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TOWARDS A PREDICTIVE MODEL OF EARLY MEDIEVAL SETTLEMENT LOCATION: A CASE STUDY FROM THE VALE OF GLAMORGAN

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Introduction

Early medieval (fifth- to eleventh-century) settlement sites are extremely rare in Wales. In the most recent discussion of the topic Nancy Edwards (1997: 2–5) lists only sixteen definite examples for the whole of Wales, and although a few sites have come to light in the last decade to the total number is still tiny, particularly in comparison to England and Ireland (Edwards *et al* 2005). The lack of sites is confounded by a bias within the existing dataset towards what appear to have been high status defended settlements of the late-fifth to seventh centuries such as Dinas Powys (Glamorgan), Coygan Camp (Carmarthenshire) and Dinas Emrys (Gwynedd). Our understanding of site types, morphology, settlement patterns and hierarchies is therefore very superficial (Edwards and Lane 1988: 2–3). This is a major problem and until further sites are identified and excavated our understanding of the period as a whole will be seriously constrained. In this paper I will explore one possible way of rectifying this problem by constructing a predictive model which may be used to aid the identification of new settlement sites.

Problems of Settlement Visibility in South-East Wales

In contrast to much of Wales the South-East, here defined as Gwent and Glamorgan, is agriculturally rich and comparatively well documented historically for the early medieval period. Nevertheless with the exception of a small number of inhumation cemeteries only fourteen sites have been attributed to the early medieval period, and only two of these (Dinas Powys and Hen Castell, both of which are high status hillforts) can be identified as domestic settlements (Seaman 2010). Thus the comparatively abundant Romano-British rural settlements appear to have been abandoned shortly after the mid-fourth century, and although later occupation of these sites is possible the numismatic and ceramic evidence as well as the lack of post-Roman coinage/pottery or any stratigraphic build-up on these sites suggests that it is unlikely (Seaman 2010: 243–245). The only exception to this is the re-use of villa sites at Caer Mead (near Llantwit Major) and Llandough as early medieval inhumation cemeteries and perhaps monastic sites (Holbrook and Thomas 2005; Redknap and Lewis 2007: 575). This activity is unlikely to represent direct continuity from the fourth century however, and evidence for any domestic occupation during the post-Roman period is extremely limited (Knight 2005). At the other end of the period excavations on later medieval settlements have not identified features earlier than the twelfth century; although elsewhere in Wales tentative evidence for pre-Norman activity has been indentified below castle sites at Hen Domen (Radnorshire) and Maenclochog (Dyfed) (Barker and Higham 2000; Scheel 2007).

The lack of early medieval rural settlements must be due, in part, to the comparatively low level of rescue and developer-funded excavation undertaken in Wales. The main problem, however, is undoubtedly the absence of common diagnostically early medieval material culture – principally pottery. Wales was aceramic for the whole of the early medieval period, and although small quantities pottery of the fifth to seventh century was imported its distribution is geographically uneven and restricted to high-status sites (Campbell 2007). Nevertheless although population densities are likely to have been low in Wales during this period (Davies 2004: 214), tentative evidence for early medieval occupation is occasionally identified on sites of other periods, although this has come about more by chance than design. Recent work by the Dyfed Archaeological Trust, for example, has identified a number of early medieval features, albeit predominantly corn driers or ovens, through a programme of extensive radiocarbon dating (Crane 2004; 2006a; 2006b; forthcoming a; forthcoming b; Blockley and Tavner 2002). Crucially none of these features were associated with diagnostic material culture so although numerous early medieval features may have been revealed on other sites, unless they have been dated scientifically they are unlikely to be identified as such. Indeed it is possible that many early medieval settlements have been misidentified as Romano-British or Iron Age on the basis of morphology or the presence of material culture which could have been re-used or residual. A roundhouse (*c.* 8m diameter) of Iron Age type, for example, was apparently associated with a radiocarbon date of 980–1160 AD at Maenclochog (Dyfed) (Schlee 2007). It is also feasible that Romano-British pottery continued to be used well into the fifth century, and so sites which have been traditionally dated to no later than the late-fourth century were occupied much later (Gerrard 2004; White 2007: 24), although the absence of the latest Roman pottery on the few sites with post-Roman import wares may render this unlikely. Thus until programmes of radiocarbon dating are extended problems of visibility and potential misdating are likely to remain.

In the meantime, however, we are faced with a problem of settlement visibility which is seriously constraining our understanding of the period. In this paper I will outline one possible solution to this problem; a predictive module of early medieval settlement location. The basis of this is the identification of areas of

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landscape which have a high potential of being favoured for early medieval settlement – 'Core Settlement Zones' (CSZs). Once identified these zones could be the target for intensive survey and excavation. GIS (Geographical Information System) technologies with their ability to integrate and manipulate large sets of spatial data are perfectly suited to this exercise and were the principal tool used for this project.

Building a Predictive Model

The identification of CSZs is dependent upon the recognition of factors which structured the choices behind the landscape location of settlements. The identification of such factors, however, is a complex matter which rests upon two major assumptions; first that past communities did exercise some rationale behind the choice of settlement locations, and second that we are able to identify these rationales within a given landscape (Wheatley and Gillings 2002: 179). The first assumption is not hard to accept, but identifying rationales within observable landscape characteristics is more complex. The choices behind settlement location were highly complex, and must have included a range of social, environmental, economic and political considerations. Nevertheless although we should be wary of crude environmental determinism it is reasonable to assume that certain environmental characteristics which we can identify today, such as soil type, hydrology and aspect, did influence the choice of settlement locations (Roberts 2008: 23–24, fig 2.8). Moreover it is possible that these characteristics were influential over long time periods, particularly before post-medieval improvements in agricultural technologies and practices. Nevertheless whilst it may be possible to define CSZs on the basis of particular environmental characteristics, it is unlikely that CSZs can ever be defined on a regional or national level; the great diversity within the British landscape means that the factors which influence settlement locations are likely to have been local in nature.

