The Interconnectivity of Cultural Sites:
Sights and Sounds across a Landscape.

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Abstract

It may be assumed that sites rarely developed in a vacuum but maintained contact with surrounding areas. Therefore sites of a common cultural heritage were connected and communicated with each other across a given landscape. But exactly how were culturally related sites connected with each other and on what basis were they dispersed across a region for the purposes of communication? Site catchment analysis has been an important research area. However beyond resource and socio-political influences this paper investigates how to go about determining possible communication-network patterns that presumably helped maintain a dominant culture in a region. A GIS can be used to evaluate the possibility that distances between sites were established in order to facilitate easy communication with each other. Mycenaean sites in Central Greece were chosen to demonstrate how an evaluation of site interconnectivity might reflect inter-site communication patterns in the past. Apart from having couriers travel with news from site to site, sights and sounds may also have been used to relay messages across the land. This paper proposes how parameters that may have influenced communication patterns can be defined and subsequently investigated.

Key words: interconnectivity, communication-patterns, parameters, visibility, audibility, GIS, Mycenaean Landscape

Introduction

Time takes its toll both on ancient landscapes and artefacts at an archaeological site. Retrieving meaningful and clearly understood data from the remains of past human activity is difficult enough. Even more elusive are remnants that could be associated with means of communication that people used across landscapes in the past. Communication has assumedly always been important to people and was perhaps another factor, apart from reasons such as trade, that may have influenced site interconnectivity. Some of the most illustrious examples of early means of long distance communication come from images of people blowing on shells or animal horns. The remains of possibly the earliest trumpets, one bronze or copper with gold overlay and another silver, were found in the tomb of King Tutankhamen (Reeves 1990). Though such instruments may have been used solely for the purposes of ritual at just one site (Gardiner 1966), it is possible that they could have been used to relay messages to other sites as well. References to additional means of communication are available from the Old Testament in the Bible: "…along the rivers of Cush, [2]which sends envoys by sea in papyrus boats over the water. Go, swift messengers, … to a people … whose land is divided by rivers. [3]All you people of the world, you who live on the earth, when a banner is raised on the mountains, you will see it, and when a trumpet sounds, you will hear it" (Isaiah18:1-4, NIV). It is possible that the location of sites across ancient landscapes provided the communication medium by which couriers, sights or sounds could have been transmitted.

In the past sights and sounds would have moved across the land as messages were relayed. This vivid means of communication contrasts to the invisible and inaudible signals of communication satellites that now relay messages across our relatively "silent" landscapes. This paper presents some ideas for the development of a GIS that can incorporate variable buffer zones for ranges of both sights and sounds that could have been used to send messages across an ancient landscape. The Central Greek landscape of the Mycenaean era (Tsountas et al. 1969) is used to illustrate how a GIS can integrate and analyse site distances in relation to parameters that impacted the three major means of communication: 1. couriers, 2. sights, and 3. sounds. When applied to data from "intensive" field surveys, such analyses may reveal sites that were established solely for the purposes of providing effective communication across a landscape. The results of any analyses would of course have to take into consideration other reasons as to why sites were located where they are. Reasons for site location would have to be proposed in *conjunction* with the possibility that some sites were maintained as "satellite sites" for the purposes of communication.

Settlement Foundation Theories

Landscape analyses have been at the forefront of GIS applications in archaeological research. The results of such GIS analyses have been used to come to an understanding of the use of landscapes by people in the past regardless of the era or area. Apart from the impact of human settlements in a region, site distribution patterns can be studied as well. A fundamental question underlying any landscape analysis is "Why are archaeological sites located where they are?" Registering sites across a landscape allows for insights as to preferred site locations. A site's position in relation to mountains, rivers, coastlines, soil types and other sites may reflect decisions that were based on strategic influences (Hillier et al. 1984). Settlement foundation theories provide theoretical reasons as to why a group of people chose a location where a site was to be established. An interplay between environmental and social or cultural factors influenced site location to a certain extent. The necessity for close proximity to basic subsistence resources such as water and arable land are perhaps the major factors that determined site location in the past. Certainly socio-economic and religious factors may also have influenced the location of sites to some degree. However the latter reasons are difficult to ascertain and determine with any certainty, unless, for example, definite sites of worship are identified. During certain times in the past it may have been necessary for a site to be located in a relatively safe area which could be easily defended from enemies if needed. Another aspect of site location is the possibility that their position allowed for easy communication across a large area. Maintaining communication networks is a rarely considered reason for the establishment of culturally linked sites across a given area. However it is possible that relaying messages across a landscape may have determined how sites were interconnected, and their position may reflect how they may have relied on the available means of communication.

It is generally agreed that geography and climate were major factors in establishing a site during the Mycenaean era and that this is reflected by settlement patterns (Hope Simpson 1981). Given the fact that agricultural tools made of wood or wood sheathed in bronze were more basic than today (Hope Simpson 1965), then proximity to easily cultivatable and fertile soil was necessary to sustain a community's subsistence requirements. Most important of all was the necessity for a perennial water supply. In many cases a spring or well water may have provided the water requirements at smaller sites. However it is difficult to ascertain this since many of these sources are no longer evident. Besides these factors there was also the requirement for a site to be well drained and easily defended. This would therefore explain why many of the sites during the Mycenaean era are on hills or slopes, which are also relatively close to fertile plains. At such sites both subsistence resources would be provided for and the location could also be defended. To these reasons Bintliff (1977) has added the possibility of the existence of a hierarchy of Mycenaean settlement sites which was based on the size of the site and the power that it had presumably attained.

