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Climate change, environment and migration: a GIS-based study of the Roman Iron Age to the Early Middle Ages in the river Oder region

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The river Oder region was virtually uninhabited from 550 to 700 AD. Was an ecological crisis the reason for that exodus? In the context of the present study, a GIS analysis of sites from the Iron Age to the Early Middle Ages was applied to the river Oder region. Through analysing results of a systematic site catchment analysis, it was possible to find out signals of the palaeoclimate. As a result we recognized dramatic climate fluctuations at the end of the Roman Iron Age (Early Migration Period) and at the beginning of the Early Middle Ages (Late Migration Period). Climate fluctuations are likely the main reason for emigration of the settlers out of this region, which was uninhabited for nearly 150 years before the immigration in the early 8th century AD.
Keywords: river Oder region, Early Middle Ages, migration, climate change, environment, GIS

Nella regione del fiume Oder le indagini archeologiche hanno verificato un abbandono degli insediamenti nel periodo delle migrazioni, e l'area fu quasi disabitata dal 550 al 700 d.C. Fu forse una crisi ecologica a causare questo abbandono? In questo studio, applicando tramite GIS la site catchment analysis *agli insediamenti dall'età del Ferro all'alto medioevo, alcuni indizi hanno permesso di ricostruire il paleoclima, riconoscendo drammatiche fluttuazioni climatiche tra III e IV secolo d.C. (prime migrazioni) e all'inizio dell'alto medioevo (migrazioni altomedievali). Le fluttuazioni climatiche sono dunque la causa principale dell'abbandono degli insediamenti in questa regione, che rimase disabitata per quasi 150 anni prima di essere nuovamente oggetto di immigrazione nell'VIII secolo.*
Parole chiave: *regione del fiume Oder, alto medioevo, migrazione, cambiamento climatico, ambiente, GIS*

1. Introduction

The revolutionary processes of the Migration Period also led to drastic changes in settlement structure in the barbarian territories (Germania Magna). The 5th to 6th centuries AD are a significant turn-

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Fig. 1. Location of the area under investigation northeast of Berlin and west and east of Szczecin at the lower Oder, the current border between northeast Germany and northwest Poland.

Fig. 2. A double ring-structure of a medieval ring rampart of the 9th to 10th c. AD is shown in the center of the aerial photograph. This fort, with a diameter of approximately 70 meters, was located on a paleo-meander from the river Oder in the flat meadow nearby Altreetz and Neureetz (Märkisch-Oderland County); (see fig. 3 and 16); Brandenburgisches Landesamt für Denkmalpflege, Luftbildarchiv: GW 191713 (photographer G. Wetzel).

ing point in the settlement of the Oder region. In this article the long- and intensely-discussed subject of migration of tribes is addressed. In particular questions regarding possible migration routes of peoples in Late Antiquity, at times hotly debated in the field of historical studies, will be addressed from the perspective of settlement archaeology. This article also features an analysis of the assumption that noteworthy routes existed at the time and so concurs with a probable "historical reality".

One majority opinion of some medievalists (Geary 2002; Pohl 2005) has shifted in recent years to the idea of a rather static, predominantly locally rooted settlement and population development in the Roman and Migration Periods. They come to the conclusion that only small, elite groups of followers migrated, and that this relates mainly to gradual transformation processes of extensive and continuously existing population groups within Germania. This implies that we must drastically correct the statements of ancient sources on "migration". However, the idea of gradual change is based on previous archaeological finds and probably only applicable for the Roman Period in the western border regions around the *limes Germanicus* – during the Romanization of local groups, for example. The finds of the area under consideration indicate instead drastic processes of upheaval at the end of the Roman and Migration Periods, partially occurring within only a few decades or even years and inconsistent with a gradual transformation, suggesting distinct breaches in the continuity of non-linear changes. The archaeological record for the 5th to 7th centuries AD in the Oder region seems to reflect dramatic processes with deep impacts. Therefore the hypothesis of gradual transformative change is not applicable to the period or region currently under discussion.

Obviously one must distinguish between very different kinds of settlement dynamics: between the *Agri Decumates*, the Germanic border lands around the *limes*, and inner Germania, between the Elbe and Vistula (fig. 1). In western central Europe the settlement processes were concurrent with gradual change in connection with substantial Romanization of the Germanic peoples. In eastern central Europe this Roman acculturation does not apply and the population retained its "Germanic character" (Volkmann, Koch 2014), as clearly evidenced by the archaeological record: Roman imported finds in the Oder-Vistula area, for example, are relatively rare. The region under investigation around the Oder in *Germania Magna* is particularly intriguing, with a wholly unique settlement dynamic due to its location at the crossroads between central and eastern Europe.

