GIS as a means to investigate " Princely Sites ", Space and Environs.New ways to answer old questions.

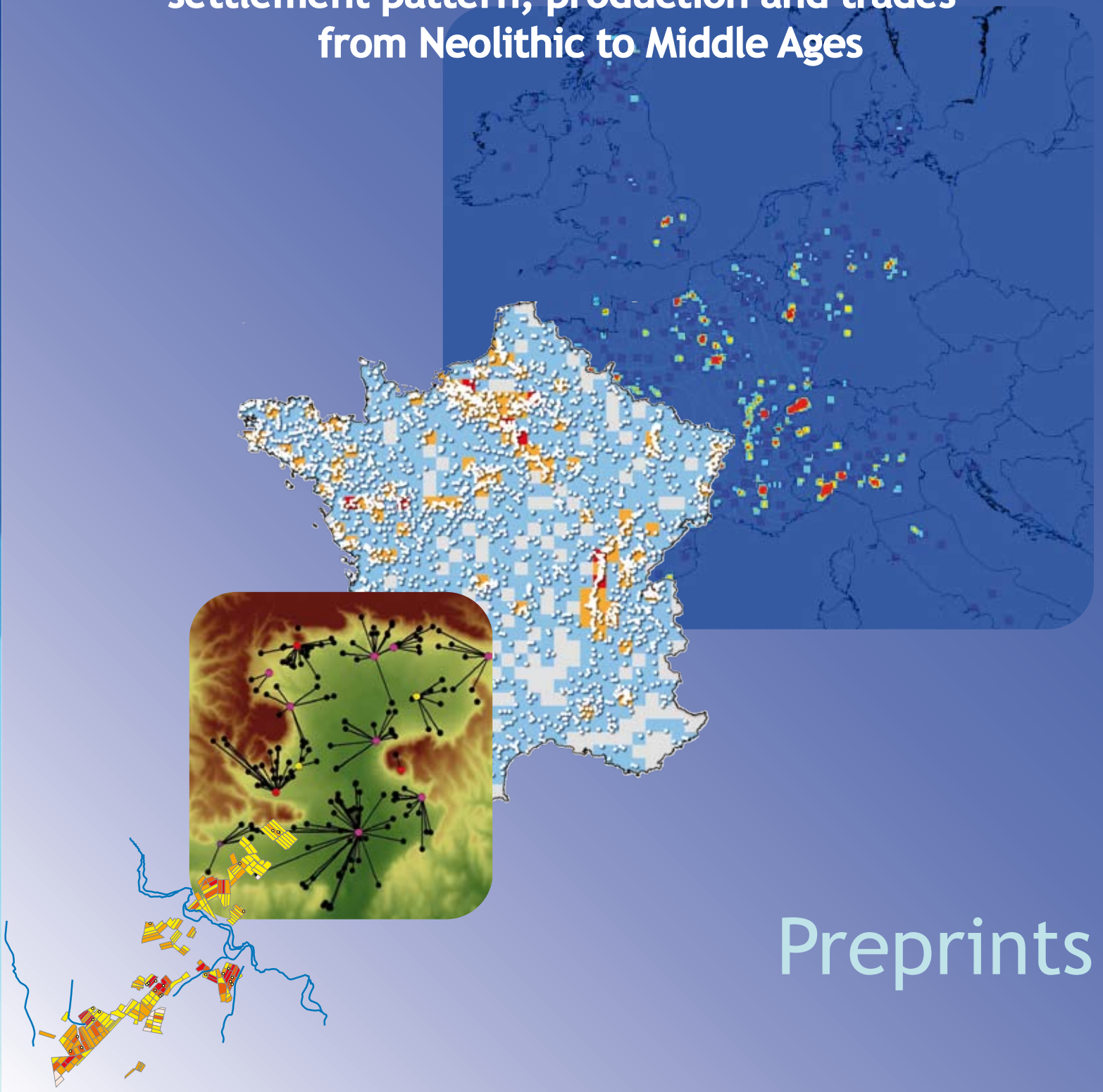
Axel Posluschny

ACI "Spaces and territories" 2005-2007
Final conference - Dijon, 23-25 june 2008

ARCHAEDYN

7 millennia of territorial dynamics

settlement pattern, production and trades from Neolithic to Middle Ages



Preprints

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Spatial dynamics of settlement and natural ressources : toward an integrated analysis over the long term from Prehistory to Middle Ages