Depending on how large a settlement site was and the power that it held over a region, distances varied from site to site, thus allowing appropriate farming areas to sustain a community according to its size (Fossey 1988). Major dominant settlements or primary sites had approximately a one hour distance from other major settlements (Bintliff 1977:135-141). This one hour distance translates to approximately a 5km radius around each site, without taking into consideration the varying terrain which may vary the amount of time it takes to travel from one point to another. Major or primary settlement sites were large in size, generally over 40,000 m^2, and consisted of at least one megaron, rural domestic buildings, and at least one 'royal' tholos tomb. Secondary settlements usually developed in areas surrounding primary sites at approximately a 2.5 km distance from them. These settlements were smaller in size and had chamber tombs instead of tholos tombs, the differences between these tombs are described by Mylonas (1966:111-130). In between these secondary sites there were smaller or tertiary sites which consisted of only one or two houses and few or no tombs at all. Linear B texts indicate that "palatial" centres had control over the collection and redistribution of goods which entails that communication with surrounding areas would have been enforced. Since most of the Linear B texts have been found within palatial contexts they provide limited knowledge about the smaller sites (Ventris et al. 1956). It is possible that this hierarchy of sites may have been an indirect outcome of the requirement for smaller sites to provide a link that would allow for messages to travel relatively quickly across the land.

In order to appreciate the location of a settlement it is important to understand the topography of a region. The geographic region of Mycenaean sites in Central Greece was digitised from Hope Simpson's Map C (1981) see Figure 1. The digitised map incorporates land regions which are approximately 500m above the present sea level, and coastlines. The presence of these features on the map can allow for an analysis of the distance of each of the various Mycenaean sites to their immediate environment.

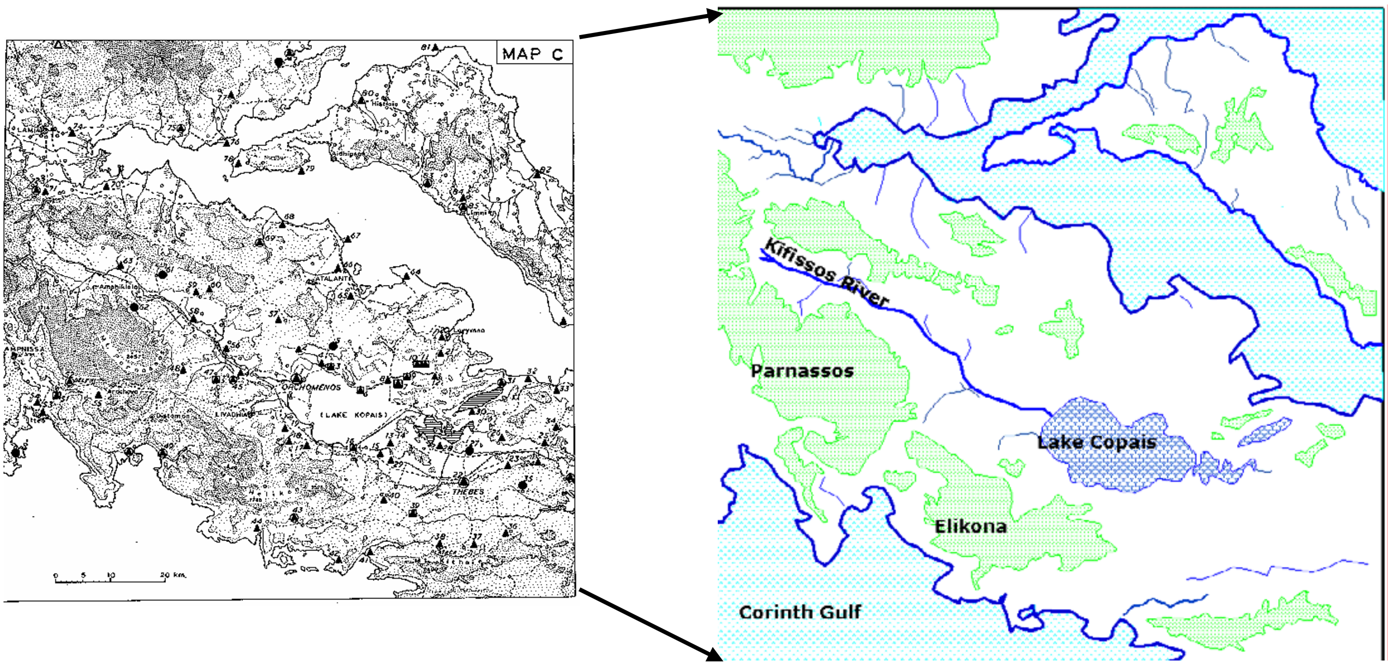


Figure 1. Digitised topography of Central Greece.

The three largest rivers and other major rivers have also been included on the digitised map. By including these rivers an analysis of the distance of each of the Mycenaean sites to the present-day courses of the rivers can be facilitated. Assuming that the courses of the rivers have not altered dramatically, observations relating rivers to site locations can be made. A 5km radius buffer zone was created around each site and can be used to determine its proximity to the rivers, see Figure 3. Results of this analysis are shown in Table 1. below.

