

Interpreting the Archaeological Record: Archaeological Space

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ABSTRACT

The present study is based on Session AR16 entitled: 'Interpreting the Archaeological Record: GIS' held at the EAA conference in Glasgow, 2015. The particularity of the session was that each presentation asked particular questions, such as: (i) how a built space of a single settlement talks to its visitors; (ii) how the monumentality of megaliths is perceived in the field by observers both past and present in relation to their visual reproductions; (iii) how large archaeological spatial data can be managed with GIS so that they become visualized and made available for on-going and future studies; (iv) how partial and incomplete archaeological spatial data can be analyzed properly and provide coherent interpretations.

The answers to these and related questions are not straightforward. Insights are borrowed from various disciplines related to the theory of mind, psychological reactions to built environment, cognition, and art. These involve technically informed studies such as GIS and multi-dimensional statistics. This wider problematic requires from participants in the session capabilities of proper way of representation of archaeological spatial data, analytical inquiry, and theoretically informed interpretation. From this point of view the disparity of the examples in this joint paper provide a vantage point that shows the necessity of developing these different topics together for any archaeological research scheme and interpretation of already acquired data.

Key words: built environment; GIS; incomplete archaeological data

Тълкуване на археологическия запис: Археологическо пространство

Маркус Спринг, Томас Ван Ден Бринк, Свен Страуман, Цони Цонев

РЕЗЮМЕ

Настоящото изследване се основава на представените доклади на сесия AR16 „Интерпретиране на археологическия запис: ГИС“, която се състоя в рамките на годишната конференция на Европейската асоциация на археолозите в Глазгоу през 2015 г. Особеността на тази сесия бе, че всяка презентация поставяше определени въпроси като: (1) как застроеното пространство на едно селище говори на неговите посетители; (2) как монументалността на мегалитните паметници се възприема от посетителите в миналото и настоящето, като се вземе предвид визуалната им репродукция; (3) колко големи могат да бъдат масивите данни, които да се управляват от ГИС, така че да могат да се визуализират и

направят достъпни за настоящи и бъдещи изследвания; (4) как частични и непълни археологически пространствени данни могат да се анализират правилно, което да води до кохерентни интерпретации.

Отговорите на тези и свързаните с тях въпроси не са непосредствени. Заемат се идеи от различни дисциплини, свързани с теорията на съзнанието, психологическите реакции към застроената среда, когнитивни науки и изкуство. Това включва компетенции от технически характер и многомерната статистика. Тази по-обхватна проблематика изисква от участниците в сесията умения за подходящо представяне на археологически пространствени данни, аналитични умения и теоретични интерпретации. От тази гледна точка, различните примери в тази съвместна публикация дават предимство, защото показват необходимостта от развитието на различни теми, които са необходими за всяко археологическо проучване и интерпретация на вече получени данни.

Ключови думи: застроена среда, ГИС, непълни археологически данни.

GENERAL INTRODUCTION

Studies of social space in archaeology play a special role in bettering the understanding of past human and social behavior. This particularity is due to the special angle of observation of spatially organized archaeological data. It stems from human ability to accumulate spatially distinct items of knowledge (Heersmink 2016). This is a process of discretization of spatially distinct items of knowledge by assigning different weights of importance to individual/social strategic aims (these are defined as “ontological categories that are potentially innate ‘recipes’ for construing new concepts” (Halloy and Wathelet 2014)) and may be considered as an epistemological device for initial management of incoming information from human perception (widely dependent on situations and contexts. Also this is a way of accumulation of knowledge that can be measured not that much in terms of distance and time as in terms of relations with different intensity established between the elements of past social behavior.

The real problem arises when it comes to managing large and diverse bodies of data and assembling their disparate elements into coherent and theoretically informed explanations. At rescue comes the technology – GIS and its potential to enable archaeologists to change their points of observation which may switch from past to present and vice versa. Such an approach leads inevitably to fragmentation of archaeological knowledge into different study domains with different theoretically and technically informed levels. This paper illustrates this fragmentation by shifting the observation points both of the researchers and of the past and present-day observers. The first part represents the ways a past observer conceptualizes the social space of a Bronze Age settlement. The second one uses both past and present observation points to present the past and present comprehension (rational and aesthetic) of megalithic monuments in the Netherlands. In both cases theoretical approaches are built-in and illustrated by particular case studies. On the side of novel technical applications in this kind of studies the next part presents how to use GIS for organization of spatial data to accurately assess the social efficiency of settlement organization of the past. The last part accounts for the particularities of archaeological spatial data and the ways to improve their interpretative features.

Although this paper may seem patchy in terms of “cultural-historical” uniformity it may be useful in illustrating how different approaches can be integrated into theoretically and technically informed studies of the past.

HOW SPACE TALKS

Markus Spring

INTRODUCTION

When people come back from trips, they often talk about their spatial impressions in foreign places. Towering cathedrals, Medieval cities with narrow lanes or wide boulevards leading to a palace may be lasting memories. These impressions illustrate that we are constantly influenced by the space

around us, whether it is the natural one or the built environment of our cities. Built space and how spatial layouts are arranged influence our feelings and reactions.

There are different ways built environments influence human behaviour (Table 1). These mechanisms function physically and according to social norms or obligations. Added to this, there are also intangible aspects such as colours, smells and sounds that can trigger human reactions (Montello 2007).

However, there are certain cultural differences in how spatial aspects influence human behaviour, which are also in today's societies not yet fully understood. Furthermore, additional filters reduce what is left from built environments in archaeological records. It is therefore impossible to reconstruct psychological reactions of individuals in the past. Still, it might be possible to look at prehistoric settlements from this perspective.

METHODOLOGY

This short sketch is not a journey into human's mind but likes exploring different ways to describe a prehistoric traveler's spatial experience in a foreign settlement. It employs methods of Space Syntax (Hillier, Hanson 1984; Hillier 2007) to illustrate where travellers could have gone or what they could

Table 1. Psychological mechanisms (Montello 2007, iv-02).

Sensory access	What can be seen, heard, etc.
Attention	What is looked at, listened to, etc.
Memorability	What is remembered, what is forgotten, etc.
Behavioral affordance	Where one can walk, eat, etc.
Affect	Mood, comfort, stress, fear, aesthetics, etc.
Sociality	Pedestrian flows, noise, eye contact, social distance, etc.



Figure 1. Location of sites mentioned and modern cities of Berne and Geneva, (author Markus Spring).

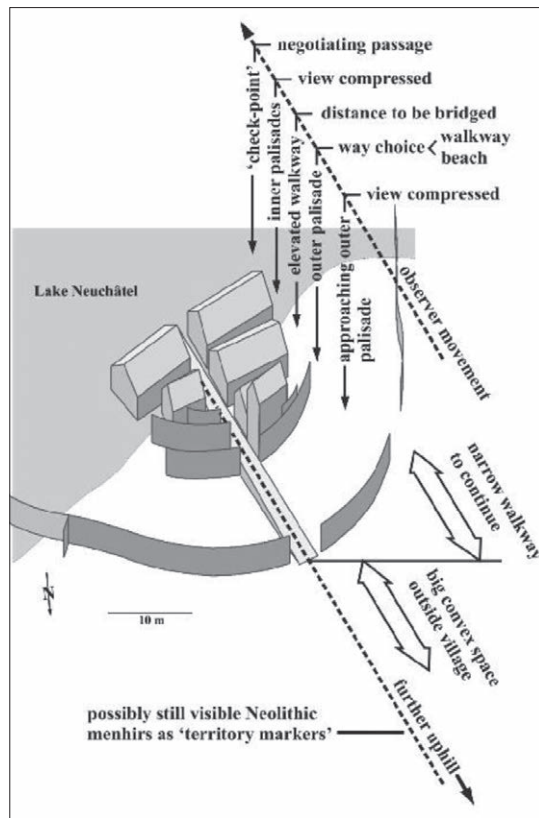


Figure 2. Approaching Concise-sous-Colachoz, phase E11 (1801-1773 BC); reconstruction based on Winiger&Burri-Wyser, 2012: 76, Fig. 8.

