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Territorial Modelling and Archaeological Data: How Complete Must the Picture Be?

Abstract: The study area in the Upper Rhine Valley, its geographical features, the archaeological record and the degree of archaeological exploration are described and a model is introduced that enables the use of incomplete and heterogeneous archaeological data. This model is based on the combination of three maps, respectively showing the environmental potential of the landscape, the degree of archaeological exploration and site density. It serves several purposes. Firstly, to determine whether the absence of sites observed in certain regions is due to a poor environmental potential for settlement and cultivation or the lack of archaeological exploration. Secondly, to detect boundaries that cannot be explained by poor environmental potential or the lack of archaeological exploration and give the archaeologist good arguments for a cultural interpretation of these boundaries. Thirdly, to produce qualified estimates of possible further sites, especially in areas with little archaeological exploration. Two case studies illustrate the detection of prehistoric boundaries and their possible interpretation.

Introduction

Landscape archaeology focuses on the analysis of whole regions in order to obtain information about land use, population densities and settlement systems during different periods together with the occupation processes and variations in population development over the course of time. Landscape studies serve as a base for further investigations into the changes in settlement patterns and the processes that cause them. Another aim of archaeological landscape analysis is to examine the type and extent of land use at different times and its effect on the environment and the exploitation of natural resources in different areas. The latter aim, in particular, is related to the research done by neighbouring disciplines such as archaeobotany and geography. Furthermore, landscape archaeology can help to detect and reconstruct prehistoric territories and boundaries.

My PhD thesis (Mischka 2007) was part of a German Research Foundation (DFG) interdisciplinary project to study landscape formation processes in the Upper Rhine region (http://www.geographie.uni-freiburg.de/ipg/gkgl/gk.htm). The main objective of the thesis was to determine whether archaeological data can be linked with the geographical disciplines as a third independent variable, in addition to pollen analysis and research on erosion processes. The geographical study of the Upper Rhine region has not yet been published so this article concentrates on only one part of my PhD thesis: the question of whether prehistoric boundaries can be reconstructed.

Site distribution maps are usually handled in one of two ways:

1) the researcher interprets the distribution pattern as historical fact and this interpretation is then disputed, by the researcher himself or others, with the argument that differing degrees of archaeological knowledge have influenced the settlement pattern; or
2) the researcher does not interpret the distribution map, for the same reason, perhaps also describing all the factors that can influence distribution maps, e.g. modern land usage, the territories and main interests of the amateur archaeologists who provided the information, colluvial deposits or erosion in certain areas, and the circumstances of the discovery of the site. Another argument against an interpretation is the often inadequate dating of the sites: it is not really known which sites, or rather settlements, were occupied simultaneously.

In order to circumvent these problems, a model has been developed as presented below.

Research Area

The archaeological data used in the study come from the Upper Rhine region in south-western Ger-

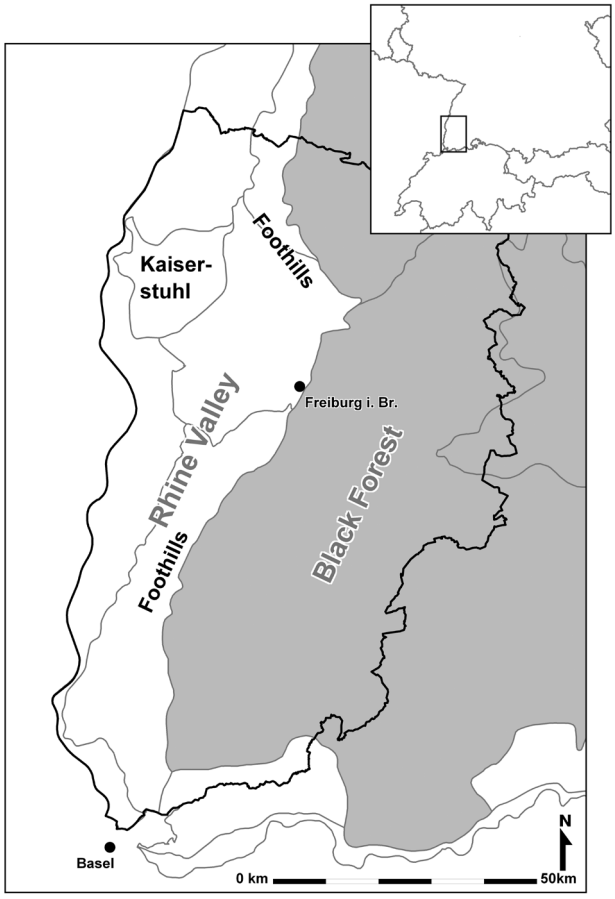

Fig. 1. Research area in the Upper Rhine Valley in southwestern Germany.