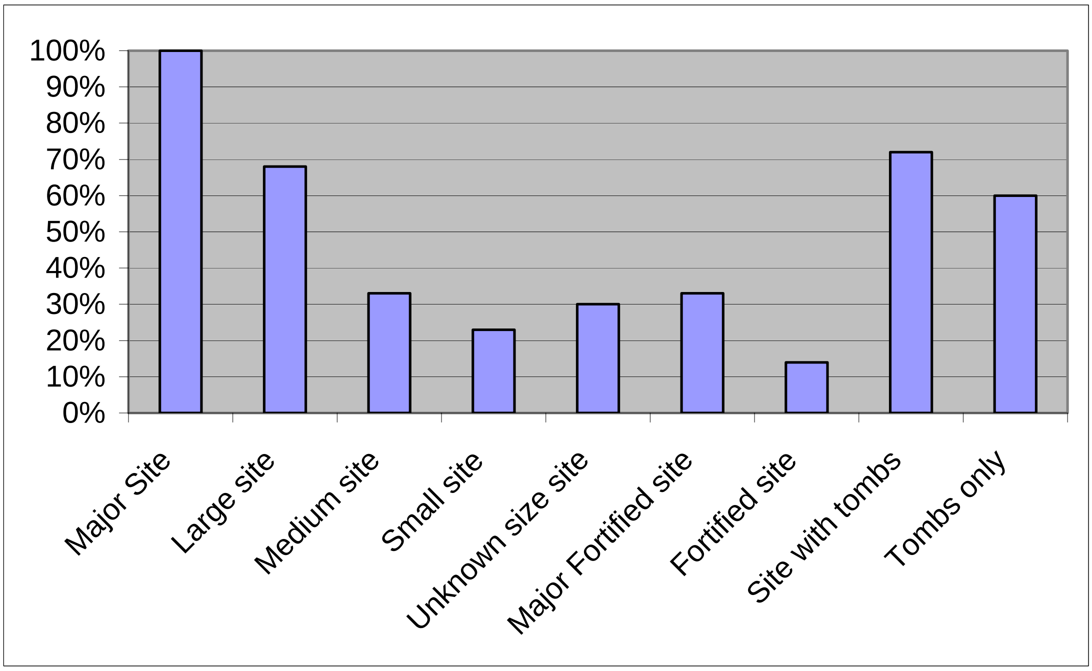


Table 1. Showing % of various site types within 5km of rivers.

All of the major sites are less than 5km away from a river, and the larger the site is the more likely it is to be located within 5km of a river. Surprisingly 60 % of the Tombs only sites are close to rivers. However this may indicate that since the majority of settlement sites are close to rivers their associated necropolis would also be nearby. Smaller sized sites and those that are fortified are least likely to be close to rivers. Presumably fortified sites would have had access to other sources of water, especially for times of siege, and the smaller sites could rely on springs or stored water.

Unfortunately for landscape studies there is a tendency to perform such analyses, which usually lead to environmentally focused interpretations of the data, at the expense of disregarding the socio-economic, cultural and communication requirements of sites across a landscape.

Communication Methods and Parameters

Assumedly people communicated by travelling with news from site to site, or in times of emergency used visual cues with fires or flags if distances allowed for that. It is also possible that audible messages were relayed between sites by beating on drums or blowing on shells, animal horns, trumpets or other instruments that would amplify sounds. Unfortunately since minimal tangible archaeological evidence exists for communication, research is limited to analysing distances between sites and the possible site hierarchy in an area that may help reveal possible connections that allowed for any of these means of communication to have been used. So far only these three communication methods have been identified as the most likely means for transmitting messages across ancient landscapes. The effectiveness of these methods depends to a large degree on the distances that the message was required to travel. All of the three means are inadvertently influenced by parameters that would either facilitate or hamper their effective transmission. Ultimately it is the landscape and the location of sites that may reflect the ease or difficulty of utilising any one of these means of communication. In order to explore any underlying communication patterns in the past it is necessary to coordinate and integrate a number of investigations that are currently facilitated by most GIS programs. Some improvements and new methods need to be introduced in order to investigate seasonal visibility and audibility ranges across the land respectively. The already existing facilities that provide Digital Elevation Models (DEM) and have been used in many case studies for cost surface analyses and viewshed or line of sight analyses (Lock et al. 1995) will be discussed in relation to each of the relevant means of communication. Factors or parameters that affected the viability of transmitting messages between sites also have to be considered.

The major factors or parameters that would have affected transmission of messages in the past are the natural environment or topography, the climatic conditions throughout the year, and the culture of an area. Parameters that relate to the surrounding environment are whether there are any natural barriers that would slow down travel or prevent visual or audible messages from being transmitted, and whether sites are close enough to necessary resources that would ensure their survival. Mountains can effectively exclude some sites from communicating with each other unless mountain passes can be identified as alternate routes that couriers could have taken. Rivers on the other hand could have been exploited as a means of travel and if this were not the case then likely crossings would have to be proposed. Additionally, the topography of an area should include soil maps so that the availability of arable land can be determined. Seasonal climatic variations during the year could inhibit travel during the winter months or decrease the visibility range between sites (Zamora 2003). For such observations to be included in results there is a requirement to incorporate data from experimental archaeology and fieldwork throughout the year that can reveal further details about the landscape under investigation.

Likely outcomes of year round fieldwork are the establishment of possible travel routes that are reliant on the weather, "climatic" or seasonal viewsheds, and how far sound travels across the land with various instruments during calm or windy conditions. Finally the extent of sites of a common culture would have to be identified because assumedly it would have been difficult to traverse with a message across "enemy" territories. A dominant culture may have flourished because an effective communication network was available to culturally linked sites dispersed across a landscape. Smaller sites should be considered for the possibility that they were located where they were in order to maintain communication in the region.