GIS based predictive modelling was developed predominantly in North America in the 1970s and 1980s (Judge and Sebastian 1988; Mehrer and Wescott 2005). Studies such as Warren and Asch's (1999) analysis of the Prairie Peninsular (north east United States) have successfully developed 'inductive models' based upon the analysis of a sample of known sites in relation to landscape characteristics in order to identify sets of correlations which can be tested on other areas (Wheatley and Gillings 2002:170). Thus, ideally, it would be preferable to analyse the location of known early medieval settlements and construct CSZs on the basis of the resulting correlations. However, the heterogeneous nature of the Welsh landscape and the limited dataset from the study area (and Wales in general) means that we cannot be sure that the few sites that have been identified are representative of the wider settlement patterns; indeed the bias towards high-status hilltop sites suggests they are not. Nevertheless evidence from elsewhere in early medieval Britain suggest that this problem can be circumvented by a comparatively detailed understanding of the Romano-British and later medieval settlement patterns, particularly in regions were traditional dispersed settlement patterns have not been disrupted by processes of nucleation and an associated shift to heavier, but more fertile soils. Archaeological and palaeoenvironmental evidence from a series of enclosed hut groups on the Graeanog Ridge in the Llyn Peninsula (Gwynedd), for example, shows that an 'island' of gravel within an area of wetter and heavier soils was continuously occupied from the late-Iron Age to the present day (Fasham *et al* 1998). Although there was slight settlement shift within the locality and the early medieval evidence was by far the most ephemeral this suggests that where environmental factors are important Romano-British and later medieval settlement evidence may act as a guide to the location of early medieval sites. On a much larger scale Sam Turner has used archaeological and place-name evidence to analyse the changing settlement patterns between the late-Romano-British period and the thirteenth/fourteenth century in Cornwall (Turner 2006). He identified three principal phases of settlement typified by; rounds, unenclosed *tre* settlements, and medieval settlements in marginal areas, the distribution of which were plotted against a Historic Landscape Characterisation (HLC) survey (Turner 2006: figs 25–38). This revealed a series of transformations within settlement patterns between the third and fourteenth centuries; during the third to fourth centuries and again in the post-Conquest period there was a tendency for limited settlement in fairly marginal locations – that is within or close to areas defined by the HLC as 'medieval rough ground' (Turner 2006: 81; compare figs 28 and 32). Such sites, however, were outliers from a 'core settlement zone' characterised in the HLC as 'medieval fields' which was occupied continuously from the Iron Age to the present day. Most importantly for the current debate Turner argues that the fourth to ninth century settlement pattern, typified by enclosed rounds and, after the sixth century unenclosed *tre* settlements, was largely restricted to this 'core settlement zone' (Turner 2006: 76, 90, figs 30, 31, 38). Although rounds, *tre* settlements and post-Conquest settlements were largely concentrated within this zone there were differences between the location of settlements at a local level; *tre* settlements, which are presumed to lie on the same location as post-medieval farms, tended to be about halfway up valley sides, commonly in sheltered positions near the break of slope, whereas rounds tended to occupy more exposed spurs on the upper edges of valleys (Turner 2006: 79).

Apart from the characterisation of the core settlement zones as 'medieval fields' in the HLC Turner does not characterise these areas further or explain why they were so attractive for settlement. Peter Rose and Ann Preston-Jones, however, have noted that core zones in the area tend to avoid the major uplands and are concentrated on the better farming areas (Rose and Preston-Jones 1995: 56). Tom Williamson's (2008) recent study of settlement patterns around Sutton Hoo (Suffolk) looked in more detail at the relationships between settlement location and environment. By using fieldwalking data he was able to suggest that prehistoric, Romano-British, Anglo-Saxon and later medieval settlements appear to cluster in core areas (Williamson 2008: 33–44, figs 11–14). This patterning, he argued, arose from constraints imposed by the particular environmental characteristics of the Sandlands landscape; the principal constraints being soil type and hydrology, with the settlements clustering on the most fertile and cultivable soils (Williamson 2008: 29–33: figs 11–15). Brian Roberts has also emphasised the major influence which by cultivable soils had on the location of medieval settlements in north east England, but he notes that soil conditions can and do change, and that the overriding factor in site location was access to arable, meadow and pasture (Roberts 1987: 110–113). These examples show that although the relationships between settlement location and landscape characteristics are complex there are correlations between them. Such overtly 'environmentally deterministic' paradigms are not currently fashionable, but are valid given the agricultural basis of rural communities in early medieval Britain. Although hunting, gathering and fishing were important elements of the rural economy communities were primarily reliant upon mixed agriculture (Dyer 2002). The above examples show that whilst large parts of the landscape were utilised as pasture and meadow, permanently occupied domestic settlements tend to be located closer to the arable, perhaps reflecting the fact this was the focus of the heaviest and most intense agricultural labour. Thus there are grounds for assuming that although settlement sites may not have remained on exactly the same locations, in some regions at least, they are likely to have remained within the same landscape zones over long periods of time.

The logical hypothesis to arise from this discussion is that it may be possible to construct CSZs by analysing the correlations between Romano-British and later medieval settlement evidence, and particular environmental and topographical factors which are known to influence the agricultural capabilities of the landscape. Once identified these areas could then be the focus of targeted field survey and excavation designed to identify early medieval settlements and test the validity of the model. The scale over which this model is applicable is likely to be restricted however. This is because the greater geological and topographic variation exhibited over large areas inhibits the identification of the specific relationships between settlements and landscape characteristics. On the smaller scale within areas of more homogeneous geology and topography, correlations will be more apparent. For this project I undertook a detailed case study of one area – the eastern Vale of Glamorgan (an area of 106km^2) (see Figure 1). But due to the restricted resources and timescale of the project I was only able to use the predictive model to construct CSZs; only future fieldwork within these zones will see if the model is successful, although a limited amount of proxy data can be used to support the general conclusions (see below).