many and range from the late Neolithic to the Iron Age. The city of Freiburg im Breisgau is located almost in the center of the study area while Basel is at the southern tip *(Fig. 1)*. The western part of the area consists of the fertile RhineValley with the Kaiserstuhl, an extinct volcano, and the so-called Vorberge (foothills). In the eastern part are the mountains of the Black Forest with the Feldberg as the highest point reaching 1492 m above sea level. Geographers subdivide this region into several different units, which are determined mainly by the relief but also by other natural parameters such as the availability of water or soil composition. The study area covers nearly 2500 m² if the Black Forest is included – or 1000 m² without it.

The Archaeological Record

First of all, it must be remembered that more than 80% of the sites consist only of collected surface finds, without excavation. They are usually registered in the archaeological record as settlement areas or graves. While burial sites are easy to recognize by finds of rich grave goods and perhaps burned (human) bones, in the case of settlements the finds are much more difficult to interpret. All other sites, e.g. hoards, ramparts, ritual places or single finds, are so rare that they can be neglected for the purpose of this study.

Distinct concentrations of sites can be observed on the site-density map: the darker the area shown on the map, the higher the settlement density *(Fig. 2)*. Nearly all the sites are in the western part of the study area, in the Upper Rhine Valley, whereas only a few finds are known from the area to the east, in the Black Forest, except in the Zartener Basin.

Within the conventional periodisation of prehistoric cultures, the late Bronze Age (Urnfield Culture) and the early Iron Age (Hallstatt period) are the best represented with more than 150 sites each. All the other periods, except perhaps the late La Tène period, are only occasionally represented.

Among the fundamental questions that arise in landscape archaeology are those concerning the dating of sites and contemporaneity of sites. Most archaeological periods have durations of several hun-

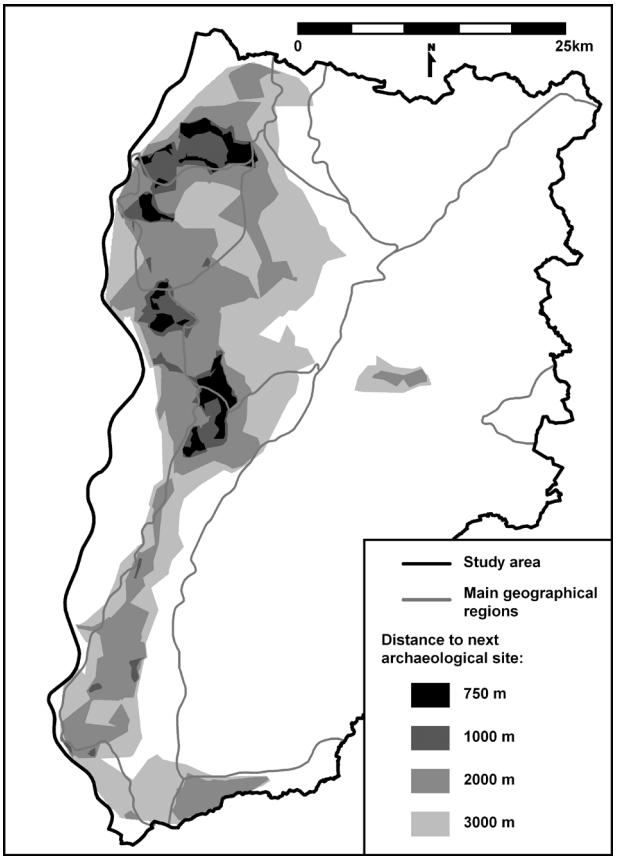

Fig. 2. Site density in the area studied.

dred years: the late Bronze Age, for example, lasted at least 400 years. Some of the large settlements or fortified 'castles' may have been occupied continuously but this is probably not the case for single farmsteads that are often known only from surface finds. The basic information is very heterogeneous; some sites are dated very accurately, others only approximately, depending of the character of the site.