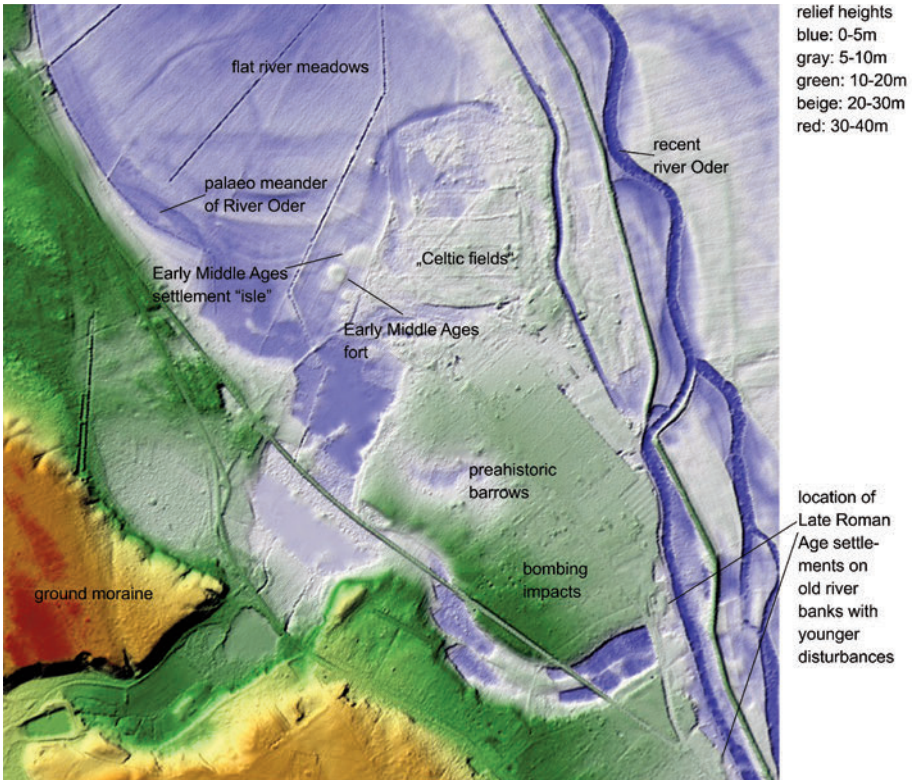


Fig. 3. High-resolution airborne laser scanning data interpolated as a digital terrain model (DTM1) in the GIS. The shallow relief with vertical exaggeration factor of 10 illustrates the location of settlements of the Late Roman Iron Age on old river banks. The early medieval ring rampart northern of Wriezen (Märkisch-Oderland County) is connected to a simultaneous settlement with the function of a craft production workshop (data: Landesvermessung und Geobasisinformation Brandenburg; GIS: author); (see figs. 2 and 16).

In addition to its respective political and economic situation, the Oder region was also environmentally quite different from western lands on the river Elbe with fertile soil. For agricultural societies like the Germanic tribes the Oder ground was very difficult to work as the geo-ecological potential restricts yields to a very low level, and crops are much more influenced by climatic factors like rainfall and temperature. The peak phase of "Germanic culture" in the *Barbaricum* in the early and middle Roman Period is apparently concurrent with widespread climate stability. In contrast, climate fluctuations during the Late Roman Period and Migration Period which had significant effects on the settled coasts of the North and Baltic Seas/Oder region can be determined with certainty (fig. 4).

We can therefore interpret this climatic instability during the 5th and 7th centuries AD to be the main reason for population migration out of the Oder region with the eventual result of a lengthy period of abandonment. It was not until the 8th century that the Oder region was re-settled in the so-called "Slavic migration" of the Early Middle Ages. Despite intensive efforts in recent decades, none of the very few sites dated to the 6th to 8th centuries show evidence of an encounter between late "Germans" and early "Slavs", and so the settlement hiatus is assumed to last approximately 100 years (see Brather 1996, 2004 about problematic

