A GIS exploratory analysis of farmsteads: A case-study of the Karystian farmsteads on the Paximadi Peninsula

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Περίληψη

Αυτό το άρθρο προέκυψε από την έρευνά μου σχετικά με τον ρόλο και τη λειτουργία των αγροικιών στη γεωργία κατά την Κλασική-Ελληνιστική περίοδο (450-250 π.Χ).[1] Η προβληματική ταυτοποίηση των αγροτικών θέσεων που διστακτικά ταυτίζονται με αγροικίες έχει οδηγήσει κάποιους ερευνητές να απορρίψουν την ύπαρξη αγροτικών θέσεων που θα μπορούσαν να έχουν διάφορες λειτουργίες (εργασία, αποθήκευση, επεξεργασία) για όσους ασχολούνταν με την γεωργία.[2] Σε αυτό το άρθρο θα παρουσιαστούν οι αγροτικές θέσεις που προσδιορίζονται ως αγροικίες στην επιφανειακή έρευνα στην Κάρυστο[3] προκειμένου να πραγματοποιηθεί μια διερευνητική ανάλυση της χωρικής κινητικότητας μεταξύ των αγροικιών και των αστικών κέντρων με σκοπό την κατανόηση του πως η προσβασιμότητα στις αγροικίες διευκόλυνε τους αγροτικούς τους ρόλους. Θα ξεκινήσω με μια σύντομη επισκόπηση βασισμένη στο ρόλο της τυπολογίας των αγροτικών θέσεων που προτείνονται στην έρευνά μου και τις προκλήσεις που συνδέονται με την εφαρμογή αυτής της τυπολογίας στις θέσεις που βρίσκονται στο ακρωτήριο της Παξιμάδας. Στη συνέχεια θα χρησιμοποιηθούν αλγόριθμοι Ανάλυσης Συμφορότερης Διαδρομής (LCP - Least Cost Path Analysis) για να διερευνηθεί το εύρος των επαφών που είχαν αυτές οι γεωργικές θέσεις με μεγαλύτερα αστικά κέντρα. Τα συμπεράσματα αυτής της ανάλυσης θα καταδείξουν πόσο προσιτό και συνδεδεμένο ήταν το γεωργικό τοπίο με την αγροτική παραγωγή καθώς επίσης και τις οικονομικές επιπτώσεις σε σχέση με τη διακίνηση των αγαθών στις αγορές.

Introduction

The aim of this paper is to carry out an exploratory study on the viability of applying GIS (Geographical Information Systems) modelling, specifically spatial mobility analysis, to the farmstead sites identified in the original survey of the Paximadi Peninsula.[4] This study is inspired by Keller and Hom's 2010 paper in which the authors noted a number of ancient route ways connecting sites in the Paximadi Peninsula. In the article the authors comment:

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1. I wish to extend my thanks to Dr Donald Keller for very kindly providing the data which allowed this analysis to happen. My thanks also to the School of Classics, UCD, and the Head of School Prof. T. Urbainczyk, who provided funding to attend the conference, Ms. J. Doyle for reading previous drafts of this paper, and the peer reviewers whose comments have greatly improved this paper.

2. Pettegrew 2001; see responses by Bintliff et al. 2002; Foxhall 2002; Osborne 2002; Pettegrew 2002.

3. Keller 1985.

4. Keller 1985; 1989; Keller and Wallace 1988.

> The analysis of routes can provide insight into the distribution of population centres as well as areas of economic activity. It can also widen our understanding of the reasons for communication (trade, social contacts, religious activities, political relations, and boundaries).[5]

