

Urban Connectivity of Iberian and Roman Towns in Southern Spain: A Network Analysis Approach

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Abstract

The Urban Connectivity in Iron Age and Roman Southern Spain project was a recently completed three-year project funded by the Arts and Humanities Research Council. The project, based at the University of Southampton, focused on the various social, economic, and geographical relationships apparent between towns and nucleated settlements. This paper introduces the computational components required by and developed within the project in order to facilitate both the incorporation and integration of disparate data sets, and their analysis through a range of spatial and statistical techniques, including network analysis. Network analysis methodologies, coupled with very-fine-grained and critical assimilation of available data, are seen to provide a context for a clearer understanding of towns in general, and in particular a clearer characterization of links between Iberian and Roman urban settlements in southern Spain.

1 Introduction

The Urban Connectivity in Iron Age and Roman Southern Spain project was a recently completed three-year project funded by the Arts and Humanities Research Council. The project, based at the University of Southampton, focused on the various social, economic, and geographical relationships apparent between towns and nucleated settlements. The study area chosen constituted much of modern Andalucía, focusing on the province of Seville, and equivalent to the central and western portions of the Roman province of *Baetica*. Temporally, the project adopted a broad range, considering sites between approximately 500 BC and AD 500. This paper introduces the computational components required by and developed within the project in order to facilitate both the incorporation and integration of disparate data sets, and their analysis through a range of spatial and statistical techniques, including network analysis. This paper fits alongside a range of papers focusing on specific archaeological concerns (e.g., Isaksen this volume; Keay and Earl 2006; forthcoming (a); forthcoming (b)) and will be supplemented by the final publication of a project monograph (Keay and Earl forthcoming (c)). It also builds upon related studies conducted by project members, including a detailed material analysis of the specific town site of *Celti*, for example modern Peñaflores (Keay forthcoming) and a visibility-based analysis of ancient *Carmo* (Keay et al. 2001).

The development, incorporation, and interaction of Roman urban settlements in the study region, and indeed beyond, are questions of fundamental importance. Such synthetic analyses are hampered by variability in data format, availability, standards, political context and management framework, attribution, terminology, and language. The full breadth of the Roman urban world is thus frequently to be understood largely through directed small-area analyses, or regional scale approaches. In the context of *Baetica*, available data are unusually dense and complex, and distributed widely between institutions and individual

specialists. Thus the project here described was required to define methods both for combining data and preserving their integrity—effectively issues of provenance and probability. It was able to draw upon information gained from across this spectrum, employing a multi-scalar Geographic Information System (GIS) and statistical approaches to the analysis of key archaeological attributes of urban settlements. This multi-scalar approach was largely based around a series of network metaphors in which the relationships between towns, their environments, and the material culture now defining them were considered as arc-node topological systems. Social and spatial network analytical approaches were applied to varying effect with the root aim of exploring how connections between towns could be defined/identified and seen to change across space and time. The context of these analyses may be summarized in terms of a set of key issues:

1. The distinctive regional and local geography of *Baetica*;
2. Relationship between geography, pre-existing urban locations, and broader Roman administrative concerns;
3. The extent to which location, status, and character of towns was privileged over inter-relationships;
4. Methodologies for characterizing connections between towns;
5. A focus upon built up centers of urban communities.

The first task in approaching these issues was to locate and define in archaeological terms the urban settlements that lay at the heart of the project, and the geographic and artificial systems that connected and divided them. At the current stage of analysis, nearly 400 individual sites are represented in the project databases. This distribution derived from a very wide range of data sources. In the first instance the *Instituto Andaluz de Patrimonio Arqueológico*

provided access to the regional site inventory, the *Catálogo de Yacimientos Arqueológicos*, by means of its new on-line databases, *Arqueos* and, more recently, *SIPHA*, as well as published syntheses and epigraphic databases, principally *CIL II*, *CILA* and *CIL II/2* (Gonzalez 1989; Stylow 1995, 1998). The information available was variable, particularly in terms of detail of recording and breadth of coverage. As a consequence, the project also engaged in intensive research of the provenance and background to the data sources “re-contextualized” through this process. It also gathered a range of novel fieldwork data including assessments of site material coverage, detailed topographic and geophysical survey, re-analysis of archive data beginning in the 19th century, and so on. One might characterize the variability encountered through these processes in terms of the broad types of information incorporated. These included descriptions of architectural remains and otherwise unidentified structures, de-contextualized ceramics, coins, sculpture, inscriptions, metalwork, burials, and other finds, published and unpublished excavation reports, field surveys, and doctoral theses. Finally, they included, where possible, the ongoing re-evaluations of the *Catálogo de Yacimientos* undertaken in the region.

2 Databases

All of the data described above were collected and recorded with the aim being to re-contextualize extant data sources in order to provide the project with a broad empirically-based framework for studying urban sites in the region. The multi-scalar analysis of urban sites that was key to the project required the creation of a network of relational databases for drawing out the key archaeological attributes of the Iberian and Roman settlements recorded. The definition and implementation of the required data structures took considerable effort and required the resolution of a wide range of complex procedural and epistemological issues, not least of which was the variability of the quality, nature, and origin of the data, and such issues as multiple names, sites with the same single name, mistaken and duplicated locations, and variable chronological systems. All of this information resided in the databases in its original form wherever possible, with no generalization imposed. Semantic links and logical operators provided the means for querying across the range of sources and types. Thus, the realities of the record—its uncertainty, variability and inconsistency—remained, without unduly limiting its potential role in a synthetic approach. The data were stored as far as possible in their original form rather than as generalized, sanitized versions.