Final Conference – University of Burgundy, Dijon, 23-25 june 2008

ARCHÆDYN

7 millennia of territorial dynamics

settlement pattern, production and trades from Neolithic to Middle Ages

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GIS AS A MEANS TO INVESTIGATE « PRINCELY SITES », SPACE AND ENVIRONS. NEW WAYS TO ANSWER OLD QUESTIONS

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Abstract:

The so called Early Celtic "Fürstensitze" undoubtedly reflect a change in settlement behaviour and in society. Our project investigates sites from the Urnfield to the Early Latène period in combination with their natural environment using GIS tools. The modelling of territories and of lines of communication is used to reconstruct the potential meaning of each «Fürstensitz» in its region, the analysis of visibilities can provide information on the prehistoric perception of space and the possible meaning of the "Fürstensitze" as places of power and control.

Key words : "Princely Site", landscape archaeology, perception of landscape, natural environment, GIS.

1. Introduction

1.1 Early Iron Age "Princely Sites"

From the beginning of the Late Hallstatt Period (Ha D1) a change in the use of hillforts (fortified hill top settlements) can be noticed throughout large parts of proto-Celtic Europe (Southern German Bavaria, Baden-Württemberg, Rhineland-Palatine and Hesse, Bohemia, Austria, Switzerland, Western France). While the number of these sites decreases, they seem to become more wealthy and powerful. Finds of Mediterranean goods like Greek amphorae or bronze vessels are the visible relicts of contacts of the Protocelts north of the Alps with the so-called advanced civilizations in the Mediterranean south, rich graves with gold and again Mediterranean imports mark the existence of an at least rich, maybe also powerful class.

A long lasting discussion about the role of these hillforts – which have been named "Fürstensitze" ("Princely Sites") – followed after KIMMIG (1969) published his first definition of these sites (e.g., FISCHER 1973; EGGERT 1991; PARE 1991; VEIT 2000). Kimmig and his disciples not only gave a definition of the term Fürstensitze, they also tried to interpret this kind of settlements as central places, inhabited by the reigning nobility, who had the power and the wealth to participate in a system of long-distance contacts to Italy, Greece, and Southern France. In many respects, this image is similar to the system of a mediaeval aristocracy and not only therefore provoked criticism.

In 2003, the German Federal Research Foundation granted a large research program, dealing with the "Fürstensitze." With the title "Early Centralization and Urbanization. Formation and Development of "Early Celtic Fürstensitze" and their Territorial Surrounding", several projects started their work in spring 2004 and will continue until 2010, hoping to find answers to the questions of the "Fürstensitz" phenomenon.

The project "Comparative Analysis of the Early Celtic 'Princely Sites' ("Fürstensitze") and their Environs with the help of GIS—or for short, "'Princely sites' and Environs"—aims to analyse different types of settlements as well as graves in their natural environments. We want to connect the sites from the Late Bronze Age (Urnfield period) to the end of the Early Iron Age (Early Latène) with aspects of their natural environment as part of their area of economic and cultural activities. On the one hand, we hope to find patterns that will allow us to recognize different types of settlements with different economic and/or cultural backgrounds. On the other hand, we want to compare the sites and their patterns of preference for special environmental factors, diachronic and interregional, to show the ways of development as well as regional tendencies.

Another aim of the GIS project is the investigation of territories, hypothetical paths of communication, and traffic routes, which we will explore with the help of viewshed and least-cost path analyses. The first should also help in detailed research of special problems such as the visibility of singular sites, landmarks (i.e., the intervisibility of the "princely settlements," and the grave mounds probably associated with them) or astronomic fixed points that can give us a hint of how prehistoric people conceptualised their surroundings and what they perceived as important in environment.

1.2 Landscape and sites

The research is carried out in several areas of about 50 x 50 km, both incorporating a "Fürstensitz" and regions without any of these sites (Figure 1).

The archaeological data is mainly based on information from the State Heritage Management of Hesse, Bavaria and Baden-Württemberg, using site data from all settlement sites, graves/graveyards and single finds from the the Late Bronze Age period (Urnfield Culture, ca. 1200 to 750 BC), the Early Iron Age Hallstatt period (ca. 750 to 450 BC; it is in a late phase of this period that the first of the Fürstensitze emerge) and from the Early Iron Age Early Latène period (ca. 450 to 250 BC; the Fürstensitze usually do not reach the second half of this period). At the moment (May 2008) we have a total of 4061 sites from those main periods plus several hundreds from the transitional phases, with unknown dating or with poor archaeological knowledge at all which will not be part of the interpretation. In some cases we can incorporate 2340 undated gravemounds into our research due to the fact that most of them are most likely to be dated into the Hallstatt period (table 1).