In order to quantify settlement densities and population estimates, the less precisely dated sites must also be taken into consideration. This can be done by applying John Ratcliffe's "aoristic analysis", based on criminological models and presented to the CAA conference at Vienna in 2003 by Ian Johnson (Ratcliffe 2000; Johnson 2004). Aoristic analysis is a method used in criminology to analyse crime incidents and determine probabilities for the contemporaneity of incidents or, when applied to archaeology, for the contemporaneity of sites. The quality of the result depends on the time span during which each site could have been occupied: the longer the period in which it could have existed, the lower the probability that it existed at any one specific point within that time span and, vice versa, the more precisely a site is dated the greater the probability that it existed at a specific point in time. Exactly dated settlements are therefore given a higher weighting, whereas imprecisely dated sites have a lower weighting. For the archaeological purpose presented here, the probability distribution can be measured at regular intervals as in the aoristic analysis of crimes (Mischka 2007, 58–72).

Model

The diagram in *Fig. 3* illustrates the principle of the model, which has to be understood as three-dimensional. In the top row, two boxes indicate the natural environment as evaluated for the Upper Rhine region in the area of the observed settlements and in accordance with the criteria described below under "Geographical Features". In the second row, the settlement density is given in each case, with the choice of 'many' or 'few' sites as shown on the site-density map. On the left-hand side, the degree of archaeological exploration is divided into 'good', 'poor' and 'indifferent' as indicated on the map of the degree of archaeological exploration. In all these boxes, a number from 0 to 3 is given in brackets. The