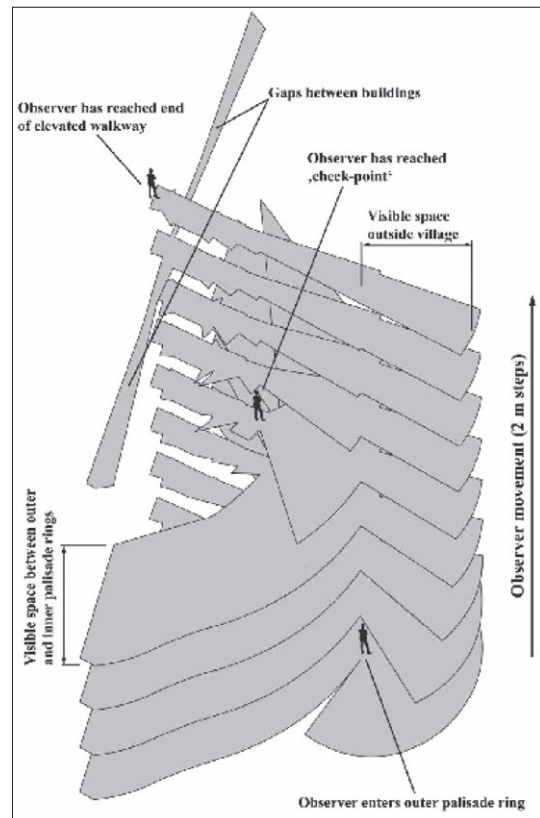


Figure 3. Concise-sous-Colachoz, phase E11. Minkowski model with observer moving along elevated walkway. (author Markus Spring).

have seen when visiting a ‘foreign’ village. As examples, the paper looks at Concise-sous-Colachoz and Zurich-Mozartstrasse, two Early Bronze Age lakeside settlements in today’s Switzerland (Figure 1).

CONCISE-SOUS-COLACHOZ

Concise-sous-Colachoz is located at Lake Neuchâtel in western Switzerland. The site extended over more than 5’000 m² and its excellent data base has allowed individualizing more than 25 villages spanning from 4300 to 1570 BC (Winiger, Burri-Wyser 2012: 21). This paper will focus on the first two of three well preserved Early Bronze Age phases tree ring dated between 1801 and 1570 BC.

Concise-sous-Colachoz, phase E11 belonged to the Aare-Rhône-Group of the Rhône Civilisation. It started out as a small village with a handful of houses oriented parallel to the shore line and perpendicularly to a central axis (Figure2). An elevated walkway connected the buildings to higher ground. The village was encircled by a 3m high outer palisade and an additional set of concentric inner palisades. There were one or two small structure(s) next to the inner palisade, not seen as normal house(s) but probably more as a ‘check-point’ controlling access to the living quarters (Winiger, Burri-Wyser 2012: 76-77).

When approaching Concise-sous-Colachoz from land, visitors faced a number of aspects that may have influenced upcoming interactions with inhabitants. Palisades repeatedly compressed and released their view; spatial qualities were different outside or inside the village and distinct physical distances had to be bridged to meet locals (Figure 2).

To analyse the ‘intelligibility’, the way a visitor may have made a map of a settlement in his mind (Hillier, 2007: 92-98), a Minkowski model can be generated (Figure 3). This space-time model shows in its horizontal plan the space seen at different stages of an arbitrary given path, in this case when moving from the outer palisade to the end of the elevated walkway. The model reveals that a visitor

to Concise-sous-Colachoz, phase E11 never lost sight of his starting point at the entrance of the outer palisade. This may have helped to understand the spatial layout of the village.

Interesting to the first phase of Concise-sous-Colachoz is that a village with very similar spatial layout can be found about 150 km further south-west in contemporaneous Sévrier-Les Mongets at Lake Annecy in the Savoy Alps. Also Sévrier-Les Mongets had a central access way, was encircled by concentric palisade rings and houses were built perpendicularly to the central axis. It too belonged culturally to the Rhône Civilisation.

ZÜRICH-MOZARTSTRASSE

Intriguing spatial changes occurred in the lakeside dwelling of Zurich-Mozartstrasse under Zurich's opera house. The site was discovered in 1981 during construction works and excavated under immense time pressure. The chronological basis is a complex combination of radio carbon and tree ring data.

The village started out as a handful of houses loosely clustered within a palisade ring (Figure 4a). The justified permeability graph ('j-graph') of early phase AA (Figure 4b) illustrates how different parts of the open space within the village were interconnected. Its rhizomorphous form indicates that despite houses being built and others thorn down, the interconnectability of subspaces offered a multitude of interaction points. This is also reflected in the 'ring' form of people movement simulated by an agent based analysis (Figure 4c). However, after a short hiatus radical spatial changes happened.

In phase B, nine houses were built in three parallel rows separated by narrow lanes. Even though village entrance and passages through different palisades cannot be identified, a split into living quarters and surrounding court yards is noticeable (Figure 5a).

The j-graph is 'deeper' with house no. 6 and the only building entrance found at the least accessible level (Figure 5b). Also visible are different cul-de-sac. When simulating pedestrian movements, a further partition within the innermost part becomes obvious. Most potential interactions occurred

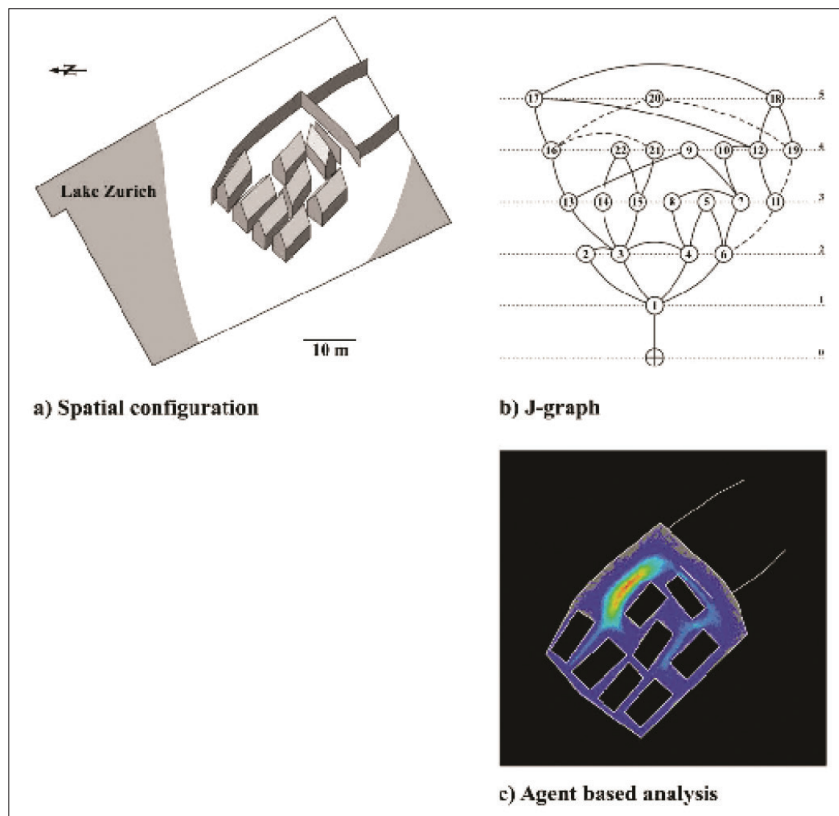


Figure 4. Spatial layout (a), justified permeability graph (b) and simulated people movement (c) in Zurich-Mozartstrasse, early phase AA (approx. mid 20th century BC). (author Markus Spring).