In this paper I compare the sections of ancient route ways identified by the author to the least cost paths generated using the GIS programme ArcGIS 10.[6] Least cost paths model routes across the landscape based on the path of least resistance. This is achieved using the elevation data acquired from an ASTERv2 DEM and generating routes between two points. It is worthwhile here, therefore, to compare the existing ancient routes against those which trace the most cost-effective path through the landscape. Additionally, a cost distance analysis will measure the time cost (measured in minutes) to travel through the landscape. These analyses could potentially provide insight into the reasons behind the positioning of roads and sites: i.e. for ease of access to particular parts of the landscape for agricultural purposes. Similar studies have been carried out in the Boeotia survey area, and interesting results concerning the accessibility of sites in the Classical agricultural landscape have emerged.[7]

The archaeological data and GIS analyses

Before GIS analyses can be undertaken it is necessary to provide a context for this discussion and to outline what is meant by the term 'farmstead'. For the purposes of this paper, a farmstead is defined as a rural site which could support either year-round or temporary occupation by a free or slave-labour force engaged in agricultural activity either for subsistence or economic gain. For Lin Foxhall, 'the modern archaeological notion of a farmstead may well be an alien intrusion in terms of classical Greek thought, primarily because there is no ancient Greek word for "farmstead" in a joined up American or European sense'.[8] The fact that there is not an ancient Greek word for a farmstead does not necessarily mean that they did not exist, primarily because the Greeks classified real property differently from our modern way of so doing.[9] To explain further, real property was made up of its individual elements, meaning that an *oikia* (house) could be found in the city as well as the countryside, and that it could be further defined by including additional information about the type of land or structures associated with it. Therefore, it is not sufficient to dismiss the existence of farmsteads solely because of issues pertaining to ancient and modern nomenclature. The difficulty in correctly naming these types of rural sites and structures is symptomatic of the challenging nature of research into ancient Greek farming. The issue of farmsteads is a complex one, and there need not be one single explanation for all farms and their systems.[10] It is important not to get bogged down in the debates concerning the terminology used to describe these rural sites, and it is not as simple as identifying the evidence on the principle of 'one size fits all'.

There is a need for new, specific criteria constructed from the accumulated findings of previous archaeological research, since it is irrefutable, based on the archaeological and textual evidence, that people worked on, moved through and lived in the countryside. Therefore, the development and application of criteria for farmsteads helps us to reconstruct how farmers used rural sites for agricultural industry.

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5. Keller and Hom 2010, 2.

6. For a discussion on the applicability of GIS technology to the archaeological record, see Connolly and Lake 2006; Van Leusen 1999; Wheatley and Gillings 2001.

7. Howard 2007, 111-125; Farinetti 2011.

8. Foxhall 2002, 216; cf. Lohmann 1992; see Osborne 1992.

9. See discussion in Pritchett and Pippin 1956; Finley 1951; Lambert 1997.

10. Pečírka 1973, 114.

Over the course of my research, I have developed a role-based typology[11] of rural agricultural sites based on the available archaeological data of sites identified in landscape survey as 'farmsteads'. In doing so, I have classified them according to their structure types, locations, ceramics and evidence for agricultural activity.[12] In brief, I have identified three types of rural site which could have supported domestic and/or industrial activity connected to agriculture. I term the three site classes 'simple rural sites', 'installations' and 'tower complexes'. Furthermore, within each site class I argue that it is possible to recognize a scalable range of activity on sites from single-use sites to sites which supported a full range of domestic and agricultural activity. Fig. 1 broadly illustrates the variety of site functions within each site class.

The activity of each site class falls within a continuum ranging from a purely agricultural function, indicated by the presence of an installation used in the processing of raw materials (threshing floors, *trapetum*, lever presses), to a primarily domestic ceramic signature with little or no evidence of agricultural activity. The results of my analyses of farmstead sites have indicated that it is highly probable that there was a broad spectrum of different types of structures and sites engaged in agricultural activity with regional variations throughout the Greek world. Significantly, this spectrum is dependent on a series of regional variables, including the topography of the landscape, socio-political regimes and the wealth of the farmer.[13] In an attempt to understand how agricultural industry was realized, it is necessary to generate models of the agricultural landscape based on the accessibility to and from each site class and the nearest urban centre, using GIS. In the context of this research, it is important to stress that the findings from GIS analysis are not complete owing to the incomplete state of the archaeological record and the crude nature of the basic data available for analysis. The purpose of this paper, therefore, is not to provide solutions, but to further question the available data in a meaningful way in an attempt to model the agricultural activity in the landscape.