The Case Study Area

The study area is defined by the limits of twenty parishes in the eastern Vale which corresponds roughly to the Dinas Powys *hundred*. This area, bounded by the river Thaw on the west and river Ely on the east, was chosen because of the relatively high density of Romano-British and medieval settlement evidence and the location within it of the important early medieval hillfort at Dinas Powys. The study area consists of gently undulating land cut in the west by the narrow valleys of the River Thaw and its tributaries, and in the east by the wider alluvial plains of the River Cadoxton. The topography stretches from sea level to as high as 130m OD in the north. The solid geology is defined by a prominent east/west divide; to the east the geology is fairly heterogeneous consisting of Carboniferous Limestone, Triassic Mudstones and Lower Lias, whereas the west is almost solely dominated by Lower Lias. The drift geology is confined to areas of alluvium in river valleys and a small area of glacial sand and gravel to the north. This prominent east/west geological divide is broadly reflected in the local soils, which are generally light and capable of supporting extensive tracts of both arable and pasture (Davies *et al* 1960; Crampton 1972). The solid geology and soils serve to divide the case study area between two farming

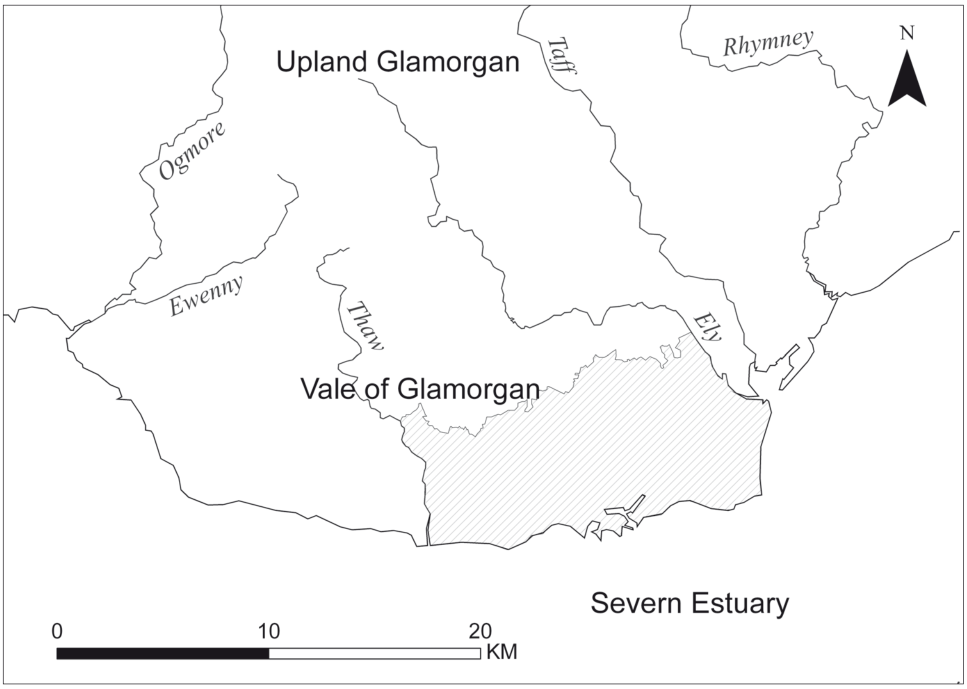

Figure 1 Study area location map.

regions; the western half forms the eastern end of the 'Vale Coastal Strip' which extends from St Brides Major to Barry. The soils of the Coastal Strip are well suited to agriculture and have been characterised in modern times by their high proportion of arable. To the east the soils of the 'Cardiff-Barry' region are more heterogeneous, and although pasture has been the dominant land-use in recent history there is still a substantial amount of arable (Thomas 1938: 28–44, 64–66; Davies *et al* 1960: 133–135, 137; Crampton 1972: 59–62, 66). Although the study area can be divided between these two areas it is noticeable that the Agricultural Land Capability survey (ALCS) classifies the bulk of the case study area as 'good' with equal proportions of 'very good' land to east and west. Most important in relation to patterns of past settlement Crampton and Webley have drawn a further distinction between soils that are impeded (poorly draining) and those which are freely draining and particularly suited to early agriculture (Crampton and Webley 1960: 388–390, 393).

Romano-British and Later Medieval Settlement Evidence

Romano-British settlement evidence in south-east Wales is comparatively abundant and well understood (Arnold and Davies 2001; Evans 2001a). In order to get as accurate as possible portrayal of the settlement pattern all published settlement sites with evidence of domestic occupation were brought together in a database which was complemented by further records from the Glamorgan Gwent Historic Environment Record. There is less direct archaeological evidence for the medieval period and that which we do have lacks chronological definition. Data within the Royal Commission volumes and Historic Environment Record is largely restricted to higher status settlements such as castles, granges, and manor houses, and religious sites. Nevertheless there is limited, although appreciable, evidence of rural settlement in the form of house platforms, houses, and shrunken settlements. It is also possible that many extant farmsteads overlie medieval precursors, but at present this hypothesis remains untested.