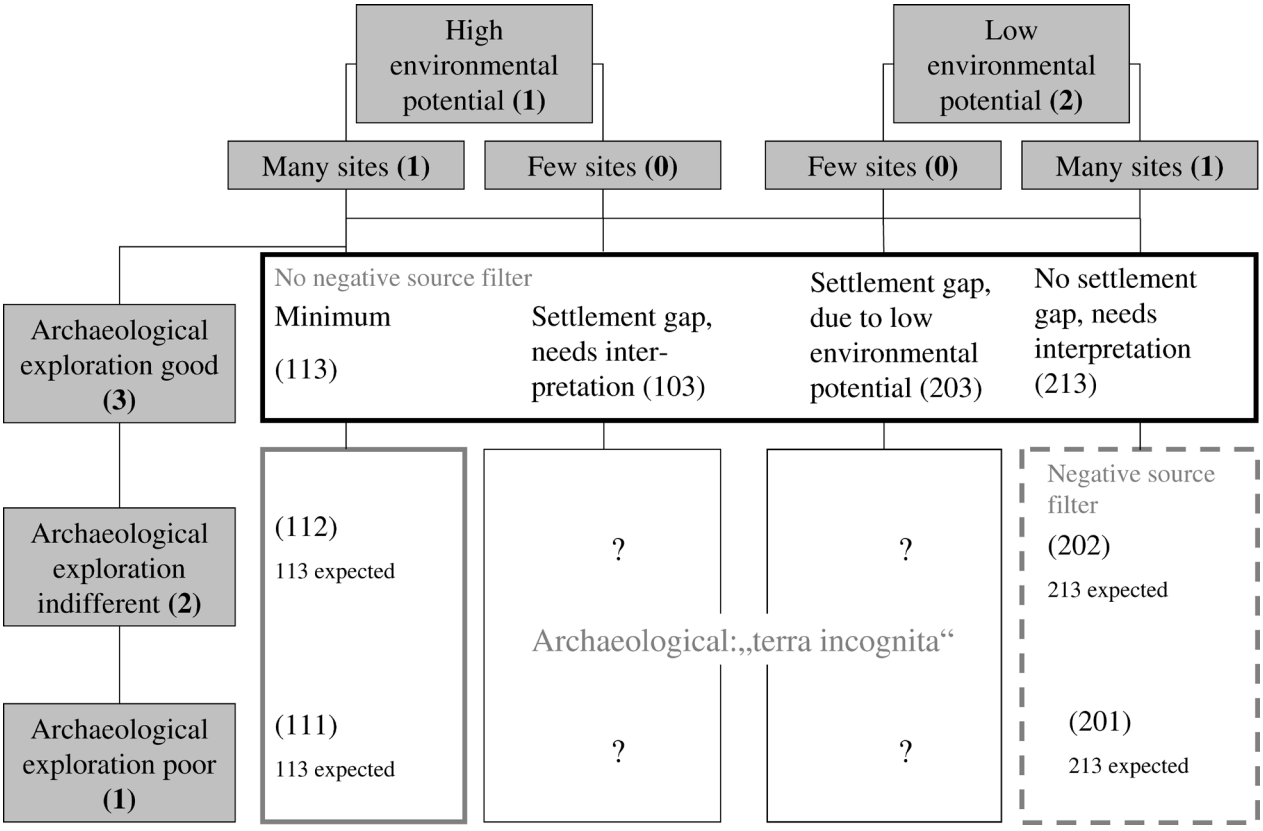

Fig. 3. Diagram showing how the landscape is evaluated by taking into account the degree of archaeological exploration, the environmental potential of each area and the known site densities.

combination of the three aspects – environment, site density and the degree of archaeological exploration – can therefore be expressed as a number with three digits. For example, if in a region with high environmental potential (1), an area has many sites (again 1) and a good degree of archaeological exploration (3) the resulting number is 113. On the other hand, if there are only a few sites in an area with high environmental potential and good degree of archaeological exploration (103) there is a significant absence of settlements that needs to be explained.

Finally, in an area with poor environmental conditions but good archaeological exploration and many sites (213), the researcher must try to understand the behaviour of the prehistoric inhabitants – why did they choose to settle in areas not suitable for cultivation?

The model can help to reconstruct the minimum original site density by extrapolating the site densities from areas with a high degree of archaeological exploration to those with the same environmental conditions but an absence of known sites due to a lack of research (or due to other influences shown on the distribution map). Nevertheless, there are still large areas (represented by the question marks in *Fig. 3*) which cannot be interpreted because of indifferent environmental conditions *and* a low degree of archaeological exploration.

The model also makes it possible to interpret the observations in archaeologically well-researched areas (as found in the best databases) as reflecting prehistoric fact by reducing the influence of environmental conditions on the distribution map and avoiding the rejection of interpretations simply because of a lack of archaeological data.

To be able to draw a map that combines all the aspects of the model, the environmental data and the degree of archaeological exploration have to be considered more closely.

Geographical Features

In this short article it is not possible to compare the geographical positions of the sites. However, the results of the study of the topography of the Upper Rhine region were used as the basis for the environmental evaluation – with altitude, aspect, slope, distance to the nearest source of water and type of soil being the most important geographical features. For the purpose of the evaluation, the frequency of sites in specific topographical situations was used to give such situations a high or low rating based on the percentage frequency. For example, 48% of the sites are situated in flat areas so all flat areas in the study area are given a weight of 0.48 while 14% of the sites are situated on low slopes so all the low sloping areas are weighted at 0.14. Similarly, 19% of the sites are found at distances of 200–300 m from the nearest river, lake or spring, so an equivalent buffer-zone around a water supply is weighted at 0.19 and so on. The whole landscape was evaluated in this manner, whereby areas with the most favourable combination received a total weighting of 2.71. By proceeding in this way, the different geographical features remain independent of one another. However, this has proved not to be the best possible weighting method for this purpose. In future research, other methods should therefore be chosen, for example simple binary addition, weighted binary addition, logistic regression or the Dempster-Shafer theory, as discussed by Ejstrud (2003).

The resulting map shows the "environmental potential", a term also used by geographers to describe the different natural resources of a region *(Fig. 4)*.

