. Embedded within everyday human activities, movement was shaped by a variety of different factors that ranged from the pre-existing street network to where a person was trying to go (Giddens, 1984). Despite the extent of existing studies, many of the approaches do not consider the motives behind movement.

A growing number of formal methods have been developed to enable the study of movement within urban environments, predominately arising from the field of urban studies. Many of these methods, while intended for modern urban contexts, have seen significant application to archaeological studies. Three predominant approaches have been applied in attempting to understand movement patterns in antiquity (Thill, 2000): 1) Geographic information systems (GIS) have seen numerous applications for the study of movement across past landscapes (Bell and Lock, 2000; Llobera, 2000; Wheatley and Gillings, 2002; Conolly and Lake, 2006, pp. 151–159); 2) Network analysis, specifically space syntax, has been used to study movement within the built environment (Hillier and Hanson, 1984); and 3) Simulations have been used to examine and develop theories of urban movement. This section reviews how these three methods have been applied to studies of ancient movement, addressing their potential for the study of processional movement.

2.4.1 GIS Models

The study of movement has become an important avenue of enquiry for the study of archaeological landscapes, with numerous approaches evolving from spatial practices (Llobera, Fábrega-Álvarez and Parcero-Oubiña, 2011, p. 843). The study of mobility within past landscapes has seen significant study within GIS environments, especially with the availability of raster based calculations (Bell and Lock, 2000; Fábrega Álvarez and Parcero Oubiña, 2007; Herzog, 2014). Where there are minimal indications of ancient pathways within the archaeological record, it presents an exploratory method for considering how the landscape lent itself to different movement routes. Since the 1970s, scholars have recognised that various factors played an important role in the time it took to reach a destination other than straight-line calculations for a route (Bintliff, 1977, p. 112).

Cost-based approaches have been adopted as a way to model the dynamic effects of movement across a given landscape. Cost, usually relating to time or energy, is computed using a raster where routes are calculated based upon moving through space conserving cost, or optimally accumulating cost (Wang, Savage and Bradley Shaffer, 2009, p. 1366; Livingood, 2012).[10] One of the primary methods is the use of least cost path (LCP) calculations, which model the best route from two points using GIS (Conolly and Lake, 2006). LCP has seen limited development for application within urban landscapes (Branting, 2004). The ways in which movement occurs within a cityscape is significantly different compared to travel across a natural landscape. Few attempts have been made to integrate raster-based approaches in order to look at movement within the cityscape. One study looked at circulation movement patterns at the Minoan Palace at Malia in Crete (Haciguzeller, 2008). Using the cost distance tool in ArcGIS, Haciguzeller considers the changes in movement circulation

[10] While slope, or the energy required to traverse terrain, is the predominantly used cost variable, alternative costs such as the availability of resources, settlement locations, or visibility can be applied (Gorenflo and Gale, 1990; Ratti, 2004; Conolly and Lake, 2006; Murrieta-Flores, 2014; Paliou, 2014).

based upon architectural modifications to the palace over time. However, further intricacies of movement, such as a specified destination or other pedestrian dynamics, cannot be incorporated within the GIS model. In relation to modelling processional routes, the use of LCP cannot be adequately applied to movement that does not take the most direct route, thereby limiting its usefulness to the present study (Ratti, 2005; Herzog, 2013, p. 2).

The study of transportation networks has developed as another application of GIS for addressing urban movement questions. The 1990s saw the development of alternative approaches for transportation modelling, which attempted to combine existing urban routes within GIS to carry out various analyses (Thill, 2000; Branting, 2004, p. 35). An infrequently used method within archaeological studies is the application of GIS-T, transportation studies within GIS (Branting, 2004). However, an issue for its application to the archaeological record is that GIS-T cannot adequately account for different forms of transportation such as carts or pedestrian movement, limiting its usefulness (Branting, 2004, p. 35). Attempting to address this issue, a specific application of GIS-T was applied by Branting (2004) to simulate pedestrian movement at the Iron Age site of Kerkenes Dağ in Turkey. His methodology employs GIS-T to study how movement patterns change according to different ages and genders along the city's street network (Branting, 2004). One of the major drawbacks to this method is that multiple software packages were necessary in order to carry out the full analysis. Additionally, while it is a useful tool for studying general traffic flows and the directionality of movement, it does not look at the creation of specific types of routes in terms of different movement intents, instead it considers random movement patterns. As a result, like the LCP models this approach is not a useful tool for trying to study processional routes at Ostia. Although GIS has been one of the predominant methods for assessing movement routes within archaeological landscapes, the limitations for addressing different pedestrian dynamics within urban contexts limits its usefulness for the present study.

2.4.2 Network Analysis

One of the principal approaches for studying movement within urban contexts has arisen out of network science methodologies, which archaeologists have been applying to spatial studies since the 1960s (Freedman, 2004). Found in virtually every aspect of our daily lives, networks range from social groups to a city's street network. The ways in which we interpret these networks, however, is another matter and has resulted in the development of various approaches (Knappett, 2011). Archaeological studies have long been interested in topics such as road or trade networks. Within any network analyses, the importance is not only on the objects in question, such as trade centres, but equally important are the connections between them. In these instances, networks are used as a way to help conceptualise these connections. Despite the application of network analysis in other fields, it has only recently gained currency within archaeology (Brughmans, 2013; Knappett, 2013). The range of network approaches across different disciplines has resulted in a haphazard application

within archaeology, with its use often based upon the questions being asked of data rather than the development of specific network methodologies appropriate for archaeological material (Brughmans, 2010, p. 277; Knappett, 2013, p. 4).

Developed as a subset of Graph Theory, network analysis presents a way of connecting real or abstract ideas together and interpreting the patterns that arise. A graph (Figure 2.1), also referred to as a network graph, in its most basic form is a group of nodes connected by edges that illustrates a set of relationships that are represented topologically (March and Steadman, 1974; Barnes and Harary, 1983; Steadman, 1983). Network science is another method that archaeologists can use for visualising and interpreting spatial data, which includes addressing movement networks (Brughmans, 2010, p. 277).

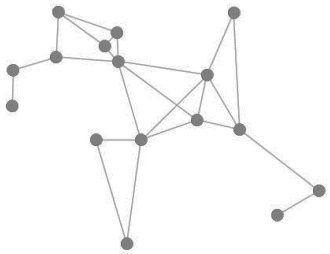

Figure 2.1 Example of a network graph showing nodes and edges.

The most commonly applied form of network analysis for archaeology is Social Network Analysis (SNA), which engages with relationships between people or ideas. One of the primary applications of this form of network analysis has focused upon trade patterns by looking at the transport of goods in order to understand communication networks, local market interactions and long-distance trade routes. An early example of studying transport networks was Isaksen's (2008) examination of the Antonine Itineraries and the Ravenna Cosmography. By analysing the possible routes between towns, he applies various measures of centrality[11] to postulate how certain towns functioned within the geographical structure of the Roman province of Baetica. Graham (2006) considers the same Itineraries to look at wider Roman perceptions of space throughout the region by applying SNA, offering a slightly different evaluation of the same dataset used by Isaksen (2008). His approach calculates distances between towns mentioned in the Itineraries to determine how they related to other spaces throughout the Roman Empire. While the intent of these analyses was to consider the relationship between towns, possible movement routes between towns were also produced as a

[11] Centrality consists of several different measurements (e.g.: closeness, betweenness, degree) that assess an individual node's relationship to the rest of the nodes within a network. Centrality identifies the most important nodes within a network structure (Collar *et al.*, 2015).

way to assess the relationship of one town to another.

The majority of network approaches within archaeology consider large-scale datasets or regional interactions. Despite the ways in which network analysis has been applied, it does not prevent its application to smaller scale studies, such as individual urban environments (Mol and Mans, 2013). The only small-scale example of network analysis applied to Roman movement is Poehler's (2016) analysis of Pompeii's street system. Interested in studying the general movement patterns of Pompeii, he looks at how the presence of doors located along the city's streets structured movement by applying betweenness centrality, a network analysis metric that measures the probability of movement passing a specific node within the network. This enabled him to determine which streets saw the greatest amount of traffic. While innovative in trying to develop an alternative way to look a Pompeii's circulation patterns, it is still applied to generic movement. It presents new insight into how the design of the street network structured movement, but it does not address the study of different forms of movement (e.g. cart or pedestrian) or how these could be approached using a similar method.

One of the benefits in applying network analysis to archaeological questions is that it serves as an exploratory method to interrogate data and ask different types of questions (Terrell, 2013). However, the limitations of incomplete datasets and the resulting interpretations need to be accounted for within any network study (Brughmans, 2010, p. 280). The most significant factor in any application of network analysis is the careful definition of nodes and edges, and clearly defining what questions are being asked of the data (Knappett, 2013, p. 4). The benefit of applying a network methodology lies in how it allows for different interpretations or visualisations of connections between objects or ideas. Furthermore, the addition and removal of nodes within a larger network system offers valuable information about a system's controlling factors.

More formal methods of network analysis have seen little engagement with the study of movement within archaeological studies. However, another applied graph-theory model termed space syntax has attempted to overcome the issues implicit within network analysis to develop ways of understanding space and its potential for structuring movement.

2.4.3 Space Syntax

The study of mobility within buildings and along streets has been analysed predominately using the graph-theory model, space syntax. Based upon trying to quantify the relationship between architecture and the urban environment, Hillier and Hanson developed the theory of space syntax in order to investigate the nature of the relationships that existed between space and human

phenomena (Hillier and Hanson, 1984).[12] Their seminal work, *The Social Logic of Space* (1984), contends that how space is structured is one of the most important factors in the measurement of movement within an urban landscape, which correlates to the accessibility of space (pp.140–142). Space syntax techniques present one of the most commonly used methods to evaluate movement within archaeological studies, either on a micro (individual buildings) or a macro (city) scale (Cutting, 2003).

Space syntax has three primary quantitative techniques that are used to study space: axial line analysis, convex isovist analysis, and convex spatial analysis (Hillier and Hanson, 1984). The predominant techniques used within archaeological studies are axial line analysis and convex isovist analysis (also known as access analysis). A wide variety of archaeological studies have applied these methods as a way to represent, quantify, and interpret spaces of the built environment and how they promoted different levels of accessibility and engagement (Van Dyke, 1999; Bafna, 2003; Fisher, 2009). While space syntax has seen numerous applications to archaeological contexts the past 30 years, its use for the exploration of movement along ancient street networks is less explored (Laurence, 1994; Moore, 1996; Van Dyke, 1999; Thaler, 2005; Newsome, 2011a).

A crucial premise of space syntax methodologies is that the configuration of space plays a key role in a space's meaning and function. For the study of movement, the ways that these spaces are linked directs how people are able to move through them (Cutting, 2003, p. 3). The geometry of space, distinguished between symmetry and asymmetry, determines whether or not a space can be traversed (Hillier and Hanson, 1984, p. 11; Stöger, 2011a, p. 44). Areas that have a high proportion of symmetrical space correlate to being more accessible, and therefore represent likely areas of movement and interaction. Asymmetrical space, in contrast, tends to control space by structuring and controlling through movement to other spaces. Space syntax represents a framework for studying the correlation between these spaces and how they structure movement, which can be applied to studies of urban movement within a cityscape.

Two methods that have seen extensive application in archaeological contexts are access analysis and axial analysis. Access analysis is particularly useful in identifying the distinction between public and private spaces by revealing patterns of integration and instances of movement. Convex spaces (areas where all locations are equally visible) are identified and linked together to construct a graph, where nodes represent convex spaces and links are the connections between convex spaces. The relationship between these spaces can subsequently be studied to determine various measures of

[12] "Space syntax…is a set of techniques for the representation, quantification, and interpretation of spatial configuration in buildings and settlements. Configuration is defined in general as, at least, the relation between two spaces taking into account a third, and, at most, as the relations among spaces in a complex taking into account all other spaces in the complex. Spatial configuration is thus a more complex idea than spatial relation, which need invoke no more than a pair of related spaces" (Hillier et al., 1984, p. 363).

access and control to the different areas of built space. The dynamics of movement, alternatively, can be illustrated by axial analysis. An axial map is created by drawing the fewest and straightest lines that pass between convex spaces. These lines also correlate to lines of sight. The axial map is a strong indicator of movement, where people will take the shortest route, or the route with the fewest turns. Access analysis is predominantly used to describe interior space or building functionality, while axial analysis addresses the behavioural characteristics of a space (Bafna, 2003, p. 25).

Pompeii remains one of the most intensively examined sites using space syntax on account of its degree of preservation and extant street network (Stöger, 2011a, p. 47). Scholars such as Laurence and Grahame have applied basic space syntax measures as a method to study the relationship that existed between Pompeian houses, different neighbourhoods of Pompeii, and the larger street network (Laurence, 1994, 2007; Grahame, 2000). Circulation patterns in Pompeii are assessed by Newsome using axial line analysis, an approach that is advanced by Van Nes who introduces further statistical analysis to look at the relationship between movement and the intensity of land use (Newsome, 2009, pp. 124–125; Van Nes, 2014). Moving beyond Pompeii specific studies, Kaiser examines the site of Empúries in north-eastern Spain by using access analysis to calculate relative street depth to examine how space was used as part of a larger enquiry into the ways a city's urban form developed (Kaiser, 2000). The relationship between visibility and movement is addressed by Paliou's (2008) research on the visibility of Theran wall paintings from the Late Bronze Age in Akrotiri, Thera.

While sites such as Pompeii have shown the potential of applying space syntax methodologies to archaeological data, it has been only minimally applied at Ostia. DeLaine (2004) was the first scholar to show the potential of applying space syntax at Ostia. Concentrating upon domestic architecture, she applies access analysis to study *medianum* apartments as a way to further understand the occupants and their socio-economic groups within Ostia (DeLaine, 2004). The most extensive work has been undertaken by Stöger to demonstrate space syntax's potential for understanding various aspects of Ostia's urban space (Stöger, 2011a). Using a combination of different space syntax methodologies, she considers *Insula* IV.2, Ostia's street network, and *scholae* (Stöger, 2011a). Kaiser, building upon his earlier work at Empúries additionally examines Ostia in comparison to three other cities, concentrating upon the space syntax metric of step depth (Kaiser, 2011). Both Stöger (2011) and Kaiser (2011) address movement potential along Ostia's street network by applying axial analysis to determine areas that saw the highest proportion of pedestrian movement. However, street based studies at Pompeii and Ostia only consider generic movement, specific types of movement, like that associated with rituals, have yet to be addressed.

Space syntax has been used by a few scholars to study various processional rituals in different time periods and cultural contexts, although there are no examples for the study of Roman processions.

One of the few archaeological examples examines processions in the Late Classical Mayan Site of Naachtun in Guatemala (Morton, 2007, 2012). Applying axial analysis, Morton determines a likely processional path through the city's architecture. The possible route followed the most integrated areas of the city, with stelae and altars located in such a way to help guide pedestrians (Morton, 2007, 2012). Metric integration was used to look at the overall connectivity of space, indicating a likely route from one end of the site to another (Morton, 2012). While this research relates a possible route to the location of public monuments, there is no attempt to address the relationship that existed between the two apart from the visibility of monuments from the route. Likewise, this study assumed that the route went directly between the two ends of the city without considering other factors such as the avoidance of crowed areas. Also problematic is the inherent bias in estimating axial analysis calculations, where an artificial boundary was drawn around the excavated city, which reduced movement to the urban centre. While this was an attempt to limit a possible 'edge-effect', it affected the results by not accounting for movement that extended beyond the city's centre (Gil, 2015).

Research into modern processions has shown how space syntax can be used to study processions with known routes. The social aspects of space syntax theory are applied to the analysis of processions in 19th century Sheffield to address the relationship that existed between the city's built form and its processional culture (Griffiths, 2016, 2017). Although the circular processions from this period were well documented within the city, space syntax is used to provide insight into city's urban topology and multidimensionality (Griffiths, 2017, p. 263). The results indicate that the streets were a dynamic feature that were a product of urban activity and changes in the city's infrastructure (Griffiths, 2012, p. 13). A similar idea is upheld by Georgiou (2016) in addressing the issue of how 19th century carnival routes in London were shaped by the city's changing and growing landscape. While he does not apply space syntax, he argues that understanding the processional route is linked to how the ritual was experienced in space (Georgiou, 2016)

Another application of space syntax for processional studies has been used to addresses the relationship between ritual activity and changing urban landscapes. A study of the Shi'I Muslim processions of Ashura at Dezfoul in Iran address how processional organisation overtime coincided with the city's urban transformation (Nejad, 2013). Axial analysis measures the relationship between known processional routes and the integration of the street network over two periods (Nejad, 2013, p. 144). The findings of the research illustrate how space syntax can highlight certain areas of localised movement, but not the full processional route. While the city changed overtime, the routes still had a strong association with the city's traditional urban configuration (Nejad, 2013, p. 154). A similar premise is undertaken by Lenart (2013) who studies the festival activity between the socialist and post-socialist period of the Hungarian city of Dunaújváros. The spatial position of churches and the processional routes between them are used to identify areas of the city that saw regular ritual use by applying axial analysis, illustrating the role that they played in the general social

cohesion of the city. Both of these studies addressed the degree to which space syntax can be used to identify areas of processional movement.

There are, however, several issues concerning space syntax's ability to adequately discern processional routes. An overview of the main critiques of space syntax (Leach, 1978; Batty, 1985; Thaler, 2005, pp. 324–326; Netto, 2015) shows that the method cannot be used on its own to determine processional routes. The various theoretical paradigms that serve as the foundation of space syntax argue that spatial organisation is based upon set rules, regardless of time period or culture (Hillier, 1996b; Giles, 2007). While space is clearly a factor in how movement patterns were structured, attention needs to be paid towards cultural and social differences. A second issue is the topological representation of space which disregards metric distance within the models. Hillier argues that the model works because of the role of hidden geometry, where equal street lengths are represented evenly on the axial map and can therefore be considered synonymous with metric measurements (Hillier, 1999, p. 182; Ratti, 2004, p. 5). However, as is the case in Ostia, a city is not always consistently structured, complicating the topological understanding of the street network. Likewise, it is possible that in relation to processional movement, distance was an important factor for the procession.

Thus, although space syntax does offer useful insights into the relative integration of a city's street network, on its own it does not adequately account for the generation of movement for rituals such as processions (Haklay *et al.*, 2001, pp. 344–345; Steadman, 2004). In all of the space syntax methods, other factors such as building function, urban activities and 3D space that may have collectively influenced movement are discounted (Batty, Jiang and Thurstain-Goodwin, 1998, p. 3; Ratti, 2004; Steadman, 2004). The method does not help us understand how a specific building or monument was perceived, let alone how this perception may have shaped surrounding movement (Adams, 2007, p. 359). Research into the urban environment has shown that pedestrian movement is not solely influenced by a city's spatial configuration, but by the interactions stimulated by both building function and other people (Batty, 2003). While it is useful for addressing certain components of a procession, space syntax on its own is not a useful tool for determining specific routes throughout Ostia. Consequently, this thesis uses space syntax to evaluate general movement potential in relation to specific temples at Ostia, and then to compare the results of this against other methods used for visualising movement.

2.4.4 Simulation

An alternative approach for researching urban pedestrian movement involves the use of computer simulations. These have been applied to the study of pedestrian movement dynamics over the past 50 years. Early approaches applied cellular automata (CA) models as one way to study topics ranging from urban development to traffic patterns (Wolfram, 1986; Torrens and O'Sullivan, 2001). Cellular

automata are models created in a discrete time and space that rely upon an underlying cellular framework, resembling a lattice framework where each cell equates to one agent (Blue and Adler, 1999). The agents are encoded to behave according to local rules, which are then run according to mathematical principals. There have been an extensive number of studies applying cellular automata models to various pedestrian dynamic studies (Blue and Adler, 2001; Kessel *et al.*, 2002; Batty, 2003). While useful for looking at the interactions between agents and the environment, the simplification of the simulation is too limited for looking at pedestrian movement within more complex systems such as within a city's street network where other urban factors need to be taken into account.

Another computational model is agent-based modelling (ABM), which is a simulation tool that involves the creation of a real-world model that can be used to observe behaviours and interactions over time. The system of agent-based modelling can be defined as "interacting autonomous entities, each with dynamic behavior and heterogeneous characteristics" (Heckbert, Baynes and Reeson, 2010, p. 40). Agent-based modelling presents a set of techniques that allows for examining and visualising complex systems or phenomena, such as the dynamics that occurred within a city (Banos, Lang and Marilleau, 2015; Heppenstall, Malleson and Crooks, 2016). The aim of a model is to create an environment that mimics, as closely as possible, a real-world environment. In order to accomplish this, however, certain assumptions have to be made with urban factors simplified in order to be integrated into the model. As a result, the modeller needs to be aware of the extent to which a model's results reflect the way in which the model is constructed or the environment it is meant to emulate. Because of the assumptions and simplifications made in creating a model, the results are not fully representative of observable real-world data (Batty, Crooks and Heppenstall, 2012). The strength of agent-based modelling lies in its ability to understand how behaviours and actions emerge from a specific environment and individual decisions. Agents are the focus of study, which can be anything from a city to a person. The agent is attributed with certain characteristics that enable it to act according to pre-coded rules relevant to the situation that is set within a larger environment. These interactions can be observed and used to study and compare the patterns that arise. As a result, this form of simulation enables us to test and study theories set in a real-world environment.

Agent-based modelling has developed as a common method to try and address the challenges of studying pedestrian movement (Turner and Penn, 2002; Crooks *et al.*, 2015). Pedestrian models have been used to simulate various crowd dynamics (Torrens, 2014), evacuation patterns (Zhan and Chen, 2008), travel patterns (Arentze, Pelizaro and Timmermans, 2010), and festivals (Batty, Desyllas and Duxbury, 2003). The benefit of applying this type of model to the study of pedestrian activity is that the agents can be encoded with a high level of autonomy, enabling them to act realistically in terms of their interactions within a streetscape (Johansson and Kretz, 2012, p. 453). However, this also means that these types of models are incredibly complex to create due to the

range of variables and rules that the agents have to be encoded with.

Since the late 1990s, agent-based modelling has seen a growing number of studies applied to archaeological contexts (Lake, 2014; Wurzer, Kowarik and Reschreiter, 2015). A large number of models, across different time periods, have explored the relationship between climate, settlement location, and population growth (Dean *et al.*, 2000; Chliaoutakis, Chalkiadakis and Sarris, 2016; McAnany *et al.*, 2016). In terms of Roman archaeological examples, the predominant applications of agent-based modelling have been used to simulate various trade interactions (Graham and Weingart, 2015; Brughmans and Poblome, 2016). Another example uses agent-based modelling in combination with GIS to address settlement distributions across the rural landscape of Roman Cyprus as a way to identify the creation of socio-economic networks (Kyriakou, 2011). As far as I am aware, there have been no studies for modelling pedestrian movement within Roman urban landscapes. In part, this is because until recently is has been difficult to integrate geographical space within a simulation to enable the occurrence of realistic spatial interactions (Aldenderfer, 2010, p. 61).

Examples of modern festival studies show the potential of applying agent-based modelling methods for studying Roman processions. A large proportion of current scholarship has focused upon religious gatherings for determining crowd control measures. One of the earliest studies by Batty, Desyllas, and Duxbury (2003) uses a model to maintain an acceptable movement flow of people along London's streets during the Notting Hill Carnival. The recent work by Basak and Gupta (2017) combines agent-based modelling with video footage in order to develop various safety measures for a Hindu pilgrimage festival at Puri in India. This builds upon previous studies that have used mobile and video data collection to implement safety procedures for large religious crowds (Mitchell *et al.*, 2013; Mowafi *et al.*, 2013). While the current interest in pedestrian modelling concerns the development of various safety precautions, these models also show how crowds can be modelled with a common movement goal that is structured by a larger festival. This type of goal-oriented movement is a key aspect that previous GIS or space syntax models are unable to capture.

The use of agent-based modelling for inquiry into pedestrian movement patterns is a new direction that Roman urban research needs to take. Modern urban pedestrian studies have illustrated that agent-based modelling is a useful tool for assessing pedestrian movement patterns within cities (O'Sullivan, 2004). Rather than addressing past movement solely by configurational space like space syntax, agent-based modelling can account for other factors such as street density, urban influences, time, and the presence of other agents. This presents a way to reassess our assumptions and theories about pedestrian movement patterns. However, the time-intensive constraints of building and implementing an agent-based model often preclude its usefulness for research. Likewise, depending upon the complexity of the system in question, which could include processional movement, there may be too many factors that have to be accounted for, which can preclude the

applicability of this type of modelling approach.

2.4.5 Limitations of Current Approaches for the Study of Processions

The above review of computational approaches to the study of pedestrian movement highlights the issues inherent in studying urban movement. A continuing issue for the applicability of these approaches is the inability to account for movement intent. While there are a variety of methods for studying the mechanics of moving across different terrains, both physical and social, this has been applied either for undirected movement or in order to find the quickest route between two points (Howey, 2011; Paliou, 2013; Herzog, 2014). GIS based methods in particular do not have methodologies that can sufficiently account for some of the important factors that affected processional movement. Aspects such as extended movement routes, visibility, the influence of spectators, and the impact of the urban environment cannot collectively be addressed with current methods. Likewise, space syntax's axial analysis can provide insight into general movement potential across a street network, but it does not adequately incorporate other urban influences that may have helped to shape movement routes. While agent-based modelling can address many of the nuances of pedestrian crowd dynamics, the ability to accurately model all the influencing factors is unrealistic. Likewise, the focus on agent movement loses much of the information gained about the urban landscape that is addressed with other methods. Individually, these various computational approaches are unsuitable for answering questions about the directionality of processional movement, factors affecting processional movement, and how possible routes can be visualised.

It is clear that while the study of movement has been a popular avenue of research for archaeological studies in recent years, the ways in which it has been studied have been limited (Laurence and Newsome, 2011; Östenberg, Malmberg and Bjørnebye, 2015). There is a disconnect between movement studies applied to Roman contexts and more rigorous methods being developed out of urban studies research. In part, this is because of the complexity of studying movement that is particular to each urban landscape. Consequently, questions have been confined to general inquiries into movement circulation patterns throughout specific cities (Kaiser, 2000; Poehler, 2006; Stöger, 2011b). While limited attempts have been made to address how age and gender affect the mechanics of walking through the city, other factors have not been addressed (Branting, 2004). The difficulties of an incomplete archaeological record and minimal literary details about urban movement have further impacted the direction of scholarship.

The review of urban processional studies (§2.2.4) indicates that researchers have not approached processional routes with adequate methodological rigour. The same difficulties apply when discussing processions at Ostia, for which we have even less surviving information (see §3.3). How and where processions went within Ostia are unknown. Our only source of evidence is comprised by the existing monumental temples and comparative evidence for specific rituals with processional

activity. This uncertainty makes the study of processional movement at Ostia incredibly challenging. Present computational approaches for the study of ancient movement do not provide insight into possible processional routes. While they detail which streets are likely to have seen high proportions of urban traffic, there has been no attempt to study different types of movement within the streets of Ostia. By building upon the recent work by Popkin (2016), which argues in favour of questioning how Rome's topography shaped the triumphal procession, in combination with different computational approaches for studying pedestrian movement, processional research can be taken further.

2.5 Re-Framing Roman Processional Approaches

The complexity of processions complicates our ability to model their routes. Both studies of Roman processions and pedestrian movement have yet to successfully implement an approach that can integrate the multi-faceted nature of both social dynamics and behaviour patterns within a study of ritual movement (Batty, 2003). As a result, existing methodological approaches are insufficient for the study of ancient urban processional routes. To address this inadequacy, my thesis applies a theoretical framework that draws upon sacred movement studies and spatial theories. Applying concepts arising out of the corpora of literature from all of these, I regard processional routes as being structured by the cityscape, which does enable them to be studied by researchers. This framework needs to be understood not as a theory, but as a lens for thinking about how processional routes were formulated. This provides an alternative approach to processional studies that can be adapted when there is limited archaeological and literary evidence. As a heuristic tool, the framework is not rigid, but can be modified to reflect changing ideas or theories about both the city in question and individual processions.

Within a broader understanding of sacred travel, movement was the action that gave meaning to the journey regardless of its length. Movement not only facilitated access to various sites within the landscape, but it enabled disparate spaces to be linked together (Turner and Turner, 1978; Malville and Malville, 2001; Golledge, 2003, p. 37). Early studies of sacred travel focused upon pilgrimage, with the aim to address the fundamental meaning of a sacred journey. The idea that *communitas,* a sense of fellowship, was the core action of sacred travel shaped how the subject was approached, largely discounting the meaning gained by movement though the landscape (Turner, 1973). The various mechanisms and stopping points, such as hospices and markets, that enabled the success of a sacred journey, were largely discounted (Turner and Turner, 1978, p. 22). More recent reconsiderations of sacred travel have transitioned away from disregarding movement to the connections it promoted within a landscape, thereby allowing questions to be raised about how urban and social factors may have affected various movement routes.

The difficulty of disassociating sacred movement from other forms of activity is well attested (Grünewald, 2017). As the Turners famously state, "a tourist is half a pilgrim, if a pilgrim is half a tourist", a statement that highlights the impracticality of disassociating religious movement with other social aspects of a ritual (Turner and Turner, 1978, p. 20). According to Reader, important pilgrimage locations contained a combination of "mundane, profane, and mercantile" aspects that contributed to their continuing importance along pilgrimage routes (2016, p. 195). Similar aspects apply when considering urban processional rituals. While the intent of movement is religious, it cannot be completely dissociated from its surrounding urban landscape.

Movement is not only the mechanism that allows a ritual to reach its intended destination, but it is one of the primary purposes of a procession (Grimes, 1992, p. 72). Roman scholarship and, more broadly, anthropological studies have shown the importance that urban space played in structuring processional rituals (Kappelman, 2001; Demarest, 2006; Morton *et al.*, 2014; Popkin, 2016). According to Lefebvre space is more than just a collection of buildings, it encompasses all facets of the multi-sensorial activities that shape a city (Lefebvre, 2014). Scholars have long recognised that a relationship exists between space and social behaviour which is manifested within the cityscape (Clarke, 1977; Giddens, 1984; Lawrence and Low, 1990; Lefebvre, 1991).

The idea that a relationship existed between a city's built form and the activities that occurred within its environs has widely developed out of the field of urban studies (Rapoport, 1977; Lawrence and Low, 1990). While early approaches focused predominantly upon a city's architecture, the advancement of modern theory has reshaped this perspective to concentrate upon the people or actors that inhabited a city's environment. Phenomenological approaches to urban studies extended enquiry beyond urban design to the people and senses that were involved in understanding a city, with focus placed upon the total urban experience. Particularly influential were early modern geographers (Jacobs, 1961; Tuan, 1977; Buttimer and Seamon, 1980; Lefebvre, 1991; Katz, 1994; Tilley, 1994). Lynch's seminal work, *The Image of the City*, introduces a theory about how people "read" and experience the city based upon five elements: paths, nodes, edges, landmarks, and districts (Lynch, 1960). Other urban theorists, such as Kostof, recognise the importance of studying architecture within its total urban environment in combination with the people who inhabited these spaces (Kostof, 1985, pp. 7–19). Jacobs, an urban planner contemporary to Lynch, argues how a city's composition is critical for fostering urban activity and that a city should contain a mix of different types of urban space rather than be compartmentalised in order to maintain dynamic street activity (Jacobs, 1961, pp. 34–38).

Questions concerning what factors influenced a city and it urban dynamics extended beyond the field of urban studies to include archaeological studies. In particular, studies of ancient streets became a focal point for looking at different forms of urban interactions. Roman scholars have adapted portions of Lynch's theory in an attempt to gain greater insight into how people interpreted

the ancient city (Lynch, 1960; Soja, 2001). Interested in the urban composition of cities and how various architectural features helped to guide ancient residents and visitors through the built space, MacDonald draws upon Lynch and other urban theorists to develop what he terms 'urban armatures' (MacDonald, 1986). He defines an armature as "a clearly delineated, path-like core of thoroughfares and plazas, which for convenience can be called an armature, that provided uninterrupted passage throughout the town and gave ready access to its principal public buildings" (MacDonald, 1986, p. 3). One of the more significant aspects of his theory is the idea that armatures create pathways throughout the city, the meanings of which are embedded within the context of surrounding architecture in addition to the people that walk through these spaces. His attempt to define specific urban structures and their function, however, resulted in little engagement with how streets existed as a form of space that promoted movement (Newsome, 2011a, p. 4). Despite MacDonald's aim to look at what composed a city's urban fabric, he discounts the role of people and movement within it.

Lynch's theory and its adaption by scholars such as MacDonald pose several issues that limit the usefulness of these types of phenomenological approaches (Lynch, 1960; MacDonald, 1982). The approach to visibility is subjective to the individual rather than adapting a more critical approach. The parameters for determining movement are also problematic. Each of Lynch's five elements and MacDonald's armatures are not always present within a city, reducing their usefulness. A final issue lies in the method taking little account of a city's social context (Malmberg, 2009, p. 39). While these early urban approaches have only minimal application, providing more of a descriptive than analytical approach of the city, their strength lies in how they have influenced and progressed studies of the ancient city. Significantly, they have provided the framework for many current studies of sacred travel, enabling scholars to question how different urban structures shape sacred movement (Friese and Kristensen, 2017).

Recognition that urban dynamics and different types of urban spaces play a crucial role in how people interact with the city has subsequently influenced both studies of the ancient city and approaches to sacred movement. Scholars concerned with ancient urbanism have applied new methods to try and explain how the city informed people's perceptions of their surrounding environments. These advances within urban studies have raised awareness about how ancient cities have traditionally been studied with little consideration of the people that inhabited them or their experiences within them. By looking at the dialogue that existed between a city's space, architecture, and people, new questions about the ways in which architecture and people constructed urban landscapes can be addressed. One of the outcomes of these various urban theories and approaches within the ancient city is that they highlight the complexity of urban space. By taking a primarily phenomenological approach these studies do not fully engage with the interplay that existed between buildings, people, and their urban activities. Trying to move towards a greater understanding about how urban activities both structured a city and vice versa has contributed to

the development of new analytical approaches. The transition away from defining space to contemplating how it can be evaluated provides the opportunity to study how dynamic events, such as processions, occupied the city.

The ways in which processions moved through Ostia and interacted with non-participants and the built environment was fundamental to the construction of the city's religious landscape. The spatial organisation of a city not only structures daily exchanges between people but also the ways in which processions can feasibly interact with various components of the cityscape (Moore, 1996). As stated by Montgomery, "the most important psychological effect of the city is the way in which it moderates our relationship with other people" (Montgomery, 2013, p. 37). Where Turner (1978) considers the environment as only secondary to the ritual act, I argue that the environment and the activities that took place within it are fundamental to the occurrence of sacred movement and helped to shape the routes taken within the ancient city. Adapting the idea that the city had certain 'attractors' arising out of urban activity, possible areas of movement can be studied (Morton, 2012; Popkin, 2016).

Despite the existing challenges, this thesis contends that urban processions can be studied at Ostia by integrating different computational methods within a larger ritual movement framework. Examination of the relationship between space and ritual activity enables us to address how religious practice was disseminated across Ostia via processional routes. Llobera *et al.* rightly argue that the study of movement should not be simplified to looking at one aspect of movement such as the arrival point or with one methodology, since these approaches distort the total study (2011, p. 843). In order to address this, a multi-layered approach is developed (Chapters 4 and 5) to assess how urban activity affected movement routes throughout Ostia. Any reconstruction of a specific procession needs to be acknowledged as an aggregate accumulation of many different incomplete sources of information. Previous reliance upon establishing a relationship between literary data and topographic information, resulting in a 'connect-the-dot' approach to the study of processional routes does not inform our understanding about why routes went in certain directions and what effected their changes through the landscape (Rogers, 1991).

The application of a framework that integrates religious movement and spatial approaches for the study of processions at Ostia creates a means for investigating the ways in which architecture and social activity may have helped to structure ritual activity associated with specific temples. This presents a novel approach to studying how individual temples constructed religious landscapes, thereby moving the focus of scholarship about Ostia's religious environment away from static studies of temples to considering religion within the context of Ostia as a moving city.

2.6 Summary

This chapter has shown how Roman processional studies have been approached. The focus upon processions detailed in the ancient literary record has shaped research to largely ignore the occurrence of processional rituals that are not extensively documented. As a result, processions are assumed to have regularly occurred, but how they navigated the urban landscape of a city and their contribution to religious life more generally has received little attention. Recognising the difficulty of studying rituals that are largely invisible within the archaeological record, an alternative method needs to be developed that draws upon approaches to studying movement within the ancient city. The overview of studies applied to looking at urban movement within the ancient city show that present methods are not sufficient for the study of processional rituals at Ostia. As a result, this thesis argues that the analysis of processional movement needs to draw more heavily upon advances made within the field of urban studies and the methods developed for studying pedestrian movement. It has been contended that an integrated methodology that is influenced by different computational approaches has the greatest potential for enabling the study of processions at Ostia.

Chapter 3: Ostia

3.1 Historical Context

Ostia remains one of the most extensive archaeological sites investigated within the Mediterranean. Located 25 km southwest of Rome (Figure 3.1), it is one of the few cities that can be studied from its foundation to its abandonment in Late Antiquity (Pavolini, 2006, pp. 20–26). Located at the mouth of the Tiber, Ostia held an initial strategic defensive position while later it became a centre for Roman trade. Today, due to its position within the Tiber estuary and the constant changes in the Tiber's course, Ostia is located 2 km inland (Figure 3.2).[13]

Figure 3.1 Location of Ostia within Italy in relation to Rome and Puteoli.

[13] The web-site (http://www.ostia-antica.org/) maintained by Jan Theo Bakker presents an introduction to the site and its monuments. Additionally, it maintains an invaluable up-to-date bibliography of Ostian scholarship (accessed 15.02.2018).

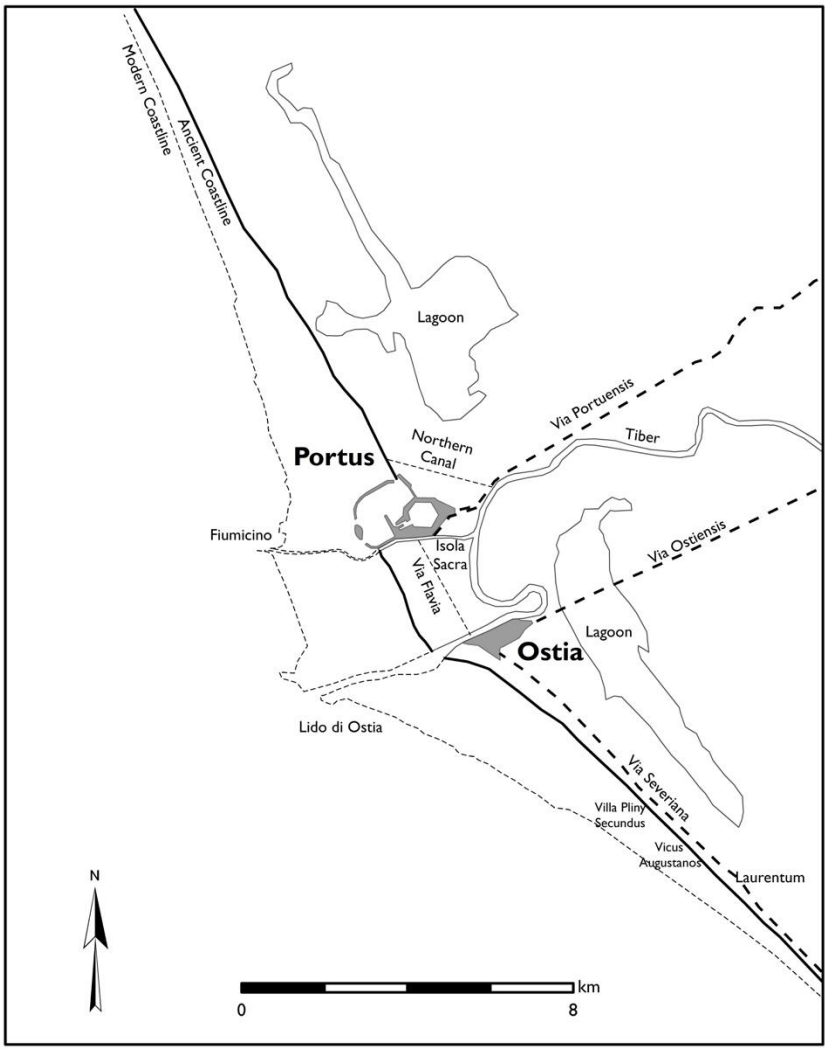

Figure 3.2 Map of Ostia and its hinterlands (after Keay & Paroli, 2011, fig. 1.1).

The Roman literary tradition (Enn. *Ann.* 2.fr20–21; Livy *Ab. Urb.* 1.33.9; Dion. Hal. 3.44.4) attributed Ostia's foundation to Rome's fourth king, Ancus Marcius, c. 640–616 BC. Livy's account (*Ab. Urb.* 1.33.9)[14] specified Ostia's role in salt processing during the Middle or Late Bronze Age. Although no firm archaeological evidence exists from this early period, recent geomorphological studies aimed at addressing the Tiber's change in course[15] indicate that the river likely disrupted any original areas of salt production (Meiggs, 1973, p. 17; Pavolini, 2006, p. 283; Giraudi, 2011). Scholars likewise speculate that an earlier settlement was located elsewhere, although its location is heavily contested (Meiggs, 1973, pp. 479–482; Pavolini, 2006, p. 4). Regardless of the literary and archaeological discrepancies surrounding the date of Ostia's foundation, the historical foundation myth remained

[14] Livy *Ab. Urb.* 1.33.9: "at the Tiber's mouth the city of Ostia was founded, and salt-works were established near-by." (Translation by Foster, 1919).
[15] Geomorphological findings indicate this change in course occurred around the 5th century BC (Giraudi, 2011).

important for the city's local identity as demonstrated by a 2nd century AD marble inscription (*CIL* XIV 4338) commemorating Ostia's position as the first Roman colony (Meiggs, 1973, p. 16).[16]

Archaeological evidence indicates that the *castrum,* a rectangular military-style urban plan (194 m x 126 m) enclosed within tufa walls, was Ostia's earliest settlement (Calza, 1953, pp. 76–77; Martin, 1996). The city was subdivided by two principal streets, the *decumanus maximus* and the *cardo maximus,* which aligned with the city's four entrance gates (Zevi, 1996, p. 74). The foundation date of the *castrum* remains debated, but scholars currently attribute it to 300–275 BC upon the basis of pottery finds originating from the foundation layers (Martin, 1996, pp. 19–38; Zevi, 2001c, p. 10).[17] Throughout the Republican period, Ostia held a predominately military role. The early settlement likely formed part of the chain of *Coloniae Maritimae* or coastal fortresses (Livy *Ab. Urb.* 27.38, 36.3; Salmon, 1963; Meiggs, 1973, p. 20) built along the Tyrrhenian coast that were implemented by the Roman State in the second half of the 2nd century BC (Zevi, 2001b, p. 3; Armstrong, 2016, p. 126; DeLaine, 2016, p. 419). Ostia's military significance was further defined as the city became a seat for the *quaestor Ostiensis* in 267 BC, an official who was in charge of the Roman naval fleet (Meiggs, 1973, pp. 24–27). Ostia eventually transitioned to a mercantile city as the military fleet was transferred to Portus Iulius on the Bay of Naples at the end of the 1st century BC (Meiggs, 1973, pp. 27–34; Zevi, 2002). The evolution to a purely commercial harbour posed many difficulties, as Ostia's incompatibility for maritime traffic was well known. Although Ostia had a small 2 ha harbour basin within its river port (Goiran *et al.*, 2014; see also Heinzelmann and Martin, 2002), strong currents at the Tiber's entrance and the presence of a natural sandbar made it unsuitable for accommodating large grain ships (Strabo 5.3.50; Cass. Dio. 60.2; Meiggs, 1973). Until the early Imperial period, these ships had to dock at Puteoli on the Bay of Naples with the grain then transported to Ostia and Rome.

The end of the Republican period saw an increase in urban growth at Ostia. The city had previously expanded beyond the original *castrum* walls, resulting in a commission from Rome of new city walls spanning c. 70 ha (Meiggs, 1973; Zevi, 1997, 2002; Heinzelmann, 2000; Pavolini, 2006).[18] During the 1st century BC Ostia gained greater autonomy from Rome, which included the establishment of its own local government (Meiggs, 1973, p. 36; Bargagli and Grosso, 1997). Evidence of the city's

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[16] *CIL* XIV 4338: *A[nco] | Mar[cio] | reg[i rom(ano)] | quart[o a R]omul[o] | qui ab ur[be c]ondit[a] | [pri]mum colon[iam] | Dedux[it].* "For Ancus Marcus, the fourth king after Romulus, who, after the foundation of the city (Rome) first founded the colony (Ostia)." (Translation by author). For an addition to the inscription see, Cébeillac-Gervasoni, Caldelli and Zevi, 2010, pp. 80–81.

[17] Early theories regarding the foundation of the *castrum* claimed that it was in response to the fall of Veii in 396 BC as an attempt to consolidate control of the Tiber, while others considered it as a necessity due to military threats such as the advancing Carthaginian fleet of 278 BC (Meiggs, 1973, p. 22; Pavolini, 2006, p. 22). In either instance, the construction of the fortified town developed in conjunction with the establishment of the naval fleet.

[18] The walls were originally attributed to the period of Sulla following the attack by Marius in 87 BC, but this has recently been challenged, questioning if they were instead constructed after the pirate attacks in 67 BC (Appian, *B Civ.* 1.8.67; Cicero, *Leg. Man.* 33). Current debates place their construction 63–58 BC (Zevi, 1997).

administration can be found in the town's *fasti*, a calendar that recorded civic and religious events (Vidman, 1982).[19] Ostia became central for enabling the supply of food to Rome. From the reign of Augustus, various offices were established at Ostia to oversee the grain supply that reported to the *praefectus annonae*[20] in Rome (Meiggs, 1973, pp. 298–309). The city's change in governmental status as well as its role in maintaining the grain trade for Rome increased its level of commercial activity, resulting in new building initiatives throughout the city. The construction of major warehouses during this time must have occurred to accommodate the city's expanding commercial function, but these are difficult to identify prior to the 1st century AD (Rickman, 1971). In terms of Ostia's religious topography, various temples were constructed during the 1st century BC, such as the *Tempio di Ercole* and the *Quattro Tempietti*, that were funded by the local aristocracy (Meiggs, 1973, pp. 337–353; Zevi, 2012). However, these were far from the first temples built in the city. One of the earliest literary accounts of Ostian religion is Livy's (32.1) 199 BC report that lightning struck the Temple of Jupiter, although its location remains unknown.[21] These temples formed what was undoubtedly an important part of religious life at Ostia during this period. Despite Ostia's growth during the Republican period, relatively little is known or understood about the Republican building phases of Ostia as the majority of structures are beneath the massive renovations undertaken during the 2nd century AD (Meiggs, 1973).

The early Imperial period saw further developments along with increased imperial interest. Ostia's importance as a city can be seen by the establishment of the first permanent theatre (*CIL* XIV 82) outside the city of Rome, financed by Marcus Agrippa, built in combination with the *Piazzale delle Corporazioni* (Calza, 1915, 1927; Becatti, 1961; Meiggs, 1973, p. 43).[22] Additional construction included a new *forum* plan, developed under Tiberius, which comprised of a marble temple to Rome and Augustus (Meiggs, 1973, p. 45; Heinzelmann, 2002, pp. 103–122).[23] The building efforts of nearby Portus under Claudius (c. AD 41–54), which was later enlarged under Trajan (c. AD 112–117), helped to establish Ostia and Portus as a Mediterranean commercial centre (Mar, 2002; Keay *et al.*, 2005). Despite the presence of warehouses at Portus, new commercial facilities and storage structures were still being built, including Ostia's largest building the *Grandi Horrea* (Rickman, 1971, 2002). This provides an indication into the commercial role Ostia continued to play even after Portus' establishment (Rickman, 1971; Heinzelmann, 2002; Heinzelmann and Martin, 2002; Keay *et al.*, 2005). The city's growing prominence and increased trade was likewise reflected by the presence of professional associations and foreign merchants from across the empire (Meiggs, 1973, pp. 54–

[19] The *Fasti Ostiensis* dates from 49 BC to AD 175.
[20] The office of *praefectus annonae,* who existed as a supervisor, was established by Augustus in order to oversee the grain supply (Meiggs, 1973, p. 45; see also Rickman, 1980).
[21] Following Meiggs' original hypothesis, some scholars attribute the temple foundations located beneath the Hadrianic *Capitolium* to the Republican period Temple of Jupiter (Meiggs, 1973, p. 352; Rieger, 2004, pp. 219–221; Zevi, 2012, pp. 537–541).
[22] For a re-examination of the original foundation date of the theatre, see Cooley, 1999.
[23] See Chapter 8 for the debate about the temple's foundation date.

64, 214–235). Under Domitian the city was raised one meter at the end of the 1st century AD (Mar, 2008, p. 132). Due to Ostia's location in a floodplain, this elevation helped to alleviate the constant threat of flooding as well as allowing for the necessary dry foundations needed for the construction of multi-storey buildings that characterised the Imperial period city (Packer, 1971, pp. 81–85; Jansen, 1999; Martin, 1999).

The second century AD saw construction far beyond the original Republican city, with expansion well beyond the eastern and southern late Republican walls (Martin *et al.*, 2002). While scholars originally believed that the Tiber defined the city's northern limits, recent discoveries indicate that the city walls and warehouses continued on the other side of the river (Pavolini, 2016, p. 228; Germoni *et al.*, 2018). Building activity during this period included the construction of the Hadrianic *Capitolitum,* a new *forum* with surrounding public buildings, public baths, and numerous warehouses and storage facilities, all of which aided in constructing a new urban topography. Innovative urban planning techniques resulted in a densely packed urban environment with brick-faced buildings. Additionally significant were the multi-story apartment buildings or *medianum* apartment blocks that were created to accommodate the growing population, with interior decorations indicative of the population's relative wealth (Packer, 1967; Hermansen, 1982; DeLaine, 2000, 2004; Raff, 2011). The cults that were in existence during the Republican period continued to retain their importance, while the creation of new temples and the establishment of various religious and commercial *collegia* (associations) contributed another dimension to Ostia's religious environment (Meiggs, 1973; Bollmann, 2001; Rieger, 2004; Tran, 2008; Zevi, 2008; Rohde, 2012). During the Imperial period, the city's extensive commercial landscape is indicative of its establishment as an entrepôt for trade with Rome and the wider Mediterranean. The variety of different storage buildings and markets attest to an assorted range of commercial needs (Rickman, 1980; Heinzelmann, 2002; DeLaine, 2005). The diversity of trade is clearly represented by the late 2nd century AD renovation of the *Piazzale delle Corporazioni* which included the creation of *stations* with their well-known mosaic floors advertising trade activities from around the Mediterranean (Becatti, 1961, pp. 64–85; Meiggs, 1973, p. 283). Smaller scale commercial activity, alternatively, would have taken place within the one or two room structures, *tabernae*, located along street frontages, of which there are approximately 800 identified within the excavated city (DeLaine, 2005).

The Late Antique periods of Ostia did not see a significant decline in prosperity as previously argued by scholars (Hdn. 1.1.4–5; Meiggs, 1973; Boin, 2013). DeLaine has more accurately described the transitions occurring in Ostia during the 3rd and 4th centuries AD as a combination of decay and building renewal (1995, p. 99). Prosperity continued into the 3rd century AD, during which time the city saw a decrease in new building activity in favour of renovations carried out upon existing

buildings, such as the alteration of the Theatre[24] (Gismondi, 1955; Pavolini, 2006, pp. 68–69) and the construction of a nearby monumental arch dedicated to Caracalla (Zevi and Pensabene, 1971). The final major structure built at Ostia was the Pantheon-like Round Temple, which was likely dedicated to the imperial family (Meiggs, 1973, p. 146; Rieger, 2004). While Ostia did not retain the same level of activity as in earlier periods, it was far from being in full decline. One example is Maxentius' establishment of a mint at Ostia in AD 309 as a way to centralise the production of coinage near Rome (Meiggs, 1973, p. 92; Albertson, 1985; Drost, 2014). Certain areas fell out of use while the south and southwestern areas flourished as the city no longer served as a predominately mercantile city, instead it existed as a resort town (Gering, 2004). Throughout the 4th century AD, urban embellishments and restorations were conducted on a small scale, including restorations to the *Terme del Foro* under Constantine and the addition of new richly decorated small bath buildings throughout the city (Cicerchia and Marinucci, 1992; Poccardi, 2006). Areas of decline, in contrast, are recognisable with the closure of the river harbour and various warehouses as well as the abandonment of different houses and streets (Gering, 2004). The city likewise saw the development of the *domus* between the 3rd–4th centuries AD (Pavolini, 1986, 2011). During this period, the seafront underwent substantial transformation with the expansion of previously existing elite houses, coinciding with Ostia's use as a resort town. These lavishly decorated residences represent a distinct change from the 2nd century AD *medianum* apartments (Becatti, 1948). By this point, Ostia lost its political autonomy and once again came under the control of Rome and the *praefectus annonae* (Meiggs, 1973, p. 186). This was additionally reflected in the rise of Portus and its establishment as an independent community by the late reign of Constantine I. While Ostia did not retain the same level of activity as in earlier periods, it was far from being in full decline.

The 5th century AD has previously been described as one in which Ostia suffered a descent into disarray (Calza, 1953, p. 162; Meiggs, 1973, p. 97). Although Ostia was clearly in decline, a result of various attacks on Rome by the Goths and Vandals, renovations were still taking place (Kulikowski, 2007, pp. 173–177). One example is the transformation of the *Tempio dei Fabri Navales* into a storage facility for marble under Volusianus in the late 4th or early 5th century AD, whereas the basilica in the *forum* area remained in use and saw restorations during the 7th century AD (Herrmann and Barbin, 1993, pp. 99–101; DeLaine, 2016, p. 433). The evident use of *opus vittatum* and *opus listatum* likely coincided with the decline of the brick industry as there is evidence of the reuse of older building material providing an additional indication of new building activity, albeit in a limited capacity. Complete abandonment of the city occurred by the 9th century AD, after which it became a quarry for marble and other items during the Medieval period that were repurposed for the nearby Borgo and churches throughout Italy.

[24] Several inscriptions discovered within the Theatre attest to its various phases of development (*CIL* XIV 82, 114, 129).

3.2 History of Research into Roman Religion at Ostia

Study of religion at Ostia remains one of the most contested topics about the site, which range from debates about the identification and function of individual temples to the definition of other religious spaces throughout the city (Pavolini, 2016, p. 201). The quantity of temples and shrines uncovered at Ostia provides an indication as to the importance that religion played within the cityscape (Figure 3.3). These temples allowed for the practice of rituals that formed an important part of Roman life (Meiggs, 1973, p. 431; Beard, 1987, pp. 7–12; Rieger, 2001, p. 247). However, following the general trend of research at Ostia, study of the city's religious environment has been fragmented. The majority of studies are focused upon individual temples or cults, which are often separated from their placement within the urban landscape (Taylor, 1912; Squarciapino, 1962). The quantity of evidence for Ostian religion has attracted significant scholarly interest, but attention towards how temples and cults structured a larger religious landscape has seen only minimal consideration. The following section provides a chronological overview into the major studies of religion at Ostia in order to illustrate how approaches to Ostian religion have developed over the past hundred years of scholarship. This places the current thesis within the tradition of scholarly research into religion at Ostia as well as demonstrating how the study of Ostian religious rituals is a topic that requires further attention.

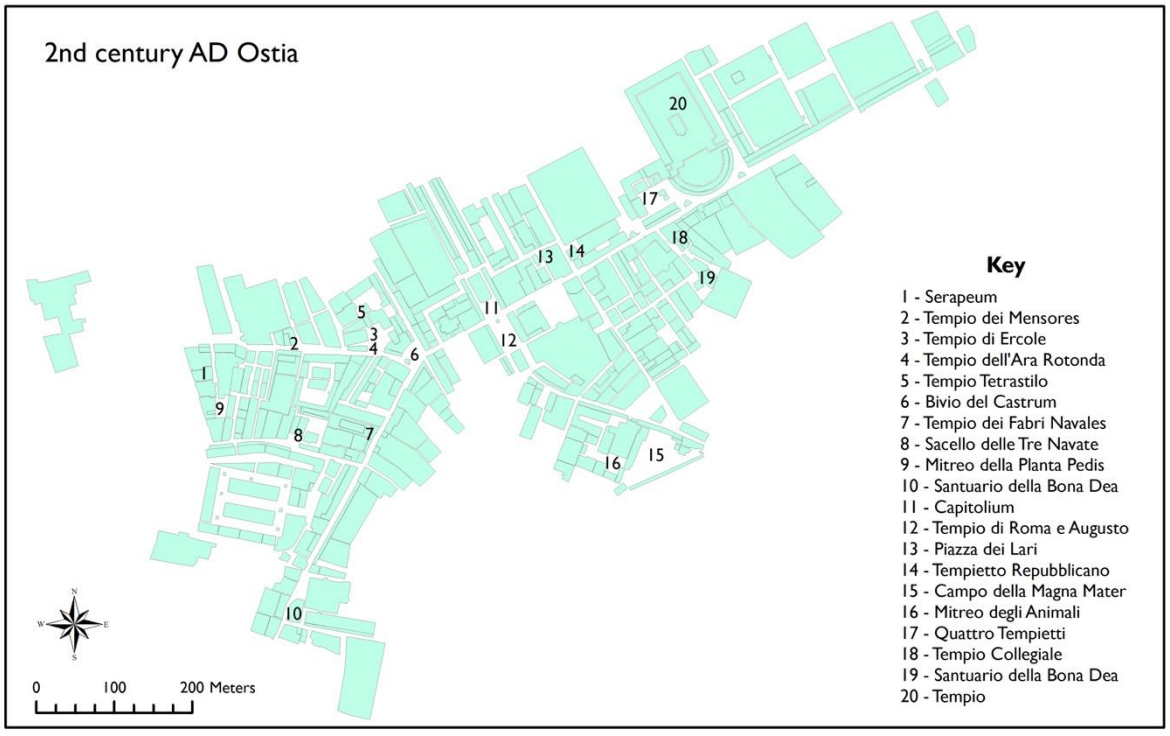

Figure 3.3 Plan of Ostia indicating some of the city's important religious structures.

The foundational work dealing with religion at Ostia is Taylor's, *The Cults of Ostia* (1912). Concerned with detailing the various deities worship at Ostia, she provides a comprehensive account of all

religions evident within the archaeological record upon the basis of epigraphic evidence. Contemporary with Paschetto's (1912) broad survey concerning the rise and fall of Ostia as well as Wissowa's (1912) foundational study of Roman religion, Taylor (1912) predominately focuses upon material evidence rather than placing the cults within the framework of Ostia's historical development.

The results of Calza's large scale excavations produced an overview of all excavated temples discovered (Calza, 1929, 1953). The most comprehensive attention was given to the analysis of the cult of Mithras, which formed one of the *Scavi di Ostia* volumes by Becatti (1953). The collection of eighteen identified *mithraea* discovered during the 1938–42 excavations are presented, as well as preliminary observations about the religious environment they collectively constructed (Becatti, 1954; Vermaseren, 1956). Becatti (1953) hypothesises that the distribution of *mithraea* throughout Ostia corresponded to the lower-class population, in terms of their areas of residence as well as the city's overall population size. While recognising that many of the temples were built into pre-existing structures, he does not provide further commentary on the relationship of these temples to the surrounding urban environment. This work follows what becomes a trend in Ostian research in producing specialised studies into different aspects of Ostia's religious landscape.

A decade after the first study into Ostian religion saw the publication of Squarciapiono's book, *I Culti Orientali ad Ostia* (1962). Building upon Taylor's (1912) research, she updates the number of know temples at Ostia from the information that came to light during Calza's 1938–1942 excavations. In addition to the material introduced by Becatti (1953), she considers other Eastern religions including evidence for the worship of Isis, Serapis, Cybele, and Attis, providing a useful catalogue of foreign cults worshiped at Ostia. Her analysis closely follows the framework developed by Cumont (1909), distinguishing between traditional Roman religions and those 'Oriental' in origin. These religious divisions are now discounted, but the approach of studying either traditional Roman or foreign cults at Ostia has persisted (Beard, North and Price, 1998, p. 246).

Previous research into Ostia's religious environment was synthesised in Meiggs' seminal work, *Roman Ostia* (1973). His attempt to compile all relevant archaeological and textual evidence relating to Ostia results in only a limited consideration of Ostian religion. Confined within a single chapter, the various religious cults are approached chronologically, placed within a larger structural narrative about Ostia's historical development. Like previous scholarship, there is still a clear distinction between traditional and 'Oriental' cults. Some attempts are made to interpret the importance of religious areas, such as his deduction that the *forum* served as both a centre of public life and religious life, with the *Capitolium* featuring as the city's most prominent temple (Meiggs, 1973, p. 337). Religious space is preliminarily approached through the distinction of temples being located either within or outside the city walls, showing only minimal attention towards their placement within the urban environment. The cult of Mithras presents one of the few instances in which the

distribution of temples is considered, but Meiggs speculates that this was because temples were reserved for surrounding inhabitants (1973, p. 374).

Mithraic studies have seen some of the greatest advances with regard to the spatial study of temples within Ostia's cityscape. The end of the 1970s saw increased interest in studies of Mithras at Ostia, resulting in a large corpus of literature on the subject. The collection of articles published by Laeuchli (1967) about the Ostian *mithraea* contributed little new information to the works already produced by Cumont (1909), Becatti (1953) and Vermaseren (1956). The large number of identified *mithraea* at Ostia has focused scholarly inquiry towards understanding their spatial layout within the city. The distribution of the cult was addressed preliminarily by Coarelli (1979) within a wider study of the cult at Rome.[25] More recently, White (2012) questions how *mithraea* were positioned within Ostia's urban context as a way to address the evolution of Mithraism overtime. White's (2012) analysis not only pays attention to the accessibility of individual *mithraea*, but he also notices possible associations with other cults, such as that of Serapis. A similar approach is adapted by Kockel (1992) who interprets their distribution as being indicative of independent neighbourhoods, with attendance restricted by a follower's residential location. Advances made specifically within the field of Mithraic studies at Ostia illustrate the potential for studying temples in relation to their surrounding environment.

The 1990s saw a transition from the study of monumental architecture, like temples, to interest in urban space. Changing views concerning the importance of studying space within the ancient city is likewise reflected in how urban space and religion is approached at Ostia. The importance of Ostia's street system and building typologies are considered by Mar (1991) as a way to study the development of Ostia's urban space. While not focused exclusively on religious space, his research ultimately illustrates the different processes that shaped Ostia's urban layout, stressing the correspondence between pre-existing roads and land division. Similar concepts were applied in an earlier study that looked specifically at the sanctuary of Hercules in relation to its placement within Ostia's urban settlement and its development over time (Mar, 1990). Mar's (1990) study presents one of the first instances in which a religious structure's urban placement is studied in relation to Ostia's urban development. The attention towards urban space also moved away from monumental temples to questioning other sources of evidence for religious practice. Focus upon religion within the private context of Ostia appeared with Bakker's publication, *Living and Working with the Gods* (1994). Presenting a detailed look at the presence of deities in private living contexts ranging from residential to commercial complexes, the work provides a detailed catalogue of available evidence at the site. Rather than concentrating just upon the deities worshiped, Bakker focused attention

[25] An earlier survey conducted by Schreiber (1967), considered the spread of Mithraism across Ostia. He concluded that the cult's spread was marked by two different stages, with the cult only appearing in the city's centre by the 3rd century AD.

upon the people undertaking the worship in various settings upon the basis of material evidence.

More recent scholarship is aimed at addressing how religious practice was defined within the cityscape. An important contribution is made by Rieger (2004), who looks specifically at three different urban sanctuaries (*Quattro Tempietti*, *Campo della Magna Mater*, *Tempio Rotondo*) to undertake a broader study of the development of Ostia's sacred topography from the Republic to Late Antiquity. In particular, her study addresses the differences that existed within urban life in terms of foreign and traditional cults as well as imperial religious practices. This enabled her to focus upon the interactions that would have occurred between sanctuaries and the people who attended them, paying particular attention to the various urban classes that would have partaken in different forms of worship. Although the focus of study is upon Ostia's religious topography, only minimal attention is afforded the presence of processional activity and what it would have contributed to the sacred landscape (Rieger, 2004). Adopting an approach that re-evaluates the definition and function of the city's sanctuaries, the study incorporates analysis of urban integration, architectural layout, different building phases, and archaeological evidence.

Concurrent with Rieger's (2004) publication saw Steuernagel's (2004) work that addresses port religions at Ostia, Puteoli, and Aquileia. Rather than tracing the development of individual cults, as has been one of the predominant approaches to Ostian religion, he provides an overview of the city's religious environment during the Imperial period. A particular strength of his work is the rigor with which he examines the various cult structures following the evidence available within the archaeological record. Addressing the cult characteristics, the importance of associations, and the presence of foreign cults, Steurengel was able to evaluate the various urban dynamics of Ostia. In particular, his focus upon associations looks at the important role they played within Ostian urban life.

More recently, Boin (2013)[26] undertakes an ambitious effort in his book to reconstruct the socio-religious transformation of Ostia during the 3rd–7th centuries AD, focusing upon the presence of different religious identities. This follows a current trend of studying late-antique Ostia (DeLaine, 2006; Gering, Kaumanns and Lavan, 2011; Underwood, 2015). While attempting to combine literary and archaeological evidence, his study falls short of making adequate use of Ostia's rich degree of evidence relating to the city's later periods. Additionally, he often makes claims unsupported by current Ostian scholarship or adequate reading of past scholarly debates, such as his hypothesis that the *Serapeum* housed a cult of Isis, for which there is no evidence (Boin, 2013, p. 210).[27] In terms of the presence of Christianity and Judaism, he raises interesting ideas concerning their growing visibility during the 4th century AD, drawing upon Lynch's (1960) concept of urban

[26] For extremely critical reviews of Boin, see Pavolini, 2014; Bruun, 2016.
[27] See Chapter 7 for a discussion of the potential association of Isis with the temple.

landscape divisions, but as with many of his arguments this is not supported by thorough analysis of the material record (Boin, 2013, p. 158). While informative about the historical development of Ostia's later periods, there is significant potential for future studies to more fully address how Christianity altered Ostia's religious landscape.

This section has presented a chronological overview of some of the major works dealing with religion at Ostia. The general trend in the treatment of Ostian religion has closely followed advances made in the field of religious studies, showing a shift in how religion is studied in relation to ancient society. Additionally, increased interest in the importance of understanding the urban environment has shaped the direction of Ostian research from the study of individual temples or cults to larger studies considering Ostia's religious environment. Despite the advances that have occurred and the wealth of existing material specific to individual temples within Ostia, the rituals that occurred at specific temples have seen only preliminary consideration. In particular, the ways in which particular cults impacted the urban environment through rituals such as processions and how this contributed to the construction of a temple's religious landscape has yet to be fully studied.

3.3 Ostian Rituals

Despite the corpus of publications relating to Ostia's religious environment, there has yet to be a detailed study about Ostian rituals, an aspect of religious practice that likely formed an important component of the city's religious landscape. One of the few articles that focuses exclusively upon individual Ostian rituals is Van Haeperen's (2006) article that addresses the religious relationship between Rome and Ostia. Within the scope of analysis are rituals related either to having a military purpose during the Republic or with maritime travel during the Imperial period. In both instances, a substantial issue remains the minimal attention afforded to the effect these rituals had within Ostian society. The recent work by Bruun (2009, 2015) takes a slightly different approach, contending that Ostia had its own unique ritual life, which was supplemented by partaking in the large festivals held at Rome. Recognising that Ostia would have had its own ritual practices, study of these rituals merits further attention. The purpose of this section is not to provide a detailed analysis of the totality of Ostian rituals, which is beyond the scope of this thesis. Instead, a brief overview about what is known of specific Ostian rituals is provided. In particular, it illustrates that while processional rituals have only been minimally addressed, their study provides one avenue for gaining additional insight into the rituals that gave life to Ostia's temples through religious practice.

The predominate evidence we have for Ostian ritual activity comes from the record of individual sacrifices offered at the city. During the Republican period, when the port was used as a naval base, certain rituals would have occurred in preparation for the naval fleet's departure. The auspices would have undoubtedly been taken as a part of this. An example is reflected in the relief dedicated by C. Fulvius Salvis between 80–65 BC (Figure 3.4), discovered in the Republican Sacred Area (I.xv),

illustrating an offering of the haruspices (Becatti, 1939; Meiggs, 1973, pp. 347–349; Van Haeperen, 2006, p. 32). The location of this sanctuary, positioned on the way to the river harbour, could have ensured it as a stopping point for such rituals prior to leaving the city. Another example is recorded by Tacitus who mentions Claudius' visit to Ostia to perform a sacrifice (Tac. *Ann.* 11.26.3).[28] Various hypotheses concerning the nature of the sacrifice and in what capacity Claudius offered them are put forward, but as suggest by Van Haeperen, this particular sacrifice is likely indicative of regular rites that occurred at Ostia (Van Haeperen, 2006, pp. 42–43). While we have limited written accounts about specific sacrifices that occurred at Ostia, the centrality of sacrificial practices for Roman religion argues for their regular occurrence (Scheid, 2012).

Figure 3.4 Relief of the haruspices being offered, dedicated by C. Fulvius Salvis (Museo Ostiense, inv. no. 157; photo K. Crawford).

The cult of Castor and Pollux consisted of annual festivals and sacrifices at Ostia to ensure the safety of navigation (Taylor, 1912, pp. 22–26; Van Haeperen, 2005, p. 240). The *Fasti Silvii* records the occurrence of the '*ludi Castorum Ostiis quae prima facta colonia est*' (*CIL* I p. 335)[29] for 27 January, which was concurrent with the dedication of the Dioscuri's temple in the *Forum Romanum.* The festival also included chariot races at some point, as detailed in inscription *CIL* XIV 1 from AD 200 (Bruun, 2009, p. 137). The temple is generally identified with a structure located next to the river harbour that was discovered through geophysical survey (Heinzelmann and Martin, 2002), rather than the unsupported claim proposed by Rieger (2004, p. 259) and Steuernagel (2004, p. 65) that associates the unidentified *Tempietto Repubblicano* (II.ix.4) with the Dioscuri and Neptune. Despite the limited evidence towards the rituals associated with the Discouri, an account from AD 359 by

[28] Tac. *Ann.* 11.26.3: "waiting only till Claudius left for Ostia to hold a sacrifice." (Translation by Jackson, 1937).
[29] *CIL* I, p. 335: "The games of Castor and Pollux in Ostia, which was founded as the first colony." (Translation by author).

Ammianus Marcellinus (18.10.4)[30] describes a sacrificial offering made to Castor and Pollux at Ostia by the *praefectus urbi* in response Rome's grain shortage.[31] Regardless of the actual temple's location, this passage attests to the continuation of cultic rites as well as the importance of observing ritual practices for maintaining safe maritime transport, and by extension Rome's grain supply. Scholarly inquiry into the cult of the Dioscuri at Ostia focuses predominately upon identifying when and why the rites occurred, the purpose of their worship at Ostia, and where the temple of Castor and Pollux was located (Taylor, 1912; Van Haeperen, 2006; Bruun, 2009). While the regularity of sacrificial offerings and occasional presence of festival activity at Ostia is acknowledged, the nature of the association of these rituals to the people of Ostia has yet to be addressed.

Funerary rituals, including funerary processions, are another form of ritual activity that have received only limited attention at Ostia. During the early Republic, funerary processions provided an important venue for displaying a person's or family's status as they passed along a city's streets, an aspect that likely held true for Ostia. Funerary rituals changed by the 1st century AD when monumental tombs began to take the place of elaborate processional rituals (Heinzelmann, 2001, p. 375). Tombs were built outside of a city, meaning that for a person to reach them they would have to cross both urban and civic boundaries (Stevens, 2017, p. 153). The deceased were visited annually as a way of commemorating the ancestors (Toynbee, 1971, pp. 62–63).[32] In particular, the festival *Feralia* that took place on 21 February was marked by a banquet held beside tombs of the deceased (Scullard, 1981, pp. 74–75). There is evidence from the *Necropoli di Porto* on the Isola to the north of Ostia, that some tombs hosted cooking facilities to enable the preparation of food (Stevens, 2017, p. 159). The ritual movement that accompanied visits to family tombs more closely resembles pilgrimage movement rather than a structured urban procession, but similar elements were still present between the two. Ostians partaking in such events would have been visible leaving the city's boundaries to enter the funerary landscape. While not a formalised procession as such, their movement would have probably attracted some degree of attention, especially depending upon the number of people in a family.

Processions were one way in which rituals associated within individual temples would have been temporarily incorporated within the larger cityscape. However, there exists no specific literary

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[30] Amm. Marc 18.10.4: *dum Tertullus apud Ostia in aede sacrificat Catorum, tranquillitas mare mollivit, mutatoque in austrum placidum vento, velificatione plena portum naves ingressae frumetis horrea referserun.* "while Tertullus was sacrificing in the temple of Castor and Pollux at Ostia, a calm smoothed the sea, the wind changed to a gentle southern breeze, and the ships entered the harbour under full sail and again crammed the storehouses with grain." (Translation by Rolfe, 1950).

[31] There is considerable debate over if *apud Ostia* means at or near Ostia. Rieger (2004, p. 216–217) and Pensabene (2005, p. 504) interpret the passage as discussing the presence of temple located near Ostia rather than directly within the city. Bruun (2012) and Van Haeperen (2006, pp. 36–41) alternatively suggest that it could in fact refer to the possible temple discovered by Heinzelmann and Martin (2002).

[32] Ovid records 13 February as the day the dead were honoured with flowers brought to the tombs (Ov. *Fast.* 2.533–542).

evidence detailing the presence of urban processional activity at the city. The only existing account addresses the procession from Ostia to Rome that accompanied the arrival of the Magna Mater at the mouth of the Tiber in 205 BC (Ov. *Fast.* 4.305–44, **A.1d**), which is analysed in detail in Chapter 6. Instead, assumptions about likely areas of processional activity are proposed without addressing the ritual purpose of a procession and what it contributed to the city's religious life.

One approach to the study of processional activity is based upon the spatial position of sanctuaries throughout the cityscape of Ostia. The development of a religious route in Ostia possibly played a role in the establishment of certain early sanctuaries. DeLaine (2008) notes that an 'archaic sacred route' (Figure 3.5) followed a diagonal path through the archaic period city. The proposed course would have begun at *Lavinium* south of Ostia, entering the city at the *Porta Laurentina* before moving northwest through the city to conclude at the temple of the Dioscouri by the river port. Some caution needs to be applied to the ending point of this route as the sanctuary of Castor and Pollux is hypothesised only upon the basis of geophysical survey results, however, it is likely that a temple was located near the river harbour (Heinzelmann and Martin, 2002). The potential of such a route is based upon the presence of sanctuaries found along this proposed path, including the *Campo della Magna Mater* and the *Tempio di Ercole*. A similar sacred path was noted at Falerii Novi, which is described as facilitating processions through the city (Keay, 2010a, pp. 34–35). No other scholarship has approached the importance of such a route within Ostia or looked at the way it structured processions as the city developed beyond the archaic period.

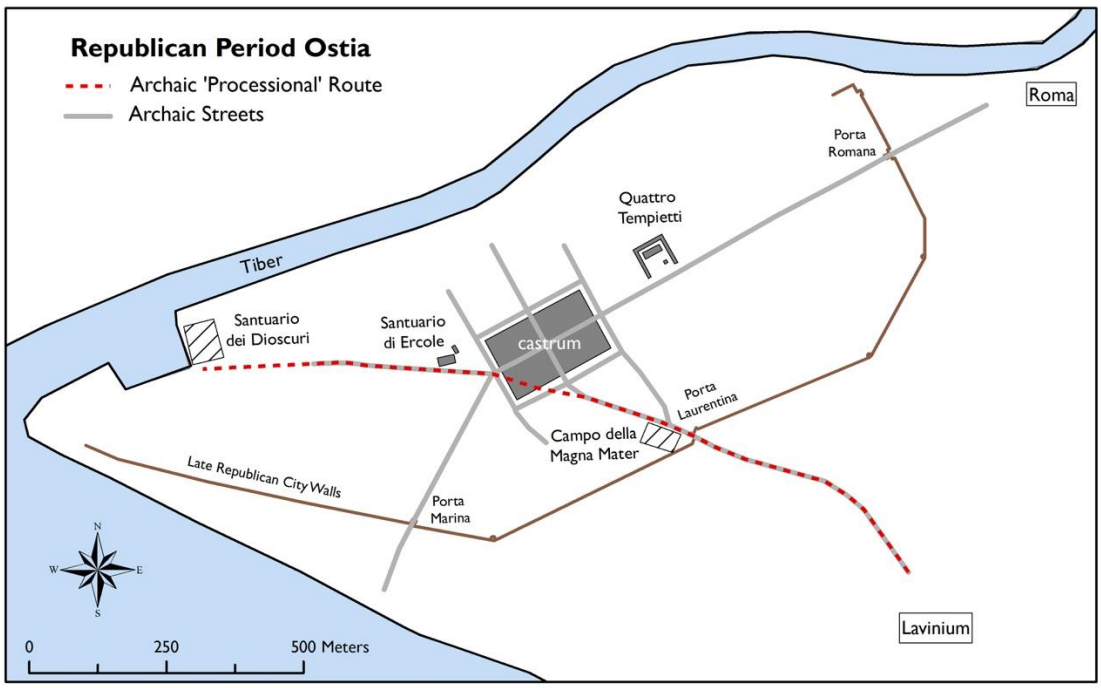

Figure 3.5 Ostia's 'archaic processional route' (after DeLaine 2008, p. 101).

Following the trend in interpreting primary streets as processional routes, the *decumanus maximus* (from here on referred to as the *decumanus*) is commonly interpreted as the main route for Ostian processions. Interested in Ostia's civic identity, Bruun (2009) briefly considers processional rituals by hypothesizing that the *decumanus* functioned as the city's primary processional route upon the basis of topographical details and visible architecture. This builds upon MacDonald's (1986) conception of urban armatures to illustrate that various topographic features like streets and arches dictated the main route. Portions of the d*ecumanus* were monumentalized under Gamala the Elder (*CIL* XIV 375)[33] during the 1st century BC while an arch was erected by the theatre during Caracalla's reign, components that feature in processional routes found in other cities (Meiggs, 1973, p. 501; Zevi, 1973; D'Arms, 2000; Bruun, 2009, p. 139). Bruun (2009) restricts his observations about processions, claiming that the limited information we have at Ostia means that only comparative examples, such as those from Ephesos and Oenoanda, can be used to hypothesise about their possible nature. Other scholars occasionally provide brief commentary about the role of the d*ecumanus* in hosting grand processions, all without further analysis or study (Boin, 2013, p. 75).

The general visibility of processions has recently received brief commentary. The relationship between temples and processional activity in Ostia is preliminarily addressed by Arnhold (2015). She draws attention to the need to consider sanctuaries within their broader spatial setting within Ostia in addition to accounting for the people engaged in various ritual activities. The creation of a temporary ritual space as processions move from a sanctuary to the street is briefly raised. However, as with previous scholarship, she stresses the need for further work to be conducted on the subject (Arnhold, 2015, p. 294). The main commonality between the few studies that mention Ostian processions is that further research is necessary.

3.4 Conclusion

The general consensus that processions followed Ostia's major streets closely mirrors the attention afforded to processions in other cities. Processions are assumed to have followed a city's main thoroughfares, but which sanctuaries these processions were associated with or what they contributed to the religious landscape are not addressed. Rather than attempting to further determine the identity of specific temples and how they inform our understanding of Ostian religion, refocusing attention towards the rituals that formed an active part of Ostia's religious environment presents us with a new way of approaching religion within the port town. Looking specifically at firmly identified temples with rituals that included documented processions can help us understand how moving rituals helped to construct a larger religious landscape. In this way, processions present us with a heuristic tool for assessing how ritual practices could extend beyond a temple's precinct

[33] The exact date that the street was monumentalized an if it refers to the *decumanus* or *cardo maximus* remains contested (Meiggs, 1973, pp. 351–352; Zevi, 1973).

to briefly inhabit the surrounding streets, creating a temporary shared religious experience with Ostian inhabitants irrespective of their religious affiliations.

Chapter 4: Modelling Ostia's Religious Landscape

4.1 Constructing a Digital Model of Ostia

The ways in which we can visualise processions within Ostia is first and foremost grounded in our understanding of the city's urban structure. In order to represent the possible connections that existed between temples, the streets that accommodated processional movement, and the broader built environment, a digital model needs to be constructed. One way to achieve this is through a GIS model that accounts for different factors that impacted how and where a procession moved within the city. This chapter details how the plan of Ostia was digitised and incorporated into a GIS within a specific temporal framework and how buildings were classified, so that the methodology developed in Chapter 5 could be applied.

4.1.1 Previous Plans of Ostia

The nature of research at Ostia has resulted in the absence of a standardised GIS-based map that all Ostian researchers use. The main plan of Ostia was published in 1953 (Calza) within *Scavi di Ostia I*. Recognising that Calza's plan was slightly out-dated, there was an attempt initiated by the *Soprintendenza per I Beni Archeologici* in 1995 to create an updated plan of the site. The plan was produced using aerial photogrammetry at a scale 1:500 (Ferri and Berreca, 1995, p. 54; Mannucci, 1995). While the goal of this project was to make a uniform plan that all Ostian researchers would use, it did not retain much of the archaeological detail present in the earlier plans which has limited its usefulness (Ferri and Berreca, 1995, p. 53; Stöger, 2011a).

A further initiative was undertaken by the *Soprintendenza* in 2004/5 that included the creation of 58 local reference points throughout Ostia that would allow for the site to be geo-referenced based upon researchers' individual maps. The reference points, however, were not tied to Italy's national coordinate system (Roma 40 Gauss Boaga). The points themselves also have not adequately survived daily wear on site, and while not fully unusable, they have not seen wide use by Ostian scholars. In large part this is because the plan produced from this research (Ostia antica - maglia caposaldi topografici 2004) exists as an unpublished database only (Stöger, 2011a, p. 53). A recent Japanese initiative undertaken by Hanghai and Hori (2009) has included a survey to reassess existing discrepancies with Calza's plan (1953) using laser-scanning and aerial survey.[34] One of the reasons for the existing inaccuracies within the original plans (Calza 1953) of Ostia is the way in which the

[34] Current work by Japanese researchers have produced a point cloud of all of the laser scanned areas of Ostia (Hori and Ogawa, 2017). The point cloud data is accessible at http://history.arch.kyushu-u.ac.jp/potree/workspace/OstiaForum.html (accessed 15.2.2018).

site has been studied, with research based primarily upon individual buildings or areas that were later compiled into a single plan of the city (Stöger, 2011a, p. 52). The site plan inaccuracies have not posed a challenge for the majority of work undertaken at Ostia, since a large proportion of the research has focused upon individual buildings. Growing interest, however, in considering the larger urban environment has necessitated a re-examination of which overall town plan should be used. While specific areas of Ostia have undergone re-recording so that they can be explored by incorporating plans into an overall GIS method, there has yet to be a fully updated site plan (Heinzelmann, 1998a; Martin and Heinzelmann, 2000; White, 2001; Stöger, 2011a).

4.1.2 Digitization of Ostia in GIS

The first step in my analysis required a GIS-based map of Ostia (Figure 4.1). As there was no previously digitised plan to which I could gain access, it was necessary to create a personalised GIS map. Due the fact that the entire site has yet to undergo a comprehensive revaluation for an accurate GIS-based plan, this was accomplished through the digitization of Mannucci's *Atlante di Ostia Antica* and portions of the *Scavi di Ostia* plans which were then geo-referenced to a general world basemap using the coordinate reference system (Roma 40 Gauss-Boaga) within ArcGIS (Calza, 1953; Mannucci, 1995). Mannucci's (1995) plan consists of 67 segments measuring 25 cm x 25 cm that were created using aerial photogrammetry. The individual segments were stitched together in ArcGIS and then digitised and geo-referenced/aligned to Italy's national co-ordinate reference system Gauss-Boaga. In an attempt to retain some of the crucial information within the original 1953 plan such as building entrances and stairways which indicate the presence of a second storey, portions of Calza's plan were also geo-referenced within the ArcGIS database and features relevant to my research were further digitised to enhance the data from Mannucci's plan (Calza, 1953; Mannucci, 1995). The digitised map does not include all of the data included within Mannucci's or Calza's plans as that would have significantly increased the time spent digitizing them (Calza, 1953; Mannucci, 1995). Examples of non-included data comprise of building material, reconstruction/later building works, and internal features which are not directly relevant to the present study.

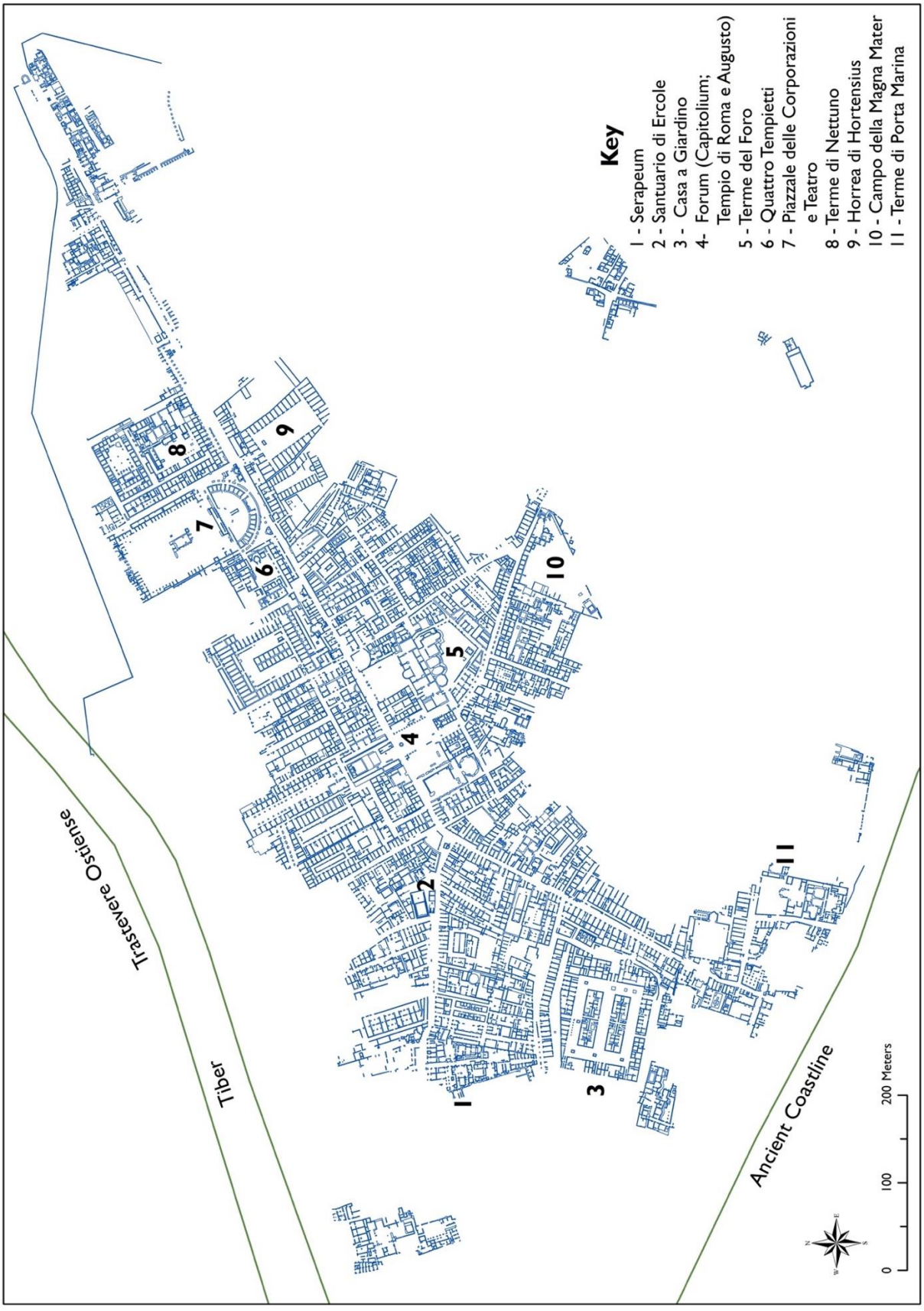

Figure 4.1 Ostia: digitised plan showing the city's important buildings (After Mannucci, 1995; Calza, 1953).

4.1.3 Classification of 2nd century AD Ostia

Classification of individual buildings and defining the street network was conducted after the initial digitization process (Figure 4.2). In order to maintain a temporal understanding of temples and their associated processions, the study of individual buildings and streets were confined to the end of the 2nd century AD. As both the *Atlante di Ostia* and *Scavi di Ostia* plans represent the entirety of Ostia rather than individual building phases, each insula had to be briefly re-examined in order to determine which structures were in use during the late 2nd century AD (Calza, 1953; Mannucci, 1995). This examination also helped to clarify which streets were in existence during the period in question, as later phases of the city saw the disappearance and alteration of certain streets. The definition of Ostia's late 2nd century AD architectural landscape followed DeLaine's classification where possible (DeLaine, 2002). Her approach to architecture presents the most stringent methodological analysis through the in-depth consideration of building phases that rests upon the identification of brick stamps. As the purpose of this thesis is not to present a re-examination of 2nd century AD Ostia, it was not feasible to reconsider every building that has been excavated across the city. In order to gain an overview of what buildings and streets dated to the end of the 2nd century AD, the primary source of evidence was based upon Calza's topographic index in *Scavi di Ostia I*, and the studies by Pavolini and Meiggs since they deliver the most thorough overview of individual structures and their chronology (Meiggs, 1973; Pavolini, 2006). Further specialist studies on individual buildings and *insulae* were consulted as necessary. Appendix B presents an index of buildings and the sources used in determining the 2nd century AD topography of Ostia.

Another crucial component was the clear identification of Ostia's late 2nd century AD street network. Due to Ostia's long period of occupation, varying quality of excavation records, and the different episodes of restoration efforts, understanding of the street network during any one period is complex (Stöger, 2011a, p. 213). The *Pianta delle regioni e degli isolati* was used as one of the primary sources for determining the street network within the excavated portions of the city (Calza, 1953). Ostia's extended street network has additionally been included, based upon preliminary results from Heinzelmann's geophysical survey (Heinzelmann, 1998a, 1999; Martin and Heinzelmann, 2000) and the space syntax axial graph produced by Stöger following these results (2011, p. 213).

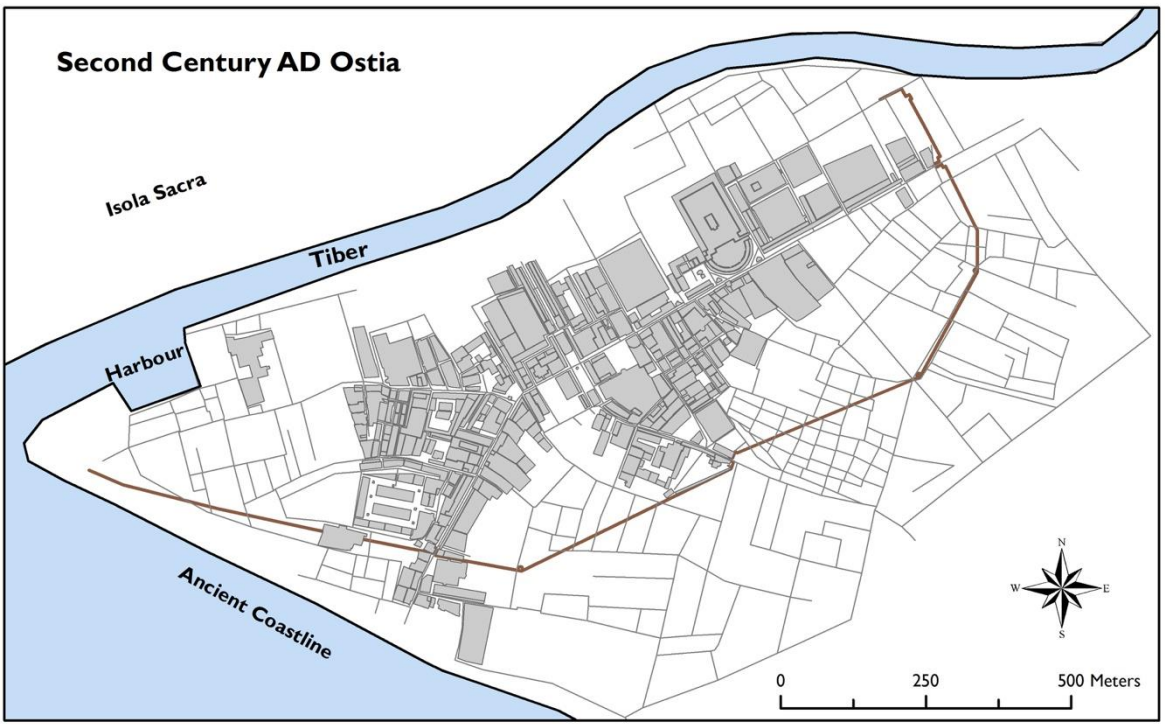

Figure 4.2 Plan of Ostia showing the built environment of the late 2nd century AD and the city's extended street network.

Due to the preliminary nature of the extended street network results, which is still awaiting final publication, it is likely that portions of the extended street network postdate the late 2nd century AD. The majority of streets within the immediate vicinity of Ostia were already built by the 2nd century AD, with evidence that repairs, rather than new construction, were primarily undertaken after this period (Heinzelmann, 1998b, p. 185). A few new streets were likely added after this period in response to new building activity in some of Ostia's southern areas. This includes a couple streets located in the area south west of the *Campo della Magna Mater* (Heinzelmann, 1998b). However, since the extended street network geophysical survey results are still awaiting final publication, all of the street segments have been included within the analyses undertaken throughout this thesis. The focus remains upon movement within the excavated cityscape. The inclusion of the extended street network, even recognising its chronological complications to the present study, is used to represent the possibility of movement occurring beyond the excavated street system. By including the extended street network, the analyses detailed in Chapter 5 reflect movement that occurs along the excavated streets while accounting for the fluidity of movement travelling beyond these streets in some manner. This ensures that the calculations do not suffer from the creation of an artificial boundary (e.g. unexcavated areas of the city), or edge-effect, that would present biased results in calculating potential movement patterns.

Although the chronological periodisation of the full street network cannot be accurately dated or associated with surrounding structures, it does provide an important framework for the movement-

based analyses that will be applied to Ostia in this thesis. While the focus of processional movement is based upon the excavated environs of Ostia, the extended street network allows for more realistic study as movement was influenced by the full street network, not just where it currently stops and starts within the excavated city. One does have to keep in mind that any alteration to the extended street network design will have some impact upon the study of movement within the excavated city. Ultimately, this classification of 2nd century AD streets and buildings serves as the basis of buildings and streets that will be analysed throughout this thesis (Figure 4.2) for studying processional movement patterns at Ostia.

4.2 The Built Environment as a Context for Processional Movement

The classification of space and architecture presents one way to categorise how urban activity structured processional movement at Ostia. More specifically, urban activity is used in reference to the spectators associated with the different types of activity occurring along or within the vicinity of Ostia's streets (e.g. commercial activity). Every processional ritual held a reciprocal relationship with both what was seen in passing by the processional participants and with the spectators actually watching the procession (Scheid 1998; Huet 2015). Without any spectators, a processional ritual had little to no meaning. Therefore, an important aspect of any processional ritual was the communicative message it intended to convey (Rüpke, 2012). This message would differ depending upon the intended audience, therefore shaping the nature of an individual processional ritual. In order to begin to assess the role viewership had upon shaping processional rituals, building classifications are used as a proxy to represent the different types of urban activities, and therefore types of spectators, that could be found within different areas of Ostia's built environment.

While urban activity is taken as the primary factor affecting processional movement for the purposes of this thesis, a range of other urban and social structures found within the city likely held importance. These could include aspects such as street width, public or private access to streets, streets being confined to pedestrian or cart traffic, and the location of city gates. While all of these urban features likely played a role in influencing processional directionality, individually they do not address how we can more fully study processions with unknown or undocumented routes. Street width and city gates, for example, could account for processional route variation due to deviation in the number of processional participants or the nature of the city's traffic flow in and out of the city. Both of these aspects, however, do not provide an indication of other urban or social factors that influenced a procession's route. As a result, they can be used to address how a procession may act at a specific point within the city, but they do not inform our understanding of the entire route taken by a procession.

In determining specific building classifications that are representative of different forms of urban activity, it needs to be stressed that the purpose of this thesis is not to reassess urban space or individual types of buildings at Ostia (e.g. identification and function of individual shops). Instead, the aim is to consider how certain broadly defined urban activities, as inferred from standing buildings of recognisable functions, might have affected processional movement. Furthermore, these classifications do not attempt to negate the complexity of urban space, but rather, they serve as an exploratory method to assess processional movement. Any discussion of space classifications within the Roman world faces issues of definition. Attempting to accurately define urban space in a way that reflects both concepts in Roman culture and that which is analogous to our modern understanding risks a degree of circularity (Russell, 2016). Further complexity arises in these analyses as even individual spaces had overlapping uses. Recognising the implausibility of providing full and accurate reconstructions of ancient space, the present methodology considers which activities are attested within the literary record in order to more closely relate specific activities that existed within the Roman city to Ostia. These are then used as a framework to question their effects upon passing processions.