The data were structured within a series of textual, multimedia (plans, photographs, aerial photographs, maps) and geographic databases. The overarching system was based around ESRI technologies, with an implementation of ArcSDE, a SQL Server enterprise database, and subsidiary Access databases. Spatial data were deployed within a geodatabase and conventional coverages as required. A fundamental lesson of the project was thus a readiness to employ simple solutions wherever possible and to integrate data only

when and where necessary. Although technological developments facilitated evermore joined-up data infrastructures, the sheer volume and variability of data encountered, coupled with the project’s relatively short timescale and limited manpower, made such pragmatic approaches essential.

The master database held numerical and textual data, such as amphora stamps, a variety of epigraphic data sets, milestones, category-scale site descriptors, and so on. Comprehensive lookup tables and thesauri were also generated and stored separately along with other aspects of the system logic. Specific textual database facets were grouped into broad categories, namely descriptive, chronology, architecture, fortification and industry, ceramic, spatial, and metadata components. In all there are now more than 200,000 individual records providing a unique view on the region and its Iberian and Roman archaeology. The data held in these databases were linked to vectorized cartography and aerial photography at scales of 1:5000, 1:10000 and 1:200000, in addition to the project fieldwork results. The geodatabase itself stored project-wide geospatial information such as raster and vector topographic data, hydrology, and annotation layers. Additional spatial archives were created as necessary and used for particular stages in the analysis. A final class of data, the interface tables used in the project intranet, was stored in a separate web database system maintained by the Archaeology Department at the University of Southampton.

2.1 Uncertainty and Database Structure

At a fundamental level the project was about sites, and more than that it was about urban sites. One was therefore required to ask, in this context: what is urban, and how does urban relate to alternative descriptions of settlement structures in the region, such as agglomerated settlements, villas, and rural sites? The archaeological reasoning behind these distinctions proved complex and at times contradictory, and as a consequence the project attempted to derive its corpus of urban sites at least semi-automatically. The criteria that underpinned such distinctions were complex and of variable relevance and integrity. As a consequence, the project has relied to a considerable degree on various fuzzy database techniques and attempted to define the semantics underlying the data when combined (Bellman and Zadeh 1970; Niccolucci et al. 2001). It employed fuzzy set theory alongside linguistic operators, and incorporated these within various data management systems.

The approach is best illustrated in terms of project chronologies. Given the diachronic focus of the project, it was felt vital that temporal site data were dealt with in a transparent fashion. A number of problems associated with these highlight wider issues encountered when attempting to maximize information from amalgamated data. Chronological indicators varied both in terms of their internal consistency—for example, use of the competing terms *Early Empire* and *Early Roman* to describe the same kinds of material on different sites—and in their integrity. In many cases the original context of the dating source was unclear, giving rise to a need for a subjective and objective

assessment of which sources to trust, what information to exclude, and how to weight the value of various information sources. Clearly, much chronological data did not support detailed scrutiny but it was vital that the analyses that used them were qualified in terms of the circumstances of their origin. As a consequence, the finished database accepted and combined four sources:

1. Excavated sequences describing chronological data within context;
2. Dated ceramics, coins and other material, preferably related to specific dating standards or traditions;
3. Chronological arguments, usually related to particular forms of material evidence or wider interpretations;
4. Chronologies ascribed to data and sites lacking any clear justification.

The significance of each of these could be adjusted. Thus, presence/absence of precise chronological material was considered more significant, and to some degree weighted above, unqualified argument. Allowance was also made for variation in the use of dating terms in publications. For the purposes of data visualization one could, therefore, choose to reclassify data within the broad chronological divisions of the Iberian (5th to late 3rd centuries BC—and corresponding to the Iron Age), Roman Republican (late 3rd to late 1st centuries BC), Early Imperial (late 1st century BC to late 2nd century AD) and Mid Imperial (late 2nd to late 3rd centuries AD) periods. However, such distinctions remained temporary and related to the original context of the data recorded. Crucially, this allowed the project record to be made in a way that was consistent with its published source(s), rather than having to reappraise all of the evidence prior to assimilating it into the project system—something clearly beyond its scope.

The fuzzy set approach was employed wherever practicable. This relied on the assignment of fuzzy parameters associated either with numeric ranges or with linguistic operators, themselves hierarchically structured in thesauri (although not necessarily conforming to standards in all cases). Thus, just as the database allowed chronological data to be entered in the formats “AD 79,” “second half 3rd C AD,” “Early 3rd AD—Late Antique,” and “Antonines,” so geographic components derived from site descriptions included “hillside” or “steep slope” (see Peuquet 1988 for an introduction to the issues posed by geographic fuzziness; Wilson and Burrough 1999). By combining numerical fuzzy sets with linguistic operators it was possible to perform queries which included the upper and lower bounds of a given membership function. In practical terms, for the project data this meant that the start of a century could be defined as “early,” and associated with a given membership function associated with the context for the record (e.g., the first 20 years of a given century +/- 5 years). In the majority of cases a specific membership function could not be assigned and therefore broad, standardized fuzzy sets were employed. However, in a number of cases—and in terms of specific sources—it was possible to define localized fuzzy set parameters. The implementation of this technique was such that the full range of Allen operators could also be employed.