In theory small sites that are not close to natural resources may have existed as satellite sites, much like "lighthouses", for the purposes of relaying messages across a landscape.

Communicating across the Mycenaean Landscape in Central Greece

The digitised Mycenaean sites in the areas of Boeotia, Phocis, Malis, Northern Euboia and Eastern Locris are from the survey in Central Greece that was undertaken by Hope Simpson (1981). Global Positioning Systems (GPS) can now be used to incorporate the position of new sites, and additional environmental, geological, geomorphologic and archaeological data into a GIS database for more detailed analyses. For the purposes of this paper the limited data that were available were used to examine methods for investigating possible communication between sites and provide ideas to establish a methodological structure for future investigations to take place. Hope Simpson (1981) classified the sites by types. The site categories are: 1. Major settlement, 2. Settlement, 3. Settlement with tombs, 4. Major fortified settlement, 5. Fortified settlement, and 6. Tombs, with a further subdivision by size in area (m^2) as defined by this paper for the 2. Settlement category: 2a. Small - up to 10,000 m^2, 2b. Medium from 10,000 to 20,000 m^2, 2c. Large 20,000 to 40,000 m^2, and 2d. Undetermined size. The various site types are depicted with different symbols, see Figure 2. Patterns of site interconnectivity may be revealed by showing how the different site types were able to communicate with each other. All of the distances between the various sites have to be examined for the feasibility of using any of the three identified means of communication.

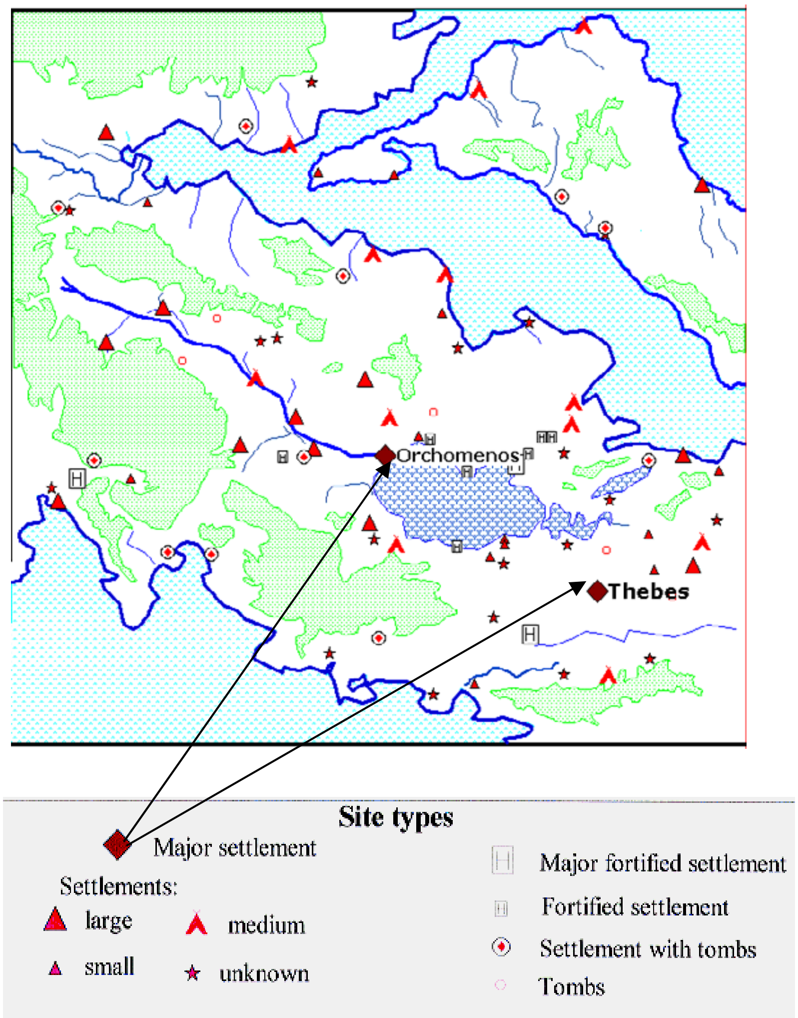


Figure 2. Mycenaean site types in Central Greece (eg. Major Sites shown).

Table 2. below is an excerpt of the database which consists of these 85 Mycenaean sites in Central Greece as identified by Hope Simpson (1981:59-84), and their associated fields of data.