In order to categorise the types of activity that occurred along Ostia's streets, the buildings were divided into datasets based upon their architectural function. While these categories in part represent our modern conception of space, the classifications of space reflect ancient interpretations as much as possible. Roman authors rarely provided a complete classification of how every structure was used in the ancient city, and the same holds true for Ostia (Laurence, 2007, pp. 94–95). These classifications, however, are by no means static. Research into urban space has regularly shown that space exists as a fluid construct (Scott, 2013, p. 1). While Ostia's architectural landscape has been compartmentalised for the sake of the current study, it does not mean that the present classifications are steadfast.

In order to have a connection to how space was understood in antiquity, the classifications provided by Vitruvius provide a preliminary basis for understanding how space can be categorised. Vitruvius' *Decem Libri de Architectura* presents one of the few literary accounts of architectural design during the Roman Empire.[35] His work strives to explain both architectural techniques and how a town should be constructed. While his study needs to be considered within the context it was written, during the period of Augustan building reform and as a form of critique of the period's changing architectural trends, his architectural discourse provides a broad suggestion about how space was used and understood (Wallace-Hadrill, 2008, pp. 144–145). Book 5 presents an overview of the

[35] Other architectural writings include Sextus Iulius Frontinus (Nerva) *de Aquaeductu Urbis Romae* and Marcus Cetius Faventinus (3rd c. AD), both follow Vitruvian themes in their explanations of architecture.

different types of public buildings commonly found within a Roman town, while earlier chapters address temples (book 3–4) and various domestic structures (book 6–7).[36]

Although much of Vitruvius' explanations refer to specific types of architecture, they also contribute towards our broader understanding of the relationship between social activity and architectural identification (Russell, 2016). He maintains that architects need to be aware of certain spatial characteristics in order to accurately build a structure that corresponds to its function (Vit. *De arch.* 1.2.5). His recognised correlation between architecture and the function of space proposes one way to understand urban space. While he acknowledges the multi-functionality of certain spaces like the *domus,* commenting upon areas that are open to the public versus those that are private, he still refers to the structure as residential and therefore a *privatus* space (Vit. *De arch.* 6.5.1). This complicates our understanding of how spaces that had multiple functions should be classified. By addressing the specific social activities that take place within these spaces, the issue of space definitions can be negated in part as each space with access to the street is provided its own classification. For example, a *domus* with front facing shops will have two classifications, residential and commercial. This varies slightly from the approach taken by Wallace-Hadrill, which only considers a shop as a distinct space if it is completely separate with no physical connections to the rest of the *domus* (Wallace-Hadrill, 1994, p. 103). While the distinction between space used throughout this thesis is in part a modern construct, it enables buildings to be analysed more incisively, rather than ascribing a single function to an entire structure.

Another influential work for looking at Roman conceptions of urban space comes from the Regionary Catalogues, which are 4th century AD lists detailing the topography of Late Antique Rome that survive by virtue of incorporation into Medieval manuscripts (Jordan, 1871; Valentini and Zucchetti, 1940; Hermansen, 1978; Reynolds, 1997).[37] While these lists contain many of the buildings referenced by Vitruvius, they go into further detail by describing a broader range of building types. These catalogues have been interpreted in a variety of ways ranging from a demographic analysis of Rome and explanation of the people that lived there (Jordan 1875; Storey 2002) to being interpreted as tourist guides and bureaucratic documents (Hermansen, 1978; Arce, 1999). For the present study, these manuscripts are extremely useful in that they provide an accounting of different buildings and their numbers found within Rome — e.g. 11 *fora*, 15 *nymphaea*, 290 *horrea,* 1,790 *domus,* 46,602 *insulae,* 856 *balnea* (private baths), 254 *pistrina* (bakeries) (Jordan, 1871). While there are considerable uncertainties surrounding the Regionaries, including how the data was collected, building identification, and absence of certain structure, they provide unique

[36] Book 5: 1 – forum and basilica; 2 – treasury, prison, senate; 3–9 – theatre; 10 – baths; 11 – gymnasia; 12 – harbour

[37] Existing copies of the *Regionaries* are from the 8th and 9th centuries. The most well-known versions are the *Curiosum* and the *Notitia* (Hermansen, 1978, p. 131). Versions of the *Notitia* are found within the *Codex Spirensis* and as a portion of the AD 354 *Codex-Calendar*.

insight into the terminology of urban structures beyond those addressed by Vitruvius, such as *pistrina* (bakeries), that can be used to define a range of different building types within the ancient city (Storey, 2002, p. 414).

Ostian buildings were classified based upon the type of urban activity that would have occurred within them. The classifications applied within this thesis derive from ancient conceptions of urban space as much as possible, but it must be recognised that there is still an element that they follow modern constructs of our understanding of space. In order to create a manageable quantity of data, the possible classifications were limited to the following six categories: commercial, production, residential, religious, public spaces, and unknown. This corresponds to a similar methodology proposed by Kaiser (2011) in his recent work that addresses the Roman street network at Ostia.[38] While the actual complexity of urban activity and the definition of space within individual structures would have far exceeded these categories, this approach provides an initial way to assess if and how different types of urban activity, occurring within specific architectural structures, affected processional routes.

The identification and classification of individual buildings at Ostia is difficult for a number of different reasons. First, because of how the site has been excavated, we do not have a clear idea of function for many buildings at Ostia. In many instances, a building's purpose is unknown due to the quality of early excavations, at which time inferences have to be made about how it was possibly used based upon comparative architecture and surrounding structures. Second, the determination of a building's function at a particular time, which in this instance is the end of the 2nd century AD, is particularly problematic. Different building phases and restoration works complicate knowing how each building was used during this period. Despite the challenges in accurately identifying how individual buildings were used throughout the city, I argue that this is not a reason to avoid classifying buildings as long as the classifications are understood within the framework of how the building typologies are constructed and the reasoning behind developing these categories.

The simplification in a single building's functionality poses another issue. Buildings rarely had one function, and as is the case at Ostia, many of the structures would have had multiple uses, both within individual rooms and across different floors. For example, spaces that had a political function like the possible curia would have inevitably had a religious function as well (Pensabene, 2005, p. 200). Buildings were classified primarily following the interpretations provided by Pavolini (2006), Meiggs (1973) and Calza (1953), supplemented by more specialised studies including those by Boersma (1985), Packer (1971), and Hermansen (1982). In trying to account for the possible variations in the use of a single building, a primary classification has been made upon the basis of the

[38] Kaiser applies the following architectural classifications: administrative, commercial, entertainment, health-related, production, religious, residential, and unknown (Kaiser, 2011, p. 114).

rooms that opened directly onto the street front, followed by secondary classification of what appears to be the primary function of the rest of the ground floor space that is directly accessible from the street. This was necessary because many of the buildings had shops along the street front, while the remainder of their spaces may have had a non-commercial function. The present classifications and resulting analyses need to be recognised as a product of the study of ground floor space.[39]

4.2.1 Commercial Building Classifications

Ostia had a rich commercial landscape, but the difficulty in correctly identifying commercial spaces within the city is well recognised (DeLaine, 2005, p. 29). Until recently, commercial activity was identified upon the basis of either storage facilities (*horrea)* or shops (*tabernae)* rather than questioning the full complexity of a city's economic activity (DeLaine, 2005). Following DeLaine's (2005) reconsideration of Ostia's commercial landscape, commercial spaces include four broad categories that represent different types of commercial activity: storage, shops, markets, and general activity. This thesis does not differentiate between different types of commercial spaces in later analyses due to time limitations (Figure 4.3).

Storage is most commonly represented at Ostia by *horrea,* or warehouses. Early identification of these were based upon a large structure that had narrow entrances to uniform sized cells or rooms (Rickman, 1971, pp. 293–7, 2002; DeLaine, 2005, p. 39; Bukowiecki, Monteix and Rousse, 2008). There are currently sixteen excavated *horrea,* although recent geophysical survey works indicate that this number is substantially higher (Heinzelmann, 2002, pp. 112–114; Germoni *et al.*, 2018).[40] The large concentration of storage buildings at Ostia is unsurprising considering the city's predominant commercial role.

Shops or *tabernae* represent a large proportion of Ostia's commercial landscape. *Tabernae* were fixed commercial structures that are usually characterised by their wide doorway openings with a threshold, often positioned behind a portico (Girri, 1956, p. 3; Hermansen, 1982; Boersma, 1985, fig. 312). Ostia has an estimated 800 *tabernae* located throughout the city, identified primarily from their shape and the presence of thresholds (DeLaine, 2005, p. 33; Ellis, 2011). Approximately 38 of these *tabernae* are identified as bars (*thermopolia*) due to surviving bar counters (Hermansen, 1982, pp. 125–183). The nature of excavations at Ostia limits our understanding of what was sold within all but a few of the identified *tabernae* (DeLaine, 2005, p. 33). Due to the uncertainty of how each *tabernae* was used, distinctions are not made to differentiate their function as any attempt to

[39] The potential bias in only accounting for ground floor space is further addressed in Chapter 9.
[40] Heinzelmann notes at least ten more *horrea* within the unexcavated areas of Ostia (2002, pp. 112–114), while the recent work undertaken in the southern part of the Isola Sacra shows several more warehouse structures (Germoni *et al.*, 2018).

consider bars separately, for instance, would present too much of an incomplete dataset when compared to the over 700 other *tabernae*.

The label 'market' denotes areas of both larger scale temporary and permanent commercial activity such as that which occurred with fairs or weekly/daily markets. While the term *macellum* is used to designate a permanent market building or space, there are no clearly identified *macella* at Ostia even though it is attested in the epigraphic record of the city (De Ruyt, 1983, pp. 122–124). Therefore, market is used in a broader sense to designate the presence of temporary commercial activity that likely attracted a greater number of people in comparison to other commercial spaces like *tabernae.* This form of commercial activity has only seen limited consideration within Ostia (DeLaine, 2005). In particular, spaces included within this category are *loggia* or large covered areas that are partially open. Examples at Ostia likely included buildings like the *Piazza dei Lari* (I.ix.3) which originally was an open sided structure and likely functioned as a market or bazaar (Frayn, 1993; DeLaine, 2005). Further spaces for temporary markets could include areas like the *forum,* but because these would not have occurred within specific buildings they are not included within the current building topology used for this study. A final area that would have seen buying and selling activities that needs to be addressed are the courtyards of *horrea.* Their degree of open space, which is comparable to market spaces, indicates that they likely facilitated various buying and selling activities, including auctions, indicating their dual purpose as a storage and market space (DeLaine, 2005, pp. 42–45).

A final category applies to buildings with joint functionalities that have not already been addressed. An important example is the *Piazzale delle Corporazioni,* the entire area of which has been attributed with three different classifications in this thesis (commercial, public, and religious). Its main function is commercial, as attested through the presence of sixty different *stationes* associated with various commercial groups that surrounded the complex (Meiggs, 1973, pp. 283–289). Their presence along all three sides of the area as well as being directly next to the street means that its commercial definition will have the greatest effect on the analyses undertaken throughout this thesis. The interior of the area, in contrast is provided a religious and public function to represent the activity associated with the interior temple and to reflect its connection to the Theatre and other non-commercial activities that might have occurred within the space (Pohl, 1978; van der Meer, 2009). Another category of buildings that likely included some form of commercial activity are associated with *scholae.*[41] While commercial activity may have been conducted within these buildings, the present thesis has identified the known *scholae* as having either a public or religious function (see below) (Hermansen, 1982; Stöger, 2011a). For several of the identified *scholae,* commercial activity is accounted for by the presence of shops located at the entrance.

[41] A *schola* was the building in which a *collegium* or association met.

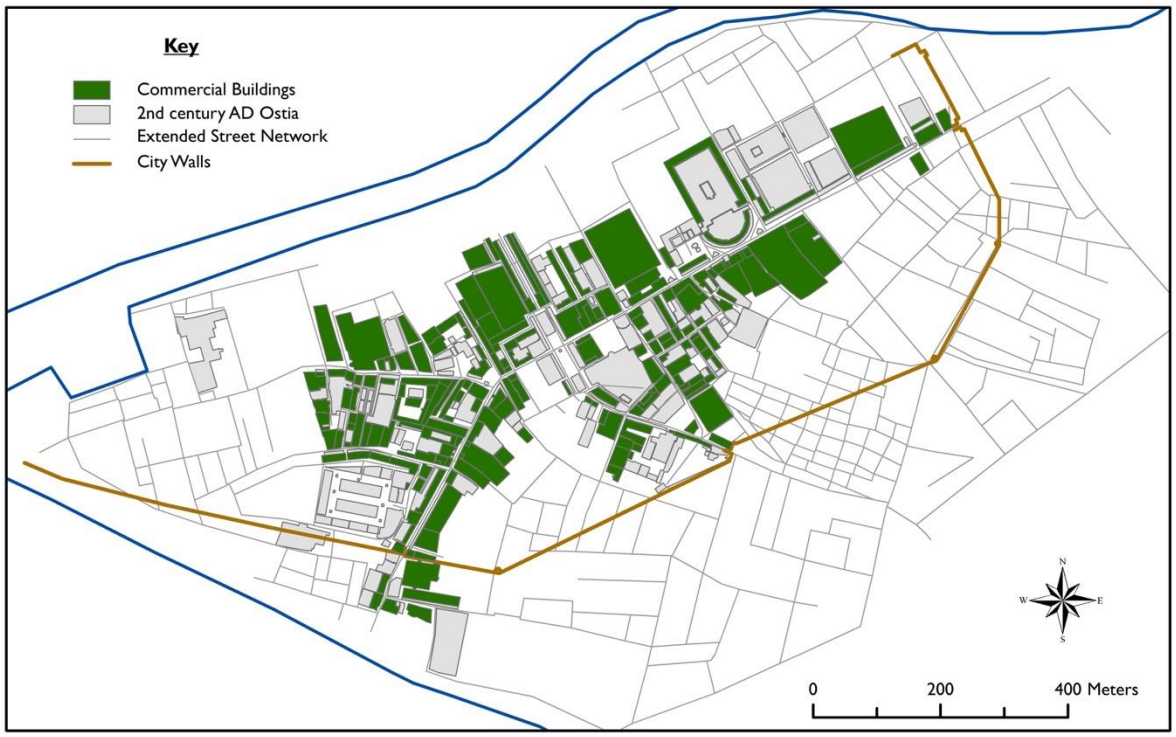

Figure 4.3 Plan of Ostia showing commercial buildings.

4.2.2 Production Building Classifications

Buildings classified as areas of production include: bakeries, fulleries, and workshops (Figure 4.4). While these spaces also clearly have a commercial component, they are considered separately since they served a slightly different function. Any potential commercial connection is accounted for in street front *tabernae* that are connected to productions spaces.

Bakeries have received limited consideration, with focus placed upon the most easily identifiable mills and bakeries evident throughout Ostia (Bakker, 1999). *Fullonicae* have received some of the greatest attention at Ostia due to their clear identification within the archaeological record (Flohr, 2013). They have been considered separately as they might have been a detractor due to smell, arguably repelling processional movement away from an area or street (Flohr, 2017). Spaces that constitute workshops were probably connected to individual *tabernae.* Due to the difficulty in identifying what was sold in individual shops throughout the city, identifying the presence of workshops associated with these shops is equally problematic. As a result, this classification has been reserved for areas that are clearly identifiable. It is acknowledged that the present number of buildings classified as production throughout the city likely represents only a fraction of those that existed. In this instance, this classification enables us to see how a limited number of buildings impacted ritual movement.

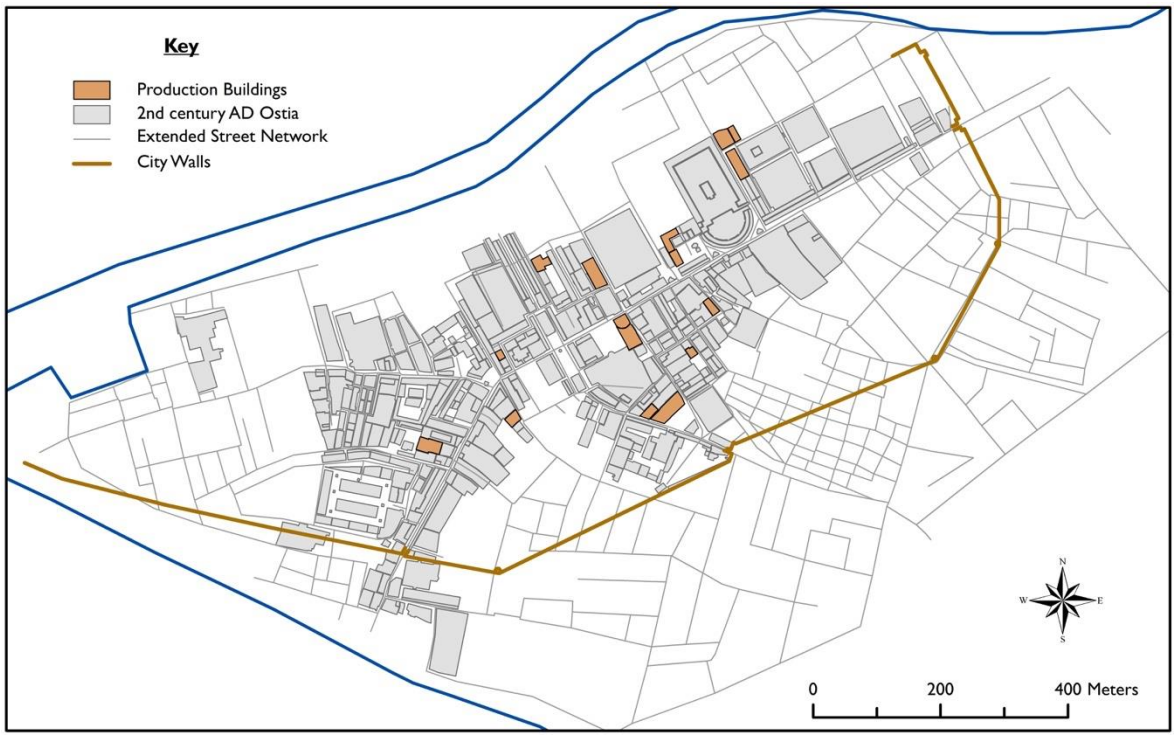

Figure 4.4 Plan of Ostia showing production buildings.

4.2.3 Residential Building Classifications

Buildings classified as residential encompass *insulae, medianum* apartments and upper class *domus* (Figure 4.5), which are well identified at Ostia (Packer, 1971; Hermansen, 1982; DeLaine, 2004, 2016). Previous studies of roman residential space have focused extensively upon classifying different categories of residential structures (Kent, 1990; Clarke, 1991; DeLaine, 2004, 2012) as well as creating a distinction between upper and lower class residential spaces (Hermansen, 1982, p. 45; De Albentiis, 1990).

Multi-storey apartment buildings constituted a large proportion of residential space at Ostia. By the period in question, many of these *insulae* had replaced previous upper class houses (DeLaine, 2012). A small proportion of buildings by the middle of the 2nd century AD consisted of the well-known combined *insulae,* which included ground floor commercial spaces in addition to 'luxury' residential dwellings arranged around a courtyard. Examples include the *Insula di Giove e Ganimede* (I.iv.2) and the *Casa di Diana* (I.iii.3–4), in which the interior decorations attest to their function as high status residential dwellings (Ceci, Falzone and Marinucci, 2013; DeLaine, 2016, p. 430). The more common residential structures were the *medianum* apartments, which consisted of a uniform design (e.g. *Casette Tipo* III.xii–xiii*; Case a Giardino* III.ix). The identified structures at Ostia occupied ground floor space as well as being several storeys tall (Hermansen, 1982). These types of apartments may have also served as long-term rentals (DeLaine, 2016, p. 430).

Domus include many of the upper class houses found throughout Ostia. Recently, scholars have begun to reassess the identification of certain *domus,* such as the *Casa del Domus Fulminata* (III.vii.5*)* (van der Meer, Stevens and Stöger, 2005). Despite the questionable identification of structures like these, they still likely had a residential function, whether or not it was a traditional *domus.* In most cases, these spaces have been classified as residential unless there is clear evidence for an alternative function.

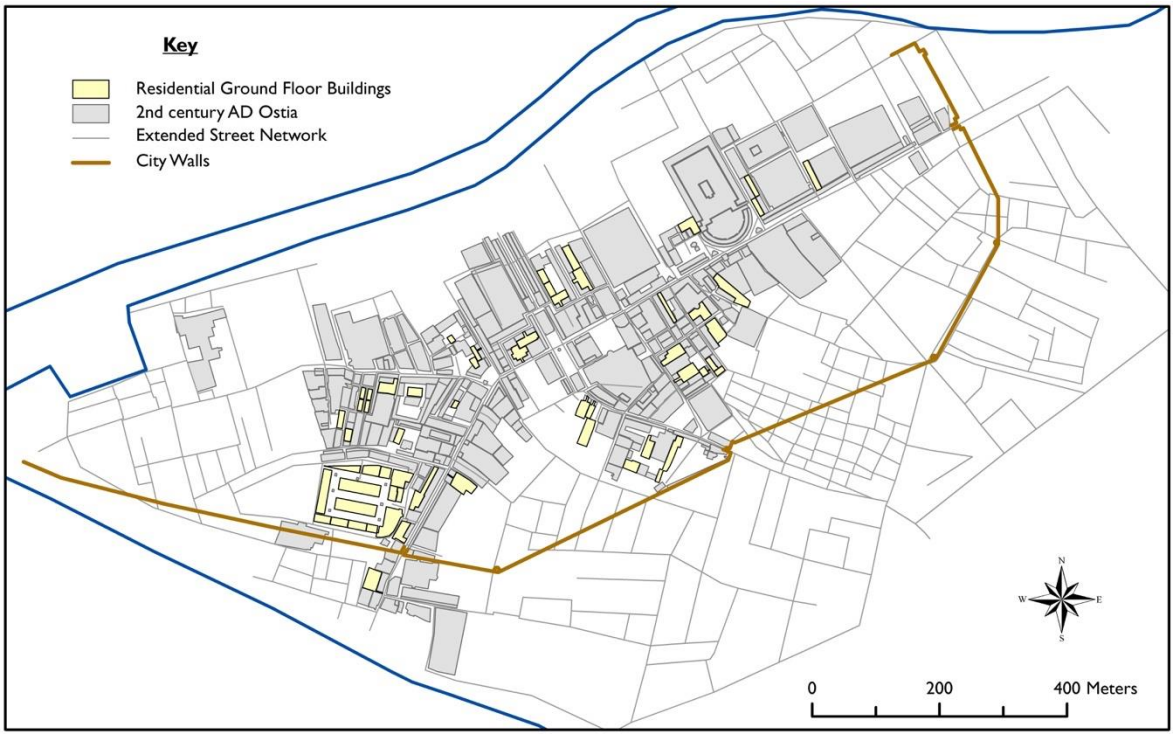

Figure 4.5 Plan of Ostia showing residential buildings.

4.2.4 Public Building Classifications

Public buildings include baths, defined open spaces, gathering points, administrative spaces, and areas of entertainment (Figure 4.6). While these all represent distinct urban activities, their similarity arises in that they are all associated with high levels of social interaction that are not strictly commercial or residential in nature. These all represent areas of the cityscape that would have seen a high degree of interaction between people. Ancient literary sources provide commentary on this topic by referring to areas that saw a high frequency of interaction (Cic. *Verr.* 2.1.154; Cic. *Dom.* 146; Plaut. *Curc.* 480–4). Laurence raises the distinction between *celeberrimus* (busiest) and *frequentissimus* (most frequented) as the perception versus the description of a specific type of space (Newsome, 2011a, p. 23). The commonality between the various buildings classified as public is that they would have had a high degree of traffic or movement, indicating a high level of interactions between people (Thomas, 2007, p. 117; Trifilò, 2008; Newsome, 2011a, pp. 22–24). In referring to public space, I do not intend to argue for a structure being identified as *publicus* or *privatus,* a debate

that many scholars have attempted to address (Russell, 2016). Rather, I take public to refer to a space that attracts a community of people, but that is not necessarily equally accessible to all.

Public spaces and gathering points all represent frequently visited spaces. These can include structures like porticos or *nymphaea* (fountains) that would have attracted movement but may not have been the intended destination (Macaulay-Lewis, 2007). Other places that would have seen a high degree of social activity would have been public baths and the Theatre. Public baths facilitated both hygienic practices as well as acting as important social centres for a city. They facilitated activities that ranged from business transactions to trading gossip with friends (Mart. 1.23; Ov. *Ars.* 3.639–40; Fagan, 1999; Allison, 2007). Areas of entertainment, such as the Theatre, would have additionally attracted a large number of visitors.

The final type of spaces defined as public include areas used for administrative gatherings or for meetings of a *collegia*. In terms of administrative structures, there are no firmly identified buildings that served this purpose at Ostia. Buildings that likely had some form of administrative purpose include the *Curia* (I.ix.4) and the *Basilica* (I.xi.5) located next to the *forum*. While these spaces may have also seen religious and economic activity, because of their multi-purpose function I have classified them as having a greater public identification.

The traditional meeting place for a *collegium* was within a *schola,* a permanent headquarters for a specific association. Most of the identified *collegia*[42] at Ostia were associated with some form of commercial activity, and their meetings very likely included various commercial transactions. For *collegia* with unidentified headquarters, meetings undoubtedly occurred in temporary locations (DeLaine, 2016, p. 428). One reference details the occurrence of a meeting at the temple in the thus far unidentified *Forum Vinarium* (*CIL* XIV 409, 430). The structures which likely hosted these types of meetings are defined as public due to the fact that they represent a gathering of people, however, the range of other activities they likely carried out needs to be recognised. For the present study, by defining *collegia* meeting locations as either religious or public enables them to be included within the present analysis.

[42] For a comprehensive re-evaluation of Ostian *collegia,* see (Rohde, 2012, pp. 95–274).

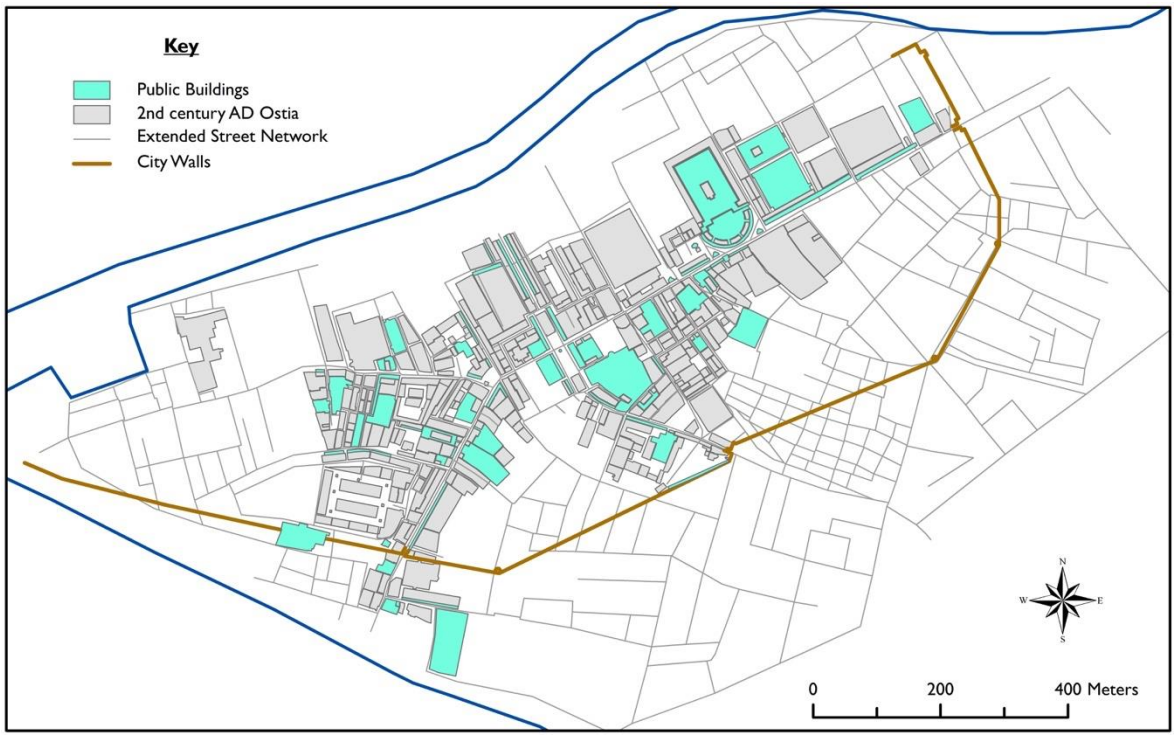

Figure 4.6 Plan of Ostia showing public buildings.

4.2.5 Religious Building Classifications

Religious spaces consist of temples, sanctuaries, and spaces with a religious affiliation (Figure 4.7). While private religion has been considered in detail by Bakker, it has not been included in this analysis since it is not manifested in monumental structures or generally accessible spaces (Bakker, 1994). Additionally, the debate surrounding identifying religious structures as being public versus private is not addressed since the purpose of the building classifications is to identify the presence of different types of urban activity, rather than creating distinctions within them. *Mithraea* are accounted for since they represent a community of people that would have gathered in shared worship. Although they are mainly accessed through other buildings, their location is not particularly hidden (DeLaine, 2016, p. 427).

Buildings with religious affiliations account for a few different types of spaces. The first include areas that likely accommodated religious activity, such as the *Foro di Porta Marina* (IV.viii.1). Other examples could include the *loggias* connected to the *Portico est e ovest di Pio IX* (I.v.2; I.vi.1), which may have been a gathering point for festival activity (DeLaine, 2005, p. 38). For the present series of classifications, these have been identified as having a more regular commercial function, but the possibility is raised to show the difficulty of always being able to clearly differentiate religious space from other building functionalities that often had a shared meaning. Certain *collegia* also had important religious functions. The identification of *scholae* associated with specific *collegia* with a predominate religious function are classified as religious structures. In some instances, the temple

of a *schola* is defined separately from the rest of the complex which is provided an additional classification.

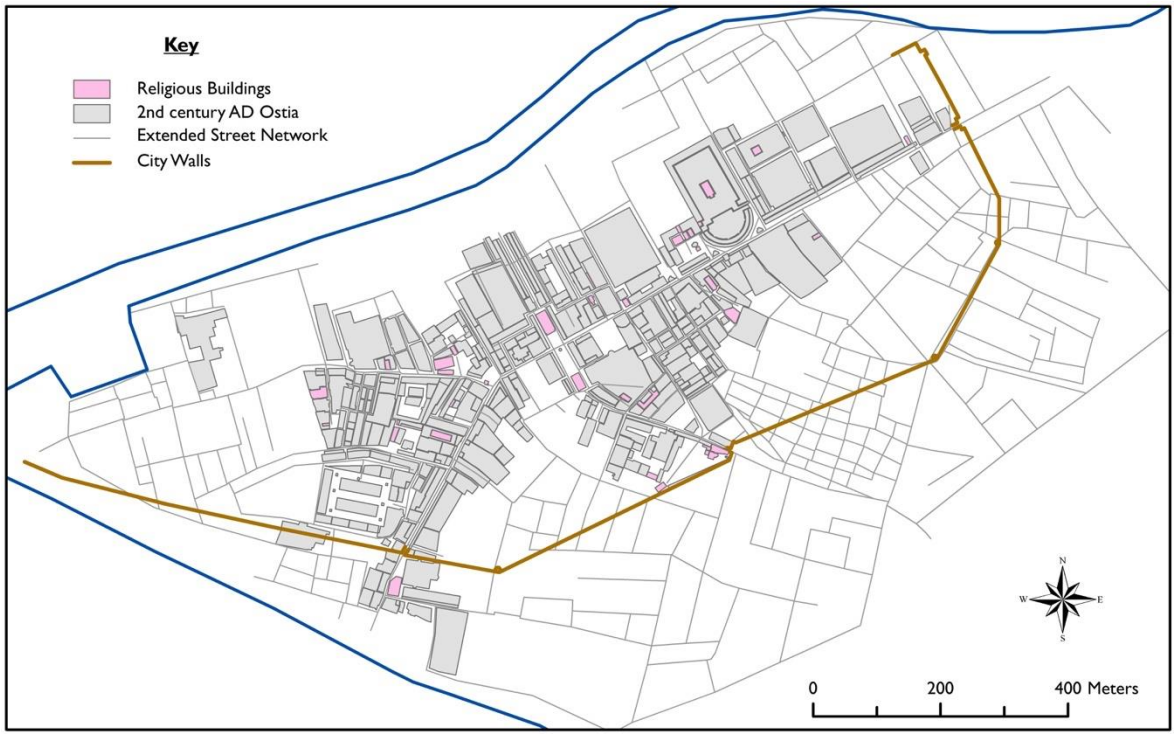

Figure 4.7 Plan of Ostia showing religious buildings.

4.2.6 Dealing with Uncertainty

It has to be stated that there is large degree of uncertainty that goes into the analysis of any ancient urban environment. Simplifying social activity and the use of space often negates further ways in which a space was used (Pirson, 2007, p. 468). However, by giving each space a set classification while trying to account for different functionalities in as much as possible, enables us to begin to assess how the built environment might have affected processional movement. These classifications have attempted to follow ancient conceptions of space as closely as possible, while reflecting social activities that may have impacted processional movement in some way. In some instances, it was impossible to provide a building with a specific classification due to a lack of any published information or any identifying features that indicate its function. In these examples, the buildings are included within the cityscape, but are not ascribed to a specific classification category. While Ostia's built environment has been given set classifications for the purpose of this study, the methods of analysis that will be introduced in the following chapter can adapt to changes in these classifications as new information comes to light or the focus of enquiry changes. These classifications, therefore, exist as a framework for assessing urban impacts and their effect upon processional movement.

Chapter 5: Visualising Religious Landscapes

5.1 Introduction

The aim of this chapter is to introduce the multi-layered approach that I use in this thesis to visualise possible processional routes. The previous chapters have already placed the present study within its larger theoretical framework (§2.5) of processions being structured by the built environment and specified Ostia's building classification categories (§4.2). This chapter begins with a brief explanation about why a multi-layered approach is being applied for the study of processional movement at Ostia. I then detail each analytical component of this approach, beginning with the quantification of space with space syntax's axial analysis. I then present urban network analysis as a way to integrate the impact of building functionality within a larger study of urban movement. Analysis then moves to an agent-based model which addresses some of the factors that cannot be accounted for in the previous two methods. Agent-based modelling additionally serves as a way to question the validity of applying a ritual movement framework and its effect on structuring processional movement. The chapter concludes with a discussion of the limitations of these approaches and how they are addressed at Ostia.

5.2 Multi-Layered Approach

Rather than attempting to address the question of processional movement at Ostia with one method, which has already been shown to be insufficient in previous chapters, a multi-layered approach presents a heuristic tool for tackling its complexity. A consistent trend in movement focused studies is the application of specific methodologies in isolation of other potential approaches. Due to the complexity of movement, applying only one method often gives narrow insight into the patterns of pedestrian traffic, an issue that is only occasionally addressed (Herzog, 2014). An additional problem is that these methods are predominately applied to the most general definition of movement, random pedestrian traffic within a city (Hillier *et al.*, 1993; Batty, Jiang and Thurstain-Goodwin, 1998; Haklay *et al.*, 2001; Newsome, 2011a). When considering processions, however, movement is far from general. The urban landscape and processional dynamics all need to be taken into account. Coupled with a fragmented archaeological record about the nature of specific processional routes, this type of study becomes even more complicated to undertake. The dynamic nature of processional movement, which cannot be adequately addressed with only one method, can be approached by the combination of several movement based analyses.

Two of the methods have their origins in network theory, space syntax and urban network analysis. The first, developing from the field of architecture, uses the graph-based method of space syntax to quantify movement patterns based upon interactions within the built environment (Hillier and

Hanson, 1984). Urban network analysis addresses some of the issues implicit within space syntax by combining structuralist and spatial theories to show that buildings and their activities had an active role in structuring movement. Agent-based modelling comprises the third method, a simulation tool that allows us to look at the behaviours that emerge from decisions made within a constructed environment. This model serves as a way to gain a more nuanced perspective about processional movement by introducing the dynamic movement of people into the present study. Additionally, it allows for the examination of the underlying assumptions about what structures ritual movement, reflecting upon the degree to which the built environment helped to structure movement routes.

This thesis investigates how the positions of individual temples structured both patterns of movement and ritual activity, which created a specific religious landscape at Ostia. These methods offer insights into Ostia's built environment and its religious practices from the perspective of interaction between the cityscape and its urban agents. Network analysis methodologies in conjunction with agent-based modelling enable investigation into what affects processional movement, moving the focus of research into processions away from static connect-the-dot approaches.

5.3 Space Syntax

The present study uses space syntax as the base method to consider potential areas of movement in relation to individual temples. Space syntax is used to both compare the spatial location of temples within Ostia's cityscape and to define the extent of movement potential surrounding individual temples, limiting the area of study (Hillier and Hanson, 1984). It must be noted that the three space syntax measurements used within this thesis have been previously applied to Ostia's street network, but not specifically in relation to the three temples in question (Kaiser, 2011; Stöger, 2011a).

There is a growing issue in how space syntax is applied, especially within archaeological studies. One of the major pillars of space syntax is the assumption that the way in which space is structured shapes society (Hillier, 1996b). This has resulted in attempts to correlate specific movement patterns rather than focusing upon the relationship of space within a city. There is an extensive body of scholarship addressing the ways in which this can be considered true or not, but it is not the intent of this thesis to delve into the more intricate issues of space syntax (Leach, 1978; Montello, 2007; Netto, 2015). The primary space syntax methods were previously discussed in Chapter 2, as well as some of the major critiques of the methodology. This section introduces the specific space syntax tools that will be applied to Ostia's street network, addressing how it will be used in combination with other methods introduced later in this chapter.

5.3.1 Axial Analysis

Axial analysis can be used to study movement dynamics within a city by looking at likely circulation patterns or areas with a high movement potential. The geometric and topological construction of a street network is seen as one of the main determining factors for how movement interacts with urban space (Hillier and Iida, 2005; Hillier and Vaughan, 2007). Axial analysis is an analytic tool that can look at how a city's spatial arrangement and resulting street network promotes movement throughout the city. In particular, its application has allowed researchers to gain an understanding into likely pedestrian routes and their relationship to other social phenomena, such as commercial activity. The correlation between a city's topological organisation and movement potential has been shown using axial analysis at a number of Roman cities, including Ostia (Kaiser, 2000; Stöger, 2011b; Van Nes, 2014).

Axial analysis identifies the most accessible street segments which are interpreted as having the greatest movement potential (Hillier, 1999, p. 169). The built environment is first constructed as a combination of axial lines, corresponding to the street network, that represent the longest and least number of lines within an urban plan following a straight line (Hillier and Hanson, 1984, pp. 97–98). The axial lines are then converted to a graph, in which nodes represent streets, and the edges, or lines, are the intersection between the streets. The average distance between nodes within the graph is calculated to present an index that represents the relative integration or 'depth' of each node (Figure 5.1). The smaller the average distance, the greater a node or street's integration (Hillier *et al.*, 1993, p. 35). Ease of access to a street is therefore defined by the least number of directional changes. The resulting model presents an illustrative graph showing which streets have the highest potential of movement or most frequent use.

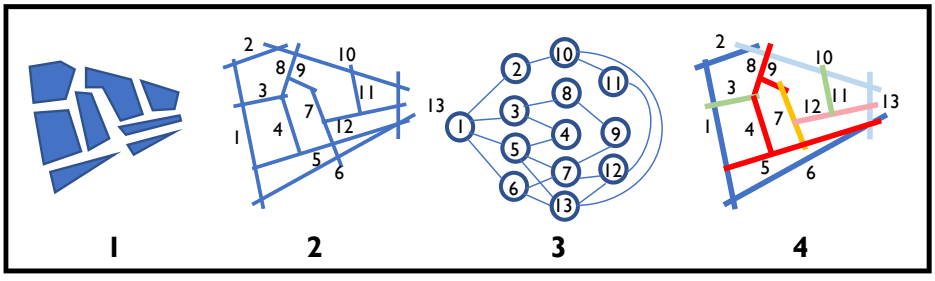

Figure 5.1 Illustration of space syntax model: 1) street system 2) axial map 3) connectivity map where nodes represent streets and links represent intersections 4) colour coded representation of connectivity transposed back onto the axial map. Red is the most integrated, blue the least integrated (after Crucitti et al. 2006a).

The axial analysis carried out within this study applies three specific measures commonly used within space syntax: integration, choice, and depth. All the calculations occur in DepthmapX, an open source software programme developed by UCL for computing space syntax calculations.[43] An axial map of Ostia was first created, following the digitization of Ostia's late 2nd century AD extended street network in ArcGIS (see Chapter 4). The graph consists of the longest and fewest straight lines that correspond to Ostia's streets. The axial lines represent the possibility of movement along a straight trajectory (Hillier, 1996b, p. 153).[44] The resulting axial graph consists of 385 axial lines, corresponding to the fewest and longest lines along Ostia's street network. This plan provides the basis for undertaking the three different space syntax measures. Each of the calculations detailed below are all displayed on a colour scale of red – blue. In each example, red equates to streets with the highest space syntax value, while blue corresponds to streets with the lowest value.

Integration

Integration is the measurement of a street's overall accessibility when compared to the total street network. Within space syntax theory, this relates to the idea of 'natural movement' which can be considered on a global (citywide) or local (neighbourhood) scale (Hillier *et al.*, 1993). On a global level, the accessibility of the total street network is accounted for by (radius n), where each street axis is calculated in relation to all other segments within the street system (Hillier and Hanson, 1984, pp. 108–109). Local integration, alternatively, is calculated by (radius 3), where only the streets that are accessible within a topological radius of 3, or by two additional streets, are considered (Figure 5.2). The results are displayed on a colour scale of red to blue, with red being the most integrated and blue the least integrated. For looking at movement within the city, this is a measure of a given street's level of accessibility, which is often correlated with its degree of use. In the figure below, the highest integrated streets are the eastern and western *decumanus* (displayed in red), which indicates that these streets saw the greatest use in comparison to all other streets at Ostia.

For the present study, integration is used to study how accessible each temple is when considered within the overall street network. While previous space syntax studies have demonstrated a correlation between processional routes and local integration (Nejad, 2013), at Ostia there is not enough differentiation between the global and local values for this to be an adequate indicator of processional routes. Rather, it can be used to show the relationship or accessibility of sacred areas to the larger movement economy at Ostia.

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[43] The open source software, DepthmapX 0.50 (2011–2015) (UCL) was used for all calculations. http://www.spacesyntax.net/software/ (accessed 15.02.2015).

[44] For a more detailed discussion of axial analysis along Ostia's extended street network, see Stöger, 2011a, pp. 213–219.

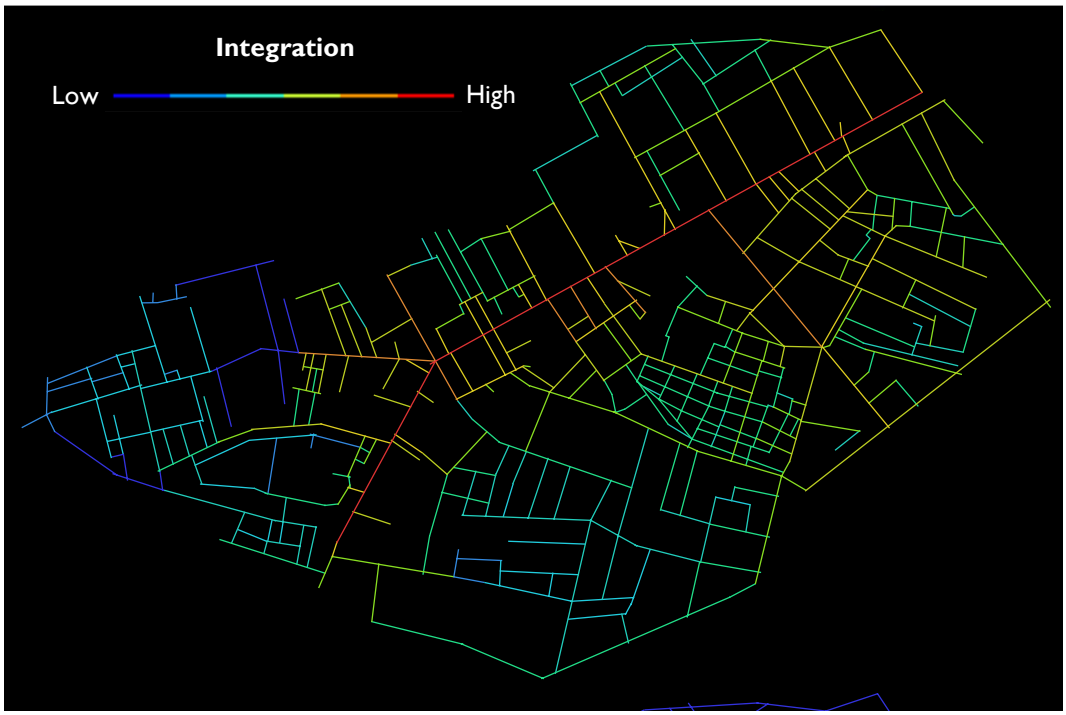

Figure 5.2 Axial map of Ostia's excavated street network showing integration (radius 3, 385 street segments).

Choice

Choice, comparable to betweenness centrality, measures how movement flowed through space. By calculating the shortest paths from all origins and destinations, it can predict movement through the street network (Turner, 2007, pp. 540–541). Several scholars focused upon urban planning have argued that choice presents one of the more accurate predictions of pedestrian movement (Turner, 2007). It is particularly useful in indicating areas or segments of the street network that are likely to be busy. The resulting graph of Ostia indicates which streets had the greatest movement potential (Figure 5.3). For the present study, choice is used as a comparative graph to indicate the likely streets to either be avoided or encountered when compared to later visualisations of possible processional routes. In particular, it can be indicative of a street's traffic congestion, which could have a direct correlation to whether or not processional movement used that street.

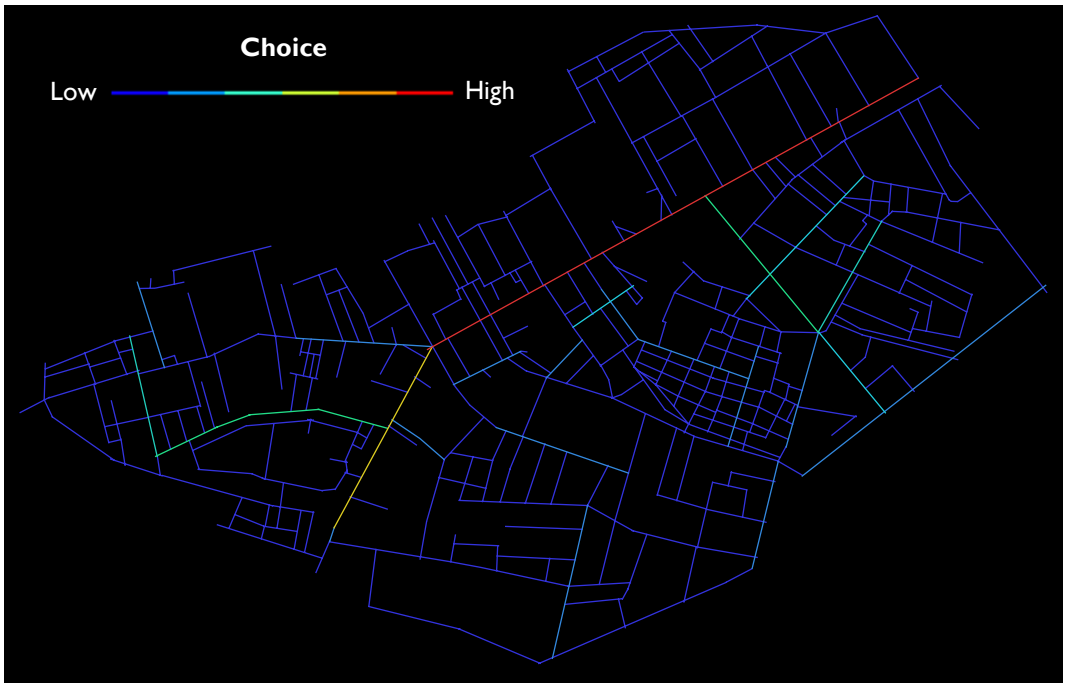

Figure 5.3 Choice of Ostia's excavated street network (radius n, 385 street segments).

Depth

Depth or step depth measures the number of streets (or number of turns) that have to be taken from a given starting point in relation to the rest of the city.[45] This provides a way of interpreting the relationship that existed between the different street segments that compose a map (Batty and Rana, 2002). Figure 5.4 shows a step depth of 0 and 2 from the eastern *decumanus.* All streets that are accessible lie within 0 and 1 streets or turns from the *decumanus.* The graph is displayed on a red – blue colour scale, with red equating to streets with the lowest depth and dark blue with the highest depth. The lower step depth a street has in relation to a specific starting point, the easier that street can be reached.

[45] Street depth has previously been calculated by Kaiser (2011) at Ostia from the city gates and the *forum*.

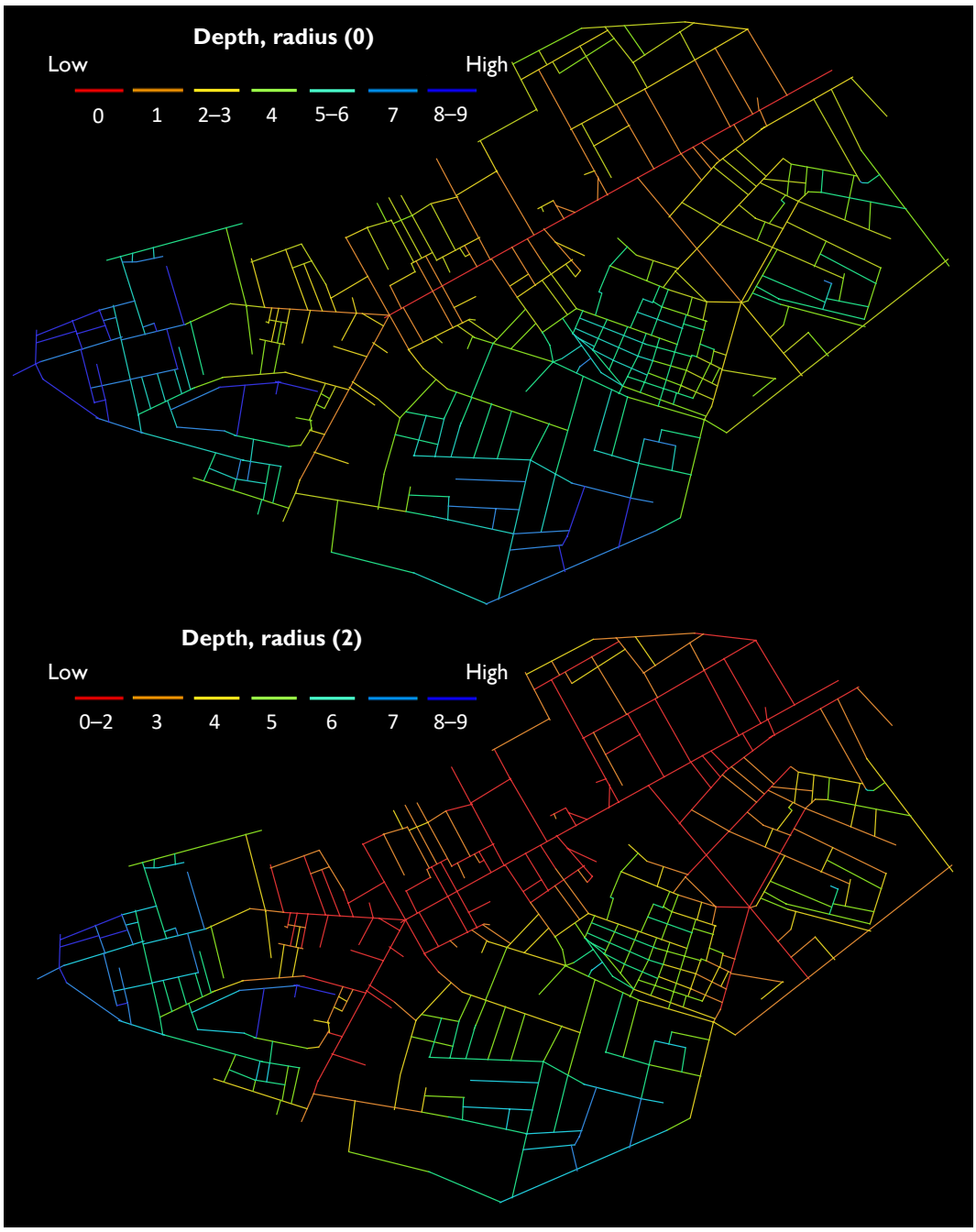

Figure 5.4 Axial graphs showing different step depths (e.g. turns) from the *decumanus* (Top: step depth – 0; Bottom: step depth – 2).

Step depth is used to determine the localised area of ritual movement relating to a specific temple. Most rituals would not have occurred on a city-wide scale, rather, they would have been confined to an area surrounding the main temple. Depth provides one way to limit the area of enquiry for each procession based upon the number of directional changes required when moving from a temple to other streets. Studies have shown that localised movement is best associated with three directional changes (Penn, 2003). In order to account for the 'edge effect' in this calculation, the periphery streets accessible by a step depth of 4 is used to limit the area of analysis for each temple.

While axial analysis can be used to study different areas of movement potential across Ostia, it still presents only a partial picture of ritual movement. Hillier argues that "the proportion of movement on each line…is determined by the structure of the urban grid itself rather than by the presence of specific attractors or magnets" (Hillier, 1996a, p. 252)**.** One of the greatest constraints of space syntax is that it cannot be calculated based upon different parameters such as avoiding certain areas, taking longer routes, or passing important ritual areas. And according to Hillier (1996a) these factors are unimportant when looking at movement along a street network. In part, as previously discussed (Chapter 2), space syntax was developed to understand space, not necessarily the movement within it. The different space syntax graphs show a general potential of movement, but this is not an exact reflection of actual movement activity undertaken by the existing urban population. By applying the various space syntax analyses in tandem with additional methods of visualising processional routes, a more rigorous analysis can be undertaken about how different streets correlated to processional routes. Axial analysis, and street depth in particular, are used as a starting point for defining the general area of ritual movement, allowing for further enquiry into processional movement.

5.4 Urban Network Analysis

Unlike many network analysis approaches, such as space syntax, that do not account for spatial distance within their model, modern urban studies have developed methods that consider cities from a topological perspective while still maintaining aspects of a city's urban geometry (Porta, Crucitti and Latora, 2006, 2008; Jiang, 2009; Sarkar, 2013). The diversity of research has shown that street systems can be modelled successfully as networks, enabling various movement based questions to be addressed (Crucitti, Latora and Porta, 2006b; Barthélemy, 2011; Sarkar, 2013). However, a growing issue within studies of urban networks is the way in which the networks are represented, in terms of nodes corresponding to intersections and edges as the connecting streets (Porta, Crucitti and Latora, 2006). Both traditional network analysis and space syntax models focus upon the topological construction of a graph, neither of which maintain the metric features of the represented system (Sevtsuk and Mekonnen, 2012). While this type of approach allows for the analysis of a large-scale system, it also presents certain challenges when applied to the ancient cityscape, such as the ways in which buildings influenced a city's street network and the activities that occurred along it. A further challenge is the integration of the analyses within a GIS platform, which often forms the basis of urban datasets.

Despite the growth of studies looking at human behaviour (SNA) within GIS, network analysis has rarely been applied to the cityscape using the same tools. While the ArcGIS Network Analyst and QGIS Network Analysis Library represent regularly used GIS toolboxes, they limit the types of calculations that can be made, consisting of variations of shortest path calculations (Karduni, Kermanshah and Derrible, 2016, p. 2). Current GIS systems are constrained by their ability to

accommodate and perform more complex network analysis calculations, such as centrality measurements. This presents a greater issue when trying to account for influences outside of a city's street network like surrounding urban activity. Many of the existing GIS platforms are ill-equipped to calculate other network analysis functions due to the challenges of integrating GIS and network analysis procedures (Andris, 2016).

Network Analysis:	**Network Analysis in GIS:**
Is created based upon a combination of nodes and edges	The GIS model is created on a planar layer
A network is constructed of edges between two points or nodes	Distance between two points is often non-linear and can include changes in elevation
Is not constrained by geography due to being a topological representation	Geographic constraints
A network is modelled in a feature of space	GIS is based in Cartesian space with a geographic datum
Distance between nodes is represented in terms of integers or 'depth'	GIS uses Euclidian distance measurements

Table 1 Comparison of the challenges of integrating network analysis within GIS (after Andris, 2016, p. 2011).

The issues indicated in Table 1 are some of the reasons why network analysis has not been fully embedded consistently within GIS. The majority of network analyses relating to archaeological contexts have been executed in the various available network analysis software programs (Pajek, Visone, UCINET, Gephi), with the resulting network map then overlaid within GIS to illustrate the geographic proportions (Isaksen, 2007). While these types of methodologies allow for the full functionality of network analysis to be applied to various datasets, it does not easily integrate with data that originates within a GIS context. At the moment, there is no straightforward and accessible approach to convert GIS-based data into a format that can be read by the various network analysis programs (Andris, 2016).

Recognising these difficulties, the current methodology applies network analysis as a method to determine what areas/buildings a procession may have passed. Due to the challenges of undertaking network analysis with data originating in GIS, a new GIS based toolbox is employed. The urban network analysis toolbox (UNA) is used with ArcGIS 10.0–10.3.[46] This toolbox allows for the calculation of the most common network centrality measurements (reach, gravity, closeness,

[46] The UNA toolbox was developed through MIT's City Form Lab, released in 2012. It can be accessed at: http://cityform.mit.edu/projects/urban-network-analysis (accessed 15.2.2018).

betweenness, straightness) directly within GIS (Sevtsuk, Mekonnen and Kalvo, 2016).[47] The incentive for using this toolbox for network analysis rather than trying to calculate the measurements within another platform more suited to network analysis is twofold. First, confining measurements within GIS negates the issue of trying to convert the relevant data into another format and computer program. Second, the UNA toolbox incorporates buildings (polygons or nodes) in addition to the street network (nodes and edges) within the centrality calculations. This is in contrast to previous methods that only compute measurements using two elements (nodes and edges) (Sevtsuk, Mekonnen and Kalvo, 2016).[48] Furthermore, buildings can be weighted based upon factors such as importance or population, adding further complexity within the centrality measurements that are lost in previous network analyses. To differentiate this method from discussions of network analysis or space syntax, it will be referred to as urban network analysis throughout this thesis and discussions of the toolbox as the UNA toolbox.

5.4.1 Betweenness Centrality

Centrality measurements are one of the primary network analysis functions available. Urban planning and other geographical studies have regularly applied centrality as a way to determine areas of high building integration and therefore greater pedestrian access (Wilson, 2000). Until recently, its application was used in terms of relational networks rather than in the context of a geographical plan (Hillier and Hanson, 1984; Crucitti, Latora and Porta, 2006a, 2006b). Centrality is based upon the idea that certain nodes within the graph are the most important within the overall network. In terms of centrality measurements, each node needs to be provided with a specific index or "weight" of importance. By looking at specific centrality measurements, the different building classifications can be compared. The most relevant calculation for assessing possible areas passed by processional movement is betweenness centrality.

Betweenness centrality is defined as the probability that a certain node will be passed when travelling the shortest distance between two nodes in a graph (Freeman, 1977).

$$Betweenness^{r}[i] = \sum_{j,k \in G-\{i\}; d[j,k] \leq r} \frac{n_{jk}[i]}{n_{jk}} \cdot W[j]$$

Betweenness centrality, $Betweenness^{r}[i]$, of a building is calculated as the distance between building $[i]$ and all other buildings within a defined search radius (r). $n_{jk}[i]$ is the shortest path

[47] UNA was also developed for Rhino 5, a 3D modelling software, which computes the same metrics as those in ArcGIS.

[48] Network analysis does have two-mode or affiliation networks, but the edges connecting the nodes can only be made to the other set. Buildings can only connect to streets, not to both buildings and streets. For more detail see, Borgatti and Everett, 1997.

from buildings *j* to *k* that pass-through building $[i]$. The value $W[j]$ represents the weight, W, of the building, $[j]$ (Brandes, 2001; Sevtsuk, Mekonnen and Kalvo, 2016, p. 14). This calculation is applied to each building within a network. The betweenness calculations assume that the trips originating from each building are proportional to the weighted importance of the building, with more important buildings having more trips compared to lesser weighted buildings.

It must be remembered that betweenness is not an indication of the ease of a route, but whether a node will be passed by or not. A node does not necessarily have to be connected to the highest number of nodes to have a greater betweenness value, but it may be located on a route that is between multiple other nodes that are connected. Assessment of betweenness is important because it provides an indication into which nodes have the greatest control within the network system (Freeman, 1977, pp. 35–36). It can account for the volume of traffic that passes through that particular node, meaning that a node with a higher betweenness value likely had a more important role within the city's total infrastructure. Often, betweenness relates to areas with a high potential for traffic bottlenecks (Isaksen, 2007, p. 67). Furthermore, it also indicates a node's potential of being passed by through-traffic, showing its probability of generating movement.

Applying betweenness measurements in relation to Ostia's building classifications presents a novel approach to looking at which buildings were most likely passed when weighted according to urban activity that may have impacted ritual movement. Recognising the existing uncertainty in any processional routes at Ostia, in addition to having no way to verify the centrality results, multiple iterations of betweenness measurements are computed. In this way, betweenness is also applied to determine the extent to which changes in building classification weights alter areas of high and low betweenness measures.

The computation of urban network analysis using the UNA toolbox requires two inputs, a street network and input buildings or nodes (Figure 5.5). First, a network dataset of Ostia's streets had to be constructed, which was done using the ArcGIS network analyst extension. Ostia's extended street network is used throughout all the urban network analysis calculations in order to limit the occurrence of an 'edge-effect' that would occur if only the excavated streets were used. Since it is uncertain the degree to which all of these streets accurately date to the late 2nd century AD, if has to be recognised that any alteration to the street network will likely have some impact upon the betweenness centrality results. Second, all of the building classifications need to be appropriately weighted to run different iterations of the betweenness calculations. These are then selected within the UNA toolbox interface, and the betweenness centrality option is selected.

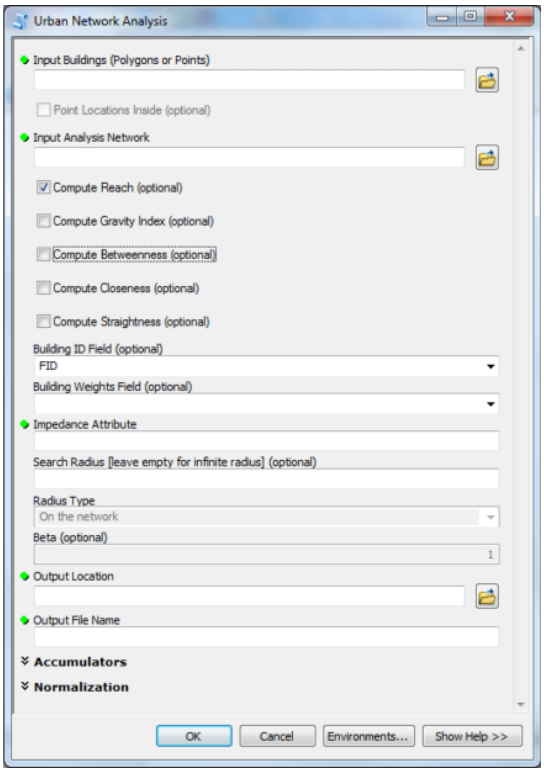

Figure 5.5 Graphic interface of the UNA toolbox showing the different variables that can be adjusted.

Radius type and search radius also need to be specified. The radius type enables the user to specify if the radius is computed using metric distance or Euclidian distance (Figure 5.6) (Sevtsuk, Mekonnen and Kalvo, 2016, p. 16). Since the present interest is in public streets and what is directly accessible or visible from the streets, a network radius is applied. In this way, the betweenness calculations reflect movement past buildings that are directly accessible from a street. If a 100 m radius is defined along a network radius, then only those buildings that are accessible within 100 m of the building of interest (building *i* in Figure 5.6), organised along the shortest path are considered. This is calculated in relation to every building within the network using this radius parameter.

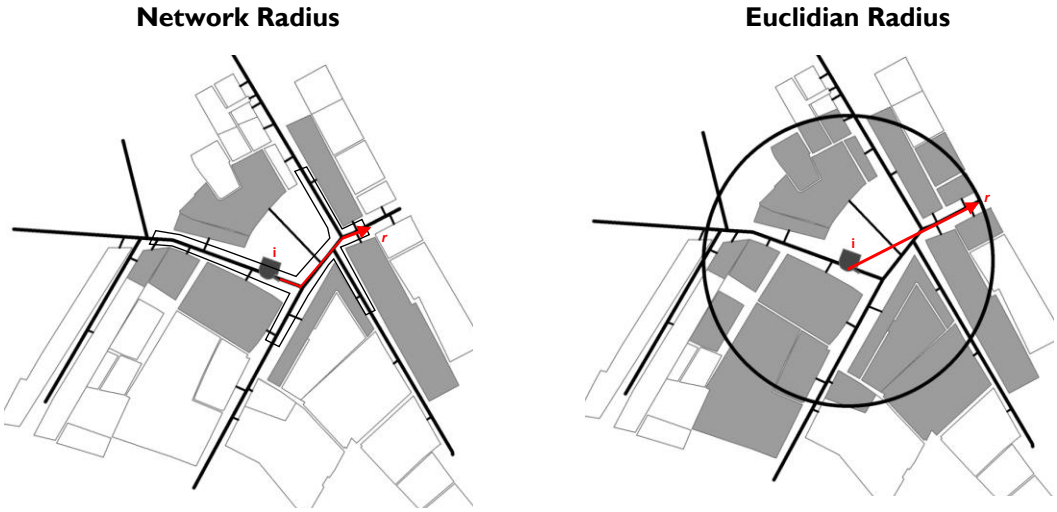

Figure 5.6 Visual representation of a network radius and Euclidian radius within a search radius.

The next parameter is search radius, which is the metric distance from each building to all other buildings within the graph structure. If left blank, then an infinite radius is used, meaning that all buildings will be accessible within the graph. The input of a metric radius limits the distance from each building to all other buildings considered within the graph. A test run of calculating betweenness centrality using different metric radii distances show a direct correlation between radius size and the resulting betweenness value. The correlation that existed between radii metric distance and the resulting betweenness value was calculated as a test in relation to 182 commercial structures at Ostia. The radius was varied along a scale of 100–800 meters. Figure 5.7 shows a positive correlation between the metric distance of the radius and the resulting betweenness values. This indicates that changing the radius value will not have an adverse or biased effect upon the resulting data. As radius is increased, a building's betweenness value rises due to the greater number of times that building can be passed due to a larger area of movement.

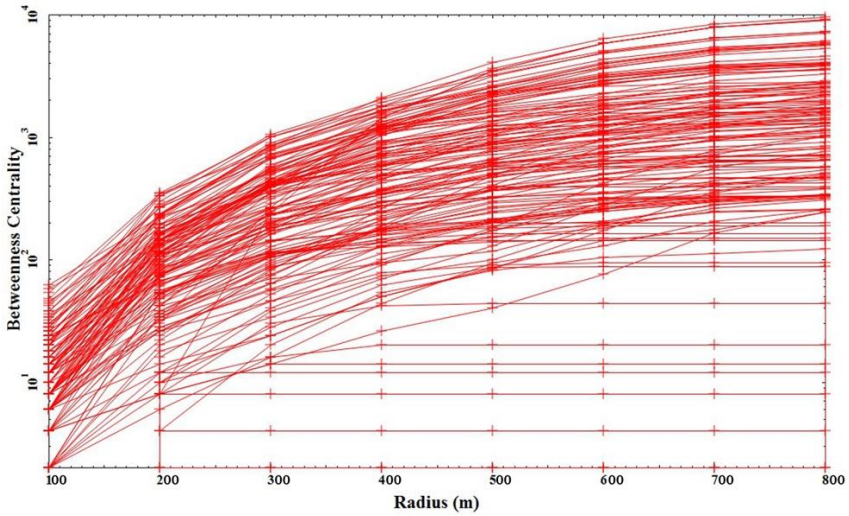

Figure 5.7 Graph showing the correlation between radii metric distance and betweenness centrality measures. Computed in relation to 182 different Ostian commercial structures.

The decision of which network radius size to apply to each case study followed the recognised correspondence of a 800 m radius as relating to vehicular movement while 400 m relates to generic pedestrian accessibility (Stöger, 2011a, p. 215). For studying smaller scale movement associated with individual processions, a 200 m radius is used to equate to more localised movement. In contrast, citywide processional rituals associated with the *forum* temples are assessed using a 400 m radius because this corresponds to pedestrian accessibility throughout the entire cityscape. This enables us to look at the streets passed by a larger citywide processional ritual.

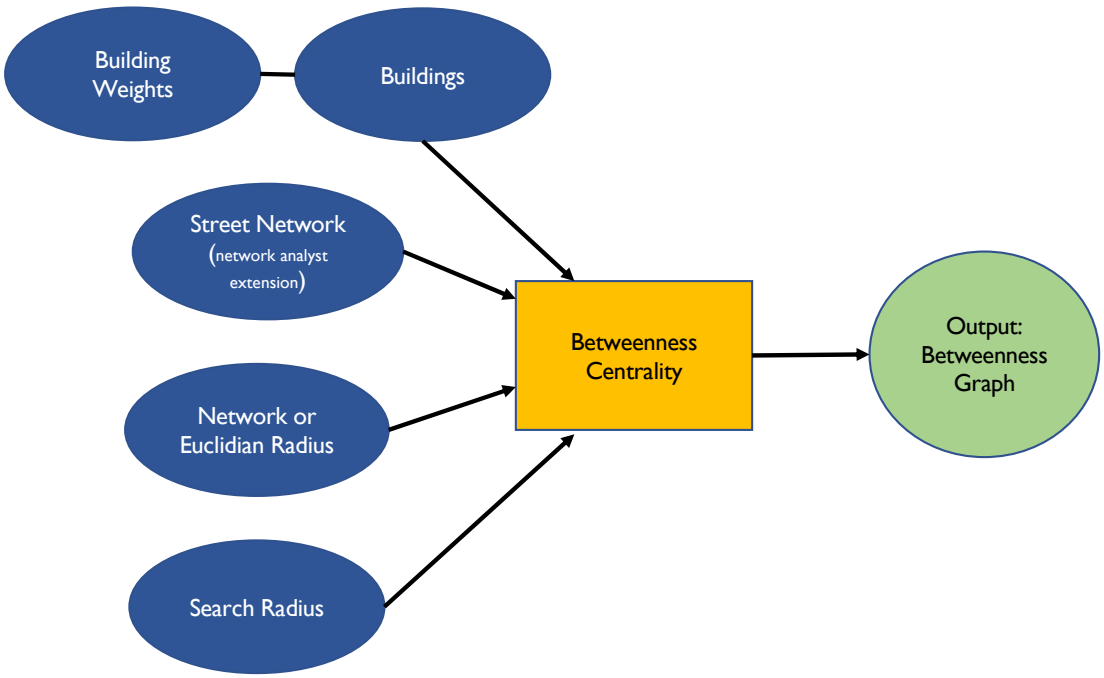

Figure 5.8 Model showing the process of calculating betweenness centrality in the UNA toolbox.

The betweenness centrality graph is computed applying all of these parameters (Figure 5.8). The resulting graph visualisation (Figure 5.9) within ArcGIS presents a map of betweenness centrality on a colour coded scale of dark green to red. The areas or buildings depicted in red have the highest betweenness centrality, indicating likely 'hotspots' of movement potential. The correlation of betweenness centrality and movement potential has already been recognised by Turner (2007). The visualisation of the different betweenness measurements provides an indication of high movement potential that directly correlates to Ostia's street network. In contrast to previous network approaches used to calculate betweenness centrality, this approach calculates the measures directly proportional to the metric street network.

To provide a more nuanced understanding of the significance of these results, the betweenness graph is subsequently presented to emphasise the streets passing the highest betweenness centrality value buildings (Figure 5.10). The streets corresponding to the buildings with the two highest betweenness centrality values are displayed in red and orange. These routes represent streets with the top 20% and 40% intensity of use as they correlate to the betweenness centrality results.

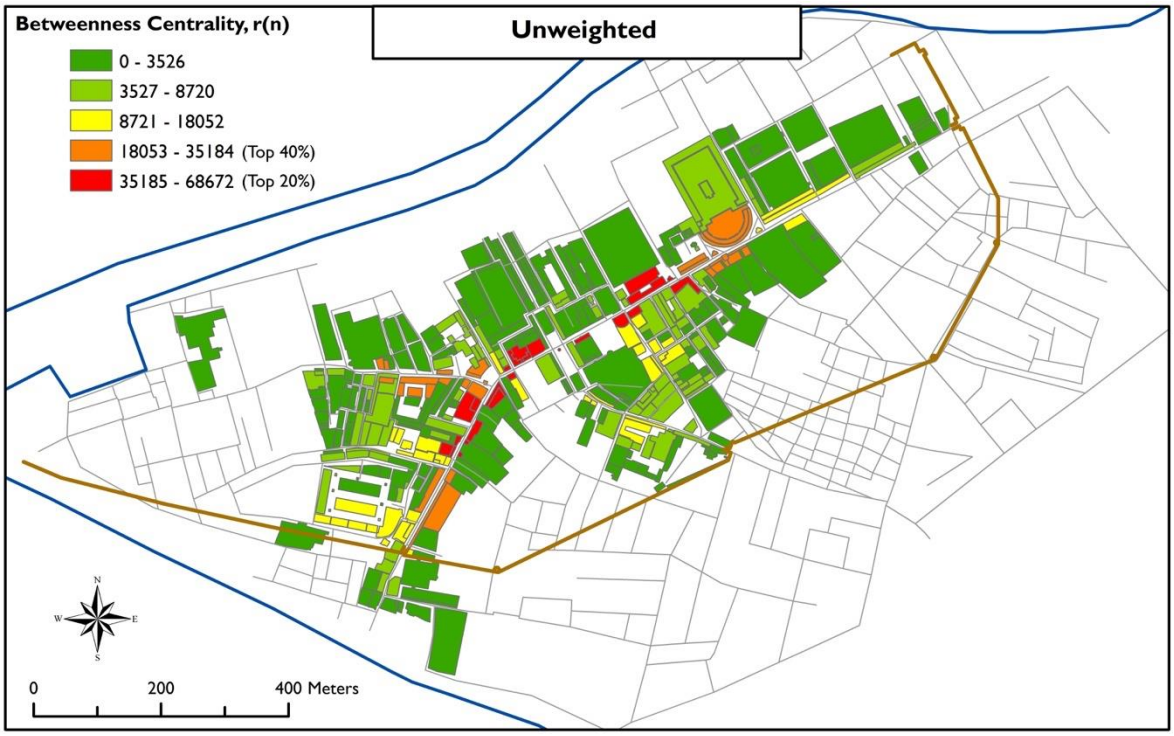

Figure 5.9 Example of a betweenness centrality graph of Ostia (radius – n) calculated in relation to the extended street network. Highest betweenness (red) equates to the greatest movement potential and the lowest betweenness (dark green) equates to the least movement potential.

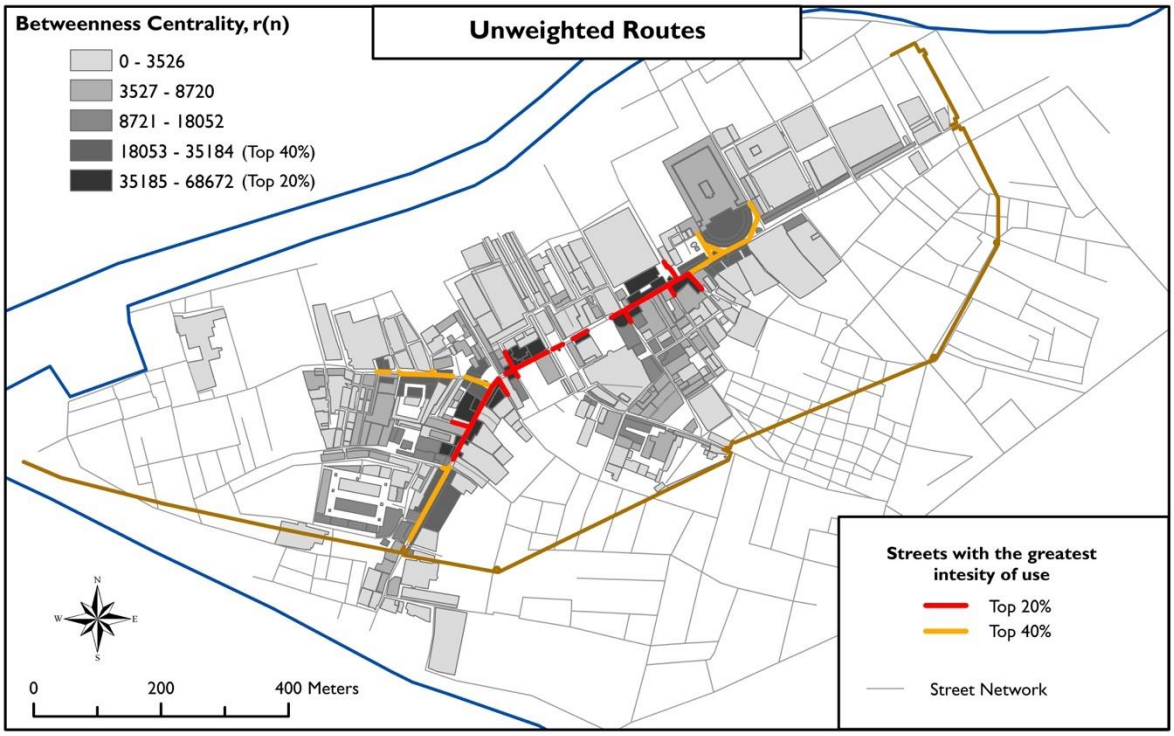

Figure 5.10 Map showing streets within Ostia with the highest potential of use when unweighted and applying radius (n). The streets following the two highest betweenness centrality metrics are designated in red and orange.

To address how the different building categories influence movement potential along Ostia's street network, betweenness centrality is run applying weighted building values. Figure 5.11 shows an example of the variation in betweenness centrality when the graph is weighted by one type of space, applying an infinite network radius. This shows that weighted buildings structure movement potential in various ways throughout the entirety of Ostia's built environment.

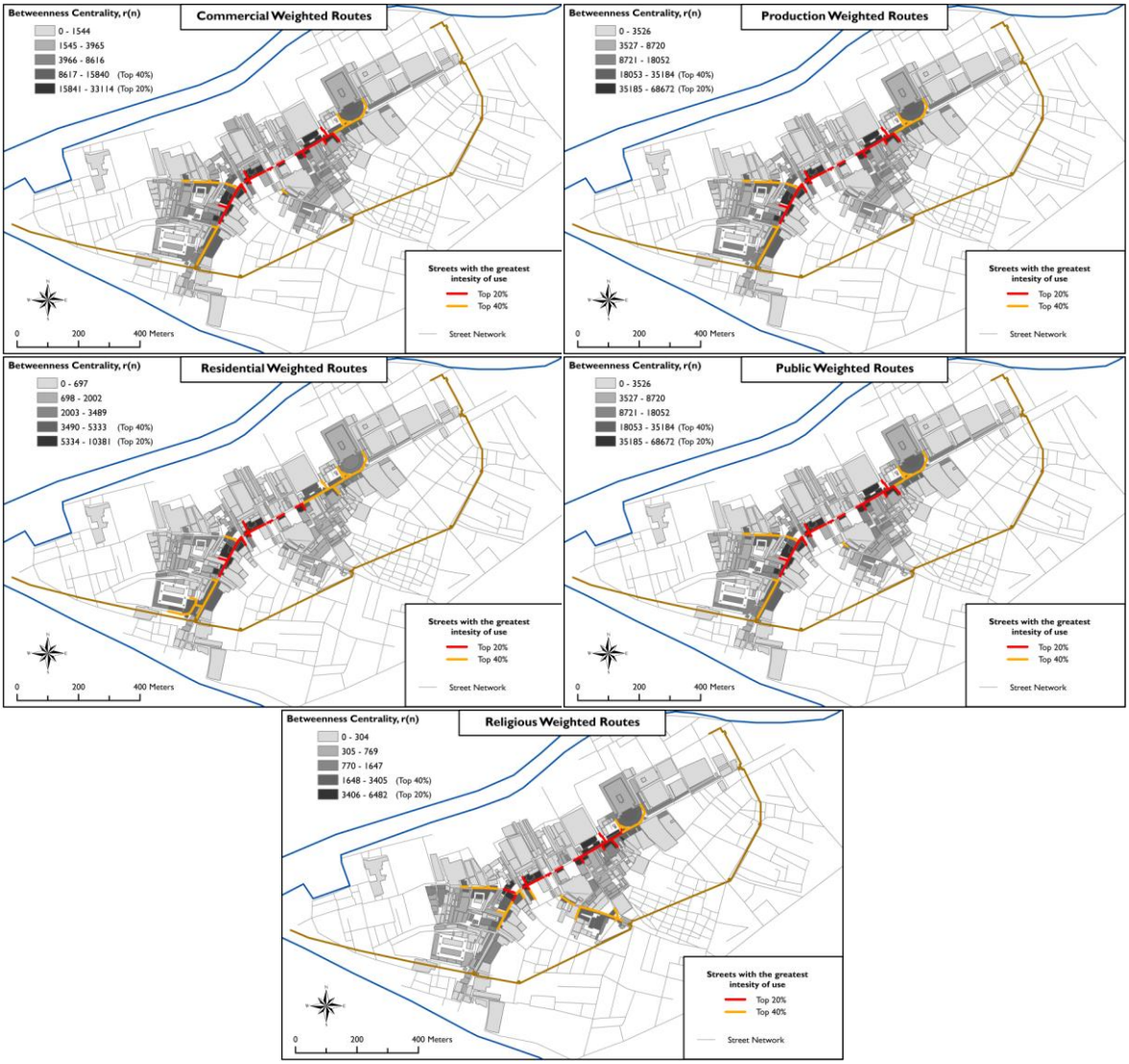

Figure 5.11 Example of betweenness centrality graphs weighted by different building classifications at Ostia (radius – n).

To address how movement potential changes when multiple building classifications are accounted for, betweenness centrality is run when buildings are weighted reflecting multiple different influence values. For this thesis, weights were assigned on a scale of 6–10 for buildings located within the defined ritual area (e.g.: commercial 10; production 6; residential 7; public 8; religious 9). The decision to use these weights rather than values on a scale of 1–5, for instance, was to create

greater clarity in the highest betweenness centrality results by differentiating the weighted buildings from buildings located outside the ritual areas of each case study. In order to determine how different weighted combinations effect possible movement routes, sensitivity analysis was run by computing all possible influence value iterations for weighting buildings, which results in 120 different betweenness centrality graphs. In order to assess the difference between these graphs, analysis focused upon the highest weighted building classification. Table 2 shows an example of all possible weighted combinations when commercial structures are weighted as the highest value. Each building classification therefore has 24 possible weighted variations. By running all possible weighted combinations, a more nuanced understanding can be obtained about how the collective urban landscape may have structured ritual movement directionality.

ID	*Commercial*	*Production*	*Residential*	*Public*	*Religious*
C_1	10	6	7	8	9
C_2	10	6	7	9	8
C_3	10	6	8	7	9
C_4	10	6	8	9	7
C_5	10	6	9	7	8
C_6	10	6	9	8	7
C_7	10	7	6	8	9
C_8	10	7	6	9	8
C_9	10	7	8	6	9
C_10	10	7	8	9	6
C_11	10	7	9	6	8
C_12	10	7	9	8	6
C_13	10	8	6	7	9
C_14	10	8	6	9	7
C_15	10	8	7	6	9
C_16	10	8	7	9	6
C_17	10	8	9	6	7
C_18	10	8	9	7	6
C_19	10	9	6	7	8
C_20	10	9	6	8	7
C_21	10	9	7	6	8
C_22	10	9	7	8	6
C_23	10	9	8	6	7
C_24	10	9	8	7	6

Table 2 Weighted value combinations for betweenness graphs weighted highest by commercial space.

The application of urban network analysis integrated within GIS deals specifically with the spatial relationship of Ostia's buildings in relation to the street network, addressing how this spatial structure helped to shaped movement potential. In particular, this method looks at the interaction between building functionality and the street network to address the possible correlation that existed between the two. However, it provides an incomplete picture into the dynamic relationship that would have in fact existed between processional activity and its movement along streets.

5.5 Agent-Based Model

The use of agent-based modelling can address the patterns of interaction that are constructed by processional movement. By applying the same framework parameters used in urban network analysis to the agent-based model, it is possible to study the different assumptions and parameters used to construct a model of Ostia's ritual movement patterns. In particular, it can enable a more nuanced study into the dynamics that existed between processional movement and the built environment. It also provides a way of assessing the assumptions applied to the construction of the space syntax and urban network analysis models.

Agent-based modelling presents a way to study human interactions within an urban landscape. In relation to movement, spatial interactions can be studied within a specific built environment that is constructed from the ground-up, using assumptions and criteria to examine different influences upon movement patterns within an urban context. These types of models consist of agents that are capable of different cognitive abilities or accomplishing designated goals (Haklay *et al.*, 2001; Kurose, Borgers and Timmermans, 2001). While these models follow rules previously defined by the user, they are helpful in understanding how behaviours arise from individual decisions. In terms of movement, agents are the people who are acting within the created environment, encoded to behave in real time using set parameters. The study of the output results of an agent-based model can then be compared to the archaeological record to determine similarities or differences, as well as data specific problematics (Costopoulos, Lake and Gupta, 2010, p. 2). Agent-based models present a valuable tool for questioning and critiquing theories developed about topics such as pedestrian movement. While the space syntax software, DepthMap, implements a version of agent-based modelling, in its case, the only movement determinant is the environment's spatial arrangement. Other cognitive properties cannot be implemented within the platform, which is one of the underlying issues of applying space syntax methodologies.

Agent-based modelling is used to evaluate the theoretical framework applied throughout this thesis as well as to assess its value as an alternative method for the visualisation of processional movement. It additionally integrates another factor in what impacted the directionality and movement of processions, namely urban street dynamics. This enables a way of attempting to account for how the people who populated Ostia's streets may have affected processional movement. This transitions processional studies away from looking at streets as an environment devoid of other interactions to considering how these interactions collectively affect ritual movement. This method does not aim to recreate processional routes, since as stated previously, it is impossible to accurately reconstruct all urban and social variables that went into the construction of a particular procession. Instead, it aims to reassess the processional influences applied throughout this thesis. It likewise presents results that can be compared to the urban network analysis outcomes.

The agent-based model explained below uses the cityscape and building classifications developed within ArcGIS. The model is used to investigate the possible processional routes taken through the cityscape that originate and conclude at a specific temple. The present model is a very simplified version of Ostia with the focus upon the relationship between the agents (e.g. processional participants) and the surrounding architecture. I do not take into account other factors on processional movement, such as the time of year or the presence of concurrent festivals. This final portion of my methodology is one of the first applications of an agent-based model to study processional movement in a city outside of Rome, and, as far as I'm aware, the first model to be created for Ostia.

This model examines three different factors relating to processional movement at Ostia:

1) The effect of buildings with different importance weights on processional movement.

2) The impact of urban street dynamics as represented through the relationship between the number of processional participants, external observers, and the possible routes.

3) How 'time' affects a procession's route.

The first aspect of this model serves as a comparative approach to the urban network analysis and space syntax approaches. The second and third factors enable more nuanced and detailed understanding of processional movement. What affected and shaped processional movement throughout Ostia is addressed by looking at specific urban variables. Agent-based modelling is used as a way to visualise possible processional patterns based upon varying criteria. Due to the adaptability of the model and its ability to encompass a range of different real-world influences, this is another method that can readily be applied to questioning how processions moved throughout Ostia's cityscape.

The agent-based model looks at several parameters directly related to influences on pedestrian movement and processional routes. By reducing the current examination to several key features, the model examines how changing these parameters influences possible movement routes. This simple agent-based model presents a first step towards attempting to model and visualise possible processional routes. While space syntax and urban network analysis can provide insight into certain street segments likely passed by processional movement, agent-based modelling allows for full route simulations by applying multiple different types of criteria.

5.5.1 ABM Methods

The agent-based model (ABM) was created in NetLogo, as it has a relatively simple platform that caters to users unfamiliar with coding or with limited coding experience (Wilensky, 1999).[49] Although NetLogo has its own dedicated language, it is substantially easier and less time intensive to learn versus attempting to create a model in an advanced coding language like Python or C++. While NetLogo is not adequate for extremely complex models (Banos, Lang and Marilleau, 2015, p. 20), this was not an issue for the questions being addressed throughout this thesis, for which it is more than sufficient. Furthermore, it allows for the integration of GIS data which simplifies the transfer of data.

The framework for the model is Ostia's urban landscape and architectural classifications. The model is run in machine-time, where time correlates to one step taken by an agent. The model is run for a certain number of steps, simulating a set time-frame. While there are ways to try and accurately model time, it makes the coding progress increasingly more complex without contributing significantly to the final result outcomes. One type of output is generated, the possible routes for a procession with a specified beginning and end point.

The purpose of this model is to serve as another method of visualisation for possible ritual movement patterns at Ostia. Since where processions went within Ostia's urban landscape is unknown, this presents an exploratory method to see how different parameters affected a hypothetical processional route. It additionally enables assessment of the validity of the present theoretical framework by evaluating the extent to which building influence values affect movement routes.

5.5.2 The Model

The following section describes the different components included within the agent-based model. Three specific questions are asked and addressed by the model: 1) how can processional routes be modelled if urban activity, structured by architectural buildings, is a major contributing factor to where routes went within the landscape; 2) how can processional movement be modelled for individual processions associated with specific temples and cults; and 3) how does urban activity and urban form affect the mechanics of processional movement. By reducing the model to a few key parameters, the ways in which Ostia's urban environment and inhabitants affected and shaped processional movement can be addressed. These questions are examined in the below model (Figure 5.12) and analysed in the following chapters in relation to three different temple case studies.

[49] NetLogo is an open source agent-based modelling environment. It can be downloaded for free from: https://ccl.northwestern.edu/netlogo/ (accessed 15.02.2018).

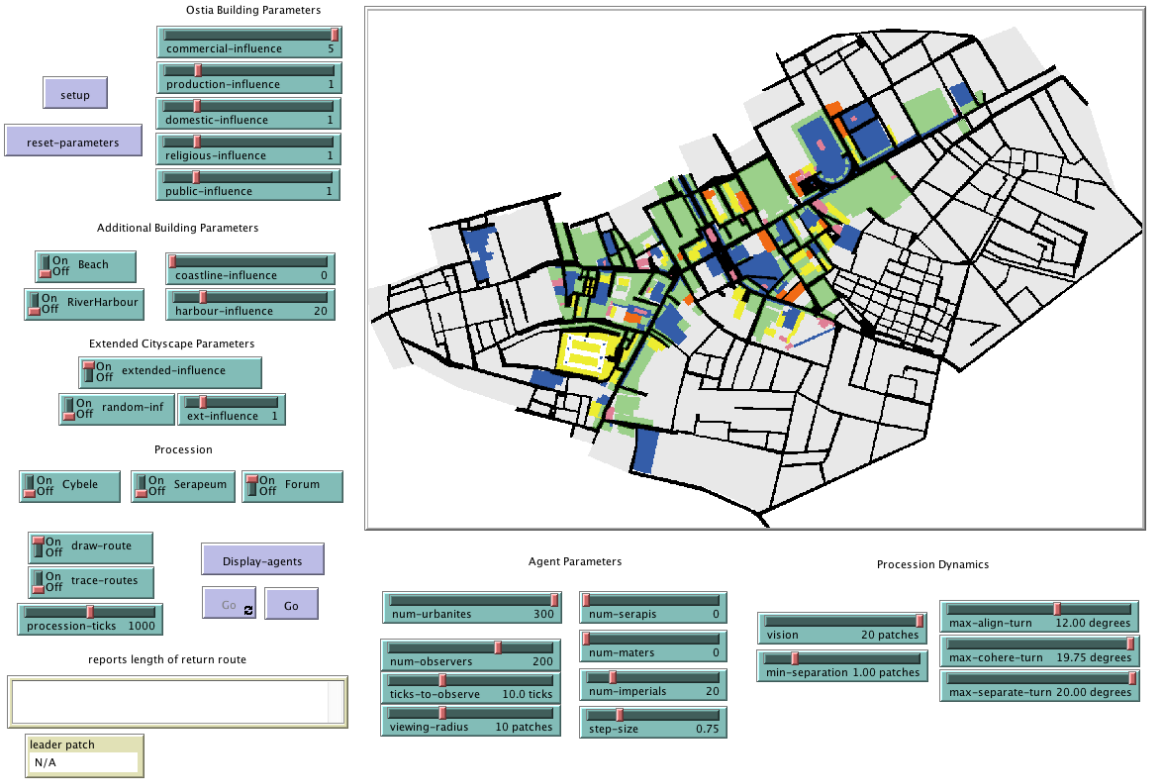

Figure 5.12 View of the model's interface in NetLogo.

The landscape

The landscape is 700-cells by 400-cells, which creates 280,000 cells for the simulation window. Each patch is equivalent to approximately 1 meter. Following the previous GIS model, the landscape is constructed of seven different landscape components (Figure 5.12): Ostia's un-excavated cityscape (grey), commercial spaces (green), production spaces (orange), religious spaces (pink), public spaces (blue), ground floor residential spaces (yellow), and streets (black). Movement, which is influenced by the different building patches, can only occur along the street patches. This ensures that the agents do not enter into any of the buildings.

The impact or influence value of the five building classifications (commercial, production, residential, religious, public) can each be set on a scale of 0–5, representing a building's influence on passing processional movement. The decision to limit the landscape to these six components is to first, make it comparable to the urban network analysis results and second, to examine a single type of process that affects processional movement. Furthermore, since this is the first agent-based model created for Ostia, it was made with the aim of being able to add further complexity in the future as the focus of research changes.

The agents

There are two groups of agents in the model: processional participants and city-dwellers. The processional participants are the 'leaders' and 'processionals' which are each associated with the three temple case studies. The setup procedure of the model ensures that the processional participants only participate in their own designated procession. The modelling of processional participants follows a flocking formation (Reynolds, 1987; Wilensky, 1998), which ensures that the processional participants move in a group, following a single agent that is designated as the procession leader. In this way, the agents follow a common task without going in adverse directions to each other or moving in a single file line. This serves as an preliminary attempt to more accurately simulate group directed movement.

The city-dwellers consist of 'observers' and 'urbanites'. City-dwellers have no directional correlation, but serve to simulate random urban activity that may affect the ease of movement and directionality of the processional participants. They have specific tasks to achieve, but there are no limits placed upon their directionality beyond remaining within the confines of the street network. The observer agents are interested in watching the procession, but they are not directly associated with the ritual. If they are within a pre-determined viewing distance of a procession, they will stop and watch the procession for a certain length of time. The 'urbanites', on the other hand, are agents that populate and move about the city but do not have direct ties to the procession. 'Urbanites' may unintentionally interact with a procession, but their main intention is to move along the city's street network.

The number of agents of both the processional participants and city-dwellers can be adjusted at the beginning of the model. A procession can have 0–50 participants, while observers and urbanites can each be set on a scale of 0–300. The ability to change how many agents are involved within the model can help to address issues of movement and density. One factor that is not account for are changes in walking speed between either the processional participants or city-dwellers.

Running the Model

Prior to running the model, all environment parameters have to be set. The individual building influences have to be fixed on a scale of 0–5 for each building classification. A single building type can be selected or all five. If a single building is selected, then all other building influence settings need to be moved to 0, otherwise they will still be applied within the model. Once the setup procedure is run, the building influence values cannot be altered without setting up the entire model environment again. To initialise the model once the initial parameters are set is achieved by using the 'setup' button and then the 'reset-parameters' button. This resets the model and prepares it for the run. Once the model has loaded, the specific procession, the number of agents, and the length of the procession has to be set.

The specific procession under consideration, (Cybele, Serapeum, Forum), is determined by selecting the appropriate switch and moving it to the "on" position. The other two processions not under consideration need to be set to the "off" position. While the study of how multiple processions interact simultaneously within Ostia's urban landscape would be an interesting direction of research, currently only one procession can be successfully run at a time. To have a route drawn following the processional leader, the switch 'draw-route' needs to be switched "on", otherwise the procession will move but the route will not be recorded. If recording the route of the individual processional participants, the switch 'trace-route' needs to be switched "on", which will result in a line being traced for each individual participant.

The length of time that the processional participants can travel also needs to be set prior to displaying the model's agents. Time is recognised as an important component of processional rituals (Favro, 2008, pp. 25–26). Within NetLogo, time is run in machine-time, which corresponds to ticks that represent a single simulation step or an entire run of the model where every agent has taken one step (Mayrhofer, 2015, p. 568). The present model equates time with a certain number of steps. Using the slider on the interface, the procession length can be set as 0–2000 ticks. Once the maximum number of ticks are reached, then the procession must follow the shortest route back to its starting temple location. While this is not a perfect solution to simulating real-world time of a procession, it does enable us to assess how routes and areas of movement change depending upon the length of "time" that the processional agents are allowed to process prior to returning to their start point.