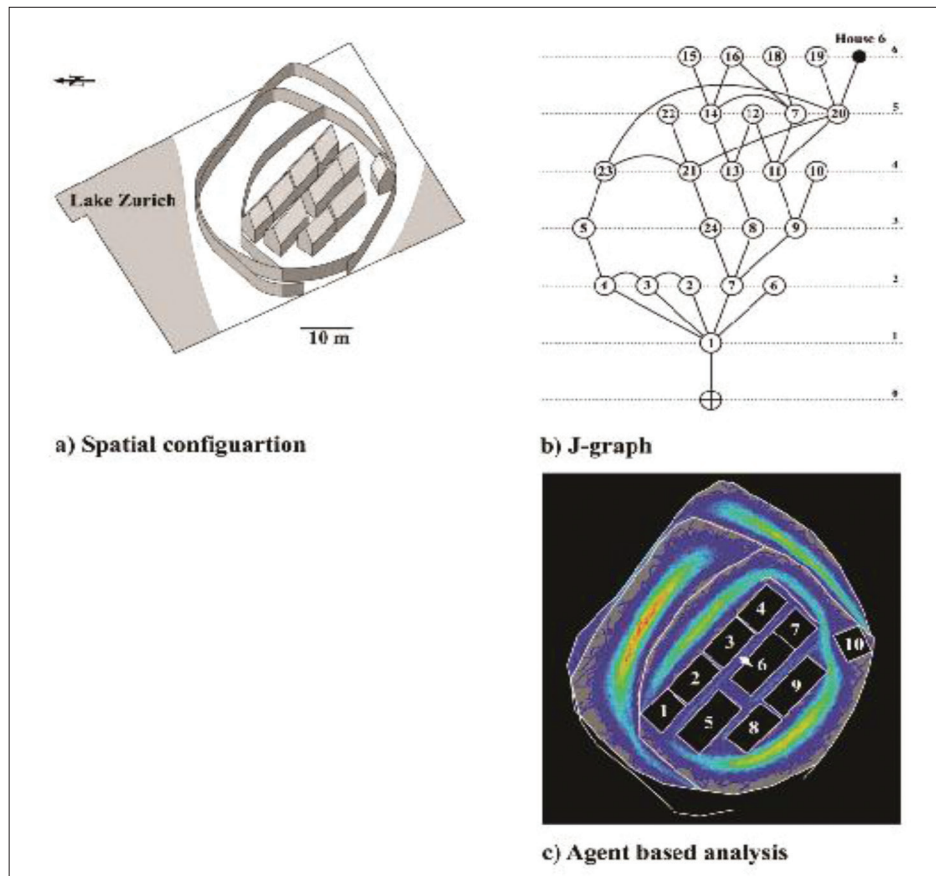


Figure 5. Spatial configuration (a), justified permeability graph (b) and simulated people movements (c) in Zurich-Mozartstrasse, phase B (end of 20th century BC). (author Markus Spring).

along the inner palisade circle (Figure 5c; yellow and red dots). And unless houses no. 1 to 4 had their entrances towards north-east, none of the buildings was accessible without passing house no. 10. Even though the function of this house is unknown, overall ‘more channelled’ people movements now governed life which may also have influenced a visitor’s experience in Zurich. This spatial segregation accelerated even further in phase C1A.

Striking feature in phase C1A was a 200 m² wooden platform built most likely as substructure of houses (Figure 6a). It was encircled by a double wattle wall and additional palisade rings (Schmidheiny 2011: 85-86).

Pedestrian movement simulation reveals likely interactions in the court yard around the living quarters in the centre (Figure 6b). Interactions within the living quarters cannot be precisely reconstructed due to missing palisade sections but may have been fewer.

Following a path from the suspected village entrance along the locations with most interactions, the Minkowski model (Figure 6c) lacks any for a visitor’s memorable structures. This rendered Zurich-Mozartstrasse, phase C1A less ‘intelligible’ (Hillier, 2007: 92-98). Visitors would therefore have experienced this phase as socially more segregated from its surrounding than previous ones.

The end of the wooden platform was marked by a fire. Circumstances of this incident are unclear. Imaginable is that parts of the surrounding fence were set on fire after houses on the platform had been dismantled (Schmidheiny 2011: 90).

However, even though the interpretation of structural remains and palisade alignments of later phases causes problems for further analysis, the spatial configuration of Zurich-Mozartstrasse had become rectilinear and less segregated with new buildings constructed around the re-used platform (Schmidheiny 2011: 66-67).

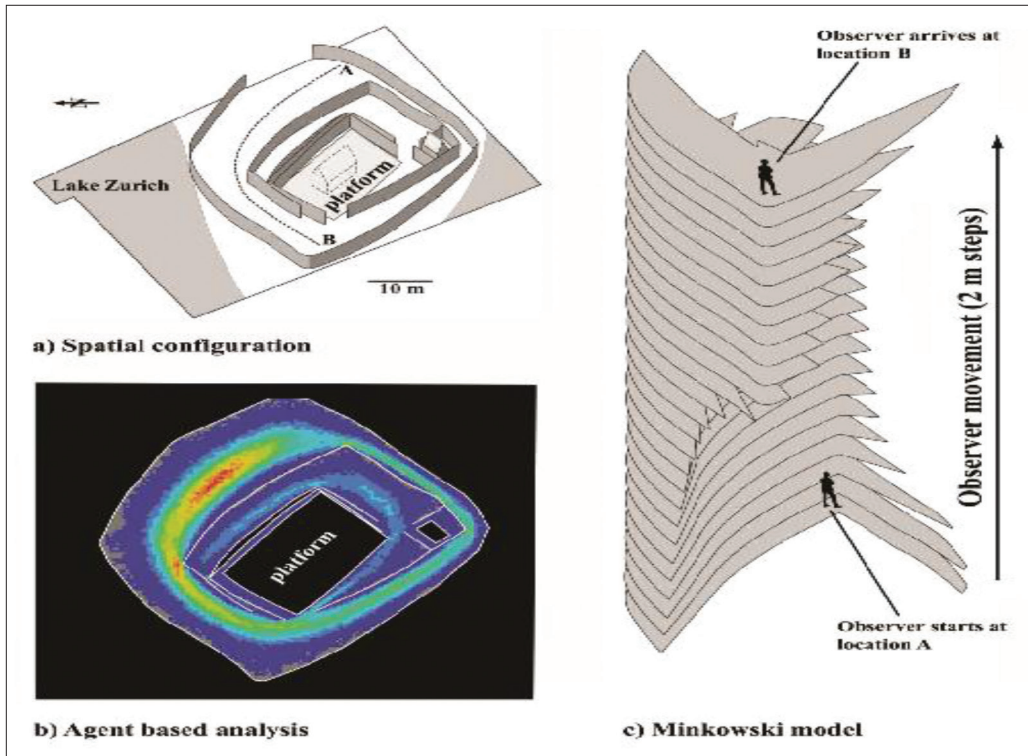


Figure 6. Spatial configuration (a), simulated pedestrian movement (b) and Minkowski model (c) of Zurich-Mozartstrasse, phase C1A (approx. 2nd half of 19th century BC). (author Markus Spring).

DISCUSSION

Even though this quick comparison only allowed a glimpse at Concise-sous-Colachoz and Zurich-Mozartstrasse, there are intriguing differences between these two villages.

The existence of Concise-sous-Colachoz, phase E11 and Sévrier-Les Mongets as two contemporaneous settlements with very similar spatial layouts is striking. Should it not be pure coincidence, is it possible that decision makers able to mobilise resources to build these settlements had a 'shared label', a common understanding, of how these villages should be experienced by visitors?

The spatial layout of Concise-sous-Colachoz also finds similarities already in Neolithic villages around neighbouring Lake Bienné (Hafner 2012). Therefore, the spatial configuration of these two western sites was not unfamiliar there.