Such an approach remains dependent upon the data and an interpretation of the terminology. For example, where a given site was described as *Iberian and Roman* in a given source, did this also mean that it could be included in an analysis considering Early Empire sites in particular? Given an excavated sequence such an interpretation could perhaps be refuted. However, if we had ignored the site, then we would have missed a potential association. A definitive analysis, integration, and presentation of the dating evidence will only come with the final project publication and even then, given its genesis, definitive will perhaps remain an inappropriate description for such inherently fuzzy information. However, it is to be hoped that in tackling this uncertainty the project will have produced a robust model for the re-contextualization of extant data of similar kinds held elsewhere.

Re-contextualization by implication requires a linking of data with location, whether relative or absolute. As stated previously, this project aimed to migrate data in a way such that the information it contained remained as intact as possible. The basis for this migration in project terminology was the site. Following the CIDOC CRM (CIDOC), each site was distinguished in terms of appellations and geographic coordinates. Much of the information available was assigned to an ancient name, modern site name, or locale. However, the geographic focus of analysis to be employed required the site to be at its fundamental level a spatially-referenced entity. Links between names and locations were problematic. In some cases reports provided the modern name and a series of alternative names, whilst in others an ancient name was associated with a variety of modern names, or with a modern name which was not referenced as a project site, or indeed as part of a nebula territory (see below). A truthful rendering of such semantic forms is relatively easy to describe but in practice the systems created made generating even comparatively simple summary statistics such as a count of inscriptions complex and laborious. To take an example:

1. Site G was defined by a scatter of material at location X,Y, interpreted as urban;
2. Site H was defined by a scatter of material at location U,V, interpreted as a cemetery;
3. Site G was called A in a report;
4. Site H was called A in a subsequent report.

On this basis, would it have been possible to determine whether the two locations should be treated as a single site? Was the site a town with an associated cemetery, or should the two sites have been considered separately? Depending on this decision the possibilities for assigning associated material culture were similarly variable. For example, site G may have been associated with the ancient name J. In the database we recorded how this attribution arrived and at what level it was defined. For example, the place defined as G was associated with J via an inscription, or perhaps J was associated with the name A. This led to considerable additional overheads when attempting to query any given subset. As a consequence, periodic creation of static tables was performed in order to speed the process of analysis, for the creation of GIS-based distribution maps, and for defining input to the analyses. Although a wholly live system

was originally intended, this proved unwieldy in practice, not as a consequence of the volume of data but rather of its contingency and uncertainty. The interpretative process described is of course no different to that undertaken by archaeologists in assessing the strengths and weakness of various conflicting arguments. However, the problem was here compounded by the sheer volume of information encountered and the desire fully to document the processes followed.

2.2 The Urban Sites

The eventual outcome of the laborious data migration process was a database of site and various regional-level variables. At the broad scale this included evidence for aspects of the interconnectivity at the project's core—for example, road markers and geographically significant sub-urban settlements. At the site level the data spanned the full breadth of Roman material culture, as detailed above. The complexity inherent in these data has already been alluded to and in addition to generating static snapshots of the data it was felt appropriate to generate site-scale summaries of the archaeological, epigraphic, geographic, and historical evidence available. Elsewhere we have used the term hierarchies to describe this summary data, given their inclusion of largely presence/absence scale data and the creation of putative ordinal scale summaries from them. These data-sensitive regional urban hierarchies have been used in the network and other inter-site analyses described below.

It is important to stress that rather than being based

upon preconceived hierarchies derived from conventional historical/epigraphic evidence or summary archaeological analyses, the hierarchies were always fluid and synchronic. Hierarchies were tied to the data—whether those data were hypothesized defensive features, public architecture, cemeteries, key classes of pottery, pottery kilns, visual prominence, or any of the classes of historical and epigraphic evidence available. More than this, and as a necessary counterpoint to a dumbly automated approach, the site summaries also benefited from input by acknowledged experts in the material culture and other information vital to an understanding of the region in this period. The input of these collaborators is acknowledged in detail elsewhere but it is clear that without the mediation provided by these experts, of the relationship between the technology and the material, the project would have been much the poorer. Although the project is largely complete, these collaborations continue to stimulate debate and new discoveries.

An area in which expert discussion proved particularly complex was territoriality. A review of the literature could suggest that previous analyses in the region have focused on the relationship between archaeological data, ancient names and epigraphy (Figure 1), towns, roads, and rivers. This relationship was conceived of in the abstract sense, in essence overlooking or broadly summarizing the geographical milieu. There has been little agreement in attempts to deal with the dispersal of data within these complex landscapes. Taking epigraphic data as an example, the project had spatially specific information, perhaps with named towns, of uncertain provenance, but crucial importance. Similarly, it needed to employ the results of regional survey that in

some cases provided the only insight into components of the region's economy.

Territoriality is not a new issue either to Roman scholars or indeed within the GIS sphere. For our analyses to represent the information available it was essential to decide upon strategies from these domains for dealing with amorphous, culturally, contextually, and temporally contingent regions. From a computational perspective whilst Cartesian systems of locational analysis (such as relatives to Thiessen polygons, Voronoi diagrams, and β -skeletons (Jimenez and Chapman 2002)) can be used as a general guide, these only allow one to attribute given sites to territories in a geometrical sense. The limitation of such approaches proved to be that they effectively ignored the geographical and social realities of the landscape.