The number of 'urbanities' and 'observers' have to each be set of a scale of 0–300. For the 'observers', the distance from which each agent will stop and watch a procession is determined using the slider 'viewing-radius.' If an observer agent is within the specified radius of a procession, then they will stop moving and "watch" the procession. The time spent watching a processions at this distance is set according to the slider 'ticks-to-observe,' at which point they will stay in one spot for a specified number of ticks before moving again or until the procession is out of range.

The number of agents additionally needs to be specified before being able to run the model. These values are adjusted using the sliders on the model's interface. Once the number of agents and procession-ticks are set, the agents are displayed within the model environment by selecting the 'display-agents' button. Once they have been placed within Ostia's street network, the 'go' button begins the simulation where each tick represents one step of the agents. The model will run for as long as the length selected for the procession.

Procession Procedures

In every time-step of the model, the processional agents determine their target to move towards, assess if the pathway is clear, move one step towards the target, and determine their next

movement direction. The observers and urbanites likewise select a random goal and move one step towards that goal (Figure 5.13).

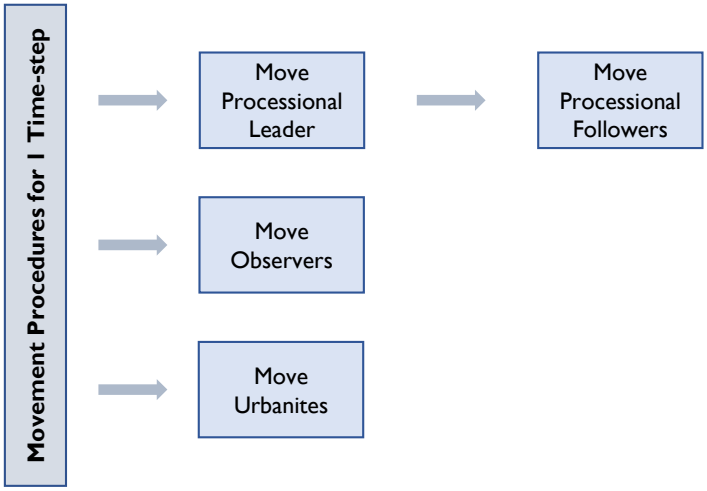

Figure 5.13 Diagram showing ABM model procedures for 1 time-step

The runtime processional procedure begins with the processional leader determining the closest highest influence target (building classification). The agent moves following an algorithm that first makes the agent face towards the target and then move towards the target following the most efficient and shortest route. The lead agent is only able to move if the patch is bordering a building that is next to a street and if there are no other agents in the way. Additionally, the lead agent is not allowed to travel along street patches that have been visited previously, this ensures that the agent does not move in circles or go backwards. Once the first target is reached, the next target is set following the same procedure, but discounting the previous patches passed to ensure that the lead processional agent continues to move forward. This procedure is replicated for a pre-defined number of steps, at which point the procession is told to return home (to the originating temple) (Figure 5.14).

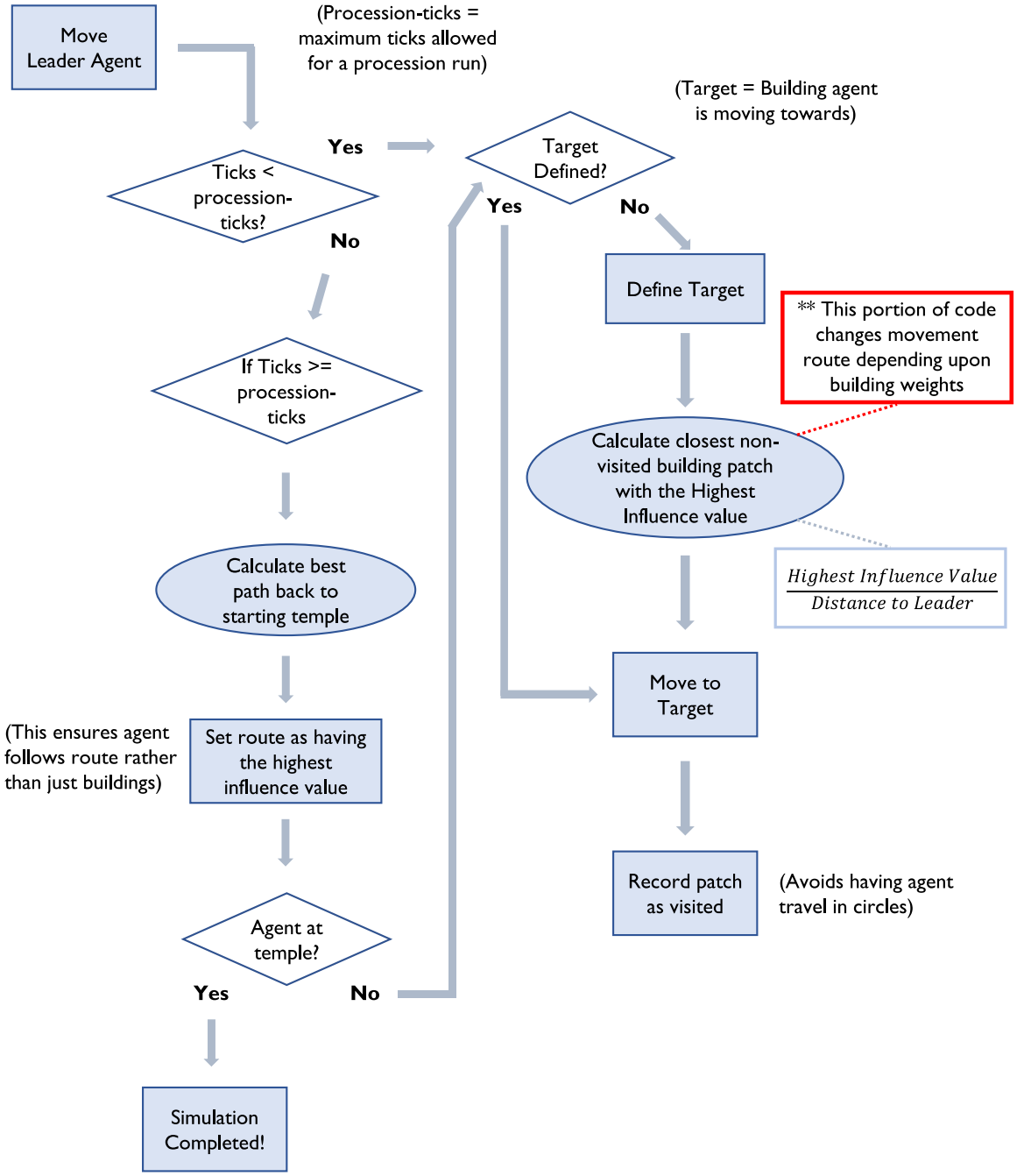

Figure 5.14 Diagram showing the movement code procedures for the Leader Agent

If processional participants are included, they follow in a less organised manner. The processional participants are coded to follow a flocking formation (Reynolds, 1987; Wilensky, 1998), which means they have to move in relation to their neighbours and in the general direction of the procession leader (Figure 5.15; Figure 5.16). The flocking procedure is called by each processional agent identifying if there are any other nearby processional agents. If there are, then there are three main parameters (separation, alignment, cohesion) that determine how far apart each agent can be from the other processionals as well as how they move in relation to each other. In addition to following a flocking movement procedure, all processional agents are then required to move in the

general direction of the processional leader. Like the lead processional agent, they can only travel along the streets and cannot occupy a patch with more that 4 other agents. In order to attempt to correlate the city's metric size to that of the model, this equates to allowing 2–3 people to occupy a square meter of space, which is realistic for looking at crowd density of a moving group. The path that is taken by the procession is recorded by having the processional agents use a pen-down function which draws a line corresponding to their movement. Once the processional run is concluded, the interface image showing the path can be exported. At this point, if the model needs to be run applying the same building parameters, the agents and route can be reset by the 'reset-parameters' and 'display-agents' buttons. This resets the patch values and the agents, as well as removing the drawn route without re-loading the entire environment.

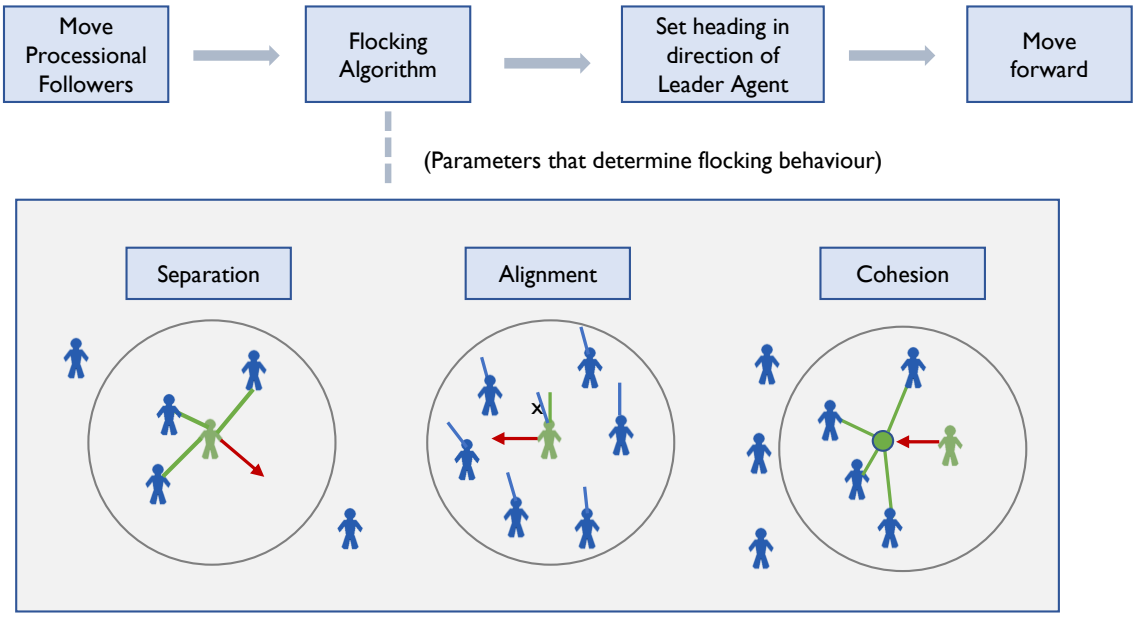

Figure 5.15 Diagram showing the movement code procedures for the Processional Followers

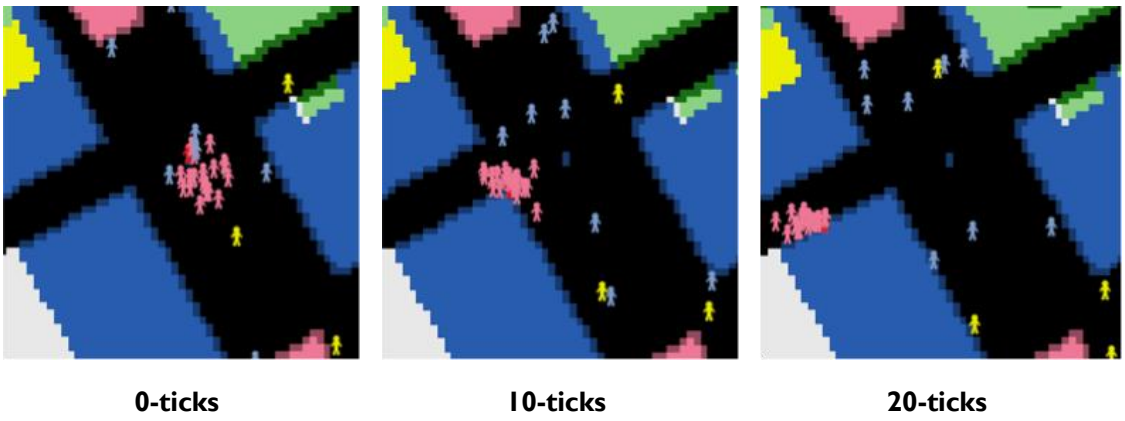

Figure 5.16 Example of the 'processionals' group flocking movement over a period of 20-ticks.
Agents: 'Processionals' – pink; 'Leader' – red; 'Urbanites' – yellow; 'Observers' – blue.

Observer agents are confined to the street network and move randomly. If there are any processionals within a designated viewing radius then an observer will stop for a set amount of time to "watch" the procession. Once the processionals are out of viewing range, observers will continue moving along the streets. Urbanites are likewise confined to the street network. Their only goal is to move along the streets and avoid running into any other agents (Figure 5.17).

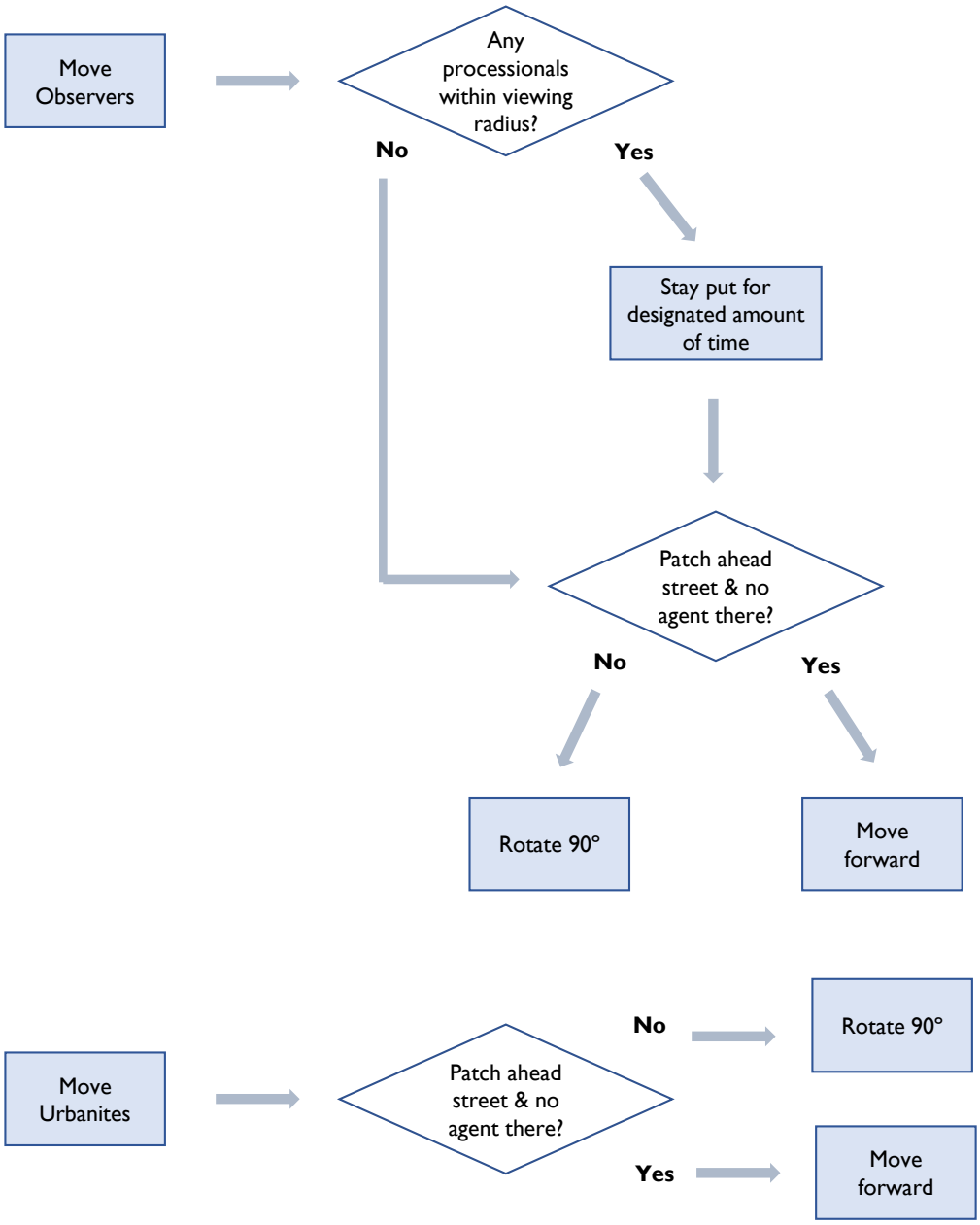

Figure 5.17 Diagram showing the movement code procedures for the Observers and Urbanites

5.5.3 Procession Experiments

Two sets of experiments are run for each individual building classification in relation to each of the three case studies. The experiments are designed to test how different building influence values and procession time affects possible routes as well as the incorporation of group movement dynamics. Therefore, the different agent parameters were provided default values that remained constant throughout all the runs for each of the two experiments (Table 3).

ABM Parameters	Experiment 1	Experiment 2
Procession-ticks	1000-ticks	300-ticks
Urbanites	300 agents	300 agents
Observers	200 agents	200 agents
Observers: ticks-to-observe	10-ticks	10-ticks
Observers: viewing-radius	10 patches	10 patches
Group Processional Variables:		
vision	-	20 patches
min-separation	-	1 patch
max-align-turn	-	12 degrees
max-cohere-turn	-	20 degrees
max-separate-turn	-	20 degrees
Simulation Runs	10	5

Table 3 ABM parameters of the 2 experiments.

The first experiment maps the route taken by the processional leader when each building classification is independently weighted with an influence value of 5, while the remaining buildings are provided a value of 1. The experiment is run for 1000-ticks, at which point the processional leader than finds the best route back to the originating temple. The result of the run (Figure 5.18) is recorded within the interface with a drawn path following the processional leader's route. Each weighted combination is run a total of 10 times using the same parameters. The results are then compiled to show the similarity in streets chosen for the procession (Figure 5.19).

Figure 5.18 Export of a single ABM run of a *forum* procession by a processional leader (route shown by red dotted line). Commercial spaces are weighted with an influence value of 5, while all other buildings are weighted with an influence value of 1. Procession time, 1000-ticks.

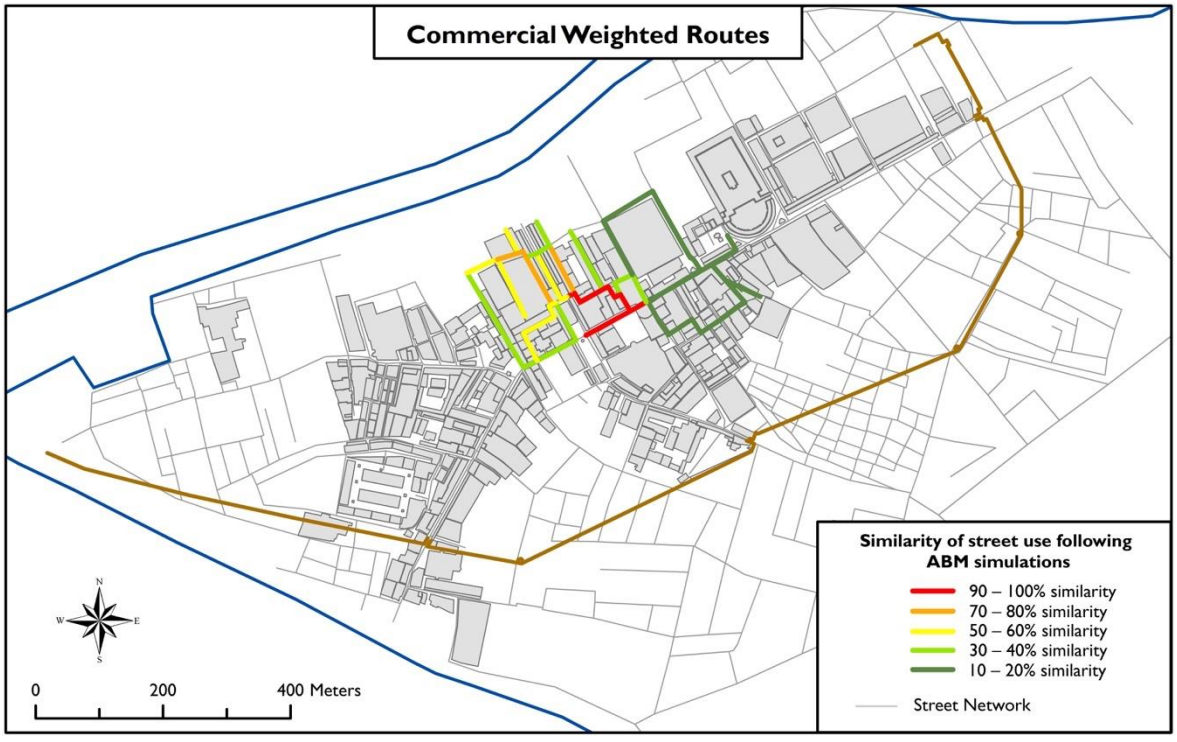

Figure 5.19 Map showing the similarity of the *forum* processional routes by each of the 10 runs where commercial spaces are weighted with an influence value of 5.

The second experiment that is run for each case study is in relation to the processional participants. This experiment aims to look at the effect on processional routes when 20 processional participants are included. The aim of this experiment is to test if a group of processional participants follows the same trajectory as the processional leader. Due to the complexity of modelling group movement, this is tested using a shortened run of 300-ticks. Each run is set up following the same influence parameters as in the first experiment, where 20 processional participants follow the processional leader for 300-ticks, at which point they return back to the starting point of the procession (Figure 5.20). Each weighted combination is run 5 times, where the results are then compiled to show the similarity in route choice by the processional participants (Figure 5.21).

Figure 5.20 Export of a single ABM run of a *forum* procession by 20 processional participants (route shown by green dotted line). Commercial spaces are weighted with an influence value of 5, while all other buildings are weighted with an influence value of 1. Procession time, 300-ticks.

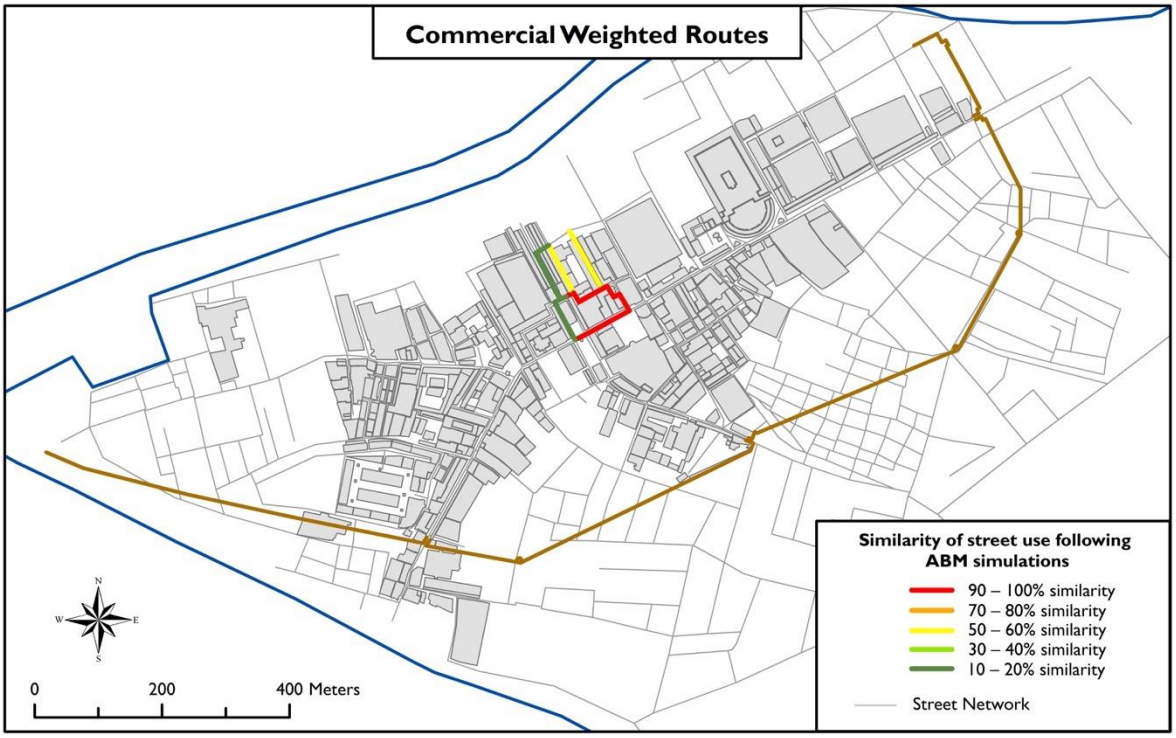

Figure 5.21 Map showing the similarity of routes by each of the 5 runs by the processional participants where commercial spaces are weighted with an influence value of 5.

The number of simulations run for each experiment needs to be more fully addressed. An important issue in agent-based modelling concerns the number of times a model should be run for each parameter change to ensure that the results are reflective of the different potential outcomes. (Ritter *et al*., 2011). For the present study this means ensuring that a sufficient number of simulations are run for each different building influence value to accurately reflect any variation in processional routes. Figure 5.22 shows the deviation in possible routes over 40 separate simulations for a procession lasting 1000-ticks that begins and ends at the *forum.* Over 50% of the street segments show consistent use between all of the runs. The same relative variation in street passage is reflected in simulations run only 10 times. Due to the length of time each simulation takes, it was deemed sufficient to undertake 10 simulation runs for each different parameter. In the simulations that include the processional followers, this was reduced to 5 simulations due to the shorter processional run (300-ticks), which greatly reduced the variation in movement along different streets. While a greater number of simulations would be ideal, there is not sufficient variation in potential routes to discount the fewer number of runs undertaken for each building influence value parameter change.

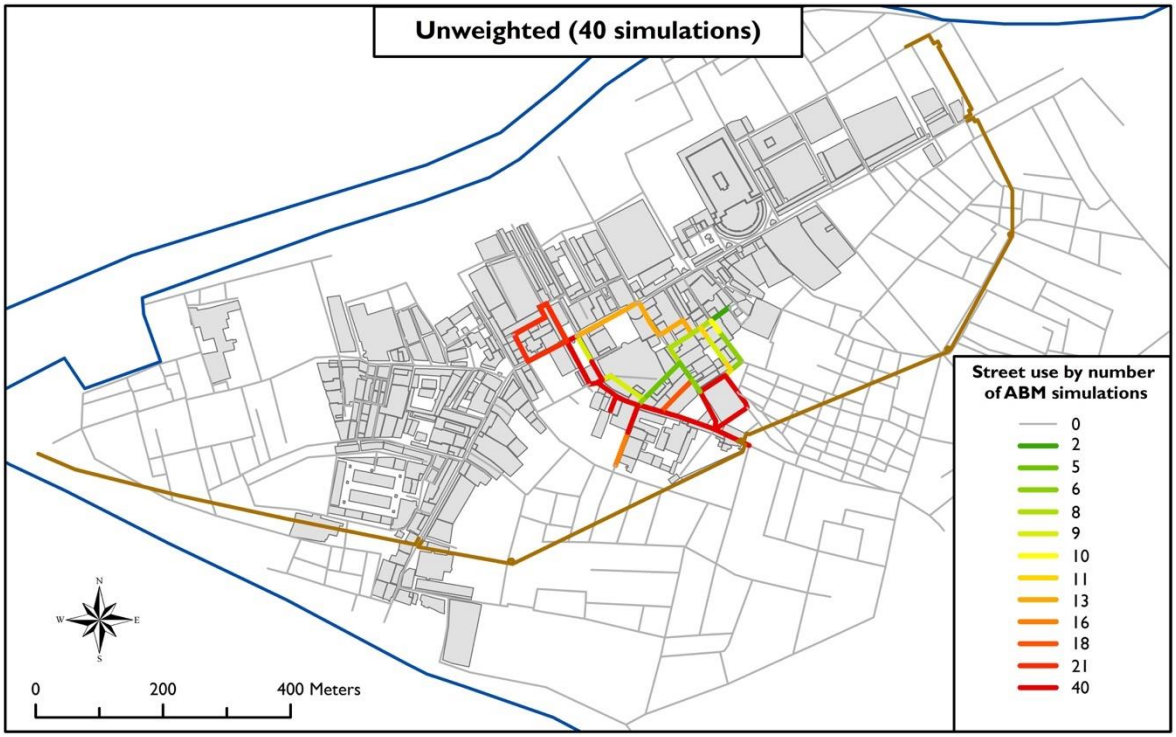

Figure 5.22 Sensitivity testing to determine number of simulation runs required. This model shows the compilation of 40 different simulations run within an unweighted environment. The sample procession begins and ends at the *forum* and lasts for a duration of 1000-ticks.

Several variables remained constant throughout each of the ABM experiments. These included the number of city-dwellers, the number of ticks each procession lasted, and the processional participant parameters. The remainder of this section addresses the values that were used as constants throughout all of the experiments for the number of urban agents and the length of the procession.

The number of people occupying Ostia's streets is the first variable that can be adjusted. For the current study, this was fixed for each run at a total of 500 people (300 urbanities and 200 observers) simultaneously occupying the street network. In all likelihood, this number would have been more varied. By the 2nd century AD, Ostia hosted an estimated population ranging from 10,000–50,000, which does not account for daily visitors (Calza, 1953; Meiggs, 1973). The percentage of these that would have occupied the street likely exceed that applied in the model. However, the intent was not to accurately simulate all forms of urban street activity, but to see if/how two different sets of urban agents (observers and urbanites) had any influence upon processional movement patterns.

The time provided to each processional run is another variable that has an important effect upon ritual area constructed surrounding each temple case study. Only one 'time' duration was used, lasting 1000-ticks. Selecting one time variable enables comparison between the different case studies.

The distances travelled by the modelled processions are set according to the number of steps the procession can take during a single run. To address the likely distance travelled by a procession, well-known processional routes can be used as a comparison to determine the general metric distance covered by a procession. To asses this, I use two comparisons, the triumphal route at Rome and the Salutaris procession from Ephesos. While there is considerable uncertainty in both of these routes, they provide a basis for looking at the distances covered by two large scale urban processions. The procession of Artemis travelled roughly 6000 meters, beginning and ending at the extra-mural temple of Artemis (Figure 5.23). The Roman triumph in contrast, consisted of an approximately 4000-meter route (Figure 5.24).

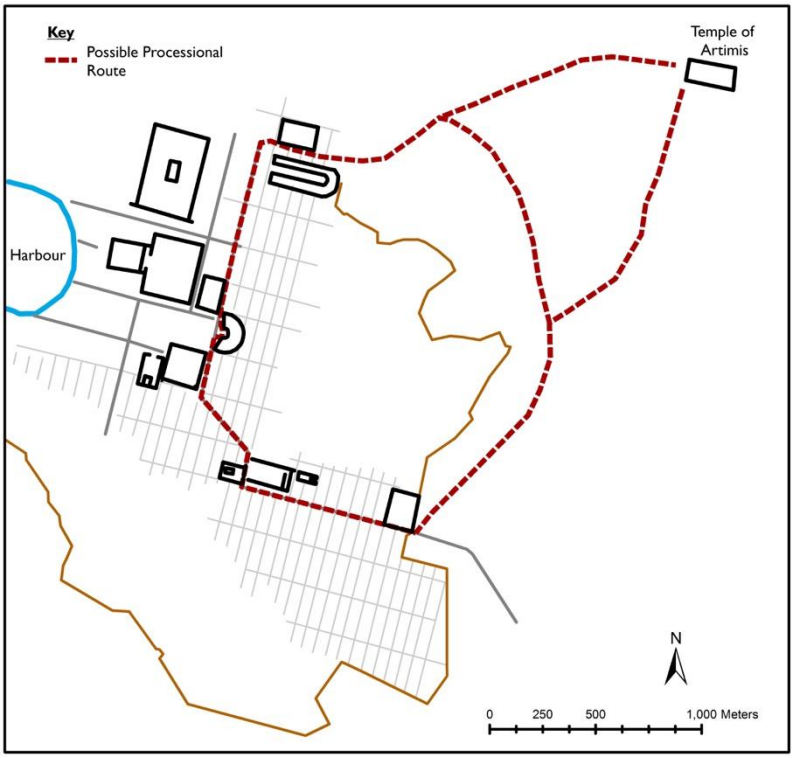

Figure 5.23 Plan of 2nd century AD Ephesos showing the Atermisian processional route (after DeLaine, 2008, fig. 6.2).

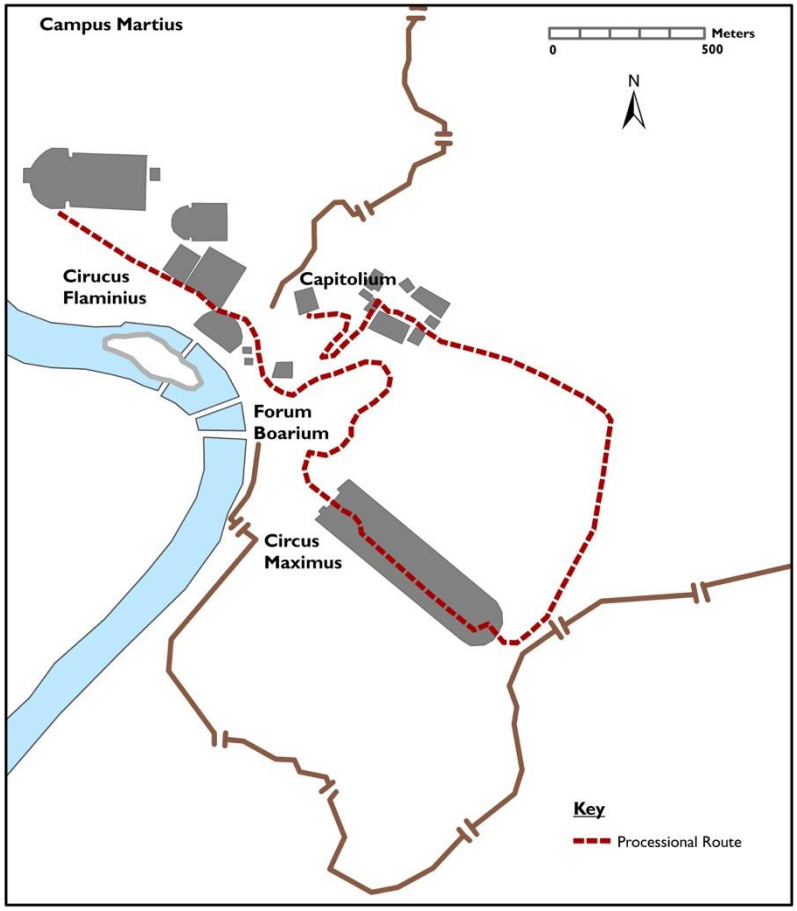

Figure 5.24 Possible triumphal processional route at Rome (after Holliday, 2002, p. 25).

Both of these examples show large scale processional activity that encompassed a significant portion of each city. When looking at Ostia, we can assume the processional rituals were held at a significantly smaller scale, including the distance covered by each procession. The simulation time of 1000-ticks roughly corresponds to 1000 meters. When assessed in terms of the distance covered by a procession, the number of ticks can be reflective of a procession's length and therefore its duration.

The output gained from each experiment is the route corresponding to each specific processional group. These results are then analysed in the same way as the urban network analysis results to assess the likelihood of paths travelling along certain streets. The correlation that exists between the agent-based model and the urban network analysis results will allow for better understanding about how processional activity linked individual temples with the surrounding cityscape and the larger ritual landscape constructed by the occurrence of these routes.

5.6 Limitations of Ostia's Data & Justification of Assumptions

There are several limitations of the data used from Ostia within this study. First, despite the scale of excavations and the preliminary geophysical survey data, there is still uncertainty concerning the exact layout of the 2nd century AD street network. This poses problems especially for network based analyses which are largely dependent upon a complete network dataset (Thaler, 2005, p. 326). Although the entire street network is included to try and limit 'edge effects' within the results, all of these street segments do not necessarily date to the late 2nd century AD. Therefore, if portions of the street network are changed the results of analysis will be altered as well. Despite these issues, the excavated street network is well known from this period, minimizing the probability of any significant changes to the results based upon the design of the extended street network.

A second limitation is that the analyses undertaken throughout this thesis and their results are inherently shaped by the excavated buildings that form the dataset. However, because only a fraction of Ostia has been excavated, there is still a large proportion of the city that is therefore discounted within all of the analyses. While the extended street network has been included within all of the models as a way to limit 'edge effects' in the data as well as accounting for the potential of movement travelling beyond the excavated city streets, it does not account for buildings that are unexcavated.

To assess the potential deviation in results due to considering only the partially excavated cityscape, exploratory analysis is undertaken. The agent-based model is used to address how movement patterns change if the full cityscape, with the Tiber existing as the northernmost boundary, is included within the model's environment. To address the impact of accounting for the extended built environment rather than just the excavated city, two experimental agent-based model simulations are run beginning and ending at the *forum*. The first simulation relates to the excavated city. All of the buildings are evenly weighted with a value of 1, and the simulation is run for a duration of 1000-ticks. The second simulation considers the impact of the non-excavated portions of Ostia. Within this simulation, an influence value of 1 is provided to all of the unexcavated areas that have surrounding streets within the excavated cityscape. The simulation is likewise run for a duration of 1000-ticks.

The simulation results inclusive of the extended cityscape are shown in Figure 5.25. The streets shown in red and orange are most likely to be traversed over the course of five different simulation runs. Streets where the top movement routes differs from the simulation conducted within the excavated city are shown by the black dotted line. The most notable difference is that the simulation run considering only the excavated cityscape shows some movement travelling within the south eastern area of Ostia near the *Campo della Magna Mater*. The inclusion of the non-excavated areas

of the city, alternatively, presents movement routes that are slightly more centralised. While there is a slight difference in the area travelled, it is not significant enough to discount the validity of applying the present methodology that uses buildings as the value of measurement. The extent to which this variation affects the results of each individual case study will be further addressed in Chapter 9.

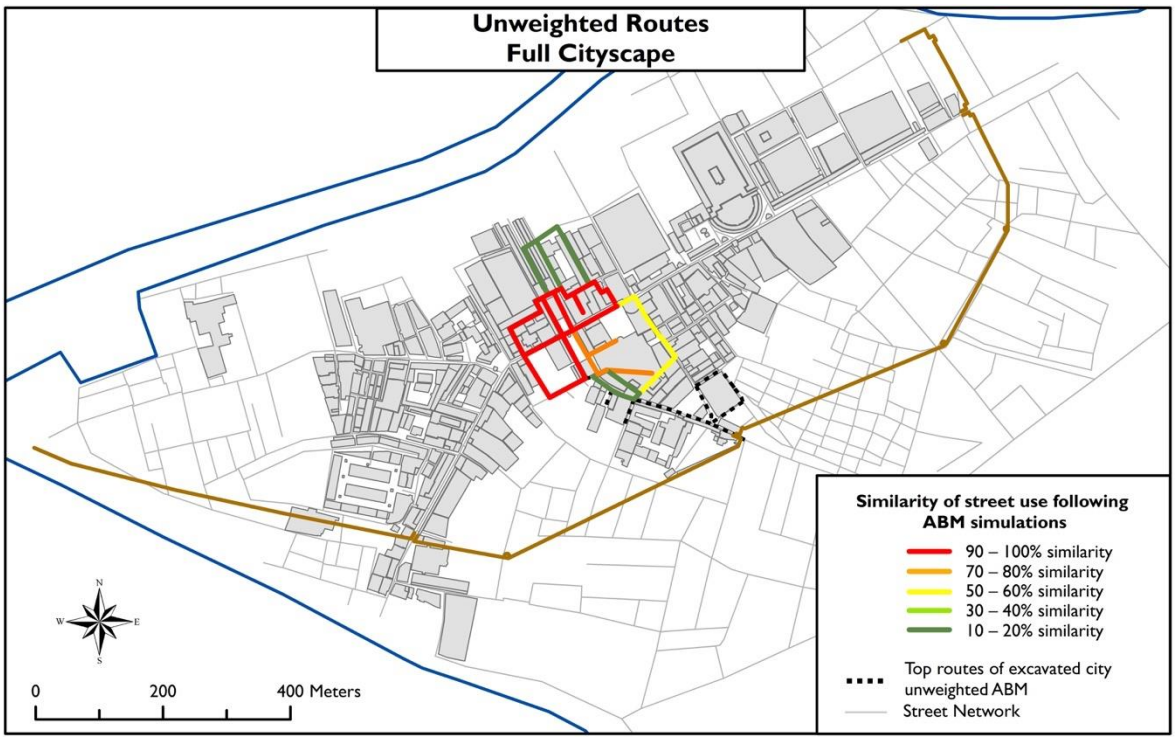

Figure 5.25 Example processional run beginning and ending at the forum that accounts for the extended cityscape. Streets that differ from the equivalent simulation run for the excavated city are shown by the black dotted line.

A third issue concerns the definition of urban space at Ostia. Defining the function of individual structures is both imperfect and incredibly complex, as addressed in Chapter 4. How the site has been excavated has resulted in a fragmented understanding about the function of many of the buildings. In many instances, spaces are classified following comparative evidence from both Ostia and other Roman cities when archaeological evidence is lacking. The limited number of classification categories has to be understood within the scope of this thesis. The intent of this thesis is not to reassess each building and the various theories about their identification, but to apply a broad understanding of Ostia's built environment, indicative of the various forms of social activity, as one way to study processional movement. As a result, these classifications are not set in stone, but can be changed as further research is conducted.

The issue of building functionalities is also raised in the multi-functionality purpose of most spaces. Many of the buildings would have had multiple purposes (e.g. shopfronts and rear residential spaces) depending upon the spaces accessible to the street and the presence of upper floors, which means

that one definition of space is not sufficient. While this was addressed partly by differentiating between the entry space and central space that had direct access to the street, it is recognised that this does represent a simplification.

A more important aspect to address is the omission of upper storey space. All of the studies that have addressed movement along Ostia's streets have accounted predominately for ground floor space (Kaiser, 2011; Stöger, 2011b). This is largely due to the uncertainty surrounding both which buildings hosted upper storeys as well as limited surviving evidence as to how these spaces were organised. The analyses undertaken within this thesis are similarly computed in relation to ground floor space. As a result, the subsequent biases in results due to this needs to be acknowledged. In some instances, the calculation of urban network analysis and agent-based modelling likely presents skewed results by discounting upper storey space and the activities that occurred within them. One classification category in particular that is particularly affected by this is residential space (Figure 5.26).[50] By the 2nd century AD, the street front was dominated by commercial buildings, while residential spaces often occupied upper floors (Packer, 1967, 1971; DeLaine, 2004). For the most part, the only surviving evidence comes from doorways and staircases leading to a building's upper stories. The *Casa di Diana* (I.iii.3–4) provides rare insight into the arrangement of first floor apartments[51] as well as evidence of additional upper floors.

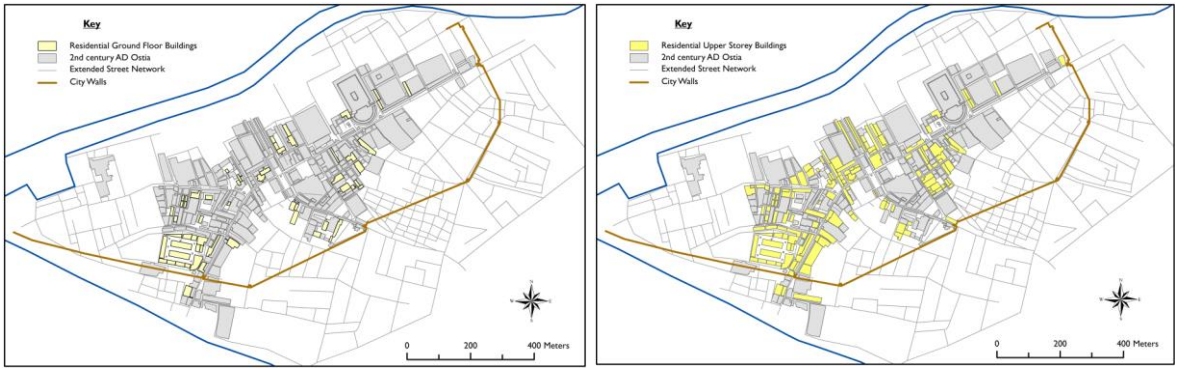

Figure 5.26 Plans showing ground floor residential buildings (Left) and probable upper storey residential buildings (Right).

In order to address the extent to which discounting upper storey space impacts the analysis results, betweenness centrality is calculated for both ground floor and upper storey residential weighted

[50] Upper story space at Ostia has been assessed following extant evidence for staircases and the architectural integrity of the structure to host additional floors (Packer, 1967, 1971; Boersma, 1985; Stevens, 2005). See Appendix B for details on the classification of upper storey buildings.

[51] DeLaine (2016) posits that many of these upper storey apartments were short-term rental properties, which would have been necessary for the seasonal populations that came through the port, although there is no surviving evidence to confirm this theory.

buildings. Figure 5.27 shows the difference between considering only ground floor versus including upper storey space. The streets following the buildings with the two highest categories of movement potential are displayed in red and orange. The results indicate that the inclusion of upper storey space presents some variation in potential movement areas. In many respects, because of the prevalence of upper storey residential spaces found across the city, consideration of only ground floor residential space provides a more accurate view about residential areas that would have likely seen increased passing movement. When considering upper storey space, the *Case a Giardino,* which was one of Ostia's larger residential complexes, shows a limited probability of movement. The ground floor classification, alternatively, highlights the potential of movement past this building complex. While there is some variation in results, the two analyses illustrate that only accounting for ground floor space likely gives more accurate results regarding how individual spaces structure movement. The extent to which the variation in accounting for ground floor and upper storey residential space affects each case study is further addressed in Chapter 9.

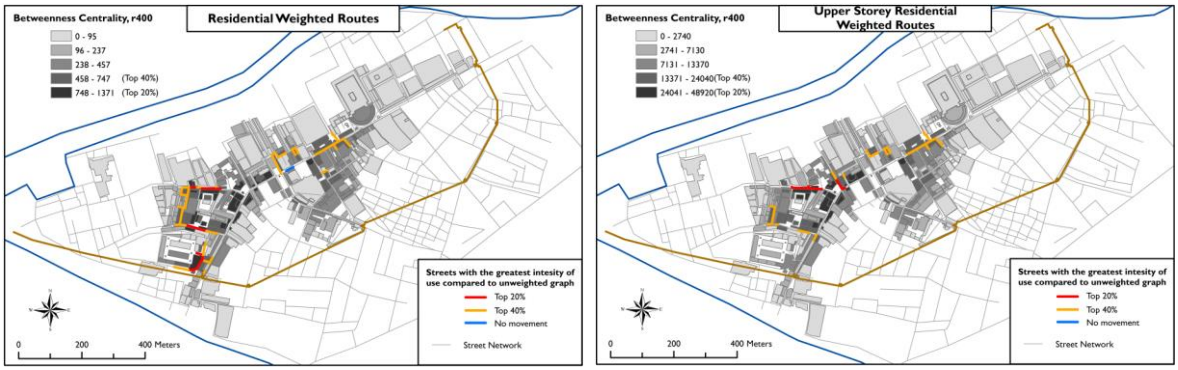

Figure 5.27 Comparison of betweenness centrality graphs weighted by ground floor (Left) and upper storey (Right) residential space.

A final aspect that is problematic with the data from Ostia is the limited literary and iconographic evidence of individual processions. However, as previously argued, the ritual movement framework that underlies the assumptions of this thesis attempts to negate this issue. By focusing upon temples with strong comparative evidence for the presence of processional activity, we are not assuming that every temple had processions. Instead, this assumption is informed by cults with clearly identified religious rituals that probably included processional activity. Likewise, the issue of unknown routes is addressed by not aiming to recreate set routes, but to visualise possible areas of movement. Therefore, as our understanding of the built environment and the factors structuring ritual movement change, our visualisations can change to reflect this.

Despite the present challenges and assumptions that have to be made concerning various aspects of Ostia's cityscape, this is the first study that aims to address how urban processions can be studied as a way to assess how temples structured religious landscapes within the city. Furthermore, it is one of the first times that three different methods for the study of urban movement have been

combined for the analysis of a Roman urban environment. The outcome of the present research is not the end point for this type of research, but it raises questions and other fruitful avenues of research not just about religion at Ostia but for religious movement throughout the Roman world (see Chapter 10).

Chapter 6: Case Study 1 – The Cult of the Magna Mater

6.1 Introduction

The cult of the Magna Mater or Cybele[52] was introduced to Rome from Phrygia in 205 BC (Livy 29.14.13–14, **A.1b**; Suet. *Tib.* 2.3; Ov. *Fast.* 4.305–44, **A.1d**; Julian. *Or.* 5.159–160 , **A.1h**).[53] Brought to Rome on the recommendation of the *Libri Sibyllini*, the goddess's cult statue arrived at Ostia from Pessinus (Figure 6.1) (Roller, 1999, pp. 266–268). A large procession then carried Cybele from the harbour to the city of Rome and placed her within a new temple on the Palatine (Fasti 4.291–328, **A.1d**). While the cult was integrated within Roman religion from the Republic, it always retained an aspect of foreignness (Roller, 1999, pp. 293–294). The reasons for Cybele's addition to the Roman pantheon, its flamboyant festivals, her association with other deities, and her religious followers have been the object of a considerable number of studies (Graillot, 1912; Fishwick, 1966; Sanders, 1972; Vermaseren and Lemmers, 1977; Burton, 1996).

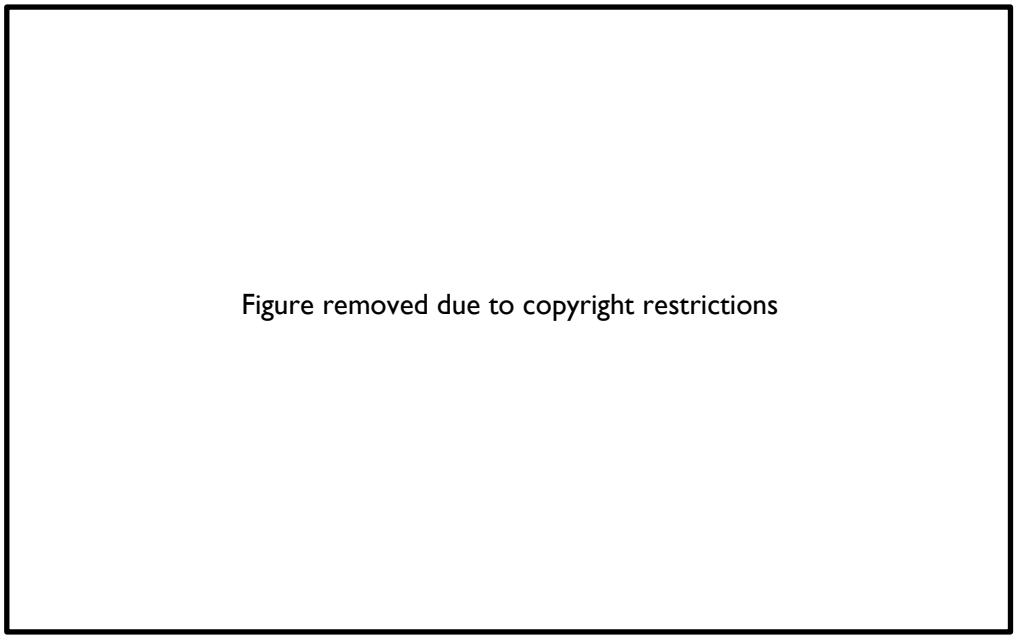

Figure 6.1 Terracotta antefixes depicting Cybele on a ship, emulating her arrival at Ostia. Left – found in the *Piazzale delle Corporazioni.* Right – found in the *Campo della Magna Mater* (Rieger 2004, Abb. 211).

[52] Cybele was the goddess of fertility, but in Rome she was also honoured as the city's protector (Roller, 1999, pp. 263–327).
[53] For an overview of foundation myth of the cult, see Alvar, 2008, pp. 65–68.

The predominance of the sanctuary within Ostia's urban landscape in combination with our extensive knowledge of the cult's festivals provide the ideal opportunity to study the cult at Ostia. The cult's arrival myth at Ostia's harbour in addition to the extent of sculptural and epigraphic evidence relating to the cult all attest to its significance (Meiggs, 1973, p. 356).[54] Assessment of how processional movement contributed to the cult's visibility and its relationship to the surrounding urban landscape presents a novel approach for studying one way the cult of the Magna Mater contributed to Ostia's religious landscape that extended beyond the actual sanctuary. This chapter begins with a discussion of the excavation and identification of the sanctuary (§6.2) and what we know about the cult's festival and processional activity at Ostia (§6.3). The methodology developed for studying processional routes, as introduced in Chapters 4 and 5, is then applied to looking at how "circular" processional routes can be visualised applying urban network analysis and agent-based modelling (§6.5). The chapter concludes by discussing the significant of these potential routes and what it contributes to our understanding of the cult at Ostia (§6.6).

6.2 The *Campo della Magna Mater* at Ostia

The *Campo della Magna Mater* is the largest religious sanctuary known at Ostia (Figure 6.2). The western portion of the sanctuary was first discovered and excavated by Visconti between 1858–70 (Visconti, 1877). Excavations continued under Calza, beginning in the early 20th century, which readdressed many of Visconti's findings as well as uncovering the eastern section of the sanctuary (Calza, 1946a, 1946b). More recent excavations were undertaken by a Spanish team during the 1990s, but the results are still awaiting publication (Mar, Nolla and Ruiz de Arbuolo, 1999; Cooley, 2015, p. 244). The adscription of the sanctuary to the Magna Mater followed the discovery of dedicatory inscriptions, a marble statue of Attis, and other statuettes found during Visconti's excavation (Meiggs, 1973, p. 358). This was further confirmed by the identification of the different temples and shrines positioned within the sanctuary. The sanctuary consists of separate temples to Cybele, Attis, and Belonna, a *schola* of the *hastiferi,* and various rooms associated with the cult. The entire sanctuary dates to the beginning of the 1st century AD and was in existence until the 4th century AD (Berlioz, 1997, p. 98; Pavolini, 2006, pp. 207–211). The presence of the Magna Mater at Ostia likely predates this, existing as early as the Republic, although the location of an early sanctuary is unknown (Taylor, 1912, p. 58; Meiggs, 1973, p. 366).

[54] Rieger (2004) records over 90 artefacts found between Ostia and Portus that are related to the cult.

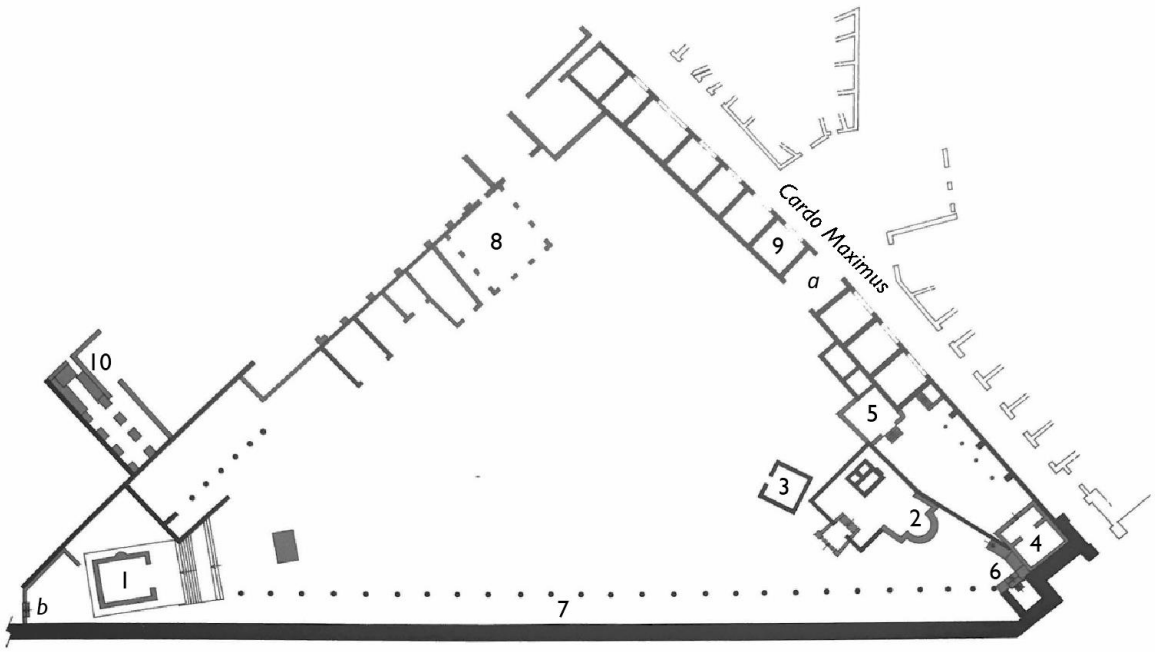

Figure 6.2 Antonine phase of the *Campo della Magna Mater*. *a* – main entrance. *b* – secondary entrance. 1 – *Tempio della Magna Mater*. 2 – *Santuario di Attis*. 3 – *sacellum*. 4 – *Tempio di Bellona*. 5 – *Schola degli Hastiferi*. 6 – *Fossa Sanguinis*. 7 – *Portico*. 8 – rooms. 9 – *tabernae*. 10 – *Mitreo degli Animali*. (After Rieger 2004, Abb. 90).

6.2.1 Spatial Context of the Sanctuary

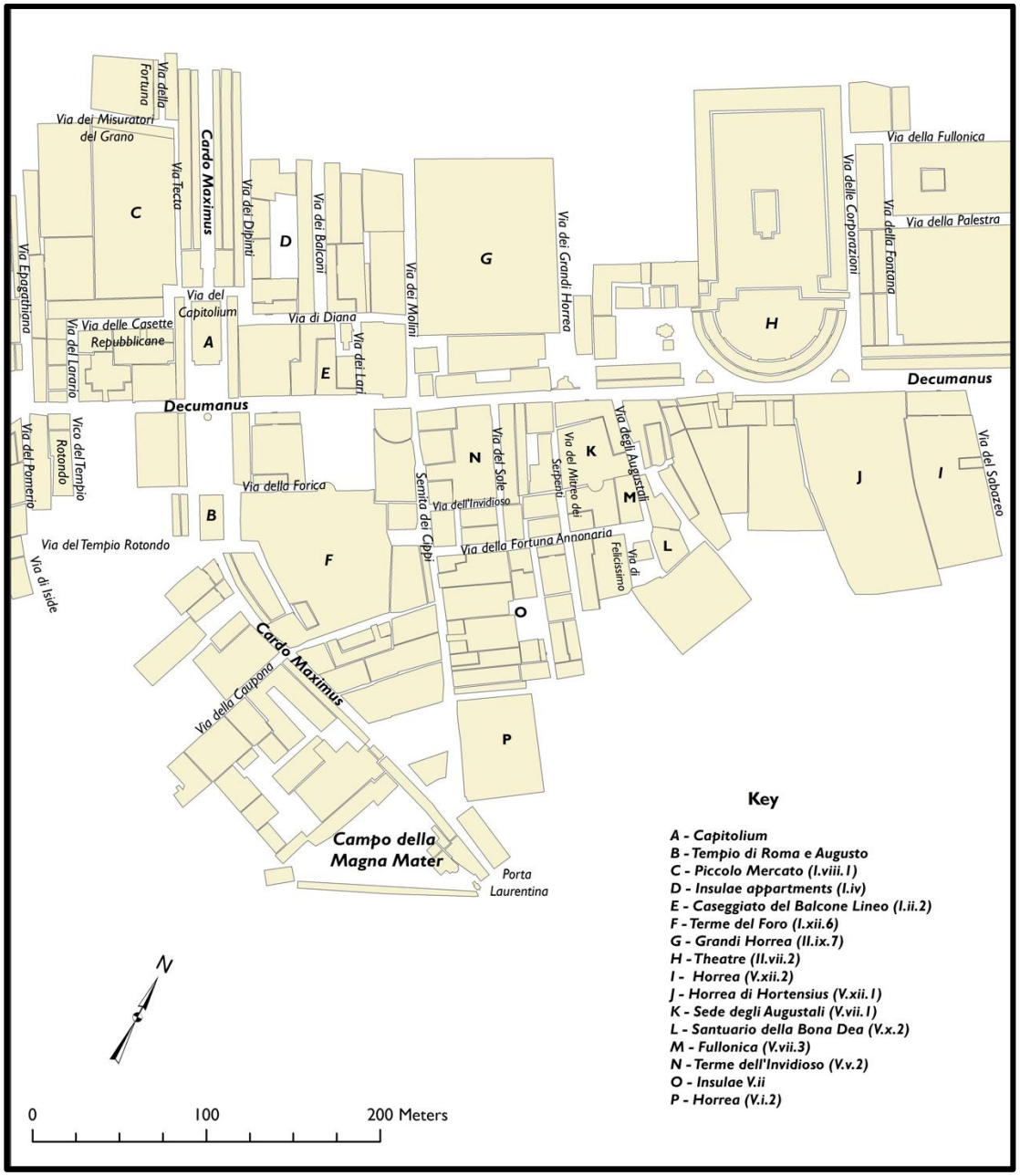

Figure 6.3 Map of the streets surrounding the *Campo della Magna Mater* and important buildings.

The *Campo della Magna Mater* (IV.i) is located along the *cardo maximus* just west of *the Porta Laurentina* (Figure 6.3). Study of the sanctuary's spatial position using space syntax's axial integration and choice measurements provides further insight into the sanctuary's accessibility and spatial importance within the city (Figure 6.4). The calculation of axial integration applying a radius of 3 to denote local movement indicates that the sanctuary is moderately well integrated within the street network, positioned along a quaternary street. The graph, which uses a colour scale of blue to red, with red equating to the highest integrated streets, provides a visual representation of how connected and accessible the sanctuary's position is within the overall street network. The

calculation of choice, which illustrates a street's movement potential, shows that the sanctuary is positioned along a street that saw extremely little pedestrian interaction. Like integration, the graph uses a blue to red colour scale, with red indicating streets most likely to be traversed by random movement patterns. Both integration and choice calculations show that the sanctuary is spatially located in an area that was not highly integrated within the street network or likely to be encountered. However, the sanctuary's position directly next to the *Porta Laurentina,* one of the city's major entrances, indicates that it had significant passing pedestrian interaction.

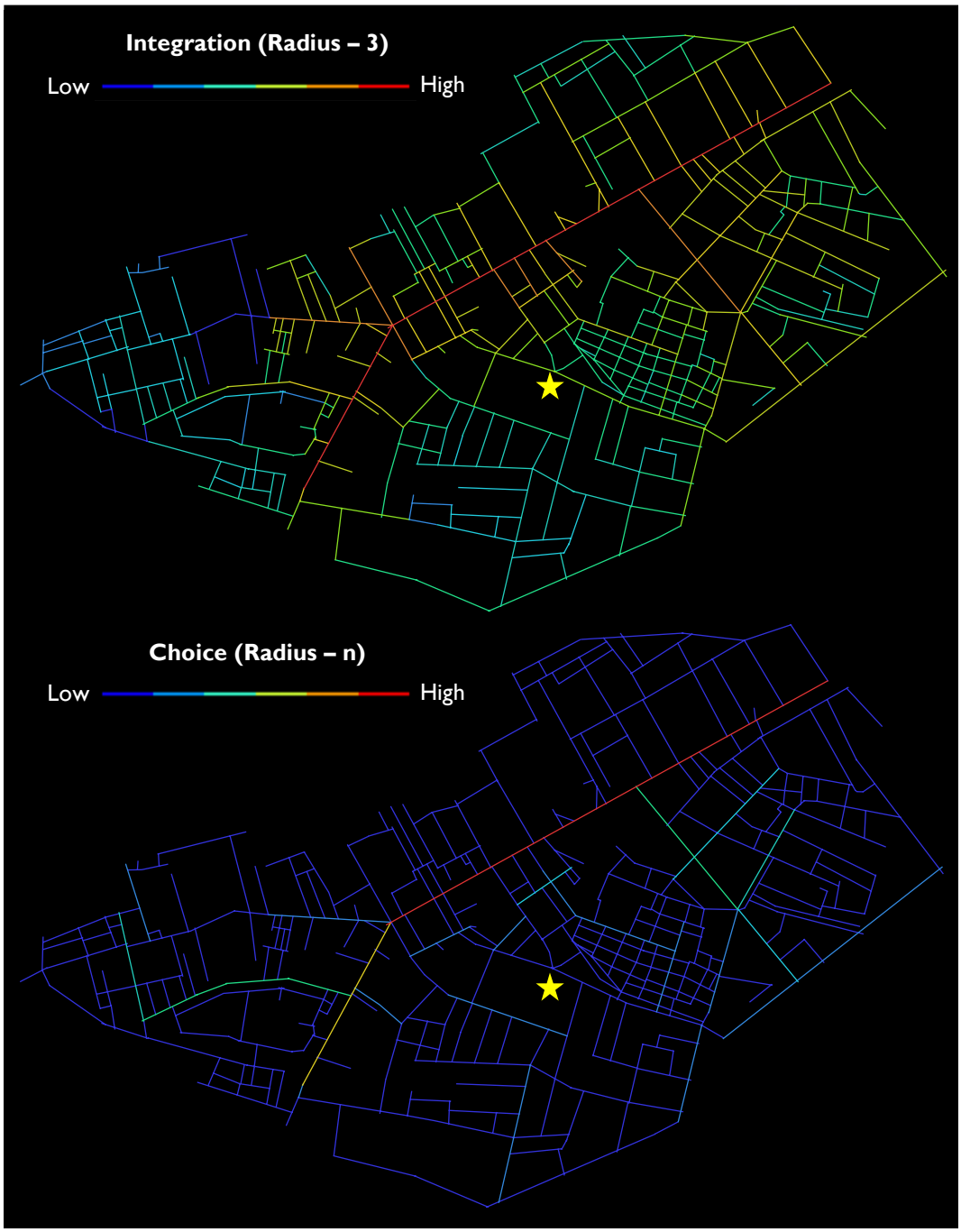

Figure 6.4 Space syntax axial graphs showing the position of the *Campo della Magna Mater* in relation to integration and choice metrics. Top: integration (radius-3, 386 street segments); Bottom: choice (radius-n, 386 street segments).

The trapezoidal area of the sanctuary measures 4,500 m^2 and hosts seven cultic structures (Meiggs, 1973, p. 357). Entrance to the area is restricted to a small entryway between a series of shops fronting the campus along the *cardo maximus* (Figure 6.5; c.f. Figure 6.2, *a*). A second entry point is located behind the *Tempio della Magna Mater* at the western end of the sanctuary (Cooley, 2015, p. 245; c.f. Figure 6.2, *b*). The interior of the sanctuary is bounded by a colonnaded portico (IV.i.2; c.f. Figure 6.2, 7) along its southern side, while the northern edge has a boundary wall against which a series rooms (IV.i.10; c.f. Figure 6.2, 8) were built (Meiggs, 1973, p. 358). The location of multiple temples positioned at different points throughout the sanctuary, which are not visible from the street, meant that people had to enter the area intentionally in order to view or interact with the various religious structures. The entire central court was likely covered with sand, possibly to allow for the *taurobolium* ritual (*CIL* XIV 39, 40, 43; *CIL* XIV suppl. 4303).[55] The large size of the sanctuary would have been well suited to the many rituals associated with the cult of the Magna Mater (Taylor, 1912, p. 59; Meiggs, 1973, p. 358).

Figure 6.5 View of the main entrance to the Sanctuary of the Magna Mater from the *cardo maximus*, looking towards the *Tempio della Magna Mater* (photo, K. Crawford).

[55] Cooley (2015) questions the requirement of sand for the *taurobolium,* and proposes that the sand was present in order to allow for the planting of trees (p. 254). This suggestion also seems unlikely as we have no evidence as yet for the presence of multiple trees within the sanctuary area. A small structure (IV.i.6) located in the north west corner, near the Sullan city walls was argued by Calza to be a *fossa sanguinis* and used for the *taurobolium* ritual (Calza, 1946a, p. 186). Re-examination by Rieger (2004) showed that the pit, which was confined within a stuccoed room, was likely just a cistern used for water throughout the sanctuary (pp. 110–12). One inscription, dated AD 170–174, details the ceremony being carried out in honour of Marcus Aurelius and the Imperial family.

The *Tempio della Magna Mater* (IV.i.1), dedicated to Cybele, is positioned at the western end of the campus (Figure 6.6). The *prostyle tetrastyle* temple, measuring 7.30 x 6.50 m, was accessed via eight marble steps that led to a small *cella*. A rectangular altar remains in situ in front of the temple. The position of the *Tempio della Magna Mater* as a focal point upon entering the sanctuary (c.f. Figure 6.2, 1) through the main *cardo* entrance indicates its importance within the overall sanctuary (Pensabene, 2005, p. 525).

Figure 6.6 View of the *Tempio della Magna Mater* and the foundations of its altar (photo, K. Crawford).

The *Santuario di Attis* (IV.i.3) is located at the eastern end of the campus near the sanctuary's main entrance (Figure 6.7, c.f. Figure 6.2, 2).[56] The temple's entrance, framed by two statues of Pan in high relief, leads to a small-enclosed shrine. Identification of the sanctuary was based upon a number of dedications and statuettes found within the structure (Meiggs, 1973, p. 359). The original temple likely dates to the Julio-Claudian period, while the present architectural structure represents a later Antonine reconstruction phase (Meiggs, 1973, p. 364).

[56] For an overview of the Attis myth see Roller, 1999, pp. 238–259.

Figure 6.7. *Santuario di Attis* (photo, K. Crawford).

The *Tempio di Bellona* (IV.i.4; c.f. Figure 6.2, 4) is located east of the sanctuary of Attis (Figure 6.8; c.f. Figure 6.2, 2). Bellona, the goddess of war, became closely identified with Cybele during the Empire (Juv. 6.512, **A.1a**; Apul. *Met.* 8.25; Squarciapino, 1962, p. 8). The temple is small, measuring 7 x 5.75 m (Figure 6.8). Identification is based upon a dedicatory inscription (Calza, 1946, pp. 198–202, inscription 4) which states that the *duoviri* of that year assigned the land while the funds for the temple were obtained from the town's lictors and slaves (Meiggs, 1973, p. 359). Meiggs dates the temple to the period of Hadrian, earlier than Calza's original estimate which suggested a construction date during the second half of the second century AD (Fishwick, 1967, p. 146; Meiggs, 1973, p. 364). Reassessment by Rieger (2004, p. 105) indicates that that the earliest phase of brickwork dates to the second half of the 1st century AD. Regardless of its date of construction, as the campus developed overtime and saw the construction of new buildings, the temple was increasingly hidden from direct view upon entering the sanctuary (Pensabene, 2005, p. 525).

Figure 6.8. *Tempio di Bellona* (photo, K. Crawford).

The *Schola degli Hastiferi* (IV.i.5), the seat of the *hastiferi* or lance-bearers association, is located at the eastern end of the sanctuary (Figure 6.9; c.f. Figure 6.2, 5), north of the *Tempio di Bellona.* The building, dating to the Hadrianic period, consists of a long hall measuring c. 5.50 x 5.50 m which is reached by a set of five marble steps (Hermansen, 1982, p. 70). Identification of the building was made in part from three inscriptions found within the campus referencing the *collegium* of the *hastiferi* (Fishwick, 1967, p. 142).

Figure 6.9. *Schola degli Hastiferi* (photo, K. Crawford).

The sanctuary had significant connections with two other important associations, the *dendrophori*[57] and the *cannophori.*[58] The quantity of the donations made by both associations attest to their membership size (Van Haeperen, 2014, p. 138). There is no evidence within the campus for the presence of a *schola* for these two associations (*AE* 1987, 198), which Meiggs argues was likely located somewhere else in the surrounding neighbourhood (Meiggs, 1973, p. 361). Hermansen (1982, p. 69), alternatively, suggests that the *dendrophori* did have a *schola* within the campus, on account of the discovery of *CIL* XIV 45 which states: *Numini Domus Aug(ustae) || D[endrophori Ostien]ses scolam (sic) | quam sua pecunia constit[uerant novis sum]ptibus | a solo [restituerunt].*[59] Regardless, none of the existing structures within the sanctuary can be identified as a *schola.* While it is clear that these two associations did have a connection to the *Campo della Magna Mater,* they either had a yet to be identified *schola* or they met in various public places which negated the need for their own headquarters.

The open space of the campus is maintained throughout its various phases of development, which attests to its importance for religious practices. In contrast, the open areas of the *Quattro Tempietti*

[57] *CIL* XIV 33, 45, 53, 280, 281; *CIL* XIV suppl. 1, 4301.
[58] *CIL* XIV 34–37, 40, 117, 119, 285; *CIL* XIV suppl. 1, 4301.
[59] *CIL* XIV 45: "for the spirit of the house of the Augustus, the *dentrophors* of Ostia have rebuilt, from the ground up and with new expenditures, the *schola* which they originally had built with their own money." (Translation by Hermansen, 1982, p. 69).

and the *Santuari Repubblicani* were both minimised over time to enable the construction of various surrounding residential structures which affected both the type and size of rituals that could be undertaken at these locations (Pensabene, 2005, p. 528). The maintenance of a large open space through the duration of the sanctuary's existence indicates the importance of having an available space for cultic activities and rituals.

The sanctuary's position at a removed distance from the main thoroughfares, which is confirmed by space syntax axial analyses, has prompted different theories about how it was perceived by the population at Ostia. It is possible that its removal from the main centre of the city was in order to maintain aspects of its exotic nature. However, there are numerous temples of the Magna Mater which were fully integrated into city centres, most notable being the goddess's temple on the Palatine in Rome (Van Haeperen, 2011, p. 112). Furthermore, its position next to one of the city's major entrance gates precludes the idea that it was intended to be completely removed from urban centre.[60] An aspect of the sanctuary's exotic character could still have been maintained through the preservation of an enclosed space which required intentional entry and admission in order to experience or witness the cult's rituals.

6.3 Evidence for Processions of the Magna Mater

The importance of Metroac rituals at Ostia dates back to the cult's initial arrival at the city. Livy (29.14.10–16, **A.1b**) provides an account of a young quaestor, Publicus Scipio, who was entrusted with greeting the goddess upon her arrival at the Tiber's mouth in the company of various upper-class women. Additional details are provided by Ovid (Ov. *Fast.* 4.291–348, **A.1d**) about the specific people and their societal positions that were present to meet the deity and carry her in a procession to Rome.

The festivals associated with the Magna Mater have seen considerable study (Lambrechts, 1952; Vermaseren and Lemmers, 1977; Lane and Vermaseren, 1996; Alvar, 2008, pp. 240–292). Two particular ritual acts have attracted the greatest attention, the self-castration of the *galli*[61] (Lucr. 2.614–17, **A.1e**; Mart. 3.81.1–5) and the *taurobolium*[62] (Sanders, 1972; Lane, 1996; Alvar, 2008, p. 246). The number of accounts about the various festivals likewise provide a relatively detailed overview of the existence of Metroac processions (Ov. *Fast.* 4.179–90, 337–72, **A.1d**; Hdn. 1.10.5–6, **A.1f**). However, the exact nature of the processional rituals are heavily reconstructed by scholars

[60] Van Haeperen (2011) argues for a potential military symbol of the cult, whereby the sanctuary acts as a protector to the city (p. 112).
[61] The *galli* were members of a specific group of cultic followers who castrated themselves in ritual frenzy of devotion to the Great Mother. For discussion of their place within Roman society, see Bömer, 1981.
[62] The most detailed account of the *taurobolium* comes from Prudentius in the 4th century AD which describes the ritual of standing in a hole and being showered with the blood of the sacrificial bull (Prudent. *Perist.* 10.1000–50).

following unspecific accounts (Beard, 2012, p. 332). The sequence of the processions, the number of people who participated, and the processional routes are not fully detailed by any ancient author (Favro, 2008, p. 28). Despite the uncertainty surrounding the exact sequence of the processional rituals, it seemed that it had to adhere to a strict procedure. Cicero comments upon the importance of following proper ritual protocol: "If the dancer has stood still, or if the flute-player has suddenly become mute…then the games have not been duly performed" (Cic. *Har. resp.* 23).[63] Cicero's comment likewise provides some insight into the visibility of the ritual and some of the features included within a procession of the Magna Mater.

The *Campo della Magna Mater* likely saw two different annual festivals that included processional activity. While existing literary accounts of the festival predominantly refer to events in Rome, the size of the sanctuary at Ostia in addition to the quantity of evidence for various *collegia* associated with the Magna Mater, suggest that it is highly probable that similar processions occurred at Ostia, albeit on a smaller scale. The first festival, which lasted between 15–28 March, commemorated the death of Attis. The second was the *Megalensia* that celebrated Cybele's arrival at Rome in 204 BC, which occurred on the 4–10 April (Scullard, 1981, p. 98).

The festival celebrating Attis that occurred over serval days in March (Table 4), began with a procession of the *cannophori* (reed-bearers) on 15 March.[64] After nine days of fasting, on 22 March, a second procession took place which was led by the *dendrophori* (tree-bearers) who carried a pine tree symbolizing Attis' death[65] to the temple of the Magna Mater (Meiggs, 1973, p. 356).[66] Cybele's temple at Ostia has two large holes positioned on either side of the staircase on the landing, which likely supported either the pine trees that represented Attis' death, or the flowers used to decorate the trees (Meiggs, 1973, p. 358).

On 24 March was the *Sanguem* which began with a religious procession inclusive of the *galli* and *hastiferi* (spear-bearers), who enacted a religious frenzy of ecstatic dancing and self-flagellation (Alvar, 2008, p. 288). The procession concluded with the initiates castrating themselves (Juv. 6.511–16, **A.1a**) and becoming *galli* in order to devote their life to the goddess (Salzman, 1990, p. 167). This festival likely occurred within the confines of the sanctuary rather than taking place within the city's streets. Rieger (2004) proposes, following a previously articulated theory of Borgeaud (1996), that the act of castration was eventually replaced by the castration of a sacrificial animal (Van Haeperen, 2005, p. 238).

[63] Translation by Watts, 1923.
[64] This first procession commemorated Attis' abandonment along the banks of the River Gallus and his saviour by either shepherds or by Cybele herself (Salzman, 1990, p. 166).
[65] The myth of Attis states that he emasculated himself beneath a pine tree which resulted in his death (Alvar, 2008, p. 7).
[66] For reference to the *dendrophori* at Ostia see: *CIL* XIV 33, 53, 67, 69, 71, 107.

The final procession of the Attis festival, the *Lavatio,*[67] occurred on the 27 March. This circular procession consisted of carrying the cult statue of Cybele from her temple so that it could be washed in commemoration of her entry into Rome, after which she was brought back to her temple on the Palatine (Fishwick, 1967; Salzman, 1990; Turcan, 2012).[68] At Rome, the cult statue was carried to the conjunction of the Rivers Tiber and Almo[69] (Ov. *Fast.* 4.337), but there are no additional details of the festival occurring in other places. However, considering that the goddess first arrived at Ostia, this portion of the festival likely held considerable significance for Ostia.

Incorporation of March Festivals of the Magna Mater into the Roman Calendar

Festival Dates	Claudius	Antoninus Pius	Later
15 March		*Canna intrat*	
22 March	*Arbor intrat*		
24 March	*Sanguem*		
25 March			*Hilaria*
26 March			*Requetio*
27 March	*Lavatio*		
28 March		*Initium Caiani [= Gaiani]*	

Table 4 March festivals and the periods when they were added to the Roman Calendar (after Salzman 1990, table 6).

The *Megalensia,* held 4–10 April, included a series of processions preceding various *ludi* that included public games and theatrical performances (Beard, 2012, p. 331). The exact nature of processions associated with the *Megalensia* are unknown, but the black stone that arrived at the shore of Ostia imbued with the goddess was carried in procession by the *galli* (Ov. *Fast.* 4.183–87, **A.1c**; Turcan, 1996, pp. 38–39). A specific inscription from Ostia (*CIL* XIV 36)[70] describing the donation of a silver statuette to the cult of Cybele could represent such a cultic object carried within a local procession, although it is just as likely that this object was a votive offering (Madigan, 2012, p. 50). Despite the closeness of Ostia and Rome, Rieger argues that Ostia developed its own religious tradition for the cult (Rieger, 2009, p. 6). *Megalensia* activities, including processions, would have occurred on a smaller scale in comparison to their Rome counterpart.

[67] The *Lavatio* ritual was likely developed under Augustus (Alvar, 2008, p. 287, fn. 315).
[68] For discussion of an iconographic depiction of the cult statue being carried in procession see, Madigan 2012, pp. 99–101.
[69] The exact location of the Almo is unknown, but was likely located near Rome and the via Appia. Stat. *Silv.* 5.1.222–224: "There is a place before the city where the great Appia begins and Cybele lays aside her grief in the Italian Almo, no more remembering Ida's rivers." (Translation by Shackleton Bailey, 2015).
[70] *CIL* XIV 36: *Calpurnia | Chelido | typum Matris | Deum argenti | p(ondera) II cantnoforis (sic) | Ost(iensibus) d(onum) d(edit) | et dedicabit.* "Calpurnia Chelido, a statue of Mater Deum, two pounds of silver, for the cannophori of Ostia, gave as a gift and dedicated." (Translation by author).

Assessment of dedications and their date gives further secondary evidence towards the occurrence of *Megalensia* rituals. An inscription from a small marble base (*CIL* XIV 119) details a dedication to Caracalla on 4 April, AD 212.[71] The date is particularly important because while being the emperor's *dies natalis*, it was also the first day of celebrations for the *Ludi Megalense* (Snyder, 1940, p. 272). More significantly, it attests to the occurrence of feasts likely relating to the cult of the Magna Mater, illustrating the rage of rituals that took place at Ostia specific to the cult.

A passage from Ovid's *Fasti* provides an apt description about the impact the procession would have made travelling through a city's urban streets:

> "Eunuchs will march and thump their hollow drums, and cymbals clashed on cymbals will give out their tinkling notes: seated on the unmanly necks of her attendants, the goddess herself will be borne with howls through the streets in the City's midst. The stage is clattering, the games are calling." (Ov. *Fast.* 4.180–187).[72]

As the procession wound through a city's streets, it was meant to be heard and seen by passers-by. The reference to howling not only serves to make the procession's presence known, but to also draw the attention of spectators. A more detailed description of the processional participants is provided by Lucretius' poem, which aims to describe the aesthetics of the procession rather than providing documentation of the event (Lucr. 2.589–668, **A.1e**). The description of the procession moving between towns rather than within a specific urban landscape also suggests that this is a highly descriptive account aimed at evoking a memory of the festival's character rather than providing an accurate description of the procession.

The conclusion of the procession is detailed in a wall painting from Pompeii that was located on a shop wall along the *Via dell'Abbondanza* (Figure 6.10). The image purports to illustrate a group of participants carrying the cult statue of a seated Magna Mater on a *ferculum* or litter. An important component of this image is that it illustrates the inclusion of both men and women within the ritual, rather than just the standard *galli*. While presenting an overview about the range of ritual participants, no details are provided that allow for the event to be localised (Favro, 2008, p. 35). The image shows the gathering of devotees and onlookers standing before the cult statue, in addition, an altar has been prepared for a sacrifice. Cybele is portrayed sitting on a litter that would have carried her in procession (Madigan, 2012, pp. 39–42). Various ancient sources provide

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[71] *CIL* XIV 119: *Imp(eratori) Caes(ari) M(arco) Au | [r]elio Anton(ino) | pio fel(ici) Severi | fil(io) Aug(usto) | C(aius) Caesius Eu | tychion imm(unis) | k(annophoris) O(stiensibus) d(onum) d(edit) a(rgenti) p(ondo libram) I (scripula) VIII | cuius ded(icatione) ded(it) | pan(em) vin(um) et (denarius singulos) I | ded(icata) pr(idie) n(onas) Apr(iles) | Aspris (duobus) cos* "To the emperor M. Aurelius Antoninus Pius Felix Augustus, son of Severus, C. Caesius Eutychion *immunis* of the Ostian reed-bearers gave as a gift (statuette?) of one pound and eight *scripula* of silver. On account of the dedication of this (gift) he gave out bread, wine and one *denarius* (each). Dedication on 4 April in the year when the two (Gaii Iulii) Aspri were consuls." (Translation by Bruun, 2014, p. 362).

[72] Translation by Frazer, 1931.

commentary about goddess's elevated position during processional rituals and how she was carried through the city (Lucr. 2.602–3, **A.1e**; Ov. *Fast.* 4.185–6, **A.1c**). Cybele's raised position within the wall painting could be indicative of her standard position within a procession, where she towered over the participants as she was carried through a city's streets (Favro, 2008, p. 37). The movement of the procession is likewise evoked and incorporated into how the painting would have been viewed by passing pedestrians at Pompeii (Clarke, 2006, pp. 91–92).

Figure 6.10 Wall painting from Pompeii (IX.7.1) showing a procession of the Magna Mater ((www.pompeiinpictures.com, © Jackie and Bob Dunn).).

Consideration of processional participants gives some insight into who actually interacted with the processional rituals. The assimilation of the cult in Rome forbade the participation of Roman citizens in its processional rites (Alvar, 2008, p. 244). A late 1st century BC law, described by Dionysius of Halicarnassus, states that, "But by a law and decree of the senate no native Roman walks in procession through the city arrayed in a parti-coloured robe, begging alms or escorted by flute-players, or worships the goddess with the Phygian ceremonies" (Dion. Hal. *Ant. Rom.* 2.19.3–5).[73] A later law from the 2nd century AD prohibited participation in any form of castration, but not more general participation in the cult (*Dig.* 48.8.4–6). During the Republican period, priests were limited to eunuchs, but by the time of emperor Claudius, participation of the cult was opened to include Roman citizens (Meiggs, 1973, p. 356). While early cultic participation was restricted to playing the

[73] Translation by Cary, 1937.

role of spectator, this changed during the imperial period. Cicero (Cic. *Sen.* 13.45) comments upon the creation of clubs by the Roman elite, while possibly acting as a way to maintain control over the early cult, it also shows wider participation in the cult (Scullard, 1981, p. 100; Turcan, 1996, p. 38). By the Claudian period, Roman citizens could directly partake in the festivals and the priestly order (Carcopino, 1942). Assessment of who was dedicating artefacts to goddess at the sanctuary as well as relevant funerary evidence provides limited insight into the people participating in the Ostian cult. Dedications made to the sanctuary were most likely donated by cultic followers. As Cooley (2015, p. 245) argues, the enclosed nature of the cult would require people to enter the sanctuary in order to view any of the temples or dedications, making a random donation unlikely.

Movement played an important role in the overall processional ritual. The majority of accounts regarding the goddess's festivals allude to the processions being a contrast in movement (Ov. *Fast.* 4.179–214, **A.1c**; Lucr. 2.589–668, **A.1e**; Hdn. 1.10.5–7, **A.1f**). The slow movement of a cult statue carried on a litter is juxtaposed with the frenzied dancers and flagellating *galli.* Despite our knowledge about the range of processions that occurred in association with the cult, we know very little about actual routes that were taken by any single procession, either in Rome or any other town.

The combination of archaeological evidence from the *Campo della Magna Mater* in conjunction with comparative processional evidence from other cities makes it highly likely that similar processions occurred at Ostia. Turcan (1996, p. 55) goes further to state that Ostia celebrated the same cycle of March festivals as those that occurred at Rome. Whether a similar *Megalensia* festival occurred at Ostia is less certain. Regardless, the size of the sanctuary in combination with the cult's identified rituals attest to the role that the cult of the Magna Mater played at Ostia (Rieger, 2004; Bruun, 2009; Cooley, 2015). Study of how these processional rituals might have traversed the streets of Ostia presents one way to assess how the cult of the Magna Mater impacted Ostians beyond the sanctuary's precinct.

6.4 Defining the Area of Ritual Movement

In order to study possible areas of processional movement in relation to the spatial location of the sanctuary of the Magna Mater, a general area of ritual movement is initially defined. The space syntax calculation of axial step depth is run from the entrance location of the sanctuary. Step depth indicates how many streets or turns each street is from a starting location. In relation to the sanctuary, the maximum number of turns required to reach any street within the city is 13. Space syntax research has indicated that a step depth of three correlates to localised movement. In order to account for the occurrence of an 'edge effect' in the calculation, a step depth of 4 was used from the sanctuary's entrance (Figure 6.11). The resulting graph shows all streets accessible from the

Campo della Magna Mater within four turns, displayed in red. The limit of the streets with a step depth of 4 is used to define a demarcated ritual area.

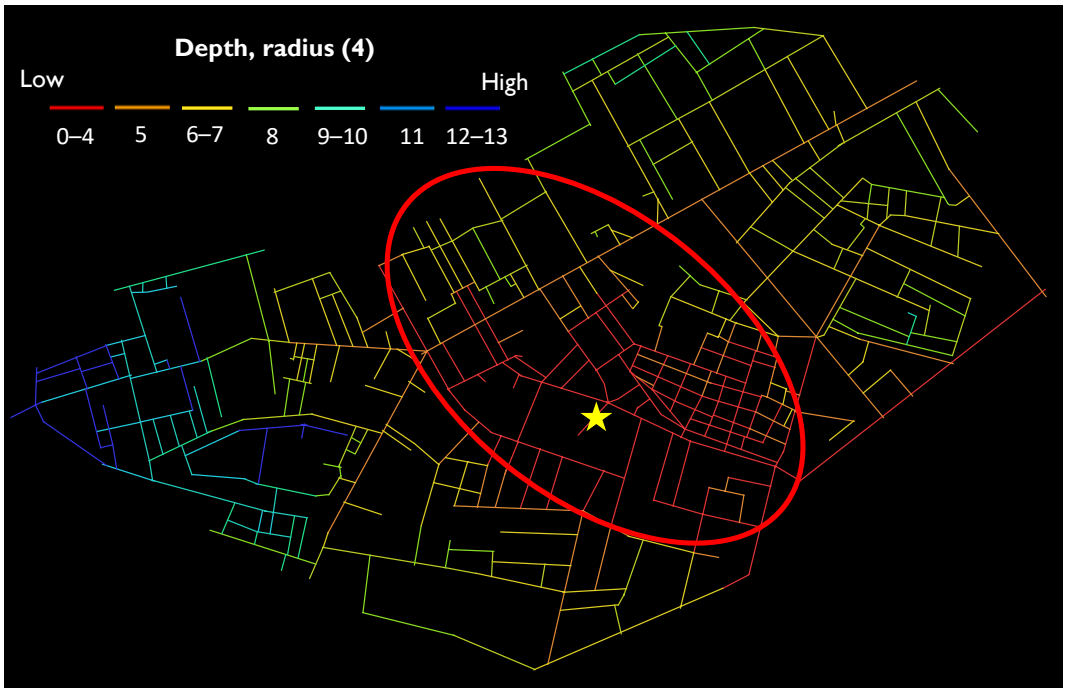

Figure 6.11 Axial graph showing a step depth of 4 from the *Campo della Magna Mater* (yellow). The area that delineates the streets with a depth of 0–4 is circled in red.

Compared to the space syntax metrics of integration and choice (Figure 6.4), step depth provides a more nuanced understanding of the extent of the sanctuary's connection to the surrounding street network. While it does not fully inform our understanding of processional movement, it provides an understanding about how the street network surrounding the sanctuary may have facilitated localised movement. The large overall size of the sanctuary and the quantity of artefacts found within it attest to ritual activity being primarily focused within this area. Consideration of how ritual movement travelled beyond this area allows for a more nuanced understanding about how the cult's rituals may have interacted with, and been influenced by, its immediate surroundings.

6.5 The Impact of Urban Activity upon Ritual Movement

The calculation of axial step depth provides a defined area for studying the movement potential past buildings that may have affected processions. The defined ritual area contains a total of 206 buildings (Figure 6.12), which are used to assess how different building influence values impact the potential movement routes within this area.

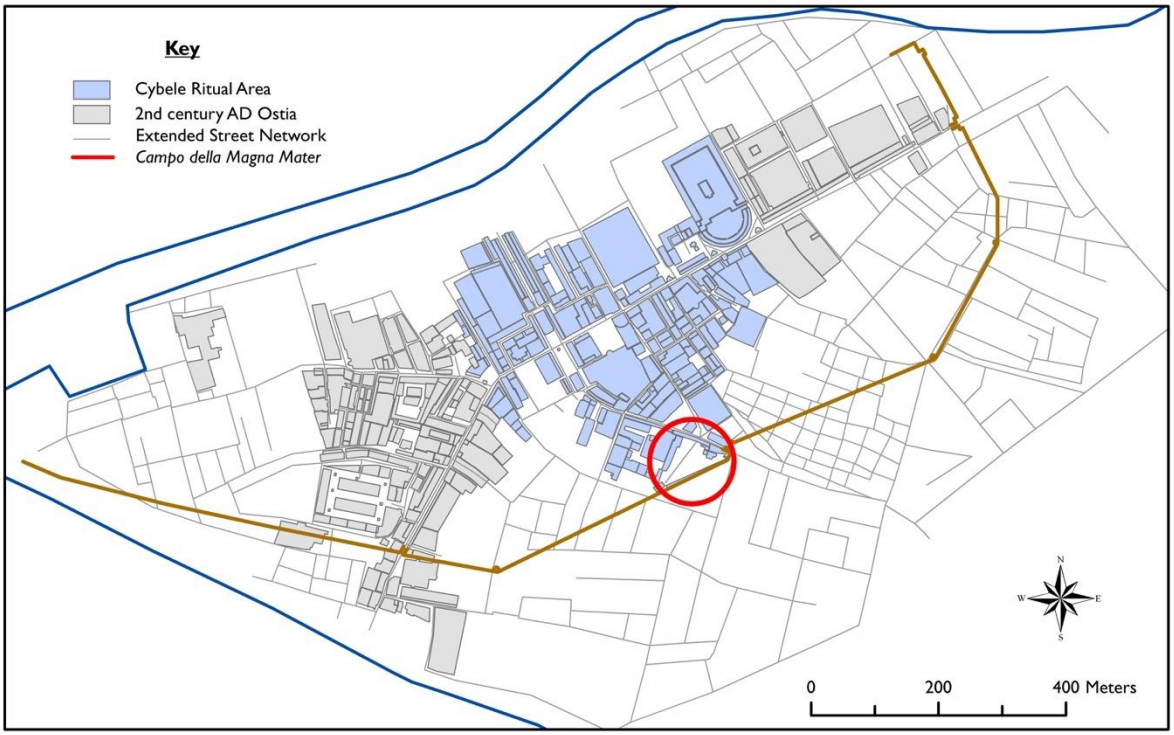

Figure 6.12 Buildings included in the Magna Mater ritual area (blue) located within the cityscape of Ostia (grey). The *Campo della Magna Mater* is circled in red.

An initial betweenness centrality model is run to determine the general movement potential of the ritual area. The 206 buildings located within the ritual area are weighted with a value of 1, while all other buildings that fall outside this area are given a value of 0. Applying a 200 m network radius, the resulting model provides a visualisation of the buildings most likely to be passed by random movement (Figure 6.13). This model provides a general understanding of the likely area of movement when building importance is not taken into consideration. The betweenness centrality results are displayed on a scale of black to light grey, with buildings displayed in black having the highest betweenness centrality measure, meaning they were most likely to be passed. The two highest betweenness centrality measures are interpreted as 'hotspots' of movement, denoting areas more likely to be passed, regardless of one's origin or intended destination. To provide a clearer understanding about how the betweenness results correlate to movement along Ostia's streets, the streets with the highest movement potential corresponding to the building betweenness results are indicated in red and orange. The red streets equate to passing buildings with the highest 20% of betweenness centrality values. The orange routes pass buildings with the highest 40% of betweenness centrality values. These routes are referred to as having differing levels of intensity of use (e.g. likelihood of seeing passing movement).

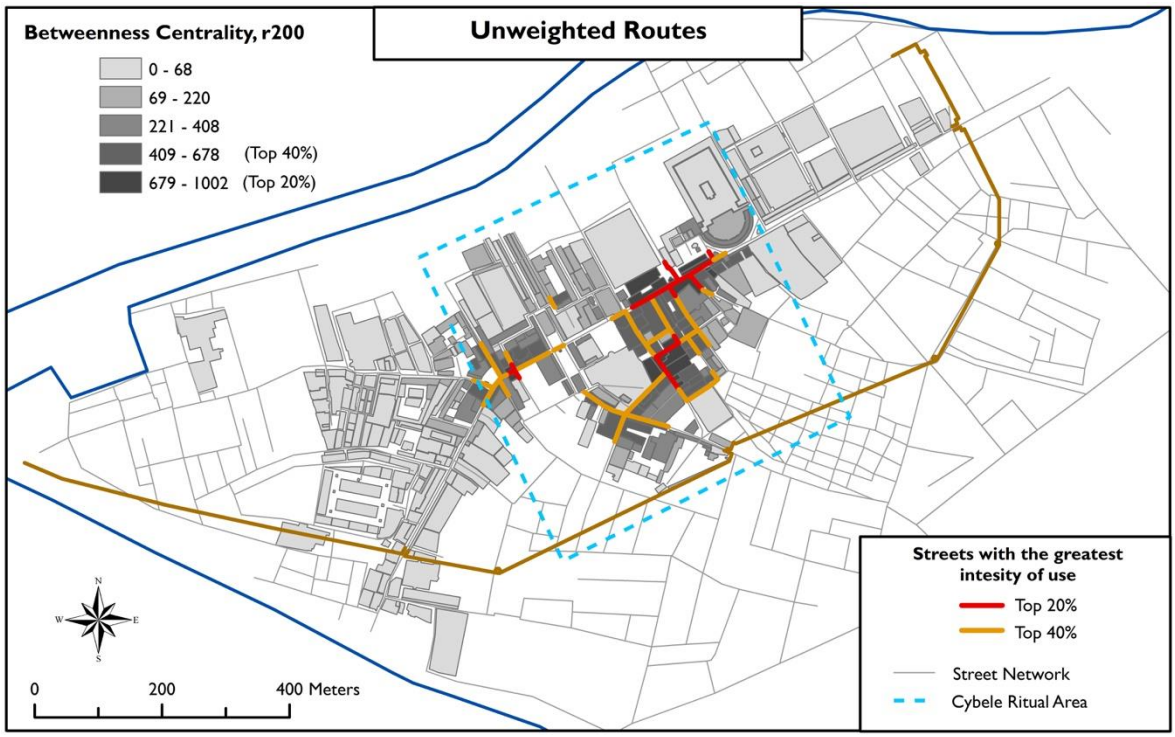

Figure 6.13 Calculation of betweenness centrality weighted by buildings located within the Magna Mater's ritual area (weight 1) and those outside the ritual area (weight 0). The streets following the two highest betweenness centrality metrics are designated in red and orange.