In contrast, the strong spatial segregation in Zurich-Mozartstrasse, increasing from phase B to C1A, was something 'strange' in an environment where houses were built in less regular alignments than in the two western sites. Most settlements here had loose rows of houses still enabling human interactions taking place on different paths within the villages.

Linking the short duration of the wooden platform in Zurich-Mozartstrasse, phase C1A to human perception discussed above may be too farfetched. It is further not possible to draw any conclusions from where the idea for spatial changes in Zurich may have come from. However, they occurred in Zurich quickly within two or three generations and most likely did not go unnoticed by its environment.

Comparing these two sites, it could be asked whether the success of a settlement also depended, apart from economic or military powers, on how it was perceived by its environment and whether it was seen by visitors as fitting into it or being considered a treat. The situation may be comparable to many modern luxurious housing developments planned as 'gated community' but causing opposition in their existing neighbourhoods.

VISUAL CULTURE AND ITS INFLUENCE ON SPATIAL BEHAVIOR

Thomas van den Brink

Human beings experience their environment through all their senses: through their eyes, ears, nose, skin and tongue. Hence, the impression of their surroundings is composed of various types of information, including light, sound, scent, touch and flavor. In a new or hostile situation, this combination can be vital for survival. However, with regard to everyday circumstances, the influence of some senses on our geographical behavior is larger than others. The things you hear and see are, for example, more dominant than information acquired from taste.

Although there is obviously more to say about the working of the (instinctive) mechanisms per sense, the focus here will be on the visual dimension. That is because over the last millennia, 'the visual' has become a separated and essential sphere within western culture. It is a process that is characterized by the transmission of the general mental process called imagination onto the physical reality of flat surfaces in the form of images (such as paintings, engravings, photo's etc.). Because the number of images produced in this way is enormous, and the period in which they were created extensive, a distinctive visual culture came about. As such, images are on the one hand singular examples while on the other hand part of a comprehensive visual culture.¹

The argument to analyse landscape images to understand geographical behavior becomes clear when the nature of the visual history is contrasted with that of other sensory histories. Compared to the history of visual culture, the history of, for example, music is much more interrupted. The main reason for this is that sounds do not persist without the reproduction, which was true until very recently. Images can however survive without performance over very long periods of time, although reproductions have strengthened their presence. This has led to their exchange between people over time and space. It also led to the accumulation of images, regardless of loss of individual pieces.

To analyze the relation between spatial behavior and a visual culture, images are thus the first objects to investigate. To do so, an approach that was inspired by the work of the famous art historian Ernst Gombrich is central for this case study. His theory originates from three important insights, namely: 1) each image is produced by specific techniques, each with its own possibilities and restrictions; 2) every image is part of a visual culture; and 3) the visual culture, in terms of style, creates a mental set which functions as a conventional filter for the artist as well as the spectator. To comprehend this statement, 'technique' should be interpreted broadly, namely: the combination of materials, instruments, knowledge and skills that are used to create an image. Central to his way of thinking is the cultural determined and appropriated 'mental stereotypes' of things (Gombrich 1962, 61). These schemata are conceptualized as fluid forms with only basic characteristics. Nevertheless, they are crucial for us to recognize objects on images but they also influence the way images are (re) produced (Gombrich 1962).

His theory was tested by applying it onto a large amount of images of a Dutch landscape object called *dolmen* (see figure 7 for some examples). The images were analyzed based on the question: which formal similarities between multifarious images of the same object can be distinguished when looked at a large collection, and how can their obvious differences be explained? The goal of this approach was to assess what the mental stereotype of the dolmen is and how this influences the corpus of dolmen-images. In other words, are we dealing here with schemata or, if one prefers, with a convention of a visual culture?

Second, a visual culture can influence the spatial behavior of its members in the real landscape. In this respect, the characteristics of the stereotype are compared with the real behavior of people in space. Especially how it influences the way people approach landscape objects they knew previously only from images and that they themselves want to make a picture of.

The analysis of the corpus of images depicting dolmens reveals a pattern that hints at the core visual characteristic of a dolmen. This core can be described as follows: 'its image consists of at least

¹ This text is a summary of a paper by Thomas van den Brink, to be published in 2017. It concerns one of Ernst Gombrich's interpretations of images within the context of art history applied to the images produced of dolmens.



Figure 7.A Selection of the images that were produced of dolmens and that were included in the analysis: photo's, engravings, map symbols and paintings: (Tilburg, 2006), 170. And: Historische Atlas Drenthe Chromopografische kaart des Rijks 1:25.000, (1989), 1.; Toeristische Sleewijkkaart 1:120.000, (± 1920); Atlas van de geschiedenis van Nederland, ingedeeld vloggers de vensters van de Canon van Nederland, (Groningen, 2008), 6.; ANWB / VVV Toeristenkaart Drenthe 1:100.000, (2003); Hottinger map (1773-1794), in: Versfelt, 45.; ANWB Topografische atlas Drenthe 1:250.000, (2006), 1., W. Roelofs, 'Het Hunebed van Tynaarlo', 1861, watercolour, 30,7 x 49,5 cm, Teylers Museum, Haarlem.

three objects where one of them is on top of the others'. This has two implications. First of all, that it can consist of more than three objects, but never less. Second, the positioning of these objects is crucial: at least one of them must be on top of the others.

The differences between individual images can be explained largely by the techniques used to create them. It influences the final appearance of the image extensively if it was engraved or a shot as a photo. Furthermore, the individual variation could, in theory, be explained by the freedom the maker has made use of, as a convention does not prevent someone to deviate from it. This however could not be tested empirically due to a lack of information about the maker's intentions.

The pattern does suggest that these stereotypes are shared as if the producers had an idea beforehand how such an image should look like. As such, it governs the production-process of individual images. This is something that seems to be in line with the locations people chose to make photos of dolmens from as archeologist Yftinus van Popta convincingly showed in his analysis (Figure 8).

However, the spatial behavior of people in the immediate vicinity of these objects is also strongly related to the physical context. Roads, obstacles and potential background vegetation, all play a role in the position the photographer chooses for his picture. Thus, it seems that the relation is quite complex (Y. van Popta 2011).

Nevertheless, it seems that the before mentioned stereotype governs us at least in two ways. On the one hand, it enables us to recognize an image as that of a dolmen despite its singularity. This is done by the comparison of the image with the mental stereotype. On the other hand, it directs us by influencing the reproduction of dolmen images. Together, these mechanisms lead to a complex reproduction cycle of images (see Figure 9).

Simplified, this cycle would have three phases. Firstly, a person is exposed to a large amount of different images about an object called 'dolmen' – often before seeing one in reality. These images are as diverse as dealt with in this paper. Secondly, all these images are reduced in the mind to a fluent, mental stereotype of a 'dolmen'. Thirdly, when this person makes an image of a dolmen, there is a big chance he will make it in line with his mental stereotype. This step is complicated by the fact that



Figure 8. Point-of-view analysis of pictures taken of a dolmen nearby the village Havelte plotted on Googlemaps.com (Y. van Popta 2011).

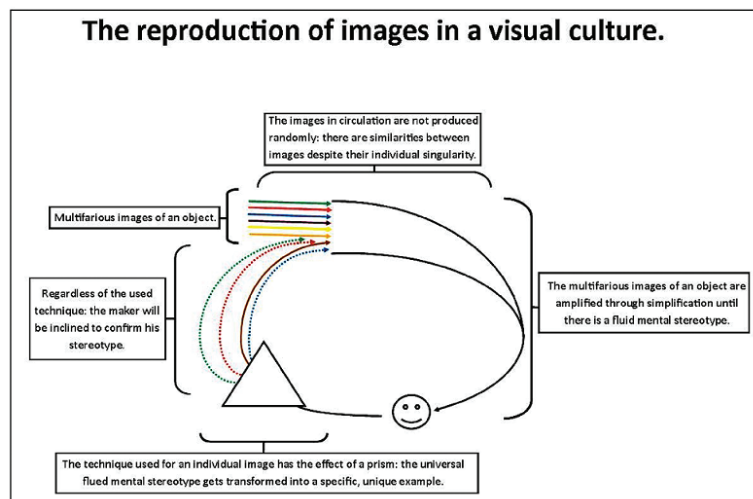


Figure 9. The reproduction-cycle of images in a visual culture (author Thomas van den Brink).