The database consists of 67 Romano-British and 204 late medieval locations with settlement evidence. Whilst this is a substantial dataset we must be aware of a number of potentially important biases which may affect our overall impression of the settlement patterns and which, must, in turn, affect the viability of the predictive model. First of all we must acknowledge that the dataset is partly a reflection of biases in both preservation and discovery. For example, in contrast to the medieval settlement evidence which includes upstanding monuments and earthworks, Romano-British sites have tended to be discovered through the identification of plough scatters. Thus there may be a tendency for the Romano-British sites to be identified in areas of arable cultivation, whereas they may be under-represented in pastoral areas, where, conversely, later medieval settlements are represented as upstanding monuments. Furthermore the fact that later medieval pottery is more ubiquitous than Romano-British and appears to have been distributed widely through manuring (Evans 2001b) means that equal weight cannot be attributed to occurrence of artefact scatters. Further problems surround the fact that the settlement evidence within the database was represented as point data (determined by grid references), whereas in reality these dots represents sites of larger, but often unknown, extent.

Definition of Core Settlement Zones (CSZs)

The methodology implemented was fairly simple; the settlement evidence database and map layers representing the local topography, aspect, geology, hydrology, soil association and agricultural land capability were uploaded into ArcGIS. The resulting spatial relationships were analysed through the use of the 'selection by location and/or proximity' and 'statistics' functions. In terms of proximity alone the relationship between Romano-British and later medieval settlement evidence is not as strong as might be expected, with only 43% of Romano-British settlement evidence lying within 200m of the later medieval evidence. This must imply some shift within local settlement locations between the fourth and the eleventh centuries, but as 73% of Romano-British and medieval settlement evidence was located within 0.5km of each other there was some broad clustering, and indeed distinct clusters of settlement evidence can be identified at Biglis, Cadoxton, Barry, Penmark, East Aberthaw, Wrinstone, Llandough, Sully, Porthkerry, Cosmeston and Dinas Powys. Thus the overall settlement pattern appears to be one of core zones of settlement with a minority of sites in locations which have not seen intensive occupation over extended periods of time. Whether the outlying settlements represent occasional expansion into marginal areas is difficult to determine however; a number of the Romano-British sites, for example, are villas which were unlikely to have been situated on marginal land. Indeed where outlying settlement evidence falls in areas classified by the ALCS it often occurs in areas classified as very good or good. It must also be noted that some outlying sites are located close to upstanding post-medieval farmsteads which may have had earlier origins. Thus it is difficult to plot CSZs by simply drawing polygons around clusters of Roman and medieval settlements; although there is considerable overlapping in the distribution, the outliers in the distribution prevent the definition of meaningful CSZs.

It is therefore necessary to refine the CSZs by taking other factors into account. Topographically all settlement evidence is located above or within 200m of the 10m above Ordnance Datum contour. This is undoubtedly a reflection of the need to locate settlements away from low lying and poorly drained areas, in particular the alluvial plain of the lower stretches of the Cadoxton River which is particularly prone to water-logging. The fact that 90% of the settlement evidence lies below 90m with a notable threshold at 60m may reflect a preference towards dry but sheltered positions. There is also a slight tendency for sites to be located on or close to the lips of cwms (river and stream valleys) – locations that are dry but still close to water sources. In relation to the solid geology there is no significant correlation between rock type and settlement evidence. The same is true of the relatively small amount of drift geology. The strongest determinants of settlement patterns appear, however, to be related to soil characteristics, although the correlations are complex. Treating soil association first (see Figure 2), in the Cardiff-Barry farming region there is a slight tendency for settlement evidence to cluster on the boundary between the Malham 1 and Worcester soil associations. Both these associations are suited to modern arable cultivation, but if their differences were more apparent to earlier farming practices it is possible that the location of settlements on the boundary between the two zones represents an attempt to utilise the potential of both areas. In the west settlements of the coastal strip farming region are fairly evenly dispersed over the arable soils of the Ston Easton association. There appears to have been more limited settlement on the Denchworth association, which, according to the Dudley Stamp map of early twentieth century land-use, may have been more suited to pasture. There are obvious problems with using these twentieth century maps to understand ancient land-use (Evans and O'Connor 1999: 108); but as the Dudley Stamp maps do at least provide an indication of past land-use prior to substantial post-war improvement they may be of some relevance to the medieval period.

Thus there is some correlation between settlement location and soil association; nevertheless there are problems which inhibit their significance; firstly not all of the case study area was classified by the Soil Survey (large areas of post-medieval development are described as 'unclassified'), so it is difficult to prove the statistical basis of correlations in the absence of data in these areas. Secondly given that all of the associations within the study area, even those of the Denchworth, are currently seen as productive and capable of supporting both pastoral and arable regimes there is little basis for assuming that soil association alone was the main determinant of settlement location. Finally the size of CSZs defined on the basis of these correlations would be too large to be of practical use for individual site location. It is therefore necessary to explore soil characteristics which, firstly, have implications for early farming regimes and, secondly, provide a much finer resolution. One way of achieving this may be to plot the settlement patterns against the ALC survey (see Figure 3). This does reveal stronger correlations, particularly in the coastal strip region where settlements on the Ston Eaton association cluster towards the boundary between land classified as 'very good' and 'good'. The ALC survey was carried out during the mid-twentieth century however, after much land improvement and the adoption of mechanised agricultural technology. It cannot therefore be taken as an accurate reflection of the land capability during the Romano-British and medieval period (Evans and O'Connor 1999: 108). Also the ALC survey does not cover the entire extent of the study area, so again the statistical significance of settlement location correlations is insecure.