The final publication of the survey and excavation material from Karystia has not yet been completed.[14] Therefore it is not possible to make statements about the nature of habitation or activity at the individual sites based on the available published ceramic material. This means that it is difficult at present to distinguish variations in site use based on the ceramic types and quantities found there. Nevertheless, the published material as it stands does suggest that the ceramics from these sites are compatible with the 'ceramic signature' identified in other farmsteads.[15] Further in-depth analysis will no doubt shed light on the different functions of these sites, but as of yet an informed discussion of activities in individual farmsteads remains an impossibility. Nevertheless, the sheer quantity of visible structural remains in this area indicates that an analysis of the ceramics will add to our understanding of an already fascinating example of an ancient agricultural landscape.

Mobility in the agricultural landscape of the Paximadi Peninsula

Fig. 2 locates the agricultural sites, settlements and ancient route ways identified by Keller and Hom used in this paper, with the addition of the GIS-generated least cost paths. The map shows a large section of ancient route way extending from the ancient site of Kourmali northwards, possibly towards Karystos, and other traces of road are indicated in the centre of the peninsula and to the south. For this

11. Farmstead typologies have been created previously for individual areas and particular site types (towers) such as Keos (Mendoni 1994, 156); see discussion of farmstead classification in Stewart 2013; 2014.

12. This classification and its applicability to the archaeological record is discussed in greater detail in the monograph *The Ancient Greek Farmstead* (McHugh 2017).

13. See discussions in Jameson 1992, 135; Lohmann 1992, 58; Pečírka 1973, 114.

14. See Keller and Hom 2010; Keller and Schneider 2009; Langridge-Noti 2004.

15. Langridge-Noti 2004, 487-494; see discussion in Pettegrew 2001; Whitelaw 1998, 231ff; Winther-Jacobson 2010.

study the sites of Kourmali, Karystos and C27 located within the peninsula could have functioned as a central place for the storage and/or sale of agricultural produce.[16] In this model, therefore, these sites are assigned a role as nodal points in the landscape. Given the importance placed on these three sites within the peninsula, it is possible to assume that these sites were accessible to and from each other via roads. By generating least cost paths between these three nodal points a comparison to the available ancient evidence can be undertaken. As illustrated in Fig. 2, the least cost paths do not exactly mirror the noted ancient roads. There are some similarities between the ancient routes and the least cost paths, particularly leading from Kourmali and from site C27. This of course is not definitive proof that the rest of the cost path follows the ancient route. However, the positioning of sites, especially along the east and north of the peninsula, does suggest that there may have been a road network which made these sites accessible. Even if the least cost paths and the ancient routes are not comparable at all to the GIS outputs, this may simply indicate that factors other than ease of access were at play for site location.

Crucially, the ability to move produce through the countryside quickly and easily increases the economic viability of agricultural industry; indeed, even farmers engaged in cultivation for subsistence purposes need to engage with markets periodically.[17] In terms of this analysis, it is important to take into account the movement of people walking to/from the city and countryside, but also the movement of animals carrying loads of agricultural produce and raw materials. By generating cost distance maps it is possible to investigate the cost, in time, for moving across the landscape and to visualize these estimates on a map. In addition to this, these estimates can then be compared to benchmark parameters for the kinds of load, speed and transport for ancient Greek and Roman contexts, as listed in Table 1.