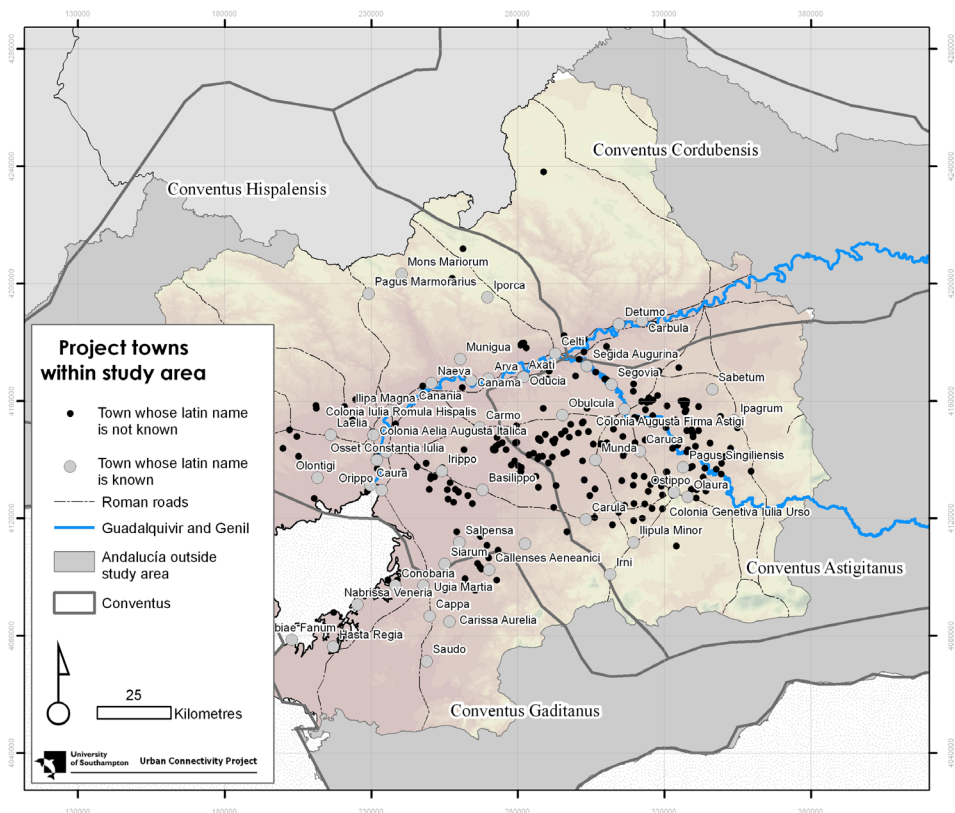


Figure 1. View of urban settlements forming part of the project database, indicating key named ancient sites.

However, this did not remove the problem that due to the dispersed nature of much of the data, spatial territories had to be ascribed to individual urban centers. Thus, the project combined topographic and related data, including visibility indices, tangible routes, patterns in archaeological material, etc., alongside territories defined through concerted epigraphic and other studies (Stylow 1998). It was hoped that by combining data sources we would approach the multiplicity of administrative and less tangible territories that may have been logistical or perhaps largely imperceptible realities to the people of Iberian and Roman southwestern Spain. In so doing we attempted not to ignore conflicting understandings of space and place emerging from GIS and elsewhere, but, rather, to produce representations of how we understood those realities might influence the material culture record. As discussed elsewhere, we must also acknowledge that this was an interpretatively complex, and far from neutral process (Zubrow 2006). The utility of a combined approach can perhaps best be exemplified by analysis of urban territories that integrated all these approaches (Figure 2).

Here we explored the diversity of territories associated with the urban centers considered by Stylow (1998). It became apparent that territoriality is a function of many components, each of which has implications for the connectivity of central and surrounding locations. The landscape could be seen as multifaceted, with relationships between places ebbing and flowing not merely in time, which was a highly significant benefit of such analyses, but also in terms of cost of travel, tangible network factors such as rivers, visibility, similarity of urban material culture assemblages, chronology and spatial patterning, topography (including slope and landscape character), and so on. The derivation of territories, whether epigraphically, topographically, culturally, or through some other means, was complicated but deserves to be explored more widely within Roman studies of the region. Our work explicitly considered the landscape around each town to be complicit in a variety of overlapping territories. Zones of visibility and cost of transport provided two options that could be readily expressed in a GIS, but more complex are the possible local communication systems implied by material culture recovered from the vast number of rural sites (more than 5,000) in the region. The project really has only begun to consider

this wider range of information and it is only possible to explore such territories in detail as case studies.

3 Network Analysis

Having established a detailed context for our analyses, the remainder of this paper considers the technological components to the interpretation of the broad datasets defined. Fundamental to these analyses has been the concept of the interconnected network, and of the potential for conceiving of and representing information in this way. This concept carries with it a number of governing principles. Firstly, it assumes that we have knowledge, and preferably a detailed understanding, of the structural components of the network. In our terms this meant the urban sites and the means, conceptual, physical, or otherwise, by which they could be considered to have interconnected in the past, and are connected today. Secondly, we must accept that the connections thus defined have or had a real meaning; one might join together any three discrete urban sites but such connectivity need not necessarily represent any meaningful links. Thirdly, to be connected at a given point in time (for an analysis such as ours taking into account both diachronic and synchronic process), all parts of the network must be contemporaneous from the perspective of the network. This aspect alone justifies the computational approaches to chronology described in detail above. Finally, a network approach must allow for, although not necessarily incorporate, aspects of connectivity related not to the points connected but rather to the mode