Analysis of the general movement potential within the Magna Mater's ritual area (Figure 6.13) indicates that the urban areas with the greatest movement potential are concentrated northeast of the sanctuary. Unsurprisingly, the street with the most predominant use is the *decumanus* leading to the Theatre, as shown by the streets with the top 20% intensity of use, illustrated in red. Another highly used street includes a portion of the *Semita dei Cippi,* while the streets radiating off from it also have a degree of movement potential as shown by the streets detailed in orange. This indicates a clear area of localised movement that is concentrated in Ostia's southeast quadrant of the city. In comparison to the equivalent space syntax metric, choice (Figure 6.4), the calculation of betweenness centrality, even using unweighted measures, provides a more nuanced view of likely street usage throughout this area.

In order to further question these results and the validity of confining the urban network analysis calculations of this case study to a specific portion of Ostia, an agent-based model simulation is run by weighting all buildings with an influence value of 1 for a total of 1000-ticks. The results (Figure 6.14)[74] reflect the routes chosen by the processional leader during five separate simulation runs. The predominate routes chosen are concentrated along the streets travelling north of the sanctuary

[74] See Appendix D in Volume 2 of this thesis for all of the agent-based model runs that were used to compile the summary ABM figures found throughout this chapter.

and surrounding the *forum*. In all of the runs, movement remains predominately confined to the ritual area previously defined by space syntax. While two of the runs, extending a short distance along the *Via della Foce* and the *Via Epagathiana*, are slightly outside the perimeter of the defined ritual area, the movement parallels the movement potential highlighted by the betweenness centrality results.

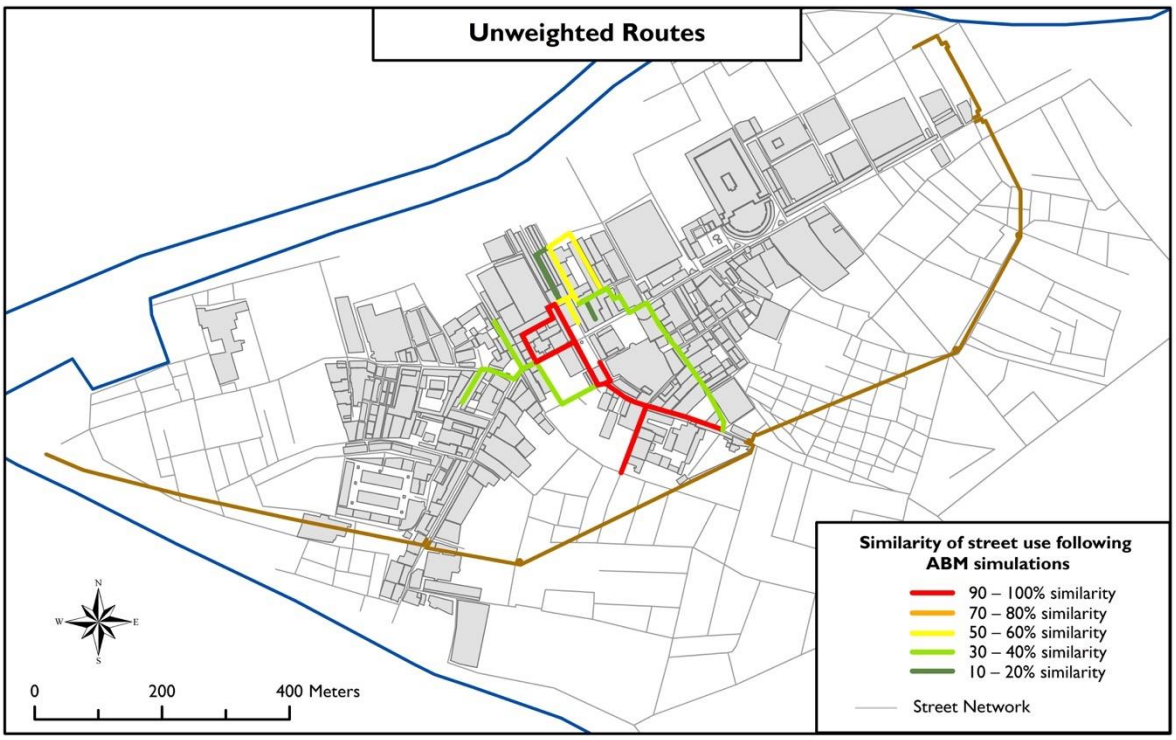

Figure 6.14 Similarity of street usage by un-weighted processional runs (all buildings have an influence value of 1). Routes chosen by the processional leader within 1000-ticks, results of 5 different runs.

Urban network analysis and agent-based modelling are implemented applying weighted measures to the ground floor spaces to assess how building importance affects likely movement routes. How each of the five building classifications (§4.2) impacts movement potential along Ostia's street network is addressed. For the urban network analysis calculations, each building classification is weighted with a value of 10 while the other buildings positioned within the ritual area are given a value of 1 (e.g.: commercial buildings - 10, other four buildings - 1). The remaining cityscape is weighted with a value of 0, so that the buildings are accounted for, but do not directly influence the calculations of movement within the ritual area. Applying a 200 m network radius additionally enables the study of localised movement that corresponds to the limited area of consideration. The results are present in terms of how movement differs when compared to the unweighted graph. Movement areas that follow the unweighted routes are displayed by black coloured streets, while areas with an absence of movement are emphasised by being displayed in blue. This provides a clearer indication about how each space classification shapes movement within the ritual area.

The agent-based modelling calculations applied to each space classification follow a similar premise, addressing two questions. The first question considers the validity of the urban network analysis results and the extent to which building influence values affect movement patterns that begins and ends at the sanctuary. Each building classification is individually run with an influence value of 5, while all other buildings are given a value of 1. The results reflect the route chosen by the processional leader. Each weighted model was run ten times to account for changes in the processional leader's choice in route. The result of each weighted run are subsequently presented in terms of how the movement routes differ from the unweighted ABM routes. This allows for a more nuanced understanding about how the movement patterns of a procession starting and ending at the *Campo della Magna Mater* are shaped by different building categories. The second question addressed by the agent-based model is the degree to which the inclusion of processional participants results in the same routes as those chosen by the processional leader. To test this, each of the above weighted classifications were run for a length of 300-ticks over five different runs. The results, therefore, begin to integrate processional participants or moving group dynamics within the analysis of potential processional routes.

6.5.1 Commercial Weighted Routes

The ritual area of the Magna Mater has 104 buildings defined as having a ground floor commercial function. The area north of the *decumanus* consists predominately of commercial structures while the ritual area south of the *decumanus* has commercial spaces located along every block, but it is not the predominant spatial classification. Calculation of betweenness centrality weighted by commercial space (Figure 6.15) has similar results to the unweighted ritual area betweenness graph (Figure 6.13). This is unsurprising considering that 50% of the buildings located in this area have a commercial function. The streets with the greatest movement potential as it differs from the unweighted graph are indicated in red in orange. The main difference in movement weighted by commercial space indicates a greater likelihood of movement travelling along the *Semita di Cippi* and the *Via della Fortuna Annonaria.*

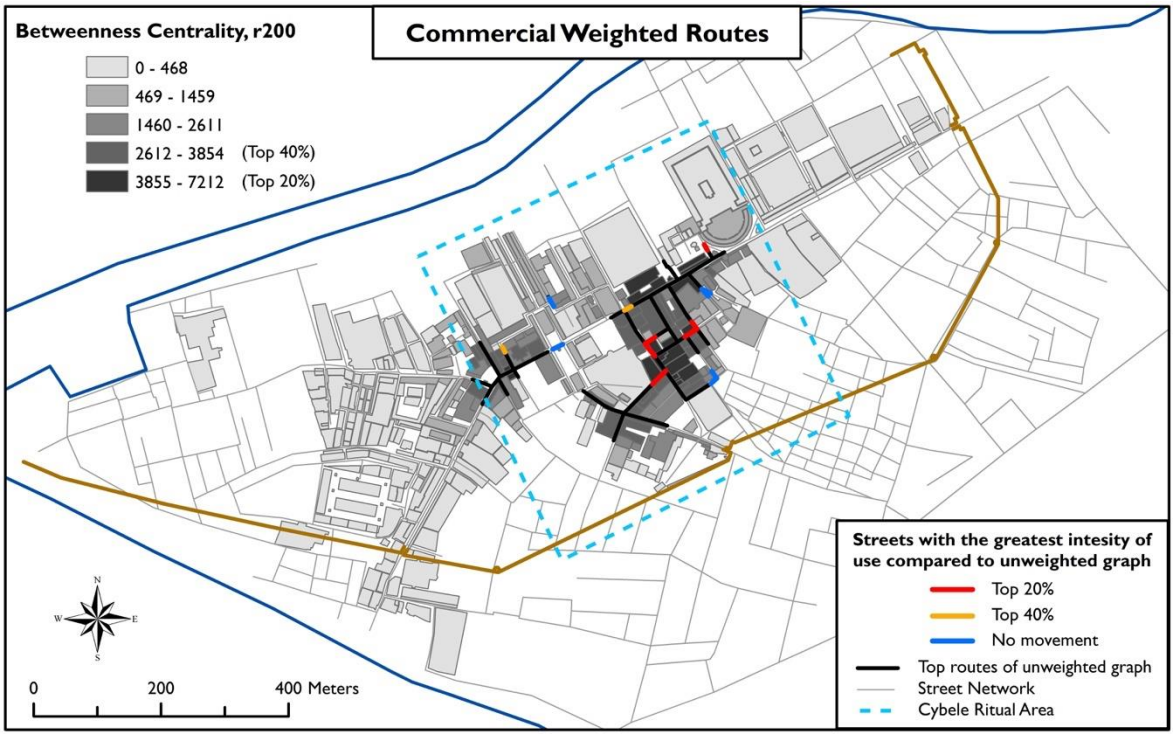

Figure 6.15 Betweenness centrality graph weighted by commercial buildings. Weights: commercial buildings 10, ritual area 1, non-ritual area 0. Streets shown in red and orange follow the two highest betweenness centrality metrics which differ from the unweighted graph. Streets shown in black follow the top 20–40% unweighted betweenness centrality metrics. Streets shown in blue emphasise areas where no movement occurs in relation to the unweighted graph.

The agent-based model results weighted by commercial space (Figure 6.16) show similar results to the betweenness centrality calculations. The routes detail the streets most likely to be traversed which are different from the unweighted ABM runs. The results indicate that during 10 different processional runs, movement is concentrated along the streets north-east of the sanctuary, travelling towards the Theatre. In contrast to the urban network analysis results, there is also some potential for movement to occur along the streets located directly north of the *forum,* although this occurred in only three of the simulation runs. More significantly, the results show that the streets located directly east of the *Semita dei Cippi* likely saw a considerable degree of use if a route was motivated by commercial space. The inclusion of 20 processional followers within the model follows close to the same route as that determined by the processional leader. The slight variation, as indicated by the red dotted line, indicates a greater likelihood of travel along the *Semita dei Cippi* rather than the southern *Cardo Maximus*.

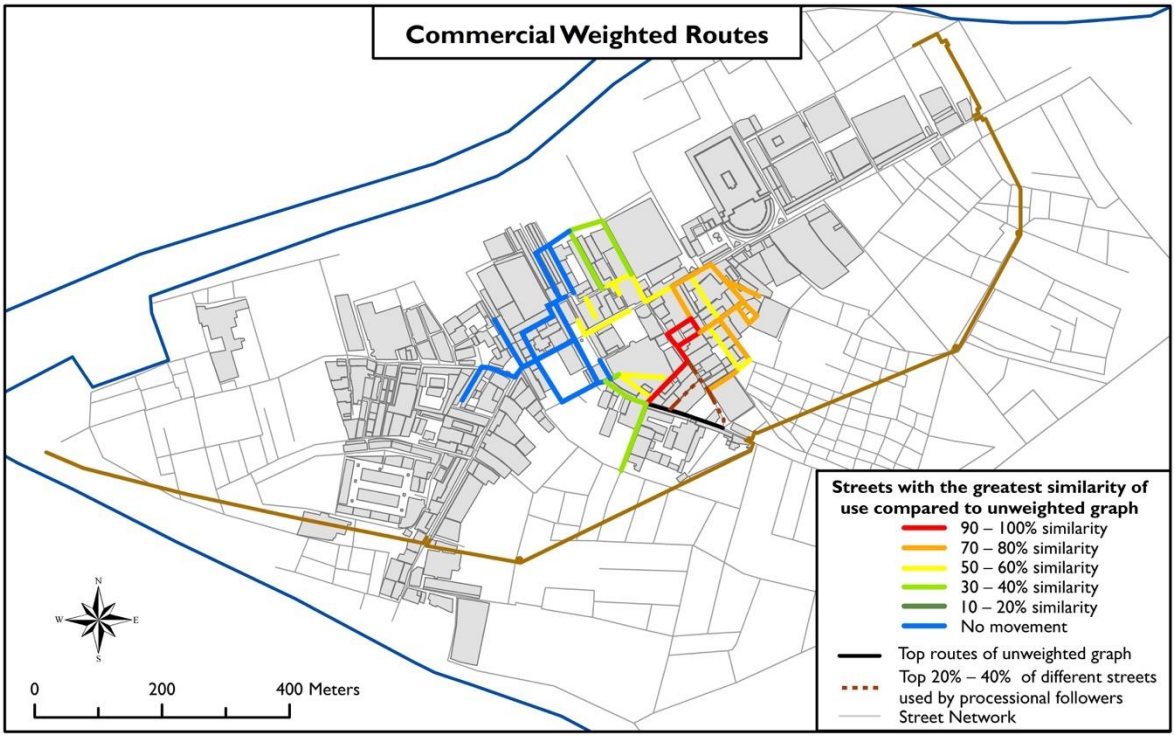

Figure 6.16 Similarity of street usage by processional runs weighted by commercial spaces (commercial building influence – 5, other building influence – 1). Routes reflect those chosen by the processional leader as they differ from the unweighted graph within 1000-ticks during 10 different runs. Streets shown in black follow the top routes of the unweighted graph. The red dotted line indicates streets where the route of processional followers deviates from that of the leader during 5 different runs lasting a duration of 300-ticks.

6.5.2 Production Weighted Routes

Production buildings account for 12 structures within the ritual area. These are not concentrated in any one place but are located throughout the area, accessible by a combination of major and minor streets. The betweenness centrality results (Figure 6.17) are comparable to both the unweighted betweenness graph and the weighted commercial graph. There is less movement occurring along the southern *cardo maximus* as well as showing and no direct connection to the *Semita dei Cippi.* There is also limited movement occurring along the streets connecting south of the eastern *decumanus.* Movement dynamics are clearly concentrated around the *Semita dei Cippi* and along the eastern *decumanus.*

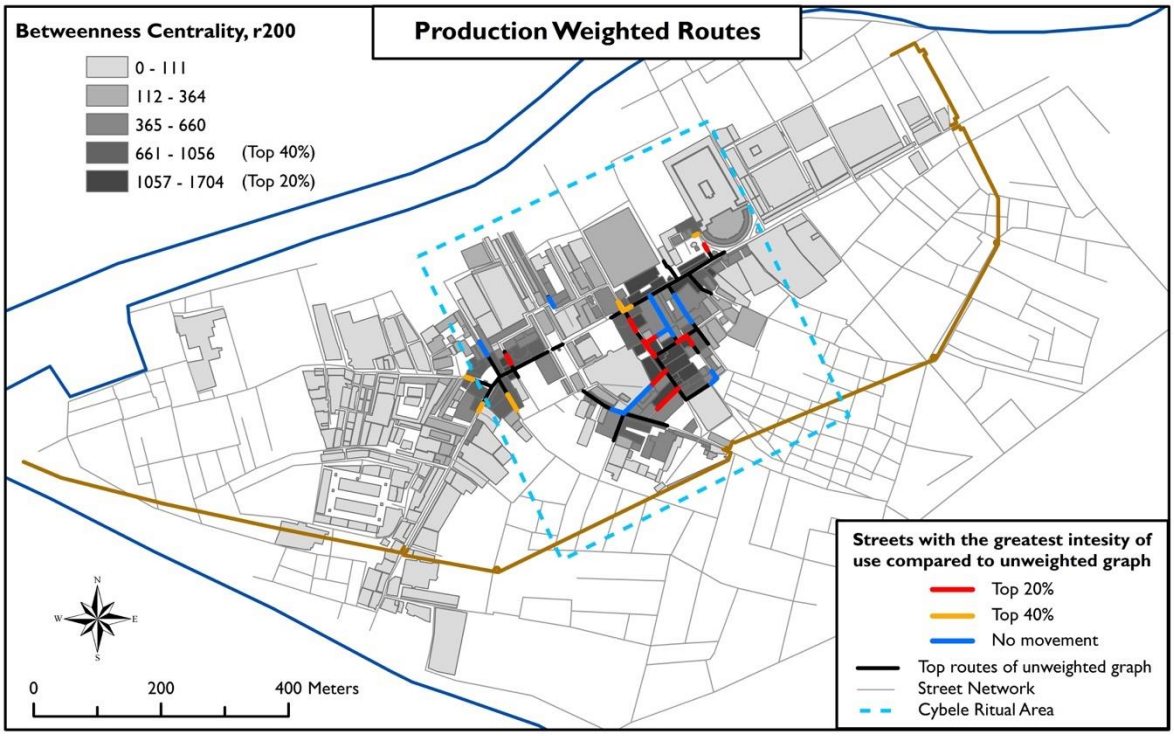

Figure 6.17 Betweenness centrality graph weighted by production buildings. Weights: production buildings 10, ritual area 1, non-ritual area 0. Streets shown in red and orange follow the two highest betweenness centrality metrics which differ from the unweighted graph. Streets shown in black follow the top 20–40% unweighted betweenness centrality metrics. Streets shown in blue emphasise areas where no movement occurs in relation to the unweighted graph.

The agent-based model results of processional routes weighted by production spaces follow the urban network analysis results. The route chosen by the processional leader (Figure 6.18) is focused along the minor streets travelling north-east of the sanctuary. These results show a more nuanced relationship to passing areas of production when compared to the betweenness centrality results. For instance, the leader agent travels past the production areas located along the small street connections between the *cardo maximus* and the *Semita dei Cippi,* as well the production buildings accessible from *Via della Fortuna Annonaria.* An interesting result is the return route that travels along the streets of the unexcavated city to return to the temple. This largely reflects choosing a route that has not already been travelled and that is also the shortest path back to the sanctuary. The inclusion of processional followers shows no variation in the route dictated by the processional leader.

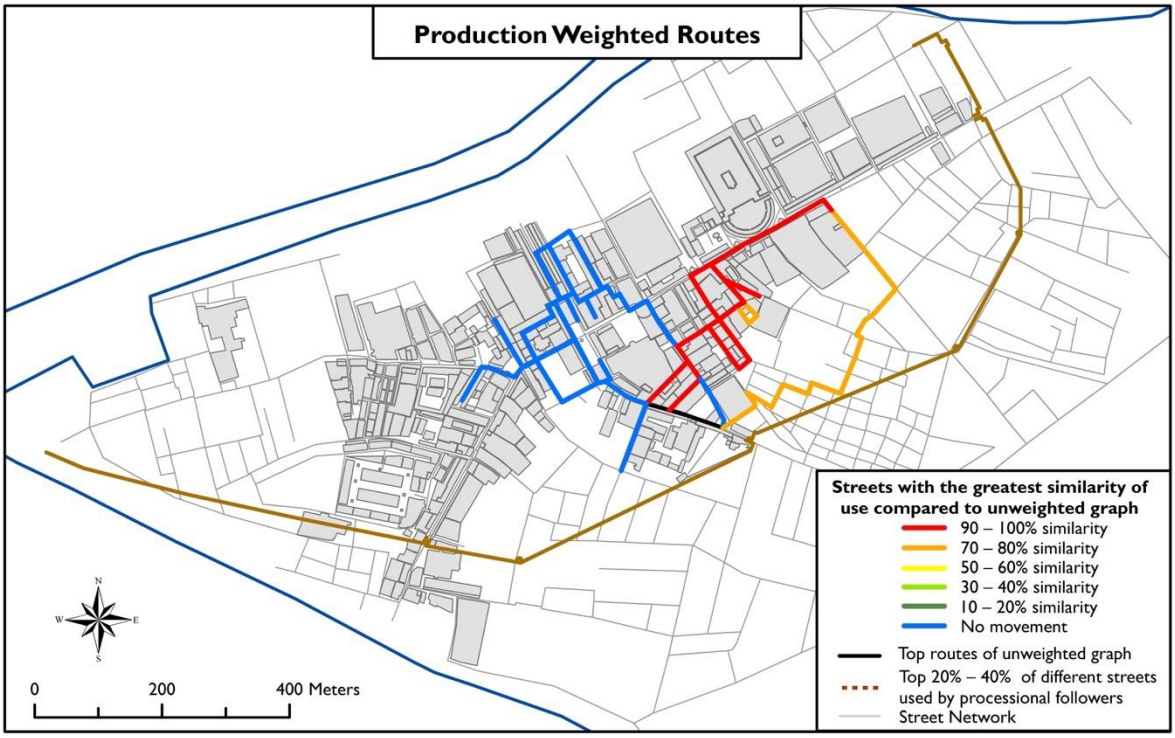

Figure 6.18 Similarity of street usage by processional runs weighted by production spaces (production building influence – 5, other building influence – 1). Routes reflect those chosen by the processional leader as they differ from the unweighted graph within 1000-ticks during 10 different runs. Streets shown in black follow the top routes of the unweighted graph. The red dotted line indicates streets where the route of processional followers deviates from that of the leader during 5 different runs lasting a duration of 300-ticks.

6.5.3 Residential Weighted Routes

Residential space accounts for only 24 ground floor spaces in the area. None of these buildings are directly accessible from the *decumanus,* but are positioned along secondary and tertiary streets. The betweenness centrality graph (Figure 6.19) displays considerable variation when compared to the other space classifications and the unweighted graph. The streets with the highest potential are displayed in red, which are focused around the *insulae* surrounded by the *Semita dei Cippi, Via della Fortuna Annonaria,* and *Via del Mitreo dei Serpenti*. Like with the previous betweenness graphs, areas with a high degree of movement potential are positioned along the eastern *decumanus.* Surprising is the minimal movement potential around the *insulae* apartments located north of the *decumanus.* Movement is clearly concentrated towards the area east of the sanctuary, only connecting to the eastern *decumanus* by the *Via del Sol.*

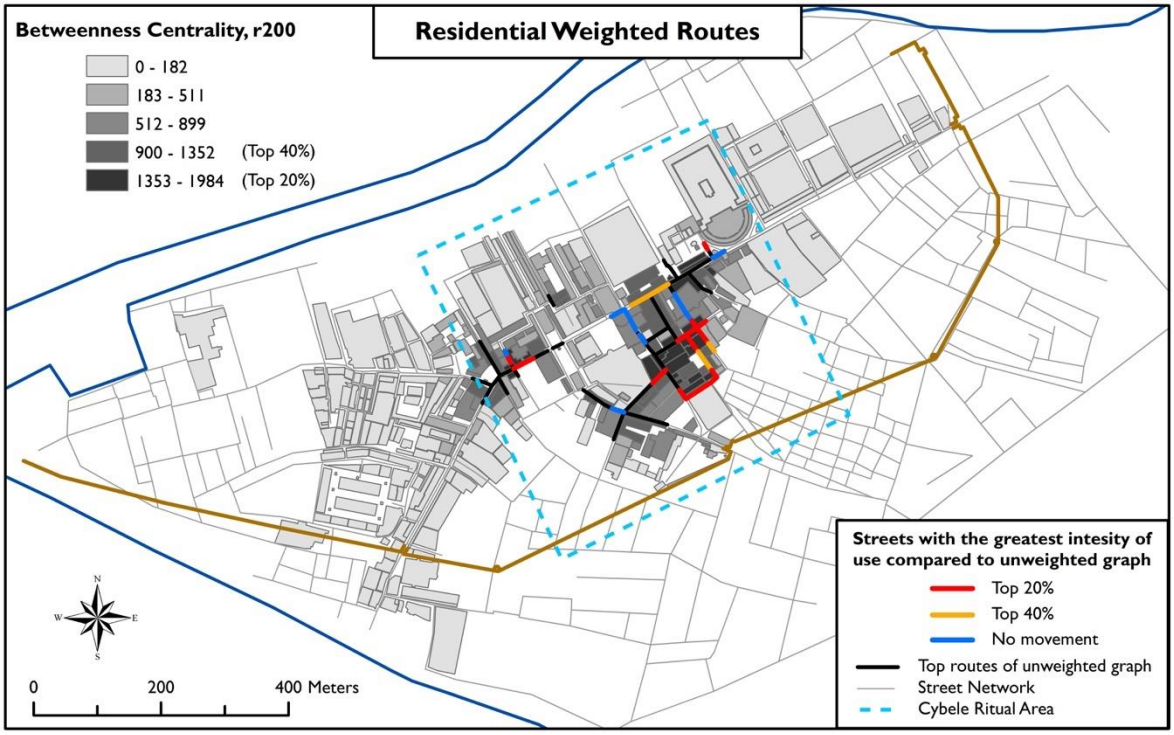

Figure 6.19 Betweenness centrality graph weighted by residential buildings. Weights: residential buildings 10, ritual area 1, non-ritual area 0. Streets shown in red and orange follow the two highest betweenness centrality metrics which differ from the unweighted graph. Streets shown in black follow the top 20–40% unweighted betweenness centrality metrics. Streets shown in blue emphasise areas where no movement occurs in relation to the unweighted graph.

The agent-based model results of likely processional routes influenced by residential space (Figure 6.20) show greater variation compared to the betweenness centrality results detailed in the previous two sections. The routes chosen by the processional leader do parallel the urban network analysis results in terms of the high probability of movement travelling around the *insula* surrounded by the *Semita dei Cippi* and the *Via della Fortuna Annonaria.* This reflects the concentration of residential structures located within this area. The remainder of the possible processional route travels north along the *cardo maximus* and along some of the streets north of the *forum.* Whereas the betweenness centrality results indicate that movement would have travelled primarily along the *decumanus* towards the Theatre, a few of the agent-based model runs show that movement could occur in the northern area of the city, passing several of the apartment complexes located along the *Via di Diana.* The analysis of the path taken by the processional participants when they are included shows less similarity with the route dictated by the processional leader. Differentiation in possible paths arise with a greater indication of movement occurring around the large commercial building located directly east of the sanctuary.

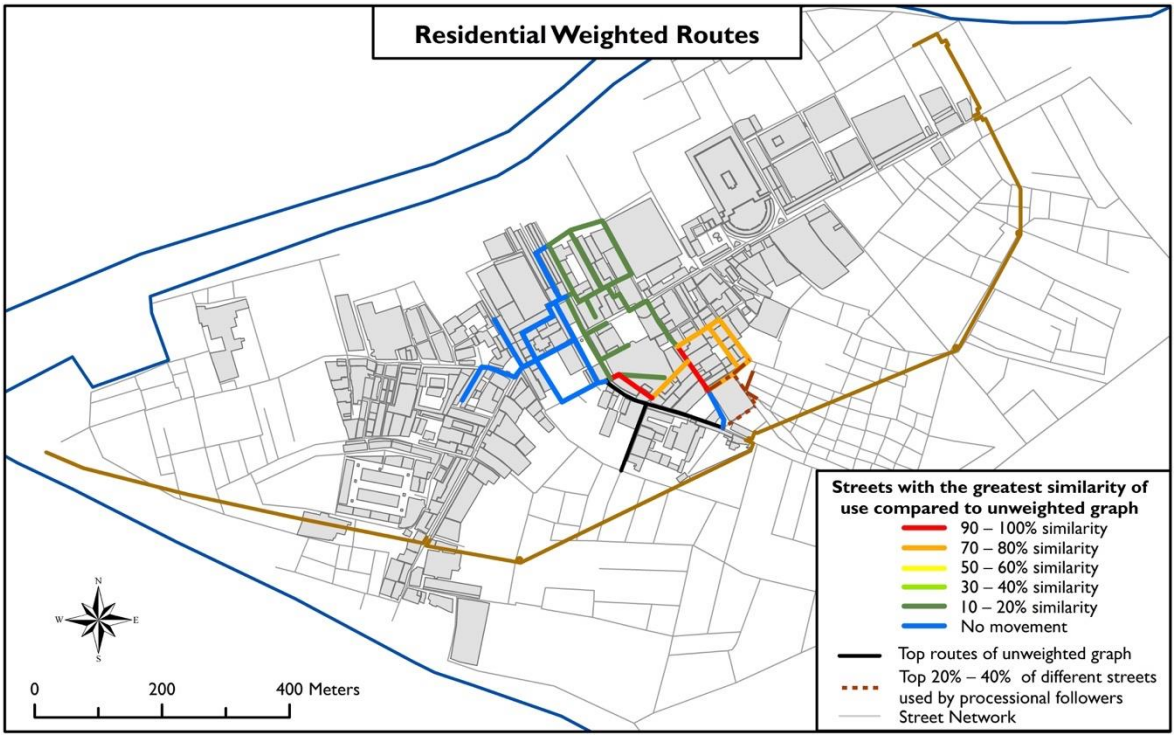

Figure 6.20 Similarity of street usage by processional runs weighted by residential spaces (residential building influence – 5, other building influence – 1). Routes reflect those chosen by the processional leader as they differ from the unweighted graph within 1000-ticks during 10 different runs. Streets shown in black follow the top routes of the unweighted graph. The red dotted line indicates streets where the route of processional followers deviates from that of the leader during 5 different runs lasting a duration of 300-ticks.

6.5.4 Public Weighted Routes

Public spaces include 41 structures within the ritual area. The large public buildings are generally accessible from the *decumanus,* while spaces like fountains and porticos are located along more minor streets. Compared to the other three weighted classifications, weighting calculations by public space shows extremely limited movement potential (Figure 6.21). Most significant are the areas where movement does not occur, as indicated by the streets highlighted in blue. The *decumanus* maintains the greatest movement potential. Secondary areas of likely movement, shown by streets coloured in orange, constitute a small portion of the *Semita dei Cippi* connecting to the *Via della Fortuna Annonaria* and the eastern *decumanus.* These results indicate that the *decumanus* remains the focal point for movement structured by access to public spaces.

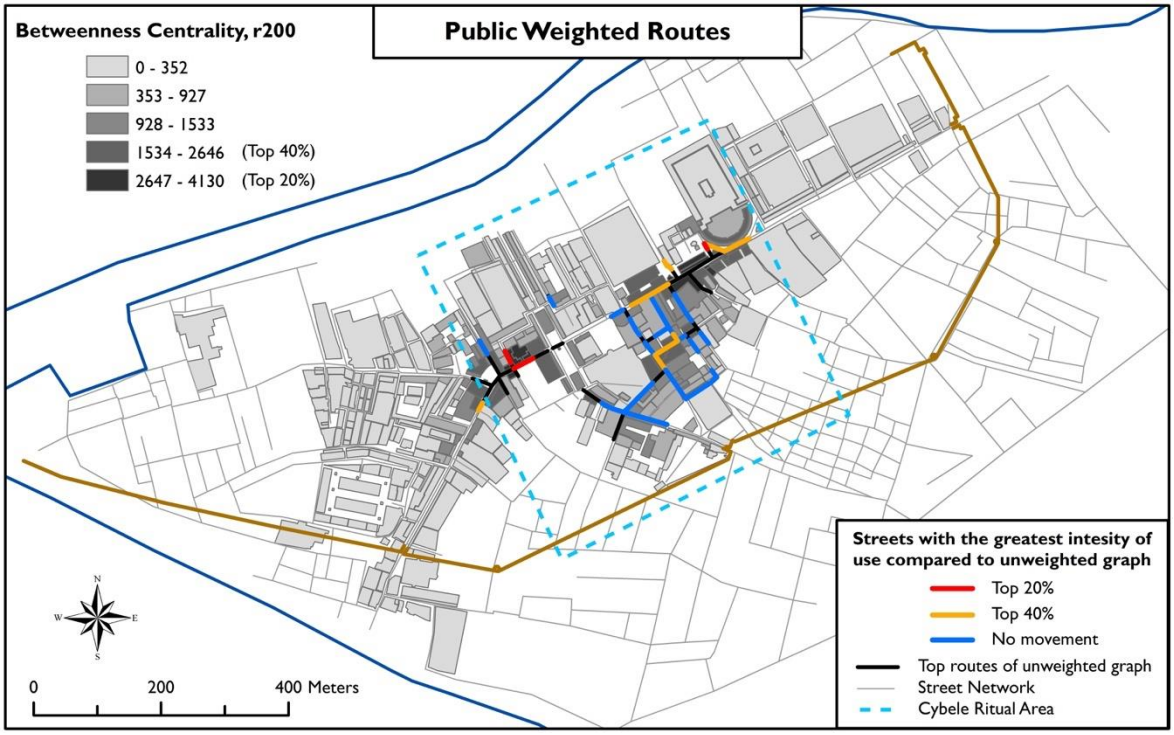

Figure 6.21 Betweenness centrality graph weighted by public buildings. Weights: public buildings 10, ritual area 1, non-ritual area 0. Streets shown in red and orange follow the two highest betweenness centrality metrics which differ from the unweighted graph. Streets shown in black follow the top 20–40% unweighted betweenness centrality metrics. Streets shown in blue emphasise areas where no movement occurs in relation to the unweighted graph.

The possible processional routes determined by the agent-based model following public weighted buildings show significant variation to the betweenness centrality results (Figure 6.22). Unlike the urban network analysis results that indicate movement is most likely to occur along sections of the *decumanus,* the path taken by the processional leader contradicts this. While there is a high probability for the full processional route to travel along portions of the eastern *decumanus,* the route chosen by the processional leader travels predominately within the areas north of the *forum* along the northern *cardo maximus.* A couple of the simulations indicate movement travelling within the area north-east of the sanctuary, but this is not the dominant route. In both instances, the paths chosen by the processional leader do closely reflect passing areas with a high prevalence of public buildings. The inclusion of processional participants likewise shows that the agents closely follow the route dictated by the processional leader.

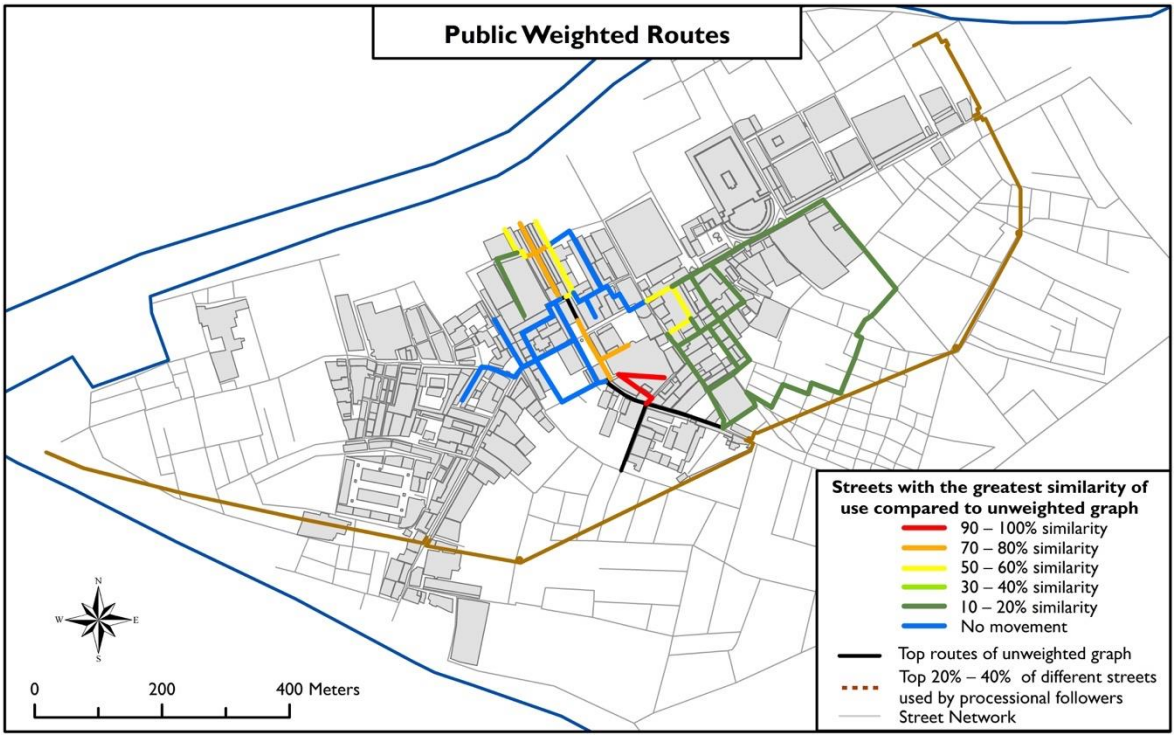

Figure 6.22 Similarity of street usage by processional runs weighted by public spaces (public building influence -5, other building influence – 1). Routes reflect those chosen by the processional leader as they differ from the unweighted graph within 1000-ticks during 10 different runs. Streets shown in black follow the top routes of the unweighted graph. The red dotted line indicates streets where the route of processional followers deviates from that of the leader during 5 different runs lasting a duration of 300-ticks.

6.5.5 Religious Weighted Routes

Temples and shrines account for 22 buildings within the ritual area. A portion of these are concentrated within the *Campo della Magna Mater*. The remaining structures are dispersed throughout the ritual area, but there is an absence of religious spaces in the *insulae* directly west of the *Terme del Foro*. The betweenness graph shows that the areas with the greatest movement potential are concentrated around the eastern *decumanus* and a small section of the *Semita dei Cippi* (Figure 6.23), which follows the results of the unweighted betweenness graph (Figure 6.13). The streets with the second highest movement potential, shown in orange, are concentrated along the *decumanus,* the southern *cardo maximus,* and the *Semita dei Cippi.* There are several areas of variation when compared to the previous weighted betweenness graphs. The influence of the *Campo della Magna Mater* on structuring movement is shown through the extension of likely movement along the *cardo maximus.* There is only limited movement potential travelling along the minor streets east of the *Semita dei Cippi,* which is similar to the movement patterns shown by the public classification movement areas (Figure 6.21).

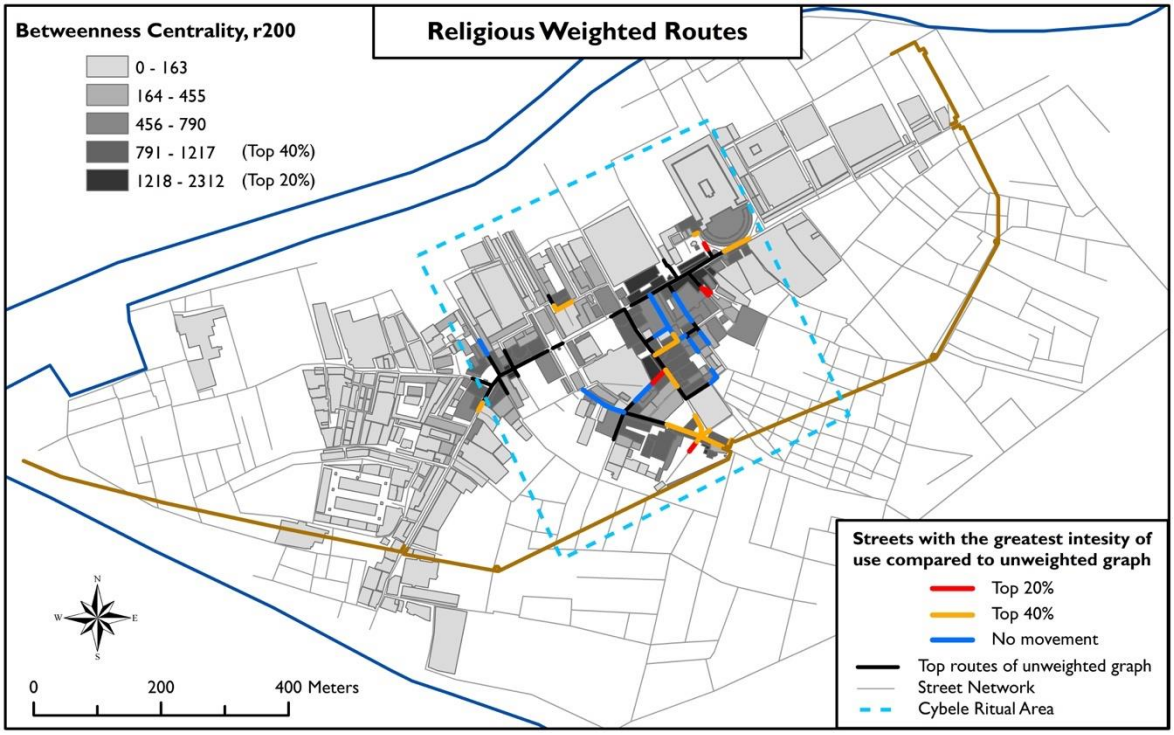

Figure 6.23 Betweenness centrality graph weighted by religious buildings. Weights: religious buildings 10, ritual area 1, non-ritual area 0. Streets shown in red and orange follow the two highest betweenness centrality metrics which differ from the unweighted graph. Streets shown in black follow the top 20–40% unweighted betweenness centrality metrics. Streets shown in blue emphasise areas where no movement occurs in relation to the unweighted graph.

Similar to the public weighted routes, the agent-based model results of the path chosen by the processional leader show considerable variation when compared to the urban network analysis results. The possible routes (Figure 6.24) predominately travel along the streets surrounding the *forum*. Considering the concentration of religious spaces within the *forum* and within its vicinity, the agent-based model results likely offer a more accurate reflection of the likely paths taken by a procession interested in passing predominately religious structures. The inclusion of processional participants (Figure 6.24) shows similar results. The variation in processional followers routes are a result of the dispersal of the group at certain points during the simulation runs.

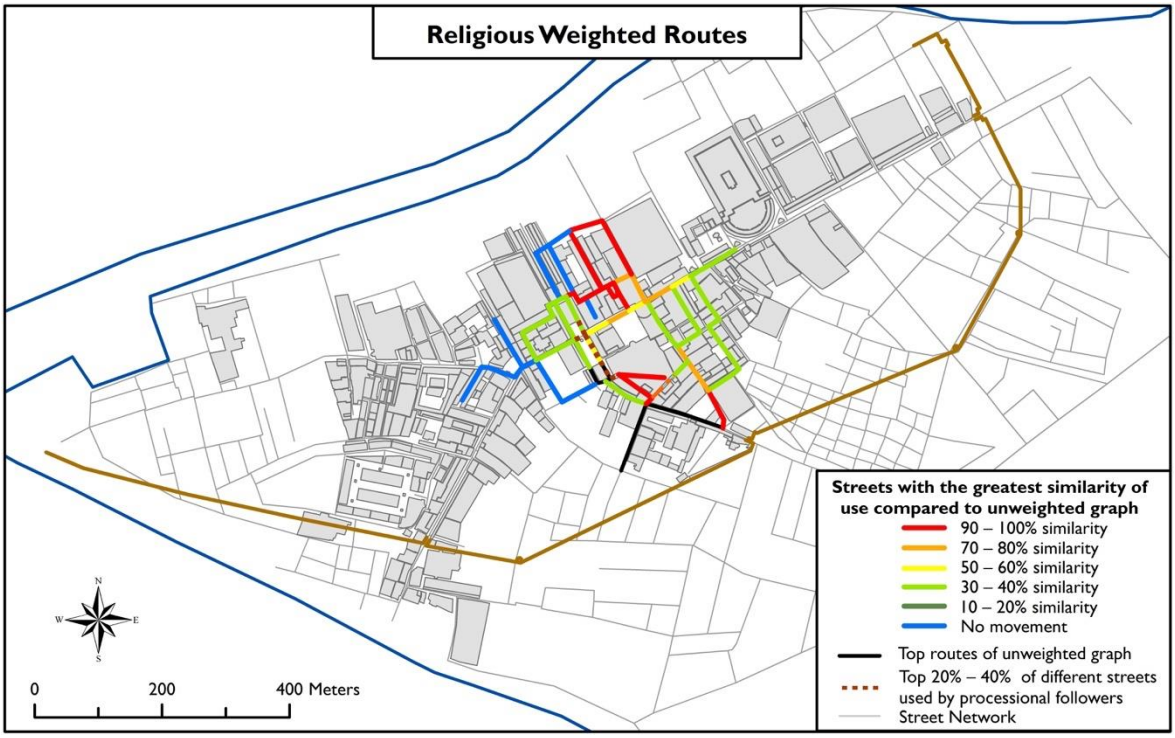

Figure 6.24 Similarity of street usage by processional runs weighted by religious spaces (religious building influence – 5, other building influence – 1). Routes reflect those chosen by the processional leader as they differ from the unweighted graph within 1000-ticks during 10 different runs. Streets shown in black follow the top routes of the unweighted graph. The red dotted line indicates streets where the route of processional followers deviates from that of the leader during 5 different runs lasting a duration of 300-ticks.

6.5.6 Potential Routes Using Combined Building Weights

The previous analysis of individual building classifications provides insight into movement if only one type of space is considered. But when assessing religious movement along a street, it is doubtful that only one building category in isolation influenced a specific route. To address how movement potential changes when different types of buildings are accounted for, various iterations were run using betweenness centrality with all the buildings weighted on a scale of 6–10. The results are then assessed corresponding to the highest weighted building classification (e.g. commercial weight – 10).

To evaluate the variation in movement along different streets within the Magna Mater's ritual area and how it differs from the unweighted graph, routes were detailed corresponding to the two highest betweenness centrality measures as well as in terms of areas that had an absence of movement. This follows the same method used for the analysis of individual building classifications. Streets detailed in red correspond to buildings with the top 20% betweenness measures. Streets shown in orange correspond to buildings that have the top 40% betweenness values. Streets displayed in yellow indicate areas that varied between passing buildings with the highest 20%–40%

betweenness centrality values within the 24 related graphs. Figure 6.25[75] shows the variation in movement when each individual building classification is weighted with a value of 10.

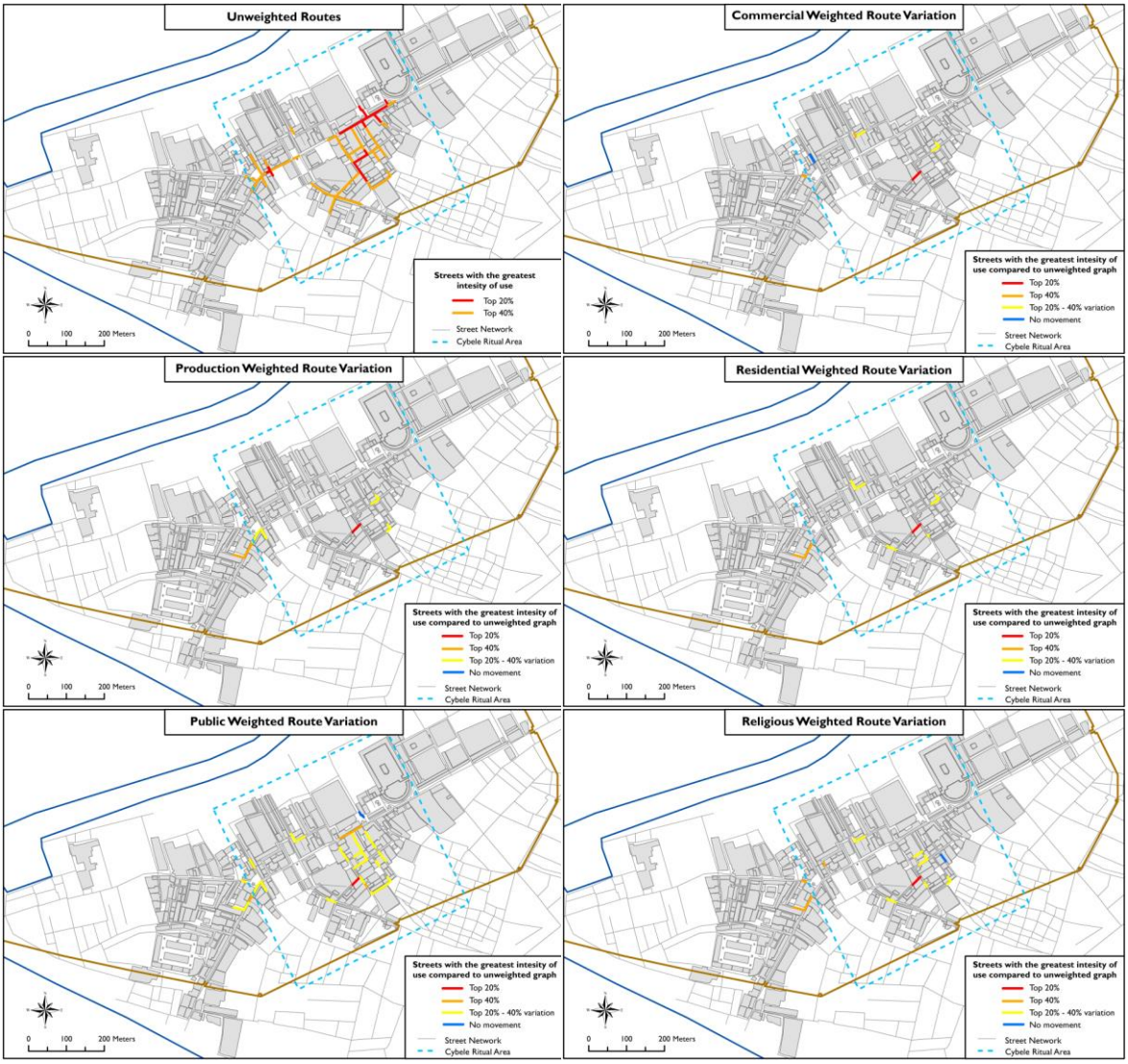

Figure 6.25 Route variation specific to each highest weighted building classification category.

Assessment of the different weighted betweenness graphs indicates some variation in streets that would have been traversed when weighted predominately by each building classification category. These possible areas of movement allow for a more focused study into the ways in which buildings with varying levels of importance structured movement throughout the defined ritual area. Attention towards the archaeological record and Ostia's built environment likewise informs our understanding of how rituals associated with the Magna Mater were disseminated across a portion of the cityscape.

[75] See Appendix D in Volume 2 of this thesis for all of the supplementary betweenness centrality graphs compiled to make the final images displayed in Figure 6.25.

The areas with the greatest movement potential are detailed in red. Within all the weighted graphs, there is little variation when compared to the unweighted graph. This means that the greatest proportion of movement, regardless of how buildings are weighted, corresponds to the eastern *decumanus* and the streets east of the *Semita dei Cippi.* The main difference in all of the weighted graphs shows likely movement travelling along the small street located directly south of the *Terme del Foro.*

Areas with the second highest movement potential are concentrated outside the ritual area, corresponding to the western *decumanus.* In all but the commercial weighted graphs, there is increased potential of movement travelling towards the western area of the city. The only other variation is shown in the public weighted graph, where a section on the eastern *decumanus* running south of the *Grandi Horrea* has a lower movement potential when compared to the unweighted graph.

The most significant variations in all of the weighted graphs is the deviation in streets as having either a highest or second highest movement potential value when compared to the unweighted graph. Variation in movement potential occurs along the streets bordering the *insulae* apartments of I.iv. All but the public weighted graphs indicate a consistent potential of movement along the *Via dei Dipinti.* A few of the graphs extend this movement to the connecting *Via di Diana.* While these buildings clearly structure movement along this section of Ostia's street network, it is interesting that the movement does not connect to the city's main streets.

The other streets with the greatest amount of variation correspond to the minor streets of the area bounded by the eastern *decumanus, Semita dei Cippi,* and the *Via degli Augustali.* All of the graphs show changing intensity of movement potential travelling along the *Via della Fortuna Annonaria,* which connects to the *Semita dei Cippi*. The variation in the likely use of the *Via della Fortuna Annonaria,* which alternates between the highest and second highest betweenness values, suggests that it existed as a regular connection between the *Semita dei Cippi* and the *Via degli Augustali.* The public weighted graph shows the most significant variation compared to all of the other weighted routes. When compared to the unweighted graph, almost all of the minor streets located in the south east portion of the city fluctuate in their likely intensity of use. In terms of public weighted routes, this suggests that movement remains concentrated along the *decumanus.*

Most surprising are the areas of the city that maintain a high probability of movement that is consistent with the unweighted graph, regardless of how different building classifications are weighted. The *cardo maximus* maintains a second highest movement potential value regardless of the weighted combinations. Since this street connected the entrance gate, the *Porta Laurentina,* with the *forum* it seems likely that this area saw a high degree of traffic use. An interesting aspect of the present betweenness results is that the *cardo* seems most likely to connect to the *Semita dei Cippi* via the street that runs directly south of the *Terme del Foro.* All of the weighted graphs indicate this

connecting street saw a high degree of movement. DeLaine notes that the *Semita dei Cippi* and *Via dei Molini* would have been the primary access route for connecting the *Porta Laurentina* with the Tiber (2005, p. 33). The urban network analysis results confirm that the *Semita dei Cippi* had a strong movement potential regardless of how surrounding structures are weighted. If the *Semita dei Cippi* was indeed a major movement corridor, it would make sense that a procession would opt for greater visibility by passing along this route rather than along the southern *cardo maximus*. However, the unexcavated area west of the *cardo maximus* likely presents slightly skewed results since the functionality of these buildings cannot be taken into account at present.

Another area of the city with a high degree of movement potential is along the streets radiating from the intersection of the *decumanus* and the *Via della Foce*. Considering that this area likely served as a major intersection for the city, it is unsurprising that all of the weighted graphs indicate that this area saw a high degree of movement. In terms of the present study for movement within a ritual area specific to the *Campo della Magna Mater,* it indicates that processional activity may have extended to the *Via delle Foce*. Considering this street led to the river port, such an association does not seem unlikely.

A final notable aspect is that all of the graphs show minimal movement potential occurring north of the *decumanus*. While this area likely saw a high proportion of movement related to commercial activity originating at the Tiber and travelling along the *cardo maximus,* the various weighted betweenness centrality calculations show that movement was focused predominately south of this area. Since the Tiber naturally delineated the city at this point, there is less potential of the results reflecting the effect of an 'edge effect' in the data. One factor that needs to be acknowledged, although it is not addressed in this thesis, is the presence of buildings on the other side of the Tiber, in what has been defined as the Trastevere Ostiense (Germoni *et al.*, 2018). This indicates the likelihood of additional movement activity within the area north of the *decumanus*. However, much of this movement probably related to commercial activity.

The analysis of the different weighted betweenness centrality graphs indicate movement routes that saw less variability compared to the previous sections that assessed movement potential in relation to only one weighted value. While there are clear differences in movement potential along some of the minor streets located throughout the ritual area, the framework of movement remains consistent. These results provide a general picture about the streets that would have witnessed movement throughout the urban landscape within a specified ritual area.

6.6 Discussion

The analysis undertaken above has shown how the *Campo della Magna Mater* structured ritual activity through the practice of processions, which were influenced by passing certain types of buildings. The remainder of this chapter expands upon these results to address their significance

and the degree to which they provide insight into the most probable areas of movement when assessed in relation to the archaeological record and our understanding of the rituals associated with the Magna Mater. The significance of these routes in contributing to Ostia's extended ritual landscape will be further explored in Chapter 9.

Addressing the potential movement areas associated with the sanctuary of the Magna Mater first and foremost needs to be considered within the context of the specific processional rituals that would have taken place. The previous section has illustrated how movement routes were structured by the surrounding built environment, focusing upon how different forms of urban activity would have influenced movement travelling within Ostia's street network. These various routes, however, are insignificant if not considered within the context of the specific processional rituals associated with the sanctuary. In order to determine the extent to which we can more fully understand the routes taken by various processional rituals, three different processions will be briefly considered: the procession of the *cannophori,* the procession of the *dendrophori,* and a procession associated with the *Megalensia* rituals. By considering what we know about these processions in light of the festivals detailed at Rome, we can propose a general framework of the Magna Mater's processional rituals. The way that the built environment then structured movement within this framework at Ostia, following the previous analyses undertaken, presents a more nuanced understanding about how processions may have navigated the area surrounding the sanctuary of the Magna Mater.

The procession of the *cannophori* (reed-bearers) opened the spring ritual period of the *Campo della Magna Mater* on the 15 March.[76] The March series of festivals were all focused upon the myth of Cybele's love of Attis and his eventual death. This first procession would have likely been one of celebration, commemorating Attis' life (Showerman, 1906, p. 28; Meiggs, 1973, p. 356). Details of the procession at Rome indicate that the *cannophori* began their journey at the River Almo, also the location of their *schola*, where they collect the reeds that would then be carried to the sanctuary located on the Palatine (Fishwick, 1966, p. 195; Pensabene, 2008, p. 23). This route is structured around the myth of Cybele's discovery of the infant Attis along the banks of the river Gallos (Julian. *Or.* 5.165; Salzman, 1990, p. 166).

The processional ritual led by the *dendrophori* (tree-bearers) occurred on the 22 March. This procession would have had a much more solemn character, likely resembling a funerary procession (Showerman, 1906, p. 28; Fishwick, 1966, p. 198). At Rome, this procession consisted of carrying a pine tree that was emblematic of Attis' death from their headquarters located on the Caelian hill (*CIL* VI 30973; Amm. Marc. 23.3.7, **A.1g**) to the sanctuary of the Magna Mater on the Palatine

[76] This part of the festival was added to the calendar during the mid-2nd century AD when Attis was gaining new importance as a deity of rebirth (Fishwick, 1966, p. 198).

(Showerman, 1906, p. 28; Pensabene, 2008, p. 27). This final procession represented the burial of Attis and Cybele's grief over his loss.

The processions associated with the *Megalensia* would have had a much different atmosphere compared to the March festivals. This procession celebrated Cybele's arrival at Rome, recalling her landing at Ostia and elaborate procession to Rome. These rituals would have preceded theatrical events that took place either before the sanctuary on the Palatine or within the theatre of Marcellus at Rome (Cic. *Har. resp.* 12; Roller, 1999, p. 288; Latham, 2012). The occurrence of such a ritual at Ostia likely held substantial significance considering the goddess's initial arrival at the city before being taken to Rome. In terms of theatrical events, these would have taken place either within the open area of the *Campo della Magna Mater* or at the Theatre. Prior to the construction of the sanctuary and the Theatre, these rituals would have likely occurred within the original sanctuary, although its location remains speculative.

In order to consider a possible framework of movement that helped to shape the Magna Mater's processional rituals at Ostia, we need to first consider how the processions would have manifested at Rome. The processions at Rome all traced a route that held mythological significance for Cybele, inclusive of her arrival at Ostia from Phygia to her placement within the temple on the Palatine. These various rituals would have consisted of a similar processional framework even if the starting points varied, as was the case for the processions of the *cannophori* and the *dendrophori.* The two most important elements of the processional route would have been the goddess's temple located on the Palatine and the river Almo (Pensabene, 2008). Other potential passage points included spaces significant to the cult. The procession at Rome likely passed the Colosseum and the *Forum* before continuing towards the *tholos* of the Magna Mater (Mart. 1.70.10; Coarelli, 1982, pp. 34–39). Alternatively, it may have chosen to go past the Circus Maximus, which included a shrine to the goddess (Coarelli, 1982, pp. 41–45; Iara, 2015, pp. 126–127). An additional place visited by the procession may have included the temple of Divus Claudius, reflecting his role in establishing the festival of the *dendrophori* (Fishwick, 1966, p. 201).

Considering how similar aspects might be evident at Ostia enables a general framework to be constructed for the processional rituals associated with the sanctuary. Certain areas of the city could serve as an adequate parallel for specific nodes of the processional route detailed at Rome. The two most important would have been first, the sanctuary itself, and second, the Tiber. The Tiber had a crucial role in acting as the entrance point for the goddess's initial landing at Ostia (Livy 29.14.10, **A.1b**; Julian. *Or.* 5.159–160, **A.1h**). Considering this, it would stand to reason that Cybele's original arrival at the harbour of Ostia would have been retained as an important component within the Ostian processional rituals. At Rome, the location of the Almo would have played a significant role in directing movement to and from the Palatine where the Magna Mater's sanctuary was located. At Ostia, we can imagine that the Tiber might fulfil a similar purpose as being

an attractor to movement travelling from the sanctuary. For the processions of the *cannophori* it serves as a symbolic representation of where Attis was first discovered by Cybele. Second, it would have enabled the practice of additional rituals such as the *Lavatio*, washing of the statue of the Magna Mater, that originally occurred in the Almo. If carrying out these rituals along the bank of the Tiber was unfeasible due to its interference with commercial activity, an alternative could include travelling towards the seafront, although this would not hold the same level of symbolic significance. It seems likely that the procession would also pass the *forum,* where both of the two temples represented a degree of imperial patronage, as a way of acknowledging the emperor's role in introducing these particular processional rituals. In terms of processions associated with the *Megalensia,* while theatrical performances may have occurred within the precincts of the sanctuary, they may have also taken place within the Theatre.

The spaces relevant to Cybele's mythic origins provide a general topographic framework for considering a general framework for possible processional rituals at Ostia. The main areas that likely saw passing movement included the *forum,* the Tiber, and the Theatre. The various processional rituals likely originated at the sanctuary. Although the *scholae* of the *cannophori* and *dendrophori* have yet to be definitively identified, it seems probable that they existed within the sanctuary due to the number of dedications discovered within the campus that were donated to these two associations (Rieger, 2004, pp. 93–172). Additionally, the large size of the sanctuary would have been well suited as a gathering point prior to the start of the ritual festivities. The processions, upon leaving the sanctuary likely travelled along either the *cardo maximus* towards the *forum* or the *Semita dei Cippi.* Movement then continued northwards in the general direction of the Tiber. The specific route taken would have been influenced by which buildings were more important to pass. If the procession wanted to be seen by particular inhabitants, potentially associated with the cult, then it might travel around either the *insula* located east of the sanctuary which hosted various residential spaces or *insula* I.iv which consisted of a variety of different *medianum* apartments. Alternatively, if passing certain public spaces held specific significance, movement might have continued northwards along the *cardo maximus.* The next node would have been the Theatre, which was likely reached by travelling along the *decumanus.* The return to the sanctuary would have taken a route either along the *cardo maximus* or back along the *Semita dei Cippi,* traversing some of the subsidiary streets located within *region V*.

How the built environment and surrounding social activity structured movement within this framework enables a more informative approach to considering the processional rituals associated with the Magna Mater. A summary assessment of both the betweenness centrality calculations and agent-based modelling results relative to each weighted classification category provides insight into general areas of movement. Figure 6.26 shows that clear route distinctions are evident within the ritual area, indicating where movement would travel depending upon the importance of passing different building classifications. Routes weighted by commercial, production, and residential spaces

are predominantly concentrated within the south-east quadrant of Ostia. Public and religious weighted routes, in contrast, tend to travel within the northern area of Ostia. Portions of the eastern *decumanus* and southern *cardo* show consistent use regardless of how buildings are weighted, indicating their role as facilitating through movement to other areas of the cityscape.

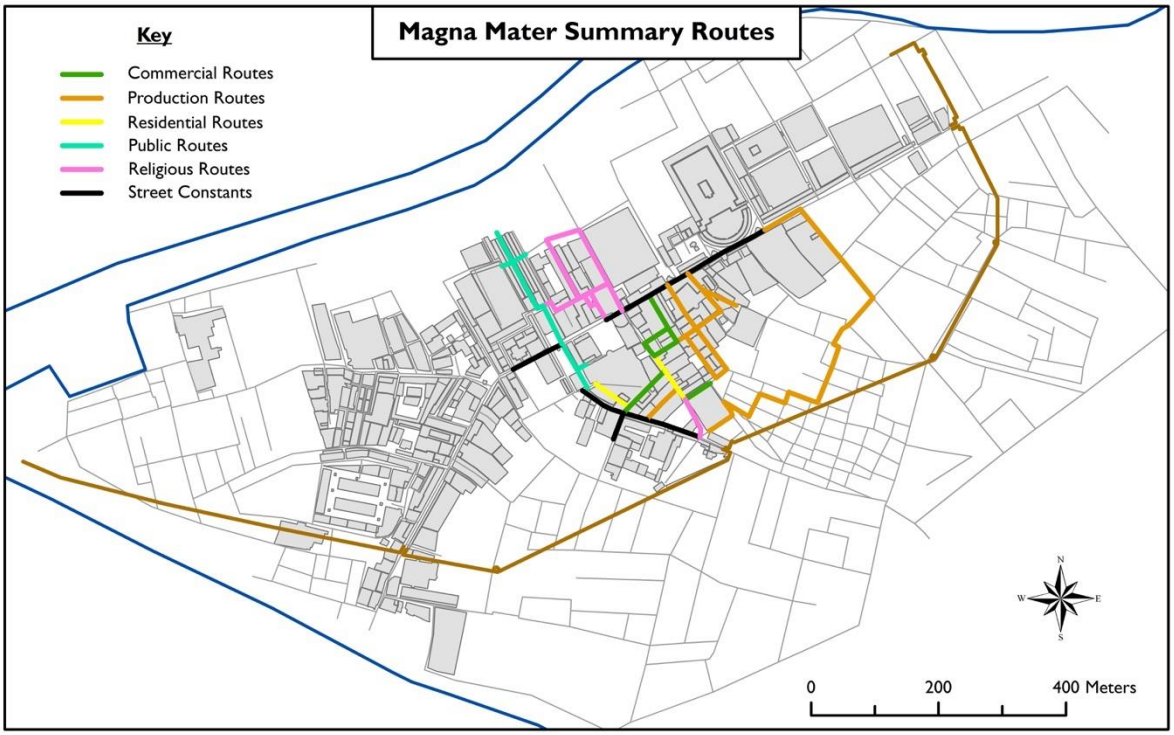

Figure 6.26 Summary of possible routes weighted by each classification category. Streets shown in black represent routes consistently used by each weighted classification.

While the mythic past of the cult provides a framework for passing certain areas of the city, considering how different urban spaces additionally affected possible routes provides a more comprehensive picture about where processional movement associated with festivals of the Magna Mater travelled within Ostia. Three potential processional routes are proposed within Figure 6.27. Route 1 shows potential areas structured predominantly by commercial and production spaces. The influence of passing primarily public and religious spaces is reflected by the movement areas of Route 2 while Route 3 illustrates potential routes influenced by residential spaces. Ultimately, these potential routes represent how processional movement changes based upon passing different areas of the cityscape.

The presentation of several routes rather than just one emphasises the variability of movement associated with the *Campo della Magna Mater*. It also demonstrates the diverse ways in which the built environment could have shaped movement routes while still passing through areas specific to the cult's mythic past. The presentation of multiple routes provides a broader understanding about the likely variation that existed, especially due to the uncertainty that exists in determining absolute routes at Ostia on account of minimal surviving processional evidence. The more important

significance of these potential routes is not their variation in street passage, but the different portions of Ostia's cityscape that they encompass depending upon the underlying purpose of each ritual. These routes additionally illustrate how the perception of the cult of the Magna Mater would change depending upon the different areas it travelled within.

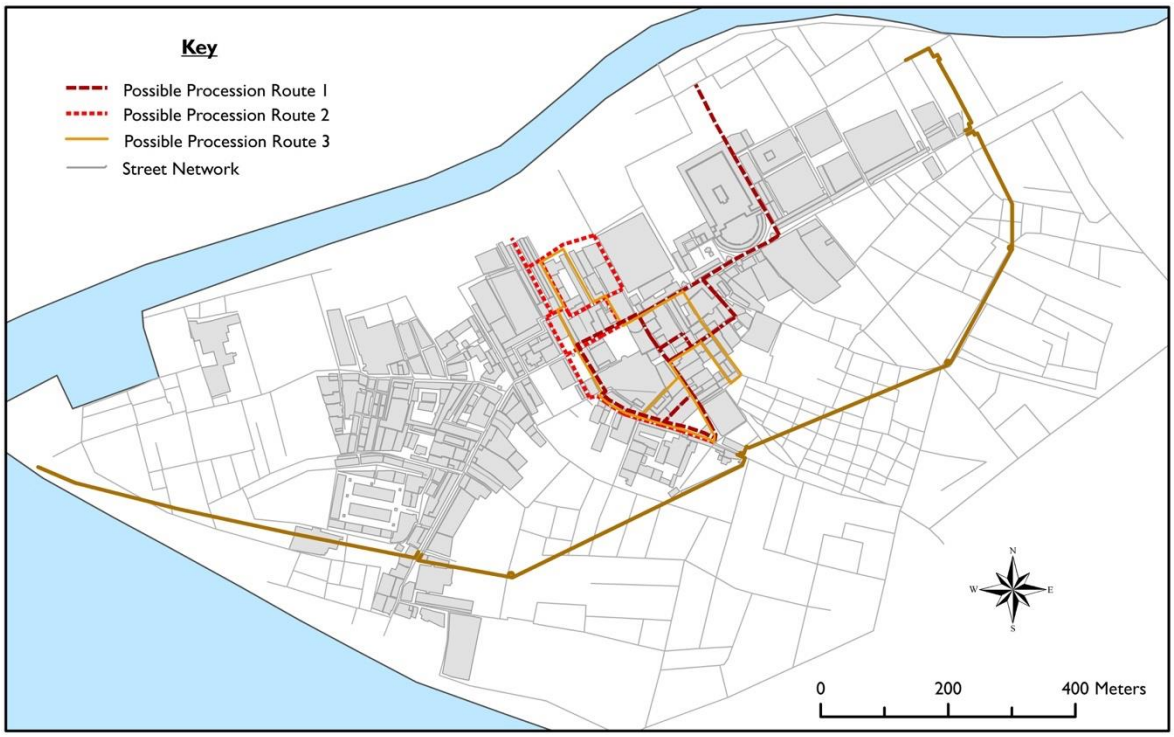

Figure 6.27 Proposed areas of processional movement related to the Magna Mater.

The people who partook in these individual rituals also need to be acknowledged. The numerous dedications found within the sanctuary provide some insight into the cultic participants that would have likely taken part in the sanctuary's ritual practices. The majority of dedications were presented by freedmen or their descendants (Van Haeperen, 2017, p. 96). Of note are additionally the number of dedications made by women (*CIL* XIV 36, 37, 69, 127). This, in addition to the greater attention provided to imperial women within the dedications (e.g. *AE* 1948, 24; *AE* 1989, 127) when compared to other associations at Ostia (Van Haeperen, 2013, pp. 164–165), could provide insight into the number of women that likewise participated in the sanctuary's rituals. Another feature to note is the degree to which these dedications also overtly refer to Ostia, indicating their association to the larger religious and public life of the city (*CIL* XIV 34–37). Recognising this, it would be unsurprising that processional rituals further emphasised this relationship. The various statuettes found within the sanctuary, as well as inscriptions detailing the donation of statuettes, including their weight and material, could have served a dual purpose of being carried in procession (Madigan, 2012, pp. 1–38). Not only would a procession have served as a way to visibly display the rituals of the Magna Mater, but also the relative wealth of donations and people associated with the cult.

These results present a much more complex picture of ritual activity associated with the sanctuary than previously presented. While rituals would have been largely confined to the sanctuary area, processions provided a venue for departing from the main religious area to encompass a wider area of the city. The literary passages that comment upon the processional ritual highlight its spectacle components, the objects carried in procession, the music, and the various forms of dancing. Ovid addresses this by stating: "the goddess herself will be borne with howls through the streets" (Ov. *Fast.* 4.186).[77] An important purpose of any of the processions associated with Cybele was to gain attention. The sound of the procession approaching, and the anticipation that would have entailed for spectators, may have been just as important as its general visibility. The transition of movement between areas like the *forum* and portions of the *decumanus* that were highly visible to smaller streets would have enabled a complex interplay between easy visibility and surprise. Its transition to minor streets between these areas likely built a degree of anticipation about where the procession would travel. These various aspects all need to be considered in addition to the potential areas of movement, as they all played a role in constructing the route that was embedded within the cult's more general mythic framework. Ultimately these components helped to enhance the public perception of the cult through its processional rituals.

6.7 Summary

This chapter has provided an overview of the Sanctuary of the Magna Mater and the evidence for the presence of processional rituals associated with the cult at Ostia. The overall size of the sanctuary in combination with the extensive amount of evidence towards the presence of different religious associations, like the *dendrophori* and *cannophori,* that have a history of partaking in processional rituals provide a strong case for their practice at Ostia. Following the assumption that processional rituals would have taken place in some form, the remainder of this chapter has assessed how processional movement can be visualised based upon the effect of the built environment on structuring different routes. In particular, this chapter has addressed how urban network analysis and agent-based modelling can be used to question the ways in which different building classifications effected possible processional routes associated with the *Campo della Magna Mater.* Considering these areas of movement within a larger framework of areas important to the cult of the Magna Mater, several possible ritual movement areas have been proposed that are influenced by passing important locations including the *forum,* Tiber, and Theatre, while passing a range of different urbans spaces. A more nuanced understanding about the routes occurring between these spaces is further defined by the built environment and the activities occurring within it by the city's inhabitants.

[77] Translation by Frazer, 1931.

Chapter 7: Case Study 2 – The Cult of Serapis

7.1 Introduction

Egyptian religion in the Roman empire has seen a rich tradition of scholarship (Witt, 1971; Dunand, 1973; Tran, 1973; Turcan, 1996; Beard, North and Price, 1998; Bricault, 2005, 2013; Bricault, Versluys and Meyboom, 2007). Since the discovery of the *Serapeum* at Ostia, a temple dedicated to the Egyptian deity Serapis, various scholars have attempted analyses of Egyptian cults within the ancient port (Squarciapino, 1962; Mar, 2001; Steuernagel, 2001; Alvar, 2002). Despite these studies, scholars have yet to consider fully how the rituals associated with the cult of Serapis helped to construct a specific religious landscape.

The *Serapeum,* currently the only excavated Egyptian temple at Ostia, likely played a cult role for a *collegium* (association) composed of worshippers of the god Serapis. This function has resulted in the temple's interpretation as being the centre of a local Egyptian community (Calza, 1953, p. 138; Hermansen, 1982, p. 83). The numerous statuettes and statues (Figure 7.1) found throughout Ostia further attest to the cult's popularity, many originating from private domestic contexts (Squarciapino, 1962, p. 34; Malaise, 1972a, pp. 83–89; Mols, 2007, p. 227).

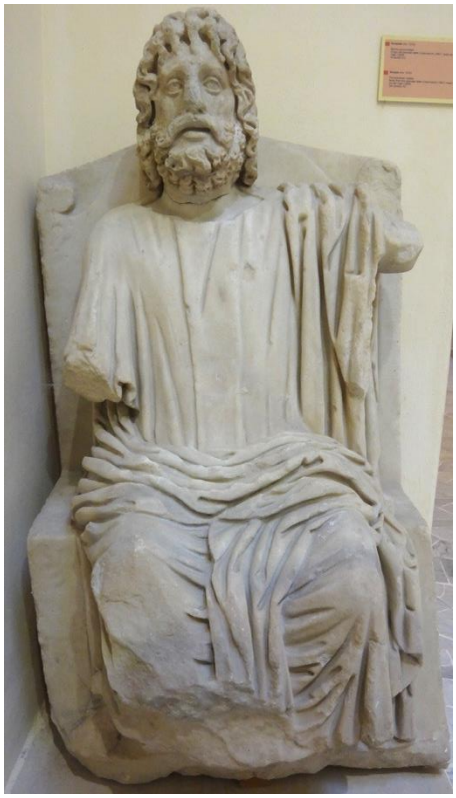

Figure 7.1 Statue of Serapis from the 3rd century AD (Museo Ostiense, inv. 1210; photo, K. Crawford).

These artefacts in combination with the temple itself present us with an ideal opportunity to study how the cult of Serapis was integrated more widely into Ostia's urban and social landscape. This chapter investigates how the spatial position of the *Serapeum* structured the channelling of religious activity through processional movement. These possible movement routes create a specific religious landscape that provides insight into interactions that would have occurred relating to the cult. Prior to examining possible processional routes, an overview of the temple's excavation and identification (§7.2) as well as analysis of the evidence towards the practice of processions for the cult at Ostia is presented (§7.3). The methodology introduced in Chapters 4 and 5 will then be applied in order to visualise how a "circular" procession beginning and ending at the *Serapeum* might have negotiated the surrounding cityscape, by applying urban network analysis and agent-based modelling (§7.5). The chapter concludes by discussing the significant of these potential routes within the context of our understanding of Egyptian rituals at Ostia (§7.6).

7.2 The *Serapeum* at Ostia

The *Serapeum* (Figure 7.2) was discovered during Calza's 1939–1941 excavation campaign (Calza, 1953, p. 138, 225; Squarciapino, 1962, pp. 19–22; Wild, 1981, pp. 29–30). Discovery of a portion of the *fasti ostienses* near the *Porta Marina* in 1941 that referred to the construction of a temple to Serapis in AD 127 aided in the temple's identification (Vidman, 1982).[78] The additional finding of an inscription dedicated to *Iovi Serapidi* (*RICIS* 503/1103) that would have been positioned on the temple's pediment and other architectural iconography relating to the Egyptian cult further confirmed the temple's association with Serapis (Bloch, 1959, p. 226; Becatti, 1961, pp. 143–153; Squarciapino, 1962, pp. 19–27; Pellegrino, 1988). The most detailed examination of the temple was undertaken between 1989–1990, which resulted in Mar's comprehensive publication of the temple (Mar, 2001).

[78] 127: *VIIIII k(alendas) Febr(uarias) templum Serapi quod [.] Caltilius P[---] sua pecunia exstruxit, dedicatum [es]t*. "on the ninth of February, the temple of Serapis which was built by [.] Caltilius P[-] at his own expense, was dedicated." (Translation by author).

Figure 7.2 View of the *Serpaeum* from the entrance (photo, K. Crawford).

Considering the large quantity of Egyptian evidence found throughout Ostia, the *Serapeum,* and more importantly its rituals, has received only cursory attention (Bloch, 1959; Meiggs, 1973, pp. 367–368; Hermansen, 1982, pp. 66–67; Pavolini, 2006, pp. 157–158). Research has focused predominately upon the identification of the temple as being public or private (Zevi, 2001a, pp. 181–185; Pensabene, 2002, p. 307), and its relationship to the surrounding urban landscape (Mar, 1992; Mols, 2007).

An interesting component of the cult at Ostia is that the majority of inscriptions are in Latin, rather than Greek as found at other ports around the Mediterranean (Squarciapino, 1962, pp. 24–25; Meiggs, 1973, p. 368). Meiggs argues that the adoption of Latin for the inscriptions is evidence of lesser ties with Egypt, which could argue for the cult's greater assimilation into the city of Ostia (1973, pp. 368–370). It seems more probable that this discrepancy is due more to the cult's association with Jupiter, especially since the inscriptions from the immediate surroundings of the *Serapeum* are written in a combination of Greek and Latin. Additionally, the presence of Egyptianizing elements such as a shrine to Serapis (III.x.3) and a *nymphaeum* with a Nilotic scene discount the idea of limited Egyptian ties (van der Meer, 2012, p. 78). Furthermore, the majority of inscriptions found dedicated to Serapis at Portus are Greek, which makes the argument for a fully Italicised cult at Ostia more tenuous (Sacco, 1984). Despite the distance between Ostia and Portus, it is not improbable that the two cities would have hosted similar religious environments where Serapis was concerned.

7.2.1 Spatial Context of the Temple

Figure 7.3 Map of the streets and important buildings surrounding the *Serapeum*.

The *Serapeum* (III.xvii.4) is located off one of Ostia's primary streets, the *Via della Foce* (c.f. Figure 7.3, A). The analysis of the temple's spatial position using the axial analysis measurements of integration and choice provides an indication into the temple's accessibility within Ostia's street network (Figure 7.4).[79] Integration, a global measure that shows a street's generally accessibility, demonstrates how easy it is to reach streets within a topological radius of 3 (Stöger, 2011a, p. 213). The graph is displayed on a scale of blue to red, with red representing the most integrated streets. Calculation of integration shows that the *Serapeum* is located off one of Ostia's tertiary streets (displayed in orange). However, the street on which the *Serapeum* is located has a very low integration value (displayed in dark blue), indicating that it was not easily accessible. The temple's limited accessibility is additionally indicated by the calculation of choice, which looks at the movement potential along a street (Figure 7.4).[80] The point at which the *Via del Serapide* intersects with the *Via della Foce* has a low choice value (dark blue), which correlates to low movement potential. In comparison to other streets throughout Ostia, the *Serapeum* is not spatially located in a way that encourages unintentional visitation.

[79] Stöger does not specifically address the *Serapeum* in her study of Ostia's street network using axial analysis (Stöger, 2011a, p. 197). Kaiser considers the location of temples along the street network in relation to street depth from the city gates and the *forum* (Kaiser, 2011, pp. 53–59). However, his analysis only considers the excavated street network, which inherently affects the accuracy of the results. He concludes that temples, the *Serapeum* included, correspond to easily accessible streets when moving from either the *forum* or city gates (Kaiser, 2011, p. 121).

[80] See Stöger 2011, pp. 213–219 for a discussion of Ostia's total street network and the application of choice and integration calculations using segment analysis.

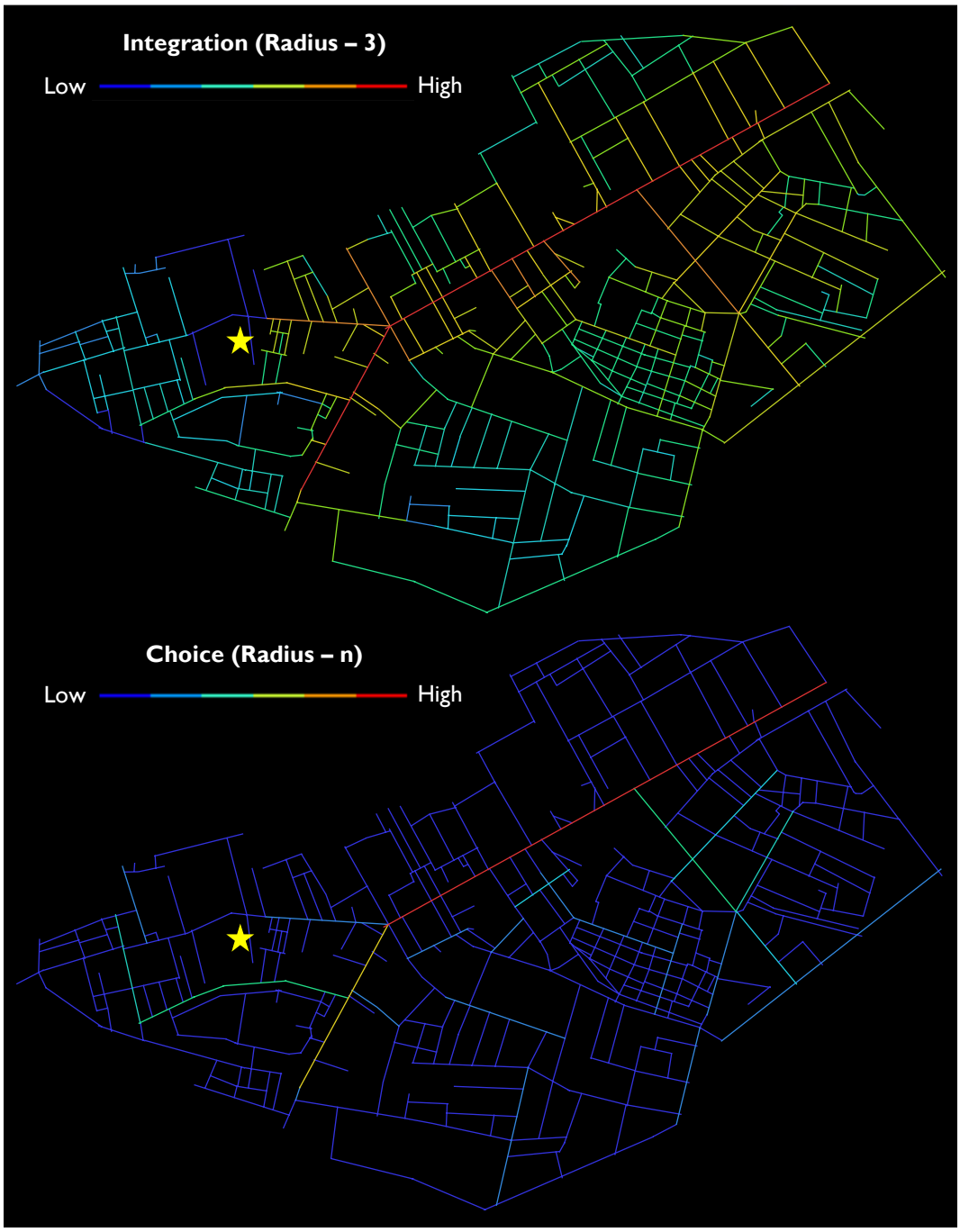

Figure 7.4 Space syntax axial graphs showing the position of the *Serapeum* in relation to integration and choice metrics. Top: integration (radius-3, 386 street segments); Bottom: choice (radius-n, 386 street segments).

The presence of visual indicators along the *Via della Foce* may have helped to increase the temple's accessibility by guiding pedestrians to the temple rather than relying upon direct visibility and access from the more integrated or busier streets. Despite its slightly removed position, a signpost exists along the *Via della Foce* that depicts the Egyptian bull Apis on a brick panel (Figure 7.5) located on a portico pillar in front of the *Caseggiato di Bacco e Arianna* (III.xvii.5; c.f. Figure 7.3, C) (Squarciapino, 1962, p. 21; Kater-Sibbes and Vermaseren, 1975, p. 15; Mar, 2001, pp. 67, 233). This could have helped to direct attention towards the temple's location along the *Via dei Serapide* which is situated

between the *Caseggiato di Bacco e Arianna* (III.xvii.5) and the *Domus del Serapeo* (III.xvii.3; c.f. Figure 7.3, B). However, the small size of the brick panel suggests that local knowledge of the area would have been necessary, with this panel existing as an aid for those already navigating towards the temple.

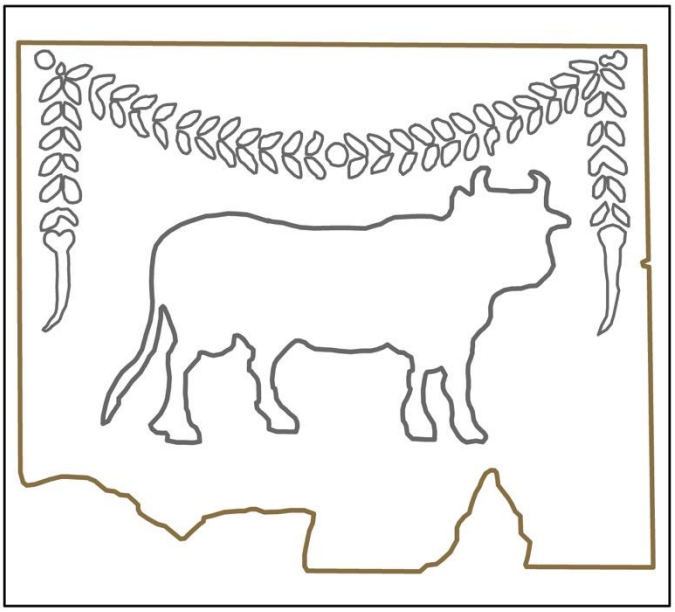

Figure 7.5 Drawing of a brick panel showing the bull Apis surrounded by a garland (after Mar, 2001, fig. 6; Neg. Sopr. Ost. B-706; inv. No 5439).

The temple is relatively small, measuring approximately 15 m x 6 m, and is situated within a *temenos* (sacred area) surrounded by a portico with pilasters (Figure 7.6). The sanctuary's entrance has a black and white mosaic of Apis (Figure 7.6), while the courtyard has a variety of poorly preserved Egyptian motif mosaics (Becatti, 1961; Meiggs, 1973, p. 368; Mar, 2001, p. 40). Access to the sanctuary is restricted to a small entrance in the portico, similar to entrances of known *scholae* at Ostia which, in combination with the temple's small size, has contributed to the argument that it was associated with a *collegium* of worshippers of Serapis (Zevi, 1971, p. 472; Subias, 1994). The prostyle tetrastyle temple is reached by a set of steps situated at the west end of the building, proceeded by a *pronaos* covered with a geometric *opus sectile* mosaic. A partially preserved brick altar is located in front of the temple in the centre of the courtyard (Mar, 2001, p. 44). The temple has been reconstructed (Figure 7.7) upon the basis of its travertine support and surviving columns (Mar, 2001, p. 46).

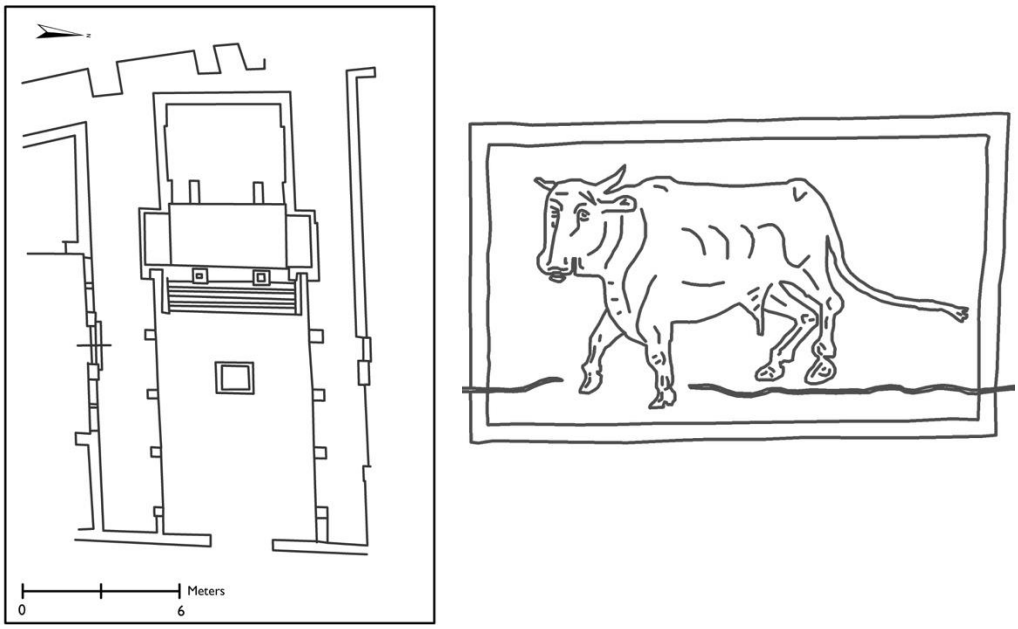

Figure 7.6 Left: Plan of the *Serapeum* (after Mar, 1992, fig. 8). Right: Drawing of the mosaic of Apis from the *Serapeum* (after Becatti 1961, Tav. Cl. n.290).

Figure removed due to copyright restrictions

Figure 7.7 Reconstruction of the façade of the *Serapeum* (Mar, 2001, fig. 11).

Adjacent to the temple is the *Domus del Serapeo* (III.xvii.3; c.f. Figure 7.3, B) which is a *schola,* or seat of an association (Stöger, 2011a, pp. 238–240). This building likely formed part of a larger complex that included the *Serapeum.* Epigraphic evidence and the building's architectural configuration led to its identification as a *schola*. However, its identification has raised questions about the *Serapeum* and if it was a private temple associated with the *schola,* its use reserved for

association members, or if it was a public sanctuary open to anyone from Ostia (Hermansen, 1982; Mar, 2001). Temples to Serapis traditionally take two forms; extensive complexes that can accommodate a large number of followers and great public festivals, or smaller sanctuaries that are more isolated and used by fewer people (Mar, 2001, p. 314). The small size of the *Serapeum* at Ostia means it was likely used for a smaller community of followers, which is consistent with its possible connection to an association and its removed position from main street access. However, there remains some debate over how this particular temple functioned. Rieger (2001) believes the temple to have been semi-public, while Mols (2007) argues there is insufficient evidence for either a public or private classification. By the end of the 2nd century AD, however, there was a separation of the *domus* from the sanctuary, with the closure of a previous connecting passageway. Focusing upon possible processional activity moves enquiry away from attempting to define the temple's function to how its religious activity travelled beyond the temple's precinct.

Studies of the *Serapeum* have largely focused upon the connection between the temple and its surrounding structures within the *insula* as being part of an Egyptian quarter (Pavolini, 1996; Mar, 2001). The nearby *Caseggiato del Serapide* (iii.x.3; c.f Figure 7.3, F), located several *insulae* away, has been associated with Serapis upon the basis of a cult niche with a relief depicting an enthroned Serapis (Bakker, 1994, p. 88). Pavolini has posited that this apartment complex housed participants of the cult (Pavolini, 1996, p. 159). A direct association between this residence and the temple, nevertheless, is tenuous as the statue likely represents a private dedication rather than a dedication originating from the *Serapeum* (Bakker, 1994, pp. 88–89; Mols, 2007, p. 229). Other surrounding structures include the *Caseggiato di Bacco e Arianna*, which was a multi-storied building with ground floor shops with upper floor housing accommodations (Hermansen, 1982, p. 125). Mar (1992, p. 33) has additionally posited that the *Terme della Trinacria* (III.xvi.7; c.f. Figure 7.3, D) located across from the temple was connected to the temple. While Egyptian cults often had associations to water, there is little evidence that the temple was connected to the baths apart from its spatial proximity (Wild, 1981; Mar, 2001; Malaise, 2005, pp. 59–66).

Early hypotheses have viewed this entire area as an 'oriental quarter' or an area that had a high concentration of eastern immigrants who participated in the cult (Taylor, 1912; Meiggs, 1973). Pavolini suggests that oriental cults were only practiced along Ostia's periphery, which Mols argues against upon the basis that its location was more central due to its proximity to the river port, which lay a short distance to the north (Pavolini, 2006, pp. 132–146; Mols, 2007, p. 230). The quantity of evidence relating to Egyptian religion found in the vicinity indicates that the cult's supporters likely lived within this area. Arguments, however, that this area was an Egyptian quarter *per se* push this identification too far (Steuernagel, 2004, p. 214). Looking at the ways in which processional movement demarcated surrounding areas of the cityscape provides an alternative approach to looking at the environment constructed by the cult.

7.3 Evidence for Egyptian Cult Processions

The cult of Serapis has been the object of a range of studies across the Mediterranean (Botti, 1895; Bloch, 1959; Fraser, 1960; Wild, 1981; Taylor, 2004). While the temples and artefacts associated with the cult have seen specialist publications (Tran-Tram-Tinh, 1983; Takás, 1995), the god's associated festivals have only received preliminary treatment (Abdelwahed, 2016, p. 1). This is largely due to the lack of evidence that limits our understanding of the god's festivals (Mar, 2001, p. 325; Alvar, 2008, p. 293).[81] One of the primary festivals for Serapis was the *Serapia*, which was introduced to Rome during the 1st century AD (Degrassi, 1963, p. 449; Lipka, 2009, p. 118). The festival was celebrated on 25 April, a date that is recorded in the *Hermeneumata* dating to the 2nd or 3rd century AD and the Calendar of AD 354 (Salzman, 1990, p. 129). While the date of the festival is known, there is limited information about the ritual components of the festival in Rome. The majority of our evidence for the festival comes from Roman Egypt and Greek cities.[82] Caution needs to be taken in relating what happened at an Egyptian festival in Egypt or Greece to what occurred on the outskirts of Rome due to the likely transformation of religious practices. Rather than trying to determine the ways in which the *Serapia* occurred at Ostia with such limited comparative evidence from Italy, the festivals that Serapis was included in with other Egyptian deities provides more substantial processional evidence.[83]

A standard feature of Egyptian religion was that individual deities were rarely worshiped singularly. Serapis and Isis were often worshiped together throughout the Principate as indicated through extensive epigraphic and iconographic evidence (Malaise, 1972b, p. 194; Alvar, 2008, p. 293). Due to the limited evidence about the rituals associated with Serapis, caution does need to be taken not to directly attribute all Isis rituals, for which we have considerable information, to Serapis. Nevertheless, looking at the existing evidence for Serapis and the accounts of his inclusion within processions with Isis presents one way of approaching plausible processional rituals that may have occurred at Ostia.

Isis and Serapis likely served as protectors of sailing and navigation at Ostia (Salzman, 1990, p. 173).[84] This association is depicted on a small terracotta lamp (Figure 7.8) found at Ostia that illustrates Isis Pelagia along with Serapis and Harpocrates (Squarciapino, 1962; Pavolini, 1996). The lamp's shape of a ship surely recalls the *navigium Isidis* festival.

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[81] The Egyptian cult was officially incorporated into the Roman calendar by AD 19–25 (Salzman, 1990, p. 171).
[82] The most detailed account of the festival is documented on one of the Oxyrhynchus papyri (*P.Oxy* XLVIII.3406, 9–11). The account provides detail of the *Serapia* that includes references to priests wearing traditional processional masks (Frankfurter, 1998, p. 57). Other accounts of the festival are mentioned in inscriptions from Tanagra in Boeotia (*RICIS* 105/0201) and Dionysopolis, Moesia Inferior (*RICIS* 618/0801).
[83] There was probably a temple of Serapis located at Portus (Sacco, 1984, inscriptions 12–13).
[84] For references to both Isis and Serapis at Ostia see: *RICIS* 503/1115, 503/1120. For examples from Portus see: *RICIS* 503/1219; Sacco, 1984, inscription 18.