SETTLE~3 Browser

settlementsite	idnumber	sizealpha	sizenumber	period
Loukisia(Ancient Anthedon	C32	large	28,800	Mycenaean LHIIIB-LH
Drosia-Soros	C33	small	4,750	Mycenaean
Rhitsona(Ancient Mykaless	C34	?	?	Mycenaean
Harma(Ancient Eleon)	C24	large	24,000	Mycenaean
Kastri-Lykovouno	C25	medium	15,000	Mycenaean
Hypaton-Tourleza	C26	small	4,000	Mycenaean
Soules	C23	small	?	Mycenaean
Mouriki-Kamelovrysi	C30	?	?	Mycenaean
Megali Katavothra	C12	?	?	Mycenaean
Larymna-Kastri	C20	medium	12,000	Mycenaean
Larymna-Bazaraki	C21	medium	18,000	Mycenaean
Daphni-Ayios Meletios	C36	?	?	Mycenaean
Erythrai-Pantanassa	C37	medium	10,400	Mycenaean
Ancient Plataea	C38	?	?	Mycenaean
Livadostro-Kastro	C41	small	7,000	Mycenaean
Halike(Ancient Siphai)	C42	?	?	Mycenaean
Chorsiai	C44	?	?	Mycenaean
Thespiai-Magoula	C40	?	?	Mycenaean
Pyri-Lithares	C28	?	?	Mycenaean
Mavromati-Panayia	C29	?	?	Mycenaean
Davlosis-Kastraki	C13	small	?	Mycenaean
Davlosis-Kalimpaki	C14	small	?	Mycenaean
Ancient Onchestos	C15	small	8,000	Mycenaean
Kato Agoriani	C17	medium	11,300	Mycenaean
Ancient Koroneia	C18	?	?	Mycenaean
Kalami	C19	large	?	Mycenaean
Theologos(Ancient Halai)	C64	?	?	Mycenaean
Kyparissi-Ayios Ioannis	C65	?	?	Mycenaean
Atalanti-Skala	C66	small	9,000	LHIIIB Mycenaean
Livanates-Pyrgos	C67	medium	11,700	Mycenaean
Melidoni-Kastro	C68	medium	15,000	Mycenaean
Poliyira	C2	medium	11,300	Mycenaean
Pyrgos-Magoula	C4	small	7,200	Mycenaean
Kastro	C8	?	?	Mycenaean

Table 2. MapInfo Database excerpt of Mycenaean sites in Central Greece.

For couriers travelling with news from site to site, relay stations may have been provided where replacement runners accepted the message and took it onto the following site. Possible communication routes (CR) may be plotted and then analysed to determine distances and therefore the likely time it would take for a message to get from one site type to another. The region of Central Greece seen in the digitised map (Figure 1.) consists of extensive mountainous regions, in particular those of Parnassos and Elikona. These mountain ranges effectively separate the coastal regions from the valleys and fields of the interior. It appears that Central Greek Mycenaean sites of the inland regions are located within close proximity to a possible central communication route (Hooker 1977). There was possibly a major communication route that ran from Thebes, along the edges of the former lake Copais and then towards the Kifissos valley and finally towards the Sperchios river delta, see Figure 4. By creating a 5km-radius buffer zone around the various site types it is possible to visualise their proximity to features in the landscape directly on the digitised map, see Figure 3. By selecting particular site types a comparative analysis by site category can be performed. In this case most of the major and large sites are located in the valleys, and closer to the possible communication route. Whereas other settlement types, such as small sites and sites with tombs, are generally located closer to the coast.