As there is in several cases more than one site at one topographic place, defined by a single coordinate (e.g. an Urnfield grave and a Hallstatt settlement have been excavated at the same place), we do separate sites (single appearance of an archaeological evidence at a given coordinate) from places (one or more sites at the same place/coordinate). Most of the sites are only known from surface finds, mainly not from a systematic survey. Due to this fact and due to problems of precise dating of pottery sherds we have to deal with uncertainties when dating and interpreting sites. As a result we have to use very coarse dating periods (Uk, Ha, eLt). In the River Main Triangle – a region with good conditions for our research – we can date 399 sites to the Hallstatt period, only 16 of those can be dated

Table 1. Archaeological sites of the project.

	settlements	graves/graveyards	others	*sum*
Urnfield (Uk)	1059	300	265	*1624*
Hallstatt (Ha)	1132	674	185	*1991*
Early Latène (eLt)	259	128	59	*446*
sum	*2450*	*1102*	*509*	***4061***

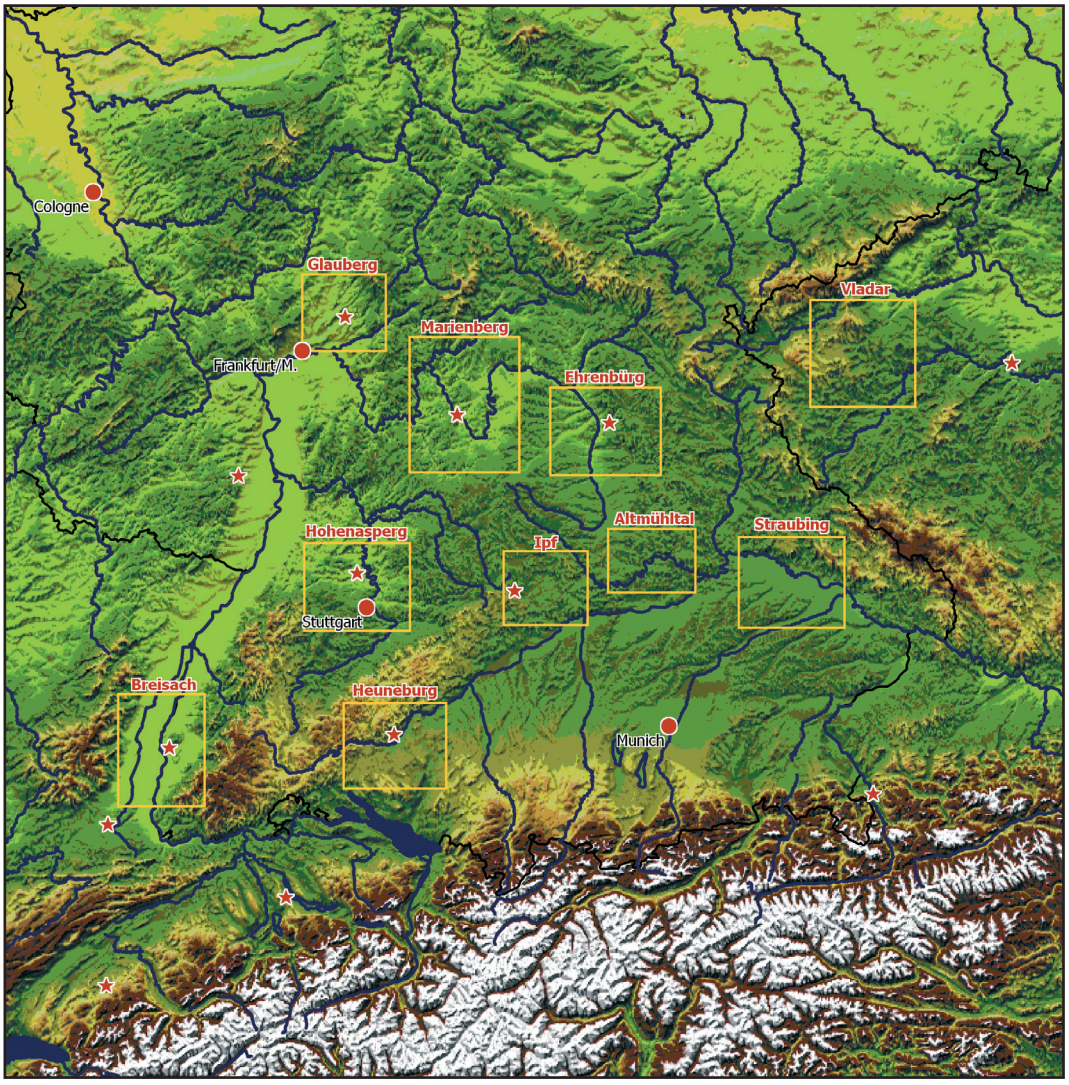

Figure 1. Areas of research of the project "'Princely sites' and Environs."