Figure 7.8. Terracotta lamp of Isis (middle), Serapis (bottom, right), and Harpocrates (top, left) (Museo Ostiense, E27268. Photo ICCD).

One of the most important festivals for Isis was the *navigium Isidis,* which celebrated the opening of the sailing season on 5 March, recorded in the *Menologia Rustica* and *Fasti Philocali* (Taylor, 1912, p. 70). The Codex-Calendar of AD 354 additionally documents the practice of the festival occurring throughout Late Antiquity in Rome and its surrounding harbour towns (Salzman, 1990, p. 173; Boin, 2013, p. 208). The festival consisted of a procession the included the ritual launching of a ship to symbolise the opening of the sailing season. A similar festival was held in October–November to symbolically mark the closing of the sailing season (Table 5).

Incorporation of Festivals of the Cults of Isis, Serapis, and Osiris into the Roman Calendar

Menologia Rustica	***Hermeneumata***	**Calendar of AD 354**	**Misc. Accounts**
March			
Isidis navigium		5 - Isidis navigium 20 - Pelusia	Pelusia
April			
Sacrum Phariae			
Item Sarapia	25 - Sarapia	25 - Sarapia	
August			
		12 - Lychnapsia	
October			
	28 - Isia	28 - Isia	28 – Castu Isidis
	29 - Isia	29 - Isia	
	30 - Isia	30 - Isia	
	31 - Isia	31 - Isia	
November			
Heuresis	1 - Isia	1 – Ex se nato. Isia	
	2 - Isia	2 – Ter novena	
	3 - Isia	3 - Hilaria	

Table 5 Table of festivals associated with Isis and Serapis in the Roman Calendar (after Salzman, 1990, p. 170).

Apuleius' *Metamorphoses* (11.9–10, **A.2a**) offers the most detailed account of the rituals associated with the *navigium Isidis*. The story is a fictional narrative, but aspects appear to have been drawn from reality when compared to iconographic representations of the festival that are found throughout the Roman Empire. One passage states:

> "there also came pipers dedicated to mighty Sarapis, who, on transverse pipes held close to the right ear, repeated the traditional melody of the god and his temple; and public heralds who kept warning the people to clear the way for the holy procession." (Apul. *Met.* 11.9).[85]

This reference provides some indication that Serapis took part in this particular Isiac procession. Even though the described procession occurs at Cenchreae (Corinth) and not at Ostia, the degree of evidence relating to the festival found at Ostia and the evidence from the Codex-Calendar of AD 354 are indicative of its occurrence at Ostia as well (Witt, 1971, pp. 165–184; Turcan, 1996, pp. 114–115; Alvar, 2008, p. 299).

The festival is depicted as a scene on a wall painting discovered in 1868 at Ostia, now displayed in the Vatican museums (Paschetto, 1912, p. 559; Stern, 1975). The illustration details the *navigium Isidis* (Figure 7.9), where we can see that a ship has been set to sail while two figures are shown pulling an empty cart used to transport the ship. Various scholars have argued that the festival was also celebrated with public spectacles such as naval battles, indicating a possible connection to Ostia's theatre (Gasparini, 2013, p. 200). This represents just one portion of the ritual where one of the primary purposes of the procession was to launch a ship filled with offerings to the goddess Isis (Apul. *Met.* 11.16–17, **A.2a**). Caution needs to be used when ascribing the ritual depicted in this wall painting to actual ritual activity, as this panel likely formed part of an illustrative calendar. Upon the basis of significant literary accounts and iconographic evidence there is little doubt that this type of procession occurred throughout the Roman world (Bricault, 2013, p. 150, 203). The range of inscriptions mentioning Isis and sculptural evidence makes the presence of a temple of Isis in Ostia probable, and by extension so also the performance of a *navigium Isidis* procession.

[85] This passage is the only direct reference to Serapis in the *Metamorphoses* (Alvar, 2008, p. 295). Translation by Jones, 2017.

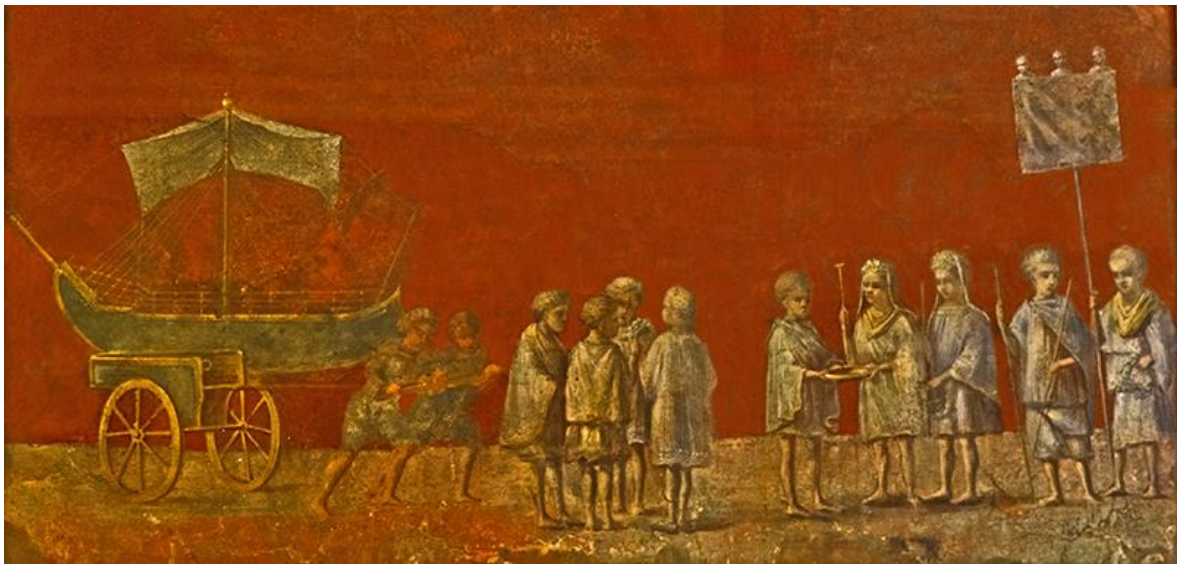


Figure 7.9. Wall painting depicting the *navigium Isidis* (left) and the birthday of Septimius Severus (right) from Ostia (VRoma, photo B. McManus, 2014).

Fragmented information about processions with Egyptian deities survives from Rome. The *Scriptores Historiae Augustae* provides selective commentary about Commodus and his devotion to the goddess Isis (*Hist. Aug. Comm.* 9, **A.2b**). He is described as being so devoted to the Egyptian cult that he shaved his head and carried the image of Anubis in a processions. While the passage is meant to demean the Emperor, showing him undertaking an act unbefitting of his rank, it does provide evidence both of Egyptian cult processions and the presence of other Egyptian deities within a procession to Isis at Rome (Madigan, 2012, p. 25). The account of the emperor Pescennius Niger provides additional information about an Egyptian procession in Rome, where Commodus stops for every necessary ritualistic pause (*Hist. Aug. Pesc. Nig.* 6.8–9, **A.2c**). While limited in their processional details, these passages provide important insights about the association of processional activity with the Egyptian cults.

A key aspect of known ritual activities associated with the *Serapeum* correspond to its imperial association. Serapis was often worshiped not only alongside Isis but also with other deities such as Sol, Jupiter, and Neptune. At Ostia, this association manifested as Jupiter Serapis,[86] Jupiter Sol Sarapis,[87] and Zeus Helios Sarapis.[88] Other epithets often attributed to Serapis include *magnus, invicutus,* and *dominus,* each of which has an underlying association with imperial ideology through their ability to endow the emperor with success and victory (Malaise, 1972b, p. 194; Salzman, 1990, p. 171). References to this can be seen in the final portion of Apuleius' account where upon

[86] *RICIS* 503/1103, 503/1105-1106, 503/1129–1130.
[87] *RICIS* 503/1108, 503/1110.
[88] *RICIS* 503/1109. The Temple of Serapis at Portus was dedicated to Zeus Sarapis, see Sacco, 1984, inscriptions 12–13.

returning to the temple of Isis, the priests pronounce "prayers for the prosperity of the great Emperor, the Senate, the knights, and the entire Roman people, for the sailors and ships under the rule of our world-wide empire" (Apul. *Met.* 11.17).[89] By the time of the Severan dynasty, and probably before, Serapis was viewed as a protector of the imperial person (Mar, 2001, p. 313). The dedication of the *Serapeum* on Hadrian's *dies natalis* represents a form of imperial homage (Bloch, 1959; Vidman, 1982; Mar, 2001, pp. 25, 339; Christodoulou, 2015). The anniversaries of the emperor and imperial family often resulted in public festivals in cities throughout the Empire (Price, 1984, p. 105). Furthermore, the connection to Hadrian is unsurprising considering his predilection for Egypt, which resulted in more Egyptian temples being associated with Hadrian than with any other Roman emperor (Taylor, 2004, p. 252). Equally important in the case of the *Serapeum* is that this is likewise one of the few events from Ostia included within the *Fasti Ostienses* (Madigan, 2012, pp. 1–38). The dedication of the temple on this date not only aligned the temple with the emperor, but ensured that the temple would likely see festivals on the same day every year as part of larger community festivals.

The *Serapeum* at Ostia was financed by Caltilius, a member of the Caltilii family that was originally from Alexandria (Keay, 2010b, p. 15). The Caltilii were elite freedmen[90] who eventually came under the emperor's patronage (Gradel, 2002, pp. 213–233). Associating the cult of Serapis with the emperor is one indication of the family's advancement within Ostia's socio-political sphere. In terms of their association to the cult of Serapis and Isis, the processional rituals provided them with a very public venue to display their patronage over both the cult's followers, which consisted predominately of freedmen and immigrants, as well as members of the Caltilli family.

Widening the scope of analysis to the possible participation of Serapis' followers in other Egyptian and Isiac processions facilitates a study of processional rituals at Ostia. A consistent feature of Egyptian religion was the inclusion of other Egyptian deities within different processional rituals. Although the ritual components of a festival specific to Serapis are unknown, the association and participation in other Egyptian cult rituals at Ostia is highly probable.

7.4 Defining the Area of Ritual Movement

The visualisation of processional routes associated with the cult of Serapis begins with the definition of a ritual area using space syntax metrics. The calculation of step depth in relation to the location of the *Serapeum* provides the area framework for studying processional movement. Step depth is the number of streets or turns away from a specific street within the total street network. In this

[89] Translation by Jones, 2017.
[90] *CIL* XIV 310: Lucius Caltilius Hilarus is referred to as being an Augustalis and a freedman of Gaia, and Caltilia Felicula, a freedwoman of Lucius.

instance, step depth is calculated from the street on which the *Serapeum* is located to all other streets within the network, which equates to a maximum step depth of 11. A step depth of 4, originating at the *Serapeum,* is used to determine the delimited area used for the calculation of urban network analysis (Figure 7.10). All streets with step depths of 0–4 are indicated in red. The buildings bounded by these streets are therefore included within the ritual area. I have not included buildings surrounding the eastern *decumanus,* since this moves beyond a local movement scale.

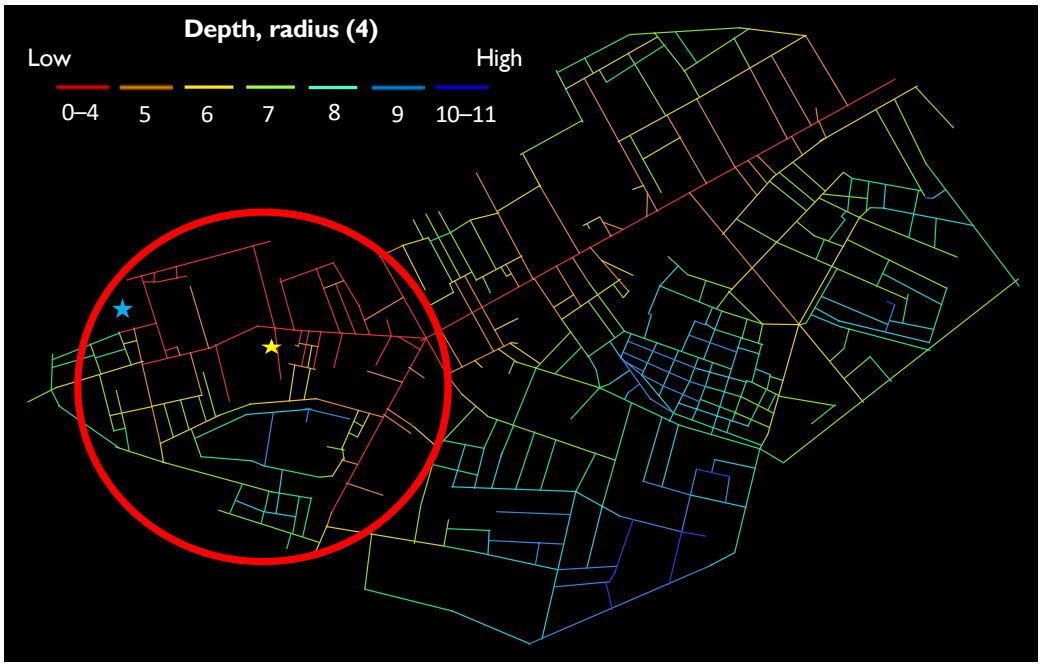


Figure 7.10 Axial graph showing a step depth of 4 from the *Serapeum* (yellow star). The river harbour is indicated by the blue star.

In comparison to the axial analysis calculation of choice, which indicates streets with the greatest movement potential (Figure 7.4), step depth from the *Serapeum* shows how the temple is bounded by the city's primary network structure. The quantity of Egyptian cult iconography and epigraphic evidence found along the western side of Ostia near the Tiber supports this being an area that saw extensive Egyptian cult activity (Torres, 2008).[91] Furthermore, the spatial proximity to the seafront caters to the possibility of the cult's participation in Isiac processions like the *navigium Isidis,* which would have likely travelled to the seafront, and area that could be reached through the *Porta Marina*.[92]

[91] Steuernagel (2004, p. 214) suggests that many of the artefacts found throughout the area surrounding the *Serapeum* may have originated at the temple.

[92] Apul. *Met.* 11.16: "After its course had taken it so far that we could no longer clearly make it out, the bearers of the sacred objects took up again what each had brought and joyfully set out on the way back to the shrine, preserving the order and fine appearance of their procession." (Translation by Jones, 2017).

7.5 The Impact of Urban Activity upon Ritual Movement

The calculation of axial step depth provides a delimited area for studying processional movement. A total number of 179 buildings fall within the defined ritual area (Figure 7.11). These buildings comprise the dataset that is used to compute movement potential along the area's localised street network.

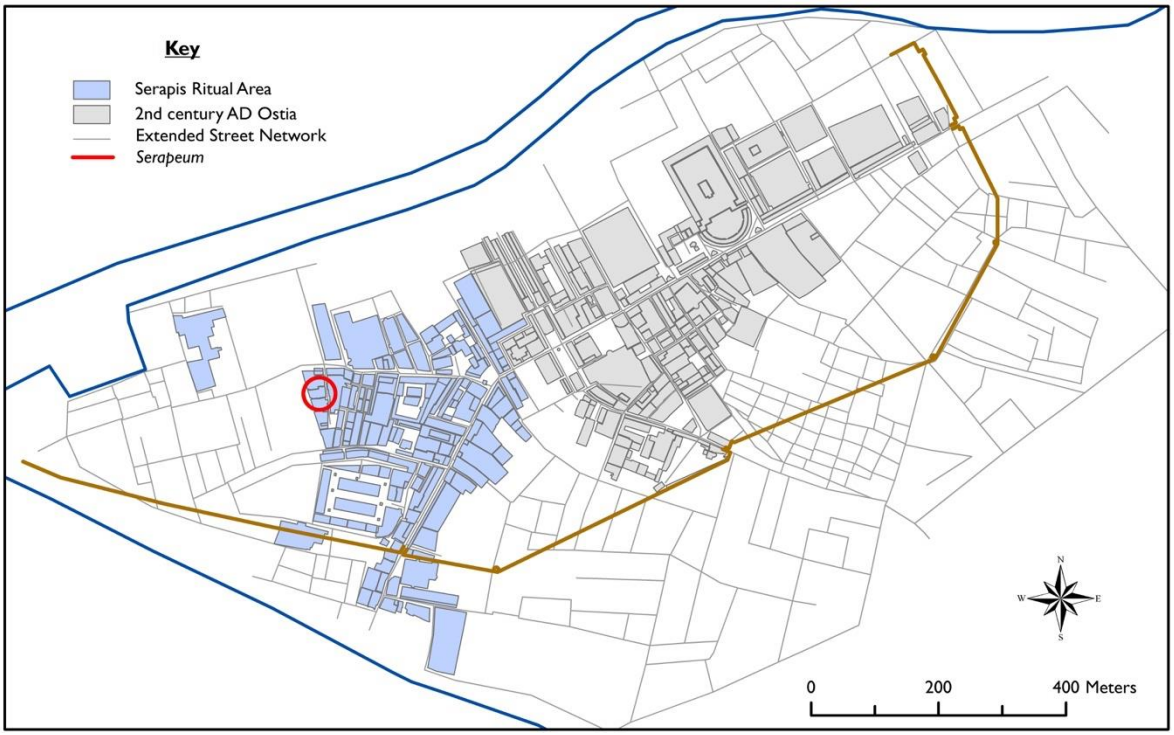


Figure 7.11 Buildings included in the Serapis ritual area (blue) located within the cityscape of Ostia (grey). The *Serapeum* is circled in red.

To assess the general movement potential along the ritual area's streets, an initial betweenness centrality graph is run by weighting buildings based upon their location inside or outside the ritual area. A 200 m network radius is applied to limit movement analyses to the defined ritual area. The resulting model, which shows the general movement potential within the ritual area, offers a comparison to subsequent betweenness centrality calculations that apply importance weights to the different building categories. Buildings included within the ritual area are weighted with a value of 1, while the rest of the cityscape is given a value of 0. The betweenness centrality graph shown in Figure 7.12 indicates how the buildings located within the ritual area structured passing movement. Betweenness centrality measures are displayed on a scale of black to grey. Streets corresponding to buildings with the highest betweenness centrality are displayed in red, while streets with the second highest probability of movement are indicated in orange.

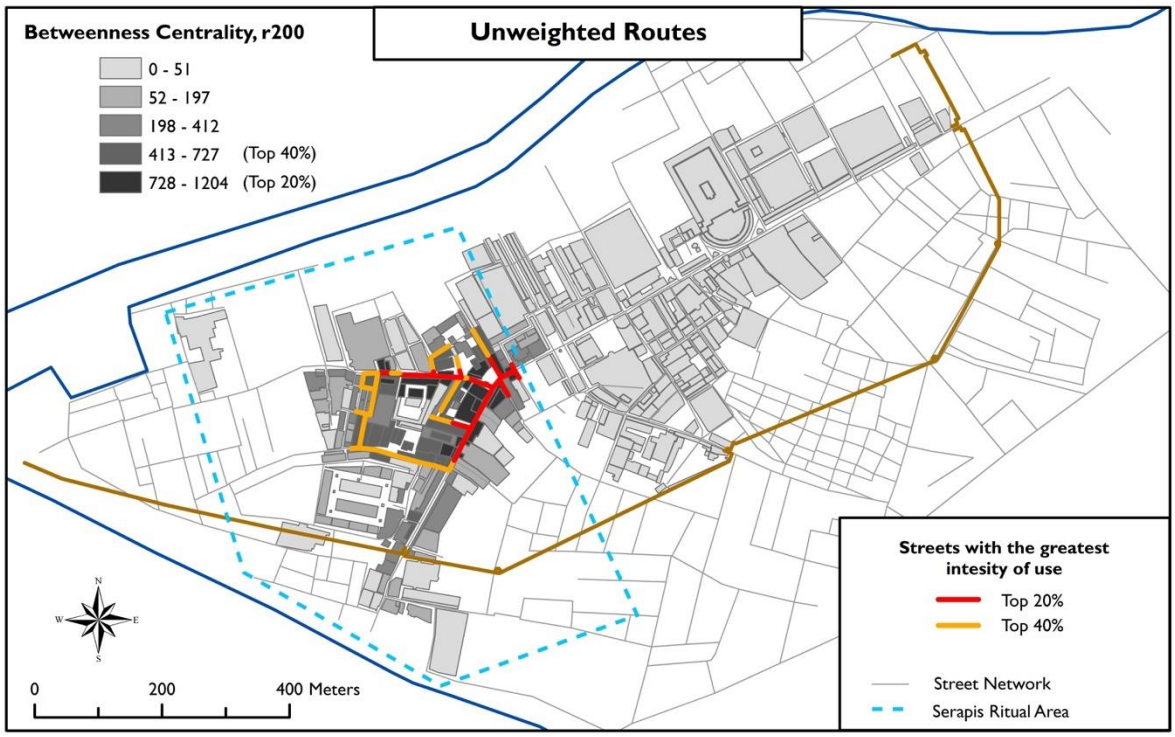


Figure 7.12 Calculation of betweenness centrality weighted by buildings located within the Serapis ritual area (weight 1) and those outside the study area (weight 0). The streets following the two highest betweenness centrality metrics are designated in red and orange.

Figure 7.12 shows the correlation of the two highest building betweenness centrality measures to the corresponding streets. Streets displayed in red equates to passing buildings with the highest 20% of betweenness values, while streets displayed in orange correspond to passing buildings with the next highest betweenness value. The highest betweenness centrality measures relate to buildings positioned around the intersection of the *Via della Foce* and the eastern and western *decumanus.* Considering this is one of the city's major intersections for the primary arterial streets, that this area saw increased movement activity is unsurprising. The streets with the highest movement potential (red streets) are comparable to the space syntax axial analysis results for choice and integration, following the *decumanus*. The second highest betweenness measure (orange streets) show more movement variation within the ritual area's street network.

A more nuanced perspective of the main traversed streets within the ritual area is provided by these results compared to the previous space syntax analyses. Unlike space syntax, which cannot account for social activity and how individual spaces along the street network were used, urban network analysis enables a more detailed looked at localised movement patterns. By questioning how buildings influenced passing ritual movement rather than just how the street network structured movement, we can gain a more comprehensive understanding about what streets processional movement may have traversed.

The ritual area defined for the *Serapeum* is further questioned using agent-based modelling. All of the excavated buildings are weighted with an influence value of 1, and a route is traced following the leader agent for 1000-ticks. Figure 7.13[93] shows the streets most likely to be traversed during five separate simulation runs. The routes reflect movement travelling within the *insulae* east of the temple and moving south towards the *Case a Giardino.* These results clearly show that movement remains confined within the previously defined ritual area.

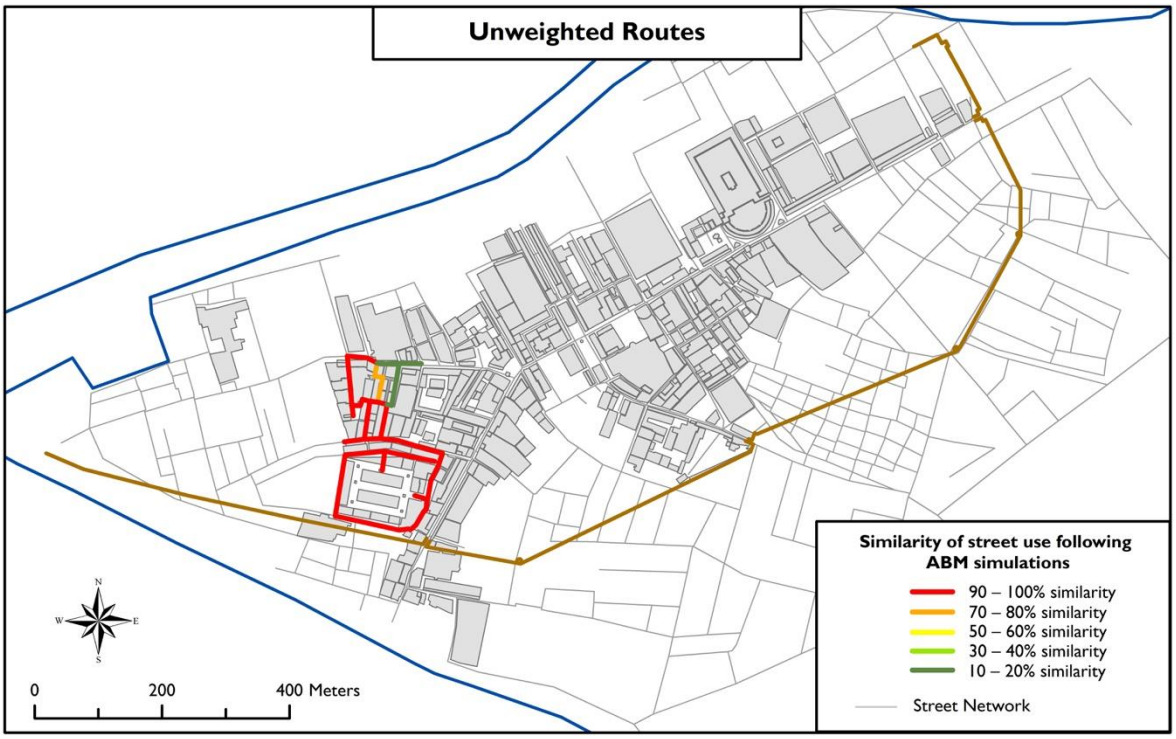


Figure 7.13 Similarity of street usage by un-weighted processional runs (all buildings have an influence value of 1). Routes chosen by the processional leader within 1000-ticks, results of 5 different runs.

To assess how building importance affects movement along the streets surrounding the *Serapeum,* urban network analysis and agent-based model simulations are run using weighted measures. As in the previous case study, each classification category is considered first using urban network analysis by applying a weighted value of 10, while the remaining buildings in the ritual area are given a value of 1. Structures located outside the ritual area are assigned a value of 0 (e.g.: commercial buildings - 10, other buildings – 1, non-ritual area buildings 0). A 200 m network radius is used in all calculations to ensure movement is localised to the ritual area under consideration. The extended street network is still accounted for in all of the calculations, which addresses the possibility of movement occurring outside this defined area. The results of each weighted graph illustrate how areas of high movement potential differ from the unweighted graph to more clearly illustrate the

[93] See Appendix E in Volume 2 of this thesis for all of the agent-based model runs that were used to compile the summary ABM figures found throughout this chapter.

way in movement is structured. Movement areas that follow the unweighted routes are displayed by black coloured streets, while areas with an absence of movement are emphasised by being displayed in blue.

The agent-based modelling experiments serve to question the results obtained from the urban network analysis calculations as well as to assess how the addition of people effects the possible movement routes. For each space classification, buildings are individually weighted with an influence value of 5, while the remaining buildings are provided a value of 1. The model is run where the route reflects the path taken by the processional leader during ten different runs. To incorporate the dynamics of processional participants, the same weighted simulations are run using 20 processional participants that are set to run for a total of 300-ticks following the processional leader. The results of both runs are presented to show how they fluctuate from the unweighted model runs. The results of these two different agent-based model experiments serve to further question the dynamics and route of processional movement associated with the *Serapeum*.

7.5.1 Commercial Weighted Routes

The ritual area has 95 buildings that have been defined as having a ground floor commercial function. Commercial space dominates the ritual area, accounting for over half of the identified buildings. The buildings are not confined to any specific area, but can be found along almost every street, with the exception of the street running south of the *Case a Giardino*. Calculation of betweenness centrality (Figure 7.14), weighted by commercial space located within the ritual area, shows that movement was concentrated along the western *decumanus* and the *Via delle Foce*. The majority of likely movement corresponds to that illustrated within the unweighted graph. The most significant difference shows that there is an absence of movement travelling along the internal streets connecting the *Via della Foce* with the *Cardo degli Aurighi*. This indicates that movement shaped by commercial spaces are largely confined to the ritual area's major streets.

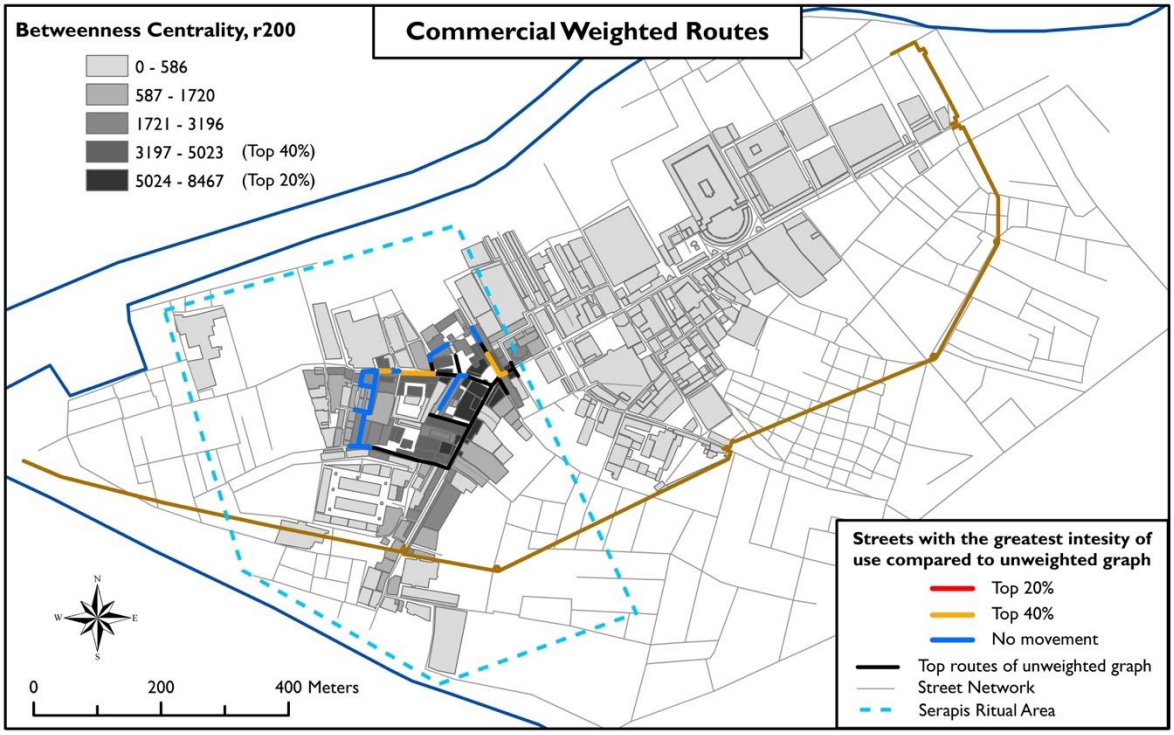


Figure 7.14 Betweenness centrality graph weighted by commercial buildings. Weights: commercial buildings 10, ritual area 1, non-ritual area 0. Streets shown in red and orange follow the two highest betweenness centrality metrics which differ from the unweighted graph. Streets shown in black follow the top 20–40% unweighted betweenness centrality metrics. Streets shown in blue emphasise areas where no movement occurs in relation to the unweighted graph.

The agent-based model results (Figure 7.15) show quite a few deviations in possible movement areas when compared to the betweenness centrality results. The route taken by the processional leader extends along the western *decumanus* in a couple of the runs, but otherwise movement is focused upon travelling from the *Via della Foce* to the *Cardo degli Aurighi.* In comparison to the betweenness centrality results, there is also a greater chance of movement extending along the streets passing the *Casette Tipo.* The simulation run with processional participants shows no variation in movement areas to that determined by the processional leader.

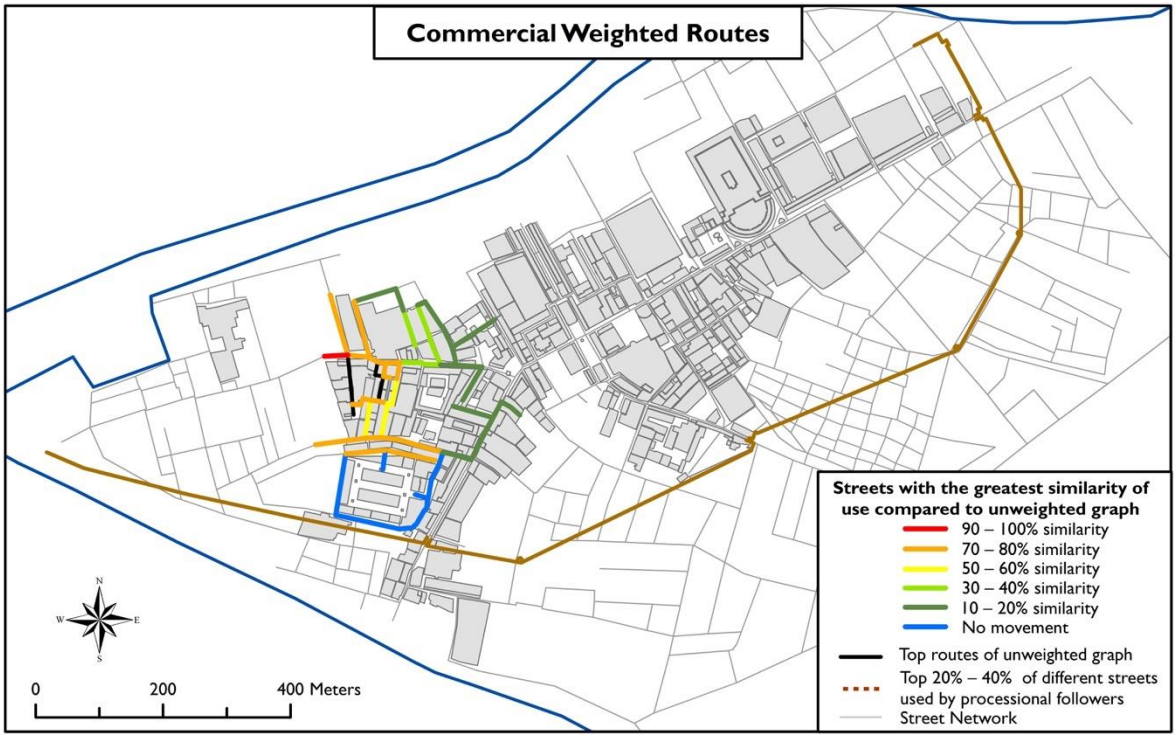


Figure 7.15 Similarity of street usage by processional runs weighted by commercial spaces (commercial building influence – 5, other building influence – 1). Routes reflect those chosen by the processional leader as they differ from the unweighted graph within 1000-ticks during 10 different runs. Streets shown in black follow the top routes of the unweighted graph. The red dotted line indicates streets where the route of processional followers deviates from that of the leader during 5 different runs lasting a duration of 300-ticks.

7.5.2 Production Weighted Routes

Areas of production only account for three buildings within the ritual area, positioned along the western *decumanus,* the *Via del Pomerio,* and the *Via del Larario.* The location of these buildings are reflected by a high degree of movement potential moving along these streets (Figure 7.16). The results also show that there is an increased probability of movement travelling along the *Via del Pomerio* and connecting to the *Via del Tempio Rotondo.* The results indicate that movement is confined much more to the area's major streets, similar to the commercial weighted results.

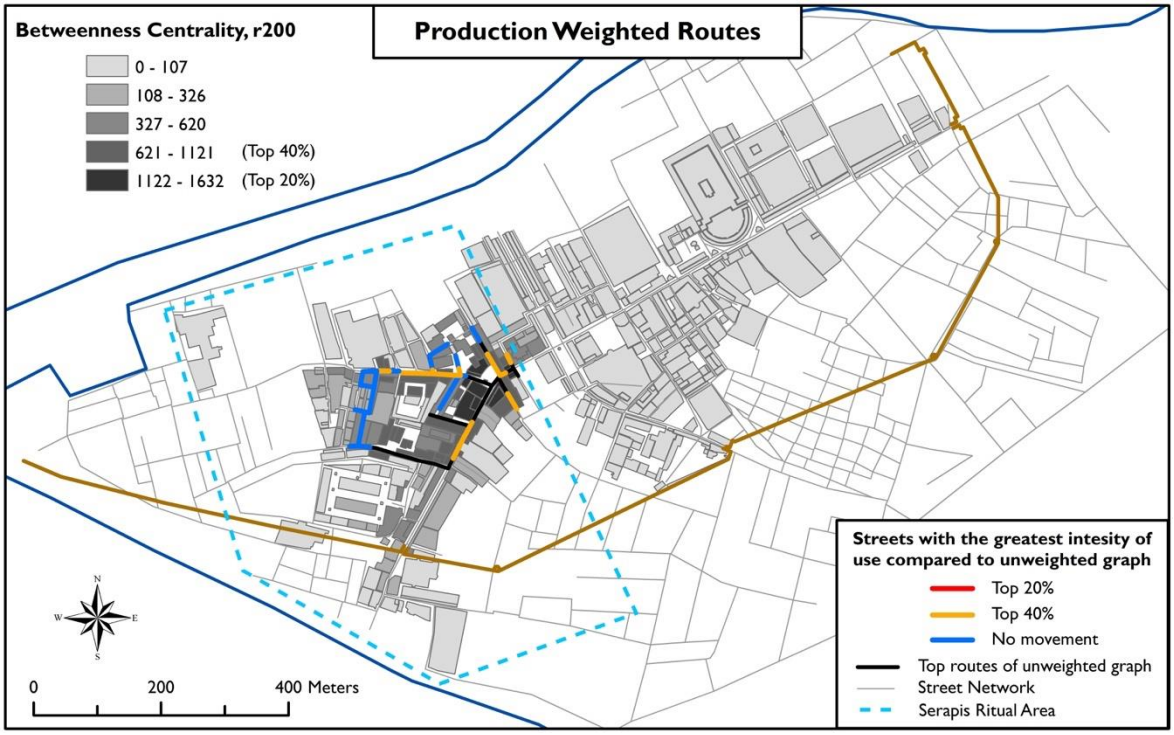


Figure 7.16 Betweenness centrality graph weighted by production buildings. Weights: production buildings 10, ritual area 1, non-ritual area 0. Streets shown in red and orange follow the two highest betweenness centrality metrics which differ from the unweighted graph. Streets shown in black follow the top 20–40% unweighted betweenness centrality metrics. Streets shown in blue emphasise areas where no movement occurs in relation to the unweighted graph.

Similar to the previous section, the agent-based model routes vary significantly from the betweenness centrality results. Figure 7.17 indicates that movement areas closely follow the routes taken by the processional leader in the unweighted simulations. The main difference shows a slight chance of movement travelling south along the *Via Ovest delle Casette Tipo.* The similarity to the unweighted simulations is unsurprising considering that the only space defined as having a production function is located along the western *decumanus,* which negates it having any influence on the movement routes. The path taken by the processional participants is likewise confined to moving around the buildings directly east of the *Serapeum.*

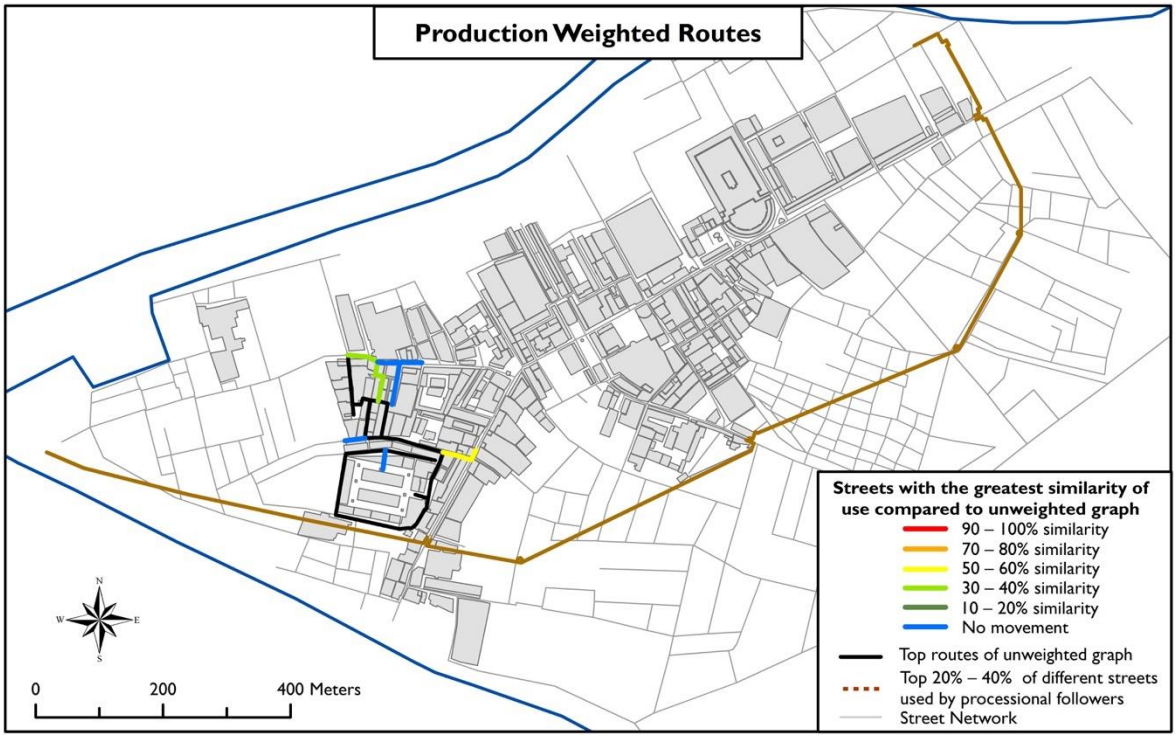


Figure 7.17 Similarity of street usage by processional runs weighted by production spaces (production building influence – 5, other building influence – 1). Routes reflect those chosen by the processional leader as they differ from the unweighted graph within 1000-ticks during 10 different runs. Streets shown in black follow the top routes of the unweighted graph. The red dotted line indicates streets where the route of processional followers deviates from that of the leader during 5 different runs lasting a duration of 300-ticks.

7.5.3 Residential Weighted Routes

Residential buildings account for only 31 ground floor spaces within the total ritual area. These are concentrated around the *Case a Giardino* and several apartment buildings within *insulae* III.x–xiii. Ground floor space weighted calculations show that movement potential is concentrated away from the western *decumanus* (Figure 7.18). Instead, there is significantly more movement along the *Via della Foce* as well as the interior streets surrounding the *Cassette Tipo* that connect to the *Cardo degli Aurighi.* Additionally, there is a greater potential of moving past the *Case a Giardino*, showing increased movement variation if focus is placed upon passing residential structures. Weighting spaces by a residential classification does not decrease movement potential along the *decumanus,* but it does indicate a greater possibility of movement along other minor streets. This variation can in part be explained by the fact that many of the residential buildings are not located directly along Ostia's primary streets.

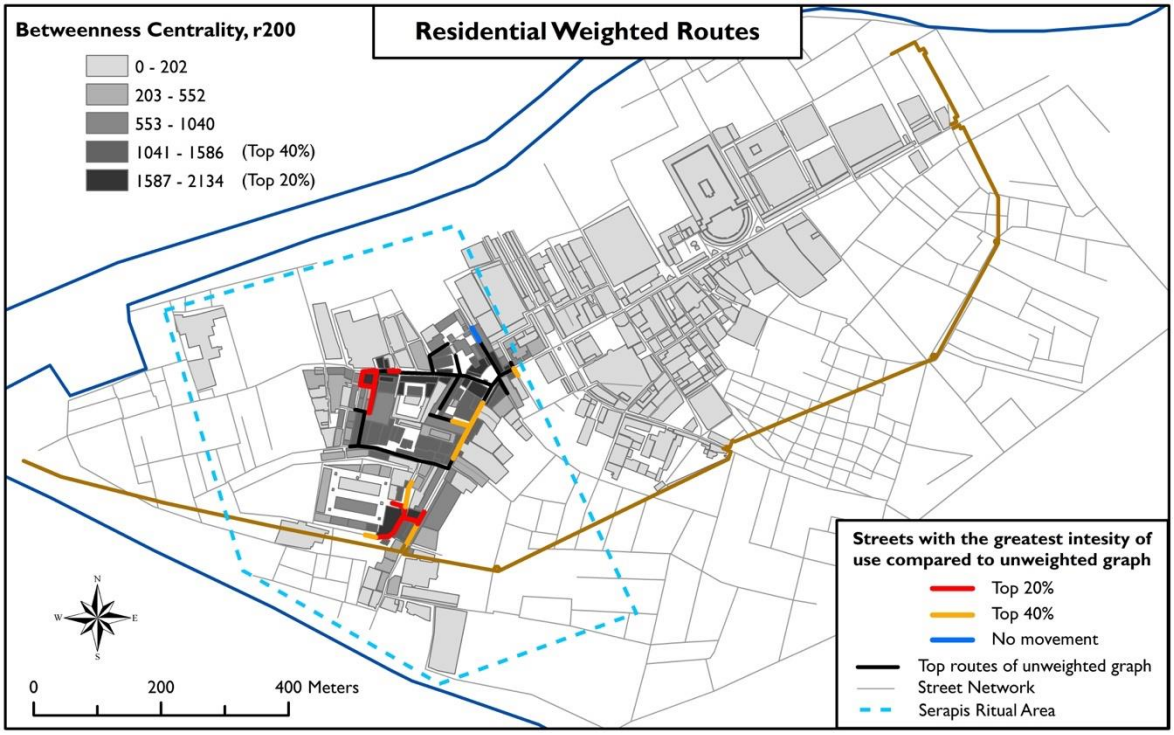


Figure 7.18 Betweenness centrality graph weighted by residential buildings. Weights: residential buildings 10, ritual area 1, non-ritual area 0. Streets shown in red and orange follow the two highest betweenness centrality metrics which differ from the unweighted graph. Streets shown in black follow the top 20–40% unweighted betweenness centrality metrics. Streets shown in blue emphasise areas where no movement occurs in relation to the unweighted graph.

The agent-based modelling results show greater similarity to the residential weighted betweenness centrality calculations than in the previous two examples. Figure 7.19 shows movement predominately occurring along the streets of the *Cassette Tipo* before travelling towards the *Case a Giardino.* These movement patterns closely reflect movement past residential spaces which are concentrated along these streets. In several of the runs, movement additionally travels along the *Via della Foce* before connecting to the *Via del Pomperio.* The addition of processional participants also shows that the same routes are travelled following the processional leader.

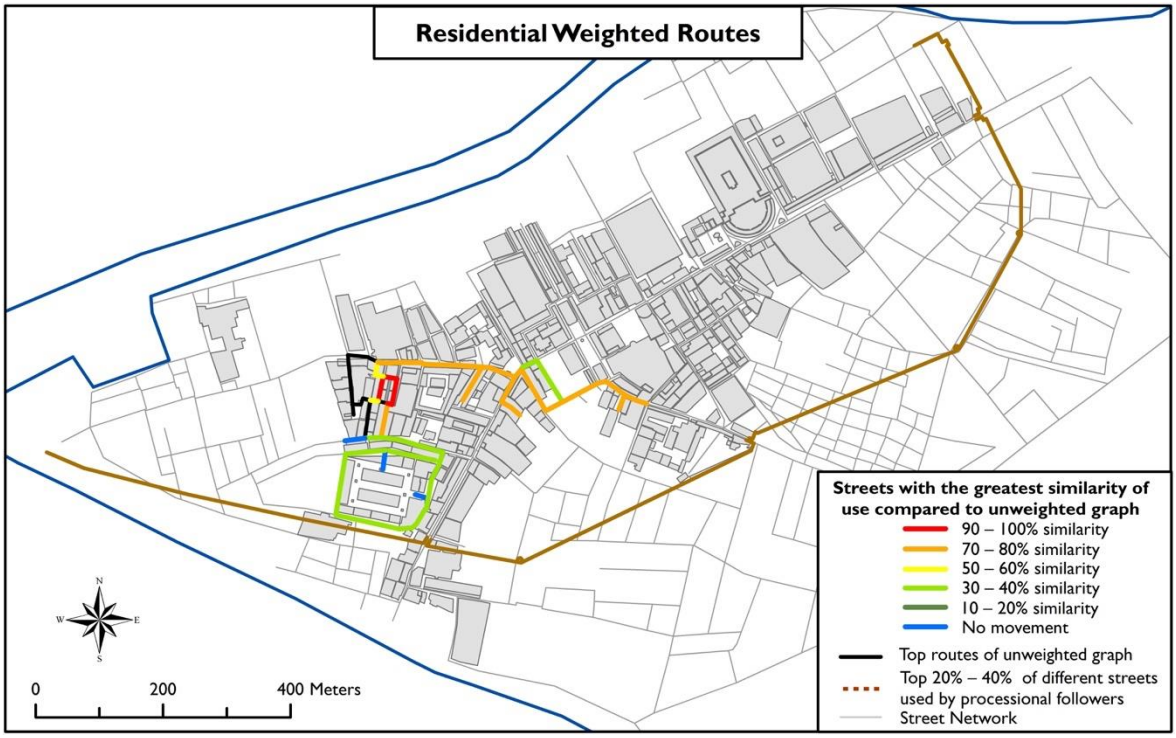


Figure 7.19 Similarity of street usage by processional runs weighted by residential spaces (residential building influence – 5, other building influence – 1). Routes reflect those chosen by the processional leader as they differ from the unweighted graph within 1000-ticks during 10 different runs. Streets shown in black follow the top routes of the unweighted graph. The red dotted line indicates streets where the route of processional followers deviates from that of the leader during 5 different runs lasting a duration of 300-ticks.

7.5.4 Public Weighted Routes

Public spaces account for 39 buildings within the ritual area. These spaces are not concentrated in any one area, but are generally accessible from one of the major arterial streets. Computation of betweenness centrality weighted by public buildings show that the greatest movement potential extends along the entirety of the *Via della Foce* and western *decumanus* (Figure 7.20). The main difference when compared to the unweighted graph shows a larger probability of movement travelling past the *Case a Giardino.*

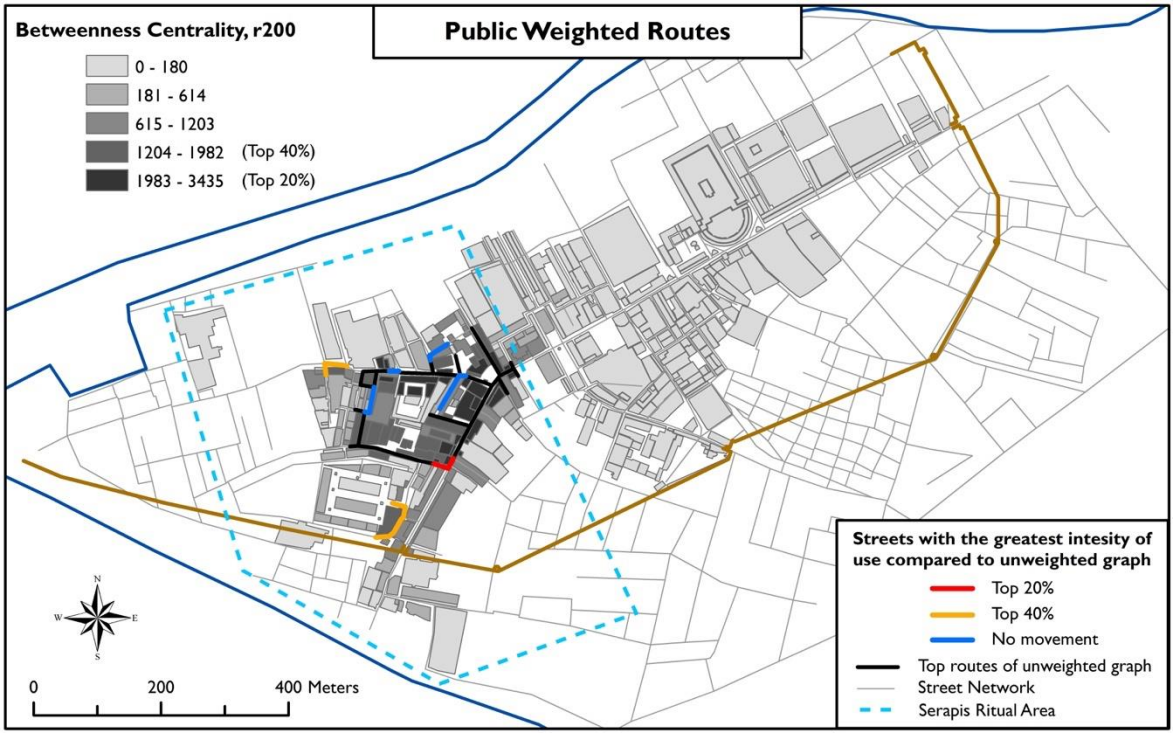


Figure 7.20 Betweenness centrality graph weighted by public buildings. Weights: public buildings 10, ritual area 1, non-ritual area 0. Streets shown in red and orange follow the two highest betweenness centrality metrics which differ from the unweighted graph. Streets shown in black follow the top 20–40% unweighted betweenness centrality metrics. Streets shown in blue emphasise areas where no movement occurs in relation to the unweighted graph.

All of the agent-based model runs weighted by public space follow the same route (Figure 7.21). Movement begins by travelling past the *Cassette Tipo* before continuing along the *Via della Foce.* This route is similar to the betweenness centrality results which indicate the *Via della Foce* saw the main degree of movement. The addition of processional participants follows the same general trajectory.

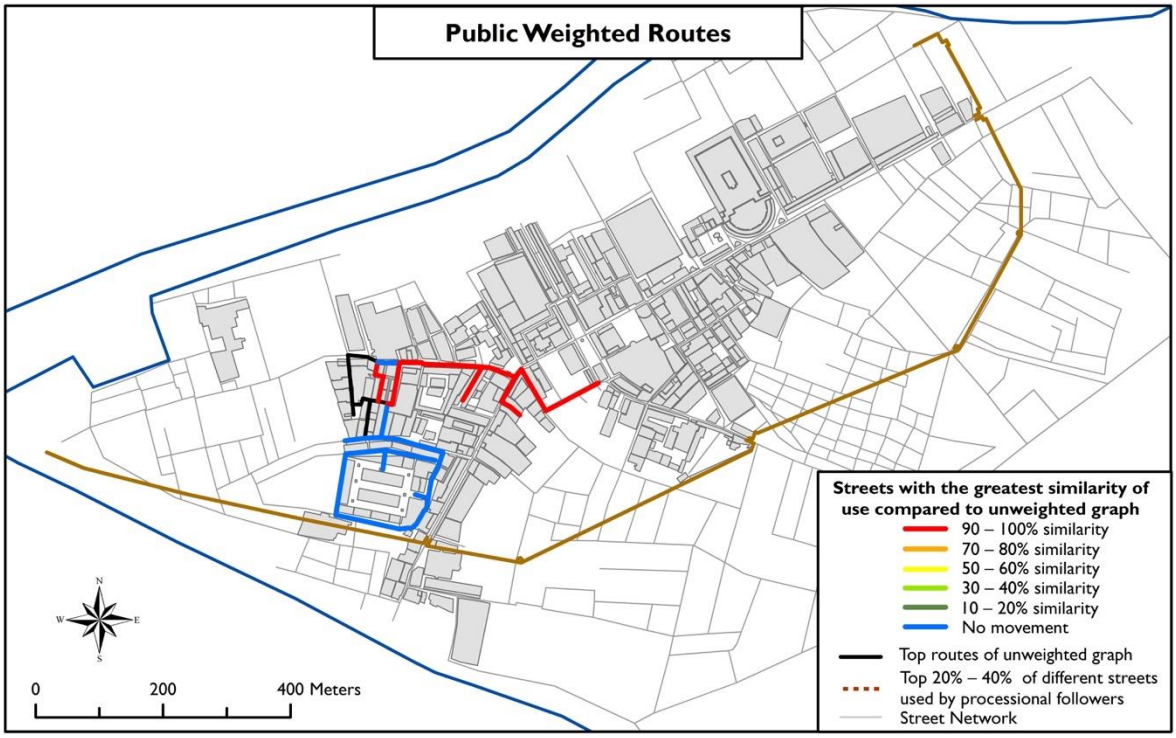


Figure 7.21 Similarity of street usage by processional runs weighted by public spaces (public building influence – 5, other building influence – 1). Routes reflect those chosen by the processional leader as they differ from the unweighted graph within 1000-ticks during 10 different runs. Streets shown in black follow the top routes of the unweighted graph. The red dotted line indicates streets where the route of processional followers deviates from that of the leader during 5 different runs lasting a duration of 300-ticks.

7.5.5 Religious Weighted Routes

Religious space accounts for 12 buildings within the ritual area, two of which are *mithraea*. The temples are accessible from the *Via della Foce,* the eastern and western *decumanus,* and the *Cardo degli Aurighi.* The calculation of betweenness centrality indicates the greatest movement potential follows these streets (Figure 7.22). The main variation in movement potential when compared to the unweighted graph shows increased movement travelling south along the western *decumanus.*

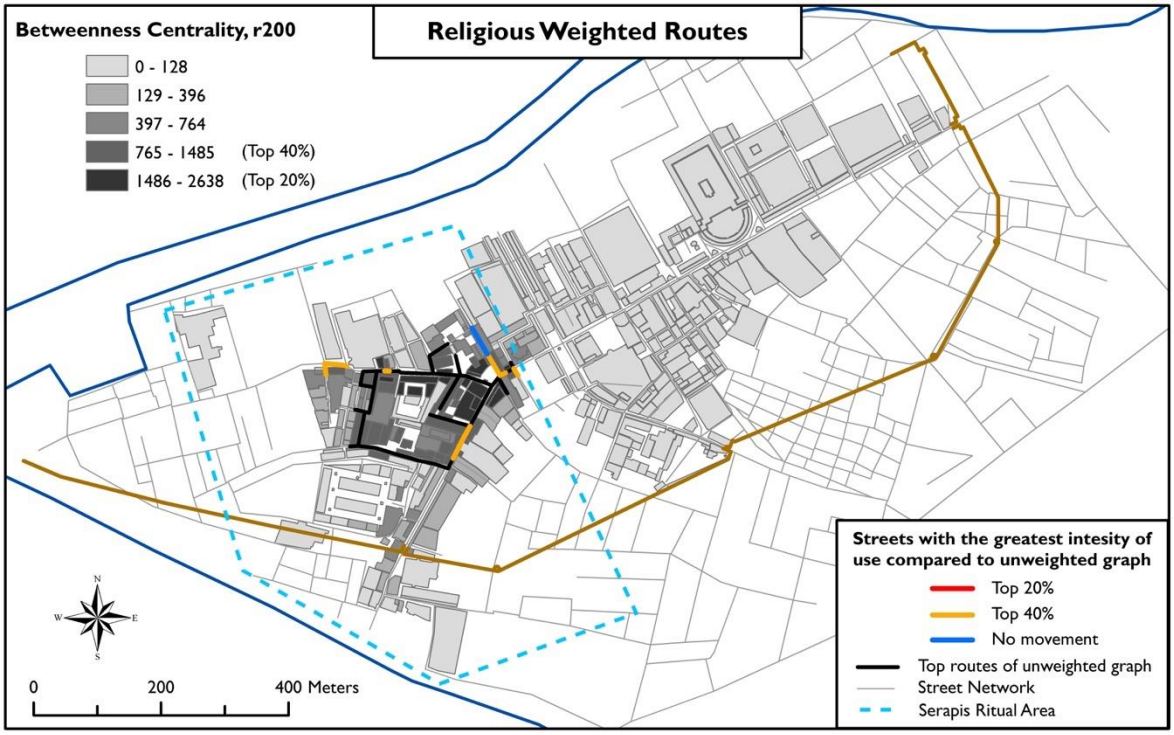


Figure 7.22 Betweenness centrality graph weighted by religious buildings. Weights: religious buildings 10, ritual area 1, non-ritual area 0. Streets shown in red and orange follow the two highest betweenness centrality metrics which differ from the unweighted graph. Streets shown in black follow the top 20–40% unweighted betweenness centrality metrics. Streets shown in blue emphasise areas where no movement occurs in relation to the unweighted graph.

The agent-based model shows significant variation when compared to the betweenness centrality results, and is the only example where movement travels along streets located north of the *Via della Foce* (Figure 7.23). The movement routes chosen by the processional leader show some movement past the *Cassette Tipo,* while the main route then continues along the *Via della Foce.* In all of the runs, the route travels along the *Via delle Terme del Mithra* as well as going past the Republican sacred area. The addition of processional participants illustrate routes that predominately follow the route determined by the processional leader.

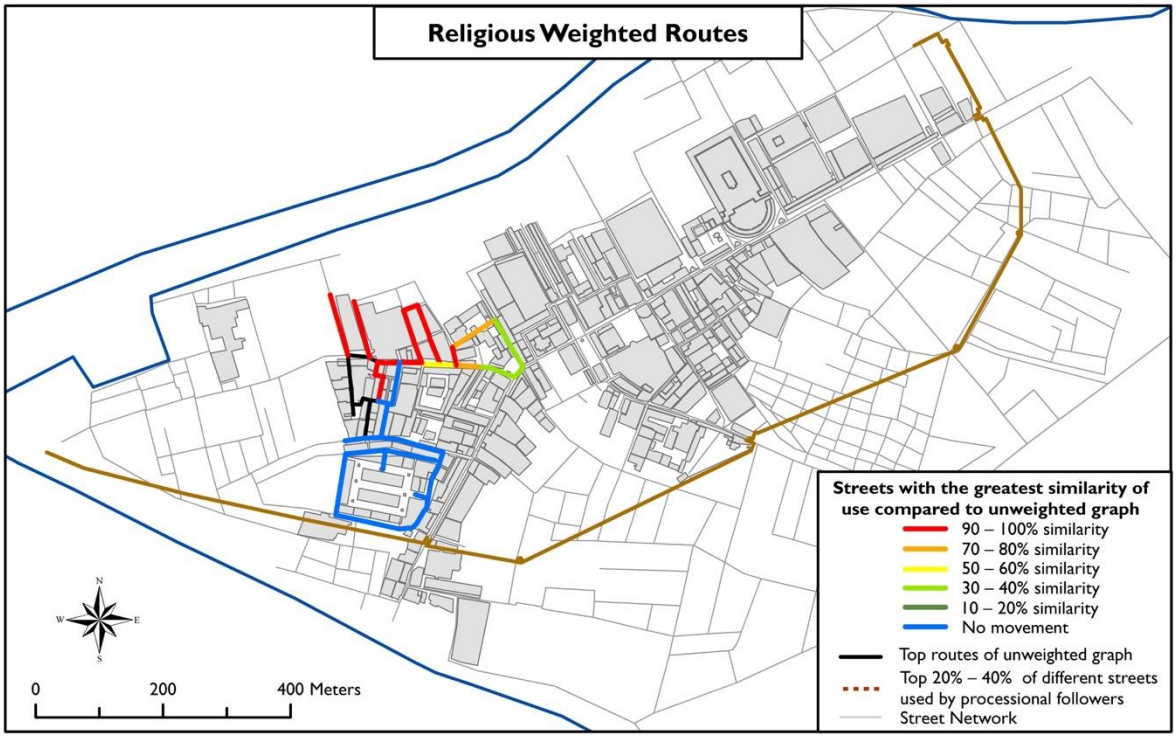


Figure 7.23 Similarity of street usage by processional runs weighted by religious spaces (religious building influence – 5, other building influence – 1). Routes reflect those chosen by the processional leader as they differ from the unweighted graph within 1000-ticks during 10 different runs. Streets shown in black follow the top routes of the unweighted graph. The red dotted line indicates streets where the route of processional followers deviates from that of the leader during 5 different runs lasting a duration of 300-ticks.

7.5.1 Potential Routes Using Combined Building Weights

As in the previous case study, movement potential is addressed when multiple different building weights are included within the calculation of betweenness centrality. Buildings within the Serapis ritual area are weighted on a scale of 6–10, correlating to their movement influence values. Figure 7.24[94] shows the route variations corresponding to the highest weighted building influence category as it differs from the unweighted graph. Streets displayed in red and orange follow buildings with the top 20% and 40% betweenness centrality measures. Streets shown in yellow indicate a fluctuation between the highest betweenness values within the 24 related graphs. Areas where there is an absence of movement when compared to the unweighted graph are displayed in blue.

[94] See Appendix E in Volume 2 of this thesis for all of the supplementary betweenness centrality graphs compiled to make the final images displayed in Figure 7.24.

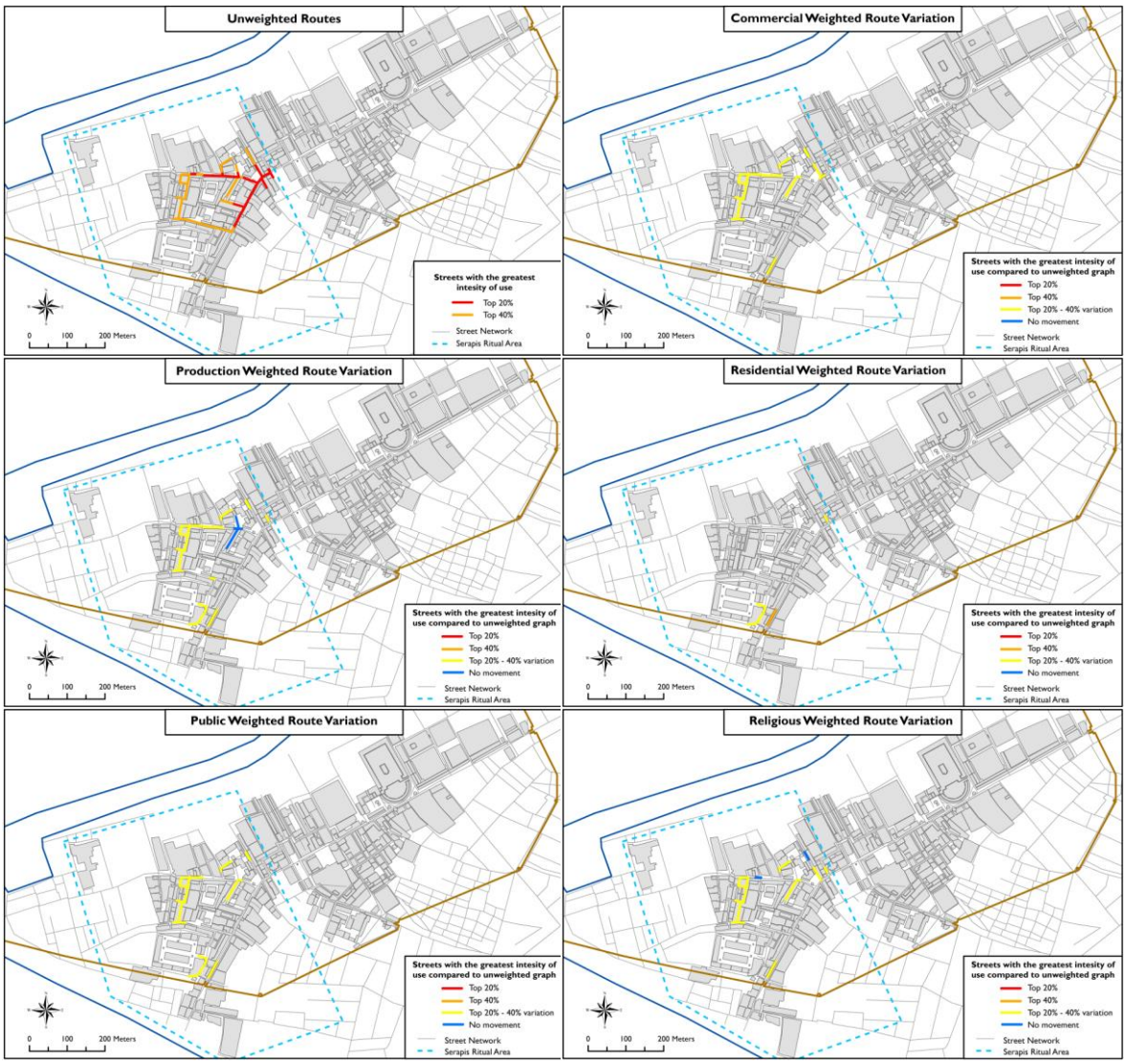


Figure 7.24 Route variation specific to each highest weighted building classification category.

Studying movement potential by looking at multiple iterations of different weight combinations highlights various patterns. How movement routes change following different building weights enables a more focused study of possible processional movement areas associated with the temple of Serapis. Attention towards the archaeological record and Ostia's built environment likewise inform our understanding of the community that developed around this particular cult.

The results when compared to the unweighted graph do not show any significant differences in terms of streets with the highest and second highest potential of use. The streets with the highest potential for movement are consistent across all of the weighted and unweighted graphs. These streets include the eastern and western *decumanus* and the *Via della Foce.* Another location along the street network that has a high degree of movement potential is the complex III.i (c.f Figure 7.3, G), located east of the *Caseggiato del Serapide*. This building complex consisted of a combination of shops, apartments, and what has been identified as a potential "hotel" enclosed within a large courtyard (Hermansen, 1982, pp. 149–150). The function of this space has alternatively been

ascribed as a setting for auctions or other public events, however, this definition is a bit tenuous (Frayn, 1993; DeLaine, 2005). It is more probable that the space served a function similar to the later period *Case a Giardino,* as proposed by Hermansen (1982, p. 149). In terms of the likelihood of movement travelling past this building, it does not make sense for a large procession to enter the courtyard area but to continue past along the *Via della Foce.* Alternatively, depending upon the features of the ritual, the procession may have stopped and enacted performances in this type of courtyard space, especially if the buildings consisted of both apartments and rented temporary lodgings that may have housed a number of the cult's followers.

The second primary area of movement that is consistent across all of the weighted and unweighted graphs is along the *Cardo degli Aurighi,* which shows a second highest movement potential value. Other areas with a high indication of movement are through the *Mercato* (III.i.7; c.f Figure 7.3, H) connecting to the street over which the *Basilica Cristiana* was later constructed (Rose, 2005, p. 398). The routes weighted highest by production space is the only example where there is no movement potential along this street, reflecting its predominantly commercial function. However, the street through the *Mercato* would have been an interior passageway, so it is likely this would not have served as a path for processional movement. Additionally, as argued by DeLaine (2005, p. 35) this building might have been a market or bazaar space, in which case processional movement through it would have been equally implausible.

The main differentiation in street usage between all of the weighted graphs concerns the internal streets of *regio* III. The streets surrounding the *Cassette Tipo* and the *Terme dei Sette Sapienti,* which connect the *Via della Foce* and the *Cardo degli Aurighi,* show varying degrees of use. The calculations weighted by residential space show the same results as the unweighted graph, where these streets have the second highest probability of movement. The other four space classifications all show that movement fluctuates between the highest and second highest movement potential categories depending upon the weighted combinations. Movement along these minor streets would give a procession a much more local emphasis, where the people populating these internal streets would have needed knowledge of the area since these are not obvious pathways (DeLaine, 2005, p. 34).

Another area that saw a differing degree of movement was the *Via delle Volte Dipinte* which passes the *Case a Giardino*. The possibility of movement travelling along this street is indicated by the graphs weighted by residential, production, and public space. Residential spaces show a 25% chance of processional movement passing them by. Both public and production weighted spaces indicated that movement past this area has only a 4% chance, shown in only one betweenness graph, making it highly unlikely that movement weighted by these two classifications would have travelled down this street. In this instance, passage along this route likely would be dependent upon the importance placed upon passing residential spaces. If a large number of residents associated with the cult of Serapis resided in these dwellings, it seems likely that a procession would have passed the complex.

Additionally, similar to the other large complex III.i, processions could have potentially entered the complex for a ritual pause. However, in comparison to the surrounding street network this street has the lowest probability of movement potential. A final area of possible movement was along the street directly north of the Republican sacred area. As these buildings are on the periphery of the excavated area, the results might in part reflect that they are positioned at edge of the area available for betweenness centrality calculations.

The calculation of betweenness centrality shows that movement potential was not only confined to the streets with the highest space syntax integration values, or by the unweighted building calculations of betweenness centrality within the ritual area. The study of movement potential based upon different building weights representing their importance shows that building functionality likely had a strong influence on passing movement. By transitioning focus away from how Ostia's street network is integrated as an indicator of pedestrian movement to the ways in which urban activity structured movement provides considerable insight into potential areas of processional movement.

7.6 Discussion

The analysis undertaken within this chapter has shown how the built environment helped to structure ritual movement within the area surrounding the *Serapeum*. The combined results of the betweenness centrality calculations and agent-based model simulations all provide an indication into the degree to which routes varied depending upon what buildings were significant for a given procession (Figure 7.25). The results indicate that movement routes influenced by commercial and religious spaces travel predominately within the areas located north of the temple. Residential weighted routes, in contrast, are restricted to the southwestern area of the city while also travelling around the *Case a Giardino*. Public weighted routes show the greatest difference in movement, confined to the major streets travelling in the direction of the *forum*.

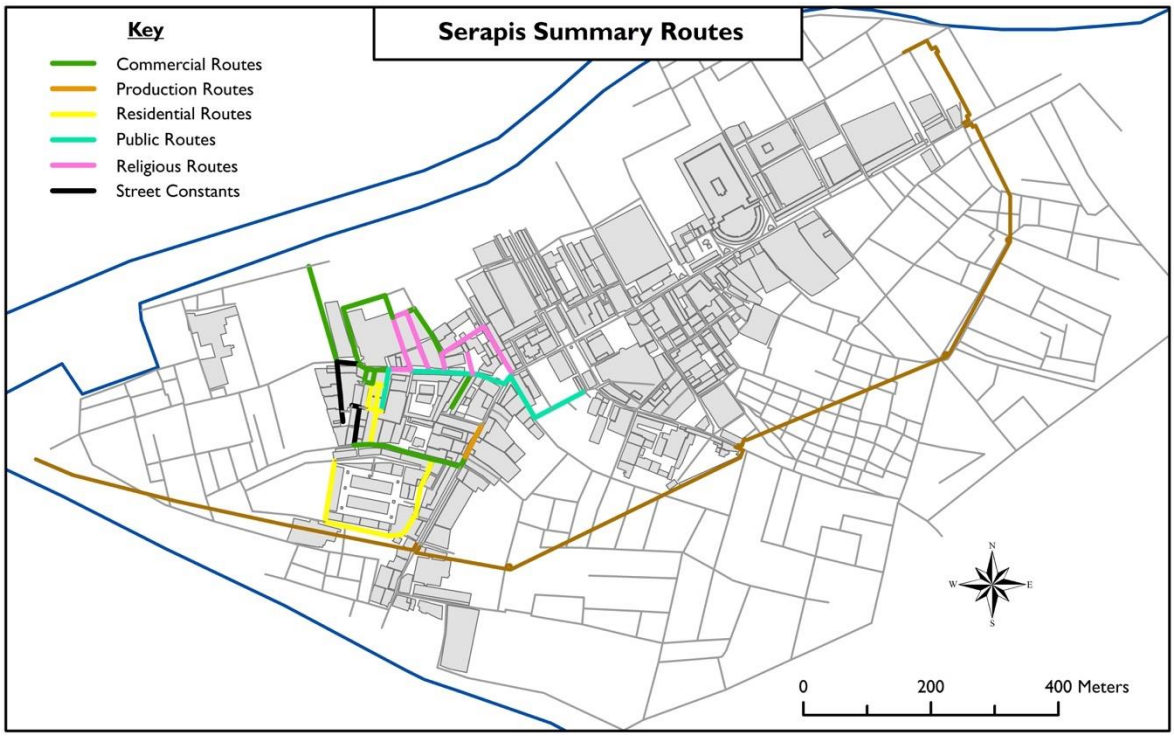


Figure 7.25 Summary of possible routes weighted by each classification category. Streets shown in black represent routes consistently used by each weighted classification.

In order to more fully relate these potential routes with the rituals specific to the *Serapeum,* the remainder of this chapter will consider the most likely routes following our understanding of Egyptian rituals and their possible nature at Ostia. Unlike in the previous chapter where the possible routes of the Magna Mater were assessed in relation to the cult's circumstantial mythological, historical, and epigraphic evidence, such an approach is less suitable for the present case study. There is insufficient evidence for comparative routes of Serapis or Isis that detail were a procession went within the urban landscape to directly relate it to individual areas of Ostia. Instead, the possible routes are discussed in relation to their association with the *navigium Isidis* and passing areas of Ostia with possible affiliations to the cult of Serapis.

The character of specific processional rituals associated with the temple will first be addressed as a way to more fully understand the possible ritual movement areas. An important aspect that needs to be accounted for is the destination of the procession prior to its return to the temple. As previously argued, if the cult of Serapis at Ostia was involved in processions associated with Isis, such as the *navigium Isidis,* then we would expect the procession to have moved towards the seafront (Apul. *Met.* 11.16–17, **A.2a**). The analyses weighted by residential and commercial space (Figure 7.25) are both indicative of movement routes travelling towards the seafront. While production weighted routes are also suggestive of a seafront movement directionality, this is largely shaped by the built environment's structure, as a similar path is shown by the unweighted analyses (c.f. Figure 7.12; c.f. Figure 7.13). But to further test this, an additional model was run to see if the

seafront had any effect upon movement routes. This was accomplished by weighting the seafront with a value of 20, while all other buildings were weighted with a value of 1. The aim was not to test the variation in building weights in addition to the seafront, but to see if the seafront can be included as an attractor in the current model.

The results of including the seafront as an attractor of movement are shown in Figure 7.26. However, the integration of the seafront into the overall model's algorithm needs further refinement. Presently, the influence of the seafront overrides the specifications of the processional leader to follow the street network for a large portion of the simulation. Once the processional leader reaches the *Cardo delgi Aurighi,* the agent travels diagonally towards the seafront, across the model's building patches rather than moving strictly along the streets towards the seafront. This is due to the fact that the seafront was included within the model following the same parameters as the other building classifications, meaning the 'Leader' will choose the seafront as a destination rather than having it existing as a general destination in addition to still trying to pass other buildings along the way. Despite the problematic issues with attempting to integrate the seafront as an influencer on movement, the results preliminarily indicate that an area of Ostia can be used as a greater attractor to movement.

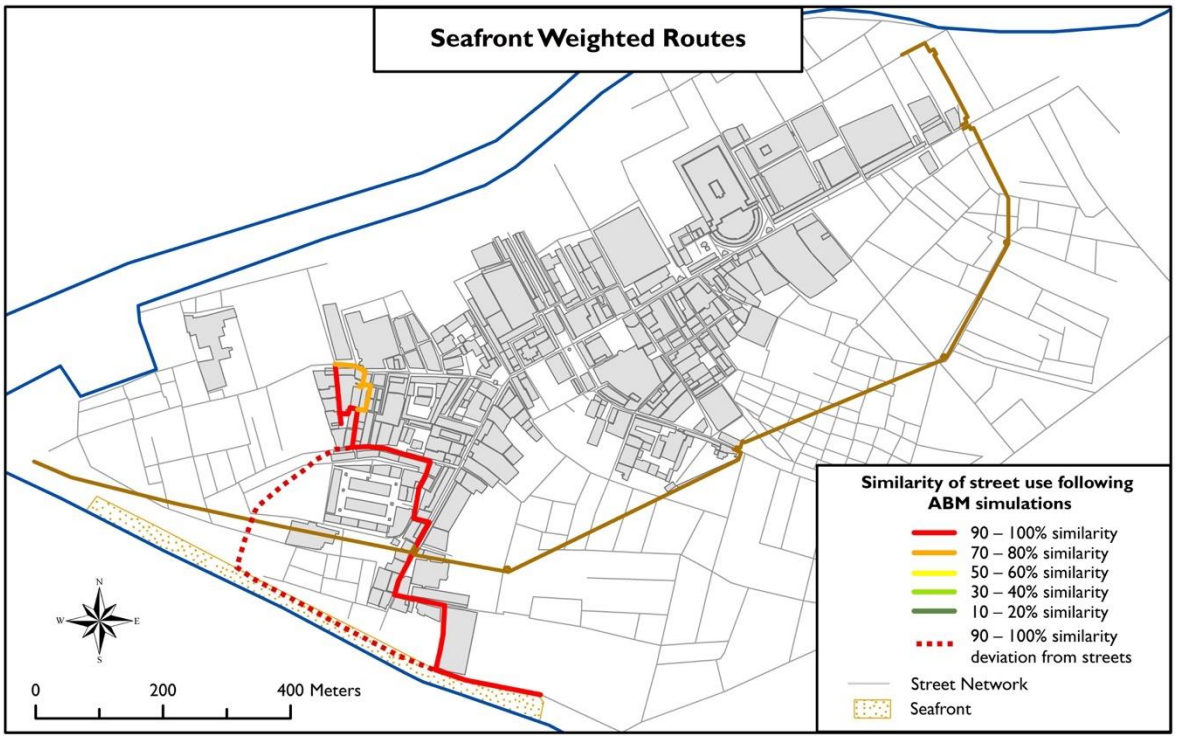


Figure 7.26 Similarity of street usage by processional runs weighted by the seafront (seafront influence - 20, other buildings influence – 1). Routes chosen by the processional leader within 1000-ticks, results of 5 different runs.

Apart from the seafront serving as a likely goal of the procession, other areas of the cityscape that may have helped to create an overall framework for the route need to be considered. Other spaces

within the area around the temple that had Egyptian elements as well as the presence of a larger Egyptian community can attest to spaces likely passed by a procession. Following this general framework, there are two possible movement routes that travelled in the direction of the seafront (Figure 7.27). In both instances, the procession would have begun its journey along the *Via della Foce.* The first possible route would include processional passage past the *Caseggiato del Serapide* if it in fact hosted a large proportion of cultic followers. Movement would have then probably have made its way south past the *Cassette Tipo* apartments towards the *Cardo degli Aurighi.* At this point, it seems most probable that it passed along the front entrance of the *Casa a Giardino* before connecting to the western *decumanus.* The procession would have subsequently travelled along the *decumanus,* through the *Porta Marina* gate and to the seafront. This route indicates movement patterns that are largely promoted by residential space and passing areas that likely housed a large proponent of Eastern immigrants associated with the cult.

The second possible route illustrates movement travelling within the area located north of the temple around various commercial structures. Movement would then travel past the Republican sacred area. This potential route would subsequently continue along the western *decumanus* before passing through the *Porta Marina* gate. Access to the seafront may have alternatively taken a route past the *Porta Marina* baths rather than directly through the area with a number of upper class residential houses. This potential route shows movement areas that preference travelling among largely non-residential spaces as well as maintaining passage along the city's major streets.

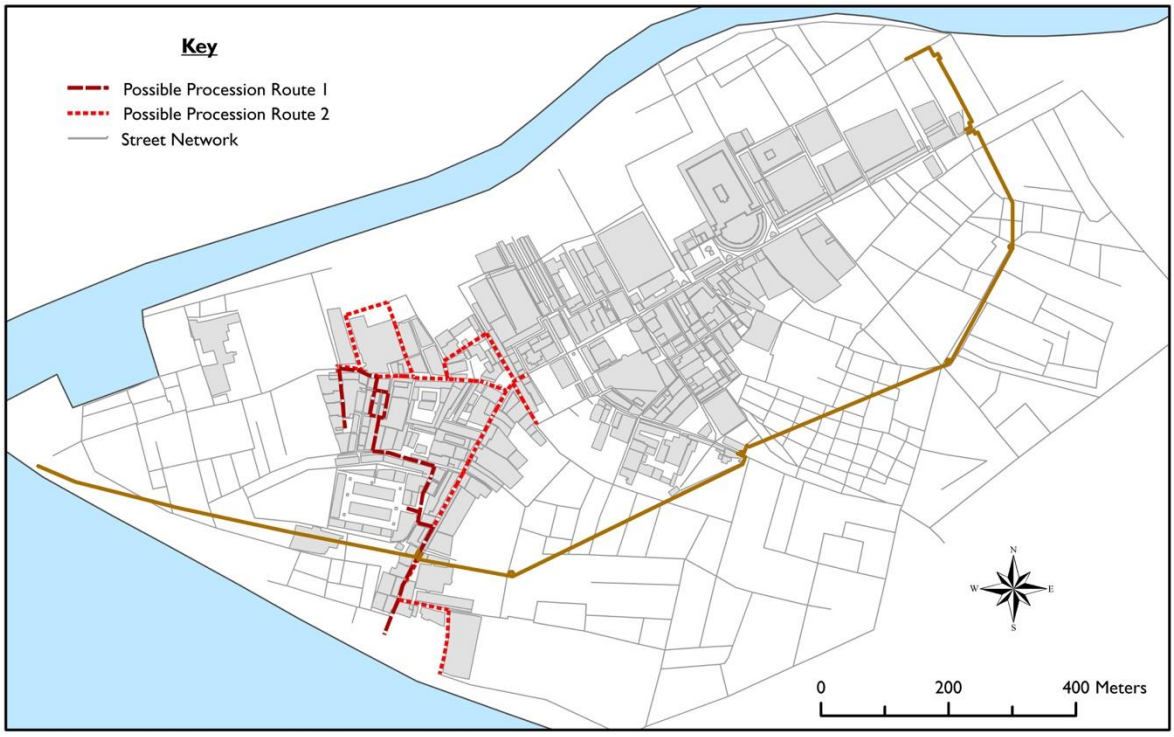


Figure 7.27 Proposed processional routes of Serapis.

The location of the *Serapeum* within Ostia's urban landscape partly restricts the number of ways a processional route could reach the seafront. Unlike with the processions of the Magna Mater, there are fewer interconnected streets that the procession can feasibly travel along. As a result, the possible routes seem largely dictated by the importance, or not, of passing residential spaces. This likewise effects the type of streets that are traversed. The route 1 procession possibility illustrates movement that occurs along primarily smaller streets located within the interior of *Regio III.* Route 2, in contrast, shows a movement area more confined to travelling along the city's major streets, which could have also enabled increased visibility of the procession.

The areas of Ostia encompassed by these different routes are additionally significant. They way in which the processional ritual navigated the surrounding areas reflect the cult's distinct nature and how it was intended to be perceived. The importance of determining possible processional routes is not in identifying the individual streets that are traversed, but how the processional ritual may have travelled through different areas of Ostia on route to the seafront. Through generalising potential routes, the broader significance of the processional ritual is emphasised, which is to collectively join a portion of the cityscape within a shared ritual experience.

Questioning the overall intent of processions associated with the *Serapeum* can help provide additional insight into the character of the processional rituals, as well as further inform our understanding about where they may have travelled in light of the present route analyses. An important aspect of the rituals associated with Serapis appears to be that it enabled the strengthening of a local Eastern group identity of the cult's followers. By being associated with a specific segment of the population, the processional rituals enacted by the cult of Serapis existed as a way to collectively show both their affiliation to the god, and, more generally to their cultic community. The dedication of the temple by Caltilius on Hadrian's *dies natalis* and its inclusion within the *Fasti Ostienses* (Vidman, 1982) are likewise indicative of the cult's initial integration within Ostia's wider civic community. Any rituals associated with this date would have alluded back to its initial foundation and to the person/family that made it possible. Additionally, processional rituals would have called attention to the temple and its community of followers as it travelled beyond its insular community towards areas such as the seafront.

The processional routes have been shown to travel predominantly within the areas south of the *Serapeum.* While being closely linked with passing areas hypothesised to have accommodated a local Eastern population, these areas also consisted of predominantly residential buildings. The seafront, in addition to several bath structures, would have comprised of several upper class *domus.* This all argues towards a processional route that was largely structured by passing residential space. In this way, it enabled active engagement with the social communities situated within this area of Ostia.

7.7 Summary

This chapter has considered the *Serapeum* and the potential processional rituals associated with the temple. While there is no direct evidence for the practice of processions specific to Serapis at Ostia, it is likely that the cult would have been associated with the various Isiac processions that would have occurred within the city. The second half of this chapter has addressed how the calculation of betweenness centrality and agent-based modelling can provide a more nuanced understanding about possible areas of processional movement, structured by the built environment. The various weighted combinations all show movement focused predominantly within the areas located east and south of the temple. When further considered within a broader processional framework inclusive of a seafront destination, the different weighted graphs provide an indication into route variations depending upon important areas to pass as the procession made its way towards this location. The relatively confined area of movement within this region of Ostia is further indicative of a procession intended to strengthen the cult's group identity. Likewise, the movement past mainly residential areas all attest towards processions intended for community cohesion.

Chapter 8: Case Study 3 - The *Forum* Temples

8.1 Introduction

The *forum* existed as the most central space in Ostia, both through its spatial position and its monumentality. Unlike the previous two case studies that have addressed temples with identified cults with definitive festivals, this last case study takes a slightly different approach. Because of the uncertainty surrounding the identification of the *forum* temples and their cultic associations, this chapter questions if the methodology developed in this thesis can address the study of a temple's ritual area when there is limited knowledge about its cultic affiliations. The previous two case studies demonstrated how temples were able to structure a temporary religious landscape by the routes taken by processional movement. The *forum* temples are used as a final case study for two reasons: first, it shows how the study of processional movement provides insight into the definition of a possible ritual area even when the identity of a temple is uncertain and; second, it presents a model of how a larger scale procession may have traversed Ostia's street. While the festivals associated with the *Capitolium* and the *Tempio di Roma e Augusto* are tenuous at best, addressing possible movement routes for generic processional activity presents one way of studying how these two major monumental temples structured ritual activity at the centre of the port town. Due to the issues in identification, in this case study I do not aim to present an argument for the practice of specific processions. Instead, I hypothesise that the same framework applied to studying processions in the previous two case studies can be applied here to define what are, in essence, un-named processions. In this instance, the resulting processional routes provide a hypothetical understanding of how the spatial location of these temples may have structured ritual activity that extended into the surrounding cityscape. This enables new assessment of the importance of these temples and their rituals to Ostia's urban environment.

8.2 The *Forum* Temple at Ostia

The *Capitolium* was one of the first structures systematically excavated at Ostia. Petrini, under the auspices of Pope Pius VII, began excavating the temple in 1802 (Fea, 1802; Guattani, 1805; Badgeley, 1929, p. 222). Further excavation and study of the temple was undertaken in subsequent years in order to confirm both the identification of the structure as well as dating its initial construction (Badgeley, 1929). More recent analysis of the brick stamps further confirms its construction date of c. AD 120 as well as showing that the four brick suppliers had close imperial ties (DeLaine, 2002).

One of the major debates about the temple concerns its cultic affiliation. During the 19th century scholars attributed the temple to Vulcan, who is attested in Ostia's epigraphic record as an important deity for the city (Taylor, 1912, p. 15). However, there is no firm evidence that Vulcan is

associated with this particular temple. Furthermore, the re-construction and dedication of an existing temple in AD 112 to Vulcan is recorded by the *Fasti Ostiensis.* As argued by Meiggs (1973, p. 381), it is highly unlikely that a completely new temple was built only 20 years later. Rieger proposes an alternative theory that the cult of Vulcan was practiced in one of the Republican period temples that was destroyed for the present *Capitolium,* after which the cult was transferred to the *Curia* (2004, pp. 219–221). This theory is in part based upon the number of *fasti* fragments found around the *forum* area*,* which Rieger (2004) contends were displayed in the *Curia*, but there is far from conclusive evidence for the presence of the cult of Vulcan in the building itself (Pensabene, 2005, p. 502).[95]

The more commonly accepted theory regarding the temple's identification is that of a *capitolium,* which was first proposed by Van Buren (1907) following his study of *fora* across the empire. His work concludes that a *capitolium* constituted a normal structure within *fora* (Van Buren, 1907; Badgeley, 1929, p. 222). While this cultic affiliation is widely accepted, scholars Quinn and Wilson maintain that there is insufficient evidence for its present identification (Quinn and Wilson, 2013, p. 140). The architectural structure does not exhibit the traditional tripartite construction generally associated with *capitolia,* nor is there evidence of multiple statue bases for the Capitoline Triad deities. Furthermore, excavation of the temple and *forum* did not reveal any epigraphic evidence to confirm this identification. The primary argument for the presence of a *Capitolium* at Ostia originates with a dedication to Mars, discovered in Rome, that mentions an *aeditu(u)s Capitoli* or priest of the *Capitolium* (*CIL* XIV 32). Meiggs contends that the dedicator, an A. Ostiesnsis Asclepiades, was part of a known family at Ostia, which could mean this inscription is referring to the Capitolium at Ostia rather than Rome (Meiggs, 1973, p. 380). While the identification remains somewhat suspect, its central location in combination with its imperial ties indicates that it was a major public temple. The issues in firmly establishing its cultic ties, however, complicates any attempt at reconstructing ritual activity specific to this temple.

Despite its central position within the forum, the *Tempio di Roma e Augusto* was not discovered until the 1921–1923 excavations, and it is only briefly mentioned in Calza's guide to the monuments at Ostia (Calza, 1925, pp. 147–151, 1929, pp. 162–164). As the first marble temple constructed at Ostia, the temple has received comparatively limited study. In part, this is due to its poor preservation, which Calza attributes to its construction in marble that was later stripped away from the building (Calza, 1929, pp. 158–164). The most comprehensive study is presented in Nucci's (2013) recent publication that compiles all known scholarship about the temple as well as

[95] Pensabene (2005) suggests another alternative, in that there were two temples to Vulcan. On would have been associated with the unidentified *Tempio Repubblicano* (identified by Rieger (2004, p. 217) as belonging to the Castors) located south of the *Grandi Horea,* and another temple was located in the *Foro di Porta Marina*, which Coarelli also hypothesises as belonging to Vulcan (Coarelli, 2007, p. 468).

introducing new material recovered from Ostia's archives.[96] A large proportion of studies concerning the temple have surrounded comparative studies of the architectural fragments and statuary (Floriani-Squarciapino, 1948; Nucci, 2013) and the transformation of the *forum* from when the temple was first constructed to the Hadrianic renovation of the *forum* (Zevi, 1997; Mar, 2002a; Polito, 2014).

The cultic association of the temple is based upon its epigraphic and sculptural evidence (Calandra, 2000, pp. 439–440; Pensabene, 2004). The inscriptions *CIL* XIV 73 and *CIL* XIV 535 attest to the presence of a temple dedicated to Rome and Augustus at Ostia. Despite the temple's identification, there has been considerable debate about ascertaining who donated the funds for its construction as well as its date of construction. The widely accepted dating of the temple places its construction during the Tiberian period (Calza, 1953, pp. 115–116). However, there are still arguments trying to place this dating slightly earlier in the Augustan period following a study by Calandra (2000).[97] Reconstruction and interpretation of the dedicatory inscription by scholars has likewise been used to try and more clearly determine the temple's date (Nucci, 2013, pp. 233–245). In particular, an addition to the dedicatory inscription (*CIL* XIV 535) that possibly reads as *patronus*[98] *coloniae* (patron of the colony) has been compared to the *patronus coloniae,* Galbrio, mentioned in *CIL* XIV 4324, who may have been part of the Augustan *Acilii Glabriones*, thereby placing the temple's date prior to the Tiberian period (Cébeillac-Gervasoni, Caldelli and Zevi, 2010, p. 125; Nucci, 2013). The continued debates about the temple's date either in the Augustan or Tiberian period have implications as to whether or not imperial support was provided for its construction (Vidman, 1982, p. 40; Mar, 2002a; Pensabene, 2007, p. 142; Nucci, 2013). Regardless of the exact period in which the temple was constructed, it developed out of the new Augustan ideology and would have had an obvious impact upon the structuring of the *forum* space (Pensabene, 2005, p. 512). The numerous debates surrounding the temple's chronology and association has resulted in very limited consideration of its ritual activity.

It is unknown whether or not this temple was directly associated with the imperial cult.[99] Most of the arguments in favour of this, predominately circumstantial, combine evidence for the transformation of Ostia's civic space with evidence for the presence of the imperial cult at Ostia in the form of various priesthoods (Polito, 2014, paras 38–39). A large proportion of evidence for imperial worship comes from other contexts at Ostia, such as one dedication given to the association of the *dendrophori,* which was made to the *Numini Domus Augustae,* "to the spirit of the

[96] For a review of the main scholarship surrounding the *Tempio di Roma e Augusto* see, Polito, 2014.
[97] Before the temple's excavation, Taylor (1912, pp. 46–47) states that a temple of Roma and Augustus was constructed prior to the death of Augustus following epigraphic evidence.
[98] *Patronus* was an honory title that could be conferred upon a person in the town. While this did not include any particular duties, they were expected to further town interests (Meiggs, 1973, p. 179).
[99] See Nucci (2013, p. 249) for further discussion on the difficulties of relating imperial worship to specific monuments. For wider discussions of the imperial cult see, Gradel, 2002.

house of Augustus" (*CIL* XIV 45). We do know quite a bit about the presence of the imperial cult, predominately through the priestly lists of *flamines*[100] and *Augustales.*[101] The priestly office potentially associated with the temple was that of the *Augustales*, with holders of the priesthood (*severi Augustales*) being well attested from epigraphic evidence at Ostia.[102] The *Seviri Augulstales* were freedmen (Taylor, 1912, p. 51; Gradel, 2002, p. 89), who were presided over by a priest of the living emperor called the *flamen Romae et Augusti (CIL* XIV 373, 400, 4142). This was a distinguished priesthood that was held for life, and likely only for the extent of the emperor's life (Gradel, 2002, p. 89). This focus of the priesthood may have been based at the *Tempio di Roma e Augusto*, although there is not firm evidence for it being here as opposed to elsewhere at Ostia (Meiggs, 1973, p. 178).

Both the *Capitolium* and the *Tempio di Roma e Augusto* are problematic in terms of their identification and, by extension, understanding their related ritual practices. As a result, scholarly enquiry into these two religious structures has concentrated predominately upon trying to either determine their cultic affiliation or confirm the dates of their dedication as a way to gain a greater understanding of their significance for Ostia's urban landscape. This focus, however, has neglected any consideration of the rituals and festivals that would have been associated with these temples and the *forum* space that lies between them. Rather than trying to enter into the existing debates, this chapter presents an alternative way of assessing the impact that these monumental temples had upon the urban landscape. By addressing the possible areas of processional movement associated with these two temples, I move the focus of the debate in order to question how associated ritual activities would have interacted with daily life at Ostia, upon the assumption that both temples were indeed the focus of religious processions.