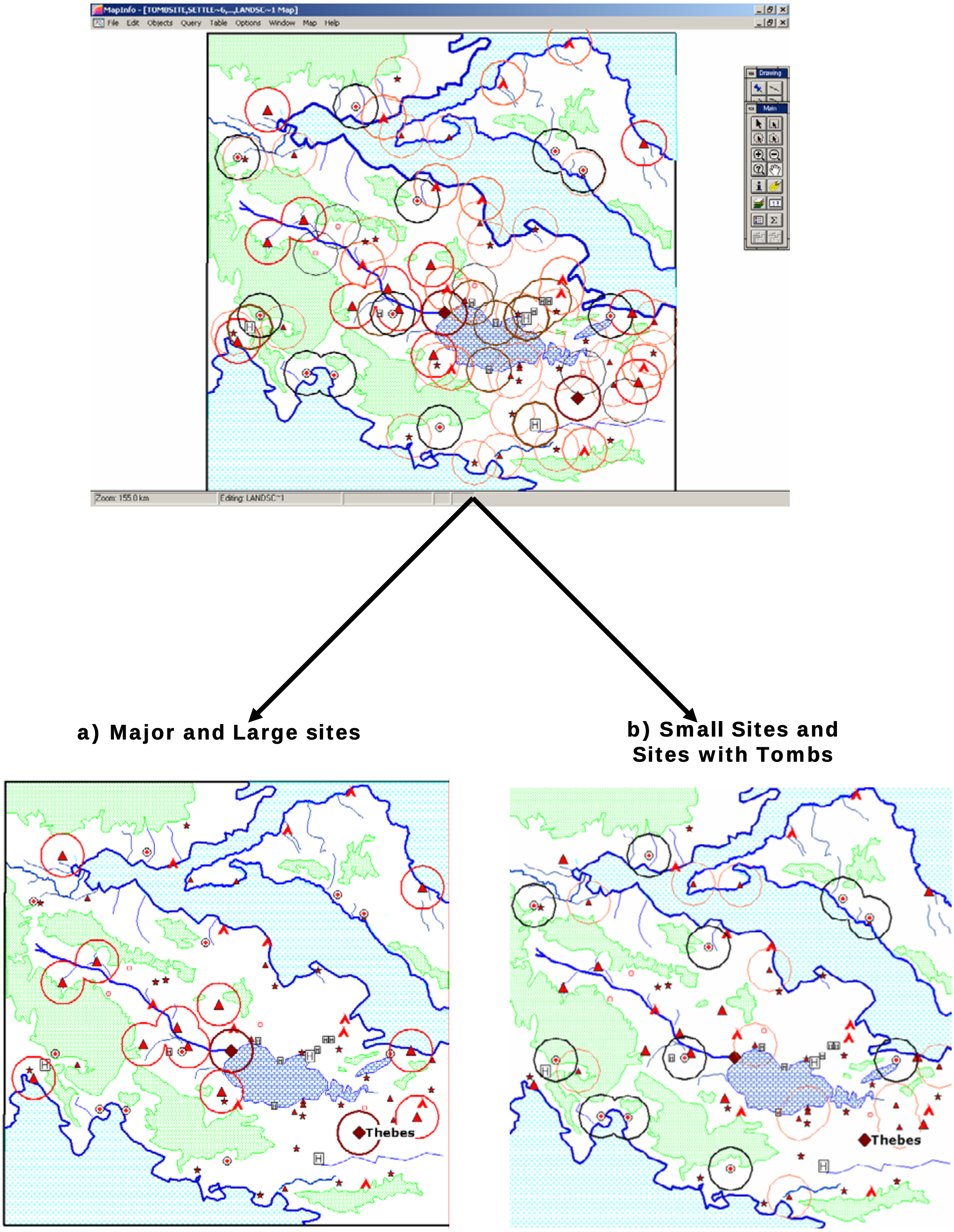
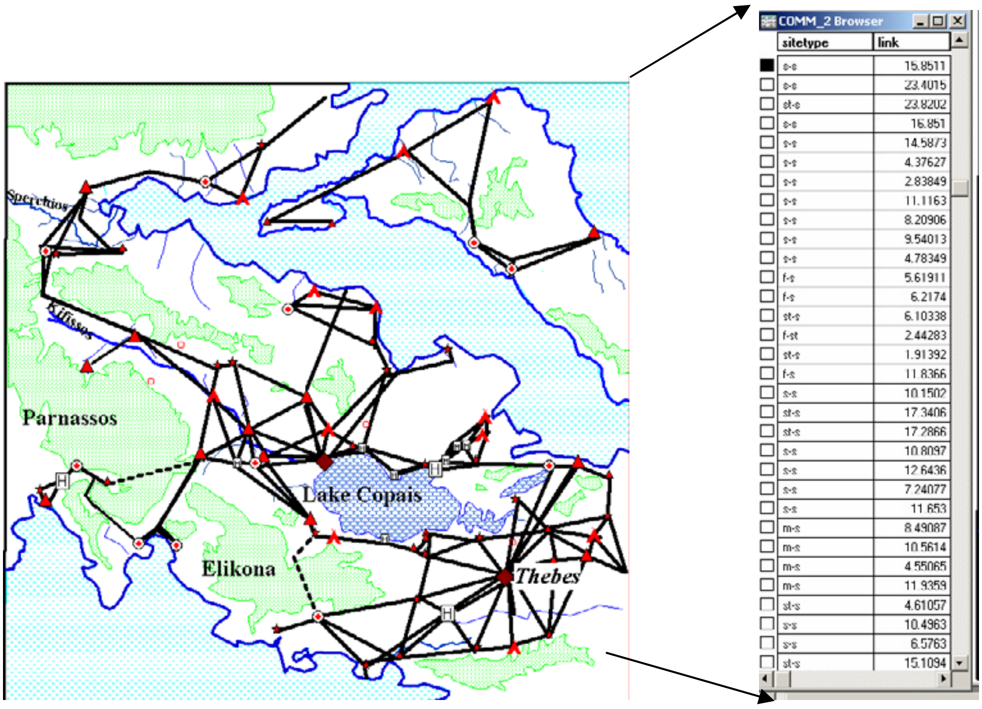


Figure 3. The 5km-radius buffer zone surrounding all site types in Central Greece, subsequently displayed separately for a) Major and Large sites, and b) Small sites and Sites with Tombs.