more precise into one of the subperiods Ha C, Ha C/D or Ha D. As a result of the small number of (totally) excavated sites we have very small knowledge about the size of a typical settlement, additionally the size of the area that brought to light surface finds has not been recorded. For that reason we are mainly dealing with sites as point data, well knowing that we have to incorporate surrounding areas as "Hinterland" of settlements, used e.g. for agricultural purposes. These surrounding areas have been defined both by regular circles around a settlement site with a diameter of 1,5 km (GRINGMUTH-DALLMER, ALTERMANN 1985, 344–348) and by a cost based, polymorphic isoline. At the moment we are testing the use of a cost model that is based on slope and broad streams as cost factors for the definition of the border. As an alternative we are going to change from slope to the slope-based Gorenflo/Gale-model which produces costs in form of walking speed instead of abstract costs (GORENFLO, GALE 1990). Information of the natural environment of all archaeological sites are connected both with the site as a single spot as well as with the surroundings (1,5 km and cost-based).

Being aware of the fact that we are dealing with prehistoric societies whose economy is strongly based on agriculture we use mainly those environmental parameters to describe the characteristics of settlement in a certain area and in a certain period that are strongly connected to the needs of farmers and herders.
Topography with all its aspects like height, slope, aspect, terrain type, prominence (LLOBERA 2001) and relief intensity can be derived from a 25 m grid DEM (DGM25-D), obtained by the German Federal Office for Cartography and Geodesy (BKG). Water supply was also one of the most important factors of everyday life, streams could have been the basis of a traffic flow as well. Information on water grids as well as the distribution of modern forests, traffic ways, and buildings as a filter of site discovery are part of the Basis-DLM, also obtained by the BKG.
For the investigation of least-cost paths of long distances (i.e., across the Alps from northern Italy to southern Germany), the fine details of a 25 m grid are not helpful because one can imagine that slope differences in an area of 25 or even 100 m might be of no relevance when travelling hundreds of kilometres, human decision making was much more based on longer distances and on other factors like e.g. tradition (aspects of decision-making processes for different types of traffic routes will be presented in HERZOG, POSLUSCHNY in preparation). For those analyses the SRTM DEM with a 90 m grid or with a reduced 200 m grid were used as a basis for least cost path models.
Climatic conditions are also strongly connected to the needs and possibilities of prehistoric societies. Precipitation plays a key role in farming societies, and can be scrutinized without the help of modern instruments along with phenological dates such as the beginning of apple tree flowering time, the same is true for soil fertility as another factor of agricultural possibilities.

2 Methods and Theories

Geographic Information Systems (GIS) in our project are simply used as tools. GIS is not a method in itself; it will not give direct answers but it can help to find and analyse patterns, and it can help to build models, or at least it can transform data into another data type that can be interpreted by the archaeologist.

"With experience, GIS becomes simply an extension of one's own analytical thinking. The system has no inherent answers, only those of the analyst. It is a tool, just like statistics is a tool. It is a tool for thought. ... In many ways, learning GIS involves learning to think—learning to think about patterns, about space and about processes that act in space" (EASTMAN 2003: 20).

The other important prerequisite of our work is the idea that human behavior was influenced among other things by the natural environment and that this behavior—like the decision where to settle—left recognizable and interpretable patterns on the landscape. It is the work of the archaeologist—with the help of GIS—to find patterns and to explain them. "The key point to emphasis is that external factors influenced behaviour, and this behaviour left patterns in space that could be objectively measured and quantified" (WHEATLEY, GILLINGS 2002: 7).
Prehistoric economy in the Late Bronze and Early Iron Age, as mentioned above, is based on agriculture. Farming and cattle breeding were the basis of survival and also the basis of surplus. The production, processing, and trade of metal and other important goods played an important role for certain parts of the society. But people were still dependent on agriculture. As a result, we can predict that the choice of at least settlement sites was dependent on, among other things, the suitability of the chosen places for agricultural needs.