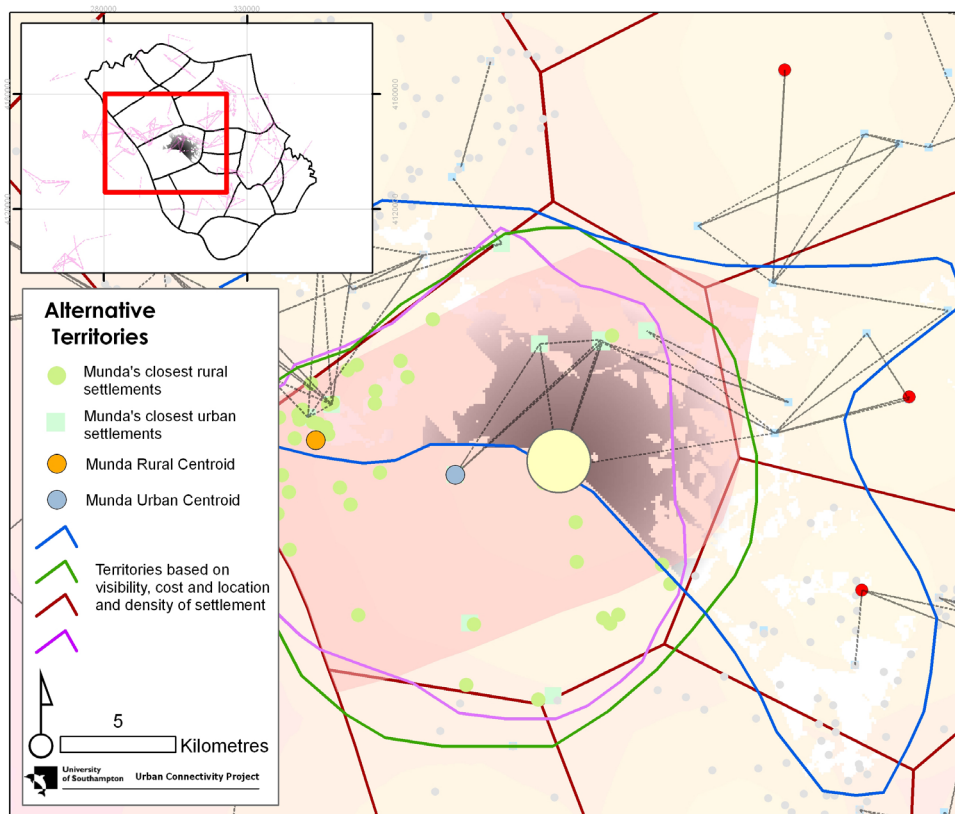


Figure 2. The types of conceptual territories to be considered when re-contextualizing data from the study regions; using the proposed location of Munda as an example focus.

of connection. Thus, a line of sight might exist in only one direction, a cost pathway might function differently according to the starting point, and the influence of a given site across a network might not only be a function of network topology but rather exert an influence over the network as a whole as a consequence of some aspects of the data modeled.

For this project the underlying assumption was that the networks considered were symptomatic of the movement of people and ideas between towns in the region, tempered/enhanced/obstructed by geographical realities of the landscape and, where relevant, mediated by natural and man-made routes of communication. The network analyses took into consideration the archaeological evidence for ancient transport systems in the region. In particular, attention was focused upon cost surface approaches and networks of transportation, incorporating roads and water systems. Our analyses considered three types of network that we have loosely termed geographic (e.g., road topology) (Figure 3), derived (e.g., cost distance or visibility), and weighted (e.g., according to urban hierarchies or epigraphic evidence).

They have considered these networks using the complementary approaches of spatial and social network analysis. The latter is described in detail by Isaksen (this volume). It is a wholly topologically based approach, resulting in statistical summaries of interconnectivity, most frequently expressed as forms of *closeness* (Freeman 1979; for archaeological implications, see Jenkins 2001; Peregrine 1991). In addition to Isaksen's consideration of itineraries, our use of social analysis has been to create mathematical summaries of the networks generated in other ways. Thus, in our assessment of patterns of inter-visibility, one might consider the role of possible visibility hubs and spokes, defined in terms of gradients of topological closeness.

3.1 Spatial Network Analysis

Spatial network analyses build upon a given network topology by locating it in a spatially-relevant context. Such analyses take account of factors such as distance and orientation, using conceptual frameworks such as the β -skeleton, TSP, p -median/location-allocation, and so on. The project applied these within the ArcGIS network analysis framework, built upon by a number of custom approaches, and drawing upon the relatively limited range of previous archaeological applications of the technology (Church and Bell 1988; Mackie 2001). In the first instance, geographic networks were used as a way of defining the potential for interconnectivity between towns. These provided an insight into the spatial configuration of sites to complement the urban hierarchies described above. They also provided essential background for understanding the relationship between and around urban settlements. For example, networks of visibility seemed to demonstrate interesting distributions around the river valleys and in discrete areas of the countryside (Figure 4).

Such networks of inter-visibility were derived from project fieldwork and from regional topographic datasets, the latter including cumulative viewsheds at between ten

and fifty meter resolutions, adopting fuzzy and probabilistic approaches, and taking account of distance and direction of view (Allen et al. 1990; Fisher 1994; Wheatley and Gillings 2002; Zhang et al. 2002). The ground-truthing of these computational visibility analyses was an unplanned additional element of project fieldwork. It proved important in identifying anomalous results and augmented our understanding of visual territory and context.