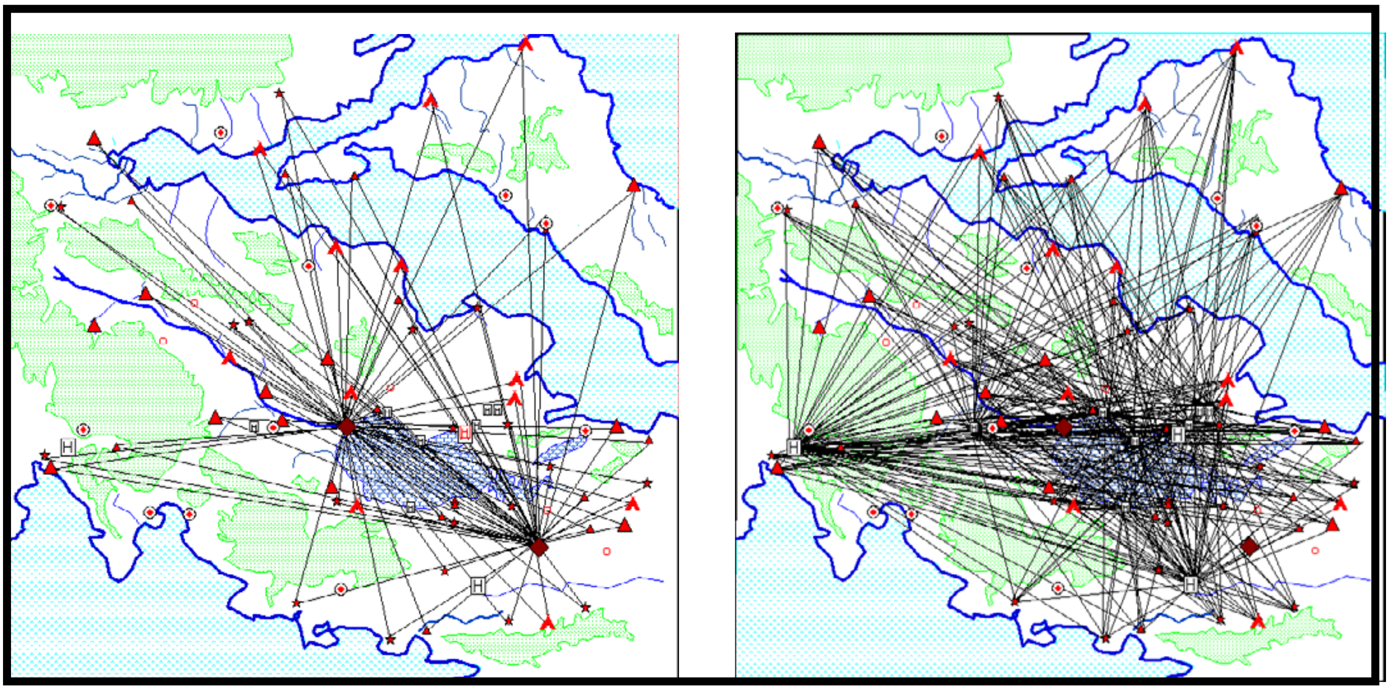
Lines of communication, especially through mountainous regions, need to be analysed in association with DEMs that allow for gradients or slopes of the countryside to be taken into consideration for the determination of Cost Surfaces or the amount of energy it would require to travel over the land. It can be expected that routes requiring the least energy would have been selected. Van Leusen (2002) discusses in detail the implications of using cost surface analyses. The distances of possible communication routes (CR) between various sites, plotted in Figure 4., that couriers may have used across the land can be analysed statistically.



sitetype	link
s-s	15.8511
s-s	23.4015
st-s	23.8202
s-s	16.851
s-s	14.5873
s-s	4.37627
s-s	2.83849
s-s	11.1163
s-s	8.20906
s-s	9.54013
s-s	4.78349
f-s	5.61911
f-s	6.2174
st-s	6.10338
f-st	2.44283
st-s	1.91392
f-s	11.8366
s-s	10.1502
st-s	17.3406
st-s	17.2866
s-s	10.8097
s-s	12.6436
s-s	7.24077
s-s	11.653
m-s	8.49087
m-s	10.5614
m-s	4.55065
m-s	11.9359
st-s	4.61057
s-s	10.4963
s-s	6.5763
st-s	15.1094

Figure 4. Possible Communication Routes across the Mycenaean landscape, with corresponding table of data.

A generalised communication network (CN) where the topography is ignored and permutations and combinations of different site interconnectivity are plotted (see Figures 5a)- 5b)) can be analysed to determine "average" distances between various sites. A more feasible method would be to use Cluster analysis. The squared Euclidean distance, where distance (x,y) = $\Sigma_i (x_i - y_i)^2$, can be used to determine how objects, in this case sites, that are further apart are distributed. These results could be examined in conjunction with the Chebychev distance where distance (x,y) = Maximum$|x_i - y_i|$ would take into account the different site types. This may determine if patterns of distances existed between the different sites. Combined statistical and cluster analyses of both CR and CN respectively may reveal further patterns.



Figures 5a)-b). Examples of a generalised Mycenaean Communication Network:
a) Major sites to settlements, and b) Forts to settlements.

Figure 6. displays both the possible communication routes (CR) between the various sites along with permutations and combinations of site networks (CN), except in the case of the settlements category where only seven strategic settlements were connected with all the others on the map. All these distances were associated with their corresponding tables of data that could then be analysed with the available statistics functions of MapInfo.

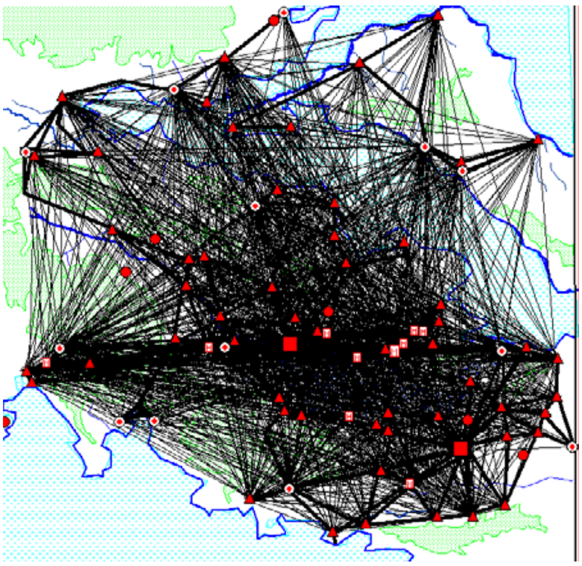


Figure 6. Communication routes overlaid with Communication networks.

In this case all the possible distances were analysed based on minimum, maximum and average distances for both the routes and networks, see Tables 3. and 4. respectively. Apart from examining all these distances for the feasibility of using visual or audible messages, the resulting summaries of distances for the various site routes can be analysed for the likely time, based on distances, that it would take for a courier to deliver a message between the different sites. An average of 5km or less between sites would define a plausible distance for delivering messages overland. This would allow runners to relay messages to other sites and return to their home base within a reasonable time.