The Dutch landscape artifact called dolmen was the central focus for the current exploration. I was especially interested in how a visual culture exercises influence on the approach its members choose towards the object in the real landscape. As only a few people outside the Netherlands will have seen the specific object in real life, I will shortly conclude with a more international example to show how this theory and methodology could be applied in future cases. The example relates to a world-famous land mark: the Eiffel Tower in Paris. It is used to highlight one of the discussed effects: the distance between the object and the location where most of the photos were made*.

the chosen technique works as a prism: the fluid, cultural determined mental stereotype becomes a specific singular sample. Nonetheless, by doing so, the person contributes to the never-ending pool of dolmen-images. As such, the cycle starts again as this image is part of the collection of images that influence the mental stereotype of others.

As such, mental stereotypes and techniques are equally important but also each other's opposite. The first one leads to convergence (images of the same object looking more similar) while the latter results in divergence (images of the same object looking less similar).

During its lifetime, perhaps over a million images were made of this tower. When these images are compared, it will come forward that there are some important similarities. One of the common

* As the Eiffel Tower is symmetric, it is not suitable to illustrate differences in perspective, as was clearly the case for the dolmen photos.

denominators could be that this landmark is depicted in its entirety. If so, this will have a direct influence on all those persons that are familiar with these images and visit the tower afterwards for the first time. The first over

Whelming experience is the gigantic size of the object: when you approach it, it is almost impossible to see it at a glance from base to top, like you were used to on images.

More specific, when a person plans to make a photo that meets the requirements of his or her mental stereotype of this tower, he or she shall move away from the object until it is possible to make a photo with the tower as a whole. As such, the huge size of the Eiffel Tower enforces a minimal distance to make these kinds of photos. Consequently, as this individual behavior is influenced by a convention it is likely that these choices lead to some kind of collective spatial behavior. When one would plot the locations of all these images around the actual tower, it is thus expected that it would reveal a very clear area where the majority of photos were made.

INTERPRETING THE ARCHAEOLOGICAL RECORD WITH THE AID OF GIS – INSULA 30 AT AUGUSTA RAURICA (SWITZERLAND)

Sven Straumann

INTRODUCTION

Within the research agenda of a PhD project at the University of Basel, it is for the first time that GIS has been employed from the start of a post-excavation analysis of the archaeological materials from Augusta Raurica. The project allows gathering valuable experience, both in making available voluminous excavation documentation and in handling this data using ArcGIS software (Straumann 2015).

AUGUSTA RAURICA

Once part of the north-west provinces of the Roman Empire, this Roman colonial town lies in the centre of Europe, some 10 km east of Basel, in Switzerland. It was situated at an extremely important transport node and enclosed an area of around 100 hectares, of which about 60 hectares was built up. Augusta Raurica remained the largest and most important settlement in the region for approximately three hundred years (Pfäffli 2010; Berger 2012).

GIS IN AUGUSTA RAURICA

Although Augusta Raurica has been excavated and studied since the Renaissance, the history of GIS in Augusta Raurica is relatively recent. It developed out of a CAD-supported excavation inventory. We were able to combine the GIS data with the attributes of the archaeological database, IMDAS-Pro.

Since early 2013, the archaeological overall plan of Augusta Raurica has been part of GeoView BL, the new, online interactive map of Canton Basel-Landschaft (www.geoview.bl.ch) (Brombach 2013).

As GIS has become increasingly well-established in Augusta Raurica, its areas of application have grown (Brombach 2010). Today its main uses are: documenting the history of the city, managing excavation results and investigations, and supporting the overall research activity.

THE INSULA 30 RESEARCH PROJECT

Centrally situated in the Upper Town of Augusta Raurica, the block known as Insula 30 was completely excavated between 1959 and 1962 (Berger 1967). Insula 30 is so far the only insula in Augusta Raurica to have been excavated in its entirety. The insula has never been the subject of a comprehensive analysis. Almost the entire area of 3,395 square metres was excavated down to the underlying natural ground, allowing not only the floor plans of the stone-built phases of the town, but also the remains of its timber-built phases of the early 1st century AD to be recorded. As a result, the Insula represents an extremely valuable archaeological source, with great research potential.

ANALYSIS USING GIS

A fundamental challenge when analysing the results of archaeological excavations is finding the most efficient way of making available the numerous data and source materials. After the excavation documentation has been initially tidied and archived, it can often be years, sometimes even decades, before it is studied and analysed in detail. This means that, although neatly stored and catalogued, the information on the finds, features and excavation results must first be brought together in a readily available form. It is particularly difficult for a researcher who has not been personally involved in an excavation to link up archive materials stored separately according to media type. It is crucial when analysing excavation results to be able to establish the spatial relationships between structures and then to characterise each structure using every available source of information. Depending on what you want to discover about a particular feature, the required sources will be stored in quite different locations within the site archive. To work efficiently, you will therefore need a strategy which, with the least possible effort, will provide you with an overview of the extensive excavation documentation. Traditional, well-tried solutions include, for example, creating lists and concordances, and photocopying and 'patching together' drawings and photographs. Using these, you can eventually work out plans of the various construction phases. In the end, once the analysis is complete, these are digitalised using drawing software and finally published.

For the analysis of Insula 30 the used procedure turns the traditional working method on its head. All the structures recorded in the original documentation were entered into Augusta Raurica's Geographic Information System at the very outset, by scanning in the original records and then geo-referencing them using the GIS software. The various components of the documentation were thus digitalised before the actual evaluation itself began. The task of producing drawings, including ongoing adjustment and correction, is thus done by the researcher himself, who minutely sifts and evaluates all the records. As a result, there is no need to prepare provisional sketches by hand and "patch together" individual drawings. At the same time as the data for the structural features are being entered into the spatial database, lists are generated using the so-called "attribute tables". Thanks to the GIS facility to link these lists directly with the spatial information, the data can then be used in very versatile ways for different types of searches. Also, once the structural features have been put into the GIS, to-scale plans can be produced at any time and almost at the touch of a button. So the preparatory work of making the excavation documentation available already produces some of the essential components of the final product, such as construction phase plans, etc.

The chosen strategy not only saves the laborious re-working and incorporation of provisional plans, but also, and more importantly, builds up within the GIS the database which will form the basis for the evaluation. Instead of the knowledge accumulated about individual structural features only being input into the GIS at the end of the research project, it is added as the work progresses, so that the data-set is constantly growing. For the researcher, the GIS software serves not just as an instrument for analysis but first and foremost as a working tool.

In addition, the basic plans accumulated in the GIS and the huge wealth of information stored in the attribute tables is both immediately available and constantly updated for use by the research community.

METHODS

Right at the start, all the excavation drawings were scanned into the GIS, geo-referenced and vectorised. At the same time, supplementary data were entered in the so-called 'attribute tables', i.e. the database section of the GIS. An overall map of all the excavated and documented features was thus created. This forms the basis for the analysis and can be constantly updated with further information from the database as the work proceeds; for example, construction phases can be allocated to the mapped structures. It is from the GIS attribute tables that the essential data for the analysis are added to the spatial information. The countless details of data, assignments, measurements and remarks in the attribute tables can be searched at any time or used to generate maps of various types.