The distribution of free draining and impeded soils, however, provides a far better means of examining settlement evidence in relation to soil characteristics

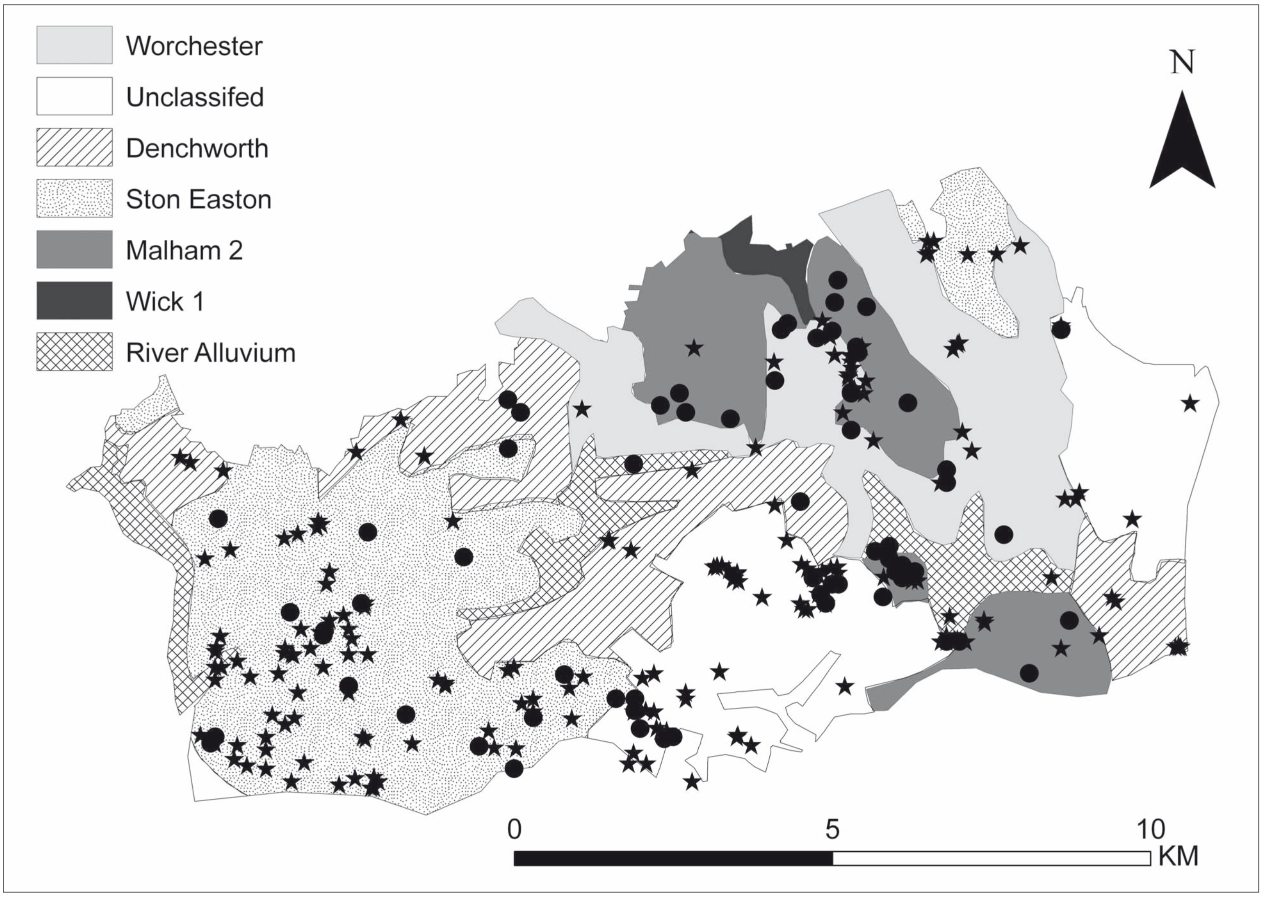

Figure 2 Settlement evidence and soil association (dots = Romano-British settlement evidence, stars = medieval settlement evidence).

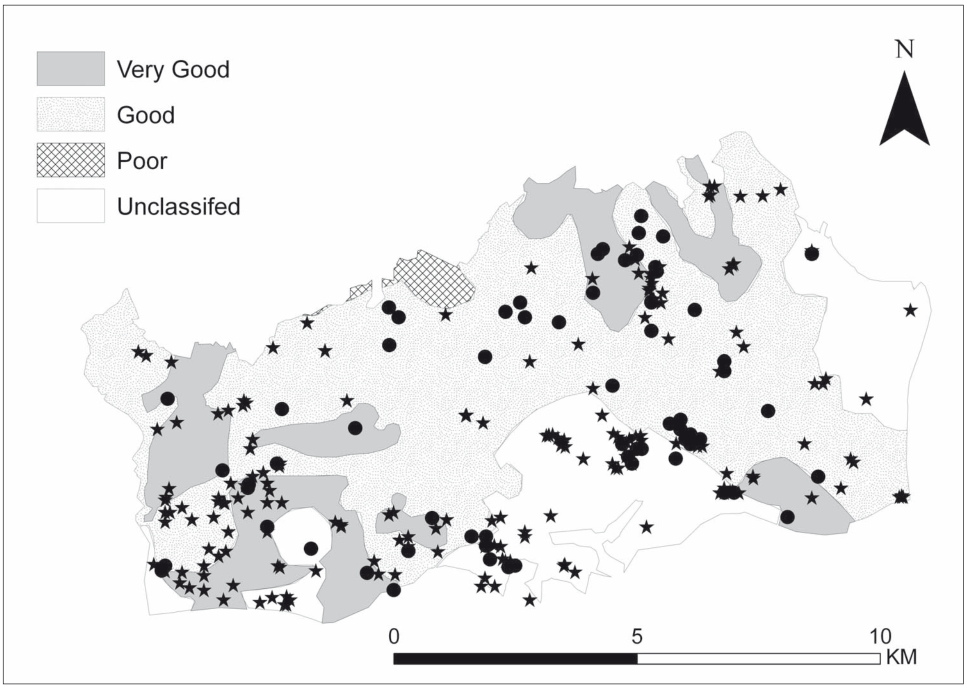

Figure 3 Settlement evidence and the Agricultural Land Capability (ALC) survey (dots = Romano-British settlement evidence, stars = medieval settlement evidence).