Type of transport	Speed (km/h)	Load (kg)
Human pedestrian	4-5	n/a
Human porter	2.5-3	30-60
Pack donkey	2.5	60-100

Table 1: List of performance estimates.[18]

Fig. 3 illustrates the amount of effort, measured in 30-minute increments, it takes to move across the peninsula from Karystos. In this instance the map illustrates that it was possible to move through the landscape within a relatively reasonable time frame. For example, let us assume a scenario where agricultural produce needs to be moved from the farmsteads in the south of the peninsula to the markets at Karystos. The map illustrates that it would take approximately 60-90 minutes for a pedestrian travelling at 5 km/h to travel between these farms and Karystos. For a pack donkey carrying approximately 60-100 kg, we should double this time. In terms of this model, these results imply that mobility in the landscape was feasible within reasonable time frames and that the countryside and the sites could be accessed from urban centres and vice versa. Importantly, in terms of agriculture, we can model the amount of time needed to travel to sites which provide clear evidence for agricultural processing in the form of presses or threshing floors, and nodal points such as Kourmali, Karystos and site C27. These tentative conclusions suggest that with additional analyses insightful results can be obtained. Further study, particularly a comparison of the ceramic data with the results from the GIS analyses, may provide valuable insight not only regarding the role of ancient farmsteads and the nature of habitation in the sites, but also trade and communication between these sites, Euboea and beyond.

16. Keller and Hom 2010, 6.
17. Davies 1998, 244-248; Foxhall and Forbes 1996, 76; de Ligt and de Neeve 1988, 401.
18. Bevan 2013.

Conclusion

The purpose of this paper was to carry out an exploratory GIS analysis of mobility in the agricultural landscape of the Paximadi Peninsula. In doing so I highlighted that both the archaeological and digital data are crude and, therefore, the results are somewhat limited, particularly concerning the different types of activity these rural sites might have supported. However, in carrying out a least cost path- and cost distance analysis it was possible to ask a series of questions of the existing data. The aim of the analyses was to fill in the landscape by understanding the ease with which people and produce moved between cities, rural sites and installations. By modelling the agricultural landscape using cost distance, it is possible to suggest that movement through the countryside could be achieved in reasonable times. Furthermore, the model suggests that the position of sites is relative to the position of the main routes to each city. This has important implications for trade and the movement of goods in the landscape. Finally, the model highlights that there was connectivity in the countryside via roads which connected farmstead sites with villages and larger towns. The implications of this for agriculture in the region are that farming was an organized physically and visually connected activity, with those farming the land making conscious choices about how they worked and moved through the landscape. This result has direct and significant implications concerning the economic objectives of the farmers and the fundamental role farmstead sites played as centres for storage, processing and occupation.

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Figures

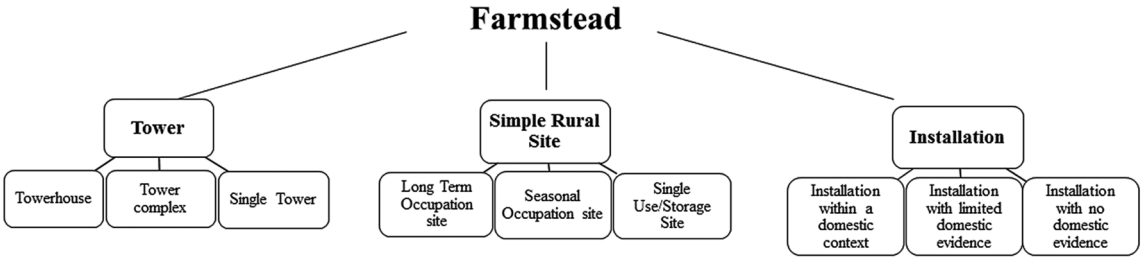

Figure 1: Variety of site types that can be used for agricultural industry.