The project was careful to treat such analytical, and indeed the subjective, phenomenologically described visibility products with care. Drawing much from Higuchi and others' dissection of the binary viewshed (Higuchi 1989), we have striven to consider the networks of inter-visibility that clearly existed and seemed meaningfully to have varied across Baetica as more complex than the can "see/cannot see" dichotomy sometimes associated with such approaches (see also Lock 2000; Llobera 2003, 2006). Our networks did not conceive of visible urban territories as discrete entities. Rather, they were what we have termed elsewhere "a statistically defined function overlying the landscape" (Keay and Earl forthcoming (b)). The analyses did, however, enable interesting patterns to emerge. Thus, in terms of visible distance between neighboring sites, the majority seemed to have very limited local visual territories, with sites at a greater distance proving more likely to be visible. Broadly, connection between sites appeared to function either with inter-visible local urban centers clustered within shared visual territories, or with sites visually divided from their local neighbors but linked into long-distance regional networks.

The networks derived in the ways described were weighted according to the re-contextualized archaeological information. These data were derived from the additional epigraphic, sculptural, and archaeological data collated for the project by Spanish colleagues, alongside information collected and analyzed by project members. They were chosen to ensure a minimum coverage for all apparent urban centers and their connections to others in the region. For the Iberian period, lack of distinctive information meant that the emphasis lay upon the presence of defenses, imported ceramics, and metalwork. For the Republican period, the presence of sculptures, occasional inscriptions, and imported Italic Black Gloss pottery were used. Far more information was available for the Early and Mid Imperial periods. Inscriptions focused upon the presence of municipal charters and other related documents, different social and cultural connections between elites, familial relationships as expressed through recurrence of similar name types at different towns, and evidence for different kinds of benefactions. The sculptural data was used to chart links and equivalences as expressed through the kinds of sculpture, the range of subjects portrayed, and the materials used. The coins were considered as one means to gauge the strength of links between towns where coins were known to have been issued and where they were used and lost. Finally, ceramic evidence was used to look at links evident in the presence of varieties of locally-produced *Terra Sigillata Italica* and amphorae.

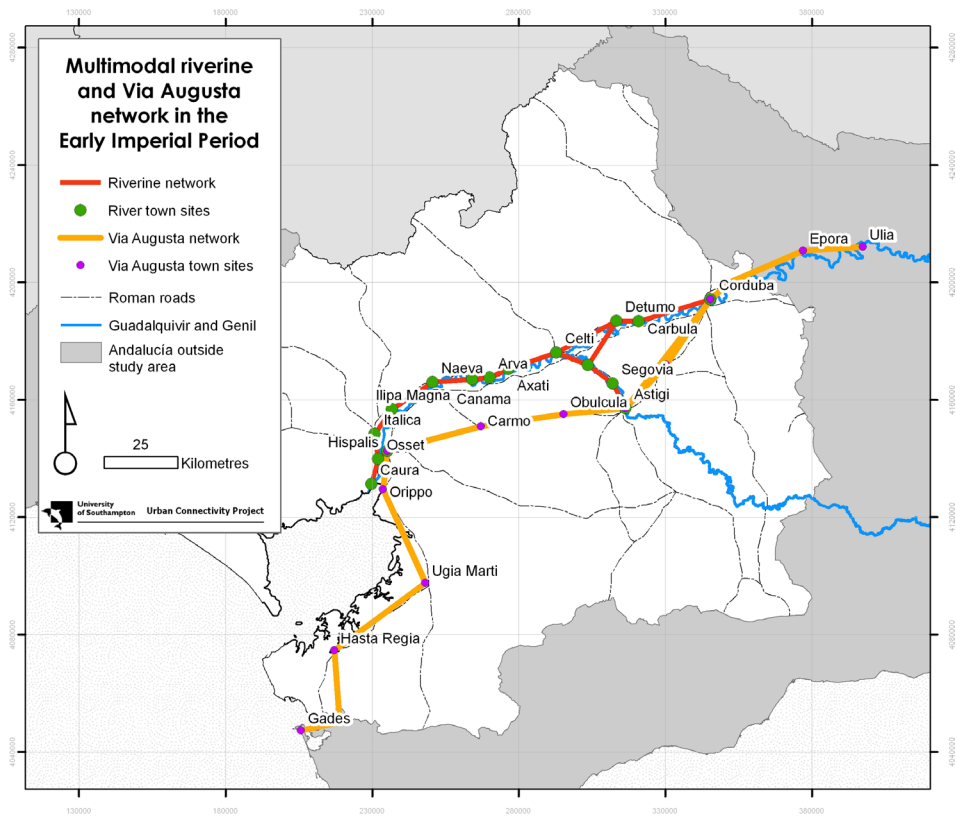


Figure 3. Multimodal networks derived from ancient itineraries, demonstrating hypothesized riverine and Via Augusta connectivity.