(Crampton and Webley 1960: map 1). Whether a soil is impeded or free draining is determined by complex relationships between soil association, geology, hydrology and topography (Crampton and Webley 1960: 388–390). The significance arises from that the fact that the distinction between free draining and impeded soils was of particular importance for early farming communities (Williamson 2003: 143–150). Indeed Crampton and Webley argue that it was the free draining soils in the Vale of Glamorgan which were most suited to prehistoric agriculturalists because they were the easiest to bring under cultivation and most productive within primitive farming practices. They contrast this with the heavier and wetter impeded soils which must have been more difficult to bring into cultivation and are most likely to have been predominately exploited as pasture, with occasional short term cultivation in places (Crampton and Webley 1960: 390). Thus the distribution of the soil characteristics defined by Crampton and Webley provides information on a landscape characteristic which is mapped for the whole study area, is likely to have been important to early farming communities, and which offers a resolution fine enough to construct manageable CSZs.

When the settlement evidence is plotted in relation to areas of free draining and impeded soils it is immediately apparent that there is a correlation between the three distributions (see table 1 and Figure 4). Both the Romano-British and later medieval settlement evidence appears to cluster within the free draining areas or on or close to the boundary with the impeded soils. Thus although free draining soils account for only 39% of the total study area they contain 51% of the settlement evidence. The central areas of the free draining areas, however, often contain only a scattering of settlement evidence. There is also a clustering of settlement evidence towards the outer edge of the free draining soils, so much so that 82% of the settlement evidence within the free draining areas is within 300m of the outer boundary. Moreover 74% of the settlement evidence which lies outside of the free-draining areas is less than 300m from the boundary (see Figure 5). In total then 87% of sites lie either within the free draining areas or within 300m of the boundary.

Why the importance of the boundary between the free-draining and impeded soils? This, I argue, reflects the efficient manner in which different parts of the landscape have been exploited. The basis of this assertion is Crampton and Webley's (1960: 390) argument that free draining soils were most suited for arable cultivation whilst impeded soils were more suited to pasture and meadow, and indeed the Dudley Stamp Maps suggests that this was certainly true of the early twentieth century. Although the limitations of these maps must be emphasised Crampton and Webley's argument is logical, and if these patterns of land-use were true of earlier periods it is reasonable to expect settlements to be located to permit easy access to arable but at the same time facilitate integration with other agricultural zones – that is on the boundary between the arable and pastoral zones. This is in keeping with influential paradigms such as the multiple estate model, which have emphasised the ways in which early medieval estate structures facilitated the exploitation of a range of ecological niches (Jones 1976; Roberts 2008: 56, fig 2.8).

It is possible to suggest that the distribution of free draining soils and the location of the boundary between the free draining and impeded soils influenced the location of Romano-British, later medieval and thus also early medieval settlements. Thus on the basis of the above relationships I constructed two CSZs (see Figure 6); one of which is located 300m either side of the free draining/impeded soil boundary (zone 1), whilst the other is located within free draining areas but over 300m from the boundary with the impeded soils (zone 2). Areas that are within zones 1 and 2, but in which settlement evidence is unlikely to occur because it falls into the low lying ground surrounding the Cadoxton, are

Table 1

Period	Total sites	Sites in free draining areas	Sites within 300m of outer boundary of free draining soils	Sites in impeded areas	Sites in impeded areas within 300m of free draining soils
Romano-British	67	48	37	19	17
Medieval	204	90	76	114	81
Total	271	138	113	133	98
Total %	100	51	82	49	74

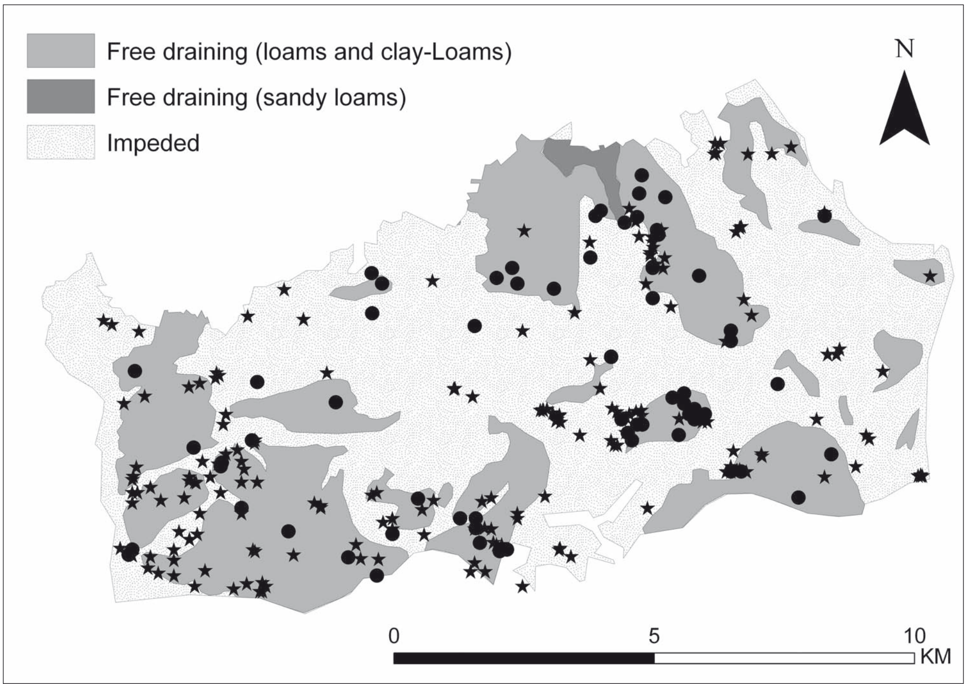

Figure 4 Settlement evidence and the soil hydrology (dots = Romano-British settlement evidence, stars = medieval settlement evidence).

classified as zone 4. The rest of the study area is defined as zone 3.