[100] *Flamines* were priests appointed to specific deities.
[101] The *Augustales* were a specific priesthoods that presided over the worship of Augustus and the imperial family.
[102] For a list of the known references to the *Augustales* at Ostia, see *CIL* XIV, p. 573–574.

8.2.1 Spatial Context of the Temples

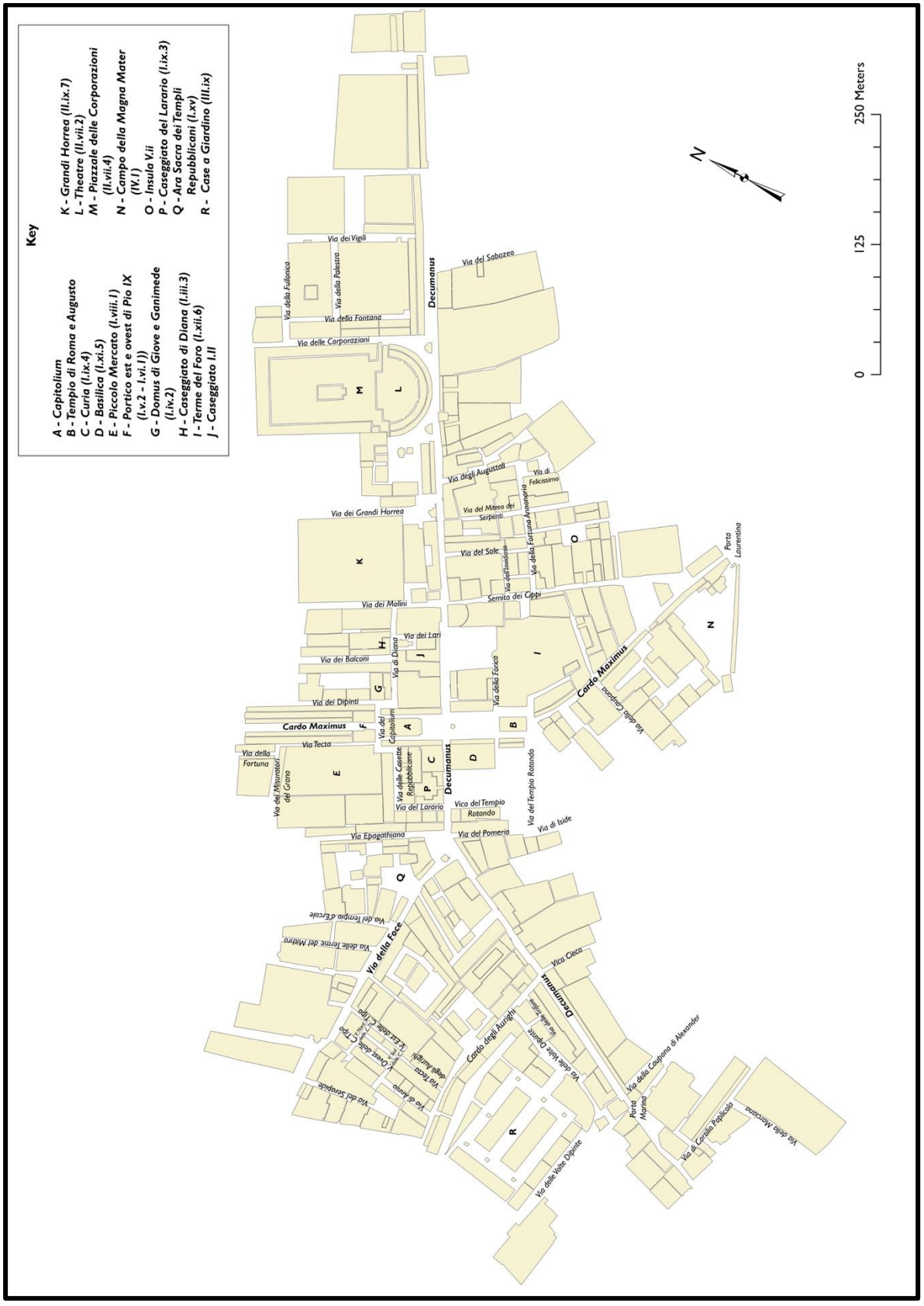


Figure 8.1 Map showing the street names of Ostia and important buildings.

The *Capitolum* (I.1), located at the northern end of the *forum,* was built facing and on alignment to the *Tempio di Roma* e *Augusto* (I.2), which defined the southern boundary of the *forum* (c.f. Figure 8.1, A, B; Figure 8.2). The *forum* was centrally located between the Tiber and the city's various entrance gates. The eastern *decumanus* runs through the middle of the *forum* area.

Figure 8.2 View of the *forum* from the *Capitolium* towards the south; the *Tempio di Roma* e *Augusto* lies behind the trees at the middle of the photo (photo, K. Crawford).

Study of the *forum* area applying standard space syntax axial analysis measures provides further confirmation of its centralised location. The computation of integration, which assesses a street's general accessibility, confirms the *decumanus* as the most integrated or accessible street within Ostia's larger street network. The calculation of choice, which measures the degree of movement potential along a street, additionally indicates that the *forum* saw the greatest probability of movement. Both graphs (Figure 8.3) are displayed on a colour scale of blue to red, with red streets representing the streets with the highest integration and choice values. The implications of this for the *forum* temples means that inhabitants and visitors to Ostia would have regularly interacted with or at least seen the temples as they moved through the *forum* area.

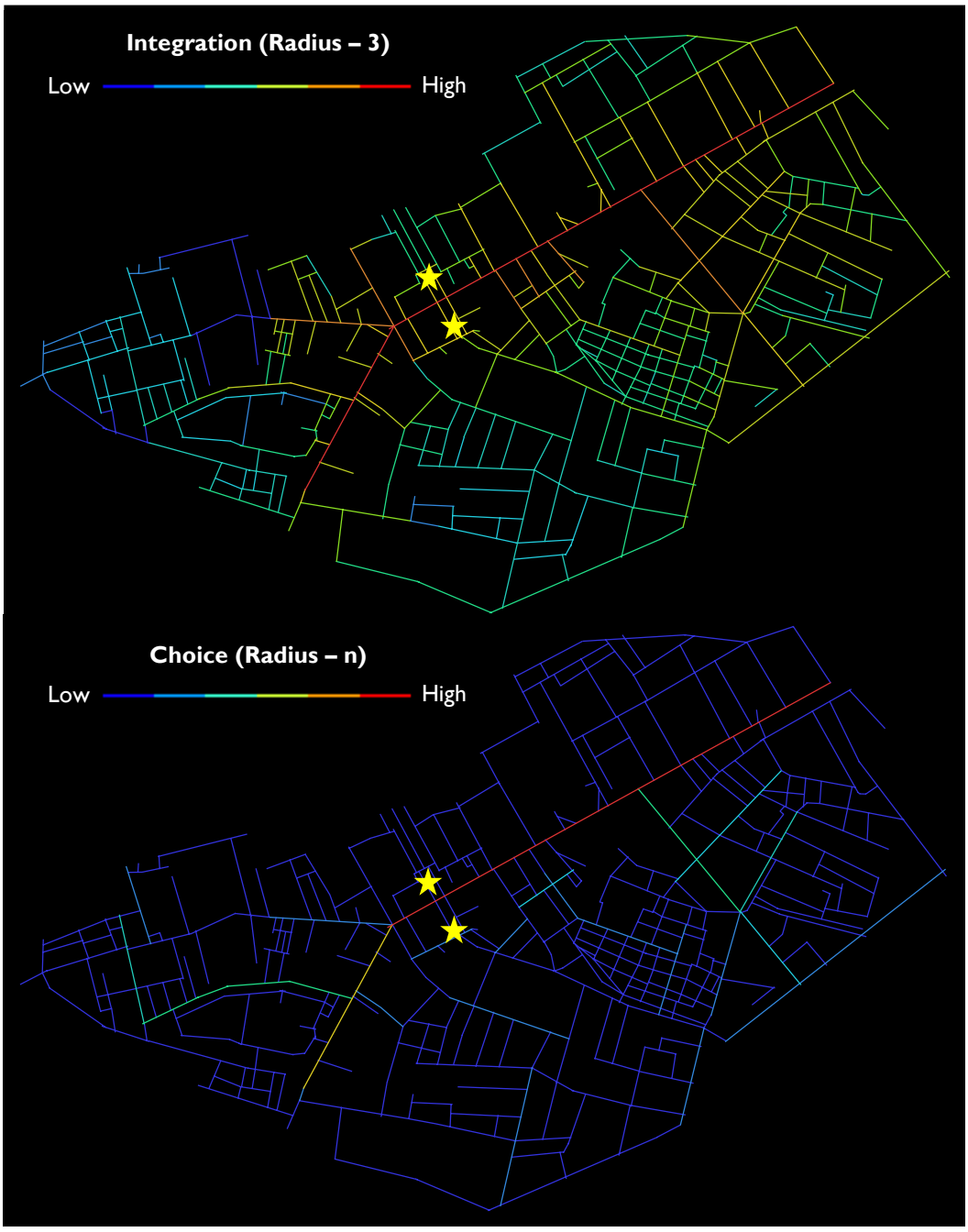


Figure 8.3 Space syntax axial graphs showing the position of the *Forum* temples in relation to integration and choice metrics. Top – axial integration graph of the extended street network (radius-3, 386 street segments). Bottom: Axial choice of the extended street network (radius-n, 386 street segments).

The *Capitolium* (Figure 8.4; c.f. Figure 8.1, A), a prostyle hexasytle temple measuring c. 35 x 15.5 m, was built atop a high podium that allowed it to stand approximately 20 m in height (Albo, 2002, p. 363). Constructed on alignment to the *Tempio di Roma e Augusto,* it replaced two previous Augustan temples (Meiggs, 1973, p. 380). The temple's *pronaos* consisted of 10 marble columns followed by a *cella* that would have been ornately covered with marble (Meiggs, 1973, p. 448). The two sidewalls

hosted three identical niches, two rectangular niches flanking a central semi-circular niche.[103] The rear podium included a base for supporting the temple's cult statue. The basement of the temple consisted of three rooms of unknown function, constructed with barrel vaults and accessed through the building's rear.

Figure 8.4 View of the *Capitolium* from the centre of the *forum* (photo, K. Crawford).

The *Tempio di Roma e Augusto* (Figure 8.5; c.f. Figure 8.1, B) is located at the southern end of the *forum*, directly across from the *Capitolium*. The prostyle hexastyle temple was likely c. 16 m tall based upon surviving facade fragments (Figure 8.6). The *pronaos* was accessed via two lateral staircases, which could be indicative of its dual purpose as a location for civic functions since it provided a platform for speaking (Calza, 1953, pp. 116–117). The inscription *CIL* XIV 353 provides further evidence for this joint function, showing that the temple occasionally served as a meeting location for the city's town council (van der Meer, 2012, p. 111). The existing architectural remains form part of the temple's substructure, which consists of a series of 4 small rooms on either side of a corridor (Figure 8.5). The temple's position within the city was first recognised during Calza's excavations, which noted that its construction necessitated the destruction of the *castrum's* southern wall (Calza, 1953, p. 115). The temple's construction during the Julio-Claudian period and

[103] It has been argued that imperial statues would have occupied these spaces, but there is no evidence either way for this supposition (Badgeley, 1929, pp. 221–223).

the *forum's* later adaption to its layout signifies its importance as a point of orientation for later imperial construction at Ostia. Its location in part dictated the development of a unified public space that became the *forum* seen today. With the monumentalization of the *forum* at the beginning of the 2nd century AD, the visual prominence of the *Tempio di Roma e Augusto* would have been diminished in comparison to the *Capitolium*.

Figure 8.5 View of the substructure of the *Tempio di Roma e Augusto* (photo, K. Crawford).

Figure removed due to copyright restrictions

Figure 8.6 Reconstruction of the *Tempio di Roma e Augusto* by M. Ricciardi (Nucci, 2013, fig. 1).

The *forum* area was enclosed within a colonnaded portico located on the eastern and western edges of the space. Located behind this on the western side of the *forum* were the *Curia* (I.ix.4; c.f. Figure 8.1, C) and the *Basilica* (I.xi.5; c.f. Figure 8.1, D). Behind the eastern portico stood various domestic structures. Positioned near the centre of the *forum,* just south of the *decumanus,* is a small round structure measuring 4.50 m in diameter (Figure 8.7). Excavated by Calza, the structure was initially interpreted as a nymphaeum (Calza, 1925, p. 147, 1953, p. 71). An alternative function as a *compitum* was proposed by Bloch (1962) following his analysis of epigraphic fragments. This is disputed by Bakker (1994) after further study of the structure which confirmed the structure's ability to hold water. The *compitum* is more likely identified with the structure located at the intersection of the *decumanus* and the *Via della Foce* (Bakker, 1994, p. 121; Steuernagel, 2004; Pensabene, 2005, p. 523). Its central position within the *forum* provides some indication into its importance and possible religious association, although its identification and function remains uncertain. These architectural structures in combination with the *decumanus* created a demarcated space within Ostia's urban centre.

Figure 8.7 The *forum* round structure (photo, K. Crawford).

The redevelopment of the *forum* during the imperial period resulted in a modification in how it was connected to Ostia's street network. The establishment of the two *forum* temples in particular altered the connection of the *cardo maximus* with the *forum.* The southern part of the *forum* underwent significant changes in circulation patterns with the initial construction of the *Tempio di Roma e Augusto*, which reduced movement to pedestrian access only through arches located on the western and eastern sides of the temple (Zevi, 2004, p. 57). Any cart traffic needing to travel between the northern and southern area of the *forum* would have been forced to travel along the streets following the original *castrum* wall, creating in essence a ring road (Tilburg, 2007, pp. 163–165; Stöger, 2011a, p. 210). The development of the *Terme del Foro* (I.xii.6; c.f. Figure 8.1, I) during the end of the 2nd century AD further restricted movement within the southern area, with any

vehicular movement needing to find new routes to travel around the *forum* (Mar, 2008, p. 139). Pedestrian access was still possible directly south of the baths, connecting the southern *cardo maximus* with the *Semita dei Cippi,* but carts would have needed to follow an alternative route.

The construction of the *Capitolium* likewise reduced the accessibility of the *forum*. The northern *cardo maximus* originally joined the *forum* directly. Its importance within Ostia's urban structure can be inferred from the inscription *CIL* XIV 375 which notes that it was paved by P. Lucilius Gamala (Salomies, 2003; Zevi, 2004, pp. 55–57).[104] The construction of the Republican period *Capitolium* initially reduced the street's width leading to the *forum* from the north, while the construction of the Hadrianic *Capitolium* further reduced access, limiting it to only enabling pedestrian movement. The *decumanus,* in contrast to the *cardo maximus* would have retained its passage through the centre of the *forum.* However, the limited accessibility from the north and south meant that non-pedestrian movement would have needed to travel around the *forum* towards the south either along the *Via del Tempio Rotondo* or the *Semita dei Cippi* (Mar, 2008, p. 128).

The *forum* represented the central node of Ostia, facilitating movement between all areas of the city. The limitations to movement directly through the *forum,* however, has interesting implications in the role the *forum* played within Ostia's urban fabric. The attempt to control the degree of access between the north and south results in its development as a greater pedestrian space (Newsome, 2010, p. 301). While the *decumanus* travelled through its centre, the articulation of pedestrian space was evident through the *forum* standing slightly above the street level (van der Meer and Stevens, 2000). Scholarship has shown that *fora* tended to regulate movement patterns within them, as well as the types of activities that occurred within the space, based upon their access from connecting streets (La Rocca, 2006; Newsome, 2011b). As a result, the *forum* needs to be understood as multi-articulated space that enabled both social gatherings as well as allowing the passage of through traffic that went from east to west (Pensabene, 2005, p. 500). The convergence of streets both through and around the *forum* helped to define its central position both in terms of its geographical location but also in terms of its role in channelling movement through the city, both pedestrian and vehicular. While pedestrian movement was directed through the *forum,* the majority of vehicular traffic would have been structured to move around the area, or directly through it along the *decumanus*.

[104] There has been some debate about whether the inscription refers to the *decumanus* or *cardo maximus.* Meiggs (1973, p. 501) originally proposed that it was in reference to the *decumanus,* which has since been revised by Zevi (2004, p. 57) to mean the *cardo maximus.*

8.3 City Wide Ritual Movement

A specific ritual area is first defined by applying the space syntax calculation of axial step depth, which looks at the number of streets away or turns from a starting point to all other streets within the city network. This is visually depicted on a scale of red to blue, with red equating to one turn or less and blue to more than five turns (Figure 8.8).

As with the previous two case studies, a general ritual area is defined which correlates to the local accessibility of streets. Step depth is calculated from the *forum* using 3 turns from a central point within the *forum* and along the eastern *decumanus*. The resulting graph indicates that almost all buildings within Ostia's excavated environs are accessible within a step depth of 3 (Figure 8.9). Due to the general accessibility of the built environment, the ritual area was defined as the total excavated cityscape.[105] It needs to be noted that by accounting for all buildings, there is not a buffer to address any 'edge effect' or errors that may result in the data due to the unexcavated areas of the city. Despite issues with the existing data, this presents the opportunity to study the variation in citywide processional movement and the extent to which a larger procession would have interacted with other smaller ritual areas.

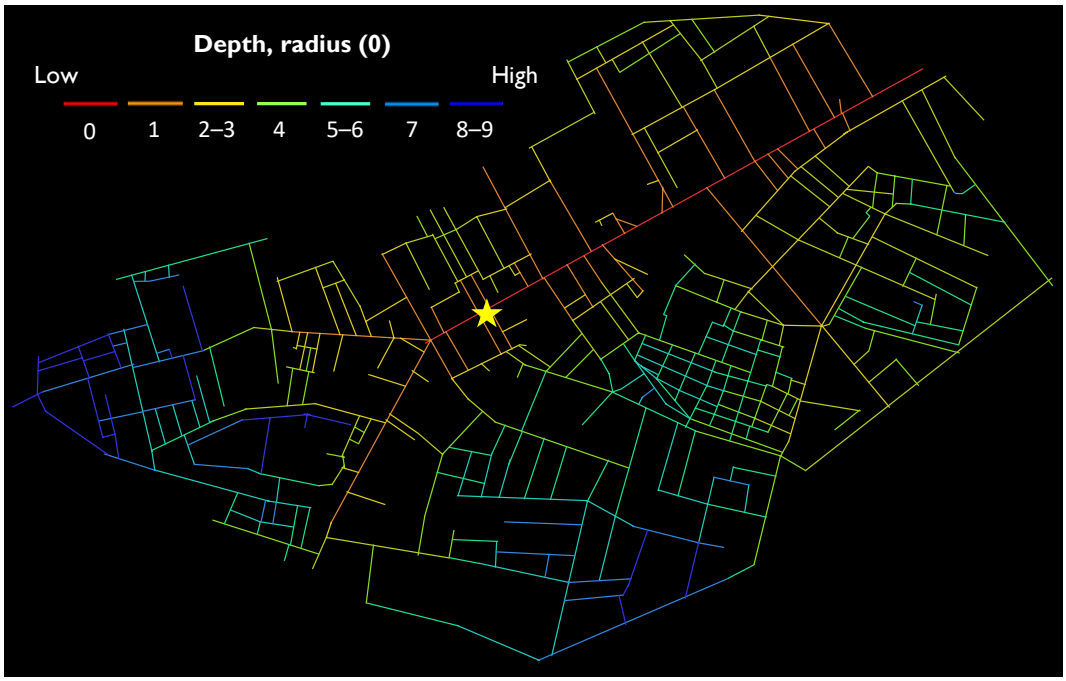


Figure 8.8 Axial graph showing step depth from the *forum*.

[105] See Kaiser (2011, pp. 122–125) for a more detailed discussion about the calculation of step depth from the *forum*. His analysis looks specifically at the type of structures that are located at different step depth values to address how that can inform our understanding of Ostia's urban patterning.

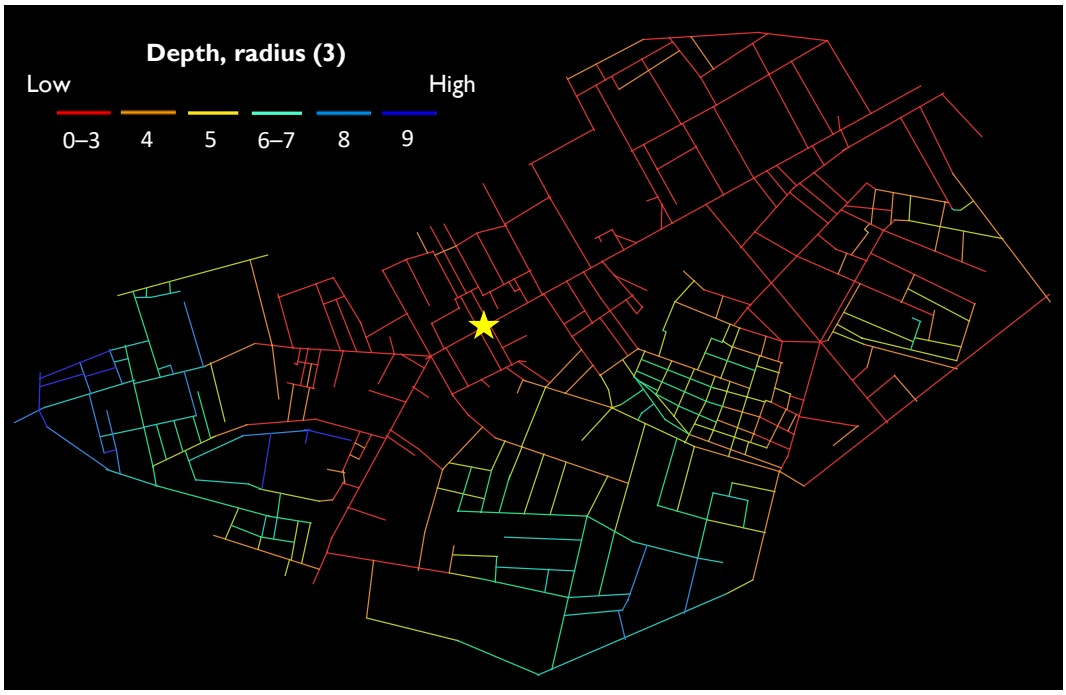


Figure 8.9 Axial graph showing step depth from the *forum* using a radius of 3. Streets represented in red are with 0–3 street turn from the *forum.*

8.4 The Inter-Relationship between Urban Activity and Urban Movement

The calculation of axial step depth provides a defined area, which includes the entire excavated cityscape of Ostia, for studying processional movement associated with the *forum* temples. A total of 395 buildings are included within the excavated cityscape. Unlike the previous two case studies that have applied urban network analysis on a local scale using a 200 m network radius, the present case study looks at processional movement on a global urban scale. Therefore, a 400 m network radius is applied to all betweenness centrality calculations. This addresses the presence of a larger scale processional route that would have likely encompassed a greater proportion of the city.

A base model is initially run to assess the general movement potential across the entire city. The resulting graph (Figure 8.10) shows the movement potential relating to a 400 m network radius. The streets corresponding to the two highest betweenness centrality buildings are displayed in red and orange. The unweighted graph shows that movement corresponding to the street network is concentrated along the eastern and western *decumanus,* the *Via della Foce,* the *Cardo degli Aurighi,* and extending down the *Semita dei Cippi.* This represents all the major streets at Ostia, and for the most part reflects the values of axial integration and choice calculated for the street network using space syntax (Figure 8.3). The main variant from the initial space syntax results is in relation to the street, *Semita dei Cippi,* which is not shown to have a high space syntax value in either calculation. The betweenness centrality results indicate that the highest potential of movement was

concentrated around the intersection of the *decumanus* and the *Via della Foce.* Looking at possible movement routes applying unweighted building values provides some indication of movement, but there is hardly any variation in what the space syntax results tell us about likely areas of movement.

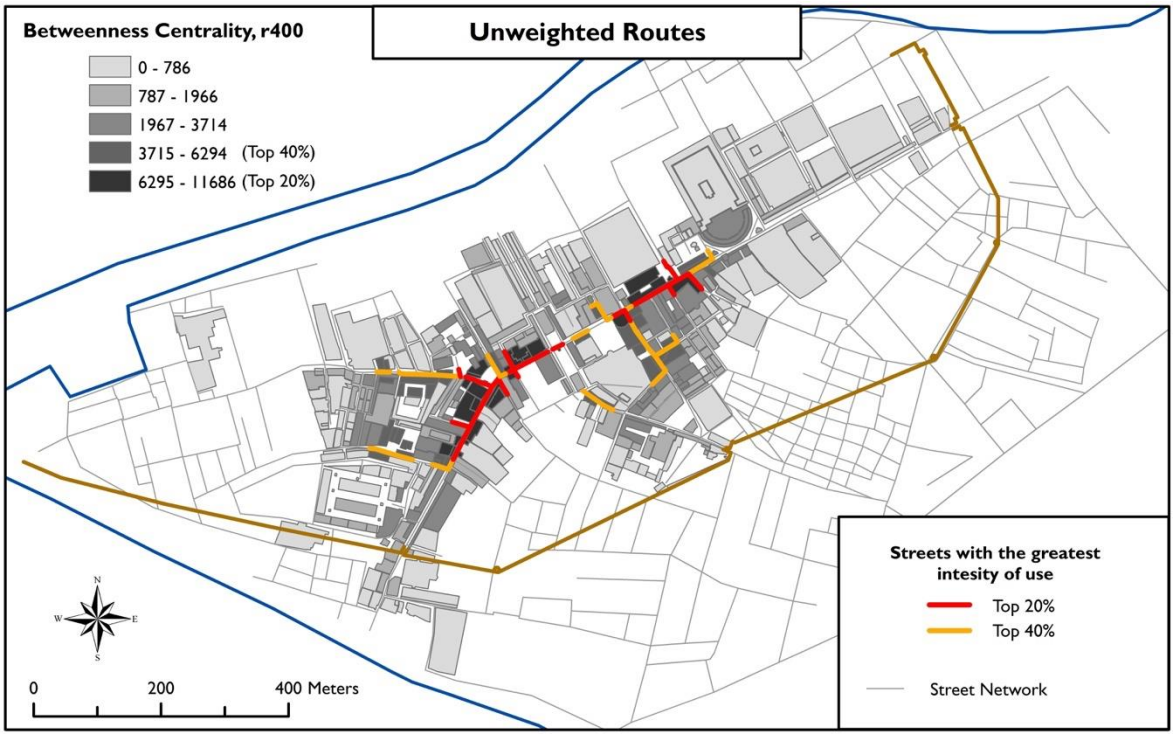


Figure 8.10 Calculation of betweenness centrality within the excavated built environment without any building weights (radius 400). The streets following the two highest betweenness centrality metrics are designated in red and orange.

The general area of movement, originating at the *forum,* is further questioned using the agent-based model. All of the excavated buildings are weighted with an influence value of 1, a route is traced from the *forum* following the leader agent for 1000-ticks. The potential routes (Figure 8.11)[106] taken during five different runs show movement predominately confined to the area south of the eastern *decumanus.* This indicates that a movement route beginning and ending at the *forum* would be more restricted compared to the betweenness centrality unweighted graph.

[106] See Appendix F in Volume 2 of this thesis for all of the agent-based model runs that were used to compile the summary ABM figures found throughout this chapter.

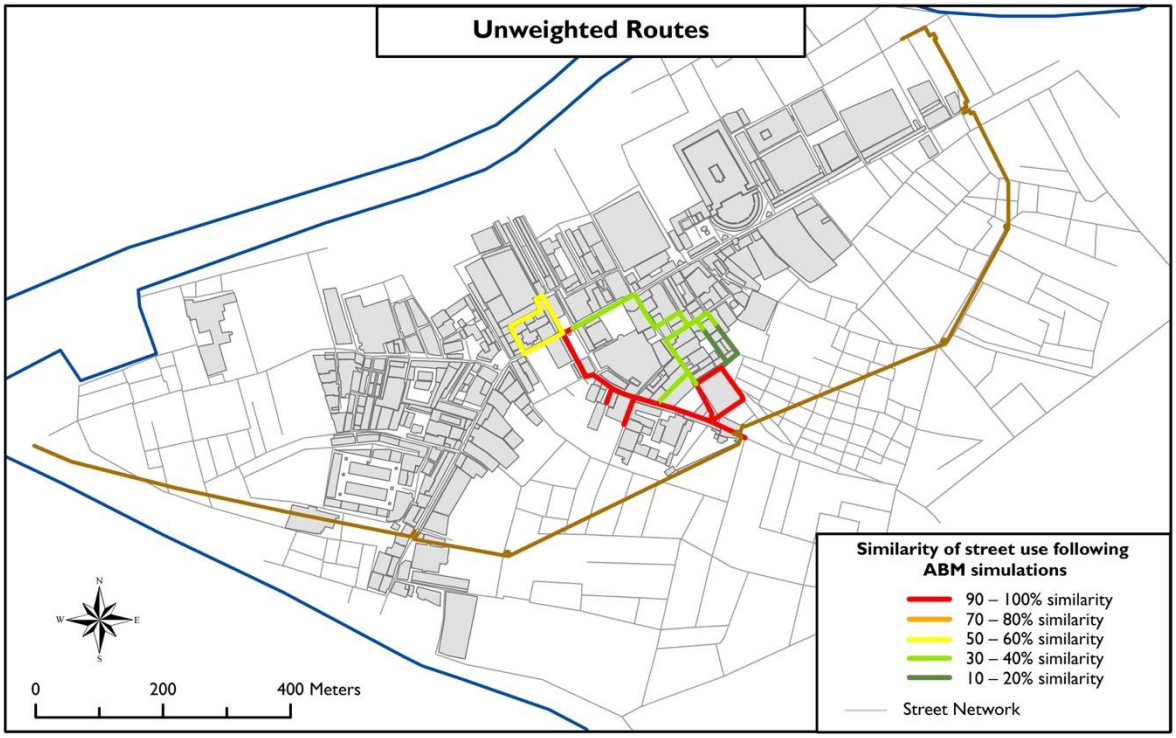


Figure 8.11 Similarity of street usage by un-weighted processional runs (all buildings have an influence value of 1). Routes chosen by the processional leader within 1000-ticks, results of 5 different runs.

8.4.1 Commercial Weighted Routes

Ostia's commercial buildings are positioned throughout the entire cityscape, found along nearly every street. Figure 8.12 shows that the greatest proportion of movement travels along the western and eastern *decumanus* and the *Via della Foce*. When weighted solely by commercial structures, the streets with the greatest likelihood of seeing movement are almost identical to the routes calculated for the excavated cityscape using unweighted buildings. The only difference is a portion of the *decumanus* near the theatre, which has a lower likelihood of being passed than is indicated in the unweighted betweenness centrality graph.

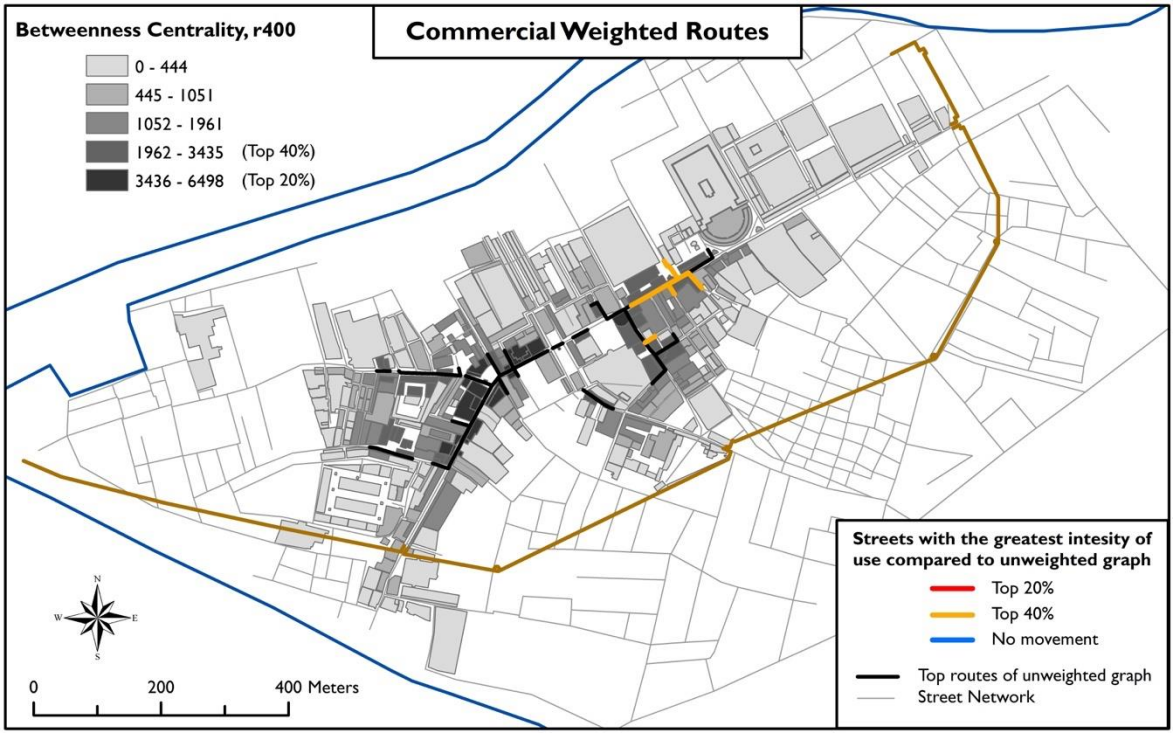


Figure 8.12 Betweenness centrality graph weighted by commercial buildings. Weights: commercial buildings 1, non-commercial structures 0. Streets shown in red and orange follow the two highest betweenness centrality metrics which differ from the unweighted graph. Streets shown in black follow the top 20–40% unweighted betweenness centrality metrics. Streets shown in blue emphasise areas where no movement occurs in relation to the unweighted graph.

The agent-based model routes determined by the processional leader differ almost completely from the urban network analysis results. All but one of the ten different runs show that movement was concentrated within the area north of the *decumanus* (Figure 8.13). Considering the predominant number of commercial structures, specifically warehouses, located within this area, it is unsurprising that movement weighted by commercial buildings would be confined to this general area. The main similarity with the betweenness centrality results is the likelihood of movement travelling along the *decumanus* before diverging to other streets. The addition of processional participants show that the same general route corresponds to the path determined by the processional leader.

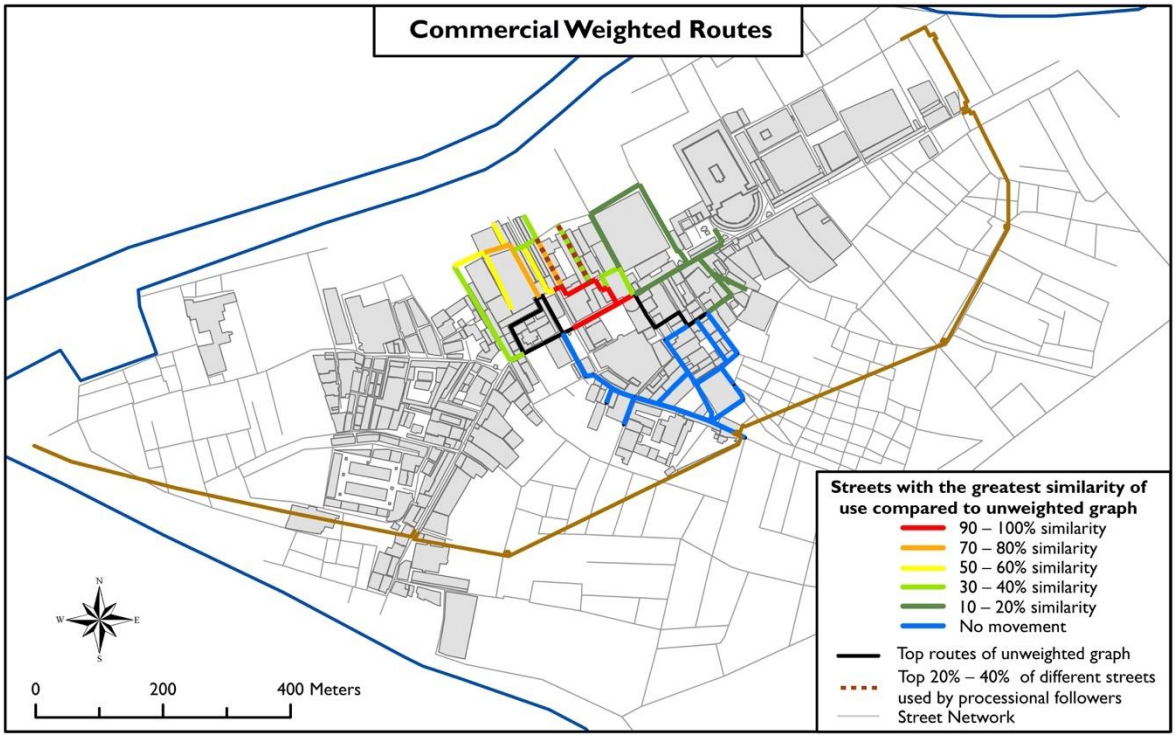


Figure 8.13 Similarity of street usage by processional runs weighted by commercial spaces (commercial building influence – 5, other building influence – 1). Routes reflect those chosen by the processional leader as they differ from the unweighted graph within 1000-ticks during 10 different runs. Streets shown in black follow the top routes of the unweighted graph. The red dotted line indicates streets where the route of processional followers deviates from that of the leader during 5 different runs lasting a duration of 300-ticks.

8.4.2 Production Weighted Routes

In comparison to the other spatial classifications, there are significantly fewer areas of production, which accounts for only 18 total buildings. The eastern *decumanus* and some of the secondary streets radiating off of it have the highest degree of movement potential (Figure 8.14). The greatest difference compared to the unweighted results indicate a high probability of movement occurring along the *Semita dei Cippi.* While there is some movement potential along the western *decumanus,* these results show a very low probability of movement travelling along the *Via della Foce* which is a significant variation from the other four categories of space.

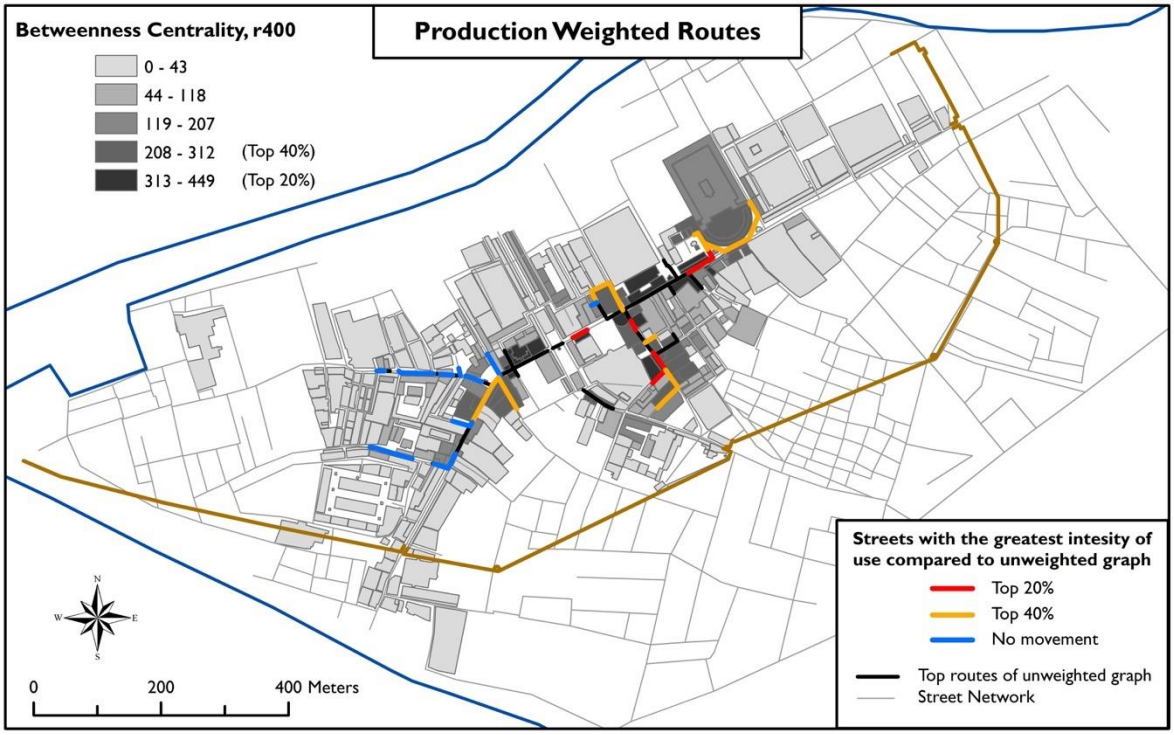


Figure 8.14 Betweenness centrality graph weighted by production buildings. Weights: production buildings 1, non-production structures 0. Streets shown in red and orange follow the two highest betweenness centrality metrics which differ from the unweighted graph. Streets shown in black follow the top 20–40% unweighted betweenness centrality metrics. Streets shown in blue emphasise areas where no movement occurs in relation to the unweighted graph.

Similar to the previous section, the agent-based model runs that are weighted by production influence values differ significantly from the urban network analysis results. The route chosen by the processional leader predominately follows the streets surrounding the *forum* (Figure 8.15). Unlike in the unweighted simulations, there is no movement occurring in the area east of the *Terme del Foro.* A couple of the runs additionally indicate movement travelling towards the *Case a Giardino.* The routes taken by the processional followers, likewise, adhere to these same routes.

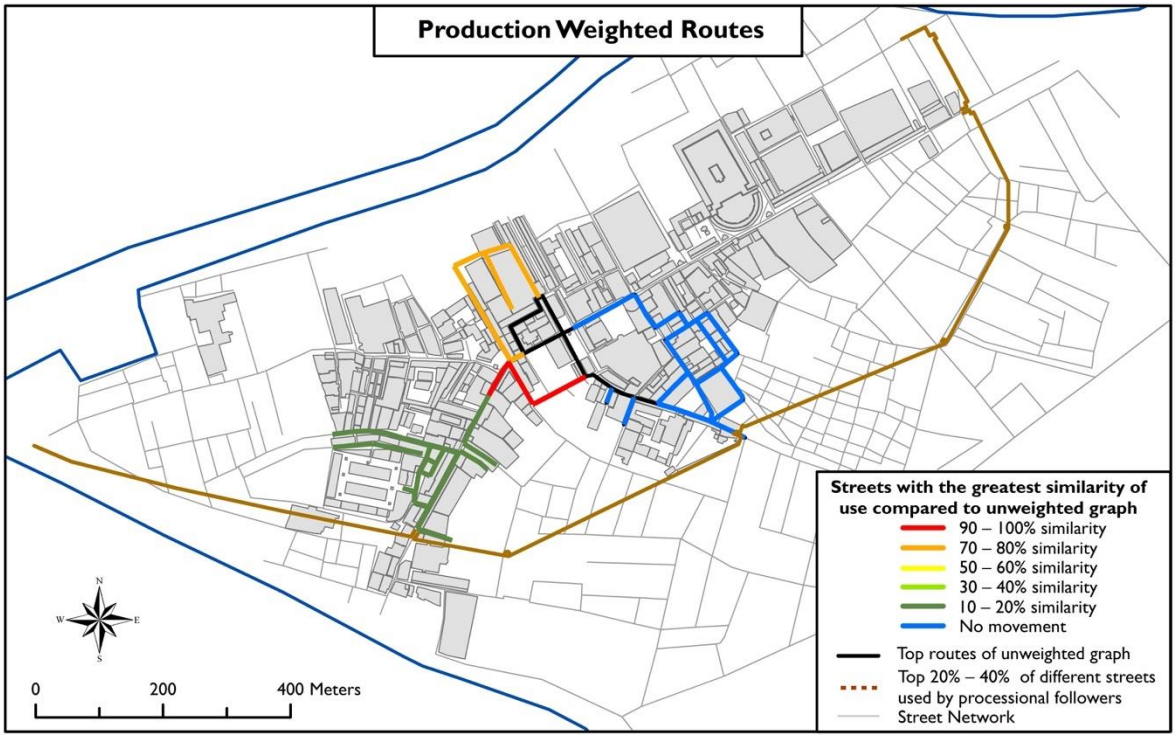


Figure 8.15 Similarity of street usage by processional runs weighted by production spaces (production building influence – 5, other building influence – 1). Routes reflect those chosen by the processional leader as they differ from the unweighted graph within 1000-ticks during 10 different runs. Streets shown in black follow the top routes of the unweighted graph. The red dotted line indicates streets where the route of processional followers deviates from that of the leader during 5 different runs lasting a duration of 300-ticks.

8.4.3 Residential Weighted Routes

The total cityscape has ground floor residential spaces unevenly located throughout the cityscape, but generally found along secondary streets. The calculation of betweenness centrality shows that while there is movement potential along the city's main streets, there is further variation among the smaller streets (Figure 8.16). There is a strong connection of movement along the smaller streets connecting the *Via della Foce* to the *Cardo degli Aurighi.* There is likewise a strong probability of movement travelling along the *Via delle Volte Dipinte* that passes the *Case a Giardino.* Greater movement potential along these streets is unsurprising since they correlate to areas with a larger residential presence, spaces that tend to be removed from the main *decumanus* thoroughfare.

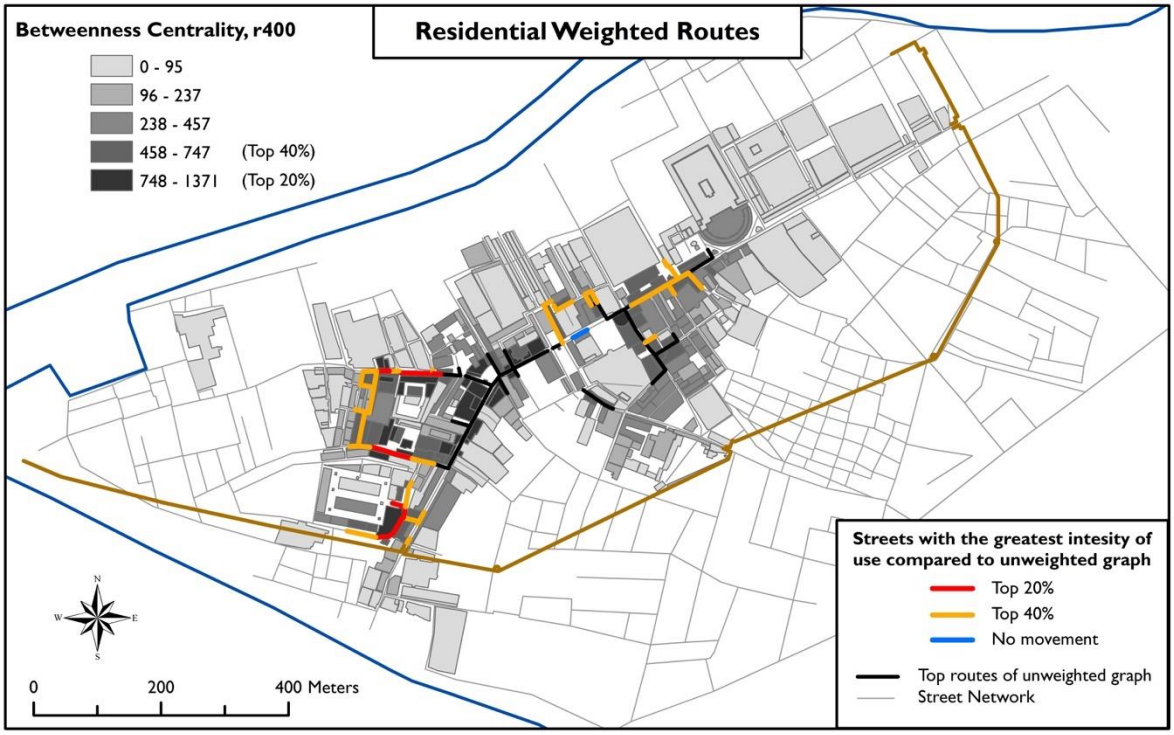


Figure 8.16 Betweenness centrality graph weighted by residential buildings. Weights: residential buildings 1, non-residential structures 0. Streets shown in red and orange follow the two highest betweenness centrality metrics which differ from the unweighted graph. Streets shown in black follow the top 20–40% unweighted betweenness centrality metrics. Streets shown in blue emphasise areas where no movement occurs in relation to the unweighted graph.

The agent-based model results indicate that movement weighted by residential space was confined almost exclusively to travelling to the north-west area of the city (Figure 8.17). Considering the few residential structures located within this region of Ostia, this movement route seems highly improbable. The processional followers adhere to a similar route. In terms of looking at the likely route structured by residential buildings, the betweenness centrality results present a better indication of likely areas of movement.

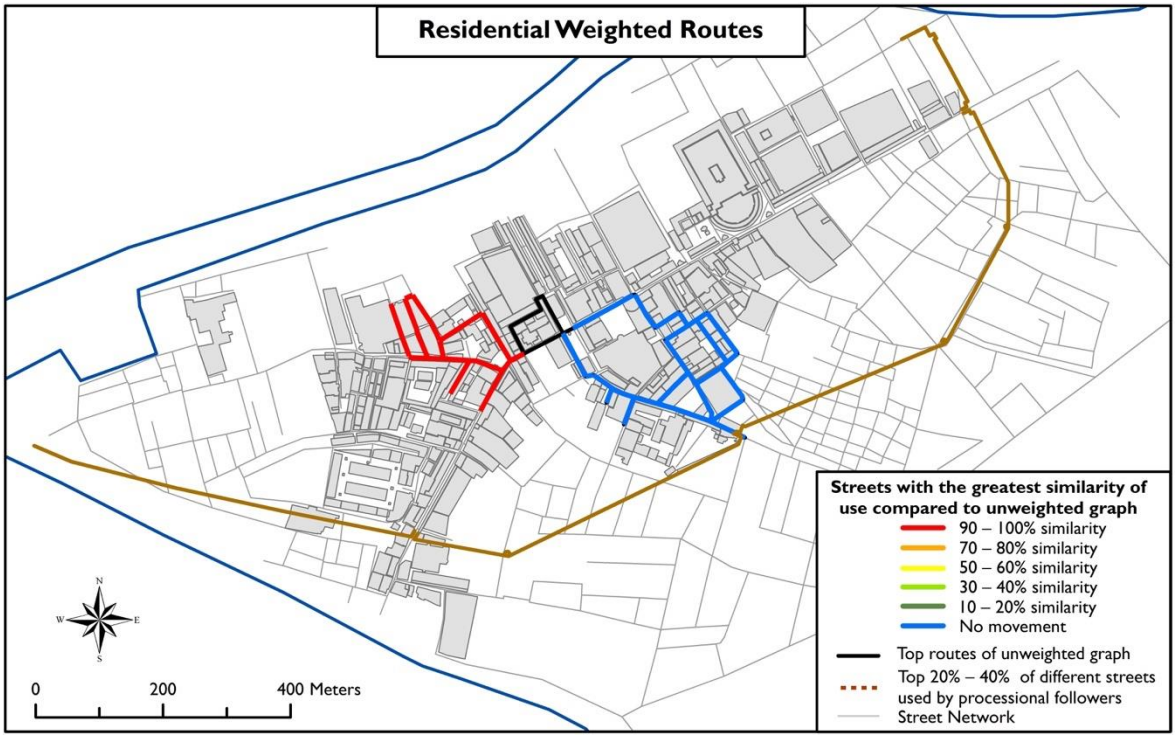


Figure 8.17 Similarity of street usage by processional runs weighted by residential spaces (residential building influence – 5, other building influence – 1). Routes reflect those chosen by the processional leader as they differ from the unweighted graph within 1000-ticks during 10 different runs. Streets shown in black follow the top routes of the unweighted graph. The red dotted line indicates streets where the route of processional followers deviates from that of the leader during 5 different runs lasting a duration of 300-ticks.

8.4.4 Public Weighted Routes

Public space accounts for structures generally accessible from the *decumanus*. The areas with the greatest movement potential are confined to the *decumanus* and the *Via della Foce* (Figure 8.18). Notable is the absence of probable movement occurring along the *Semita dei Cippi* or the areas east of the *Terme del Foro.* Movement is very much confined to the city's main streets, comparable to the choice calculations in space syntax.

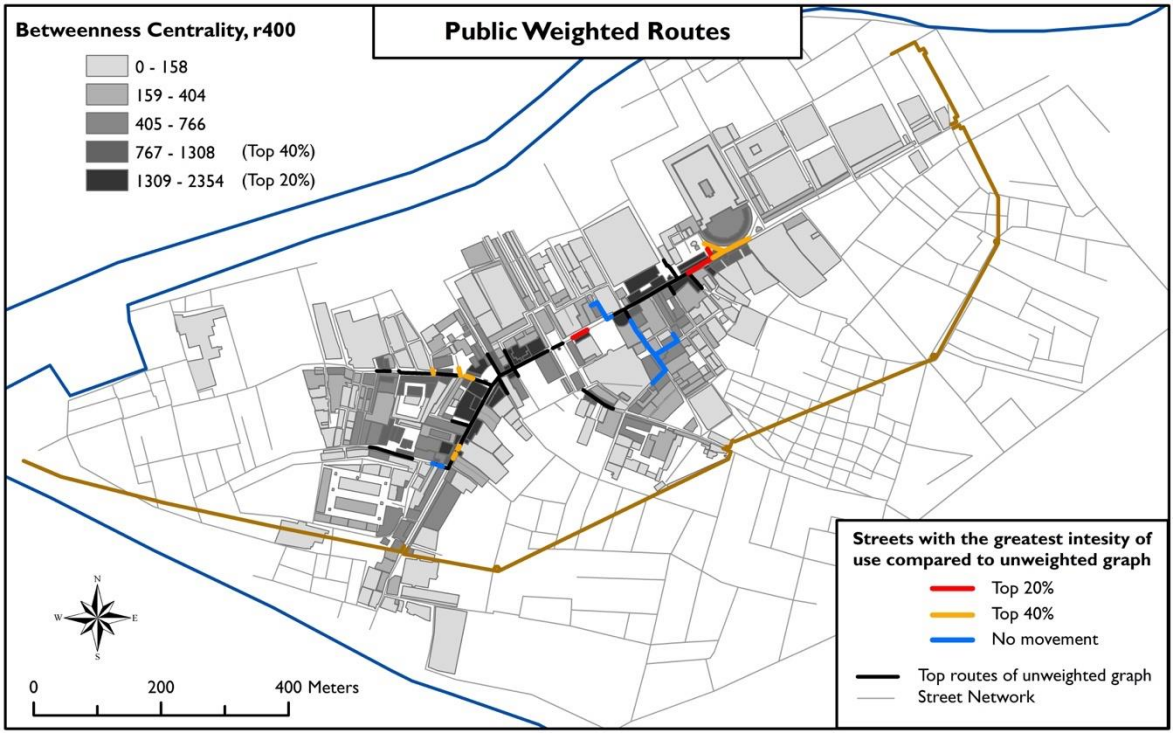


Figure 8.18 Betweenness centrality graph weighted by public buildings. Weights: public buildings 1, non-public structures 0. Streets shown in red and orange follow the two highest betweenness centrality metrics which differ from the unweighted graph. Streets shown in black follow the top 20–40% unweighted betweenness centrality metrics. Streets shown in blue emphasise areas where no movement occurs in relation to the unweighted graph.

The agent-based model routes weighted by public buildings travel mainly along the northern and southern *cardo maximus* (Figure 8.19). The routes also show some potential of travel along the *decumanus* in the direction of the Theatre, which is similar to the betweenness centrality movement area. The focused area of movement around the *forum* is indicative of the number of public buildings and porticoes located within this area. The addition of processional participants within the model show the same route is taken. The main variation for the processional followers is the greater likelihood of movement travelling along the *Via del Larario.*

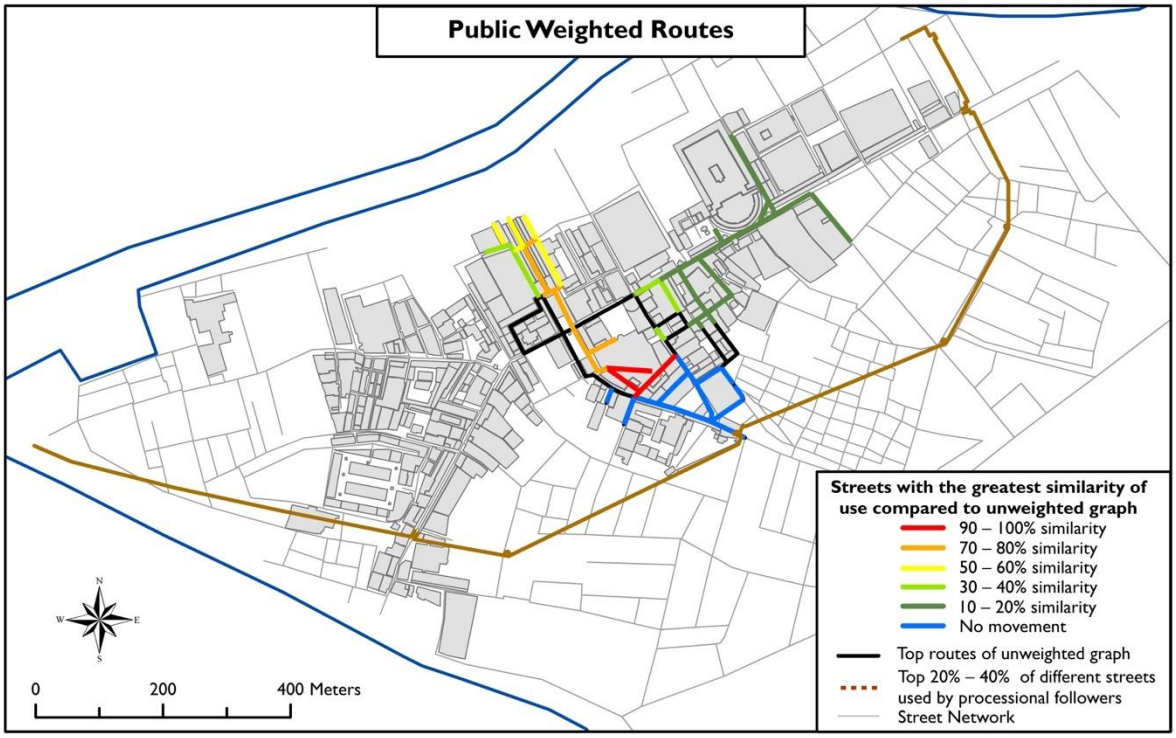


Figure 8.19 Similarity of street usage by processional runs weighted by public spaces (public building influence – 5, other building influence – 1). Routes reflect those chosen by the processional leader as they differ from the unweighted graph within 1000-ticks during 10 different runs. Streets shown in black follow the top routes of the unweighted graph. The red dotted line indicates streets where the route of processional followers deviates from that of the leader during 5 different runs lasting a duration of 300-ticks.

8.4.5 Religious Weighted Routes

Religious space accounts for various temples, sanctuaries, and shrines located across the cityscape. Movement potential relating to this spatial classification shows that the city's primary streets saw the greatest potential of use (Figure 8.20). Additionally, there is greater chance of movement travelling within the various streets located south of the eastern *decumanus*. This classification indicates an increased probability of movement travelling along the southern *cardo maximus* when compared to the other classification categories.

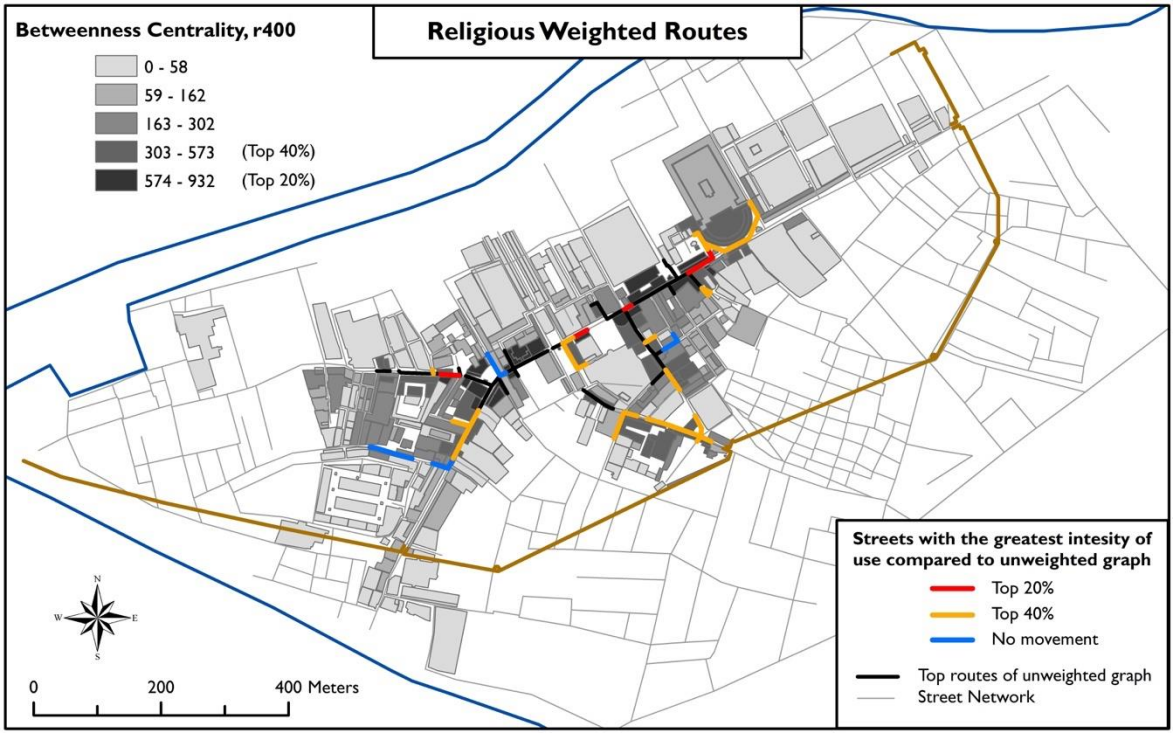


Figure 8.20 Betweenness centrality graph weighted by religious buildings. Weights: religious buildings 1, non-religious structures 0. Streets shown in red and orange follow the two highest betweenness centrality metrics which differ from the unweighted graph. Streets shown in black follow the top 20–40% unweighted betweenness centrality metrics. Streets shown in blue emphasise areas where no movement occurs in relation to the unweighted graph.

Similar to most of the examples in this case study, the agent-based model results differ significantly from the betweenness centrality results. The pathway chosen by the processional leader, weighted by religious buildings, travels to the north of the *forum* and along the eastern *decumanus* to the Theatre (Figure 8.21). Like the residential weighted runs, these routes do not appear to correspond very well to passing that many religious spaces. This is likely due to the minimal number of religious structures that are directly accessible from the *forum.* The addition of processional participants show that their route follows the same path as the processional leader.

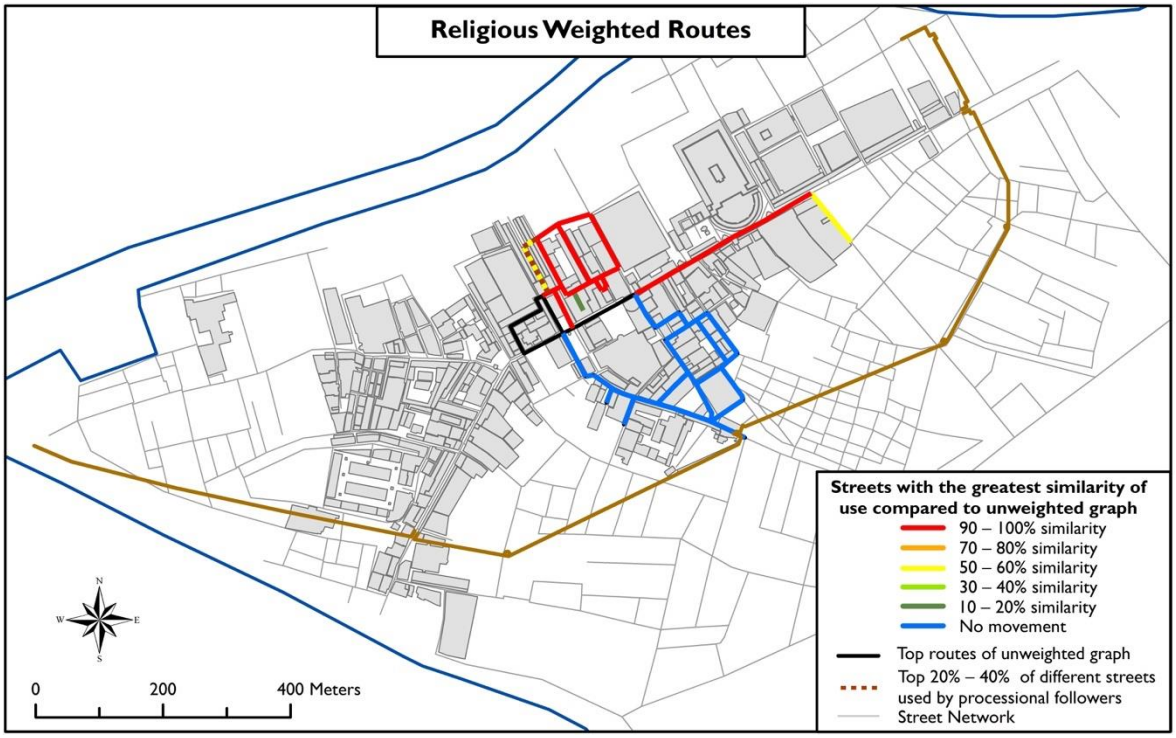


Figure 8.21 Similarity of street usage by processional runs weighted by religious spaces (religious building influence – 5, other building influence – 1). Routes reflect those chosen by the processional leader as they differ from the unweighted graph within 1000-ticks during 10 different runs. Streets shown in black follow the top routes of the unweighted graph. The red dotted line indicates streets where the route of processional followers deviates from that of the leader during 5 different runs lasting a duration of 300-ticks.

8.4.1 Potential Routes Using Combined Building Weights

In order to assess how combined building weights affect movement potential across the city, the same combined weighted measurements applied in the previous two case studies are used. The results provide an analysis of the route variations corresponding to the highest weighted building influence category between 24 related betweenness graphs. Figure 8.22[107] shows the route correspondence to graphs weighted highest by a specific building classification. Streets shown in red and orange correspond to the two highest categories of betweenness centrality measurements. Streets displayed in yellow designate variation between these two highest betweenness categories within the 24 related graphs. The streets shown in blue indicate areas where there is no movement when compared to the unweighted graph.

[107] See Appendix F in Volume 2 of this thesis for all of the supplementary betweenness centrality graphs compiled to make the final images displayed in Figure 8.22.

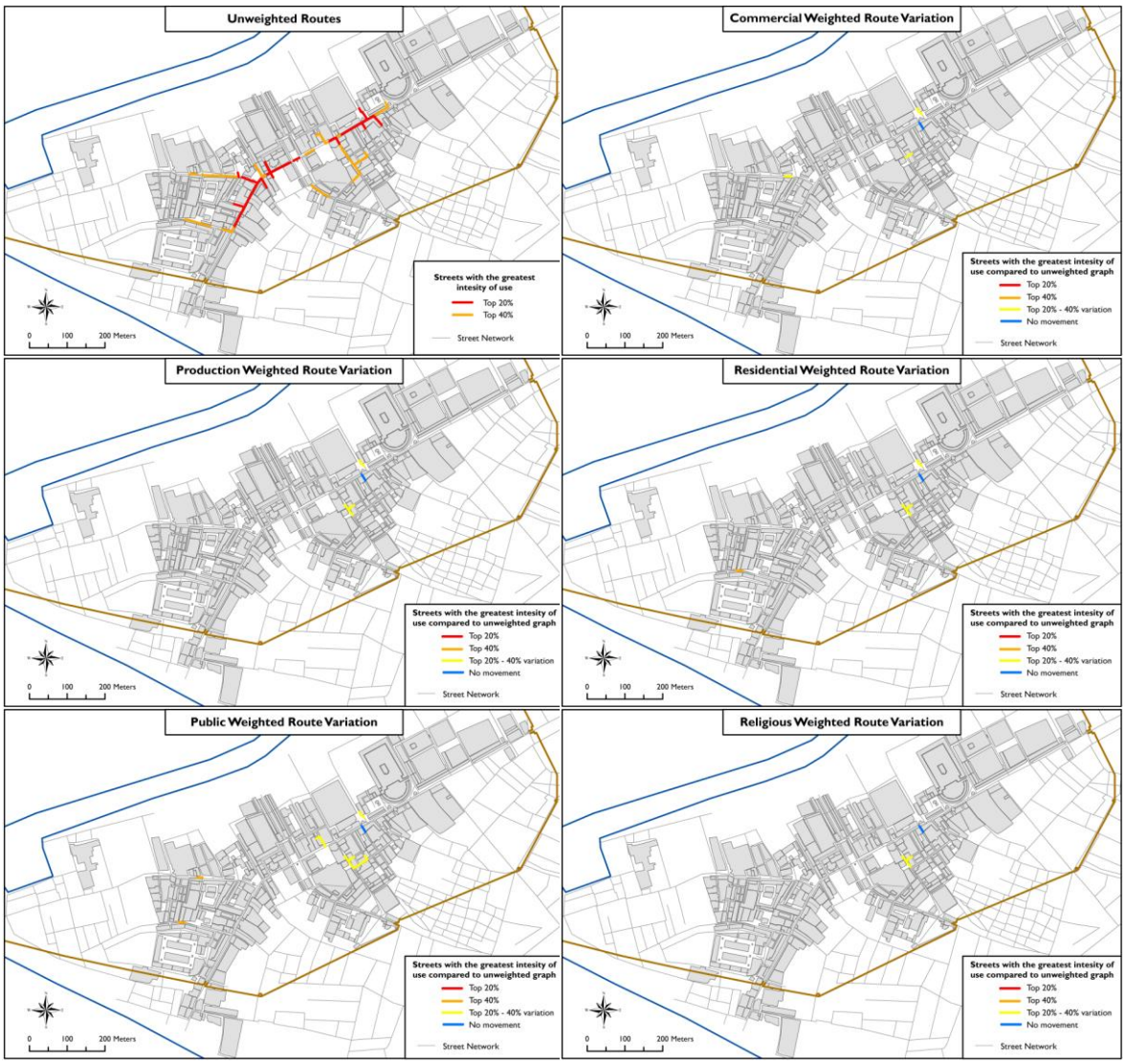


Figure 8.22 Route variation specific to each highest weighted building classification category.

Unlike with the previous two case studies, the computation of movement areas using combined building weights does not provide significant insight into changes in citywide ritual movement patterns. Figure 8.22 shows very few differences in movement areas when compared to the unweighted graph. The primary difference between all five sets of calculations is the intensity of movement surrounding the streets located east of the *Terme del Foro.* Movement along the *Via dell'Invidioso* shows a 91% probability for secondary movement past commercial space, 70% probability for production, and 58% and 54% for religious and residential spaces respectively. Movement weighted by public buildings, in contrast, indicates no movement along this street.

Another area with a varying likelihood of movement is the *Via dei Lari* which connects the eastern *decumanus* with the *Via di Diana.* In most of the weighted graphs, this street has a high chance of being traversed. This varies within the public classification, where only 87% of the betweenness graphs show a significant degree of movement potential along this street. Similar to the study of movement within the ritual area associated with the Magna Mater, the combined routes for the

entire cityscape show an extremely limited potential of movement travelling along the streets north of the *decumanus.*

The study of movement routes associated with the *forum* argues for a citywide procession that occurred on a more global scale, travelling along the city's more major streets. The computation of urban network analysis relating to individual building classifications shows further nuanced results following the weighting of a single structure. While the combined weights do not provide substantial insight into how multiple building weights affect movement, they do indicate that movement was not as likely to travel along minor streets, but was instead confined to the *decumanus, Via delle Foce, Semita dei Cippi,* and *Cardo degli Aurighi.* These results suggest that space syntax choice and integration metrics that provide insight into the city's general movement patterns are similar to the movement areas highlighted by the urban network analysis calculations, addressing the issue of which streets may have been traversed by processions.

8.5 Discussion

This chapter has looked at how the study of processional movement can provide new insight into the religious environment structured by the *forum* temples though virtue of their rituals. Unlike the previous two case studies, the possible processional routes cannot be assessed in relation to a larger cultic framework since the cultic affiliation of these temples remain tenuous at best. Therefore, the remainder of this chapter will discuss the implications of ritual practices extending beyond the *forum* and what it contributes to our understanding about Ostia's two most central temples.

Assessment of movement potential in relation to the *forum* temples demonstrates how they were connected to the surrounding cityscape. The betweenness centrality results are all consistent in their designation that the movement routes, regardless of building weight, followed the city's primary streets. The minimal indication of movement along streets other than the *decumanus* shows paths that encompassed the entirety of Ostia. While not necessarily indicative of complete processional routes, it does reveal the likely areas of the city that a larger scale procession would have traversed. Just like the *decumanus* served as a connective entity within Ostia's urban structure, processional movement proceeding along it that was associated with the *forum* temples may have likewise facilitated the integration of Ostia's various religious areas. Processions travelling along the *decumanus* would have enabled the connection of disparate areas of the cityscape, creating a shared ritual experience for the duration of the processional ritual.

The agent-based model results, alternatively, provide a more nuanced understanding about possible routes that are not solely confined to the *decumanus*. The various simulations all indicate movement areas focused around the *forum.* In this respect, the *decumanus* acts as the processional route's core, facilitating movement within the city's northern and southern areas. The major difference when

compared to the betweenness centrality results is that all of the routes are focused along the eastern *decumanus.* This is alternatively indicative of processional routes being constructed predominantly within Ostia's urban centre rather than fully connecting the breadth of Ostia's different neighbourhoods together. Depending upon what types of structures were important to pass, the shape of the procession fluctuates in the extent it travels in the areas north and south of the eastern *decumanus.*

The compilation of both network analysis and agent-based modelling methods illustrates distinct areas of movement relative to each weighted classification category. Figure 8.23 shows the most probable movement areas specific to passing different building classifications. The results indicate that movement structured by commercial space is primarily confined to travelling past the large commercial structures located in the northern areas of Ostia. Residential structured routes show movement patterns concentrated within the western area of Ostia. Public spaces, in contrast, show movement areas located in the areas both north and south of the *forum.* Religious weighted routes, similarly to the public routes, show movement travelling north and south of the *forum,* while also extending further along the eastern *decumanus* towards the Theatre.

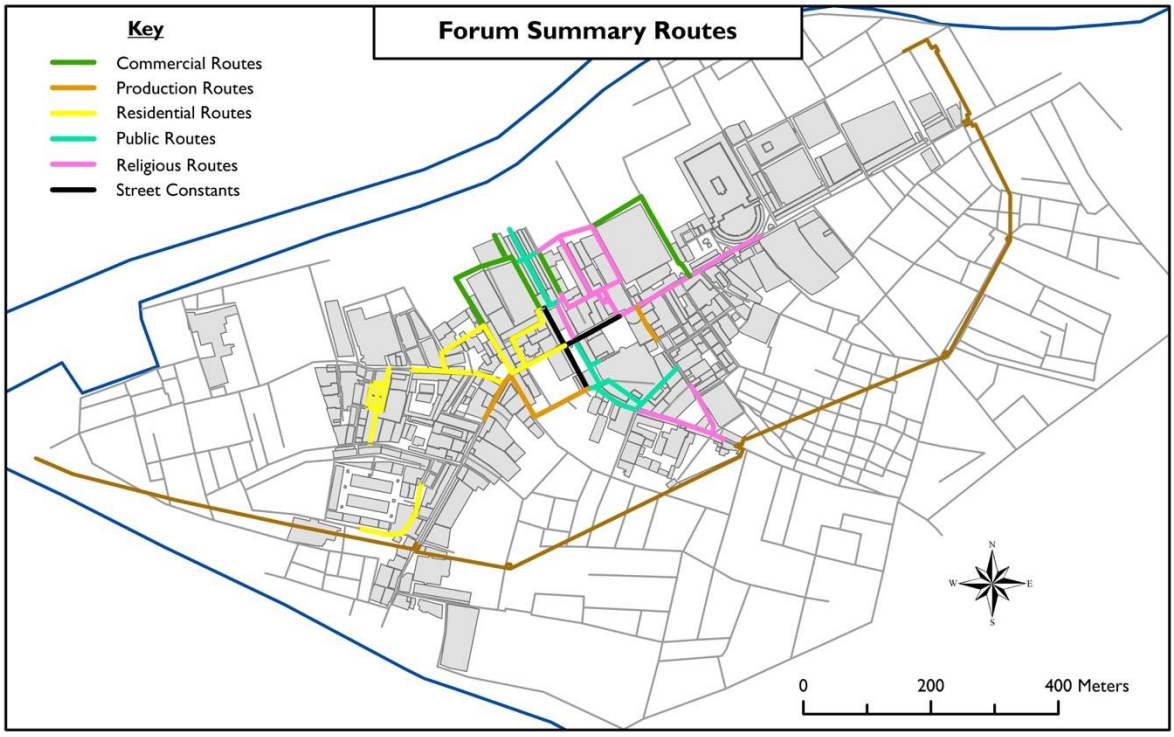


Figure 8.23 Summary of possible routes weighted by each classification category. Streets shown in black represent routes consistently used by each weighted classification.

One aspect that has not been fully addressed in this case study is the extent to which a longer procession duration affects the shape of the ritual area. The idea of a larger scale processions was addressed above within the urban network analysis results, reflected in the calculation of betweenness centrality using a 400 m network radius. Ideally, a similar premise would be applied to

the simulation of processional movement. To address the effect that a longer procession might have upon the present results, a test simulation was run to evaluate how the movement routes change if the model is run for a total of 2000-ticks instead of 1000-ticks using unweighted values, representing a procession lasting twice as long. Figure 8.24 reflects the routes chosen by the processional leader during five test runs where all buildings were weighted with an influence value of 1. The results show movement routes following the results of the initial unweighted route computed within a 1000-tick timeframe (c.f. Figure 8.11). Deviation occurs with movement extending past the Theatre and travelling within the area of *Regio V*. This shows that even with providing a procession a longer duration, movement is still largely focused around the same area delineated by the shorter run. If longer runs were applied to the simulations using different influence values, we would expect to see movement follow similar routes, just slightly extended.

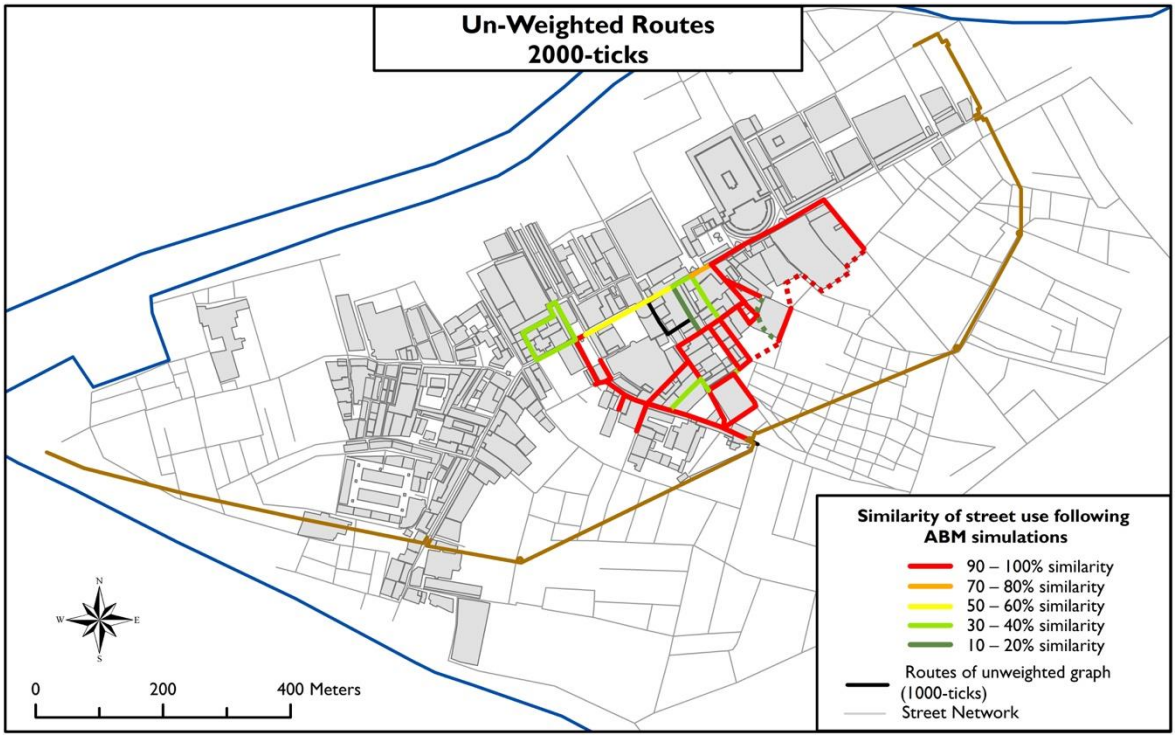


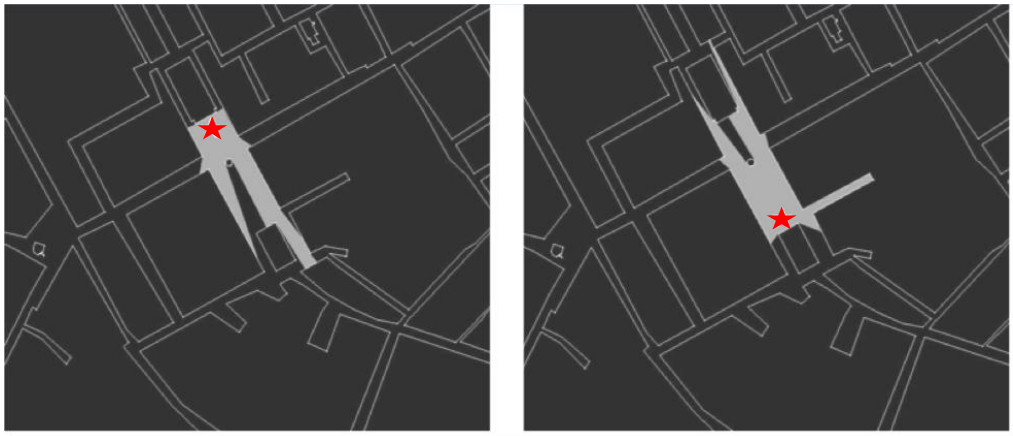
Figure 8.24 Similarity of street usage by un-weighted procession simulations. Routes chosen by the processional leader within 2000-ticks, results of 5 different runs. Dotted lines show places where the processional leader deviates from the street network.

The overall nature of the processional routes associated with the *forum* temples seems to be one of urban inclusion. The betweenness centrality results are all indicative of movement predominantly travelling along the city's primary streets, connecting the various areas of Ostia within one ritual. The agent-based modelling results present a slightly different perspective. Each of the weighted simulations encompass a larger area surrounding the *forum,* rather than extending fully along the western and eastern *decumanus.* And while there is some variation in the extent to which movement travels, it is still indicative of being inclusive of the various spaces directly surrounding the *forum.*

The longer time simulation (Figure 8.24) shows movement extending further along the eastern *decumanus,* which compares more closely to the urban network analysis results.

One aspect of the route that can be more fully considered is the procession's return to the *forum.* Provided the temple associated with each procession was the focal point, it would stand to reason that the temple's visibility during the procession's return to the *forum* would hold some degree of importance. In order to determine the ideal entrance direction to the *forum* that would optimise the visibility of each temple respectively, visibility graph analysis (VGA) within space syntax was calculated in relation to each temple. VGA is a form of isovist or viewshed analysis that measures everything that is visible from a specific point (Benedikt, 1979; Turner *et al.*, 2001). In this case, a centre point in front of each temple was chosen to simulate visibility of the temple. The resulting analysis shows all the areas this point (e.g. temple) is visible from within a 360 degree radius (Figure 8.25). Although VGA is only representative of 2D space, an issue that has received substantial critique (see Llobera 2003, p.27; Paliou 2013), the height of the multi-storey surrounding buildings would have largely obscured the visibility of both temples from outside of the *forum.* Therefore, this gives a relatively accurate indication about the general visibility of the temples prior to entering the *forum.*

The visibility analysis results indicate that the ideal visibility of each temple would have been from the northern and southern entrances of the *forum* (Figure 8.25). The return route of processions associated with the *Capitolium* most likely entered following the southern *cardo maximus.* Despite the temple's monumentality, its position, which was set back within the *forum,* meant that it was not visible from the *decumanus* until the *forum* was entered. For processions favouring a southern entrance, the agent-based model routes weighted by production (c.f. Figure 8.15) and public (c.f. Figure 8.19) buildings show the greatest potential of movement travelling from this direction. Considering the importance and central position of the *Capitolium,* it seems likely that it would favour passing areas predominantly public in nature. Other entrance routes would greatly reduce its overall visual impact, which largely precludes returning to the temple from the northern part of the city. In this way, the agent-based model results seem to more accurately reflect movement patterns associated with this type of route. The visibility of the *Tempio di Roma e Augusto* alternatively favours an entrance location from the north. Like the *Capitolium,* the temple is only visible when standing directly within the *forum*. The routes that would enable entrance from the north would favour passing predominately commercial (c.f. Figure 8.13), public (c.f. Figure 8.19), and religious (c.f. Figure 8.21) spaces.



Capitolium *Tempio di Roma e Augusto*

Figure 8.25 Visibility graph analysis from both temples in the *forum*. Star indicates the point from which the isovist was calculated for each temple.

Entrance routes focused upon optimal visibility of the temples largely precludes entrance from the *decumanus*. Just as the betweenness centrality measurements and the agent-based model simulations are indicative of movement extending along short sections of the *decumanus* and within the areas surrounding the *forum,* the return to the *forum* also seems to follow this pattern. In contrast to the role of the *decumanus* as the city's main thoroughfare for general urban traffic, the analyses of ritual movement show that the *decumanus* had a slightly different functionality. It facilitated the connection between different areas of the city, but was not the predominantly used street for ritual movement. Furthermore, the *decumanus* appears to have been the least likely route taken when returning to the temples.

The ritual movement dynamics structured by the *forum* largely reflect its role within Ostia's urban and social structure. The associated processional routes created a definitive space that promoted integration of the surrounding cityscape with the ritual practices of the *forum* temples. This likewise follows the more general articulation of urban space that occurred with the re-development of the *forum* and the construction of the Hadrianic *Capitolium*. These changes enabled Ostia's importance to be overtly displayed through the establishment of a clear urban centre that was recognisable to all who visited the city (Kockel, 1992, p. 112). Just as the *forum* dictated the interactions and spatial relationships that could exist within the immediate area (La Rocca, 2006), processional rituals associated with these temples helped to shape the city's larger religious ideology through the manifestation of ritual practices. While the *forum* and its temples were never completely removed from the city's traffic and more general urban life, its restricted access enabled it to take on a new focus, one that was dominated by two of the city's monumental temples.

8.6 Summary

The analyses undertaken in this chapter in relation to the *forum* temples have yielded a number of conclusions about the occurrence of rituals associated with two of the city's most prominent temples. Although the exact rituals that occurred in relation to these two temples are uncertain, study of the potential areas of processional movement provide new insight into how these temples impacted the surrounding city through the practice of processions. In particular, processional rituals enabled the integration of various areas of Ostia within a shared ritual experience that were structured by the *Capitolium* and the *Tempio di Roma* e *Augusto.*

Chapter 9: Discussion: Assessing Ostia's Religious Landscape

The implications of the findings discussed in the previous three case studies, Chapters 6–8, are examined within the context of the larger ritual movement framework introduced in Chapter 2. This serves to address the final two research objectives of this thesis: 1) "Does the modelling of processional routes help us better understand the ritual landscape that is structure by different Ostian temples?" and 2) "How far might processions have played an active role in defining social and religious practice across urban space at Ostia?". The first half of this chapter begins by evaluating the first question to determine the extent to which the use of computational methods inform our understanding of processional routes at Ostia. The second part aims to reflect upon the significance of the observed areas of processional movement and how this contributes to a more nuanced understanding about how individual temples structured broader areas of ritual movement across Ostia's urban landscape. The chapter concludes with a more general assessment of how processions functioned within Ostian society and the ways in which this study has changed previous Roman processional assumptions.

9.1 Reflecting upon the Application of Computational Methodologies for Ostian Processional Studies

The research objectives concerning the best method for studying processions at Ostia has been addressed specifically in Chapters 2, 4, and 5, as well as applied to each of the three case studies. The combination of space syntax, urban network analysis, and agent-based modelling allowed us to question how the built environment structured processional movement and the ways in which this could be visualised. This enabled the construction of a narrative about how temples, in combination with Ostia's built environment, constructed areas of ritual movement. These models of potential routes, however, need to be understood in light of the underlying data, which means considering the existing uncertainties in the results. This section addresses how the omission of upper storey space and the inclusion of the unexcavated cityscape effects the results of each case study, as preliminarily discussed in §5.6.

9.1.1 Integration of 3D Space

In order to further address the possible bias of considering only ground floor space within the analyses undertaken throughout this thesis, residential space is assessed using urban network analysis to look at the potential influence of upper storey space upon passing processional movement. The results of movement potential in relation to upper floor and ground floor

residential space are compared to determine the level of error that exists in only focusing upon ground floor space within the case studies. In each graph, residential space is weighted with a value of 10, the remaining ritual area with a value of 1, and buildings outside the ritual area with a value of 0. The results specific to each case study indicate that there is considerable similarity between the weighted graphs for ground floor and upper floor residential space.

9.1.1.1 *Campo della Magna Mater*

The highest betweenness centrality areas specific to upper storey space (Figure 9.1, right) which deviate from the unweighted graph are concentrated around the intersection of the *Via delle Foce* and *decumanus,* along the street south of the *Terme del Foro,* and at the connection between the *Semita dei Cippi* and the *Via della Fortuna Annonaria.* These areas with the highest movement potential are directly comparable to the ground floor weighted calculations (Figure 9.1, left). The primary difference is the extent to which movement potential extends along each street. Assessment of upper story space shows that the greatest movement potential is slightly more constricted compared to the ground floor focused calculation. An additional difference is along the street located north of *Horrea* V.i.2. Within the graph weighted by upper storey space, this street shows the same value as the unweighted graph, while the ground floor weighted graph indicates this street has the highest degree of movement potential. The inclusion of movement along this particular street provides an indication towards more circular movement within this area of the city, connecting to the more major *Via della Fortuna Annonaria.*

The streets with the second highest betweenness measures, as indicated by streets shown in orange, show slightly more variation within the upper storey weighted graph. The most prominent difference indicates a greater likelihood of movement travelling along the *Via delle Casette Repubblicane.* This is the only example when compared to the other betweenness graphs computed within this ritual area that this street has a significant probability of movement. In this instance, the results are reflecting the concentration of residential spaces situated within the area west of the *forum.* The upper storey weighted graph also shows a lower potential of movement travelling towards the Theatre when compared to the ground floor weighted results.

The significance of these results shows that while there is some variation in which streets saw the highest probability of movement when upper storey spaces are accounted for, this does not greatly alter the overall results. The areas of potential ritual movement remains consistent between both the ground floor and upper storey weighted graphs. As a result, we can infer that other building classifications focused upon upper storey space would have similar results.

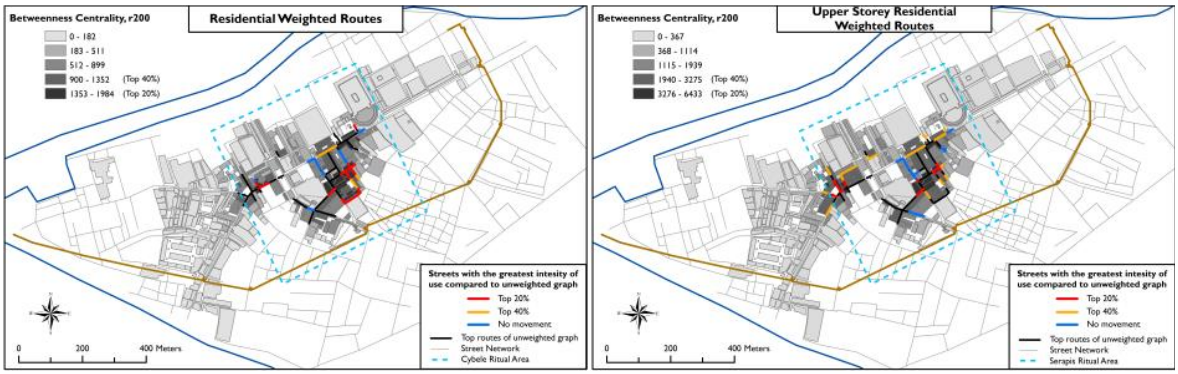


Figure 9.1 Betweenness centrality calculations for ground floor (left) versus upper storey (right) residential space within the Cybele ritual area as they compare to the unweighted graph.

9.1.1.2 *Serapeum*

The comparison of ground floor and upper floor residential space within the area surrounding the *Serapeum* shows more significant variation in the betweenness centrality results. Figure 9.2 shows the comparison between the two different weighted graphs compared to the respective unweighted graph. The weighting of upper storey space illustrates that the areas with the highest potential of movement are consistent with the results of the unweighted graph.

The streets with the second highest potential of movement show minimal variation compared to the ground floor weighted graph. The main difference illustrates that the *Via delle Foce* has a second highest movement potential when weighted by upper storey space. The most significant variation is illustrated by areas with no movement potential. Unlike in the ground floor weighted graph, there is almost no likelihood of movement travelling within the interior streets connecting the *Via delle Foce* with the *Cardo degli Aurighi* or movement extending around the *Case a Giardino*. The reason for this difference is largely due to the high concentration of upper storey residential spaces located throughout *Regio III* (c.f. Figure 5.26). Because betweenness centrality represents the number of trips that occurred past different buildings, a larger concentration of residential spaces within the buildings between the *Via delle Foce* and the *Cardo degli Aurighi* results in greater movement within this area. When compared to the ground floor weighted residential space, the *Via delle Volte Dipinte* going past the *Case a Giardino* exerts a stronger influence upon movement when there are fewer numbers of other residential spaces comparatively.

Because of the quantity of upper storey residential spaces, analysis of ground floor residential space demonstrates a more nuanced understanding about the relative influence on movement. It likewise provides a better indication about how the *Case a Giardino* structured passing ritual movement.

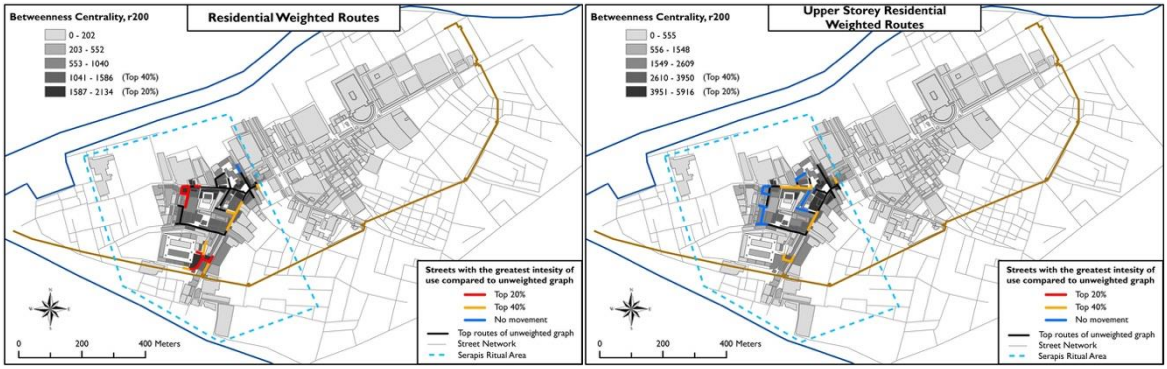


Figure 9.2 Betweenness centrality calculations for ground floor (left) versus upper storey (right) residential space within the Serapis ritual area as they compare to the unweighted graph.

9.1.1.3 *Forum* Temples

The comparison of ground floor and upper storey residential space shows a similar result to those of the previous two ritual areas (Figure 9.3). The areas with the greatest movement potential are almost identical, differing mainly in respect to the possibility of travelling past the *Case a Giardino*. As in the graphs relating to the Serapis ritual area, the *forum* graphs show that when weighted by ground floor residential space, the highest betweenness measures indicate movement past this area. However, when weighted by upper storey space, the movement is confined predominately to the *decumanus* and the *Via delle Foce*.

The streets with the second highest movement potential, indicated by streets shown in orange, are focused around the *Cardo degli Aurighi* and some of the streets connecting to the *Semita dei Cippi*. Upper storey weighted space shows slightly less movement travelling within the streets north of the *forum*. Ground floor weighted space, alternatively, indicates that possibility of movement travelling along the *Via delle Casette Repubblicane*, which connects to the street north of the *Capitolium*.

The two weighted graphs both indicate that movement potential is concentrated along the *decumanus,* the *Via delle Foce,* and the *Cardo degli Aurighi.* While slight variations exist in the potential of movement along some of the subsidiary streets, such as the *Via delle Casette Republlicana* and the *Via delle Volte Dipinte,* both ground floor and upper floor residential weighted graphs show otherwise comparative areas of movement potential.