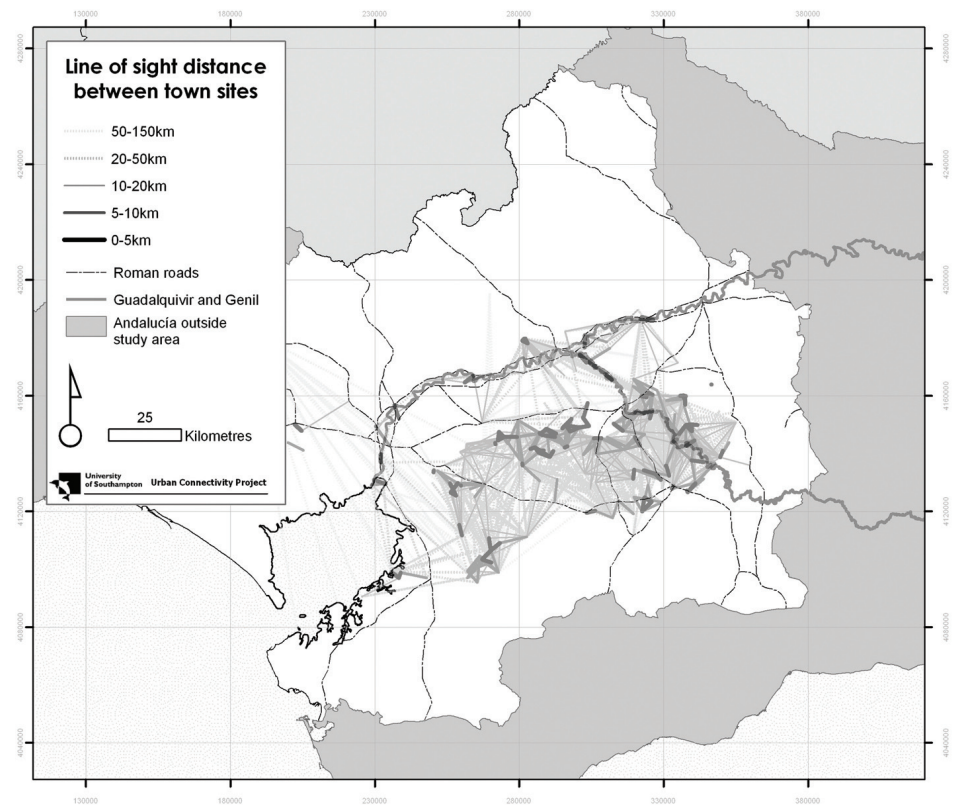


Figure 4. Sample visibility network, based on a reclassification of cumulative probabilistic viewsheds.

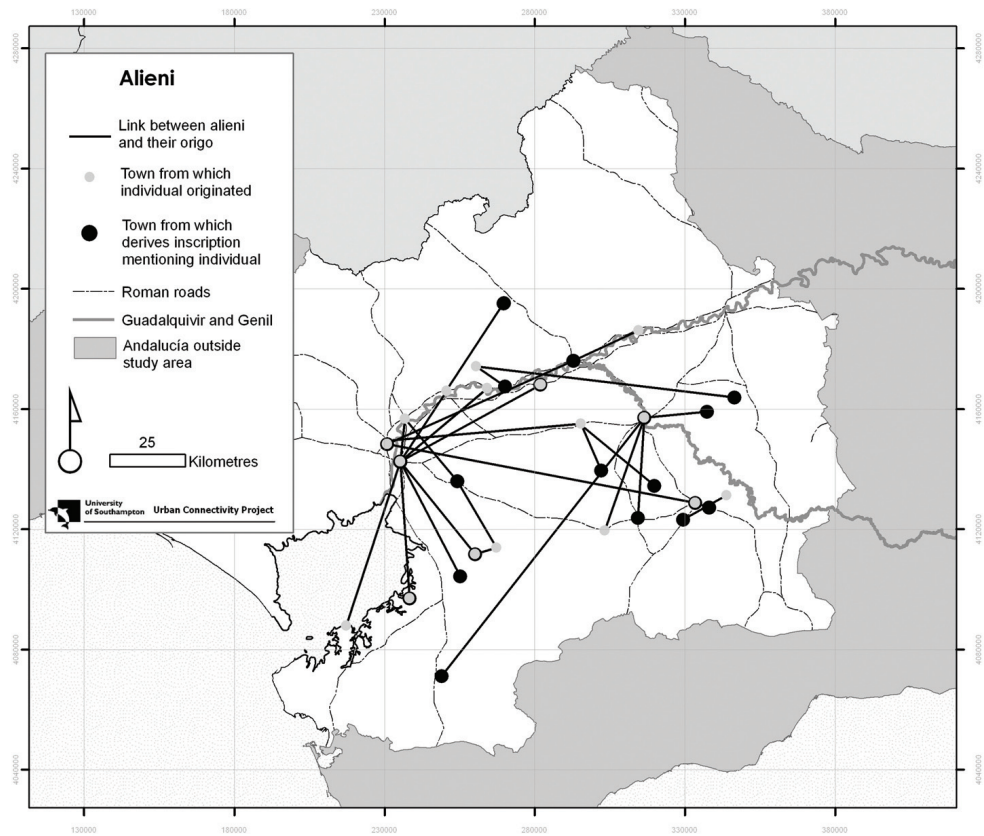


Figure 5. Sample analysis local and regional connectivity, based on alieni.