The validity of these zones can be explored by examining the figures for long term patterns of land-use. Table two shows a series of chi-squared tests undertaken to test whether the frequency of sites within zones 1, 2 and 3 (zone 4 is too small to be statistically valid) is statistically significant in relation to the relative size of the zones. Where there is sufficient data for the tests to be valid (that is where the expected number of sites is no less than five) the tests show that the distribution of sites in relation to the zones is statistically significant for all periods bar the post-medieval. The figures also show some interesting changes over time; during the Neolithic period early farmers appear to have favoured areas within zone 2, whilst during later prehistory zone 1 appears to have been more favoured. Although the small sample size limits the significance of this observation, one explanation for it may be that as groups became increasingly sedentary zone 1 which helps facilitate a broader spectrum economy would have become more desirable.

Zone 1 appears to have been the most attractive for Romano-British and medieval settlement evidence, and can be seen as the part of the landscape which is most likely to contain early medieval settlement evidence. Early medieval settlement can also be expected within zone 2, but in much lower densities, whilst settlement in zones 3 and 4 can be expected to be rare. There is little early medieval proxy data with which to test this model, but it can be noted that stray finds of early medieval date (four in total) have been recovered from zones 1 (three examples) and zone 2 (one example), whereas none have thus far been recovered from zone 3 (although the provenance of these finds may not be precise). Two early medieval settlements are known from the study area; Coldknap, a poorly understood Romano-British settlement with evidence of occupation in the seventh to eleventh centuries, lies within zone 2, and Dinas Powys, a major fifth to seventh century hillfort, lies within zone 1.

There is some Romano-British and medieval evidence for settlement in zone 3, but 97% of the Romano-British settlement evidence does lie within zones 1 and 2, and 92% of all the settlement evidence in zone 3 is medieval. This could have arisen as a result of the biases within the settlement evidence dataset discussed above; indeed analysis of the Dudley Stamp land-use map for Glamorgan shows that in recent times arable ploughing has been more common in zones 1 and 2. Thus it is possible that Romano-British settlement evidence is under represented in zone 3 not because it was not there, but because it has not been discovered due to the difficulty of identifying plough scatters in

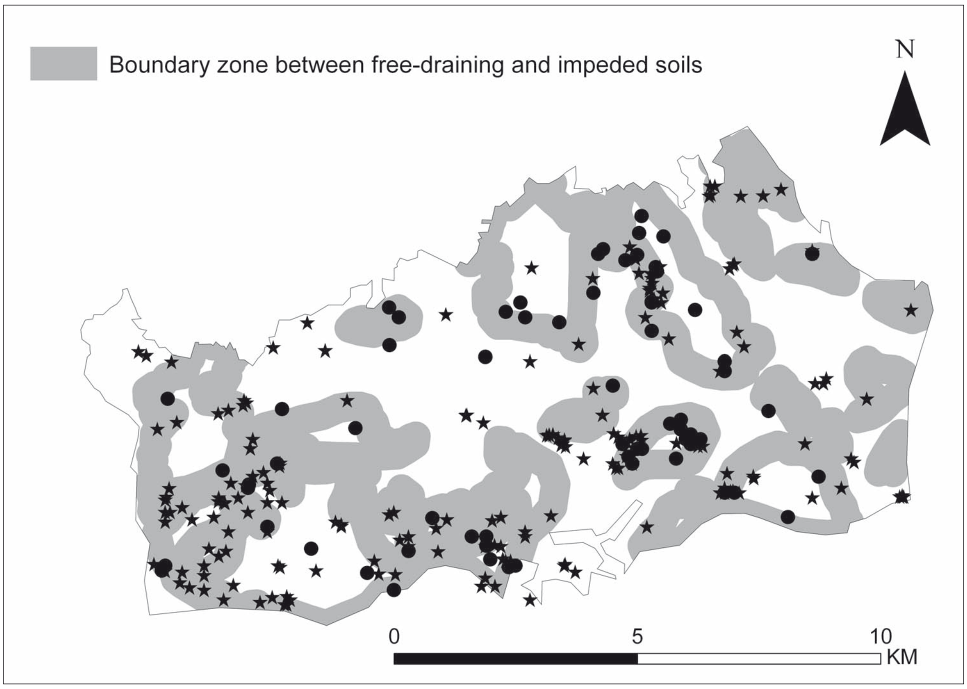

Figure 5 Settlement evidence and the boundary between free draining and impeded soils (dots = Romano-British settlement evidence, stars = medieval settlement evidence).