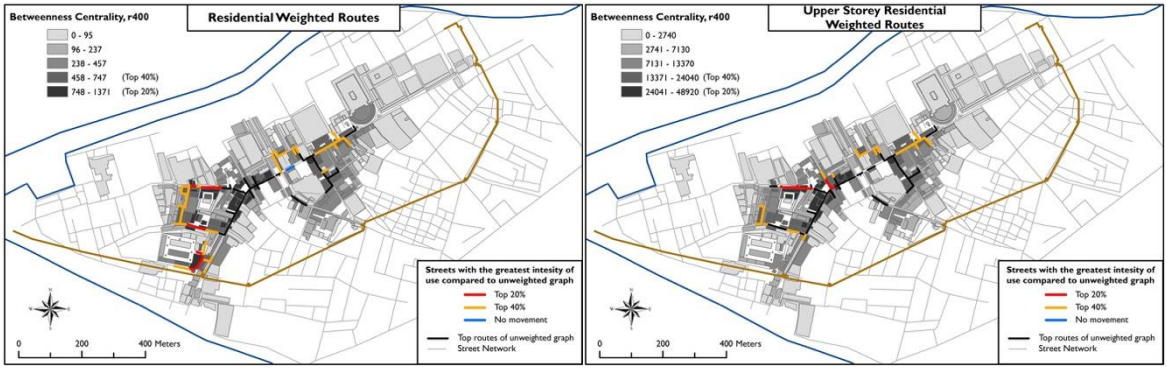


Figure 9.3 Betweenness centrality calculations for ground floor (left) versus upper storey (right) residential space within the *forum* ritual area as they compare to the unweighted graph.

Summary

The computation of betweenness centrality for upper storey residential space in each case study does not present considerable variation to the results gained for ground floor weighted space. While discounting upper storey space presents a slight bias in the present calculations, the sample of upper storey weighted structures indicates that it is not significant enough to discount the various weighted urban network analysis calculations run throughout this thesis.

9.1.2 Questioning the Effect of the Unexcavated Cityscape upon Processional Movement

As addressed at the conclusion of Chapter 5, the results of the three case studies are based upon the buildings found within the excavated city. I have already addressed the minimal variation in results that occurs, in relation to movement beginning and ending at the *forum,* when Ostia's extended built environment is included within the simulation. This is further considered with regards to the different building classifications of each case study. Two separate simulations are run for each case study.

1) The first experiment traced the routes of the processional leader for a duration of 1000-ticks with all the buildings and unexcavated areas with surrounding streets weighted with an influence value of 1. Results reflect 5 different runs.
2) The second experiment traced the routes of the processional leader during 1000-ticks when each building classification is separately weighted with an influence value of 5. All remaining buildings and unexcavated areas are weighted with an influence value of 1 (e.g. commercial influence – 5; other buildings and extended city influence – 1). Results reflect a total of 5 runs per building classification.

These experiments follow the same agent-based modelling procedure previously used for each case study. The lead processional agent determines a processional route following buildings with the

highest influence values. Each run lasts for 1000-ticks, at which point the processional leader finds the best route back to the starting temple.

9.1.2.1 *Campo della Magna Mater*

Exploratory simulations undertaken in relation to the *Campo della Magna Mater* present some deviation in results compared to the previously computed routes (Chapter 6). The unweighted simulation results (Figure 9.4, A) inclusive of the extended cityscape shows substantial deviation from the results of the equivalent simulation consisting of just the excavated cityscape, which is indicated by the black dotted line. Instead of moving towards the *forum,* which occurs in the excavated cityscape simulations, the routes are concentrated along the streets surrounding the sanctuary. This indicates that possible movement routes are affected by the sanctuary's position at the edge of the city. The general trajectory of movement differs depending upon whether or not buildings within the unexcavated city are included within the simulation.

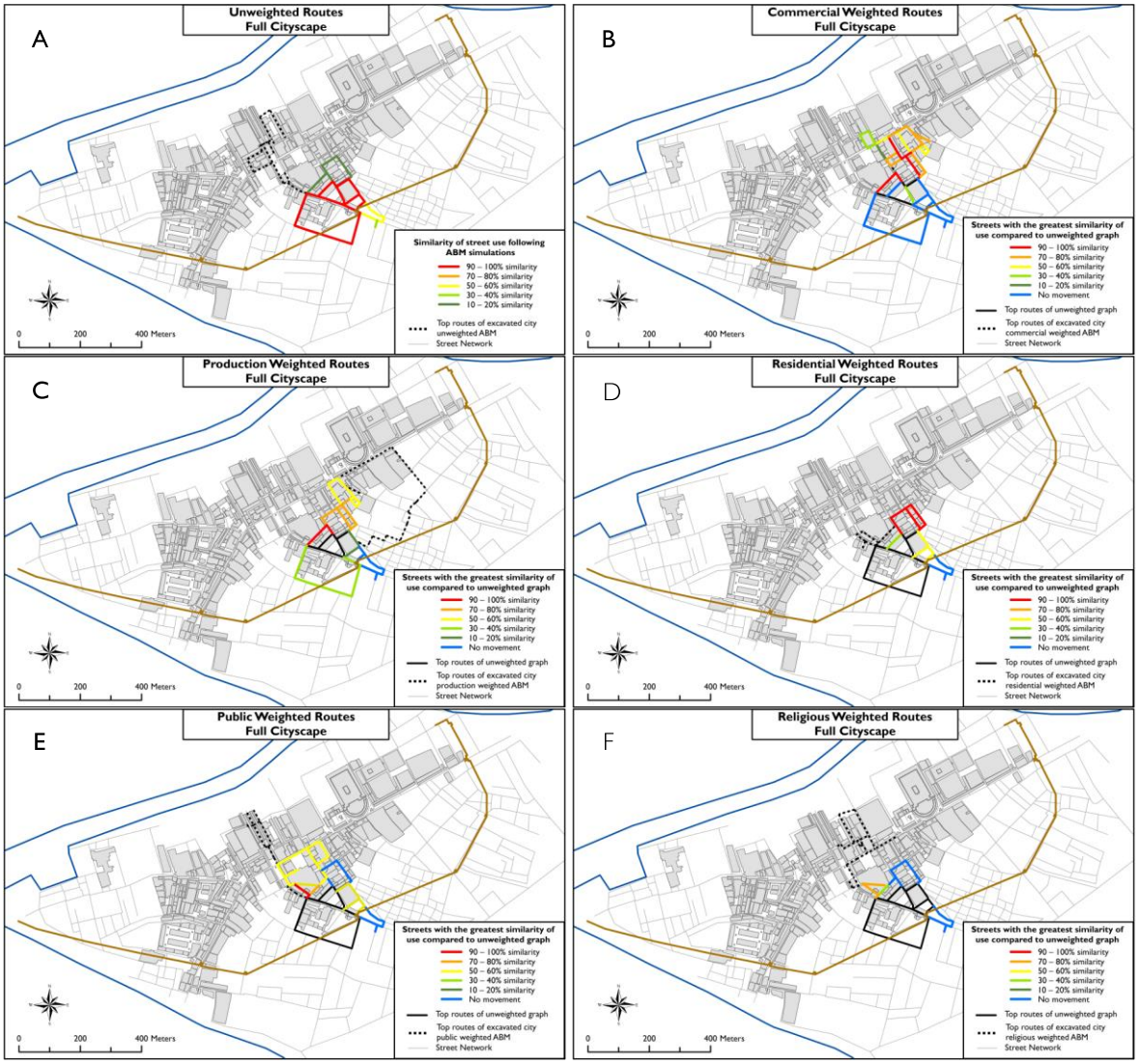


Figure 9.4 Similarity of street usage by un-weighted (A) and weighted building classifications (B–F) accounting for the unexcavated cityscape. Black dotted line shows deviation from the excavated cityscape simulation results in Chapter 6. Routes chosen by the processional leader within 1000-ticks, results of 5 different runs.

To determine how the routes vary depending upon different weighted building influence values, the same simulations conducted in Chapter 6 were run with the extended cityscape included (Figure 9.4, B–F). The routes chosen by the processional leader show only minimal variation when compared to the results inclusive of only the excavated city. Deviation that occurs in relation to each equivalent weighted simulation within the excavated city is shown by a black dotted line.

The primary difference between the present results show that movement would have travelled outside out the *Porta Laurentina* prior to following a similar trajectory to the routes detailed in Chapter 6. In almost all of the experiments, the movement areas are still concentrated along the same streets. The predominant difference arises in the paths detailed for the religious weighted processional route (Figure 9.4, F). Whereas the simulation run within the excavated city indicates movement travelling predominately north towards the *forum,* here the route is concentrated around the streets directly surrounding the sanctuary. The public weighted route (Figure 9.4, E) also shows some slight variations when the full cityscape is accounted for, with movement constricted to moving around the *Forum* and *Terme del Foro* rather than north along the *cardo maximus*. Despite a few variations, all of the experiments inclusive of the extended cityscape indicate that movement routes are still largely concentrated within the previously defined ritual area.

The degree to which processional movement would have travelled outside the city gates needs further clarification. In one instance, if processions were confined within the city walls, then processions might travel within a portion of the unexcavated cityscape west of the sanctuary, with movement then following similar patterns to what was computed for the case study. Alternatively, there is a potential that at least one of the processions had an extra-mural component such as the procession of Attis that occurred 22 March. This procession included the transport of a pine tree into the sanctuary, a tree that would have needed to be obtained potentially from a location outside the sanctuary or even the city. Additionally, the number of tombs lining the streets in the southern unexcavated areas of Ostia could further enhance the funerary quality of this particular procession (Heinzelmann, 1998b).

The significance of these experimental runs indicates that the missing city data, while having a slight effect upon the routes, does not negate the usefulness of this method for modelling full processional routes beginning and ending at the *Campo della Magna Mater*. The results of the experimental runs show that discounting the extended city does slightly impact the results. However, the experiments indicate that movement will still follow similar routes within the excavated city. More significantly, movement stays within the confines of the ritual area determined relative to the sanctuary.

9.1.2.2 *Serapeum*

The experimental runs undertaken in relation to the *Serapeum* show that the unexcavated city has some influence upon the previously detailed processional routes. The unweighted simulation run

inclusive of the excavated and non-excavated portions of the city show routes travelling in the direction of the river harbour (Figure 9.5, A). This is in contrast to the un-weighted run computed for the excavated city where the processional leader travels in the direction of the *Case a Giardino,* indicated by the black dotted line. These results imply that based upon the position of the *Serapeum,* the western most portion of the city likely had some effect upon movement patterns.

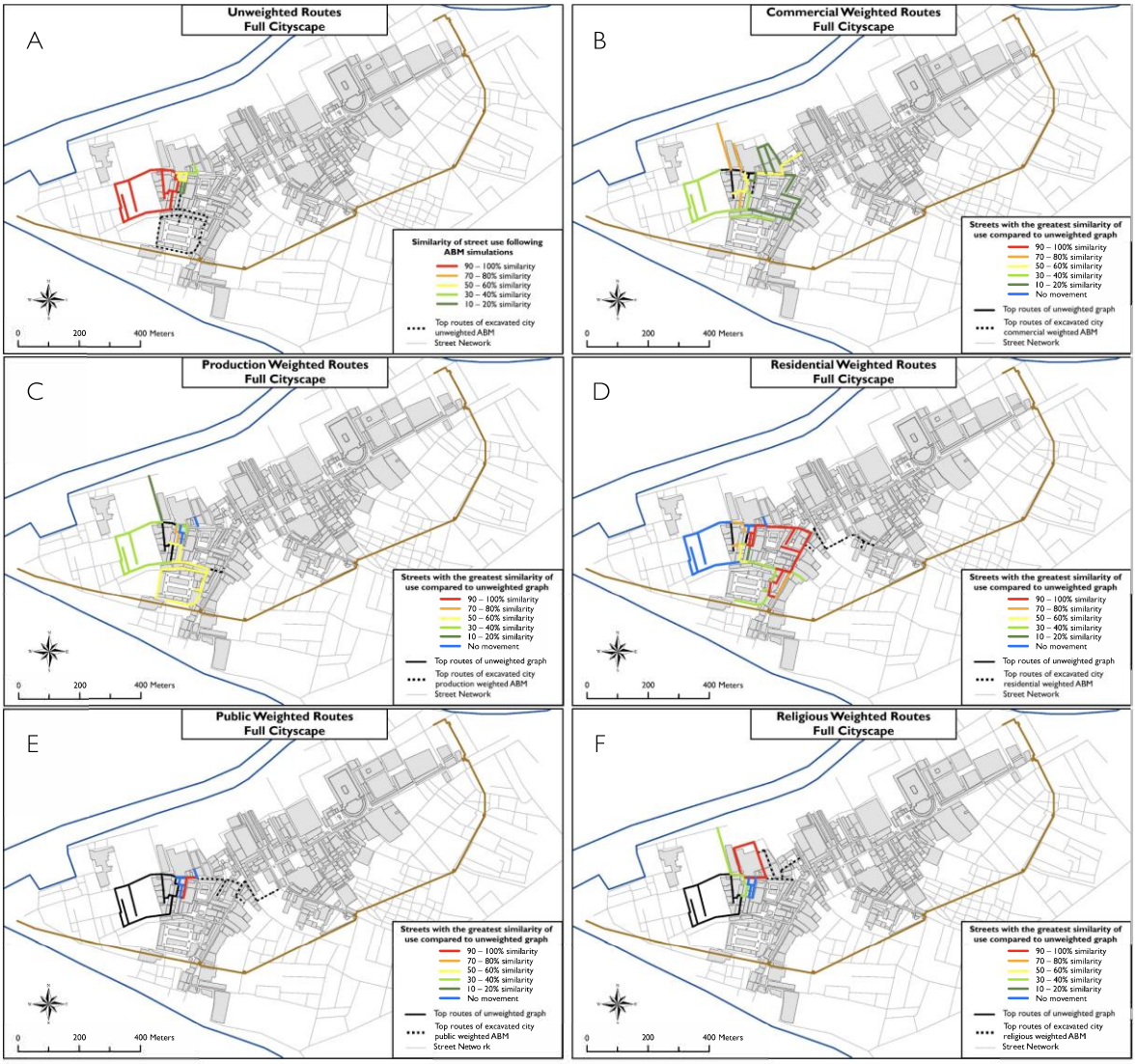


Figure 9.5 Similarity of street usage by un-weighted (A) and weighted building classifications (B–F) accounting for the unexcavated cityscape. Black dotted line shows deviation from the excavated cityscape simulation results in Chapter 7. Routes chosen by the processional leader within 1000-ticks, results of 5 different runs.

The primary variation in the routes weighted by individual building classifications is the addition of movement travelling around the buildings located directly west of the temple. The simulations run in relation to public (Figure 9.5, E) and religious (Figure 9.5, F) weighted buildings show the greatest potential of movement around this area. The other weighted runs show that movement in this direction is likely, but does not occur consistently during each individual simulation run. The residential weighted simulation (Figure 9.5, D), for instance, shows a lack of movement travelling

within the westernmost portion of Ostia. The general trajectory of movement that is inclusive of the extended cityscape relative to each classification remains consistent to those routes detailed in Chapter 7. The only major different is in relation to the public weighted simulation (Figure 9.5, E), where movement travels predominately towards the river harbour rather than along the *Via della Foce* towards the *forum.*

The various weighted calculations show that the extended cityscape does have an influence upon where processional movement travelled. The degree of movement travelling in the direction of the river harbour needs to be assessed in terms of the buildings present within this area as well as the more general direction that the Egyptian procession would have likely travelled. The westernmost streets that the processional leader travels along surround what is likely a large warehouse (Figure 9.6). A large proportion of the westernmost area of Ostia seems to have been inclusive of commercial structures. The several identified *horrea* likewise date to the end of the 2nd century AD, meaning they are contemporary to the present study (Martin *et al.*, 2002, p. 269). If such classifications are included within the agent-based model in future analyses, most of the runs should therefore largely avoid this general area. The second aspect that needs to be considered is the general direction the procession would have travelled. I have already addressed the likelihood of movement being focused towards the seafront (§7.6). This aspect in addition to the concentration of large commercial structures west of the *Serapeum* indicate that movement would have most likely travelled towards the southern area of the city.

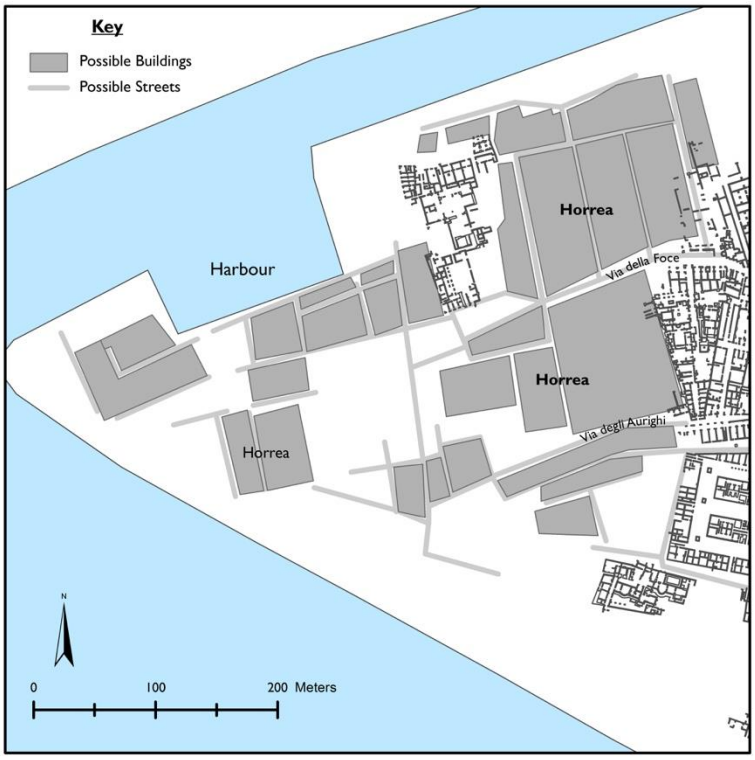


Figure 9.6 Preliminary geophysical-survey results and interpretation of the western unexcavated area of Ostia (after Martin *et al.*, 2002, fig. 12).

Despite the discrepancies in movement routes when the western area of Ostia is included within the analysis, movement still occurs predominantly within the excavated city. All of the experimental runs additionally show that movement is confined to the previously demarcated ritual area. These experimental runs confirm that the general area of ritual movement does not differ significantly when the unexcavated portions of Ostia are included. A more significant effect upon possible processional routes is the intermediary destination of the procession, e.g. the seafront, rather than data that is missing from areas of the un-excavated city.

9.1.2.3 *Forum* Temples

The experimental runs including the extended cityscape indicate almost no variation in the area of processional movement relating to the *forum* temples. Figure 9.5 (A) shows the routes taken by the processional leader during five different runs where the entire extended cityscape has a uniform influence value of 1. The potential movement areas remain confined within the excavated portions of the city. This indicates that regardless of the value buildings are weighted with, movement occurs predominantly within the streets directly surrounding the *forum.* Even when movement travels down the southern *Cardo Maximus* towards the *Campo della Magna Mater,* movement does not extend into the unexcavated areas of the city. The central position of the *forum* asserts a greater influence upon movement than the unexcavated portions of the city.

The processional routes specific to each building classification that include the extended cityscape (Figure 9.5, B–F) are almost identical to the results shown in Chapter 8. All of the examples detailed above designate movement that is predominately structured surrounding the *forum.* This indicates that the calculation of routes specific to the *forum* temples are not unduly impacted by the unexcavated areas of the city. One aspect that does need further consideration is the length of the procession and if a longer simulation time (e.g. 2000-ticks) has a significant effect on the overall processional routes. When compared to the other two case studies, the analysis of routes specific to the *forum* are not affected by the limits of the excavated built environment.

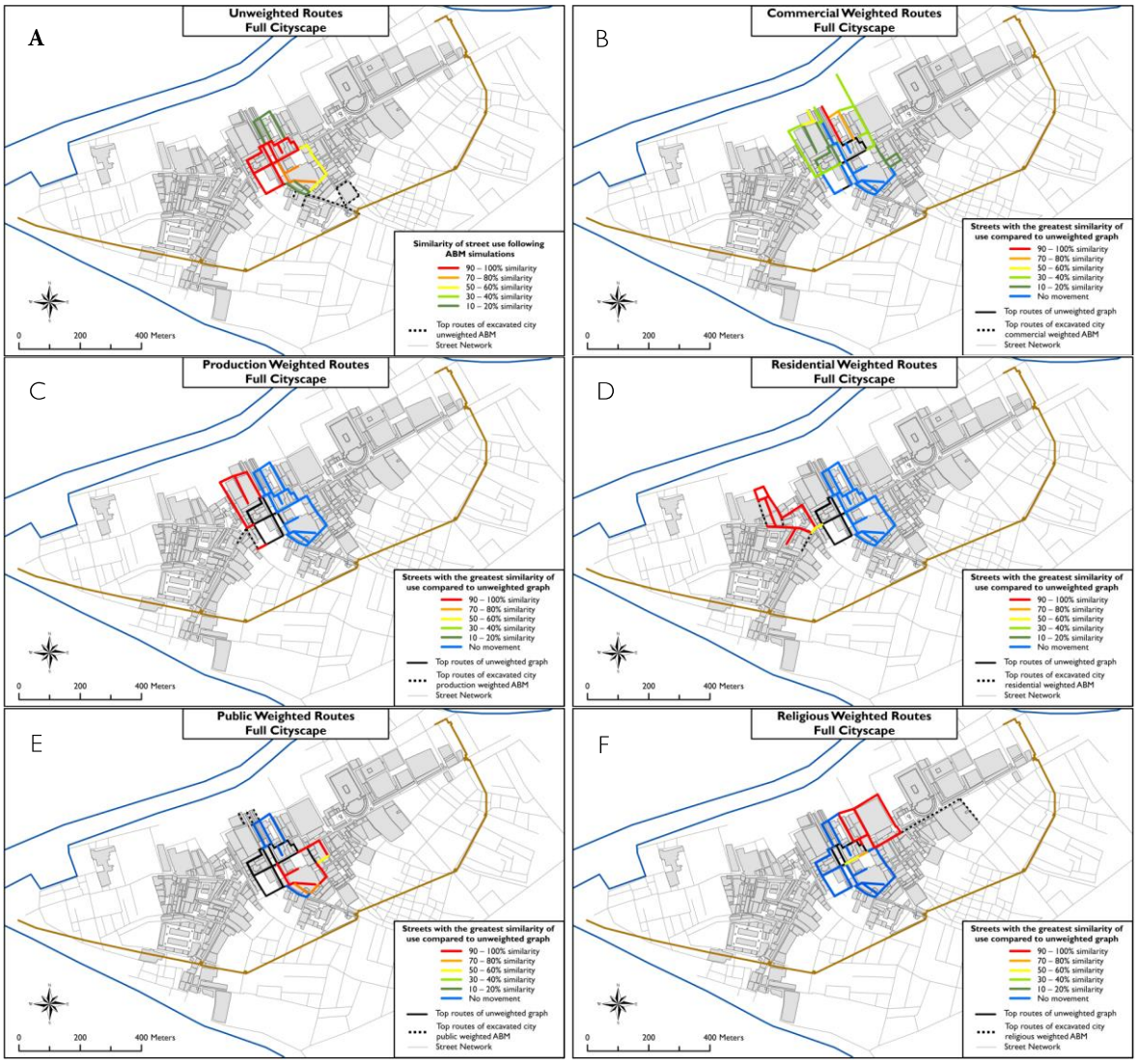


Figure 9.7 Similarity of street usage by un-weighted (A) and weighted building classifications (B–F) accounting for the unexcavated cityscape. Black dotted line shows deviation from the excavated cityscape simulation results in Chapter 8. Routes chosen by the processional leader within 1000-ticks, results of 5 different runs.

Summary

The results of the simulations accounting for the extended cityscape show different degrees of route variation when compared to the analyses undertaken within each case study chapter. The results confirm that the unexcavated area of the city has some effect upon the results. However, analysis of the results in light of our archaeological understanding of the unexcavated cityscape as well as the nature of the different processional rituals limits the degree to which this effect holds true. These additional analyses further confirm the validity of applying this approach even with an incomplete urban dataset.

9.2 Synthesis of the Case Study Results

9.2.1 Demarcated Ritual Movement Areas at Ostia

The analyses undertaken throughout the three case studies show that processional routes were not only structured by the spatial location of individual temples, but also by the surrounding urban environment. Studying the ways in which building importance affects passing movement provides one method of researching processional movement that extends beyond standard text based approaches (Fless, 2004). In particular, this method begins to address Graf's statement that a procession's total ritual context needs to be considered in any ritual movement study (Graf, 1996, p. 64). While the full complexity of processional rituals can never be completely understood, this thesis has shown that looking at how the built environment structured processional movement, within the context of individual cultic rituals, is one way that studies of processional movement can progress when archaeological and literary evidence is otherwise limited.

The ways in which processions inhabited Ostia's streets represents a temporary appropriation of the agency of a Roman street. This street space that was generally occupied by daily social life formed the spatial infrastructure for the city's rituals (Nejad, 2013, p. 22; Griffiths, 2016, p. 80). Street social space, which Hillier *et al.* (1976, p. 180) term as profane due to the occurrence of everyday activities, became a temporary religious space for the duration of a processional ritual. This allowed the various cults located throughout the city to be seen and experienced beyond their temple precincts. The purpose of a procession was not constant, and could vary between a purely religious purpose to having different social and political agendas. However, the recursive relationship that existed between the built environment and processions has only recently garnered attention (Stavrianopoulou, 2015; Popkin, 2016).

To assess the connection between the built environment and a constructed ritual landscape, this thesis has integrated three different computational methodologies in order to study individual ritual processions at Ostia. The intent was not to determine an absolute path for specific processions, for which the existing archaeological evidence at Ostia is too limited. Rather, the intent has been to draw attention towards what urban and social factors may have affected processional movement, and how these aspects helped construct specific movement routes that can be visualised within the urban landscape. By recognising that processional rituals were fluid and dynamic events that took place within a living landscape, we can begin to rethink how processions are studied and what they can tell us about a city's religious life through the larger ritual area they constructed.

The implementation of a method that studies how building usage structures the direction of passing movement shows distinct variations. The resulting visualisations of both movement potential and full routes, as demonstrated by urban network analysis and agent-based modelling respectively, are in part a product of the classifications constructed for this thesis. However, scholarship concerning

sacred movement has shown that a close correlation exists between urban space and areas of movement (Morton *et al.*, 2014; Popkin, 2016; Kristensen and Friese, 2017). While the limited number of classification categories presents an inherent bias in all of the models created for this thesis, the use of only five categories enabled the study of how each of these categories structured possible movement routes. Any additional complexity that is added to a model decreases our ability to fully comprehend how different variables affect the outcome of a particular model. The results gained from the three case studies clearly show that the built environment had a direct effect upon possible movement patterns. More significantly, the resulting areas of movement enabled a broader study of the ritual area subsequently created in relation to each of the three temple case studies.

9.2.1.1 Ritual Area of the *Campo della Magna Mater*

The quantitative analysis of processional movement associated with the cult of the Magna Mater shows a deliberately demarcated ritual area. The results of urban network analysis indicate that movement is predominately confined to the *decumanus* and the southern area of Ostia. The various agent-based model experiments indicate a bit more variability, with movement travelling into the area directly north of the *forum,* depending upon how buildings are weighted. In this case, movement is still confined within the area east of the western *decumanus* and the *Via Epagathiana*. Both the betweenness centrality and agent-based model results show that movement is unlikely to travel much beyond the Theatre. This represents a confined area of movement within the cityscape.

The calculation of axial step depth provided a similar area of movement when confined to a step depth of 4. While the computation of space syntax can provide insight into the general area of ritual movement for the *Campo della Magna Mater,* it does not sufficiently address which streets saw likely use and where processional movement may have travelled within this area. The integration of urban network analysis and agent-based modelling enabled a more nuanced evaluation of which streets saw likely use depending upon how the surrounding buildings were weighted by their influence factor. Assessment of the potential relationship between a procession and the buildings it passes can inform our understanding of the people intended to see and experience the moving ritual. Furthermore, possible routes can be analysed within the wider context of Ostia's street usage. If streets like the northern *cardo maximus* and the *Via di Diana* were predominantly used by commercial traffic coming from the Tiber, these streets may have been avoided by a procession.

The possible areas of processional movement, shown by the various computational approaches, all provide insight into the ritual area constructed around the *Campo della Magna Mater.* Figure 9.8 shows a compilation of the primary streets that would have seen processional movement from the calculation of betweenness centrality and agent-based modelling routes. Almost all the streets are focused around the *forum,* however, movement is not shown to actually go through this space along the *decumanus*. This is largely due to the present methodology that is focused upon buildings, not open spaces. Understanding this area as being structured by key points of the cityscape that were

specific to the cult further inform our understanding of the larger movement area. The sanctuary, *forum,* Tiber, and Theatre construct a broader framework for assessing movement patterns. Variation within the internal streets within this framework are dependent upon what spaces were more important for a procession to pass within the context of its wider ritual.

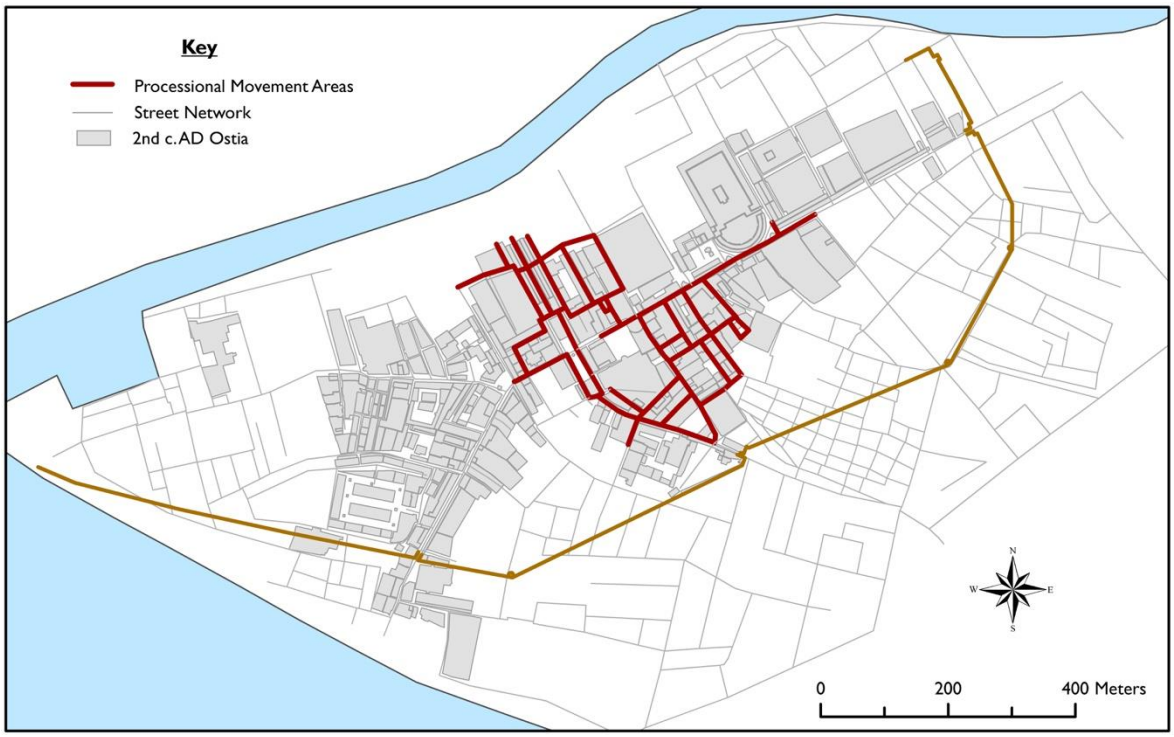


Figure 9.8 Map showing the areas of processional movement for the *Campo della Magna Mater.*

9.2.1.2 Ritual Area of the *Serapeum*

Urban network analysis and agent-based modelling indicate that a specific ritual area is delineated around the *Serapeum* by processional movement. The likely areas of movement are confined within the area west of the *decumanus* and the *Via Epagathiana.* Likewise, by weighting the five building categories with different influence value iterations, distinct streets arise as having a greater or lesser probability of use as indicated by betweenness centrality computations. Agent-based modelling provides a more nuanced understanding about how movement would have feasibly departed from and returned to the *Serapeum.* In most instances, depending upon the weighted values, the streets traversed are comparable to the two highest movement potential streets that are represented by betweenness centrality. Depending upon which types of buildings are considered most important, there is visible variation in the streets likely to be traversed.

Addressing the mechanics of the feasibility of movement within the *Serapeum's* surrounding streets brings attention towards where rituals likely occurred. While the results are comparable to the initial axial step depth calculations, the ways in which various urban activities structured this movement has presented a multi-faceted visualisation of areas that may have seen processional

movement. While we do not know the extent to which any of these spaces directly impacted movement, by looking at the numerous variations certain patterns arose about the likely streets used by processions. Additionally, the application of an agent-based model has provided a more detailed understanding about how movement left and returned to the *Serpaeum* within a certain time-frame. By further integrating some of the street dynamics a procession would have had to contend with, including other pedestrians, study of the processional movement is removed from a map-based study to integrating the people involved in shaping the ritual.

By looking at the *Serapeum* through a lens of how it structured ritual activity provides a new prospective for studying the surrounding urban landscape. From the viewpoint of streets being temporary ritual spaces, the dissemination of Egyptian rituals beyond the temple precinct can be considered. And while we cannot be certain of the regularity of processional activity or their routes, this case study has proposed one way of visualising how ritual movement traversed a portion of Ostia's urban landscape. Figure 9.9 shows the most likely processional routes following the betweenness centrality measurements and the agent-based model results. Movement is most intense along the *Via della Foce* and the *Cardo degli Aurighi,* which is connected either along the *decumanus* or by some of the internal streets. While movement past the *Case a Giardino* is not likely for all building weighted combinations, if passing residential space is an important influencing factor on a processional route, then this area would have seen activity. Likewise, the complex has a few Egyptianizing features, such as a Nilotic scene on one of the fountains, which could attest to some of the cult's followers residing here although this is far from concrete evidence (van der Meer, 2012, p. 78). More importantly, this shows a consistent direction of movement towards the seafront, which may have been an important destination for a procession. The possible routes all attest to a larger ritual space that is structured by the *Serapeum.*

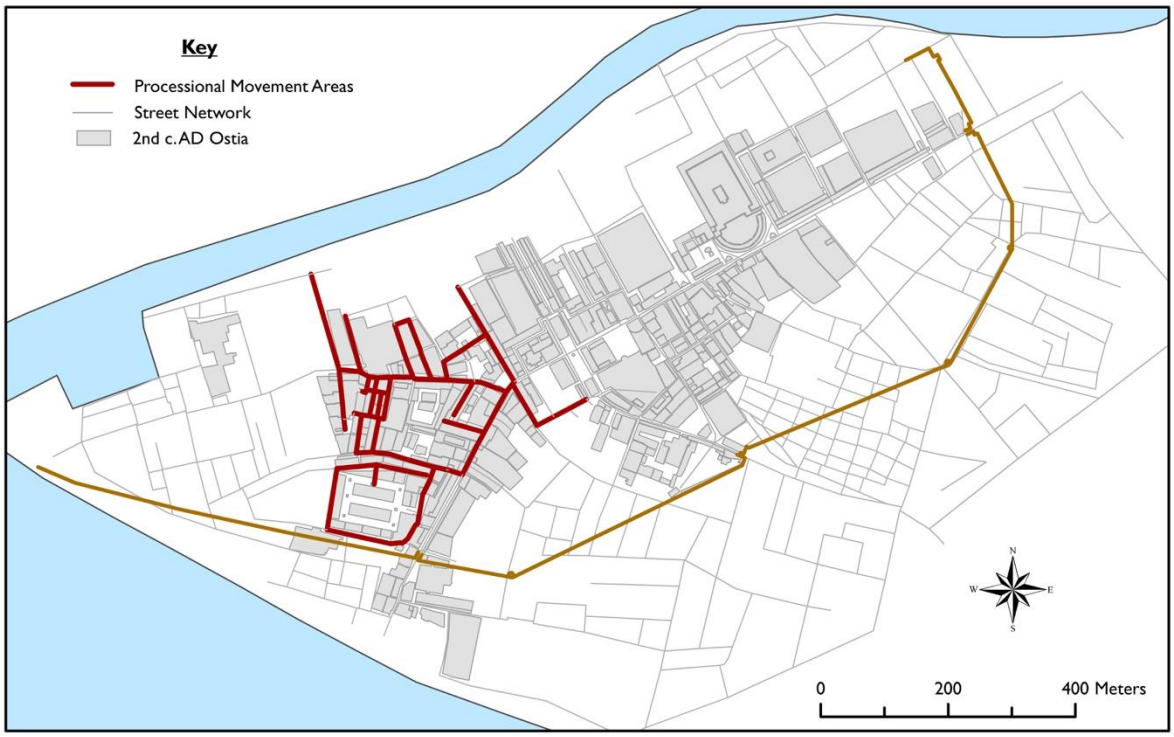


Figure 9.9 Map showing the areas of processional movement for the *Serapeum*.

9.2.1.3 Ritual Area of the *Forum* Temples

Study of processions organised by the *forum* temples indicates the construction of a specific ritual area. Unlike in the previous two case studies, the calculation of axial step depth does not provide sufficient insight into the general ritual area constructed by the city's street network and urban layout. The urban network analysis results help discern a ritual area that is focused along the *decumanus* and the *Via della Foce*. This shows some intersection with the ritual areas demarcated by the *Serapaeum* and *Campo della Magna Mater*, which would not be surprising for a larger scale processional ritual. Movement that travels within these other two ritual areas is largely confined to the *cardo maximus* and the *Semita dei Cippi* within Cybele's ritual area and the *Via della Foce* and the *Cardo degli Aurighi* within the ritual area of Serapis. Agent-based modelling provides a better visualisation of processional movement for the *forum* temples. The agent-based model results show more variability in travel occurring along some of the minor streets that can be accessed from the *forum*. Similar to the urban network analysis results, movement is still largely structured by the *decumanus,* even if movement along it is sporadic.

The ritual area delineated for the *forum* temples is structured around the city's major streets. Figure 9.10 shows the likely areas of movement between the urban network analysis and agent-based modelling results. There are three general areas of movement. The first extends along the *decumanus* to the *Via della Foce* or *Cardo degli Aurighi,* indicating movement travelling towards the river harbour, or it is reflective of this street's purpose as a passageway through the city. This

indicates that processions may have had a close connection to the river harbour and the commercial activity that coloured the port town. Second, there is some movement travelling south of the *decumanus,* connecting along the southern *cardo maximus* and the *Semita dei Cippi.* This area constituted a larger proportion of public spaces, like the *Terme del Foro,* which could account for movement within this area. The third general area of movement is north of the *decumanus,* along the streets surrounding some of the city's large commercial structures. Depending upon the extent to which processions would have travelled along areas with predominantly commercial activity could indicate some of this area saw less use. These movement areas all show that when looking at a citywide procession, movement was confined to more major streets and saw less movement within various *insulae* or neighbourhoods compared to the previous two case studies.

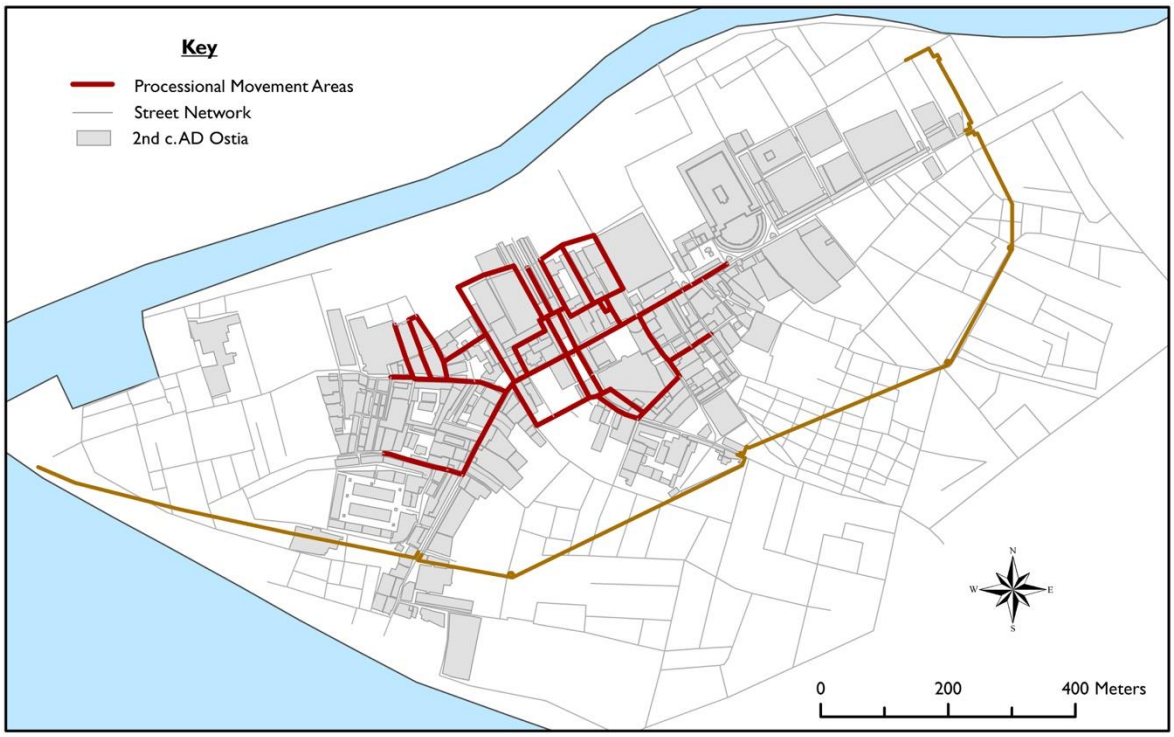


Figure 9.10 Map showing the areas of processional movement for the *forum* temples.

9.2.2 The Creation of a Ritual Landscape

Assessment of the combined ritual areas indicates that Ostia hosted a complex ritual landscape. Figure 9.11 shows the intersection that occurred between all three processional areas. Both Serapis and the Magna Mater had movement areas relatively distinct to each other, focused within the areas surrounding their temples. The *forum* temples, in contrast, merged with both of these areas. In this sense, not only would these centralised temples have hosted large scale processions that traversed a greater proportion of the cityscape, but they also created a more unified ritual landscape. By intersecting with different ritual areas and even passing different temples, these *forum* processions

likely served to unite the entire city and bring distinct cultic groups together in a shared ritual experience that was focused upon the larger Ostian community.

Whereas study of the spatial organisation of individual temples can show their relative relationship to the cityscape, looking at how temples structured a ritual area provides a much different view into the intersection of religious activity with the rest of the city. This shows that religion was not confined to singular areas, but throughout the year extended beyond individual temple precincts to intersect with the wider urban landscape of Ostia. This provides new insight into the role religion and ritual practices played at Ostia and the extent to which it impacted, even if only for the duration of a procession, the people inhabiting or visiting the city.

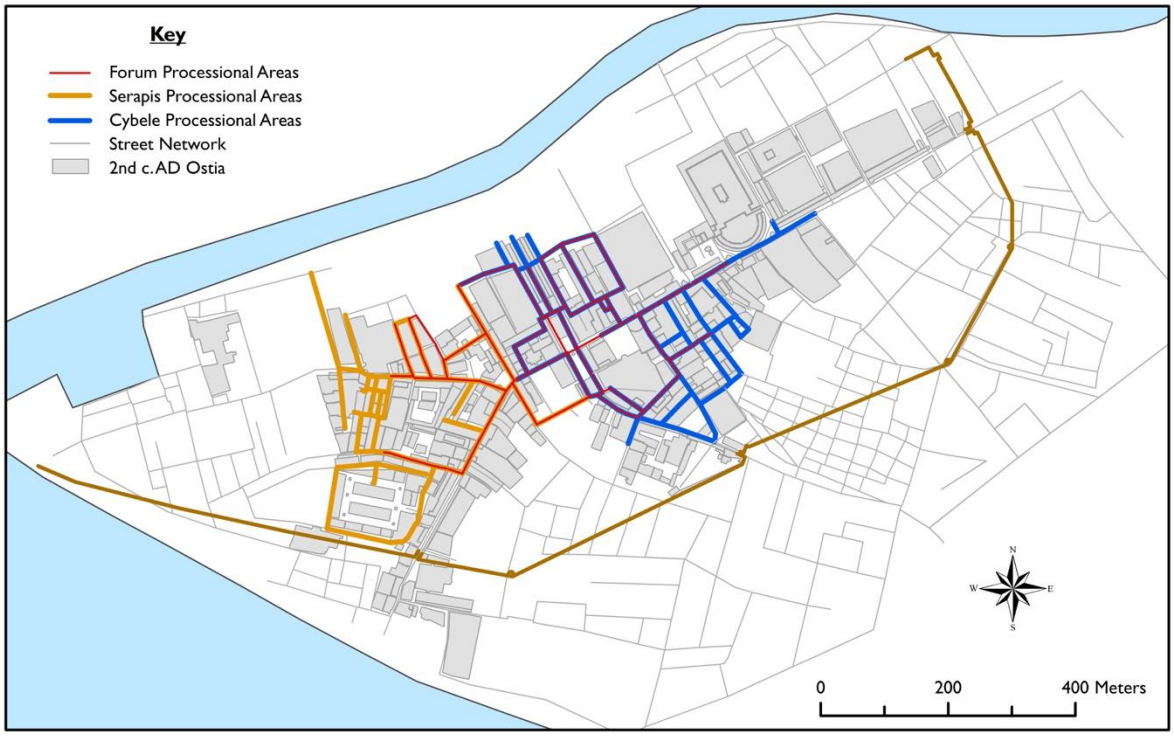


Figure 9.11 Map showing how all three ritual areas intersect.

9.2.3 A Visible Ritual Landscape

The three case studies each show a distinct area of ritual movement within Ostia's cityscape. Returning to the final questions asked at the beginning of this thesis, the present results show that processions played a crucial role in how distinct ritual areas were structured, and therefore how religious landscapes extended beyond the temple proper. Assessment of the likely areas of movement as indicated by urban network analysis and agent-based modelling in combination with the archaeological record and our understanding of particular processional rituals enables a closer study into the socio-religious practices that occurred within different defined ritual spaces. These

different ritual areas assisted in the manifestation of a larger ritual community that is connected by processional movement.

A central aspect of a procession was its function as a communicative event, structured through multi-sensory ritual elements (Geertz, 1973, p. 93). The religious processions looked at throughout this thesis occurred as a way to both honour different deities and to provide a structure for the gathering of people (Stavrianopoulou, 2015, p. 349). Processions provided a vivid expression of both a cult and its rituals. The ways in which this religious expression was understood by Ostia's inhabitants is in part structured by the ritual area created by a procession's route. Their practice fashioned a street performance that engaged with not only cultic participants, but also with the surrounding community. For individual cults, these rituals served as an expression of their cult identity for the wider cityscape (Graf, 2015, p. 4).

The location of temples in addition to the occurrence of processional rituals gave cults increased social visibility. People entering or exiting the city by the *Porta Laurentina* would have been aware of the sanctuary of the Magna Mater, but its closed architecture that required entry, and likely permission, into the campus would have enhanced its seclusion both from the public's eye as well as general understanding of the cult. The demarcation of a ritual area beyond the temple precinct provided a venue for cultic participants to enact a public display of their religion for the larger cityscape. As a mystery religion, the majority of rites associated with the Magna Mater would have occurred within the isolation of the sanctuary's campus. For the cult of the Magna Mater, the practice of processions was one way to ensure that people were aware of the cult and its distinct character. The processional rituals temporarily brought the city's residents into the fold of the cult, allowing them to visibly see the cult statue, and witness the dances, clothing, and music that gave life to this cult.

For temples like the *Serapeum* which are less ornate and removed from main streets, the practice of processions likewise facilitated the cult's visibility. For the cult of Serapis, the rituals that intersected with street activity would have been an important venue for public veneration and display of the religion. Its location near the main street for connecting the river harbour with Ostia's urban centre cannot be discounted. The occurrence of processions within this area of Ostia would have particularly attracted the attention of visitors having just arrived at the city. Furthermore, with the high population of easterners residing within this area of the city, such processions would have likewise served as a general celebration of their community.

The rituals associated with the *forum* temples would have served a slightly different purpose. Their central prominence within the city meant that they would have been regularly seen and interacted with as people traversed the city's streets. Since both these temples were always visible, the associated rituals were not necessarily intended to alert the Ostian people to their general

presence, rather they highlighted Ostia's ritual environment. Any processional rituals that occurred, therefore, would have complemented this by drawing the city together in a shared ritual experience.

9.2.3.1 Experiencing Processions

Visual participation in a procession was one of the central features of the ritual. The importance of viewing Roman festivals has seen an extensive body of scholarship and many similar components can be applied to the performative aspect of processions (Elsner, 1998; Bergmann and Kondoleon, 1999, p. 11). The trajectory of a procession represents a delineated space that allowed for the ritual to be seen, whereas the built environment structured how a procession could be experienced and viewed (Georgiou, 2016). Both of these aspects contributed to the larger perception and understanding of the ritual context of processions at Ostia (Stavrianopoulou, 2015, p. 354).

Urban spectators played an active role in determining how to best view a procession. This was in part structured by the built environment based upon open urban spaces that facilitated watching the ritual. How the city structured spaces for processional viewership beyond general street movement encompasses an important component of ritual practices. A procession needed crowds to actually see and experience the ritual. The greater the visibility of a procession, then the greater number of people who could actually engage with and be receptive of the ritual (Brilliant, 1999, p. 221). While the route taken by a procession would have interacted with passing inhabitants to a degree, areas that would have enabled large groups to gather is an aspect that has not been addressed.

Assessment of which spaces could have fulfilled this role within Ostia's cityscape provides further insight into likely spaces passed by a procession. Study of the different percentages of land use at Ostia provides preliminary insight into where people may have intentionally gathered to watch a passing procession. Within the excavated cityscape, streets account for 33% of the city's total ground use. This constitutes a sizable portion of urban space that can be temporarily appropriated for ensuring the spectatorship of a passing procession. For spectators, the constricted space of the streets for a passing procession meant that they became temporary participants in the ritual purely due to spatial proximity.

Open spaces that allowed for the gathering of a group of spectators, such as street corners, porticos, and plazas, may have directed a procession to pass along certain streets at the expense of other less visible streets. For processions associated with Cybele and the *forum* temples, the obvious choice would be the open *forum* space. Other areas associated with largescale shopping or market activity could include the *Portico est e ovest di Pio IX* and the *Caseggiato del Pantomimo Apolausto.* Both these areas would have hosted large numbers of people, as well as providing porticos to watch a passing procession. The Republican sacred area had an open space that enabled visual access to the passing *Via della Foce,* acting in a similar fashion for the cult of Serapis and citywide rituals. As the

city became more densely populated, previously open spaces were increasingly encroached upon by new buildings, and the Republican sacred area presents one such example (Pensabene, 2005). In future, a more formalised study of where a high number of people gathered within the cityscape could enhance our understanding about the relationship between a procession's actors and spectators.

The crowd of people that engaged with or waited for a procession to pass all called attention towards a specific cult, and by extension, to their associated temples. For the more secluded temples like the *Serapeum,* this enabled its presence to be visibly acknowledged. In terms of the temples at the forefront of the city's visibility such as the *forum* temples, the enacted procession served to bring the community together.

Upper storey viewpoints present another component that aided in the viewership of a passing procession. Accounts of processions from Rome comment upon people gathering on roofs to gain a glimpse of a procession (Pliny *Pan.* 22.4; Cass. Dio 63.4.2). While these examples are in relation to major triumphal or circus processions, it provides some insight into how building height was used to facilitate experiencing a ritual. At Ostia, we can imagine similar examples of people taking to upper stories and even roofs to witness a passing procession.

The way in which a procession navigated Ostia's street network articulated the relationship between a specific sanctuary and the city. Without surviving evidence of the various cultic artefacts carried within individual processions, we cannot fully understand the visual communication that occurred within these processions. The association of specific groups of people with these processions, however, would have presented them with a way for expressing or communicating their affiliation to a cult. This seems a likely outcome for some of the followers of Serapis. Funded by the Caltilii family, their hosting and inclusion within a processional ritual would have presented a visual display of their connection to the cult. For the cult of the Magna Mater, the processions served as a way to visibly communicate aspects of the cult and its rituals that were otherwise confined to its sanctuary. For both of these cults, moving within a fixed ritual area that may have included a large proportion of cultic followers would have drawn additional attention towards a temple's wider religious community.

9.3 Re-understanding Processional Rituals

This thesis has demonstrated the complexity and multi-faceted nature of Roman processional rituals. By moving processional studies away from the city of Rome, this thesis has demonstrated the potential that exists for furthering studies of urban processional movement. The remainder of this chapter considers the larger significance of processional rituals at Ostia and what implications these findings have for our understanding of processions throughout the Roman empire more

broadly. It concludes with considering how the application of a multi-layered computational approach further contributed to our understanding and study of processional rituals.

9.3.1 The Complex Function of Processional Rituals

Processions were multi-faceted events, their purpose and significance changing depending upon their cultic affiliation. At Ostia, the involvement of different parts of the urban population as both spectators and participants within these rituals likewise created an intricate interplay between religious and social practices within the city. As complex rituals, they had multiple functions concerning their role and purpose within the ancient city. What these contribute to our understanding of the rituals at Ostia and processions more generally will be considered in the remainder of this chapter.

9.3.1.1 Religious Function

The role of Ostian processional rituals in contributing to the city's religious landscape has been the focus of this thesis. The religious function of processions, however, is considerably more complex. At its foundation, religious processions were intended to be performed as rituals to the gods. Beyond this, more importantly were the religious messages communicated by processional rituals which imparted an understanding of a cult's individual theology, organisation, and social significance for a community.

As a performative event, processions facilitated the collective gathering of people in order to partake in a shared ritual experience. This would have enhanced the feeling of a larger ritual community by bringing different people and groups together. In many respects, this exemplifies the idea of *communitas* and the religious structure provided to the community through the collective participation within a processional ritual (Turner, 1969). The practice of different processional rituals overtime would serve to strengthen the religious community surrounding different temples within the city. In relation to Ostia, the regular performance of processional rituals would have likewise affirmed the presence and importance of various deities within the city. What is particularly significant for Ostia is that processions would have been one of the primary ways in which large social gatherings could occur. Ostia's theatre is the only known built structure that was intended to host a large gathering of people. While temporary structures may have been constructed to host games within the city (Meiggs, 1973, p. 427), processions would have been an important venue for facilitating social interactions within the city.

Processional rituals played an important role in transmitting knowledge and understanding about a specific cult (Feeney, 1998). In particular, some processions served as a reminder of a cult's mythic past. This was especially true for the processions associated with the cult of the Magna Mater at Ostia. The procession of the *dendrophori,* which consisted of carrying a pine tree to the goddess's

temple, represented the death of Attis. One aspect of the cult's mythological foundations were thereby disseminated to the larger Ostian community through virtue of its processional rituals. While myths were not necessarily of central importance for a cult, they were especially significant for the practice of processional rituals (Scheid, 2003). Their occurrence within the city likely also served on some level as a medium to educate foreigners newly arrived at the port about Roman religion, culture, and practices (Beard, North, and Price, 1998, p. 75).

9.3.1.1 Territorial Function

Processions and their territorial engagement played a fundamental role in developing both a cult's rituals as well as integrating that cult more widely within Ostia's urban landscape. For the duration of a procession, the streets traversed were both visually and symbolically appropriated for temporary religious use as they were incorporated within a temple's larger sacred landscape. This religious transformation ultimately increased a cult's prominence within the city.

Processions likewise played an important role in organizing sacred space throughout Ostia. The sociologist Polignac (1984) was an early scholar who recognised the territorial role that processions played in developing urban landscapes. While his study was specific to the Greek Archaic period, a similar phenomenon can be seen at Ostia. Processions could be used to demarcate a larger ritual area surrounding individual temples within the city. The navigation of a processional ritual through the city therefore enabled the territorial expression of an individual cult. The flexibility of the route as it changed over time created a malleable border or boundary surrounding individual temples. Processions, therefore, could be used to delineate the limits of the ritual area, bringing attention to certain areas of the urban landscape and thereby highlighting the association of different urban spaces with a specific cultic temple. This is particularly evident in the example of the Magna Mater where urban areas corresponding to the cult's mythic past likely would have been included within the processional route. In this instance, the procession not only served as a way to create a larger ritual area surrounding the cult, but enabled it to highlight important spaces within the cityscape that were relevant to the cult of the Magna Mater.

Ritual demarcation through the practice of processions can be particularly important for defining a temple's importance within the urban landscape. By travelling within a larger area of the cityscape, the ritual landscape of a temple and cult is not only expanded, but it enables a temple to achieve greater overall visibility, bringing increased attention to a specific temple. This would have been especially true for the *Serapeum* which was spatially situated in a fairly secluded location. The subsequent expansion of a temple's ritual area could additionally serve to alter the status and overall influence of the temple within the city. The opposite likely held true if the area covered by a processional ritual was reduced.

Individual processional movement areas additionally provide insight into the construct of a processional hierarchy within the city. As shown in the three case studies, at Ostia there was a degree of differentiation in processional ritual scale. Processions like those associated with the *forum* temples present an example of a larger scale ritual that traversed a sizable portion of the city. The incorporation of disparate areas of the cityscape within a shared ritual attests to its greater socio-political significance. Medium sized processions, like those associated with sanctuaries of the Magna Mater and the *Serapeum,* encompassed a fairly large area of the city, but where more constrained in where they travelled. They might intersect with some areas covered by a larger processional ritual, but they did not follow identical routes. Small scale processional rituals, alternatively, would have likely been confined to individual neighbourhoods. The relative size of these processions and the ritual areas that they encompassed shows the hierarchical importance of both different rituals and cults.

Equally important would be the ritual movement overlap that was allowed for individual cults. A smaller cult that was able to follow portions of the ritual area delineated by a city's major procession could help to increase its cultic significance. Likewise, passing important structures commonly included within citywide processional rituals would serve to further integrate a cult within the city's complex ritual landscape. Alternatively, depending upon the influence or importance of an individual temple, it may be possible to have their temple included within another cult's processional route. We can hypothesise about the efforts undertaken by smaller religious communities to have their temples potentially included within the route of a citywide processional ritual, thereby increasing their overall visibility within a town.

9.3.1.2 Socio-Political Function

Processions provided a venue for the dissemination of messages that extended beyond purely religious purposes to the urban crowds at Ostia. In many regards, a procession could be considered as having as much of a religious function as a socio-political purpose. The Roman triumph and circus processions that occurred at Rome are some of the more commonly known examples of processions that had overt political intentions. The underlying intent of these processions, their route through the city, their grandeur, and various ritual components were all intended to convey a larger political statement. Comparably, the spectacle aspect of even minor processions all contribute to the larger socio-political nature of individual rituals as well as their function within a community.

The original foundation of a ritual is often tied to whomever procured the funds for the dedication of the temple, which thereby brought the associated deity to the city. While this information does not always survive, at Ostia it can be broadly categorised into two categories, private and state funding. In terms of privately funded temples, the *Serapeum* is one such example of a private citizen and family attempting to enter into the larger civic community of Ostia by participating in the city's

urban economy through the donation of a temple. By dedicating a temple they are making a larger political statement to the community as to their wealth, piety, and commitment to ensuring Ostia's success. Any processions that are likewise associated with this temple are grounded in the temple's foundation history. Furthermore, the temple's foundation date and its inclusion within the *fasti Ostiensis* further emphasises the Caltilii family's position within Ostia's political sphere. State funded temples, like the *Capitolium*, hold a similar political purpose. Rather than bringing attention to an individual Ostian family, it highlights the Roman state's interest and generosity in providing the city such a central temple. The presence of a temple like this in the epicentre of the city creates a highly political statement. Any processions subsequently associated with the temple would uphold many of the same connotations.

The different visual components of a procession contribute to the larger socio-political reception of rituals at Ostia. Their degree of visibility in part existed as a way for different Ostians to publicly display their ritual donations, illustrating their generosity to a specific cult. This is specifically apparent for the cult of the Magna Mater. Within the sanctuary, numerous statuettes survive that are often inscribed with the dedicator's name and the weight of the object (*CIL* XIV 36) which attests to their value (Rieger, 2004, pp. 143–146; Cooley, 2015). It can be hypothesised that the heavier and therefore more expensive statuettes were likely donated by either higher officials of the cult or those attempting to increase their socio-political standing within the cult. This would be particularly important if any of these statuettes were carried in procession, where a donor's wealth and devotion to the Magna Mater was publicly displayed (Madigan, 2012, pp. 1–38). This provides just one way for certain association members to publicly display both their dedication and wealth. An alternative example is shown with the public commemoration of the *Serapeum* and its record in Ostia's calendar. Processions became a venue to display not only ones devotion to a specific cult, but also as a way to exhibit their wealth and ultimately their importance within the Ostian community more broadly.

The appropriation of space through the practice of processional rituals by different social groups within Ostia was another way in which a cult's visibility was maintained. For a city that would have been ethnically and socially diverse due to its position as a port town, these rituals served an important venue for developing and strengthening a larger urban identity. This follows what Bruun (2014) refers to as the city's civic identity. The practice of certain processional rituals, like those associated with the *forum* temples, likely served as a way to emphasise and uphold an Ostian identity. Alternatively, processions could also be used to reaffirm one's association to a particular community within the city. This would have been especially apparent with rituals like those associated with the *Serapeum*, whose members were likely largely composed of eastern immigrants. The action of participating within a public ritual enabled them to affirm their dedication to the cult as well as display their affiliation to the city of Ostia, thereby integrating within Ostia's social landscape. At some level these rituals would have also enabled the connection of people with the same cultural

identity. Rather than just existing as a procession to a specific deity, the processions would have also existed as a larger community performance for the city.

The regularity of processional rituals also helped to maintain a cultural memory of certain events, linking to the city's cultural past. In terms of the processions of the Magna Mater, the occurrence of an Ostian *Megalensia* festival with processions on 4 April would provide a remembrance of the goddess's original arrival at Ostia in 204 BC (Scullard, 1981, p. 98). Yearly processions associated with this event links the city's past and present history within one ritual, where the goddess's mythical foundation in Rome and Ostia's role in facilitating her initial arrival are celebrated. The number of rituals that occurred within the city can provide different insight into the overall investment that people made with regards to their city. In many respects, they can be used to gain insight into Ostian identity. The nature of processionals rituals not only reflected the purpose of complex rituals associated within individual cults and temples, but they could be changed, altered, and built upon as the needs of the community evolved.

Processional organisation is another topic that has particular significance. Every procession would have needed someone to oversee the organisation and staging of the ritual (Flower, 2014). We can infer that a certain degree of competition occurred both between members and different cults by looking at evidence for other forms of ritual activity that occurred within the city. There are several examples of inscriptions stating that certain important Ostian citizens were the first to organise games within the city (van Haeperen, 2014, p. 134). One example from the mid-2nd century AD relates to the Ostian citizen Hostilianus who was both a *duovir* of Ostia and a *flamen* for the imperial cult. The funerary inscription from his tomb references that he was the first to organise games since the city's foundation (*CIL* XIV 4616, 5381). Another funerary inscription attests to the provision of *ludi scaenici* at personal expense by Hermogenes, a *flamen* of Hadrian (*CIL* XIV 4642; Meiggs, 1973, p. 561). These examples provides some insight into the political status likely provided to a spectacle event's local benefactor. One can imagine that a similar increase in political standing occurred for anyone who contributed to the costs of individual processional rituals.

Study of known participants or families within different cults can provide some insight into the social and economic mobility of Ostian inhabitants. The Caltilii, the founders of the *Serapeum,* were originally freedman (*CIL* XIV 310). Their dedication of the temple served as one method of gaining social and political advancement within Ostia. They also achieved this through both marriage connections and their involvement with the imperial cult as *flamen* (*CIL* XIV 332; Meiggs, 1973, p. 204). This provides some indication into the level of social mobility that was possible within Ostia, an aspect that would have likely been especially important for the number of immigrants that lived within the city. Involvement with either a cult or priesthood, therefore, existed as one method of elevating one's socio-political standing within the city (Meiggs, 1973, p. 217). While clearly assimilated within Ostia's civic sphere, the association of the Caltilli with the *Serapeum* reaffirmed

their connections to the Eastern immigrants of Ostia. Their involvement with ritual processions like the *navigium Isidis* might additionally present further opportunities to engage with foreign traders present within the city, enabling them another occasion to increase their economic standing.

The scale of different processional rituals can also attest to a temple's overall economic success. Increase funding for a temple could correlate to the practice of better ritual processions. Reversely, more opulent processions or processions with a greater number of dedications all attest to the financial success of the cult. Although the relative scale of individual processions is unknown at Ostia, study of the size of temples as well as their dedications all provide some insight into the economic standing of different cults within the city.

9.3.2 The Shape of Processional Rituals

A range of other factors would have had significant importance for developing the character of processional rituals. One aspect that has not been specifically addressed thus far within this thesis is how individual processional rituals developed overtime and how this influenced their form at any specific period.

The premise taken throughout this thesis was that the built environment played a role in structuring how processions navigated Ostia. However, a much greater reciprocal relationship likely existed between processional rituals and urban development. The itinerary of early processional routes might have had a significant impact upon where certain buildings and temples were constructed over an extended period. Chapter 3 raised the idea that several of Ostia's early sanctuaries were spatially constructed along an 'archaic sacred route' that went diagonally from the south of the city to the river harbour (DeLaine, 2008, p. 101). The organisation of Ostia's pre-*castrum* street network and the urban design of the *castrum* likewise played a crucial role in the city's early urban development (Mar, 1991). The nature of processional rituals or important areas of processional movement would have inevitably been affected by the 2nd century AD building boom. The construction of new buildings and overall expansion of the city would have necessitated a change to original processional itineraries. Likewise, the development and restructuring of specific neighbourhoods throughout the city may have been partly influenced the by the religious rituals that needed to be maintained.

The triumphal processions in Rome exhibit a similar phenomenon, where the built environment and processional movement routes jointly influenced the development of each other. Overtime, the route of the triumphal procession would have evolved as Rome's topography changed. One example of this occurred with the construction of permanent theatres, like the Theatre of Marcellus. Several scholars contend that the original route was altered to pass these new permanent theatre spaces (La Rocca, 2008; Monterroso, 2009). Additions to the built environment, like temples

or monuments associated with the triumph, where additionally constructed within the vicinity of existing routes (La Rocca, 2008, pp. 35–41).

Another important aspect is the memory of past rituals that are imbedded within individual processions. The processions of the Magna Mater, for instance, ensure that people remember the goddess's foundation myths and eventual journey to Rome. These myths are further highlighted, as argued in Chapter 6, by certain urban nodes that are passed within the city by the processional route. Hölscher proposes the idea that monuments associated with the triumph in Rome created a stage for the ritual to occur (2006, pp. 198–190). A similar idea can be seen at Ostia, where processions used the city's built environment as a backdrop for various processional rituals. The historical development of a procession within the city is likewise maintained within the memory of the processional journey. Although the movement area of processional routes changed over time, the tradition of passing certain urban markers within the city enabled a certain continuity of ritual practice even as the route was update as necessary.

The extent to which this relationship can be studied within Ostia during the 2nd century AD is difficult. One needs to be aware when studying a processional ritual during a specific period, as was the case throughout this thesis, that the ritual's form is developed both over a period of time and influenced by a myriad of different socio-political and religious factors. Furthermore, processions would have changed and been adapted over time as the needs of a community changed (Wiseman, 1995, p. 2).

9.3.1 Evaluating Previous Processional Assumptions

In terms of the scholarly study of urban processions, this thesis has re-evaluated how processions can be studied. Whereas most processional studies have traditionally focused upon well documented processions, like the Roman triumph, this thesis has developed a novel approach for studying processions in urban contexts where processional evidence is lacking. Scholars often assume that processions occurred within all Roman cities, however, studies tend focus upon examples where there is sufficient surviving literary evidence detailing individual processions. In contrast, this thesis stressed how the likely presence of processional rituals can be considered through the comparative study of a city's religious and ritual evidence. In particular, archaeological evidence attesting to specific cults within a city, such as firmly identified temples, in conjunction with known festivals recorded in calendars across the empire present one way to approach this issue. Each of the three case studies addressed how individual cults and their processional rituals can be studied within Ostia. Such an approach holds significant potential for studying processional rituals within a diverse set of urban contexts that moves beyond the city of Rome.

Scholarly interest in processional routes has often resulted in trying to define specific movement itineraries within a city. This approach is constrained by existing evidence for specific processional

routes as well as its temporal time frame. This thesis has taken an alternative movement focused approach to the study of processional routes, concentrating upon the variety of ways a procession might have navigated the city. Such an approach not only address the existing uncertainty in how processions negotiated a city, but it also accounts for the fluid nature of processional rituals that often changed over time. Approaching processions in this manner enables us to question how different processions moved within the city rather than trying to ascertain one specific movement route.

In urban contexts where evidence for processional rituals is non-existent, scholars have traditionally assumed that movement occurred along a city's primary street. This thesis has amended this view to consider the larger urban landscape traversed by processional rituals. In light of this reassessment, the role that a city's primary street played within processional rituals has also been addressed. The results of the three case studies illustrated that there was much greater variability in terms of what types of streets would have been negotiated by the moving ritual.

The role that Ostia's *decumanus* played as a processional corridor, in particular, has been reconsidered. Previous scholarship considering processional activity within Ostia has assumed that the *decumanus* functioned as the city's primary processional way (Bruun, 2008). This thesis has presented a slightly different view to that traditionally upheld by scholars. The various case studies have shown that while the *decumanus* saw a significant amount of processional movement, it predominantly served as a throughway which facilitated the passage of movement to different areas of the cityscape. In considering other Roman cities, we will likely see a similar phenomenon. Rather than assuming that a city's primary street was also the main venue for processional activity, we can begin to consider how a city's main street or streets created an underlying framework for structuring processional rituals. From this reassessment, our understanding of urban processional movement in other urban contexts can transition away from assuming it occurred only along a single street to considering how it encompassed a wider ritual area.

The temporary ritual area that is shaped by individual processional rituals presents a new understanding about how processions functioned within a city. Rather than attempting to define a single processional route for a given ritual, this thesis has stressed the multiplicity of possible movement areas. This approach not only accounts for the fragmentary nature of evidence that survives but also the fluid character of processional rituals that are constantly influenced and altered due to changing urban, social, and religious dynamics within the city.

9.3.2 The Contribution of a Multi-Layered Computational Approach

This thesis presented a clear account of a new methodological approach that was developed to examine processional movement (Chapter 5) which integrated space syntax, urban network analysis, and agent-based modelling techniques. The use of only one method, as discussed previously

(§5.2), would have severely limited our understanding of potential areas of ritual movement and raised questions about the validity of the results. Furthermore, the lack of any extant archaeological or literary evidence at Ostia attesting to the presence of specific processional routes would likewise question the validity of the results if only one method was applied. The success of using all three of these methods in combination exists in their ability to both question and build upon the results of each other. The suitability of each method to address the questions asked throughout this thesis are considered below in greater detail.

The use of space syntax to measure the integration and choice values of the street network surrounding each temple case study provided a useful starting point for thinking about how the city's urban structure may have designated areas of ritual movement. However, when considered alone the results remain devoid of the human agency that drives and provides meaning to processional rituals. The results of such analysis, even when calculated from an individual temple, is not unique to processional movement, but could be applied to any form of urban movement within the city. The usefulness of applying space syntax is therefore limited to its ability to generate a general area of movement surrounding individual buildings. While the method of space syntax was not very illustrative for answering questions of processional movement, its application was necessary to demonstrate the necessity of applying alternative methods.

The application of betweenness centrality using the UNA toolbox presented a method similar to space syntax methodologies, but that enabled the inclusion of Ostia's buildings. The ability to weight individual buildings by their hypothetical importance provided a much more nuanced understanding about how certain areas of the city structured movement. While the street network is one factor that drives the analysis, the building weights are what generates the different results. The analysis was run by weighting individual building classifications within each ritual area. When compared to the unweighted graphs, the single weighted building classifications computed for each case study provided the most significant and useful results. The multi-weighted graphs that accounted for combined building weights provided surprisingly limited additional information. If undertaken again, rather than applying it to each case study I would have used the multi-weighted graphs as an example to show that it does not contribute significantly to our understanding of movement patterns.

The most informative method for considering potential full processional routes was through the application of agent-based modelling, however, it required extensive computing time. Each simulation took between 10–20 minutes to run which limited the total number of simulations that could realistically be undertaken for each weighted parameter change. There were additionally several limitations and issues that arose in terms of coding the model's various movement procedures. If I were to undertake the model's development again, there are a couple aspects that I would adjust and improve.

First, the algorithm used by the lead processional agent would benefit from further refinement. At times, the attraction of a building supersedes the requirement of the agent to move along the street. This results in occasional "jumping" across buildings. This problem was particularly evident in the simulations associated with the *Serapeum*. Reworking the procedure that determines how the processional leader reaches the next target by emphasizing movement along the streets should solve this issue.

Second, the inclusion of processional participants within the model highlighted the difficulty of simulating group movement dynamics. This was especially apparent when trying to ensure that the processional participants consistently followed the processional leader. Preliminary analysis applied a flocking algorithm as one way to model group movement dynamics following a processional leader. The initial results indicate that the agents forming the processional group follow close to the same trajectory as the processional leader. The implementation of this portion of the code, however, needs significant refinement to ensure that the processional group continues to move towards a common goal, which in this instance is towards the processional leader. The difficulty in adapting the flocking algorithm is due to its original purpose that is meant to be representative of movement without a leader or an intended direction. The attempt to modify this group movement procedure is successful until the processional leader gets too far away from the group, at which point they stop following and move randomly along the streets. If developing the model again, I would either further refine the group movement procedure or try to implement an alternative algorithm.

Despite the time intensive nature of implementing an agent-based model, it presented a novel approach for questioning how circular processional routes may have navigated the city. The value of this method lies in its confirmation that routes can be selected depending upon how buildings are weighted. Furthermore, the results indicated that the general ritual area designated by space syntax is supported. Likewise, the results of each simulation weighted by a different building classification category predominately followed the areas indicated as having a high movement potential within the betweenness centrality graphs. Therefore, agent-based modelling is by far the most useful methodology to apply when looking at full processional routes. Considering the uncertainty in the nature of these processions at Ostia, however, the joint application with other methods is necessary to examine the accuracy and probability of these simulation results.

An integrative methodology is the most appropriate way for looking at ritual movement at Ostia where we have no further archaeological or literary evidence recounting specific rituals. At sites where there is more surviving evidence, such as Ephesos, agent-based modelling alone would likely prove sufficient for study of specific processional routes.

9.3.2.1 Methodological Implications for Archaeological Studies beyond Ostia

The exploratory nature of the methodology developed within this thesis has significant potential for addressing questions that move beyond processional movement and religious landscape studies at Ostia.

The method developed throughout this thesis can be adapted for the study of processional movement at cities beyond Ostia. The increasing number of urban contexts known through geophysical survey data presents an opportunity to study religious movement patterns more broadly. As long as a temple can be identified through its architectural form, the present methodology can be modified to consider how religious landscapes were constructed within different unexcavated ancient cities. This will enable scholars to move present processional studies beyond hypothesizing about possible routes occurring along a specific major street. This method can likewise be used to test existing hypotheses about processional routes in other Roman cities such as Epehsos, which previously have been predominately informed by written or epigraphic evidence.

The wealth of geophysical survey data coming to light also presents an opportunity for undertaking more rigorous urban landscape studies. The possibility of incorporating geophysical survey data was preliminarily introduced within this thesis in terms of integrating the city's extended street network as well as the exploratory analysis conducted by accounting for the non-excavated built environment (§9.1.2). There is significant potential for further integrating both excavated and geophysical survey data from urban contexts in order to address broader questions about urban development and the construct of religious landscapes. In particular, the present methodology can be adapted to address questions about how cities developed overtime. It would be possible to model how a city's religious landscape changed over time as its built environment was altered.

Another avenue of research could apply to more general studies of various urban movement dynamics. At present, the main studies of urban mobility have taken place within well excavated urban contexts, such as Pompeii (Poehler, 2017). The methodology introduced throughout this thesis, while specific to the study of processional movement can be adapted for other forms of mobility such as cart traffic. A particular strength of the present methodology is its ability to study movement within both excavated and non-excavated urban settlements. The main determining factor is that there is sufficient knowledge of a city's overall street network. The wealth of data on full cities that are now known through geophysics enables us to move beyond focusing on only excavated cities when studying urban mobility. As a result, future urban mobility studies can adopt this method to address topics such as how specific types of mobility differ across different cities and time periods.

The value of applying a methodology like the one developed throughout this thesis is that it enables us to propose and test new hypotheses about the ancient city while increasing our knowledge and understanding of human interactions within the past.

9.4 Summary

This chapter has considered the extent to which the methods developed for the study of processional movement are inherently shaped by the dataset that discounts upper storey space and the unexcavated cityscape. The results show that while the methods applied throughout this thesis are affected slightly by these two aspects, the variation in results are not significant enough to discount the present analyses. The second half of the chapter began with a discussion of the broader implications of the areas of processional movement and how they constructed individual ritual areas surrounding different temples. To more fully understand the significance of these ritual areas relative to each temple, we have to consider the underlying function of processions as visual ritual events. Discussion then transitioned to considering the larger function of processions and what this contributes to our understanding of their function in terms of the religious and socio-political life of Ostia. The chapter concluded by discussing how the work undertaken within this thesis has affected our understanding of Roman processional rituals more generally.

Chapter 10: Conclusions, Implications, and Directions of Future Study

10.1 Introduction

This thesis has questioned how temples enabled the creation of a religious landscape that extended across a city. The first aim of this thesis, which aimed to develop a new framework for assessing how temples structured ritual activity, was addressed by using Ostia as a case study. The second aim, which sought to understand how the spatial dynamics of processional rituals created a unique religious landscape, was addressed by using processional movement as a heuristic tool to question how ritual practices encompassed an area beyond the immediate boundaries of individual temples. The final aim, which questioned how the human component of processional rituals can be incorporated within a spatial focused methodology, was accomplished through the development of a novel methodological approach that enabled us to visualise potential processional routes, the results of which provide a new narrative about how ritual practices were integrated within Ostia's cityscape.

In relation to Ostia, the following research objectives were raised to address how the study of processional rituals inform our understanding about the city's religious environment:

1. How far did the location of temples at Ostia contribute towards the construct of a broader religious landscape across the cityscape as a whole?
2. How have scholars approached processions and to what extent can we study processions within the archaeological record at Ostia?
3. What is the best methodology for modelling and visualising religious processions at Ostia?
4. How far might processions have played an active role in defining social and religious practice across urban space at Ostia?
5. Does the modelling of processional routes rooted at temples help us better understand the broader ritual landscape at Ostia?

This conclusion will demonstrate how these questions have been answered in relation to Ostia by discussing the results of the previous chapters. It will then be discussed how this thesis contributes to scholarship relating to Ostia's religious environment and Roman religion more generally. To conclude, the limitations of the current research and future avenues of research are addressed.

These questions were first addressed in Chapter 2 by reviewing how processions traditionally have been studied. The review has shown that processional research has concentrated upon the major processions that occurred in Rome, which have extensive literary commentary and iconographic

evidence. There remains an assumption that processions were regularly occurring rituals, but beyond this very few attempts have been made to address the occurrence of these rituals in cities outside of Rome. Chapter 3 further addressed the extent to which we can study processions at Ostia based upon our understanding of ritual activity. Although there is no surviving evidence detailing specific processions at Ostia, the study of temples with specific cultic affiliations that had well attested processions elsewhere presents one way of approaching the topic.

The possible methods that can be applied to the study of processional movement at Ostia were developed in Chapters 4–5. A multi-layered computational approach was developed that integrated GIS, network science, and agent-based modelling to visualise possible processional routes that were structured by the surrounding built environment and urban activity. This methodology presents a novel approach to the study of a specific type of directed pedestrian movement, which has, until now, never been applied to a Roman context. The application of betweenness centrality provided insight into the general movement potential past buildings weighted by different importance values. These results were then questioned using the agent-based model developed for this thesis, while additional complexity was added by beginning to integrate group movement dynamics into the model.

The three case studies applied in this thesis provided examples of the application of the methodology. They all illustrate the degree to which the built environment, indicative of social activity, structured ritual activity that extended beyond individual temple precincts. In regards to the first two case studies — *Campo della Magna Mater* and *Serapeum* — space syntax's axial step depth was first applied to determine a general ritual area. Betweenness centrality was then computed for each of the three case studies as a way to assess the movement potential along different streets within this general area, or the entire excavated city as was the case for the *forum* temples case study, depending upon how buildings were weighted. Agent-based modelling was then applied to determine possible "circular" routes applying the same building weights. This allowed confirmation of the general ritual area that processions, associated with each temple, would have moved within as well as confirming that movement can be structured by passing certain types of buildings. Second, it enabled the integration of processional movement dynamics, showing that processional participants likely followed the same routes determined by the processional leader in each of the simulations.

The significance of the potential processional routes associated with each case study were then assessed. For the processions associated with the Magna Mater and Serapis, the potential routes were considered within a broader cultic framework, which consisted of nodes within the cityscape particular to each cult. The routes specific to the *Campo della Magna Mater* travelled within a topographic framework particular to the cult's mythic foundation. The different urban classifications provided a more nuanced perspective about were processions may have travelled within this general

framework, which were largely confined to the northern and eastern areas of the city. The *Serapeum* routes were likewise considered within the context of a broader cultic framework. By assessing potential destinations, such as the seafront, and the overall processional characteristic, the resulting routes are indicative of ritual movement intended to strengthen a collective cultic group identity that is focused within the western area of Ostia. The final case study that looked at the *forum* temples took a slightly different approach. Building upon the methodology applied in the first two case studies, it was used to determine the extent to which the ritual environment surrounding the *forum* temples could be studied when the specific cultic associations are unknown. The potential routes, structured by the surrounding built environment, indicate the occurrence of larger processional rituals that effectively linked the cityscape within a shared ritual experience. This provides a new approach for studying the impact that these two central temples had within the cityscape, transitioning away from the circular debates concerning their deity associations towards considering their larger contribution to Ostia's religious landscape.

The final two questions were further addressed in Chapter 9. The analysis of the ritual area constructed through processional movement specific to each temple showed distinct areas of movement. These routes, when assessed in relation to the most probable movement areas specific to each cult, illustrate an area that extends well beyond individual temples. Returning to the first question, the analyses performed throughout this thesis shows that temples and their spatial position played a crucial role in determining where processional movement would have travelled, which was further defined by the impact of the surrounding built environment and the nature of individual processional rituals.

10.2 The Contribution of this Thesis

Through assessing the complexity of processional rituals at Ostia and how they inform our understanding of individual temples, this thesis makes a contribution to several research topics related to both Ostia and Roman religion more generally. This section will begin with the new insights afforded to Ostian scholarship. These implications will then be placed within a broader scope to assess their contribution to studies of Roman religion.

In regards to Ostian research, this thesis has demonstrated that the way in which religion is approached in relation to temples can move beyond architecturally focused studies to questioning the larger impact they had both in terms of the city's urban structure as well as its religious life. Although varying degrees of attention provided to temples at Ostia have addressed their presence within Ostia's urban landscape (Rieger, 2004; Steuernagel, 2004; White, 2012; Zevi, 2012; Arnhold, 2015), the ways in which their spatial organisation facilitated the construction of a larger religious landscape through ritual activity has not been previously approached. This thesis has shown that

processional rituals associated with different temples constructed a multi-faceted religious landscape that extended across Ostia's cityscape.

Second, the present research contributes to the growing interest in looking at Ostian rituals (Rieger, 2004; Bruun, 2009, 2016). In this thesis I move beyond questioning what rituals took place at Ostia to questioning how they effected the people that inhabited the city through virtue of the routes different processions took through the city. In order to more fully address this, a new methodological approach was developed that questioned how we can study the ways in which processional movement travelled throughout the city. The larger area traversed by these moving rituals ultimately shaped how both individual groups and the city more widely interacted with and understood particular rituals. The three different case studies have illustrated that the processions associated with different temples had various functions, ranging from the expression of a social group's collective identity, as was likely the case with the *Serapeum*, to a way of integrating the cityscape within a single urban ritual as occurred through the practice of processions associated with the *forum* temples. How these rituals subsequently interacted with the surrounding urban and social landscape begins to provide a complex view about the interaction that existed between ritual activity and Ostia's inhabitants.

A final contribution to Ostian studies is the approach taken to urban movement. This thesis is situated within a growing interest in developing methods to study movement within Ostia and Roman cities more broadly (Tilburg, 2007; Kaiser, 2011; Stöger, 2011a; Poehler, 2017). The present study moves beyond research that is focused upon the spatial configuration of the street network and visible indicators of movement such as wheel ruts. Instead, it has approach processional movement by questioning both the factors that influenced movement patterns as well as taking into account the people involved in the act of moving. In this way, a more informative understanding of a specific type of urban movement has been demonstrated.

Transitioning focus away from Ostia, the insights gained from the present study at Ostia have several implications for studies of Roman religion more generally. In terms of our understanding of urban processions, the present methodology has presented a novel approach for examining a phenomenon that has thus far received only limited attention. By questioning what influences the route taken by processions, this thesis has introduced a new approach that does not rely solely upon literary evidence in order to address the agency of processional rituals. A procession was a complex phenomenon that reflected the interplay that existed between individual cultic groups and the built environment. In order to question the nature of different processional rituals and how they contributed to the ritual atmosphere of a Roman town, attention needs to be drawn not only to cultic affiliations, but also the people involved in the ritual and its overall purpose. As illustrated at Ostia, the resulting routes are reflective of a complex religious landscape.

These processions also need to be considered within the context of the other religious activities taking place throughout the city, ranging from rituals occurring within a temple to small community practices around a neighbourhood altar. The occurrence of simultaneous processions would have contributed another dimension to a city's religious landscape. The joint occupancy of the street, and potentially different rituals all vying for the attention of spectators presents a complex picture of religious activity and its impact upon the cityscape. While this thesis has addressed processional rituals individually, we need to keep in mind that their occurrence was just one of the many activities occupying a city's streets at any given time. The larger ritual area and the routes they encompassed attest to how they were interconnected with the various aspects of urban life.

The general crowdedness of a city's streets and how this effects processional rituals more generally is likewise important. This thesis has preliminarily addressed the presence of other actors travelling along the streets within the agent-based model. However, because the focus was upon the movement of the procession itself, little consideration was given to the other people moving along the streets. In terms of the model that was developed, the pedestrian dynamics resulted in agents moving out of the way of the procession, therefore having no noticeable impact on a procession's movement patterns. However, in reality the negotiation of a city's streets by a procession would have been arguably more complex. Contending with cart and animal traffic as well as pedestrians all would have complicated the navigation of movement especially depending upon the size of a procession.

Ultimately, this study has shown that processions provide a method of assessing how a city's temples helped to construct a religious landscape through a complex interplay between ritual practice and daily life. This likewise provides a more nuanced understanding about the important role temple's played in creating a religious landscape that extended beyond its immediate boundaries. While the research undertaken throughout this thesis is specific to Ostia, the approach to studying urban processions can be applied to other towns. The application of a computational methodology allows for the study of what are often invisible rituals in Roman cities, enabling a better understanding about the interconnected nature of religious practices and the role temples played in this.

10.3 Limitations and Directions of Future Research

A range of limitations were encountered during the research process, many of which have the potential for future studies. The decision to study processional movement at Ostia resulted in the need to develop of multi-layered methodology that could address a topic that is virtually invisible within Ostia's archaeological record. The lack of literary sources attesting to processional movement meant that an alternative approach needed to be developed for studying possible processional routes. The focus upon the built environment, which is indicative of social activity and different groups of spectators, as a driving factor behind ritual movement drew upon current studies

of sacred movement to consider routes that are largely informed by the surrounding landscape (§2.5).

The first limitation is in regards to the classification of Ostia's excavated cityscape, which presented a dataset that could be used for assessing how the built environment shaped movement routes based upon their degree of importance for a passing procession. Every effort was made to classify buildings as accurately as possible, but there is a high degree of uncertainty surrounding the functionality of many of Ostia's buildings. Likewise, buildings would rarely have held only one function. In both these instances, a specific definition had to be decided upon. Limiting the potential categories to five, not counting buildings with unknown functions, enabled a reasonable dataset to work with, but it also results in an over simplification of the complexity of urban activity that would have occurred in these spaces. The difficulty of accurately assigning each building a specific definition has already been addressed in detail (Chapter 4), but it needs to be articulated that any change in the classifications as well as the extended street network will likely affect the results presented throughout this thesis. However, the purpose of this thesis was not to present absolute processional routes, rather, the methods served as a way to assess how we can study processional movement and by extension the larger ritual areas constructed in relation to various Ostian temples. While these classifications are a simplified understanding of each building's function and associated social activity, the results show that by altering the importance value of these five categories, movement routes varied. Processional rituals were fluid events, constantly changing and reacting to the dynamics of a city. The variability in the built environment's influence upon passing movement largely reflects this uncertainty. The present classifications will allow for future questions to be asked that build upon this approach as well as enabling more comprehensive study about how buildings and social activity, such as different types of commercial spaces, structure ritual movement.

A second limitation is in regards to the agent-based model. As the research for this thesis progressed, it became clear that agent-based modelling could serve as a way to question the degree to which the building classifications directly altered movement routes. It is also one of the few methods that can be used to look at "circular" processional movement, whereas the betweenness centrality results only provided a partial view into the most heavily used streets. It enabled the integration of procession dynamics into the study, transitioning focus away from a purely static representation of the city to considering the interactions that occurred between processional participants and other pedestrians. Its potential in generating possible processional routes has been discussed throughout the three case studies.

Further refinement of the group movement procedure would allow for several new avenues of research. In particular, looking at how the variation in processional participant numbers affects routes has important implications for routes taken by different sized processions. Another topic of consideration is how differing group size and general density of the pedestrian street population

effects movement routes. Building upon the mechanics of modelling group processional movement, the addition of cultic objects, such as carrying a cult statue of the Magna Mater on a *fericulum* (liter) or a ritual ship of Isis, would provide data for how the procession would have moved. Large objects that required multiple people to carry them restricts their movement capability. In terms of a ship, the angle of street corners could be a limiting factor it what streets could be taken by a procession. Assessment of how their movement is shaped by their ability to travel along certain streets would further refine possible movement areas throughout the city.

Engagement with other urban factors affecting processional movement such as street width or the impact of city gates is another important avenue for future research. While these topics cannot be used on their own to study processional movement with unknown routes, incorporating them within the present methodology used throughout this thesis could provide additional insight into route variation particularly as the number of processional participants changes. The joint effect these additional factors had in addition to the influence of the built environment would provide an even more detailed understanding about how processional movement is shaped by a city's urban landscape. This type of study would likewise have interesting implications for addressing processional rituals across different time periods and the extent to which a city's changing urban infrastructure shaped processional rituals.

A further avenue of research is specific to the movement dynamics of other pedestrians within Ostia. At present, two different urban street agents were included within the model. However, they showed to have virtually no impact upon the processional route as they just avoided the processional agents. Closer consideration about how Ostia's daily commercial street activity affected possible processions would be a fruitful direction for the present research to be taken. The ways in which commercial traffic occurring along the streets, the movement structured by activity occurring at both the river harbour and from the northern side of the Tiber, and movement entering and exiting through the city gates would constitute a more dynamic environment to assess how processions would have jointly occupied street space. The inclusion of additional street dynamic variables such as being aware of and/or avoiding streets with a high proportion of commercial traffic would serve to more accurately simulate the relationship between processional activity and other forms of daily movement. This could also include varying levels of activity depending upon the time of day. A second aspect is in regards to possible observers of a procession. Further assessment of where people might have gathered to watch a procession could help inform our understanding about possible processional routes.

Despite the various limitations discussed, this thesis has presented a novel approach for assessing the creation of a multi-faceted religious landscape at Ostia through the practice of processional rituals. The archaeological record of Ostia provided the context for this study, while comparative study of potential processional rituals associated with each of the temples enabled a movement

focused methodology. The integration of multiple different computational methodologies allowed for a detailed look at how processional movement could have navigated Ostia's streets. The narrative produced from these possible routes provides new insight into the larger ritual landscape that was constructed at Ostia. The integration of the three routes under consideration illustrated a complex interrelationship that extended well beyond individual temple precincts. While the exact nature of processional rituals at Ostia remains largely speculative, this integrated study, which has combined archaeological evidence with a multi-layered computational methodology, illustrates how research specific to Ostia's religious environment can be pushed beyond traditional studies focused upon temple structures and their identification.

In conclusion, the aims and objectives considered throughout this thesis and the methods developed for addressing them all helped to look at the relationship that existed between ritual activity and the people that inhabited Ostia. The results, ultimately, indicate that Ostia had an intricate religious landscape that was largely informed by the rituals that occurred within the city.

Appendix A Literary Passages

A.1 Selected literary passages relating to the Magna Mater

a) Juvenal *Satires* (6.512–530)

"Look! In comes the troupe of frenzied Bellona and the Mother of the Gods, along with an enormous eunuch, a face his perverted sidekick must revere. A long time ago now he picked up a shard and cut off his soft genitals. The noisy band and the common drums fall quiet in his presence and his cheeks are clothed in the Phrygian cap. In a booming voice he tells the woman to beware the arrival of September and the southerly winds, unless she purifies herself with a hundred eggs and presents him with her old russet-coloured dresses, to ensure that any serious or unforeseen disaster that's impending disappears into the clothes and atones for the whole year in one go. In the wintertime she'll break the ice, step down into the river and submerge herself three times in the morning Tiber, even cleansing her terrified head in those swirling waters. Then, naked and shivering, she'll crawl right across the Proud King's Field on bleeding knees. If white Io tells her to, she'll go to the ends of Egypt and bring back water fetched from sweltering Meroë to sprinkle in Isis' temple, towering next to the ancient sheepfold. You see, she thinks her instructions come from the voice of the Lady herself!" (*Translation by Braund, 2004*)

b) Livy (29.14.10–16)

"Publius Cornelius was ordered to go to Ostia with all the matrons to meet the goddess, and himself to receive her from the ship, and carrying her to land to turn her over to the matrons to carry. After the ship had reached the mouth of the river Tiber, in compliance with the order he sailed out into open water on a ship, received the goddess from her priests and carried her to land. The foremost matrons in the state, among whom the name of one in particular, that of Claudia Quinta, is conspicuous, received her. Claudia's repute, previously not unquestioned, as tradition reports it, has made her purity the more celebrated among posterity by a service so devout. The matrons passed the goddess from hand to hand in an unbroken succession to each other, while the entire city poured out to meet her. Censers had been placed before the doors along the route of the bearers, and kindling their incense, people prayed that gracious and benignant she might enter the city of Rome. It was to the Temple of Victory, which is on the Palatine, that they carried the goddess on the day before the Ides of April, and that was a holy day." (*Translation by Moore, 1949*)

c) **Ovid *Fasti* (4.179–214)**

"Let the sky revolve thrice on its never-resting axis; let Titan thrice yoke and thrice unyoke his steeds, straightway the Berecyntian flute will blow a blast on its bent horn, and the festival of the Idaean Mother will have come. Eunuchs will march and thump their hollow drums, and cymbals clashed on cymbals will give out their tinkling notes: seated on the unmanly necks of her attendants, the goddess herself will be borne with howls through the streets in the City's midst. The stage is clattering, the games are calling. To your places, Quirites! and in the empty law-courts let the war of suitors cease! I would put many questions, but I am daunted by the shrill cymbal's clash and the bent flute's thrilling drone. "Grant me, goddess, someone whom I may question." The Cybelean goddess spied her learned granddaughters and bade them attend to my inquiry. "Mindful of her command, ye nurslings of Helicon, disclose the reason why the Great Goddess delights in a perpetual din." So did I speak, and Erato did thus reply (it fell to her to speak of Venus' month, because her own name is derived from tender love): "Saturn was given this oracle: 'Thou best of kings, thou shalt be ousted of thy sceptre by thy son.' In fear, the god devoured his offspring as fast as they were born, and he kept them sunk in his bowels. Many a time did Rhea grumble, to be so often big with child, yet never be a mother; she repined at her own fruitfulness. Then Jove was born. The testimony of antiquity passes for good; pray do not shake the general faith. A stone concealed in a garment went down the heavenly throat; so had fate decreed that the sire should be beguiled. Now rang steep Ida loud and long with clangorous music, that the boy might pule in safety with his infant mouth. Some beat their shields, others their empty helmets with staves; that was the task of the Curetes and that, too, of the Corybantes. The secret was kept, and the ancient deed is still acted in mimicry; the attendants of the goddess thump the brass and the rumbling leather; cymbals they strike instead of helmets, and drums instead of shields; the flute plays, as of yore, the Phrygian airs." (*Translation by Frazer, 1931*)

d) Ovid *Fasti* (4.291–348)

"She had reached the mouth where the Tiber divides to join the sea and flows with ampler sweep. All the knights and the grave senators, mixed up with the common folk, came to meet her at the mouth of the Tuscan river. With them walked mothers and daughters and brides, and the virgins who tended the sacred hearths. The men wearied their arms by tugging lustily at the rope; hardly did the foreign ship make label against the stream. A drought had long prevailed; the grass was parched and burnt; the loaded bark sank in the muddy shallows. Every man who lent a hand toiled beyond his strength and cheered on the workers by his cries. Yet the ship stuck fast, like an island firmly fixed in the middle of the sea. Astonished at the portent, the med did stand and quake. Claudia Quinta traced her descent from Clausus of old, and her beauty matched her nobility. Chaste was she, though not reputed so. Rumour unkind had wronged her, and a false charge had been trumped up against her: it told against her that she dressed sprucely, that she walked abroad with her hair

dressed in varied fashion, that she had a ready tongue for gruff old me. Conscious of innocence, she laughed at fame's untruths; but we of the multitude are prone to think the worst. When she had stepped forth from the procession of the chaste matrons, and taken up the pure water of the river in her hands, she thrice let it drip on her label, and thrice lifted her palms to the heaven (all who looked on her thought that she was out of her mind), and bending the knee she fixed her eyes on the image of the goddess, and with dishevelled hair uttered these words: 'Thou fruitful Mother of the Gods, graciously accept thy suppliant's prayers on one condition. They say I am not chaste. If thou dost condemn me, I will confess my guilt; convicted by the verdict of a goddess, I will pay the penalty with my life. But if I am free of crime, give by thine act a proof of my innocency, and, chaste as thou art, do thou yield to my chaste hands.' She spoke, and drew the rope with a slight effort. My story is a strange one, but it is attested by the stage. The goddess was moved, and followed her leader, and by following bore witness in her favour: a sound of joy was wafted to the stars. They came to a bend in the river, where the stream turns away to the left: men of old named it the Halls of Tiber. Night drew on; they tied the rope to an oaken stump, and after repast disposed themselves to slumber light. At dawn of day they loosed the rope from the oaken stump; but first they set down a brazier and put incense on it, and crowned the poop, and sacrificed and unblemished heifer that had known neither the yoke nor the bull. There is a place where the smooth Almo flows into the Tiber, and the lesser river loses its name in the great one. There a hoary-labeled priest in purple robes washed the Mistress and her holy things in the waters of Almo. The attendants howled, the mad flute blew, and hands unmanly beat the leathern drums. Attended by a crowd, Claudia walked in front with joyful face, her chastity at last vindicated by the testimony of the goddess. The goddess herself, seated in a wagon, drove in through the Capene Gate; fresh flowers were scattered on the yoked oxen. Nasica received her. The name of the found of the temple has not survived; now it is Augustus; formerly it was Metellus." (*Translation by Frazer, 1931*)

e) Lucretius (2.589–668)

"First, the earth contains the first bodies from which the springs, rolling coolness along, industriously renew the illimitable sea, and she contains the source of fires. For in many places the crust of the earth burns aflame, while form the depths come the fiery eruptions of Etna. Then further she contains the means to raise up bright corn and fruitful trees for the races of mankind, the means to produce rivers and leaves and fruitful pastures for the mountain-ranging brood of wild beasts. Therefore she alone is called Great Mother of the gods, and Mother of the wild beast, and maker of our bodies.