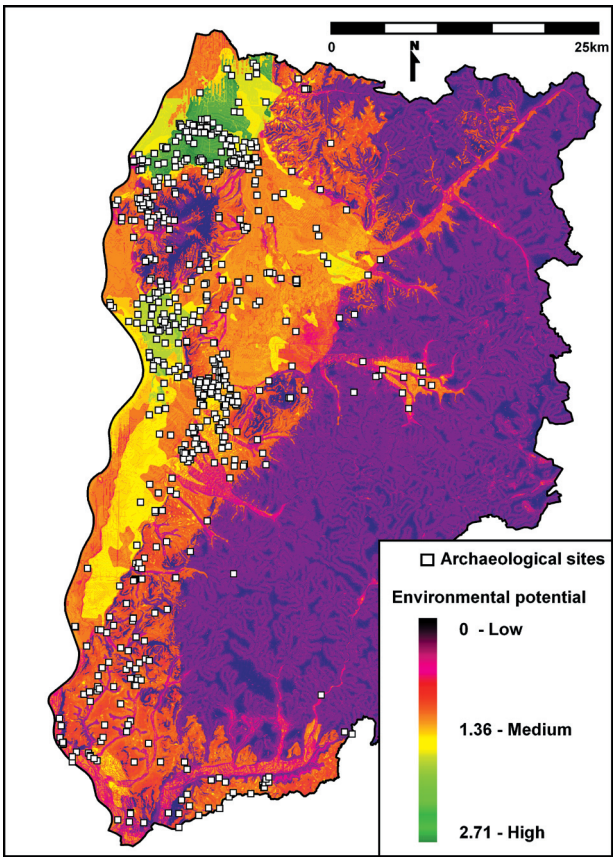

Fig. 4. The "environmental potential" of the different areas in relation to the distribution of archaeological sites.

The green colours indicate very fertile areas up to the highest possible evaluation of 2.71, as described above. The reddish colours indicate less fertile areas or those not suitable for cultivation, such as the steep slopes of the Black Forest. If the site-distribution map is superimposed on the map of the environment, other areas are revealed which are not infertile but in which only a few sites are known. The question then arises of whether this is merely the result of a lack of information or does it represent prehistoric reality?

Degree of Archaeological Exploration

It is necessary to evaluate not only the environmental potential but also the degree of the archaeological exploration. For this purpose, the most important aspects to be considered are the modern use of the land, the areas covered by amateur archaeologists, the colluvial cover or erosion in some areas, and the circumstances of the discovery of the site. The evaluation is calculated in the same way as the environmental map – by using the known data to evaluate the whole landscape. The result is that a few areas are well known because collectors regularly inspect arable land or observe building activities: these are shown in green on the map *(Fig. 5)* while, at the other extreme, dark red signals unsupervised areas, especially in the Black Forest.

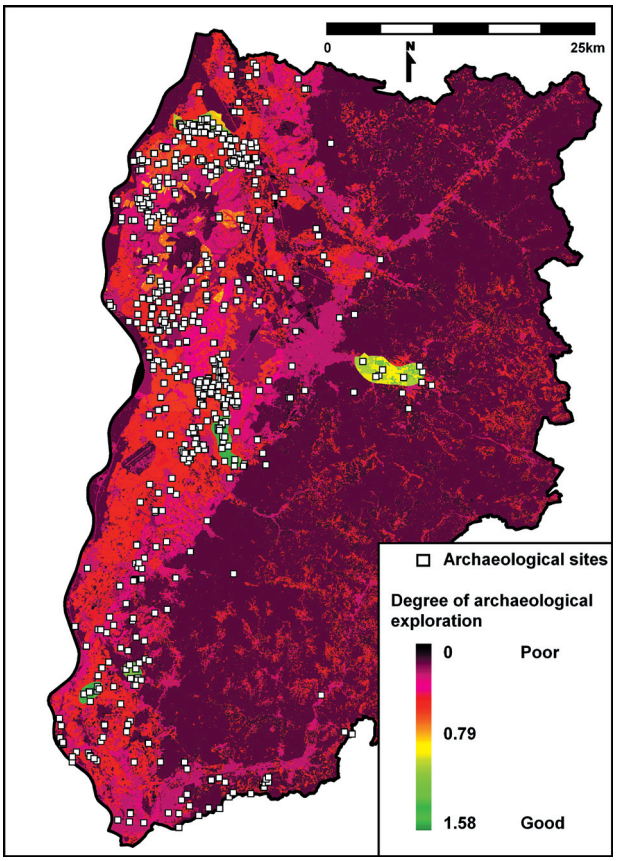

Fig. 5. The "degree of archaeological exploration" in the different areas in relation to the distribution of known sites.