At the same time, we cannot expect a monocultural adjustment to environmental factors to maximize agricultural yields. To be able to react to the dependency on climate and environment, prehistoric settlers would have acted in a way to minimize risks, which means they would have tried to break down into different lines of agricultural production, such as the cultivation of different kinds of crops, the breeding of different kinds of animals, and the completion of the diet by hunting and gathering (EICHFELD 2005: 91). When speaking about patterns of human behaviour in the landscape, this would mean that different aspects of the environment could have played a role in the decision of where to settle, and that the resulting patterns might overlap. This does not only include environmental factors in the sense of economic parameters. It also includes a wide range of cultural factors, based on sociology, tradition, religion and so on. These factors and parameters undoubtly had an influence on the where and the how of peoples living but are hard to recognise and even harder to measure. Post-processual approaches have tried to deal with human perception of landscape (e.g. TILLEY 1994, BENDER et al. 1997) but failed in the comprehensible interpretation and assessment of non-economic/non-.ecologic factors due to their unbiased cognitive faculties (EICHFELD 2005; POSLUSCHNY in press). The discrepancy between a purely eco-deterministic interpretation of human behavior (where eco is short for economic and for ecologic) and the lack of consideration of personal/private, ritual and cultural motives in the interpretation of human patterns in the landscape (GAFFNEY, VAN LEUSEN 1995) can be solved by the use of GIS. Every pattern we detect in a distribution of certain sites in a certain region in a certain period is based on different parameters. All those patterns that can not be explained by an economic determinism are either solely random or based on in the broadest sense cultural parameters and factors. By detecting the economic and ecologic component of a site distribution pattern (by the use of GIS) we can also find those patterns that are dependent on other aspects of human behaviour. That still leaves us with the problems of judging and interpreting these aspects but at least they can be connected with the overall knowledge of the culture or era we are dealing with.

Anything beyond the things we would recognize as economic-based patterns in the landscape has to be interpreted in a different way. A settlement site on a very steep slope, far away from sources, streams, and fertile ground, is not what we would expect as "normal" human behavior in prehistoric times, where people usually earned their living by agriculture. Thinking about the questions posed for our project, we can assume that there might be social reasons creating a pattern of sites on a landscape. Connecting these patterns with the well-known archaeological or cultural contexts – in our case with the emergence of the so called "princely sites" – and looking at the development of these patterns can help to understand the contextual background. The question is whether prominent places like the Early Iron Age "Fürstensitze" had an influence on the site patterns in their area. And, did these patterns change due to the change in social life during those periods?

3 Patterns and Significance

The main idea behind the finding and the interpretation of (environmental) factors that had an influence on the people during the Late Bronze Age and the Early Iron Age is the testing of the statistical significance of a site distribution. Finding out that 70 % of all settlements are situated on fertile loess grounds does not say much about the influence of these fertile grounds on the decision where to settle as long as we do not know how much the share of these Loess grounds is in the whole area of research. Having 95 % of loess in the investigated area gives a hint that these grounds have not been preferably used while having 50 % loess and 70 % settlement sites on loess produces the image of a Loess-dependent decision where to settle. Speaking in statistical terms the observed value (OV) is the amount of sites in a special environmental area (e.g., percentage of settlement sites on loess) whereas the expected value (EV) is the share of that environmental area relative to the whole area of research (e.g., percentage of loess in the area of research). The simple division of the observed value by the expected value shows if the environmental factor was avoided (OV/EV < 1) or preferred (OV/EV > 1); but it does not show anything about the reasons of that behaviour.

There is much evidence for the existence of different kind of patterns, especially of settlement sites. They are usually connected to parameters like soil fertility, distance to water and so on – all those factors we would have expected for a society with an agricultural economy. The weighting between these factors on the other hand is not fixed, it changes between different regions – which gives a strong hint that prehistoric