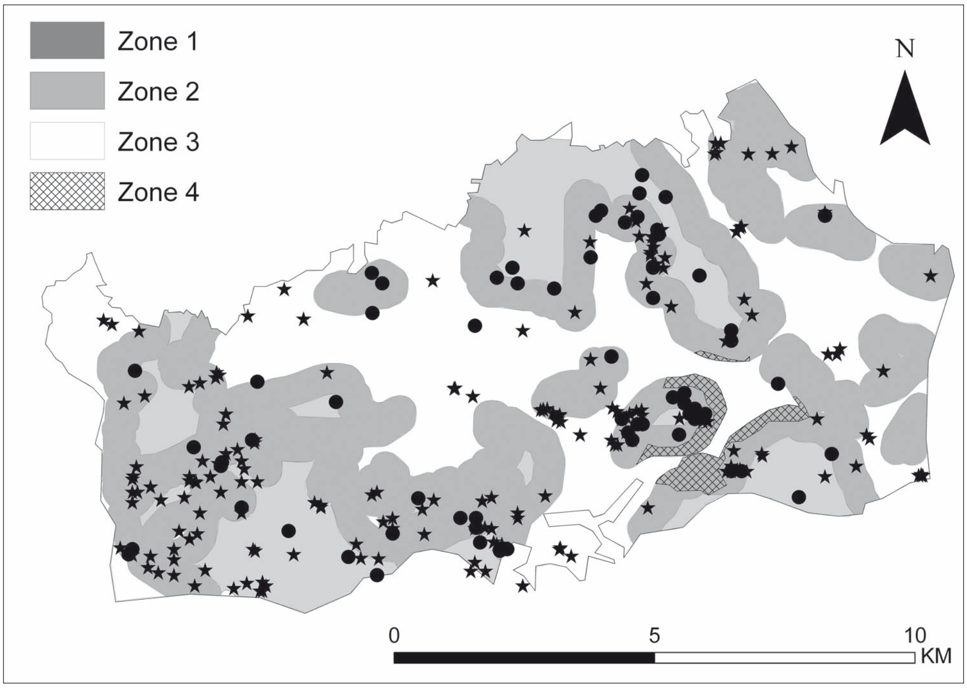

Figure 6 Settlement zones (dots = Romano-British settlement evidence, stars = medieval settlement evidence).

pastoral areas. Nevertheless given that the free draining areas have been subject to cultivation the clustering of settlements towards the outer edge of these areas does appear to be a genuine reflection of the settlement distribution. Moreover given that soil characteristics were so important to early communities, and that some arable cultivation has taken place in zone 3, it is likely that the distribution of settlement evidence is a fair reflection of a genuine pattern.

The data suggests, therefore, that a shift to increasing, but still limited, settlement within zone 3 took place sometime after the Roman period. It follows that the validity of the CSZs could be undermined to a small extent if this shift had started to take place during the early medieval period. It is noticeable, however, that all of the castles and the single motte within the study area are located within zone 1. Now if the location of these settlements was determined, if only in part, by a need to control the pre-existing population then their positions may bear some relation to the pre-Norman settlement pattern, thus suggesting that expansion into zone 3 took place at a later date. Nevertheless palaeoenvironmental, place-name and archaeological evidence from neighbouring regions such as Cornwall and in particular mid-Devon and the Exmoor edge suggests that a transformation in settlement patterns

Table 2

Period	% of study area	No. of sites Observed	Expected	$(O-E)^2/E$
Zone 1				
Neolithic	50	20	19	0.052
Bronze Age	50	14	9	2.777
Iron Age	50	18	12	3
Romano-British	50	50	34	7.529
Medieval	50	144	102	17.294
Post-Medieval	50	60	54	0.666
Zone 2				
Neolithic	16	14	5	16.2
Bronze Age	16	3	2	invalid
Iron Age	16	2	4	invalid
Romano-British	16	15	11	1.454
Medieval	16	21	33	4.363
Post-Medieval	16	12	17	1.47
Zone 3				
Neolithic	33	3	13	7.692
Bronze Age	33	2	6	2.666
Iron Age	33	3	7	2.285
Romano-British	33	2	22	18.181
Medieval	33	39	67	11.701
Post-Medieval	33	37	35	0.031

Period	χ^2	Critical value at 0.001
Neolithic	23.944	13.828
Bronze Age	Invalid	N/A
Iron Age	Invalid	N/A
Romano-British	27.164	13.828
Medieval	33.358	13.828
Post-Medieval	2.446	13.828

and agrarian regimes took place during the seventh and eighth centuries (Turner 2004: 29; 2006: 75; Fyfe and Rippon 2004: 40; Fyfe 2006: 20–21). If a similar process took place in south-east Wales it is feasible that it was connected with settlement expansion into zone 3. If so it is possible that settlement in zone 3 was largely restricted to the later part of the early medieval period.

During the post-medieval period settlement appears to have continued to expand into zone 3 and even to a limited extent in zone 4. Thus the locations of farms and hamlets on Yates's 1799 map of Glamorgan show that areas that were more marginal during prehistory and the Romano-British and medieval periods were becoming more intensively occupied. This pattern is likely to reflect a combination of factors, including improvements in agricultural technology, population and economic pressure, land improvement, and the development of specialised cattle and sheep farms.

Conclusions

By mapping the distribution of Romano-British and medieval settlement evidence in relation to landscape characteristics which are likely to have structured the nature of agricultural practices it has been possible to divide the study area into zones which reflect past settlement intensity. Zones 1 and 2 would be the most profitable areas for survey and targeted trial excavation aimed at identifying early medieval settlements. Indeed these zones, which are still quite large, could be broken down further by targeting particular areas within them such as the lips of cwms and sheltered south facing slopes. Factors such as proximity to known early church sites or roads and tracks could also be taken into consideration. It must be noted, however, that the CSZs constructed here are not specific to the early medieval period. Rather they identify the parts of the landscape which have been intensely occupied since the Neolithic. Large numbers of settlements of all periods are therefore likely to be discovered through fieldwork within these zones. This problem is compounded by the lack of a widespread diagnostic early medieval material culture to assist in the identification of sites. Thus the validity of the CSZs can only by tested through the implementation of large scale survey methods such as fieldwalking and geophysical survey in conjunction with techniques, such as metal detector survey (finds of early medieval metalwork have been very important for identifying new early medieval settlements in Wales such as Llanbedrgoch on Anglesey) and trial excavation with regular radiocarbon dating which have the ability to identify the ephemeral settlement evidence. After early medieval settlements have been identified it may become possible to identify other factors which structured settlement locations which could be used to refine the model further and tailor it more specifically to the identification of early medieval settlements. The model may also have further implications however, particularly for examining patterns of land-use; the relationship between the settlement zones and evidence for medieval strip fields (as revealed through cartographic evidence and fieldwalking data), for instance, may help us to develop a more complete and contextual understanding of the medieval landscape.

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