Application of the Model

In order to apply the model, the three maps are combined using map algebra: the site-density map *(Fig. 2)*; the environmental potential – reduced to high and low environmental potential *(Fig. 4)*; and the degree of archaeological exploration – reduced to good, poor and indifferent *(Fig. 5)*. The resulting map *(Fig. 6)* gives a value for each area as follows:

- first digit – environmental potential (high 1; low 2)

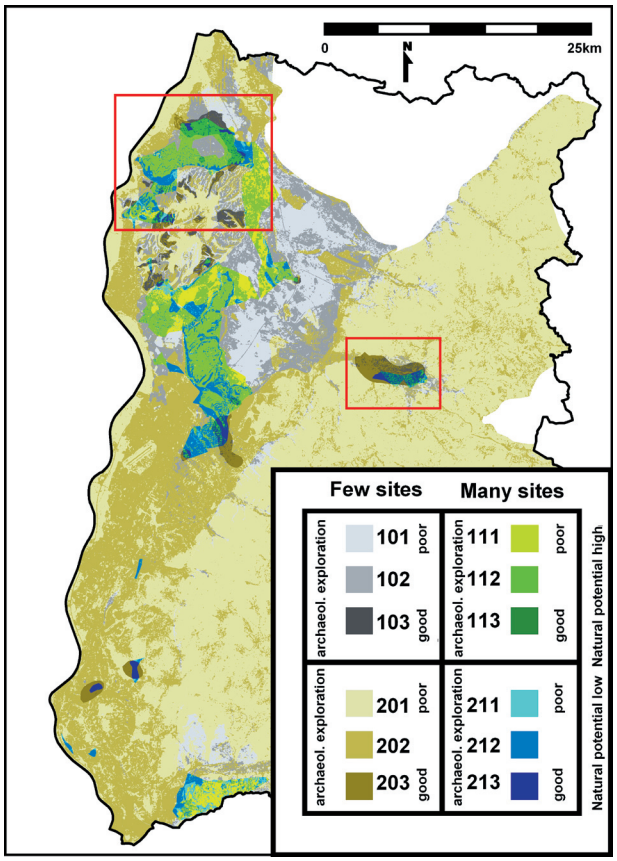

Fig. 6. Map combining site density *(Fig. 2)*, "environmental potential" *(Fig. 4)* and the "degree of archaeological exploration" *(Fig. 5)*. The red rectangles mark the locations of the Forchheimer Plateau (upper left-hand side) and the Zartener Basin (centre), which are discussed in the text.

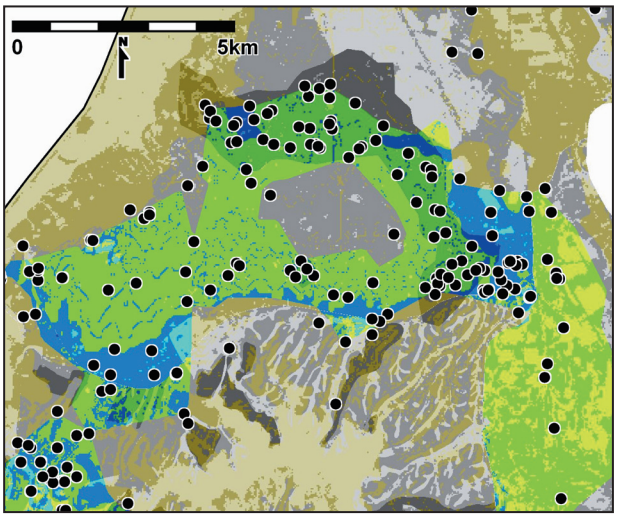

Fig. 7. Case study Forchheimer Plateau: good degree of archaeological exploration and a good environmental potential for prehistoric farming.

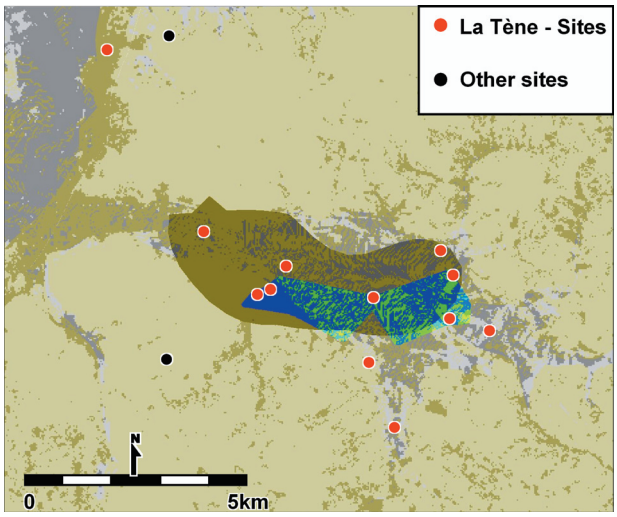

Fig. 8. Case study Zartener Basin: good degree of archaeological exploration but inferior environmental potential for prehistoric farming.