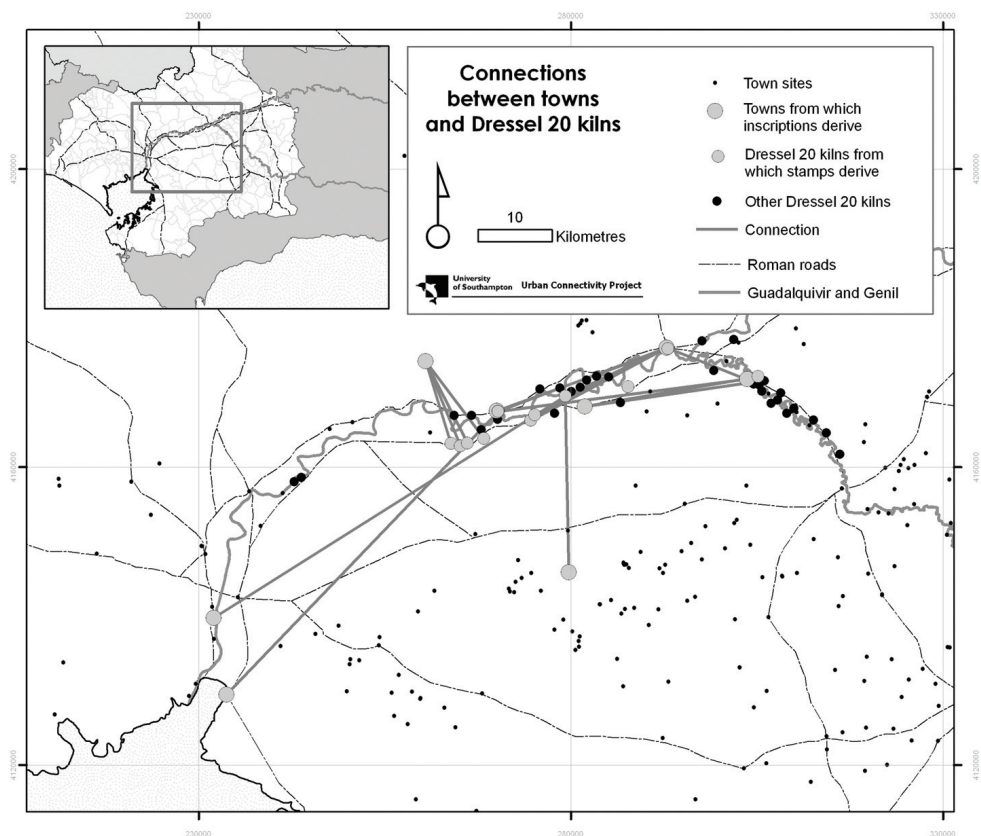


Figure 6. Economic connections indicated by Dressel 20 amphora stamps.

3.2 Multi-scalar Networks

The data gathered allowed for analyses at multiple resolutions. Thus, whilst the urban summaries could be used to weight transportation networks, subsets of the available data allowed localized networks of towns to be explored. The project approached these by charting the appearance of objects of known origin at towns away from point of origin. Objects studied included Ibero-Roman coins, some ceramics, the presence of *alieni* recorded on inscriptions (Figure 5), the spread of the epigraphic habit as a whole, and so on.

Again, the implications of these networks have been explored in detail elsewhere, but it was clear that they suggested a differential distribution of localized movements across the study area. In some locales materials indicated widespread connections apparently maintained by connected individuals or families, whilst in others the connections seemed comparatively weak, with connectivity indicators extending only a short distance from their origin. This work is being underpinned by ongoing studies, taking place with the input of specialists who are exploring possible relationships between Dressel 20 amphora kilns, the individuals or *gentes* named on Dressel 20 stamps, and stone inscriptions with similar names from towns in the region (Figure 6). This work may provide further evidence for extent of links between towns and related areas of economic activity, and information regarding the importance of the local and the regional within the Baetican economy.

By combining multi-scalar networks it was possible to highlight the participation of individuals and communities in inter-urban contacts, as well as to suggest the possible existence of regional urban networks at different points during the Republican and Early to Mid Imperial periods. This was the means by which new light was shed upon the negotiation and renegotiation of urban identities and, as a consequence, the creation and development of Roman provincial landscapes. To take one example, it seemed that there was a broad continuity of Iberian urban settlement from the Republic into the Early Imperial period. Nevertheless, the distribution of urban settlements remained markedly differentiated, perhaps in part as a function of the Via Augusta. Such differentiation could be traced back to the possible processes by which Iberian communities were integrated into the political and economic structure of a Roman Baetica. We have argued, therefore, that extant networks of communities became focused around key urban centers such as Carmo and Urso, within territories relating to visual dominance, location within multimodal transportation networks, localized systems of control, and long-distance relationships with the emerging urban centers such as Astigi and Hispalis.

4 Conclusion

Network Analysis methodologies, coupled with very-fine-grained and critical assimilation of available data has provided a context for a clearer understanding of towns in general, and in particular a clearer characterization of links between Iberian and Roman urban settlements in southern

Spain. Issues of data cleaning and interoperability of database components resulted in a range of largely pragmatic choices, such as the maintenance of multiple DBMS. Greater standards compliance, perhaps assisted by a more thoroughly XML or object-relational based infrastructure, could have been enforced from the beginning, for example greater CIDOC CRM integration, although moves in this direction continue. In terms of its interpretative goals, the project was able to explore regional differences in character, location, and connections between towns, local scale of connections between centers, and the importance of indirect contacts for flow of information and ideas. The networks uncovered, created and analyzed by the project did not provide all of the answers. It remained unclear precisely how urban communities chose to participate in the social, cultural, and political life of the Roman Empire, and archaeological variables could only offer suggestions. In all cases it seemed that one needs instead to think in terms of the idiosyncrasies of different communities and their changing relationships to neighboring towns and the broader province. Although the project is largely complete and in the process of publication, the implications of its data continue to grow, and we look forward to the expansion of our coverage into new questions, new databases, and new locations.

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