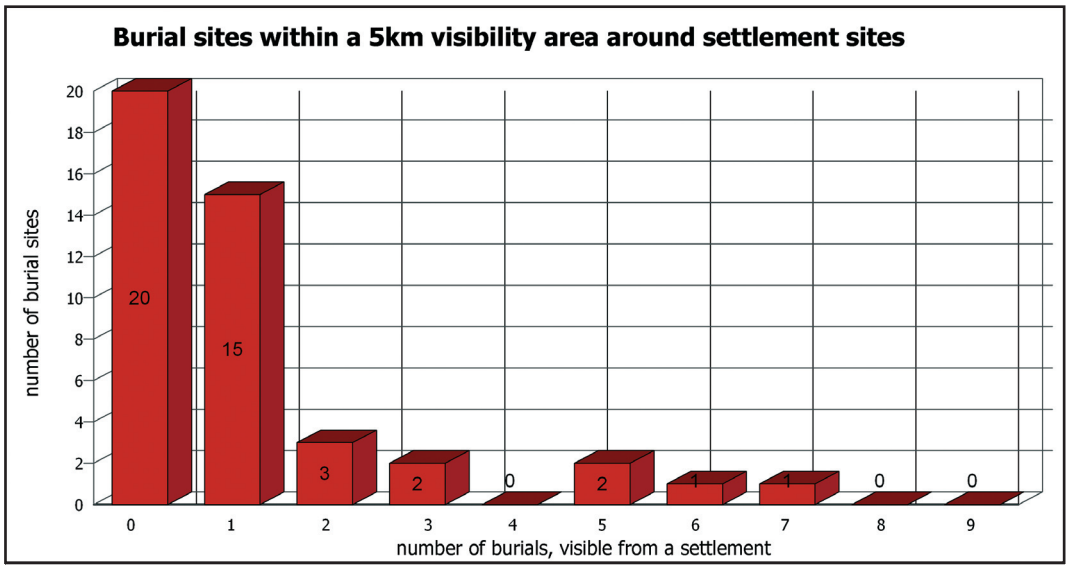

Figure 2. Burial sites within a 5 km visibility area around settlement sites in the Glauberg region.

people knew about the characteristics and possibilities and they knew how to cope with it.

The weighing also changes between different periods. In the River Main Triangle we can ascertain a change in the settlement behaviour between the Late Bronze Age/ beginning of the Early Iron Age and the end of the Early Iron Age. Prehistoric settlers changed their preferences from more humid to more arid (or at least less humid) areas and from more plough able soils to those that are more suitable for stock farming. This leads to the idea that cattle breeding became more important than before—while still not dominant over crop farming (*cf.* SAILE, ZIMMERMANN 1996). It seems as if a change in society – maybe as a reaction to climatic or even cultural or sociological change – lead to a change in the way people lived and consequently in the way they dealed with their environment.

4 Visibility between graves and settlements

There is much evidence for the thesis that a grave or a graveyard, belonging to an Early Iron Age settlement is not further away than 5 km. If we assume that people during that period built their grave mounds on places that could be seen from the settlement – and we have evidence for that as well – we can test if there is an interpretable pattern between the settlements and the burial places belonging to them. The question is whether these graves have been built on prominent places and if so, what "character" of prominence we can see: Either prominent in a wider area and for a couple of settlements or only prominent to the settlement that belongs to the burial site (fig. 2).

In the Wetterau, a fertile area north of Frankfurt around the Glauberg "Princely Site" nearly 50 % of all Hallstatt burial sites are not situated in an area that is visible within 5 km from a contemporary settlement site. Following our prerequisite we can assume that these graves belong to settlements that are still not known or vanished due to intensive ploughing. A significant high number of burial places could have been seen by exactly one settlement site whereas the number of graveyards that were visible from more than one settlement are significantly low and might be the result of different dating within the Hallstatt period. If we take into account that the number of graveyard sites is slightly lower than the number of settlement sites during the Hallstatt period it is most likely that burial sites are more stable and are used for a longer time, even if the associated settlement is moved. There is a strong evidence for the model of a micro-scale connection between settlements and burial places: Usually one settlement belongs to one graveyard (and *vice versa*) and the connection between those to types of sites becomes manifest in the intervisibility whereas the burial site is hidden for other settlements (fig. 3).

The surrounding landscape of a settlement can be interpreted as the sphere of the living which has a strong interconnection with the sphere of the dead, symbolised by the graveyards. These two spheres form a closed unit for each separate community. The situation around the Glauberg hill fort itself is quite different. Within a radius of 5 km a total of 13 burial sites from the Hallstatt period or undated burial mounds are visible,