- second digit – known site density (many 1, few 0)
- third digit – degree of archaeological exploration (poor 1, indifferent 2, good 3)

This combined map cannot be discussed in detail here but two small areas are worth closer consideration to illustrate the possibility of modelling cultural-territory boundaries: the Forchheimer Plateau in the north of the Kaiserstuhl *(Fig. 7)* and the Zartener Basin *(Fig. 8)*.

Case Studies

The Forchheimer Plateau is covered by fertile loess soil and is very carefully supervised by an amateur archaeologist whose main interest is to collect Neolithic artefacts. The area has natural limits formed by the Kaiserstuhl mountain rising to the south and, perhaps, the flood plain of the Rhine to the west, but there are no topographical reasons limiting settlement to the north or the east. Consequently, there is no obvious cause for the lack of sites in the grey area to the north of the area with all the known sites, shown in green on the map *(Fig. 7)*. Both areas are archaeologically well explored, but no sites of any period from the late Neolithic to the end of the Iron Age are known in the grey zone. As previously mentioned, most known sites are from the late Bronze Age to the early Iron Age and I would like to suggest that during those periods there were two 'natural' limits as a result of topographical features (Kaiserstuhl, Rhine valley) while, to the north and north-east, there were cultural territorial boundaries within the settlement system.

The Zartener Basin in the Black Forest is the second example *(Figs. 6, 8)*. This natural basin, formed by the river Dreisam, is not very fertile because it is filled with river gravel under only a thin layer of loam. Today, between the rivers and streams, there are cultivated terraces with fields or meadows. However, although the region is not as suitable for cultivation as the Forchheimer Plateau, it has been closely observed by the archaeologist Heiko Wagner and his collegues. It is of particular interest because of the discovery of the location of Tarodunum, the Celtic oppidum described by Ptolemaios in the second century AD, exactly between the river Dreisam and the smaller river Rotbach. This huge oppidum covers 190 ha and is surrounded by other sites that are registered as settlements dated to the middle or late La Tène period or – less precisely – to the La Tène period in general. Here, too, there are two areas with a similar degree of archaeological exploration and a similar environmental potential but with different site densities in a topographically clearly defined area *(Fig. 8)*. Perhaps it can be compared with another settlement pattern of the late La Tène period where the inhabitants supply their needs only from the area within and in the vicinity of an oppidum, with just a few surrounding farmsteads. The reason for the foundation of the Tarodunum oppidum has to be seen in its well-chosen position next to a probable trade route crossing the Black Forest.

In these two case studies, both areas have a high degree of archaeological exploration but the Forchheimer Plateau has very good environmental conditions for agriculture while the Zartener Basin has less favourable environmental conditions. In the first case, the non-use of good soils must be examined; in the second, we have to ask why people whose economy was based on farming chose to settle on such unfavourable soils. The priority in the Zartener Basin seems to be the connection with the trade route across the Black Forest.

Conclusion and Discussion

It is essential to find ways of working with different kinds of incomplete data. In this article, a model is presented that is based on the creation of a map using a GIS-supported evaluation of the landscape linked with *both* the degree of archaeological exploration and settlement suitability parameters. These parameters allow us to identify and map areas that provide representative archaeological "snapshots" for a given point of time with a certain degree of reliability.

Even with very incomplete data – the study is based mainly on unexcavated surface finds – it is possible to identify specific regions that have almost the same degree of archaeological exploration and the same natural environment but with different site densities. These have to be interpreted from a cultural point of view. The observed differences in settlement density cannot be explained by source filters (in German: Quellenfilter – a method used to make allowance for factors that can lead to unreliable archaeological information) or, for example, because they have different types of soil or water supply, so other explanations have to be found for the different site densities. One explanation – and I must stress here that there could well be others – might be the presence of social boundaries.

There remains much work to do: the site densities in the different areas have to be verified with surveys; the factors used for the evaluation of the landscape and source-filter parameters have to be checked again; and, last but not least, some excavation of each type of settlement – single farmsteads, hamlets and villages of each period – is necessary to provide a more accurate base for the dating of sites and estimating population densities. My study focused on land use, but the cultural changes reflected in changing settlement sizes and possible hierarchies in prehistoric societies would also be of interest.

This paper has attempted to demonstrate that it is worth taking the risk of using incomplete data to help gain an insight into some of the most fascinating aspects of landscape archaeology.

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