For archaeological analysis, it is essential to determine the spatial locations of the individual features documented in the excavation records. This is indispensable if the various sources of information are to be linked up. Here too, the GIS are of practical help. For example, the positions from which photographs were taken during the excavation can be mapped in the GIS and linked directly with scans of the photographs themselves (Figure 10). Clicking on a 'photo spot' on the map will thus open the corresponding photograph in a separate window. There is no need to spend time hunting for the analogue photograph in the archive folder.

As these examples show, the GIS offer a simple way of linking all sorts of documentation components with their spatial locations. The preliminary work of scanning-in and entering the data rewards the user with quick and flexible access to the documentation.

DENSITY MAPPING

For example, from their upper and lower boundaries, the volumes of find complexes can be calculated. From these, in turn, interesting and revealing density maps can be created. Moreover, it is possible to access the archaeological finds database directly from the GIS database. For example, with a single click, a researcher can see which finds are catalogued under a particular find-assemblage number.



Of course, you can also simply create find maps with GIS. It takes very little trouble to produce maps with a great deal of information; you might choose, for example, to include the inventory numbers of finds. To help you to form a mental picture of the spatial relationships between finds, you might also create a three-dimensional representation.

CONCLUSION

These examples show that an analysis supported by GIS, especially in the case of excavations with mainly analogue documentation (for example, old excavations) brings many advantages. Of course, the amount of data available from older excavations does not usually reach the levels generated by an excavation today. Nevertheless, the documentation offers a wealth of information in various analogue media. Digitising the records and integrating them into the GIS system allows the potential of old excavation documentation to be much better and more efficiently exploited.

As a spatial database, the Geographic Information System allows large quantities of data to be quickly accessed. Especially for researchers who have not been personally involved in an excavation, this provides a relatively quick way of obtaining a (spatial) overview (Figure 11). Individual sources of information, such as photographs and drawings, are linked with one another and can be located in three dimensions.

The GIS can be used at any time to search for information, even while the data is still being entered, but especially during the actual work of analysis. It takes only minutes, for example, to search for particular structures or to extract calculations of areas. The whole treasury of data stored in the attribute tables is available to be searched or to generate maps of every type.

Finally, an essential aspect of this method of analysis is its continuing usefulness on many levels. Apart from the “return on investment” for the researcher himself other researchers also benefit. The digitally captured sources and data stored in the GIS are readily, transparently and reproducibly available for anyone in the research community to use for his or her own investigations, and to supplement with further data.

Even though the advantages of the method illustrated here are undoubtedly convincing, there still remains the question of whether the return justifies the investment. Whether using GIS makes sense or not must be decided on a case-by-case basis, depending on the size of the excavation to be evaluated and the questions to be answered. If a project involves studying relationships between excavation results from across a large area – an entire insula in this example – GIS will always be a huge and lasting asset. In excavations which need to be seen as part of a larger whole, linking up with the surrounding features is essential. If all the structural features will finally be stored in a GIS system anyway it makes sense to work with GIS right from the start.

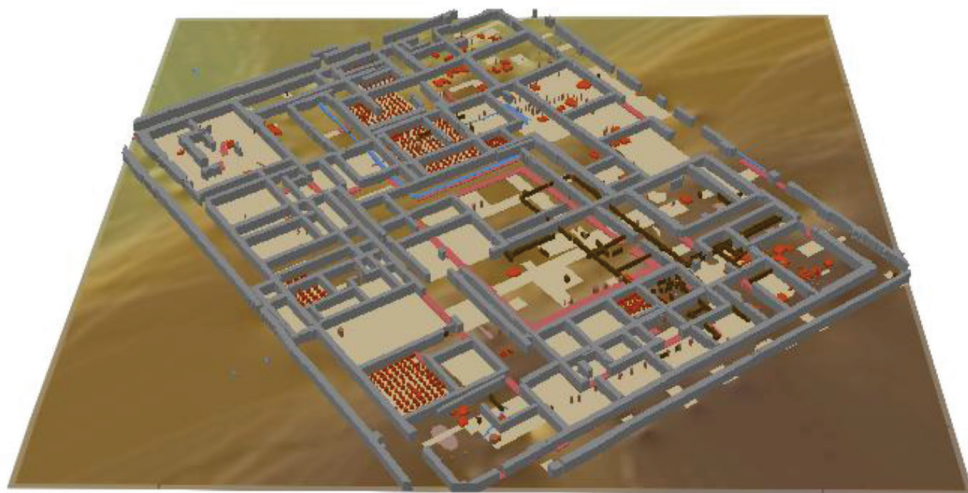


Figure 11. Three-dimensional model of Insula 30 over the topographical model

An archaeological evaluation using GIS offers an attractive alternative to traditional methods. In the end, however, every researcher must decide for him or herself whether it represents a feasible approach for the project and research questions involved. The success of the methods selected for the pilot project on “Insula 30” can only be finally judged once the analysis is complete. GIS opens up new prospects, not only as a working tool for archaeology in general, but, in particular, as an aid for the efficient and ongoing evaluation of excavation results.

PROPERTIES OF ARCHAEOLOGICAL SPATIAL DATA AND THEIR IMPACT ON INTERPRETATION OF ARCHAEOLOGICAL MATERIALS

Tsoni Tsonev

INTRODUCTION

There is no doubt that archaeological spatial data are partial and incomplete. Yet traditional archaeological interpretation schemes are constantly trying to reconstruct invariant relationships understood as perpetuation of a given archaeological culture based on symmetry of presence/absence models of archaeological artifacts, structures, monuments. The theoretical expectations of this kind are that the frequency of occurrence of a given category of artifacts when counted at a large number of sites in a region will outline a center and periphery that will characterize their spatial distribution. This leads to research practices of taking into consideration only the major and most numerous artifacts, structures, and monuments. In most cases interpretations take the form of a linear evolution of a chain of normally distributed archaeological categories. Thus the concept of uniformity of archaeological record gains greater significance at the expense of its diversity.

A question arises how explanation of partial and incomplete empirical facts contributes to archaeological interpretation. In order to answer it I will provide a novel approach to analyses of these data and will illustrate it with an example. The latter contradicts traditional understanding that the evolution of the flint-knapping techniques and toolkits in the Neolithic in Bulgaria follows “cultural regress” (Gatsov 1992). The results of my analyses suggest that the combination of new subsistence strategies, based on the study of macro-plant remains from a sample of early Neolithic sites (Popova 2009) with the increasing on-site craft specialization, develops both cognitive abilities and learning practices that lead to changes in the entire lifestyle of the early farming communities in the eastern Balkans.

A RELATIONAL APPROACH TO PARTIAL AND INCOMPLETE ARCHAEOLOGICAL DATA

Generally, the archaeological record consists of disparate events that have little or no direct relations between them. This assumption suggests that particular archaeological categories cannot be expected to be normally distributed along a time-period or within a social-geographic space. I will illustrate this by analysis of the presence/absence (non-symmetrical) pattern of macro-plant remains from a sample of early Neolithic sites in Bulgaria (Figure 12).

For this purpose I constitute a presence/absence data-matrix where I score the presence of a given plant species at a given site by 1 and its absence by 0.01 (Table 2).

Thus arranged the data-matrix itself shows that the data cannot be approximated by Normal distribution. This is why a correspondence analysis based on uniform probability distribution is applied. The theoretical expectations are

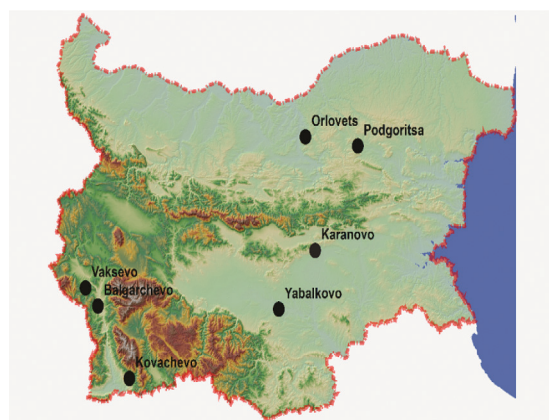


Figure 12. Map of Bulgaria with the early Neolithic sites involved in this study.