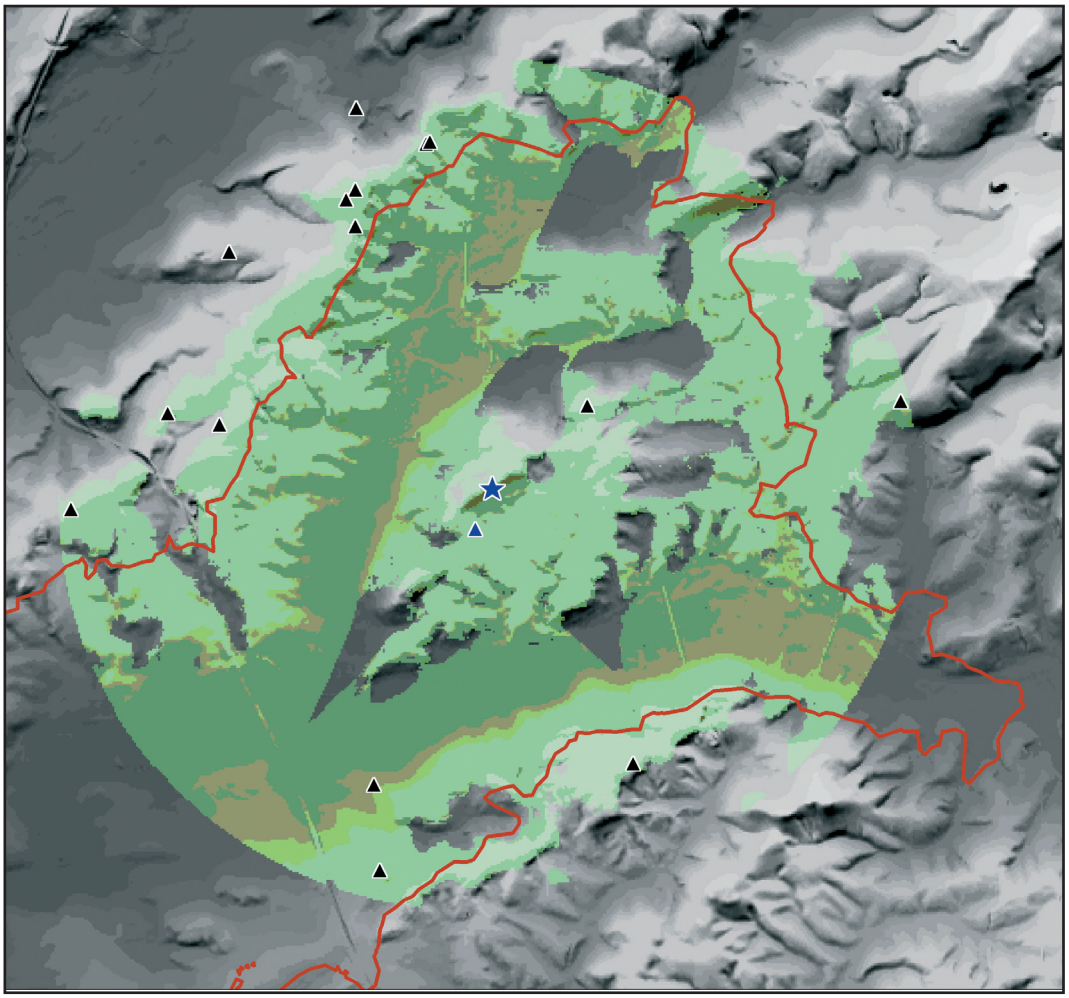

Figure 3. The Glauberg "Fürstensitz" (blue star) and surrounding burial mounds (Ha or undated) within a 5 km visibility. The red line indicates a hypothetic hinterland, based on the cost surface analyses.