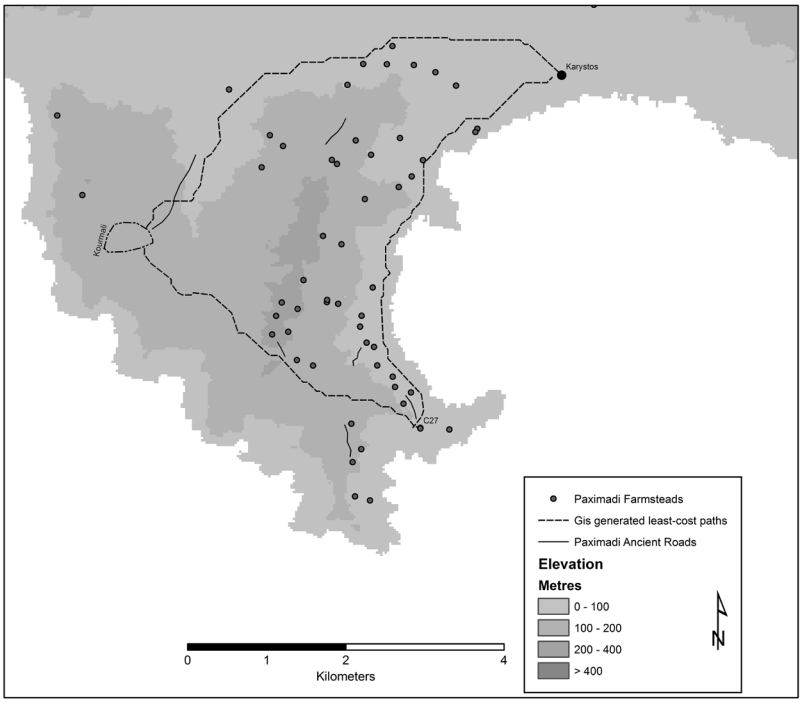

Figure 2:
Location of rural sites with GIS-generated least cost paths and known ancient routes.
My thanks to Dr Donald Keller for providing me with a recent map of Classical-Hellenistic agricultural sites, urban centres and ancient roads. The data was used to generate the maps in this paper.

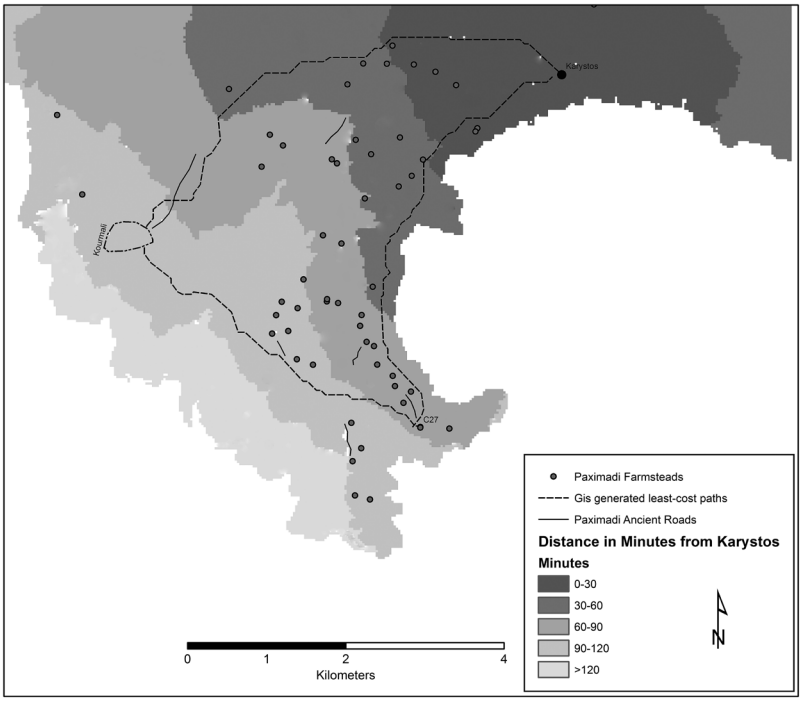

Figure 3:
Cost distance in minutes from Karystos, Paximadi Peninsula.