Table 2. Data-matrix with the distribution of the identified plant species across the early Neolithic sites.

Plant species	Balgarcevo	Vaxevo	Kovachevo	Orlovets	Jabalkovo	Karanovo
1. <i>Triticum monococcum</i>	1	1	1	1	1	1
2. <i>Triticum dicocum</i>	1	1	1	1	1	1
3. <i>Triticum aestivo/durum</i>	0,01	1	1	0,01	1	1
4. <i>Hordeum vulgare</i>	0,01	1	1	1	1	0,01
5. <i>Hordeum vulgare v.nudum</i>	0,01	0,01	1	1	1	0,01
6. <i>Secale cereale</i>	0,01	1	0,01	0,01	0,01	0,01
7. <i>Panicum miliaceum</i>	0,01	0,01	1	0,01	1	0,01
8. <i>Avena sativa</i>	0,01	0,01	0,01	0,01	1	0,01
9. <i>Lens culinaris</i>	1	0,01	1	0,01	1	1
10. <i>Vicia ervillia</i>	1	0,01	1	0,01	1	1
11. <i>Vicia sp.</i>	0,01	0,01	0,01	0,01	1	0,01
12. <i>Pisum sativum</i>	1	0,01	1	0,01	1	0,01
13. <i>Latyrus sativa</i>	0,01	0,01	1	0,01	0,01	0,01
14. <i>Pistacia terebinthus</i>	0,01	0,01	1	0,01	0,01	0,01
15. <i>Cornus mas</i>	0,01	0,01	1	0,01	0,01	1
16. <i>Vitis vinifera ssp. sylvestris</i>	0,01	0,01	1	1	0,01	0,01
17. <i>Prunus sp.</i>	0,01	0,01	1	0,01	0,01	0,01
18. acorn – <i>Quercus sp.</i>	0,01	0,01	1	0,01	0,01	1

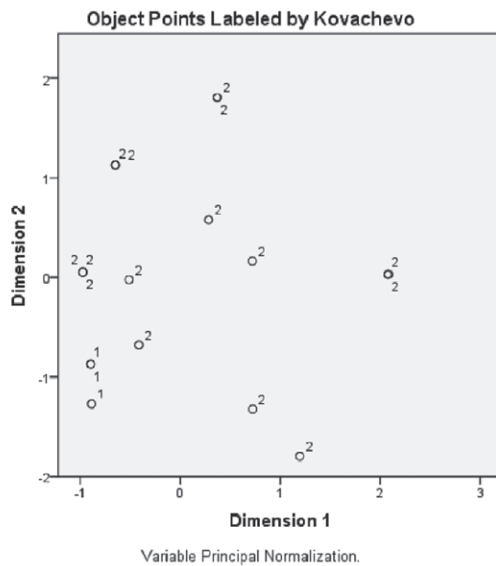


Figure 13. Distribution of variables '1-absence' and '2-presence' within the identified in the Kovachevo site plant species.

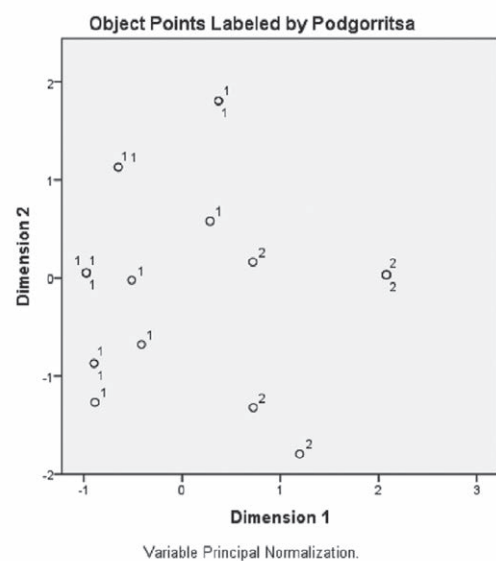


Figure 14. Distribution of variables '1-absence' and '2-presence' within the identified in the Podgoritsa site plant species.

that each plant species has particular frequencies across the sites. This provides the possibility to study the relational character of the presence of the identified species and to approximately reconstruct some of their evolutionary patterns.

The first step of this analysis of data is to check whether such evolutionary patterns are visible in this set of partial and incomplete data. In order to do this two variables are constituted: 1-absence and 2-presence. The question arises as to what types of associations they will form across these data?

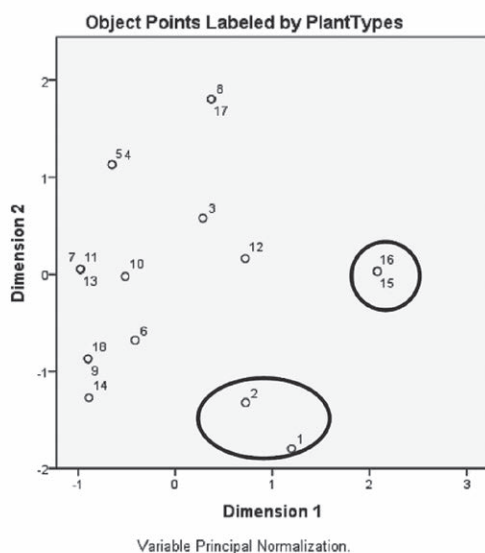


Figure 15. Positive relationship between two stable associations: (1, 2 – *Triticum monococcum*, *Triticum dicoccum*); (15, 16 – *Vitis vinifera ssp. sylvestris*, *Cornus mas*).

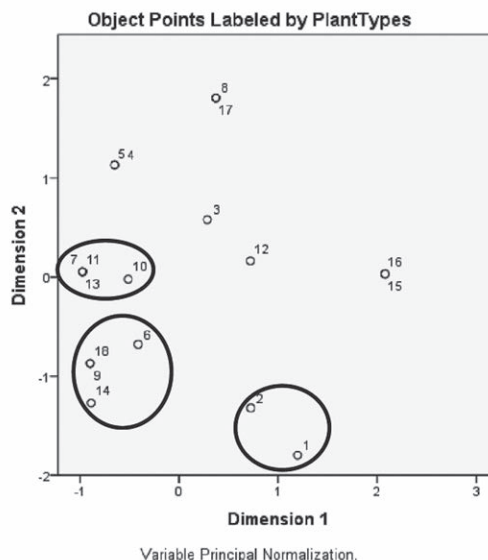


Figure 16. Negative relationships along the first dimension between associations: 1, 2 – *Triticum monococcum*, *Triticum dicoccum*; 6, 9, 14, 18 – *Secale cereale*, *Lens culinaris*, *Pistacia terebinthus*, acorn of *Quercus sp.*; (7, 10, 11, 13 – *Panicum miliaceum*, *Vicia ervilia*, *Vicia sp.*, *Lathyrus sativum*).

If properly excavated and recorded the sets of these variables should exhibit an even distribution without marked clustering.

In the Kovachevo distribution, these variables (Figure 13) show that variable '2-presence' has both positive and negative associations and contributes significantly to the overall variation. This result suggests that it is worth trying to discover the existing stable associations between particular plant species.

The Podgoritsa distribution shows that the two variables form symmetrical negative association (Figure 14). It suggests the existence of serious epistemological bias in archaeological explanatory schemes due to non-satisfactory excavation practices. The latter is illustrated by the formal symmetry between the presence and absence variables where the 'expected' species (cereals) were systematically identified while the 'unexpected' ones (wild plant species) were not.

In summary these results show that although there is a lack of precise data they bear enough information and may be helpful in assessing how these communities developed strategies for diversification of their resource exploitation.