Distances between possible site routes (km):

MINimum distance

	Major	Major Fort	Fort	Settlement&Tombs	Settlement
Major	x	X	6.59	11.14	4.55
Major Fort	x	X	1.97	X	1.73
Fort	6.59	1.97	2.09	2.44	1.92
Settlement&Tombs	11.14	X	2.44	7.85	1.81
Settlement	4.55	1.73	1.92	1.81	2.83

MAXimum distance

	Major	Major Fort	Fort	Settlement&Tombs	Settlement
Major	x	X	11.38	18.59	20.46
Major Fort	x	X	6.89	X	7.36
Fort	11.38	6.89	6.39	3.52	15.12
Settlement&Tombs	18.59	X	3.52	8.04	24.03
Settlement	20.46	7.36	15.12	24.03	25.71

AVerage distance

	Major	Major Fort	Fort	Settlement&Tombs	Settlement
Major	x	X	8.98	14.87	11.08
Major Fort	x	X	5.02	X	4.55
Fort	*8.98*	5.02	3.81	2.98	7.06
Settlement&Tombs	*14.87*	X	2.98	7.94	11.56
Settlement	*11.08*	4.55	7.06	11.56	9.11

Table 3. Minimum, Maximum and Average distances between various sites route access.

The distances between site routes can be compared with those of the site network for any possible patterns. In the case of possible routes the differences of average distances between Major sites to Forts, Settlement & Tombs and to Settlements, is analogous with the increments of their corresponding average distances for the site network (in italics).

Distances over a site network (km):

MINimum distance

	Major	Major Fort	Fort	Settlement&Tombs	Settlement
Major	[35.76]	18.01	2.5	11.39	4.78
Major Fort	18.01	X	2.66	19.07	1.45
Fort	2.5	2.66	1.03	2.95	1.6
Settlement&Tombs	11.39	19.07	2.95	6.62	(2.15)
Settlement	4.78	1.45	1.6	(2.15)	(2.07)

MAXimum distance

	Major	Major Fort	Fort	Settlement&Tombs	Settlement
Major	[35.76]	21.42	74.82	92.81	94.31
Major Fort	21.42	X	61.70	74.05	73.42
Fort	74.82	61.70	67.03	89.82	96.14
Settlement&Tombs	92.81	74.05	89.82	91.52	(93.41)
Settlement	94.31	73.42	96.14	(93.41)	(105.93)

AVerage distance

	Major	Major Fort	Fort	Settlement&Tombs	Settlement
Major	[35.76]	19.72	23.41	46.41	37.24
Major Fort	19.72	X	18.43	44.41	33.04
Fort	*23.41*	18.43	28.20	45.86	38.63
Settlement&Tombs	*46.41*	44.41	45.86	48.99	(44.96)
Settlement	*37.24*	33.04	38.63	(44.96)	(51.97)

Table 4. Minimum, Maximum and Average distances between various sites network access.

As mentioned above, sending messages overland would require the results of a DEM. In the case of visual messages Line of Sight analyses or viewsheds also rely on DEMs (Van Leusen 2002). Factors influencing the accuracy of viewsheds are the amount of available light, the visual cue that was used- fires or smoke are more visible than flags- and the season or prevailing climatic conditions. As Zamora (2003) proposes natural variations of visibility would have to be incorporated into GIS programs. The introduction of "soundsheds" to determine the extent of audible messages across the landscape entails further development to GIS programs. It is proposed that viewsheds (Vsheds) and soundsheds (Asheds) based on the Visibility and Audibility across a landscape be represented as *variable* buffer zones that determine the viewing and hearing potential at each site under varying conditions. If small relatively isolated sites appear in the landscape within these zones it is possible that they existed so that visual and audible messages could be transmitted.

Future Developments: Incorporating sights and sounds into a GIS database

Sound and improved sight algorithms will have to be developed and incorporated into the spatial analytical capabilities of a GIS. Sound algorithms may reflect differing analytical requirements. For instance urban planners could use GIS soundsheds to analyse the impact of varying decibel levels on neighbourhoods located close to sources of noise pollution. Whereas archaeologists could use soundsheds to analyse and determine the range of audible communication that would be possible across the landscape. This would entail experimental archaeology and the results of research dealing with the transmission of sound. The integration of GIS with multimedia technology (Scholten et al. 1997) may allow for interactive analyses of the varying intensity of "sound" zones across the landscape. This will require incorporating the necessary sound algorithms that take into account the varying terrain and prevailing wind conditions that would either reflect or absorb sound by varying degrees. Subsequently *variable* buffer zones would allow for the depiction of variations in how sound is propagated. The same principle would apply to viewsheds with any variations, such as climate, taken into consideration. Incorporating both vsheds and asheds as buffer zones allows for the ability to analyse the visual and audible contact between sites. Figure 7. proposes that both sheds are superimposed along with any possible variations (e.g. seasonal viewsheds) that may affect the range of message transmission.

Figure 7. Proposed *variable* ViewSheds and SoundSheds, superimposed.

Average buffer zones could be determined for year round communication patterns. Otherwise variable zones should be defined and plotted according to the results of fieldwork or theoretical interpolations of existing data. These developments would enhance future research into the various parameters that affected the viability of communication and hence the interconnectivity of cultural sites across ancient landscapes.

Acknowledgements: Thank you to the CAA conference organisers for financial support to attend the CAA2003 meeting in Vienna, and Professor T. Sellis for providing computing facilities at the National Technical University of Athens.

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