She it is of whom the ancient and learned poets of the Greeks have sung, that seated in a chariot she drives a pair of lions, thus teaching that the great world is poised in the spacious air, and that earth cannot rest on earth. They have yoked in wild beasts, because any offspring however wild ought to

be softened and vanquished by the kindly acts of the parents. And they have surrounded the top of her head with a mural crown, because embattled in excellent .positions she sustains cities; which emblem now adorns the divine Mother's image as she is carried over the great earth in awful state. She it is whom different nations in their ancient ritual acclaim as the Idaean Mother, and give her troops of Phrygian, to escort her, because men declare that first from that realm came the corn, which then spread over the round world. They give her eunuchs, as wishing, to indicate that those who have violated the majesty of the Mother, and have been found ungrateful to their parents, should be thought unworthy to bring living offspring into the regions of light. The taut, tomtoms thunder under the open palm, the hollow cymbals sound around, horns with hoarse-echoing blare affright, hollow pipes prick up the spirits with their Phrygian cadences, martial arms show a front of violent fury, that they may amaze the ungrateful minds and impious hearts of the vulgar with fear through the goddess's majesty. Therefore as soon as she rides through mighty cities, silently blessing mankind with unspoken benediction, they bestrew the whole path of her progress with silver and copper, enriching it with bounteous largess, and snow down rose-flowers in a shower, over-shadowing the Mother and her escorting troop. Here an armed group, whom the Greeks name the Curetes, whenever they, sport among the Phrygian bands and leap up rhythmically, joyful with blood, shaking their awful crests with the nodding of their heads, recall the Dictaean Curetes, who are said once upon a time to have concealed that infant wailing of Jupiter in Crete; when, boys round a boy in rapid dance, clad in armour, they clashed bronze upon bronze to a measure, that Saturn might not catch him and cast him into his jaws and plant an everlasting wound in the Mother's heart. For this reason they escort the Great Mother armed; or else because they indicate the command of the goddess that with arms and valour they be ready to defend their native land, and to be both protection and pride to their parents.

But well and excellently as all this is set forth and told, yet it is far removed from true reasoning. For the very nature of divinity must necessarily enjoy immortal life in the deepest peace, far removed and separated from our affairs; for without any pain, without danger, itself mighty by its own resources, needing us not at all, it is neither propitiated with services nor touched by wrath. The earth indeed lacks sensation at all times, and only because it receives into itself the first-beginnings of many things does it bring forth many in many ways into the sun's light. Here if anyone decides to call the sea Neptune, and corn Ceres, and to misapply the name of Bacchus rather than to use the title that is proper to that liquor, let us grant him to dub the round world Mother of the Gods, provided that he forbears in reality himself to infect his mind with base superstition.

Often therefore cropping grass from one field, are woolly sheep and the warrior breed of horses and horned herds of cattle, beneath the same canopy of heaven, and quenching thirst from one river of water, which live each in a different shape and each race keeps its parents' nature and imitates their ways after its kind: so great a diversity of matter is there in each kind of herbage, so great in each river." (*Translation by Rouse, 1924*)

f) Herodian (1.10.5–7)

"On a fixed date in early spring each year the Romans celebrate a festival in honour of the mother of the gods. All the tokens of people's wealth and the treasures of the imperial house—things of marvellous material and workmanship—are paraded in honour of the goddess. Free licence is given to all kinds of revels; anyone can disguise himself as any character he wants; there is no position so important or exclusive that someone cannot disguise himself in that dress and play the fool by concealing his true identity, making it difficult to tell the real person from the man in fancy dress. This was the occasion Maternus thought was an ideal opportunity to get away with the plot. He hoped that if he put on the disguise of a praetorian, and armed his followers in the same way, he could mingle with the crowd of guards, apparently taking a part in the procession. Then when people were obviously off their guard, he would rush upon Commodus and cut him down. But Maternus was betrayed by some of his men, who went ahead to Rome and revealed the plot. (It was jealousy that drove them to it—the prospect of having an emperor in place of a robber chief.) Before the day of the festival Maternus was arrested and beheaded, while his fellow-conspirators received the punishments they deserved. Commodus sacrificed to the goddess and conceded a public thanksgiving before completing the festival and joining in the rejoicing and procession of the goddess. During the festival the people had a public celebration for the safety of the emperor." (*Translation by Whittaker, 1969*)

g) Ammianus Marcellinus (23.3.7)

"Then delaying for a time, in order to confirm the omen by favourable signs from victims, he came to the fortified camp of Davana at the source of the river Belias, a tributary of the Euphrates. Here we rested and took food, and on the following day arrived at Callinicum, a strong fortress, and most welcome because of its rich trade. There, on the twenty-seventh of March, the day on which at Rome the annual procession in honour of the Mother of the Gods takes place, and the carriage in which her image is carried is washed, as it is said, in the waters of the Almo, he celebrated the usual rites in the ancient fashion and spent the night in peaceful sleep, happy and full of confidence." (*Translation by Rolfe, 1940)*

h) Julianus *Orationes* (5.158–160)

"When they learned the response of the oracle, the inhabitants of Rome, that city beloved of the gods, sent an embassy to ask from the kings of Pergamon[3] who then ruled over Phrygia and from the Phrygians themselves the most holy statue of the goddess. And when they had received it they brought back their most sacred freight, putting it on a broad cargo-boat which could sail smoothly over those wide seas. Thus she crossed the Aegean and Ionian Seas, and sailed round Sicily and over the Etruscan

Sea, and so entered the mouth of the Tiber. And the people and the Senate with them poured out of the city, and in front of all the others there came to meet her all the priests and priestesses in suitable attire according to their ancestral custom. And in excited suspense they gazed at the ship as she ran before a fair wind, and about her keel they could discern the foaming wake as she cleft the waves. And they greeted the ship as she sailed in and adored her from afar, everyone where he happened to be standing. But the goddess, as though she desired to show the Roman people that they were not bringing a lifeless image from Phrygia, but that what they had received from the Phrygians and were now bringing home possessed greater and more divine powers than an image." *(Translation by Wright, 1913)*

A.2 Selected literary passages relating to Serapis

a) Apuleius *Metamorphoses* (11.9–11; 16–17)

"In the midst of these joyful, crowd-pleasing pageants, which wandered all over the place, the special procession of the saviour goddess was now getting under way. There were women gleaming with white vestments, rejoicing in their varied insignia, garlanded with flowers of spring; they strewed the flowers in their arms along the path where the sacred company would pass. Others had shining mirrors reversed behind their backs, to show homage to the goddess as she passed; or carried ivory combs, and moving their arms and curving their fingers pretended to shape and comb the royal tresses. Still others shook out drops of delightful balsam and other ointments to sprinkle the streets. Besides these, a great throng of both sexes carried lamps, torches, candles, and other sorts of artificial light to honour the source of the heavenly stars. Next a lovely orchestra of pipes and flutes played sweet melodies. They were followed by a beautiful chorus of picked youths, brightly shining in their snow-white holiday garb, repeating a charming hymn composed and set to music by a talented poet with the Muses' help; the text gave interim preludes to the "Greater Vows." There also came pipers dedicated to mighty Sarapis, who, on transverse pipes held close to the right ear, repeated the traditional melody of the god and his temple; and public heralds who kept warning the people to clear the way for the holy procession.

Then the crowds of those initiated into the divine mysteries came pouring in, men and women of every rank and age. They shone with the pure radiance of their linen robes; the women's hair was anointed and wrapped in a transparent covering, while the men's heads were completely shaven and their skulls gleamed brightly—earthly stars of the great religion. All together made a shrill ringing sound with their sistrums of bronze and silver, and even gold. Next came the foremost high priests of the cult, tightly garbed in white linen cinctured at the breast and reaching to their feet. They carried before them the distinctive attributes of the most powerful gods. The first held out a brightly shining lamp, not at all resembling our lamps which provide light for night banquets, but a golden boat which

kindled a rather large flame in an opening at its centre. The second was similarly clad, but carried with both hands an altar, that is, "a source of help", whose special name was derived from the helping providence of the supreme goddess. Then came the third, holding aloft a palm branch made of fine gold leaves, and also a caduceus like Mercury's. The fourth showed as a symbol of justice a deformed left hand with palm extended, which, because of its natural slowness and lack of cleverness or dexterity, seemed more appropriate for justice than a right hand; he was also carrying a small golden vessel rounded like a breast, from which he poured libations with milk. The fifth carried a golden winnowing-fan woven from golden twigs; and the sixth carried an amphora.

Immediately thereafter came the gods, deigning to walk with human feet. First that awesome messenger between the gods above and those below the earth, with a face now black and now gold, tall, raising high his dog's neck: Anubis, carrying a caduceus in his left hand and brandishing a green palm-branch in his right. Immediately in his footsteps followed a cow reared to an upright posture, a cow, the fertile symbol of the divine mother of all, which, supported on his shoulders, one of the priesthood carried with proud and rhythmic steps. Another carried a basket containing secret attributes, concealing hidden objects of magnificent sanctity inside. Another carried in his happy arms the venerable image of the supreme deity. This did not resemble any domestic animal, or bird, or wild beast, or even the human form itself, but by an ingenious discovery inspired reverence by its very strangeness, an ineffable symbol of a somehow deeper sanctity which must be cloaked in great silence. But it was formed of flashing gold in exactly this manner: it was a small urn, skilfully hollowed out, perfectly round at the bottom, its outer surface engraved with strange Egyptian images. Its mouth was raised only a little and stretched out into a beak, projecting in a long spout. To the opposite side was attached a handle extending far back in a wide curve; on top of the handle sat an asp in a coiled knot, rearing high the striped swelling of its scaly neck.

------ (11.16–17) ------

The good priest, breathing laboriously after this prophetic utterance, fell silent. At once I joined the ceremonial line of march and walked along in attendance on the shrine. The whole city knew about me and I was the centre of attention as people pointed their fingers and nodded at me. Everyone was talking about me: "He is the one who was transformed back into a human being today by the majestic force of the all-powerful goddess. How fortunate he is, by Hercules, and thrice blessed! It is doubtless because of the innocence and faithfulness of his past life that he has earned such remarkable patronage from heaven that he was in a manner reborn and immediately engaged to the service of her cult."

In the meantime, amid the tumult of festive invocations, we had slowly advanced and were now approaching the seashore. We arrived at the very spot where as an ass I had stabled the day before. There, after the images of the gods had been set in their proper places, the chief priest consecrated a ship, which was constructed with fine craftsmanship and decorated all over with marvellous Egyptian pictures. He took a lighted torch, an egg, and sulphur, uttered prayers of great solemnity with reverent

lips, and purified the ship thoroughly, naming it and dedicating it to the goddess. The gleaming sail of this auspicious barque bore an inscription woven in letters of gold, whose text renewed the prayer for prosperous navigation during the new sailing season. Now rose the mast, a round pine, high and resplendent, visible from far off with its conspicuous masthead. The stern curved in a goose-neck and flashed light from its coating of gold-leaf, and the entire hull bloomed with highly polished, pale citron-wood. Then all the people, worshippers and uninitiated alike, outdid one another in loading the ship with baskets heaped with spices and similar offerings, and on the waves they poured libations of grain-mash made with milk. When the ship was laden with generous gifts and auspicious sacrifices, it was untied from its anchor-ropes and offered to the sea, as a mild breeze arose especially for it. After its course had taken it so far that we could no longer clearly make it out, the bearers of the sacred objects took up again what each had brought and joyfully set out on the way back to the shrine, preserving the order and fine appearance of their procession.

When we arrived at the temple itself, the chief priest and those who carried the divine images and those who had already been initiated into the awesome inner sanctuary were admitted into the goddess's private chamber, where they arranged the lifelike effigies in their prescribed places. Then one of this group, whom everyone called the scribe, stationed himself before the door and summoned the company of the pastophori—the name of a consecrated college—as if calling them to an assembly. Then from a lofty platform he read aloud from a book verbatim, first pronouncing prayers for the prosperity of the great Emperor, the Senate, the knights, and the entire Roman people, for the sailors and ships under the rule of our world-wide empire. Then he proclaimed, in the Greek language and with Greek ritual, the opening of the navigation season. The crowd's acclamation which followed confirmed that his words had been auspicious to all. Then, steeped in joy, the people brought forward boughs and branches and garlands and kissed the feet of the goddess, who stood on the steps, fashioned of silver. They then dispersed to their own homes. For my part, my heart would not let me go a nail's breadth away from that spot, but I continued to concentrate on the goddess's image as I pondered my former misfortunes." (*Translation by Hanson, 1996*)

b) *Historia Augusta Commodus* (9)

"He practised the worship of Isis and even went so far as to shave his head and carry a statue of Anubis. In his passion for cruelty he actually ordered the votaries of Bellona to cut off one of their arms, and as for the devotees of Isis, he forced them to beat their breasts with pine-cones even to the point of death. While he was carrying about the statue of Anubis he used to smite the heads of the devotees of Isis with the face of the statue. He struck with his club, while clad in a woman's garment or a lion's skin, not lions only, but many men as well. Certain men who were lame in their feet and others who could not walk, he dressed up as giants, encasing their legs from the knee down in wrappings and bandages to make them look like serpents, and then despatched them with his

arrows. He desecrated the rites of Mithra with actual murder, although it was customary in them merely to say or pretend something that would produce an impression of terror." (*Translation by Magie, 1921*)

c) *Historia Augusta Pescenius Niger* (6.8-9)

"On the rounded colonnade in the garden of Commodus he is to be seen pictured in the mosaic among Commodus' most intimate friends and performing the rites of Isis. To these rites Commodus was so devoted as even to shave his head, carry the image of Anubis, and make every one of the ritualistic pauses in the procession." (*Translation by Magie, 1921*)

Appendix B Building Classifications

This appendix presents the catalogue of buildings that were in existence during the 2nd century AD. It details how all the ground floor and upper storey buildings were classified for purposes of this thesis.

Reference Abbreviations:

Bak94 = (Bakker, 1994)

Bak99 = (Bakker, 1999)

Bec61 = (Becatti, 1961)

Bec54 = (Becatti, 1954)

Boer85 = (Boersma, 1985)

Cooley99 = (Cooley, 1999)

DeL05 = (DeLaine, 2005)

DeL04 = (DeLaine, 2004)

DeL2002 = (DeLaine, 2002)

Flo17 = (Flohr, 2017)

Hein2002 = (Heinzelmann and Martin, 2002)

Heres = (Heres, 1982)

Herm82 = (Hermansen, 1982)

Koc99 = (Kockel, 1992)

Meig = (Meiggs, 1973)

Pac71 = (Packer, 1971)

Pav = (Pavolini, 2006)

Ric71 = (Rickman, 1971)

Rieg = (Rieger, 2004)

Ruyt83 = (De Ruyt, 1983)

SO = *Scavi di Ostia I* (Calza, 1953)

Spz = (Spurza, 1999)

Stevens 05 = (Stevens, 2005)

Stog = (Stöger, 2011a)

S/R 1996 = (Scrinari and Ricciardi, 1996)

Zev99 = (Gallina Zevi *et al.*, 1996)

Building ID	Building Name	Date	Ground Floor Classification	Upper Storey Classification	References
I	Forum portico	Hadrianic	public; portico	n/a	*SO*: 235; Meig: 136
I	Forum portico	Hadrianic	public; portico	n/a	*SO*: 235; Meig: 136
I	Portico	Hadrianic	public; portico	n/a	*SO*: 235; Meig: 136
I	Forum portico	Hadrianic	public; portico	n/a	*SO*: 235; Meig: 136
I.-.-	Circular structure [sacello dei Lares Augusti]	Trajanic	public	n/a	Pav: 105; *SO:* 71
I.-.-	Bivio del Castrum	1st c. BC	public	n/a	Pav: 117
I.-.1	Capitolium	c. 120 AD	religious	n/a	Pav: 103–4; *SO*: 129, 235
I.-.2	Tempio di Roma e Augusto	13-37 AD	religious	n/a	Pav: 106–7; *SO*: 119, 234
I.0.0	Palazzo Imperiale	145–150 AD	Public; bath		Pav: 129–131; Spz: 133
I.i.0	Piazza dei Lari	Claudian	religious	n/a	Pav: 86–7; Meig: 222
I.i.4	Caseggiato	Hadrianic	commercial; shops	?	Pac71: 80; Pav: 79; *SO*: 235
I.ii.2a	Caseggiato del Pantomimo Apolausto shops 2	120 AD	commercial; shops	?	Pac71: 80; DeL5: 35; *SO*: 120, 235
I.ii.2b	Caseggiato del Pantomimo Apolausto	120 AD	commercial; market	?	Pac71: 80; DeL5: 35; *SO*: 120, 235
I.ii.2c	Caseggiato del Pantomimo Apolausto shops	120 AD	commercial; shops	?	Pac71: 80; DeL5: 35; *SO*: 120, 235
I.ii.5	Caseggiato del Termopolio	c. 120 AD	commercial; shops	residential	Pac71: 80, 127; *SO*: 132, 235; Meig: 428
I.iii.1	Caseggiato dei Molini	Hadrianic	production; bakery	commercial	Pac71: 80; Bak94; Pav: 81; Meig: 274
I.iii.2	Sacello del Silvano	Hadrianic	religious; shrine	n/a	Pav: 82
I.iii.3	Caseggiato di Diana	150 AD	residential	residential	Pac71: 133; *SO*: 142, 216, 237; Herm82: 48; Meig: 241
I.iii.4	Caseggiato di Diana shops	150 AD	commercial; shops	residential	*SO*: 216, 237; Herm82: 47; Pav: 87
I.iii.5a	Caseggiato del Mitreo di Menandro shops	Hadrianic	commercial; shops	residential	Pac71: 80; Meig: 442
I.iii.5b	Caseggiato del Mitreo di Menandro	Hadrianic	residential	residential	Pac71: 80; Meig: 442
I.iii.6	Caseggiato	Hadrianic	commercial	?	*SO:* 235

Building ID	Building Name	Date	Ground Floor Classification	Upper Storey Classification	References
I.iv.1	Botteghe	Hadrianic	commercial; shops	residential?	Pac71: 80; Pav: 87; *SO:* 235
I.iv.2a	Domus di Giove e Ganimede shops	Hadrianic	commercial; shops	residential	Pac71: 138; *SO*: 131, 235; Meig: 246–7
I.iv.2b	Insulia di Giove e Ganimede	Hadrianic	residential	residential	Pac71: 138; *SO*: 131, 235; Pav: 89; Meig: 246–7
I.iv.3	Insula di Ballo Fanciullo	Hadrianic	residential	residential	Pac71: 141; *SO*: 13, 216, 235; DeL4; Pav: 90–1
I.iv.4	Insula dei Dipinti	Hadrianic	residential	residential	*SO*: 216, 235; Herm82: 47; Pav: 88–9; Meig: 246
I.iv.5	Caseggiato dei Doli	late Hadrianic	production	commercial	Pav: 91; Meig: 274
I.ix.1a	Caseggiato dietro la Curia shops	c. 12 AD	commercial; shops	residential	Pav: 99; *SO*: 235
I.ix.1b	Caseggiato dietro la Curia	c. 12 AD	residential	residential	Pav: 99; *SO*: 235
I.ix.2	Caseggiato	120 AD	commercial; shops	residential	Bak99: 95–7; *SO*: 182–3; Pav: 100
I.ix.3a	Caseggiato del Larario shops	120 AD	commercial; shops	residential	Pac71:154; *SO*: 132, 217, 235; Pav: 113; Meig: 241
I.ix.3b	Caseggiato del Larario	120 AD	residential	residential	Pac71: 154; *SO*: 132, 217, 235; Pav: 113; Meig: 241
I.ix.4	Curia	81–117 AD	public; admin?	?	Herm82: 79–81; Pav 104–5; Meig: 133
I.v.1	Botteghe	c. 120 AD	commercial; shops	residential	Pac71: 80, 141; *SO*: 216, 235
I.v.2a	Portico est di Pio IX	c. 119–123 AD	public; portico	n/a	Pac71: 80, 144; *SO*: 216, 235
I.v.2b	Portico di Pio IX	c. 119–123 AD	commercial; shops	residential	Pac71: 80, 144; *SO*: 216, 235
I.v.2c	loggia	c. 119–123 AD	commercial; market; religious	n/a	DeL05
I.vi.1a	Portico ovest di Pio IX	c. 119–123 AD	public; portico	n/a	Pac71: 80, 144; *SO*: 216, 235
I.vi.1b	Portico di Pio IX	c. 119–123 AD	commercial; shops	residential	Pac71: 80, 144; *SO*: 216, 235
I.vi.1c	loggia	c. 119–123 AD	commercial; market/religious	n/a	DeL05
I.vi.2	Caseggiato del Balcone a mnsole	Hadrainic	commercial; shops	residential	Pac71: 80; Pav: 98
I.vii.1	Caseggiato dei Misuratori del Grano	120 AD	commercial; shops	commercial?	Pac71: 80, 148; *SO*: 216, 235; Pav: 98

Building ID	Building Name	Date	Ground Floor Classification	Upper Storey Classification	References
I.vii.2	Caseggiato dei Misuratori del Grano portico	120 AD	public; portico	n/a	Pac71: 80, 148; *SO*: 216, 235; Pav: 98
I.viii.10	Botteghe	120 AD	commercial; shops	residential?	Pac71: 81
I.viii.1a	Piccolo Mercato portico	120 AD	public; portico	n/a	*SO*: 235; Meig: 135
I.viii.1b	Piccolo Mercato	120 AD	commercial; storage	commercial	Pac71: 81; Herm82: 227–35; Pav: 98; Meig: 135
I.viii.2	Horrea	119–120 AD	commercial; storage	commercial	Ric71: 293–7; Herm82: 230; Pav: 99
I.viii.3	Horrea Epagathiana et Epaphroditiana	145–150 AD	commercial; storage	residential	Pac71: 152; *SO*: 142, 237; Herm82: 47–8; Pav: 114–5; Meig: 76
I.viii.4	Caseggiato	Hadrianic	commercial; shops	residential	*SO*: 235
I.viii.5	Caseggiato	Trajanic	commercial; shops	residential	*SO*: 234
I.viii.6	Caseggiato	Trajanic	commercial; shops	residential	Pac71: 81; *SO*: 236
I.viii.7	Caseggiato	Hadrianic	commercial; shops	residential	Pac71: 81; *SO*: 235
I.viii.8	Botteghe	Antoninus Pius	production?	residential	*SO*: 237
I.viii.9	Botteghe	Antoninus Pius	commercial; shops	residential	*SO*: 237
I.x.1	Taberne Repubblicane	25–15 BC	commercial; shops	residential	*SO*: 233
I.x.2	Caseggiato	end 1st c BC; alterations 2nd c. AD	commercial; shops	residential	*SO*: 234
I.x.3	Officina Stuppatoria	Trajanic (standing architecture 222–235 AD)	commercial; shops	?	Herm82: 61–2; *SO*: 234
I.xi.4a	Portico	Hadrianic	public; portico	n/a	*SO*: 236
I.xi.4b	Portico	Hadrianic	commercial; shops	residential	*SO*: 236
I.xi.5	Basilica	81–117 AD	public	public	Pav: 105; *SO*: 234; Meig: 66
I.xii.10a	Caseggiato a tabernae	138–161 AD	commercial; shops	commercial?	Herm82: 135
I.xii.10b	Caseggiato a tabernae portico	138–161 AD	public; portico	n/a	*SO*:
I.xii.11	Portico	117–138 AD	public; portico	?	*SO*:
I.xii.1a	Caseggiato dei Triclini shops1	120 AD	commercial; shops	association	Pac71: 159; *SO*: 132, 217, 235; Herm82: 6; Pav:111–12; Meig: 244

Building ID	Building Name	Date	Ground Floor Classification	Upper Storey Classification	References
I.xii.1b	Caseggiato dei Triclini	120 AD	public; association	association	Pac71: 159; *SO*: 132, 217, 235; Herm82: 6; Pav:111–12; Meig: 244
I.xii.1c	Caseggiato dei Triclini shops2	120 AD	commercial; shops	association	Pac71: 159; *SO*: 132, 217, 235; Herm82: 6; Pav:111–12; Meig: 244
I.xii.3	Exedra	Standing 4th c. AD; previous Hadrianic	production; bakery	?	*SO:* 238; Bak99: 98
I.xii.4	Caseggiato della Cisterna	Hadrianic	production; bakery	?	*SO*: 235; Bak99: 98
I.xii.5	Caseggiato	Hadrianic	commercial	?	*SO*: 236
I.xii.6	Terme del Foro	third quarter of 2nd c. AD	public; bath	public	Pav: 107–10; Meig: 411–15
I.xii.6.6	Terme del Foro shrines	third quarter of 2nd c. AD	religious; shrine		Pav: 110; Meig: 411–15
I.xii.7a	Botteghe portico	Antoninus Pius	public; portico	n/a	*SO*: 237
I.xii.7b	Botteghe	Antoninus Pius	commercial; shops	?	*SO*: 237
I.xii.8a	Sede di una corporazione	161–180 AD	commercial; shops	?	Herm82: 83; *SO:* 237; Pav: 110
I.xii.8b	Sede di una corporazione	161–180 AD	public; association	association	Herm82: 83; *SO:* 237; Pav: 110
I.xii.9	Edificio	138–161 AD	commercial; shops	?	*SO:* 237
I.xiii.1	Horrea	Trajanic/Hadrianic	commercial; storage	commercial	Bak99: 113; Pav: 215; *SO*: 235
I.xiii.2	Caseggiato	Hadrianic	unknown	?	*SO*: 235
I.xiii.3	Fullonica, 3 shops	Hadrianic	production; fullery	production	Flo17: 47–8
I.xiii.4	Molino	100–125 AD	production; workshop	production	Bak99: 39–58; Pav: 214; *SO:* 234
I.xiii.6	Domus delle Gorgoni	2nd – 4th c. AD	commercial	commercial	Pav: 213; Meig: 256
I.xiv.1	Caseggiato	Early Hadrianic	commercial; shops	residential	*SO:*
I.xiv.2a	Caseggiato del Mosaico del Porto portico	Commodus	public; portico	n/a	Pav: 117
I.xiv.2b	Caseggiato del Mosaico del Porto portico2	Commodus	public; portico	n/a	Pav: 117
I.xiv.2c	Caseggiato del Mosaico del Porto	Commodus	commercial	residential	Pav: 117
I.xiv.3	Casa	Commodus	residential	residential	Pav: 122
I.xiv.4	Caseggiato	Trajanic	residential	residential	*SO:* 238; Herm82: 48

Building ID	Building Name	Date	Ground Floor Classification	Upper Storey Classification	References
I.xiv.5	Domus di Amore e Psiche	current house 4th c AD	commercial; shops	residential	Pav: 122–3; Meig: 259–60
I.xiv.6	Caseggiato	Hadrianic	commercial; shops	residential?	*SO*: 235
I.xiv.7	Caseggiato	Trajanic	commercial; shops	residential	*SO*: 235
I.xiv.8a	Terme del bagnino Buticosus shops	Trajanic	commercial; shops	public	Pav: 123–4; *SO:* 234; Meig: 133
I.xiv.8b	Terme del bagnino Buticosus	Trajanic	public; baths	public	Pav: 123–4; *SO:* 234; Meig: 133
I.xiv.9a	Caseggiato shops	Trajanic	commercial; shops	residential	*SO*: 235
I.xiv.9b	Caseggiato	Trajanic	residential	residential	*SO*: 235
I.xix.1	Aula dei Mensores	Trajanic	public; association	n/a	Herm82: 65–6; Pav: 127–8
I.xix.2	Tempio dei Mensores	Trajanic	religious	n/a	Pav: 127; Herm82: 65–6
I.xix.3	Aula dei Mensores	Trajanic	public; association	n/a	Pav: 127; Herm82: 65–6; Pav: 127–8; Meig: 324
I.xix.4	Horrea dei Mensores	Trajanic	commercial; storage	commercial	Pav: 127; Herm82: 228; Meig: 133
I.xv.1	Edificio pubblico	Trajanic	unknown	unknown	*SO:* 234
I.xv.2	Tempio Tetrastilo	2nd c. BC	religious	n/a	Pav: 118
I.xv.5	Tempio di Ercole	1st c. BC	religious	n/a	Pav: 119; *SO:* 234; Meig: 347
I.xv.6	Tempio dell'Ara Rotonda	end 1st c. AD	religious	n/a	Pav:121; Meig: 37, 535
I.xvi.2	Caseggiato	late Hadrianic	commercial	?	*SO*: 235
I.xvii.1	Caseggiato con fornace per laterizi	Hadrianic	commercial; shops	residential	Pav: 127; *SO*: 235
I.xvii.2	Terme del Mitra	Hadrianic, Severan modifications	public; baths	public	Pav: 125–6; *SO*: 235; Meig: 397
I.xx.1	Horrea	Hadrianic	commercial; storage	commercial	Ric71: 71; Herm82: 228; *SO*: 235
II.i.1	Caseggiato del cane Monnus	Trajanic	commercial; shops	residential	Pav: 53–4; *SO:* 235
II.ii.1	Magazzini Repubblicani	1st c BC	commercial; shops	commercial	Pav: 54–5
II.ii.3a	Terme dei Cisiarii	Hadrianic	public; baths	public	Pav: 55–6; Meig: 419
II.ii.3b	Terme dei Cisiarii shops	Hadrianic	commercial; shops	public	Pav: 55–6; Meig: 419
II.ii.4	Sacello	Hadrianic	religious	n/a	Pav: 56; *SO:* 235
II.ii.6a	Portico del Tetto spiovente shops	Hadrianic	commercial; shops	commercial	*SO:* 235; Pav: 57
II.ii.6b	Portico del Tetto spiovente	Hadrianic	public; portico	n/a	*SO:* 235; Pav: 57

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II.ii.7	Horrea Antoniniani	Commodus	Commercial; storage	commercial	Ric71:293–7; Pav: 57
II.iii.1	Edificio	Hadrianic	unknown	unknown	*SO:* 236
II.iii.3	Casa di Via dei Vigili	Hadrianic	residential	residential	DeL04; *SO:* 236
II.iv.1	Portico di Nettuno	Hadrianic	public; portico	public; portico	*SO:* 236; Zev99; Pav: 58
II.iv.1	Portico di Nettuno shops	Hadrianic	public; portico	public; portico	Zev99; Pav: 58; *SO:* 236
II.iv.2	Terme di Nettuno	Hadrianic	public; baths	public	Zev99; Pav: 58–60; *SO:* 236; Meig: 409–11
II.ix.1	Ninfeo	Antonine?	public		*SO:* 237
II.ix.2	Caseggiato	Antonine	commercial; shops	residential?	
II.ix.4	Tempietto repubblicano	80–50 BC	religious	n/a	Pav: 77
II.ix.5	Edificio	Claudian	unknown	unknown	
II.ix.6	Edificio	Claudian	commercial; shops	?	
II.ix.7	Grandi Horrea	Claudian	commercial; storage	commercial	Ric71:293-7; Herm82: 228; Meig:132, 536
II.v.1a	Caserma dei Vigili	Hadrianic	Public; admin	public; admin	Herm82: 224; Pav: 61–2; *SO:* 236
II.v.1b	Caserma dei Vigili shos	Hadrianic	commercial; shops	n/a	Herm82: 224; Pav: 61–2; *SO:* 236
II.v.2	Augusteo	Severan	religious	n/a	Herm82: 224; *SO:* 236
II.vi.3	Casa dell'Ercole Bambino	Hadrianic	commercial; shops	residential	*SO:* :220, 236; Herm82:48; Pav: 65
II.vi.4	Casa dell'Ercole Bambino	Hadrianic	residential	residential	*SO:* 220, 236; Herm82:48; Pav: 65
II.vi.5	Casa del Soffitto Dipinto	Commodus	commercial; shops	residential	DeL04; Herm82: 48; Pav: 64–5; *SO:* 236; Meig: 246–7
II.vi.6	Casa del Soffitto Dipinto	Commodus	residential	residential	DeL04; Herm82: 48; Pav: 64–5; *SO:* 236; Meig: 246–7
II.vi.7	Caseggiato delle Fornaci	Hadrianic	production; bakery	commercial; storage	Bak99: 84–9; Pav: 64; *SO:* 236
II.vii.2a	Teatro protico	end 1st c. BC	public; portico	public; portico	Cal53; Cooley99; Pav 68–70; Meig: 420–5
II.vii.2b	Teatro shops	end 1st c. BC	commercial; shops	n/a	Cooley99; Pav: 68–70; Meig: 420–5
II.vii.2c	Teatro	1st c BC	public	public	Cooley99; Pav: 68–70; Meig: 420–5
II.vii.3	Sacrello dell'Ara dei Gemelli	late Hadrianic?	religious; shrine	n/a	Pav: 73
II.vii.4	Piazzale delle Corporazioni	Augustan	commercial	?	Herm82: 84–5; Pav: 70-3
II.vii.4b	Piazzale delle Corporazioni	Augustan	public	n/a	Herm82: 84–5; Pav: 70-3
II.vii.5	Tempeo	81–96 AD	religious	n/a	Herm82: 84–5; Pav: 70

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II.vii.6	Ninfeo ai lati del teatro	81–96 AD	public	n/a	Pav: 67; *SO:* 234
II.vii.7	Ninfeo ai lati del teatro	81–96 AD	public	n/a	Pav: 67; *SO:* 234
II.viii.1a	Botteghe protico	Hadrianic	public; portico	m/a	*SO:* 235
II.viii.1b	Botteghe	Hadrianic	commercial; shops	?	*SO:* 235
II.viii.2	Quattro Tempietti	2nd c BC -	religious	n/a	Pav: 76; Meig: 141
II.viii.3	Ninfeo	Hadrianic	public	n/a	*SO:* 235
II.viii.4	Sacello di Giove	1st c BC	religious; shrine		*SO:* 234
II.viii.5	Domus di Apuleio	remod. post 148	residential	residential	Pav: 73–4; Meig: 351
II.viii.6	Mitreo delle Sette Sfere	early 2nd c AD	religious; mithras	n/a	Pav: 74–5; Meig: 371
II.viii.7	Caseggiato	Hadrianic	production	?	*SO:* 235
II.viii.8	Caseggiato	Hadrianic	production	residential	*SO:* 235; Herm82: 48
II.viii.9	Caseggiato	Hadrianic	commercial	?	*SO:* 235
II.xi.1	Fullonica	Hadrianic	production; fullery	?	Flo17; Pav: 63; *SO:* 235
II.xi.2	Caseggiato della Fullonica	Hadrianic	production	n/a	
II.xii.0	Edificio a cortile portico	Hadrianic	unknown	unknown	
III.i.1	Caseggiato	Marcus Aurelius	commercial; shops	residential	*SO:* 237
III.i.10	Edificio	Trajanic	commercial; shops	residential	*SO:* 126, 235; Her82: 149; S/R96: 97
III.i.11	Caseggiato	Trajanic	commercial; shops	?	Rose05: apx33
III.i.12	Insula	Trajanic	residential	n/a	*SO:* 126, 235; S/R96: 98
III.i.14	Botteghe	Hadrianic	commercial; shops	residential	*SO:* 126, 137, 222, 235; S/R96: 98-9
III.i.15	Caseggiato	Hadrianic	commercial; storage	res?	*SO:* 126, 137, 222, 235; S/R96: 98-9
III.i.2	Caseggiato	Trajanic	commercial; shops	?	*SO:* 127, 234–5; S/R 1996: 91
III.i.3	Terme della Basilica Cristiana	Trajanic	public; bath	public	*SO:* 127; Bec 61: 92–3; S/R 1996: 161–2
III.i.4	Basilica Christiana early shops	Trajanic	commercial; shops	n/a	*SO:* 110, 234, 238; Boe85: 213; Pav: 145–6; Meig: 397
III.i.5	Caseggiato	Trajanic	commercial; shops	residential	*SO:* 110, 127, 235; S/R 96: 40
III.i.6a	Domus and Mitreo delle Pareti Dipinte shops	2nd c BC; modified Aug	commercial; shops	?	*SO:* 110, 233; Bec 54, 59–68; Pav: 144–5; Meig: 371–2

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III.i.6b	Domus and Mitreo dell Pareti Dipinte	2nd c BC; modified Aug	commercial; shops	?	*SO:* 110, 233; Bec 54, 59–68; Pav: 144–5; Meig: 371–2
III.i.6c	Caseggiato delle Pareti Dipinte	2nd c BC; modified Aug	residential	residential	Pav: 144–5
III.i.6d	Mitreo delle Parenti Dipinte	Marcus Aurelius	religious; mithras	n/a	*SO:* 233–4; Bec 54: 59
III.i.7a	Mercato	Trajanic	commercial: shops	n/a	*SO:* 110, 126, 235; S/R 96: 94–5; Pav: 144
III.i.7b	Mercato B	Trajanic	commercial	n/a	Del5: 35; Pav: 144; *SO:* 235
III.i.8a	Caseggiato	Hadrianic	commercial: shops	res	*SO:* 126, 235
III.i.8b	Caseggiato	Hadrianic	commercial	res?	*SO:* 126, 235; S/R96: 95–6
III.i.9	Caseggiato	Trajanic	commercial; market	res?	*SO:* 126, 235
III.ii.1	Fabri Navales shops	end of 2nd c. AD	commercial; shops	n/a	Pav: 149
III.ii.10a	edificio portico	Hadrianic	public; portico	n/a	*SO:* 235
III.ii.10b	Edificio	Hadrianic	commercial; shops	?	*SO:* 137, 235
III.ii.11	Sacello	Antoninus Pius	religious	n/a	*SO:* 222, 237
III.ii.12	Sacello delle Tre Navate	Antoninus Pius	religious	n/a	*SO:* 222, 237; Pav:143
III.ii.2a	Tempio dei Fabri Navales	Marcus Aurelius or Commodus	public; association	n/a	Pav: 149; Herm82: 62; *SO:* 237
III.ii.2b	Tempio dei Fabri Navales	Commodus	Religious	n/a	*SO:* 149; Meig: 327–8
III.ii.3a	Domus sul Decumano portico	Prior 50 BC; Severan 210–235 remodel	public; portico	n/a	*SO:* 235; Pav: 150
III.ii.3b	Domus sul Decumano	prior 50 BC; Severan 210–235 remodel	commercial; shops	residential	*SO:* 235; Pav: 150
III.ii.4	Caseggiato	late 2nd-early 3rd AD	production	?	*SO*:110-11, 125, 222, 235; Bec61: 95
III.ii.5a	Domus di Marte	Hadrianic	commercial; shops	n/a	*SO:* 137, 222, 235; Bec61: 95; Her: 75
III.ii.5b	Domus di Marte	Hadrianic	public; association	n/a	Stog11: 237; Herm82: 75–6
III.ii.6	Horrea	Trajanic	commercial; storage	commercial	*SO:* 125, 222, 235; Rick71: 54–8; Pav: 152
III.ii.7	Botteghe	Trajanic	commercial; shops	n/a	*SO:* 110, 126, 222, 235
III.ii.8	Edificio	3rd c	unknown	unknown	*SO:* 137

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III.ii.9	Caseggiato	Hadrianic	residential	residential	*SO*: 137; Herm82: 48
III.iii.1a	Caseggiato dell Trifore (shops)	Antoninus Pius	commercial	residential	Pav: 151; *SO*: 237
III.iii.1b	Caseggiato delle Trifore	Antoninus Pius	residential	residential	Pav: 151
III.iii.2	Edificio	Hadrianic	commercial	residential	
III.iv.1	Insula Trapezoidale	Hadrianic 128–130 AD	commercial	residential commercial	Pav: 151
III.ix	Case a Giardino fountain	123–125 AD	public; fountain	n/a	*SO*: 236; Meig: 139
III.ix	Case a Giardino fountain	123–125 AD	public; fountain	n/a	*SO*: 236; Meig: 139
III.ix	Case a Giardino fountain	123–125 AD	public; fountain	n/a	*SO*: 236; Meig: 139
III.ix	Case a Giardino fountain	123–125 AD	public; fountain	n/a	*SO*: 236; Meig: 139
III.ix	Case a Giardino fountain	123–125 AD	public; fountain	n/a	*SO*: 236; Meig: 139
III.ix	Case a Giardino fountain	123–125 AD	public; fountain	n/a	*SO*: 236; Meig: 139
III.ix	Case a Giardino fountain	123–125 AD	public; fountain	n/a	*SO*: 236; Meig: 139
III.ix.1	Domus dei Dioscuri, Garden Houses	2nd c. AD	residential	residential	Pav: 166; Meig: 139
III.ix.10	Case a Giardino	123–125 AD	residential	residential	Pav: 163; *SO*: 236; Meig: 139
III.ix.11	Case a Giardino	123–125 AD	residential	residential	Pav: 163; *SO*: 236; Meig: 139
III.ix.12	Casa delle Pareti Gialle	123–125 AD	residential	residential	DeL04; Meig: 139
III.ix.14	Case a Giardino	123–125 AD	residential	residential	DeL04; *SO*: 236; Meig: 139
III.ix.2	Case a Giardino	123–125 AD	residential	residential	Pav: 163; *SO*: 236; Meig: 139
III.ix.20	Case a Giardino	123–125 AD	residential	residential	DeL04; *SO*: 236; Meig: 139
III.ix.21	Insula del Graffito, Garden Houses	Hadrianic	residential	residential	Pav: 160; *SO*: 236; Meig: 426
III.ix.22a	Domus delle Muse (shops)	Hadrianic	commercial; shops	residential	*SO*: 236; ; Meig: 139
III.ix.22b	Insula Delle Muse	Hadrianic	residential	residential	Pav: 156; *SO*: 236; Meig: 139
III.ix.23	Case a Giardino	123–125 AD	commercial; shops	residential	Pav: 163; *SO*: 236; Meig: 139
III.ix.24a	portico 3	123–125 AD	public; portico	n/a	*SO*: 236; ; Meig: 139
III.ix.24b	Case a Giardino	123–125 AD	commercial; shops	residential	Pav: 163; *SO*: 236; ; Meig: 139
III.ix.25a	portico 2	123–125 AD	public; portico	n/a	Meig: 139; *SO*: 236
III.ix.25b	Case a Giardino	123–125 AD	commercial; shops	residential	*SO*: 236; Pav: 163; Meig: 139

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III.ix.26a	portico 1	123–125 AD	public; portico	n/a	Meig: 139
III.ix.26b	Case a Giardino	123–125 AD	commercial; shops	residential	*SO:* 236; Pav: 163; Meig: 139
III.ix.3	Case a Giardino	123–125 AD	residential	residential	*SO:* 236; Pav: 163; Meig: 139
III.ix.4	Case a Giardino	123–125 AD	residential	residential	*SO:* 236; Pav: 163; Meig: 139
III.ix.5	Case a Giardino	123–125 AD	residential	residential	*SO:* 236; Pav: 163; DeL04; Stevens 05
III.ix.7	Case a Giardino	123–125 AD	residential	residential	*SO:* 236; Pav: 163; Meig: 139
III.ix.9	Case a Giardino	123–125 AD	residential	residential	*SO:* 236; Pav: 163; Meig: 139
III.v.1	Insula delle Volte Dipinte	Hadrianic c. 120 AD	commercial	commercial	Pav: 153-6; Meig: 246, 9
III.vi.1	Domus del Ninfeo	2nd c AD	residential	residential	Pav: 169; Meig: 261
III.vi.2	Domus del Ninfeo	2nd c AD	commercial; shops	residential	Pav: 169; Meig: 261
III.vi.3	Domus del Ninfeo	2nd c AD	commercial; shops	residential	Pav: 169; Meig: 261
III.vi.4	Ninfeo	Hadrianic	public; fountain	n/a	Pav:
III.vii.1	Edificio	Hadrianic	unknown	unknown	
III.vii.2	Monumento Funerario	30–20 BC	public	n/a	Pav: 173
III.vii.3	Domus Fulminata	c. 70 w/ restoration	commercial; shops	residential	Pav: 174: Meer 2005; Herm82: 86; Meig: 253
III.vii.4	Domus Fulminata	c.70–75	residential	residential	Pav: 174; Meer 2005; Herm82: 86; Meig: 253
III.vii.6	Caseggiato	Trajanic	commercial	commercial?	
III.vii.7	Caseggiato	Trajanic	unknown	unknown	
III.viii.2	Terme Marittime	c. 130 AD	public; baths	n/a	Pav: 170; Meig: 417
III.x.1a	Caseggiato degli Aurighi	Antoninus Pius	commercial; shops	residential	Mols20; Herm82:221; Pav: 41–3; *SO*: 237
III.x.1b	Caseggiato degli Aurighi	Antoninus Pius	commercial; market	n/a	*SO:* 237; DeL5:36; Pav: 41–3
III.x.1c	Caseggiato degli Aurighi	Antoninus Pius	commercial; shops	residential	Herm82:220-1; *SO:* 138, 147, 237; Pav: 41–3
III.x.2	Terme dei Sette Sapienti	Hadrianic	public; baths	public	*SO:* 126, 138; S/r96: 163–7; Pav: 139–40; Meig: 417–18
III.x.3a	Caseggiato del Serapide (shops)	Hadrianic	commercial; shops	residential	Herm82: 220; Pav: 139; *SO*: 236
III.x.3b	Cassegiato del Serapide	Hadrianic	residential	residential	Herm82: 220; Pav: 139; *SO*: 236
III.x.4	Caseggiato	Trajanic	public; portico	n/a	*SO:* 235; S/R96: 123

Building ID	Building Name	Date	Ground Floor Classification	Upper Storey Classification	References
III.xi.1	Caseggiato	Trajanic	commercial; shops	residential	*SO:* 125–6, 235; S/R96: 123
III.xii.1	Casette Tipo	Trajanic	residential	residential	*SO:* 125–6, 235; Bec61: 138–9; DeL04; Herm82: 49; Pav: 137
III.xii.2	Casette Tipo	Trajanic	residential	residential	*SO:* 125–6, 235; Bec61: 138–9; DeL04; Herm82: 49; Pav: 137
III.xiii.1	Casette Tipo	Trajanic	residential	residential	*SO:* 125–6, 235; Bec61: 138–9; DeL04; Herm82: 49; Pav: 137
III.xiii.2	Casette Tipo	Trajanic	residential	residential	*SO:* 125–6, 235; Bec61: 138–9; DeL04; Herm82: 49; Pav: 137
III.xiv.1	Edificio a tabernae	Antoninus Pius	commercial	public	*SO:* 147, 237; Herm82: 159; S/R96: 125
III.xiv.2	Caseggiato	Hadrianic	commercial	residential	*SO:* 236
III.xiv.3	Magazzino dei Doli	Hadrianic	commercial; storage	?	*SO:* 225,6; Meig: 275; Boer85: 196; Pav: 137
III.xiv.4a	Caseggiato di Annio (shops)	Hadrianic	commercial; shops	residential	Pac71:13–4; Meig: 275: Herm82: 160–1; *SO:*136
III.xiv.4b	Caseggiato di Annio	Hadrianic (c. 128 AD)	residential	residential	*SO:* 136, 225, 236; Herm82: 160
III.xv.1	Caseggiato	Trajanic	commercial; shops	n/a	*SO:* 125–6,235; S/R96: 125
III.xvi.1	Botteghe	Trajanic or Hadrianic	commercial	?	
III.xvi.2	Caseggiato	Hadrianic	residential	residential	*SO:* 236; Herm82: 49
III.xvi.3	Edificio	Antoninus Pius	commercial	commercial	*SO*: 237
III.xvi.4	Edificio	Hadrianic	commercial; market	commercial	DeL5: 36; *SO*: 136
III.xvi.5	Edificio	Trajanic	commercial; shops	residential	
III.xvi.6	Caseggiato	Hadrianic	commercial; shops	residential	*SO:* 136
III.xvi.7	Terme della Trinacria	Hadrianic	public; baths	public	Pav: 136; Meig: 417; *SO*: 136
III.xvii.1	Horrea	Hadrianic	commercial: storage	commercial	Pav: 135; *SO*: 136
III.xvii.2a	Caseggiato del Mitreo dell Planta Pedis	second half of 2nd c	commercial	?	Pav: 135; Meig: 372; *SO*: 136
III.xvii.2b	Mitreo della Planta Pedis	second half of 2nd c	religious	n/a	Pav: 135; Meig: 372; *SO*: 136
III.xvii.3	Domus del Serapeo	Hadrianic	public; association	association	Pav: 134; Stog: 239

Building ID	Building Name	Date	Ground Floor Classification	Upper Storey Classification	References
III.xvii.4	Serapeum	c. 123–126	religious	n/a	Pav: 134; Herm82: 66–7; Meig: 139; *SO*: 236
III.xvii.5a	Casegiato di Bacco e Arianna portico	Hadrianic	public; portico	n/a	*SO*: 236; Pav: 133
III.xvii.5b	caseggiato di Bacco e Arianna (shops)	Hadrianic	commercial; shops	residential	*SO*: 236; Herm82: 161; Pav: 133
III.xvii.5c	Caseggiato di Bacco e Arianna	Hadrianic	commercial / association?	residential	Pav: 133; Herm82: 67
IV.i.1	Tempio della Magna Mater	c. 194 AD	religious	n/a	*SO*: 236; Herm82: 69; Pav: 208; Meig: 358
IV.i.10	Edifici	various	residential	n/a	Pav: 206; Berlioz: 98; Rieg: 93–172; *SO*: 236
IV.i.2	Porticus	Hadrianic	public; portico	n/a	*SO*: 236; Pav: 208;
IV.i.3	Santuario di Attis		religious	n/a	Herm82: 67–70; Pav: 210; Meig: 359
IV.i.4	Tempio di Bellona	Antoninus Pius	religious; association	n/a	Herm82: 67–70; Pav: 209; Meig: 359; *SO*: 237
IV.i.5	Schola degli Hastiferi	Antoninus Pius	religious; association		Herm82: 67–70; Pav: 209; *SO*: 237
IV.i.6	Fossa sanguinis		religious	n/a	Herm82: 67–70
IV.i.8	Sacello	Hadrianic	religious; shrine	n/a	Herm82: 67–70; Pav: 210; *SO*: 236
IV.i.9	Botteghe	Hadrianic	commercial; shops	n/a	*SO*: 236
IV.ii.10	Bldg	Trajanic	unknown	unknown	*SO*: 236; Stog: 137–8
IV.ii.11	Mitreo degli Animali	150–175 AD	religious; mithras	n/a	Stog: 139–146; Bec54: 97–92; Meig: 374; *SO*: 235
IV.ii.13	Loggia	Trajanic or Hadrianic	commercial	residential	
IV.ii.14	Tabernae	Trajanic	commercial	residential?	*SO*: 236; Stog11: 151
IV.ii.1a	terme shops	Trajanic	commercial; shops	public	Herm82: 162
IV.ii.1b	Terme del Faro	mid-2nd AD–5th c	Public; bath	public	Stog: 69, 78; Pav: 206; Meig: 416; *SO*: 235
IV.ii.2	Portico e Caseggiato dell'Ercole	160–170 AD	public	?	*SO*: 145, 237 ; Pav: 107–8; Stog: 92–104
IV.ii.3	Caseggiato dell'Ercole	160–170 AD	commercial	?	Herm82: 163; *SO*: 237
IV.ii.5	Caseggiato	160–170 AD	residential?	unknown	Stog: 110; *SO*: 237
IV.ii.6	Caupona del Pavone	Hadrianic	commercial; shops/hotel	commercial	*SO*: 145, 226, 237; Stog: 117–123 ; Herm82: 167
IV.ii.7	Caseggiato	c. 150 AD	commercial; shops	residential	*SO*: 236; Stog:125–9; Herm82: 169
IV.ii.8	Edificio	Hadrianic	commercial; shops	residential	*SO*: 236; Stog: 129–32

Building ID	Building Name	Date	Ground Floor Classification	Upper Storey Classification	References
IV.ii.9	Caseggiato	Trajan/Hadrian	residential	residential	Stog: 133–6; *SO*: 235
IV.iii.1	Domus delle Colonne	c. 230 [c. 190 AD]	commercial	?	Heres 1982; Pav: 201
IV.iii.2	Edificio	Hadrianic	commercial; shops	residential	*SO*: 236
IV.iv.2a	Domus delle Nicchia a Mosaico shops	modif. late 2nd c AD	commercial	residential	Pav: 199; Meig: 252
IV.iv.2b	Domus delle Nicchia a Mosaico	modif. late 2nd c AD	residential	residential	Pav: 199; Meig: 252
IV.iv.3a	Casa di Giove Fulminatore	150BC–2nd c AD	commercial	residential	Pav: 198-9; Meig: 252
IV.iv.3b	Casa di Giove Fulminatore	150BC–2nd c AD	residential	residential	Pav: 198-9; Meig: 252
IV.iv.9	Insula con Viridario	first half of 2nd c AD	residential	?	Pav:197
IV.ix.1	Loggia di Cartiliio Poplicola	Hadrianic	commercial; market; / Pub	n/a	Pav: 178; DeL5: 38; *SO*: 236
IV.ix.2	Sepolcro di Cartilio Poplicola	25–20 BC	public	?	Pav:178
IV.ix.3	Edificio	Hadrianic	unknown	unknown	*SO*: 236
IV.ix.4	Edificio	Hadrianic	commercial; shops	?	*SO*: 236
IV.v.10	Terme delle Sei Colonne	Trajanic	public; bath	residential	Pav: 191; Herm82: 170; Meig: 416; *SO*: 235
IV.v.11	Terme delle Sei Colonne shops	Trajanic	commercial; shops	residential	Pav: 191; Herm82: 170; Meig: 416; *SO*: 235
IV.v.12	Horrea	1st c. AD	commercial; storage	commercial	Bak99; Pav: 194
IV.v.15a	Schola del Traiano	Antoninus Pius	public; association	association	Pav: 190–1; Herm82:71-5; Meig: 324; *SO*: 237
IV.v.15b	schola del traiano shops 1	Antoninus Pius	commercial; shops	n/a	Pav: 190–1; *SO*: 237
IV.v.15c	schola del traino shop 2	Antoninus Pius	commercial; shops	n/a	Pav: 190–1; *SO*: 237
IV.v.18	Caseggiato delle Taberne finestrate	Trajanic	commercial; shops	residential	Pav: 190; *SO*: 235
IV.v.1a	Taberne dei Pescivendoli portico	Commodus	public; portico	n/a	*SO*: 237
IV.v.1b	Taberne dei Pescivendoli	Commodus	Commercial; shops;	?	Pav: 195; *SO*: 237
IV.v.2	Macellum	180–192 AD	commercial; shops	?	Pav: 195; Ruyt83; Koc99; Meig: 47
IV.v.3	Caseggiato	Marcus Aurelius (161–180 AD)	production; fullery		Flo17; *SO*: 237
IV.v.4	Caseggiato del Sacello	Commodus or Severan	unknown	residential	Pav: 193; *SO*: 237
IV.v.5	Edificio	Hadrianic	commercial; shops	residential	
IV.v.7	Edificio	Hadrianic	commercial; shops	?	Hein 2002; Pav: 191–2; *SO*: 236

Building ID	Building Name	Date	Ground Floor Classification	Upper Storey Classification	References
IV.vi.1a	caseggiato a botteghe shops	Hadrianic	commercial; shops	residential	Pav: 189–90; *SO*: 236
IV.vi.1b	Caseggiato a botteghe	Hadrianic	residential	residential	Pav: 189; *SO*: 236
IV.vii.1	Portico della Fontana con Lucerna	Hadrianic	public; portico	n/a	Pav: 187; *SO*: 236
IV.vii.2	Caseggiato della Fontana con Lucerna	120	commercial; shops	residential	Pav: 189; Herm82: 175; *SO*: 236
IV.vii.3	Caseggiato	Hadrianic	commercial; shops	residential?	Herm82: 175; Pav: 187–9; *SO*: 236
IV.vii.4	Caupona di Alexander e Helix	Antonine	commercial; shops		Pav: 186; Herm82: 161
IV.vii.5	Caseggiato	Hadrianic	commercial; shops	?	*SO*: 236
IV.viii.1	Foro di Porta Marina	Hadrianic	commercial; market /Rel	n/a	Pav: 186; DeL5:38; *SO*: 236
IV.viii.3	Santuario della Bona Dea	first half 1st c AD	religious	n/a	Pav: 185; Meig: 352, 381
IV.viii.5a	Edificio portico	Hadrianic	public; portico	n/a	*SO*: 236
IV.viii.5b	Edificio	Hadrianic	commercial; shops	residential?	*SO*: 236
IV.x.1	Terme di Porta Marina	Antoninus Pius	public; bath	public	Pav: 180-1; ; Meig: 408; *SO*: 237
V.i.1	Caseggiato a botteghe	Severan	commercial; shops	residential	*SO*: 153, 237
V.i.2	Horrea	c. 50 AD	Commercial; market	commercial	*SO*: 118, 234; Rick71: 72; DeL5: 38; Pav: 214
V.ii.1	Caseggiato	1st c. AD	commercial; shops	n/a	Boe85: 105–6; *SO*: 235
V.ii.13a	Caseggiato del Pozza shops	Severan	commercial; shops	residential	Boe85: 189
V.ii.13b	Caseggiato del Pozzo	Severan	residential	residential	Boe85:189
V.ii.14	Caseggiato	Trajanic	commercial; storage	n/a	Boe85: 191; *SO*: 235
V.ii.2	Caseggiato	Trajanic	commercial; storage	n/a	Boe85: 26; *SO*: 235
V.ii.3a	Caseggiato shops	Trajanic	commercial; shops	residential	Boe85: 120; Meig: 257; *SO*: 235
V.ii.3b	Caseggiato	Trajanic	commercial; workshop	residential	Boe85: 120; Meig: 257; *SO*: 235
V.ii.4	Domus del Protiro shops	Hadrianic	commercial; shops	residential	Boe85: 104; *SO*: 236
V.ii.5	Domus del Protiro	Hadrianic	residential	residential	Boe85: 104; Meig: 553; *SO*: 236
V.ii.6	Terme del Filosofo	Trajanic	commercial; shops	residential	Boe85:124
V.ii.8a	domus della fortuna annonaria shops	150 AD	commercial; shops	residential	Herm82; Boe85: 160; Meig: 254; *SO*: 237
V.ii.8b	Domus della Fortuna Annonaria	150 AD	residential	residential	Herm82; Boe85: 160; Meig: 254; *SO*: 237

Building ID	Building Name	Date	Ground Floor Classification	Upper Storey Classification	References
V.ii.9a	caseggiatio shops	150 AD	commercial; shops	n/a	Boe85: 58; *SO*: 236
V.ii.9b	Caseggiato	150 AD	production	n/a	Boe85: 58
V.iii.1a	caseggiato dei Lottatori shops	Hadrianic	commercial; shops	?	*SO:* 236; Herm82: 76–7
V.iii.1b	Caseggiato dei Lottatori	Hadrianic	public; association	?	*SO:* 236; Herm82: 76–7,113–5; S/R: 172–4
V.iii.2	Edificio	Trajanic	commercial	n/a	Pak71: 11–20; SO: 235; Herm 113–5; *SO*: 235
V.iii.3	Domus del Pozzo	Hadrianic	residential	residential	Bec49: 25; SO: 236,238; S/R96: 135–6
V.iii.4	Casa	Hadrianic	residential	residential	*SO:* 236, 238; Herm: 31–2,113–5; DeL2002: 46
V.iii.5	Caseggiato	Hadrianic	commercial; shops	residential	*SO:* 236; Herm82: 27–31; DeL2002: 46
V.iv.1	Caseggiato	Antoninus Pius	commercial; shops	residential	*SO:* 145, 237; Herm82: 178–9
V.iv.2	Caseggiato	Hadrianic	commercial; shops	commercial?	*SO:* 134, 236 S/R96: 175
V.iv.3	Caseggiato	Hadrianic	commercial	commercial?	*SO:* 145, 234, 236; Boe85: 201, 208
V.ix.2	Caseggiato	2nd c AD	unknown	unknown	Bec54: 105–112
V.v.1	Caseggiato dell'Invidioso	Antoninus Pius	commercial; shops	unknown	*SO:* 218, 237; Bec61: 218–9; S/R96: 176
V.v.2	Terme dell'Invidioso	50 AD	public; baths	public	*SO:* 144, 234, 237; Bec61: 220; Meig: 417
V.v.3	Caseggiato	Antoninus Pius	commercial	?	*SO:* 237
V.v.4	Caseggiato	Hadrianic	commercial; shops	residential	*SO:* 233, 236; Boe85: 201
V.vi.1a	Caseggiato de Sole shops	Antoninus Pius	commercial; shops	residential	*SO:* 117, 144–5, 237; Bec54: 125–8; Herm82: 179–82; Meig: 145
V.vi.1b	Caseggiato del Sole	Antoninus Pius	residential	residential	*SO:* 117, 144–5, 237; Bec54: 125–8; Herm82: 179–82; Meig: 145
V.vi.2	Caseggiato	Hadrianic	commercial; shops	residential	*SO:* 145, 234, 236; Boe85: 201–8
V.vi.3	Caseggiato	Antoninus Pius	commercial; shops	residential	*SO:* 236
V.vi.4	Caseggiato	Hadrianic	unknown	n/a	Boe85: 208; *SO*: 236
V.vi.5	Caseggiato	Hadrianic	unknown	unknown	*SO:* 234, 236; Boe85: 201, 8
V.vi.7	Caseggiato	Hadrianic	commercial	residential	*SO:* 236
V.vii.1	Sede degli Augustali shops	160–180	commercial; shops	n/a	*SO:* 134, 143, 156, 227; Herm82: 62

Building ID	Building Name	Date	Ground Floor Classification	Upper Storey Classification	References
V.vii.2	Sede degli Augustali	160–180	public; association	residential?	*SO:* 134, 143, 156, 227; Herm82: 62; Pav: 224–5
V.vii.3	Fullonica	Antoninus Pius	production; fullery	?	*SO*: 144, 237; S/R96: 177–8; Flo17: 49–51; Pav: 225
V.vii.4	Domus dei Capitelli di Stucco	2nd c BC	residential	residential	*SO:* 143–4, 233; S/R96: 178–9; Pav: 227
V.vii.5	Caseggiato	Marcus Aurelius	commercial; shops	residential	*SO:* 144, 237
V.viii.1	Domus del Larario	Antoninus Pius	residential	residential	*SO*: 237
V.viii.2	domus del Larario shops	Antoninus Pius	commercial; shops	residential	*SO*: 237
V.x.1	Domus su via degli Augustali	2nd c AD	commercial; shops	?	Pav: 231–2; *SO*: 236
V.x.2	Santuario della Bona Dea	2nd c B; Augustus	religious	n/a	Pav: 231; Meig: 352
V.x.3	Terme del Nuotatore	89–90 AD	public; baths	public	Pav: 229–31
V.xi.1a	Tempio Collegiale	end 2nd c	religious; association	n/a	Herm82: 64; Pav: 233; *SO*: 237
V.xi.1b	Tempio Collegiale	end 2nd c	religious	n/a	Herm82: 64; Pav: 233; *SO*: 237
V.xi.2a	Caseggiato del Temistocle shops	Hadrianic	commercial; shops	residential	Herm82: 41, 49, 96–111; Pav: 232; *SO*: 236
V.xi.2b	Caseggiato del Temistocle	Hadrianic	residential	residential	Herm82: 41, 49, 96–111; Pav: 232; *SO*: 236
V.xi.3a	Edificio porticus	Hadrianic	public; portico	n/a	*SO*: 236
V.xi.3b	Edificio	Hadrianic	commercial; shops	residential	*SO*: 236
V.xi.4	Portico del Monumento Repubblicano	150–125 BC	public; portico	n/a	*SO*: 237; Pav: 233
V.xi.5a	Magazzino Annonario shops	Hadrianic	commercial; shops	n/a	Pav: 233–4; *SO*: 236
V.xi.5b	Magazzino Annonario	Hadrianic	commercial; storage	n/a	Pav: 233–4; *SO*: 236
V.xi.6	Monumento Repubblicano	120–90 BC	public; monument	n/a	Pav: 234; *SO*: 237
V.xi.7	Portico degli Archi Trionfali	Commodus	public; portico	n/a	Pav: 235; *SO*: 237
V.xi.8a	Horrea dell'Artemide shops	Trajanic	commercial; shops	n/a	Pav: 236; Meig: 122; *SO*: 235
V.xi.8b	Horrea dell'Artemide	Trajanic	commercial; storage	commercial	Pav: 236; Meig: 122; *SO*: 235
V.xii.1	Horrea di Hortensius	25–50 AD	commercial; storage	commercial	Herm82: 227–35; Pav: 236–7
V.xii.2a	Horrea shops	25–50 AD	commercial; shops	commercial	Pav: 238-9; *SO*: 236
V.xii.2b	Horrea	Hadrianic	commercial; storage	commercial	Herm82: 228; Pav: 238–9; *SO*: 236

Building ID	Building Name	Date	Ground Floor Classification	Upper Storey Classification	References
V.xii.3	Sabazeo	120–125 AD	religious	n/a	Pav: 239; Meig: 124; *SO*: 236
V.xvi.2	Castello d'Acqua		commercial; market	n/a	

Appendix C Agent-Based Model Code

This appendix presents the code used for the development of the ABM model used by all three case studies. The code is annotated to explain how it works. These explanations are indicated by the notation ';;', which is written on the line following the relevant code. In instances where the description applies to a larger block of code, the description is provided at the beginning. The entire model is accessible as an electronic supplement. In order to run the model, you will need to download and install NetLogo 6.0.2.[108]

```
extensions [ GIS ]

;; one extension is used within this model

;; it allows the importation of GIS data into the NetLogo model

;; The GIS extension comes included when you download NetLogo


globals

[

   cityscape

;; parameter used to denote the extended cityscape

   streets

;; parameter used to denote streets

   commercial

;; parameter used to denote buildings defined as having a commercial function

   production

;; parameter used to denote buildings defined as having a production function

   domestic

;; parameter used to denote buildings defined as have a domestic function (what is referred to as residential throughout the thesis)

   religious

;; parameter used to denote buildings defined as having a religious function

   public

;; parameter used to denote buildings defined as having a public function

   Coastline
```

[108] NetLogo can be accessed from https://ccl.northwestern.edu/netlogo/download.shtml (accessed 15.02.2018).

;; parameter used to denote the seafront

Harbour

;; parameter used to denote the river harbour

influence-field

;; value accessible in the model interface that controls the total influence of each individual building classification

the-leader

;; parameter that designates one turtle within a procession as the leader. This turtle determines the initial route that is taken by the procession

bldg-designation

;; parameter that denotes if a patch is defined as any type of building

bldg-list

;; patches belonging to a list of buildings

open

;; parameter used in a list to denote all available patches for moving towards

closed

;; parameter used in a list to denote all patches that were previously in an open list but were travelled across and therefore moved to a closed list

optimal-path

;; parameter used to determine the best path

]

patches-own

[

street? ;; parameter that is true if a patch is part of a street

comm ;; patches defined as commercial

prod ;; patches defined as production

dom ;; patches defined as domestic

rel ;; patches defined as religious

pub ;; patches defined as public

scape ;; patches defined as belonging to the extended cityscape

;; patches defined as being part of the cityscape, including buildings within the extended street network

influence ;; influence value of each patch

visited? ;; leaders, designate if a patch has been previously visited

visit? ;; processionals value for moving towards leaders path

route? ;; the route defined for return path to temple

meaning

ptype ;; parameter that differentiates between building and street patches

parent-patch ;; pathfinding variable. Patch's predecessor

f ;; pathfinding variable. Value of knowledge plus heuristic cost function f()

g ;; pathfinding variable. Value of knowledge cost function g()

h ;; pathfinding variable. Value of heuristic cost function h()

path? ;; parameter used to identify the pathway for returning to the temple

]

breed [leaders leader]

;; the agent in the model that is associated with a specified temple. They determine the route that the other processional participants should follow

breed [processionals processional]

;; the agents in the model that compose a procession's participants. They must move in a group formation, towards the direction of the leader

breed [observers observer]

;; the agents in the model that are Ostia city-dwellers. They are interested in watching the procession, but they will not follow or intentionally move towards the procession. They are positioned randomly along Ostia's streets and can only move along streets

breed [urbanites urbanite]

;; the agents in the model that populate the city but do not intentionally interact with the procession. They are randomly dispersed along Ostia's street network and can only move along streets

observers-own

[

ticks-since-here

;; reporter, parameter that identifies how long an observer has stayed in one place watching a procession

count-down

;; reporter, parameter that tracks the number of ticks left before an observer can begin moving

]

leaders-own

[

traveled?

;; parameter to keep track of whether or not a leader has travelled towards a target

target ;; parameter that determines which patch the leader is moving towards

visited-list

;; parameter that tracks which patches a leader has already travelled across so that they do not return to patches previously crossed

home-xy ;; parameter that sets the leaders start patch as the return destination

path ;; parameter used for determining best route back to the temple

current-path ;; parameter that designates what path is left to be followed

]

processionals-own

[

traveled?

;; parameter to keep track of whether or not processionals have moved or not

goal ;; parameter related to their target

visit-list

;; list parameter used to keep track of which patches have already been visited by each processional turtle

processmates ;; agentset of nearby processional

process-neighbor ;; closest one of the processmates

start-patch

;; parameter that sets the starting location, pre-defined in start-up procedure

direction

;; location with the highest influence value, is reset continually throughout the procession

tar ;; parameter that determines where the processional turtles will move

mobile? ;; parameter that determines if the turtles have moved or not

]

;;

;;;;;;;;; setup ;;;;;;;;;;;;;;;;

;;;

to setup

clear-all

create-environment ;; this creates the model environment

setup-edges

;; this creates a boarder around every building that connects to the street. These are the patches that can be called as a target by leaders

end

to reset-parameters

;; this sets/resets the building influence values along the border patches (setup-edges) of all the buildings

reset-variables ;; resets influence values from previous run

cd ;; clears drawing of previous processional route

ask patches

[

set visited? 0

;; initialize the model by ensuring that none of the patches have been visited

set path? 0

;; initialize the model by resetting all previous paths to 0

]

end

to display-agents

;; separate setup procedure allows multiple runs with different number of agents without resetting the environment

ct ;; clears turtles from previous runs

cd ;; clears drawing

```
    reset-ticks      ;; set ticks back to 0
    setup-observers
    setup-urbanites
    setup-processionals
end


;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;;;;;;;;;;;  GO ;;;;;;;;;;;
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;


to go
  process
  move-urbanites
  move-observers
  tick
end


;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;;;;;;;; setup procedures ;;;;;;
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;


to create-environment
    ask patches [set pcolor white]          ;; sets background of the model white


;;;;;;;; load full cityscape dataset using GIS data;;;;;;;;;


;; all of the relevant GIS shapefiles are loaded as well as the associated coordinate system
  gis:load-coordinate-system "Ostia_cityscape.prj"
  set commercial gis:load-dataset "commercial.shp"
  set production gis:load-dataset "production.shp"
  set domestic gis:load-dataset "domestic.shp"
  set religious gis:load-dataset "religious.shp"
```

```
set public gis:load-dataset "public.shp"
set cityscape gis:load-dataset "Ostia_cityscape.shp"
set streets gis:load-dataset "streets_NL.shp"
set Coastline gis:load-dataset "Coastline.shp"
set Harbour gis:load-dataset "Harbour.shp"
setup-world-envelope
```

;; display the cityscape and show the building classification shapefiles and street network as patches and change them to a specific identifying color.

```
ask patches
 [
  ifelse gis:intersects? cityscape self
   [ set scape true ]
   [ set scape false ]
 ]
ask patches with [ scape ]
   [ set pcolor grey + 4
   set ptype "building"
   set ptype "building1" ]

ask patches
  [
   ifelse gis:intersects? commercial self
    [ set comm true ]
    [ set comm false ]
  ]
ask patches with [ comm ]
   [ set pcolor green + 2
   set ptype "building"
   set ptype "building1" ]

ask patches
  [
```

```
      ifelse gis:intersects? production self
      [ set prod true ]
      [ set prod false ]
    ]
  ask patches with [ prod ]
      [ set pcolor orange
      set ptype "building"
        set ptype "building1"]

  ask patches
    [
      ifelse gis:intersects? domestic self
      [ set dom true ]
      [ set dom false ]
    ]
  ask patches with [ dom ]
      [ set pcolor yellow
      set ptype "building"
      set ptype "building1" ]

  ask patches
    [
      ifelse gis:intersects? religious self
      [ set rel true ]
      [ set rel false ]
    ]
  ask patches with [ rel ]
      [ set pcolor pink
      set ptype "building"
      set ptype "building1" ]
```

```
  ask patches
     [ ifelse gis:intersects? public self
     [ set pub true ]
     [ set pub false ]
   ]
  ask patches with [ pub ]
     [ set pcolor blue
     set ptype "building" ]
```

;; if Beach is switched "on" in the interface, then the beachfront will be loaded within the mode

```
  ask patches
      [ ifelse gis:intersects? Coastline self
            [  set coast true ]
            [  set coast false ]
       ]
  ask patches with [ coast ]
     [ if Beach = true
            [ set pcolor 38
            set ptype "building" ]
     ]
```

;; if RiverHarbour is switched "on" in the interface, then the harbour will be loaded within the model

```
 ask patches
     [ ifelse gis:intersects? Harbour self
            [ set harb true ]
            [ set harb false ]
      ]
 ask patches with [ harb ]
    [if RiverHarbour = true
     [ set pcolor 84
     set ptype "building"]
  ]
```

```
  ask patches
     [ ifelse gis:intersects? streets self
            [ set street? true ]
            [ set street? false ]
      ]
   ask patches with [ street? ]
      [ set pcolor black
      set ptype "street"]
end
```

;; create border patches between buildings and streets.

;; if the relevant patch is part of a building patch group and next to street patches, then it will be changed to an edge patch

;; the building influence values specified on the interface are specific to these edge patches. This ensures that the influence value can be registered by the leader without requiring the agent to enter the different buildings

```
to setup-edges
   ask patches with [pcolor = green + 2]
      [if any? neighbors4 with [pcolor = black]
            [set pcolor green - 2
            set ptype "building" ]
      ]
   ask patches with [pcolor = orange]
      [if any? neighbors4 with [pcolor = black]
            [set pcolor orange - 2
            set ptype "building" ]
      ]
   ask patches with [pcolor = yellow]
      [if any? neighbors4 with [pcolor = black]
            [set pcolor yellow - 2
            set ptype "building" ]
      ]
```

```
    ask patches with [pcolor = blue]
       [if any? neighbors4 with [pcolor = black]
             [set pcolor blue - 2
             set ptype "building" ]
       ]
    ask patches with [pcolor = pink]
       [if any? neighbors4 with [pcolor = black]
             [set pcolor pink – 2
             set ptype “building” ]
        ]
    if extended-influence = true
    [
       ask patches with [pcolor = grey + 4]
         [if any? neighbors4 with [pcolor = black]
             [set pcolor grey
             set ptype "building" ]
        ]
    ]
end


to setup-world-envelope
    gis:set-world-envelope gis:envelope-of cityscape
;; defines the limits of the world parameters of the interface
    let world gis:world-envelope
    gis:set-world-envelope world
end


;;;;;;;;;;;next setup procedure;;;;;;;;;;;;;;;;;;;;;;;;
to reset-variables
;; sets/resets the building influence values of a building’s edge patches without re-loading the entire model environment
    ask patches [set path? 0]
```

```
    ask patches with [pcolor = black]
        [set influence 0]
    ask patches with [pcolor = green - 2]
        [set influence commercial-influence
        set ptype "building"]
    ask patches with [pcolor = orange - 2]
        [set influence production-influence
        set ptype "building"]
    ask patches with [pcolor = yellow - 2]
        [set influence domestic-influence
        set ptype "building"]
    ask patches with [pcolor = blue - 2]
        [set influence public-influence
        set ptype "building"]
    ask patches with [pcolor = pink - 2]
        [set influence religious-influence
        set ptype "building"]
if extended-influence = true [
```

;; if this is switched "on" in the interface, then influence values will be attributed to the extended cityscape buildings plots of land

```
    ask patches with [pcolor = grey]
        ifelse random-inf = true
```

;; if the switch is on/true, influence values are randomly attributed to 'buildings' located within the street network of the extended cityscape

;; this enables the agents to move within the extended cityscape rather than being predominately confined to the excavated city

```
            [set influence random 5
            set ptype "building"]
            [set influence ext-influence
            set ptype "building"]
        ]
  set bldg-list [9 57 25 45 135 105 36 82]
```

;; patch list inclusive of specific pcolors

```
  set bldg-designation bldg-list
end


;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;;;;;;;;; urban agents setup ;;;;;;;;
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;


to setup-observers
    create-observers num-observers
        [
        set size 3
        set color blue + 2
        set shape "person"
        set count-down ticks-to-observe
;; from reporter, initialize the variable for how long an observer will stay in place and watch a procession. The initial number of observation ticks are specified by the slider in the interface
        ]
    ask observers
        [
        move-to one-of patches with [street?]
;; moves all observers to a different random patch that is part of a street
        ]
end


to setup-urbanites
    create-urbanites num-urbanites
        [
        set size 3
        set color yellow
        set shape "person"
         ]
    ask urbanites
        [
```

```
        move-to one-of patches with [street?]
;; moves all urbanites to a different random patch that is part of a street
      ]
end


to setup-processionals
if Serapeum = true [
;; setup procession specific to the Serapeum
  create-processionals num-serapis
;; initialize all parameters. This makes sure the model knows that none of the agents have moved
and that all parameters are set to 0
  [
   set xcor -296 + random 4
   set ycor -19 + random 4
;; coordinates for placement of processionals agents in front of the Serapeum on the street
   set size 3
   set color 16
   if trace-routes = true
    [pen-down]
;; if true, a route will be traced following each processional agent
   set shape "person"
   set traveled? false
   set visit-list []
   set mobile? false
  ]
  create-leaders 1
;; the agent that all processionals participants will follow
  [
   setxy -296 -17
;; coordinate placement of the processional leader
   set home-xy patch-here
;; parameter that set the start patch as the same patch that will be returned to
   ask patch -296 -17 [set ptype "destination"]
```

```
    set visited-list []
;; creates a list of patches that are visited by the leader, this sets the number of patches as 0
    set size 3
    set color red
    set shape "person"
    set the-leader self
    set heading 90        ;; heading set within 90 degrees
    set traveled? false
;; ensure model know that during the setup that none of the agents have moved
    if draw-route = true
      [ pen-down ]
;; if true, a route will be traced following the agent
    ]
    ask leaders [
      define-target ]
  ]

 if Cybele = true [
;; setup procession specific to the Campo della Magna Mater
     create-processionals num-maters [
;; initialize all parameters. This makes sure the model knows that none of the agents have moved
and that all parameters are set to 0
     set xcor 93 + random 4
    set ycor -73 + random 4
;; coordinates for placement of processionals agents in front of the Campo on the street
     set size 3
     set color orange
     set shape "person"
     set traveled? false
     if trace-routes = true
      [pen-down]
;; if true a route will be traced following each processional agent
     set tar the-leader
```

```
 ]
    create-leaders 1
  [
    setxy 92 -72
;; set coordinate location of the leader in front of the temple
    set home-xy patch-here
;; parameter that set the start patch as the same patch that will be returned to
    ask patch 92 -72 [set ptype "destination"]
    set visited-list []
    set size 3
    set color red
    set shape "person"
    set the-leader self
    set heading 90
    set traveled? false
    if draw-route = true
     [ pen-down ]
;; if true, a route will be traced following the agent
    ]
  ask leaders [
    define-target ]
 ]


 if Forum = true [
  create-processionals num-imperials [
;; initialize all parameters. This makes sure the model knows that none of the agents have moved
and that all parameters are set to 0
    set xcor -51 + random 4
    set ycor 23 + random 4
;; coordinates for placement of processionals agents in the forum
    set size 3
    set color white
    set shape "person"
```

```
    set count-down 3
    set tar the-leader
    set traveled? false
    if trace-routes = true
        [pen-down]
;; if true a route will be traced following each processional agent
  ]
  create-leaders 1
  [
    setxy -52 26
;; set coordinate location of the leader in front of the temple
    set home-xy patch-here
;; parameter that set the start patch as the same patch that will be returned to
    ask patch -52 26 [set ptype "destination"]
    set visited-list []
    set size 3
    set color red
    set shape "person"
    set the-leader self
    set heading 90
    set traveled? false
    if draw-route = true
      [ pen-down ]
    ]
  ask leaders [
    define-target ]
  ]
end


;;;;;; target procedures ;;;;;;;;
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
```

```
to define-target
;; this defines the initial destination of the leader agent
  if ticks < procession-ticks
;; if ticks are less than that specified by the procession-ticks slider
    [set target highest-influence]
;; reporter that calculates the patch with the highest influence value in relation to the agent's current position
  if ticks >= procession-ticks
;; if ticks are greater than or equal to that specified by the procession-ticks slider
    [move-to one-of neighbors with [pcolor = black]
      find-path-to-temple
;; reporter, calculate the best route back to the start temple
      output-show (word "Shortest path length : " length optimal-path)]
;; records in the output window the number of patches needed to reach the temple
  if ticks > procession-ticks
    [set target return-influence]
;; reporter that calculates the highest-influence values following the best path back to the temple
end


;;;;;;;;; run-time procedure ;;;;;;;;;;;
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;


to process
  move-leaders
  move-processionals
end


;;;;;;;; leader procedures ;;;;;;;;
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
to move-leaders
  ask leaders [
     if target != nobody [
     if distance target = 0
```

```
      [
      define-target
      ]
     if distance target > 1
      [
      travel-leaders
      ]
     if distance target <= 1
      [
```

;; agent moves to the highest influence patch. This patch is then placed within the visited list so the agent cannot visit it again during this run of the simulation

```
      move-to target
      set visited-list lput target visited-list
      ]
    ]
 ]

end

to travel-leaders
  ask leaders [
    move-towards-target
  ]
end

to move-towards-target
 ask leaders [
  ifelse [meaning] of patch-ahead 1 = "street"
```

;; if the patch ahead of the agent's current position is a street, either avoid that patch or continue moving forwards. This ensures that the agent follows the building influence values, and stays confined to the following a patch along the edge of buildings

```
    [ Avoid-Function ]
    [ Move-Function ]
 ]
```

```
end


to Move-Function
 let t target
 ask leaders [
  if target != nobody [
    if any? all-possible-moves
       [face min-one-of all-possible-moves [distance t]
```

;; takes into account all the possible ways of reaching the target patch and choses the best next patch to move towards

```
        fd 1
        ask patch-here [set visited? 1]
```

;; patch that has now been visited will be put in the visited list so the agent cannot return to the same position

```
       ]
     ]
  ]
end


to Avoid-Function
  let t target
 ask leaders [
   if target != nobody [
    if any? all-possible-moves
    [face min-one-of all-possible-moves [distance t]
```

;; takes into account all the possible ways of reaching the target patch and choses the best next patch to face towards

```
    ]
   ]
 ]
end
```

```
to leave-a-trail

  ask patch-here [set visited? 1]

;; if values are greater than 0, than the associated reporter will discount this patch from
calculations to determine the next highest influence value and therefore possible target locations

end


to determine-destination

  ask leaders [

   define-target]

end


;;;;;;;;;;;;;;;;;;;; return to temple ;;;;;;;;;;;;;;;;;;;;

;;;;;;;;;;;; A* path finding algorithm ;;;;;;;;;;;;;;;

;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;

to find-path-to-temple

  ask leaders [

    define-origin

    compute-route

  ]

end


to define-origin

;; reporter to determine the current patch the leader is standing on when the maximum number
of ticks are reached, triggering the find-path-to-temple algorithm

  ask location-leader

      [set ptype "source"]       ;; this patch is defined as a source or starting patch

end


to compute-route

  ask one-of leaders

   [

    set path find-a-path one-of patches with [ptype = "source"] one-of patches with
[ptype = "destination"]
```

;; the starting patch and ending patch have to be defined. The best route following the street network will then be calculated between these two points

```
    set optimal-path path

    set current-path path

    ]

end


to-report location-leader

  report [patch-here] of the-leader

;; reporter for defining the agent's origin point

end


;; the implementation of the path finding algorithm. The start and end patches are the main inputs

;; the best path between these two points are then determined

to-report find-a-path [ source-patch destination-patch]

;; initializes all variables to default values

  let search-done? false

  let search-path []

  let current-patch 0

  set open []

  set closed []


  set open lput source-patch open

;; add source patch (e.g. starting point) to the open list. This includes the patch within the algorithm

  while [ search-done? != true]

;; loop until we reach the destination or the open list becomes empty.

  [

    ifelse length open != 0

    [

      set open sort-by [ [?1 ?2] -> [f] of ?1 < [f] of ?2 ] open

;; sort the patches in open list in increasing order of their f() values

      set current-patch item 0 open
```

```
    set open remove-item 0 open
```

;; take the first patch in the open list as the current patch (which is currently being explored (n)) and remove it from the open list

```
    set closed lput current-patch closed
```

;; add the current patch to the closed list

;; explore the patches located left, right, top and bottom to the current patch

```
    ask current-patch
    [
```

;; if any of the neighbors are the destination, stop the search process

```
    ifelse any? neighbors4 with [(pxcor = [ pxcor ] of destination-patch) and (pycor = [pycor] of destination-patch)]
      [
       set search-done? true
      ]
      [
    ask neighbors4 with [ ptype != "building" and (not member? self closed) and (self != parent-patch) ]
```

;; ensures that neighbors should not be obstacles or already explored patches (part of the closed list)

```
        [
          if not member? self open and self != source-patch and self != destination-patch
```

;; the neighbors to be explored should also not be the source or destination patches or already a part of the open list (unexplored patches list)

```
          [
            set open lput self open    ;; add the eligible patch to the open list
```

;; in the next three lines, update the path finding variables of the eligible patch

```
            set parent-patch current-patch
            set g [g] of parent-patch  + 1
            set h distance destination-patch
            set f (g + h)
          ]
        ]
      ]
```

```
    ]
  ]
  [
user-message( "A path from the source to the destination does not exist." )
    report []
```

;; if the search for a path back to the temple is incomplete: a path is not found (search is incomplete) and the open list is exhausted

;; display a user message and report an empty search path list.

;; the run will need to be stop, reset, and restarted

```
  ]
 ]
set search-path lput current-patch search-path
```

;; if a path is found (search completed) add the current patch (node adjacent to the destination) to the search path.

;; trace the search path from the current patch all the way to the source patch using the parent patch variable which was set during the search for every patch that was explored

```
 let temp first search-path
 while [ temp != source-patch ]
 [
   ask temp
  [
    set influence 50
```

;; this high influence value ensures that on calculating the route home, these patches are the most desirable to move towards

;; this prevents the agent from travelling towards high influence buildings instead of staying on the street to go back to the temple

```
  ]
  set search-path lput [parent-patch] of temp search-path
  set temp [parent-patch] of temp
 ]
```

;; add the destination patch to the front of the search path. This determines where the route to return to the temple begins

```
 set search-path fput destination-patch search-path
```

;; reverse the search path so that it starts from a patch adjacent to the source patch and ends at the destination patch

set search-path reverse search-path

report search-path

end

;;;;;;;;;;procession procedure;;;;;;;;;

;;

to move-processionals

if any? processionals [

ask processionals [

process-processionals

move-towards-path

]

ask processionals [ifelse [pcolor] of patch-ahead 1 = black

[fd 1]

[rt random 180]

;; if there is not a street, rotate 180 degrees

]

]

end

to move-towards-path

ask processionals [

ifelse [pcolor] of patch-ahead 1 = black

;; to ensure that the agents stay on the streets and don't move onto building patches

[fd step-size]

;; the size of the agents step as determined by a slider on the interface

[rt random 90

if patch-ahead 1 = black [fd step-size]]

;; can only move ahead if the patch belongs to a street

]

End

Appendix C

```
;;;;;;;;;;;; Adapted Flocking Procedure ;;;;;;;;;;;
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;


to process-processionals
    ask processionals
      [find-processmates
;; determine if there are any other processional agents present
     if any? processmates
         [ find-process-neighbor
;; if there are, than find the closest agent e.g. neighbor
         ifelse distance process-neighbor < min-separation
;; parameters to determine how close or far apart the agent can be from all other processional agents
;; this follows boids law on bird flocking formations
          [ separate ]
          [ align
            cohere ]
     ]
   ]
end


to find-processmates           ;; turtle procedure
  set processmates other processionals in-radius vision
end


to find-process-neighbor      ;; turtle procedure
  set process-neighbor min-one-of processmates [distance myself]
end


;;;;;;;;; Separate ;;;;;;;;
to separate        ;; turtle procedure
  turn-away ([heading] of process-neighbor) max-separate-turn
end
```

```
;;;;;;;;;;;;; Align ;;;;;;;;;;;;;

to align  ;; turtle procedure
  turn-towards average-processmates-heading max-align-turn
  face the-leader
;; set heading direction of the leader agent
;; this ensures that the agent group travels in the general direction of the leader agent while
maintaining the previous separate and align specifications
end


to-report average-processmates-heading          ;; turtle procedure
;; this uses trigonometry to get accurate results about the heading. If averaged, the result would
return a value of 0
  let x-component sum [dx] of processmates
  let y-component sum [dy] of processmates
  ifelse x-component = 0 and y-component = 0
    [ report heading ]
    [ report atan x-component y-component ]
end


;;;;;;;; Cohere ;;;;;;;;;;;;;;
to cohere          ;; turtle procedure
  turn-towards average-heading-towards-processmates max-cohere-turn
end


to-report average-heading-towards-processmates  ;; turtle procedure
  let x-component mean [sin (towards myself + 180)] of processmates
  let y-component mean [cos (towards myself + 180)] of processmates
  ifelse x-component = 0 and y-component = 0
    [ report heading ]
    [ report atan x-component y-component ]
end
```

;;;;;;;;;;;; Helper Procedures ;;;;;;;;;;;

```
to turn-towards [new-heading max-turn]                  ;; turtle procedure
  turn-at-most (subtract-headings new-heading heading) max-turn
end


to turn-away [new-heading max-turn]          ;; turtle procedure
  turn-at-most (subtract-headings heading new-heading) max-turn
end


;; turn left or right, but not more than the 'max-turn' degrees
to turn-at-most [turn max-turn]              ;; turtle procedure
  ifelse abs turn > max-turn
        [ ifelse turn > 0
       [ rt max-turn ]
       [ lt max-turn ] ]
    [ rt turn ]
end


;;;;;; building influence reporter calculations ;;;;;;
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;


to-report highest-influence
  let to-visit patches with [
    influence > 0 and
    not member? self [visited-list] of myself ]
  report max-one-of to-visit [ influence / ( distance myself ) ]
;; ensures that the most desirable patch to visit next has the highest influence value in relation to the agent's current position
end


to-report return-influence
   let to-visit patches with [
    influence = 50 and
```

```
    not member? self [visited-list] of myself ]

  report max-one-of to-visit [ influence / ( distance myself ) ]
```

;; only patches with a value of 50 will be considered in order to follow the route returning to the temple start point

```
end


to-report all-possible-moves

  report neighbors4 with [meaning = "street" and visited? = 0 and distance myself  < 1 or distance myself  > 0 ]

end
```

;;;;;;;;;;;;;;;; to run urban agents procedures ;;;;;;;;;;;;;;;;;;;;

```
to move-urbanites

  ask urbanites [
```

;; if the next patch is not a street or there is another agent on that patch than the agent rotates 90 degrees in a random direction. If the patch is free than the agent can travel forward one patch

```
    ifelse [ptype] of patch-ahead 1 != "street" and not any? other turtles-on patch-ahead 1

      [rt random 90]

      [fd 1]

  ]

end


to move-observers

  ask observers [

   ifelse any? processionals in-radius viewing-radius
```

;; if there are any processional agents within the viewing distance defined in the interface, than wait a certain number of ticks

```
    [

      stay

    ]

    [

      ifelse [ptype] of patch-ahead 1 != "street" and not any? other turtles-on patch-ahead 1
```

;; if there is no procession, the patch ahead is a street and there is not another agent in the way, then the observer can move forward

```
      [rt random 90]
      [fd 1]
    ]
  ]
end


to stay
  set count-down count-down – 1
```

;; determines the length of time an observer will stay in one position. This value is then subtracted by one each tick. Once 0 is reached, the agent can move

```
  if count-down = 0
    [move-observers
     reset-count-down]
end


to reset-count-down
  set count-down ticks-to-observe
end
```

Glossary of Terms

Centrality – a term that refers to several different network analysis measures (eg: closeness, betweenness, reach).

Betweenness Centrality – the proportion of shortest paths that runs between a pair of nodes.

***Capitolium* –** One of the main temples of many Roman cities that was dedicated to the deities Jupiter, Juno, and Minerva.

***Cardo* –** one of the central streets in a Roman town that ran along a north–south axis.

***Castrum (-a)* –** a military camp or fortification.

***Collegium (-a)* –** an association comprised of either officials or religious affiliation.

***Coloniae Maritimae* –** maritime colonies that served a military defensive purpose.

***Decumanus* –** one of the central streets in a Roman town that ran along an east–west axis.

***Domus* –** a roman town house with a predominately residential function.

Edge Effect – the creation of an artificial boundary around a dataset or exclusion of model elements that can affect the results of network analysis or agent-based modelling.

***Fasti* –** a civic and religious calendar. Different ones are found throughout the Roman Empire.

***Fasti Ostiensis* –** the civic and religious calendar of Ostia that was written in marble and displayed to the public.

***Ferculum (-i)* –** a litter often used in processional rituals.

***Horreum (-a)* –** a public warehouse, often used to store grain.

***Insula (-ae)* –** a city-block. It can also be used to refer to a large multi-storey apartment building.

***Laudatio* –** a funeral oration.

***Loggia (-ae)* –** a covered corridor or room that is open and supported by columns.

***Macellum (-a)* –** a permanent indoor market area.

***Medianum* –** Medianum apartments were a multi-storey residential structure typically found at Ostia. They consist of apartments arranged around a central space.

***Opus Listatum* –** a Roman wall construction technique that alternates rows of bricks and rocks.

***Opus Vittatum mixtum* –** a Roman wall construction technique that includes a rows of *tufa* blocks alternated with one or more rows of bricks.

Patch(es) – In NetLogo, the rectangular grid of the model's environment which turtles move over.

***Praefectus Annonae* –** an official in Rome that was in charge of the grain supply, introduced under Augustus.

Praefectus Urbi – a prefect of the city of Rome

***Praeses ludorum* –** an official who sponsored Roman games, usually referred to in the context of games occurring within Rome's Circus Maximus.

***Quaestor Ostiensis* –** a Roman official that was in charge of overseeing the Roman fleet.

***Schola (-ae)* –** a building that was the seat or headquarters of an association (*collegium*).

***Taberna (-ae)* –** a one or two room space that is traditionally used as a shop. They can also be used for storage, as a workshop, and as a residential space for the owner.

Turtle(s) – in NetLogo, these are the agents which are coded to complete a set task acting according to pre-coded parameters.

Bibliography

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