This conclusion is supported by the results of the correspondence analysis carried out on the same data (Figure 15). They show that there are seven stable associations that emerge from the identified plant species. The first one is the positive association between *Triticum monococcum*, *Triticum dicoccum* (numbers 1, 2) and the Cornel-tree and wild grape (numbers 15, 16 on the plot). It may correspond to mixed human activities focused on working lowland fields and their hilly margins.

This pattern suggests that there are two alternative strategies. The first one involves growing and collecting *Lens culinaris* (No 9), *Pistacia terebinthus* (No 14), acorn (No 18) and rye (No 6). The second involves millet (No 7), *Lathyrus sativum* (No 13), *Vicia ervilia* (No 10), *Vicia sp.* (No 11) (Figure 16). These are overlapping subsistence strategies that may relate human response to small climatic oscillations (10-15 years of average duration) and to systematic land-use in combination of cycles of varying intensity of production and consumption.

The remaining four stable associations may be ascribed to arbitrary (e.g. not related to external climatic influence) human preferences that have local and regional significance. They reveal that people not only usefully adjust to the surrounding environment to their needs but under the influence

of these changes alter their own cognitive space, which allowed them to plan and execute long- and short-term subsistence strategies (Van der Veen 2014).

The first association answers the question how fast the collection of wild plant species increases alongside growing cereals that pre-supposes their subsequent domestication. A linear regression model has been constituted based on the average presence of all cereals in the data-matrix and the average absences of Cornel-tree, wild grape and plums. The result (Figure 17) shows that there is a moderate growth but with considerable local variations based on individual choice of each community.

The next three associations reveal strategies that aim to improve the quality of the expected harvests. They involve growing *Hordeum vulgare*, *Triticum aestivum/durum* and *Pisum sativum* (Figure 18). The social significance of this strategy can be discerned from the fact that *Hordeum* was domesticated before wheat (Riehl et al., 2015). The practices of long-term cultivation of *Hordeum* would entail elaboration of sophisticated knowledge which intensifies individual and community communication that stimulated cultivation of other cereals and growing selected combinations of them according to the local environmental conditions and social demands and dependences.

The analyses of the above show an increasing diversification of subsistence strategies of these early farmers. Also this process of 'on-going diversification' sheds light on interpretation of the evolution of flint-knapping techniques and toolkits during the Neolithic. Because of the lack of precise data, my analysis is based on the common changes in lithic techniques and tool morphology. The latter includes categorization of tool's purpose (single, multiple) in combination of artefacts' technotypological characteristics, function and provenance of lithic materials. I place these changes in the context of the growing in number and sophistication symbolic expressions of the developed Neolithic communities in the eastern Balkans.

As it was established, the early Neolithic assemblages are featured by the presence of long blades (8-15 cm in length) made by special techniques that were carried out on high-quality flint varieties. Their provenance from Cretaceous limestone strata in northern and northeastern Bulgaria has been established (Nachev 2009). All the other technical and morphological elements are subordinated to this strategy. From this initial stage lithic techniques and toolkits changed and diversified significantly. These changes may be categorized as tendency of production of single purpose tools. Combined burins become rare and each single burin has its own purpose. The same is observed with end-scrapers and microliths which are made by different from the Upper Palaeolithic technique.

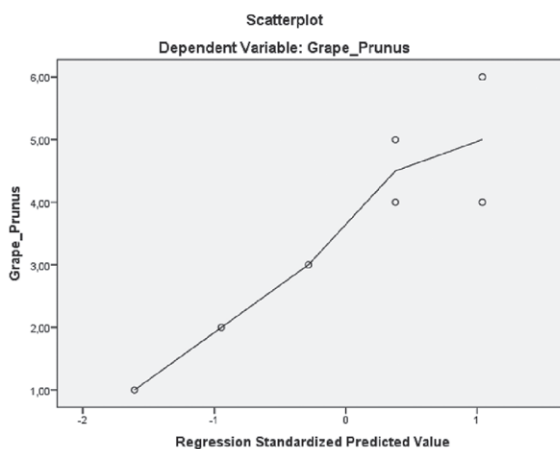


Figure 17. Linear regression model for the growth of wild plant species: wild grape- *Vitis vinifera ssp. sylvestris*, *Cornus mas*-Cornel-tree, *Prunus sp.*-plums.

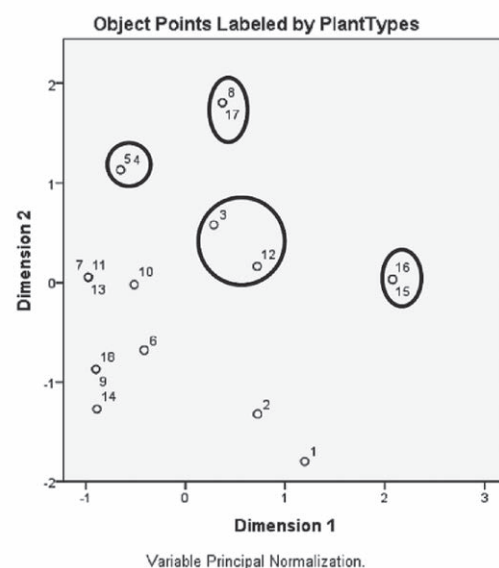


Figure 18. Three negative associations relative to *Triticum monococcum*, *Triticum dicoccum* (No 8 – oat, No 17 – plum); (No 4 – *Hordeum vulgare*, No 5 *Hordeum nudum*); (No 3 – *Triticum aestivum/durum*, No 12 – *Pisum sativum*).

The domestic (on-site) flint-knapping techniques show significant diversity, especially within the operational chain of exploitation and enlarging of the flaking surface of the nucleuses (Tsonev 2007). Their enormous variety has prominent local particularities and show different technical combinations related to different locales for acquiring raw materials. Thus to these localities, there may have been ascribed symbolic meaning by constituting biographies of local and distant landscapes containing flint outcrops (Tilley, 1994). All this indicates increased on-site craft specialization (Baysal 2013) for working diverse objects including beads, shell, stone ornaments for cloths and small objects of art.

CONCLUSION

Traditional approaches lead to uniform labeling of these early communities as farmers. The above presented data do not confirm this understanding. Additional data that have not been included in this study support this conclusion. For example, the Eneolithic site – Orlitsa in Bulgaria does not have a single bone uncovered (Boydzhev, Boyadziev, 2008). It was shown that the mobility of the Neolithic populations is greater than that of the Mesolithic ones in the Danube Gorges (Boric and Price 2013). The domestication of cereals goes back as far as 23 000 B.C. at the site Ohalo II, Israel (Snir et al., 2015). Early experimentation with domesticated wheat as well as the practice of mobile 'itinerary farming' is observed in Western Europe (Pétrequin and Pétrequin 1988: 31-33).

The key element in all these changes is that the intensification of communication leads to novel cognitive development (novel cognitive cues dispersed within the surrounding landscapes) that enables people to interact with the surrounding world (Roberts, 2015). The early farmers were not passive recipients of novel subsistence practices. They were innovative and active agents with a range of multiple identity practices that not only created novel strategies for engagement with the environment but increased their own dependency on them and, what is most important, developed new cognitive capacity for complex interaction with them.

GENERAL CONCLUSION

In this joint paper it has been shown that space has its own social dimension that can help archaeologists understand how past societies used it to create social meaning and value. The first example reveals how past built environment within the frame of a single settlement sharpens the sensitivity of both its inhabitants and outside visitors to the established public norms of behavior. The next example shows how a visual culture contains mental stereotypes of monumental structures that influence the spatial behavior of modern observers that want to make their own image of these structures. The third example reveals the potential of GIS and 3D representations for analyses and interpretation of the spatial organization of the large urban center from Roman times. The final example provides a critique to the typical understanding of the organization of spatial data in archaeology and offers a way of analyzing both present and absent data in order to extract the maximum information and constitute a coherent interpretation from the otherwise disparate and loosely related data.

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