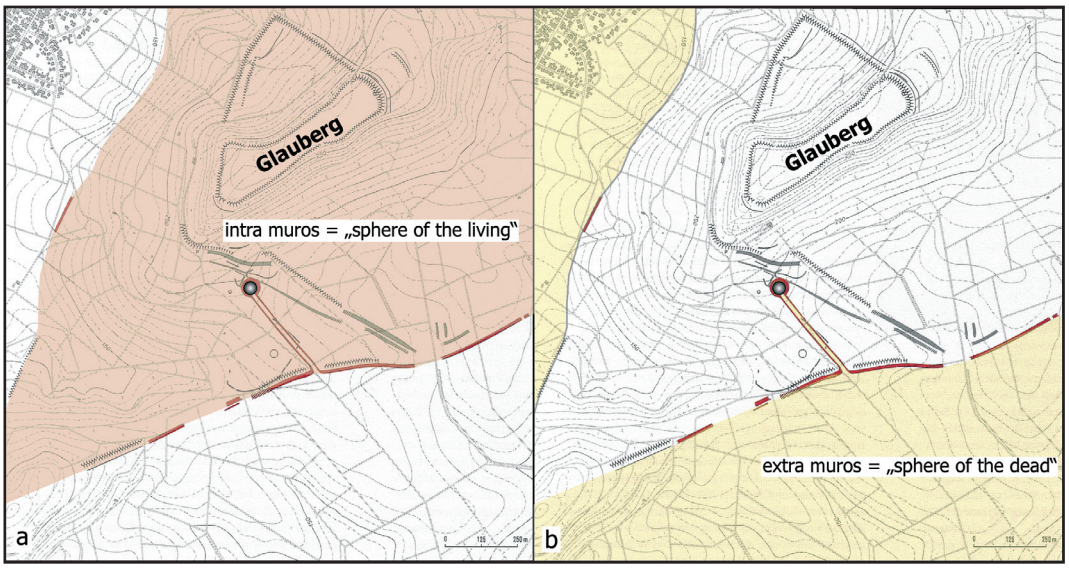

Figure 4. Situation of the "Princely" grave on the Glauberg foothill. a: Part of the settlement area = sphere of the living. b: Part of the outer settlement area = sphere of the dead.

three more graves are within this radius as well but cannot be seen from the Glauberg (Figure 3). Most of the visible burial sites are single mounds and are within close proximity to the borders of a hypothetic hinterland that was calculated by means of a cost surface (based on slope). The area within the border can be reached with the same maximum cost (≈ travel time or calories). It seems as if these grave mounds are situated as some kind of territorial markers for the Glauberg hinterland, visible for people approaching the hillfort. The later (Early Latène) burial mound on the foothill of the Glauberg itself (fig 3, blue triangle) is the grave of the Glauberg "Fürst" ("prince") himself and is much more incorporated into the settlement area itself (Figure 4 a) but still following the rules of a *extra muros* sepulture (Figure 4 b).

5 The Glauberg "Fürstensitz" – Economic welfare or cultural reasons for it's importance?

There is no doubt that the Glauberg site had some importance during the Early Iron Age: The plateau of an hill of about 8 hectare (nearly 20 acres) has been fortified, another 12 hectares have been fortified by a rampart and a ditch to incorporate a spring in the north of the plateau and the whole area is surrounded by another rampart-ditch system which is only known to a small extend by now but covers at least an area of 206 hectares; the finds of the "princely" graves show a rich and maybe powerful caste (BAITINGER, PINSKER 2002; HERRMANN 2005).

But what made this place so important and some of its occupants rich and wealthy?

One reason for the relevance of the Glauberg site could have been the fact that it was conveniently situated for interregional traffic routes (BAITINGER 2007). The distribution of several kinds of finds from the Glauberg in different regions of Germany and all over Europe make clear that there were connections reaching far beyond the surrounding region of the Wetterau. But the Glauberg itself is situated in the foothills of the Vogelsberg mountains, not near large streams or rivers that might have worked as traffic routes. The topography all in all is not very prominent, least cost paths analyses have shown that there are far more convenient routes to connect the centres of distribution of the before mentioned finds (POSLUSCHNY 2008)[1]. The position to a hypothetic traffic or communication system seems not to be the reason for the importance of the Glauberg in the Early Iron Age. So still the question remains: what made this place so special?

A ditch system around the big grave mound with its spectacular finds was clearly shown in geophysical surveys. This ditch system is part of the large system of ditches all around the Glauberg hill and especially around the grave mound (Figure 4) and was recently called "Prozessionsstrasse" ("procession alley").

Without going into detail it is now clear by the work of B. Deiss (DEISS in print) that all these ditches have a special astronomic and mathematical meaning with the great "Prozessionsstrasse" aiming at the point of the Southern Major Standstill of the moon's 18.61-year precession (maximum extreme of the moon setting) and other ditches aiming at the dates of the solstices. This is an evidence for the implications of the whole structure as a ritual or holy place with long term calendrical meaning as well as with short term seasonal meaning. Observations very similar to these can be made at several places on earth like for instance the great Hopewell earthworks in Ohio (HIVELY, HORN 1984)[2].

While several other "princely sites" like the Münsterberg in Breisach or the Marienberg in Würzburg (Figure 1) obtained their significance and meaning by their situation on trade routes the Glauberg seems to have played a role as some kind of ritual centre for a maybe large region. The knowledge connected to the calendar building of the Glauberg was reserved to very few if not only one person. His ability to "foresee" astronomical incidents as well as his "control" over time (dates of feastings as well as dates of sowings) made him wealthy and the Glauberg itself a prominent and important place.

All in all it becomes clear that the so called "Fürstensitz" phenomenon can not be lumped all together – every site has its own history and its own meaning, embedded into the social and cultural history of its era.

1. A detailed discussion on several methods and algorithms for least cost path analyses and the (cultural and environmental) factors that have to be taken into account will be published in HERZOG, POSLUSCHNY in preparation.

2. The alignment in Newark is aiming to the point of the moon's Northern Major Standstill

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