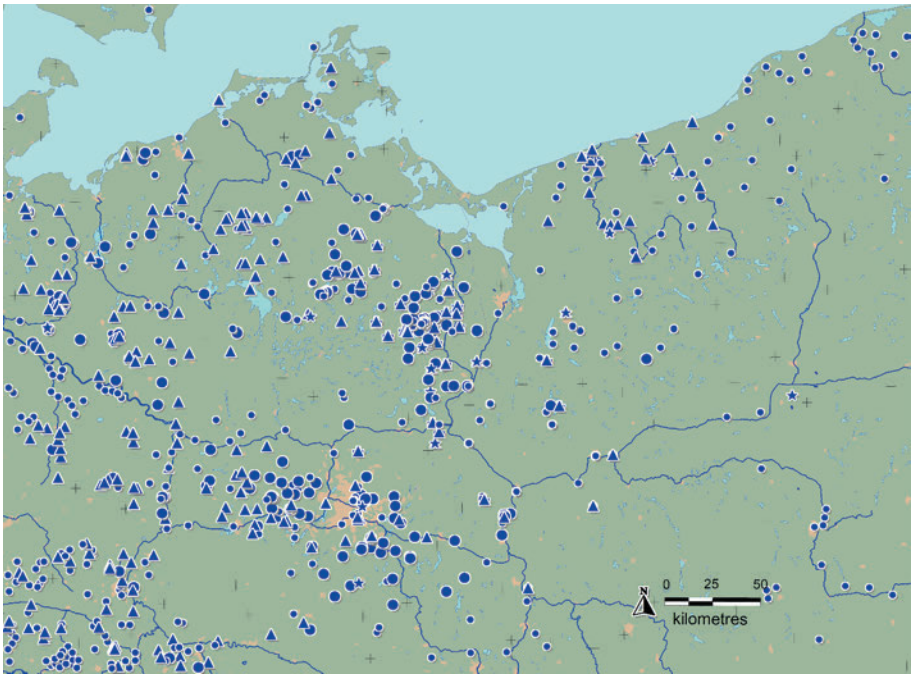


Fig. 4. Sites from the Migration Period (late 4th to 6th centuries AD) in the relevant region; image centered around the river Oder, which drains into the Baltic Sea nearby Szczecin (around 150 km northwest of Berlin). In the eastern Oder region, a markedly reduced number of sites can be seen although this most likely is less a reflection of reality, and more the result of varied research intensity and spatio-temporal logistical in focus. From the natural potential here, with very fertile, Chernozem-like soil on either side of the lower Oder, one would theoretically expect a comparable number of sites on the east and west sides of the river mouth. There are however quite different results in Germany and Poland due to differing research approaches into alleged "Germanic" and "Slavic" sites, e.g., those of the Late Roman Iron Age and Early Middle Ages, the evidence of which is apparent from the map and complicates comparison (see Volkmann 2013a, 30ff and 111ff);
Legend: triangle = graves; large circle = settlement; small circle = single find; star = hoard (author credit).

ethnic interpretations based on archaeological finds). The latest "Germanic" settlements however were often located close beside the earliest "Slavic" ones in the same areas with identical agricultural aspects optimized for geo-ecological potential, so that similar economic structures, heavily dependent on natural resources and climate conditions, can be postulated (Frey 1999).

2. Methodological approach

A comprehensive and, above all, a systematic environmental analysis of sites from the Roman Iron Age to the Early Middle Ages was applied (Volkmann 2013a). A new methodological concept was developed for this purpose, whereby data for the subsequent cartographical and statistical analysis were collected within a standard geo-information key. Highly detailed datasets and digital map collections which are not freely available could be evaluated as a database in a standardised manner in collaboration with partners from the appropriate technical and regional authorities. However, in addition, the archaeological site information in the archives and in the relevant technical literature was also consolidated across

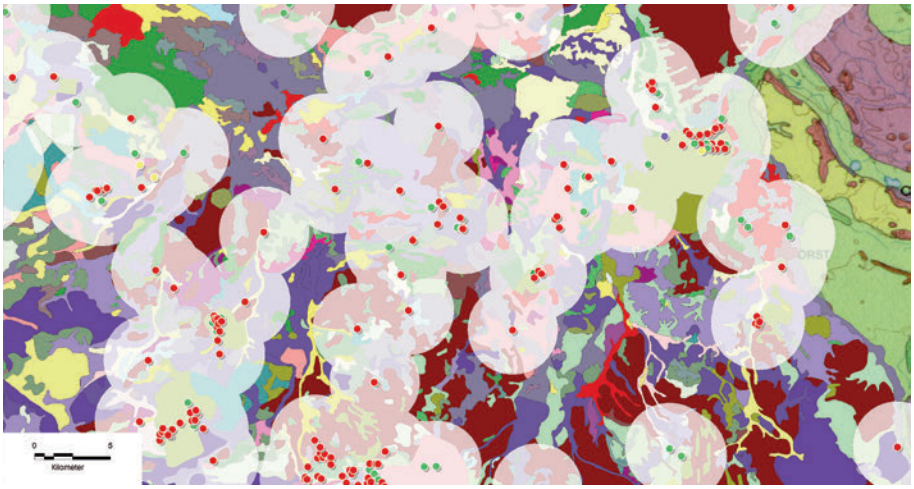


Fig. 5. Soil map of Brandenburg (BÜK 300) and in the northeast, on the lower Oder in the Polish Woj (Zachodnio-Pomorzkie) the geological-geomorphological map (GK 25) in GIS showing as an example settlements from the Early Roman Period phases A (green) and B (yellow), and Late Roman Period phase C (red), to the Early Migration Period phase D (blue). Also the settlements of the Late Migration Period and Early Middle Ages were studied within the systematic site catchment analysis (GIS author).

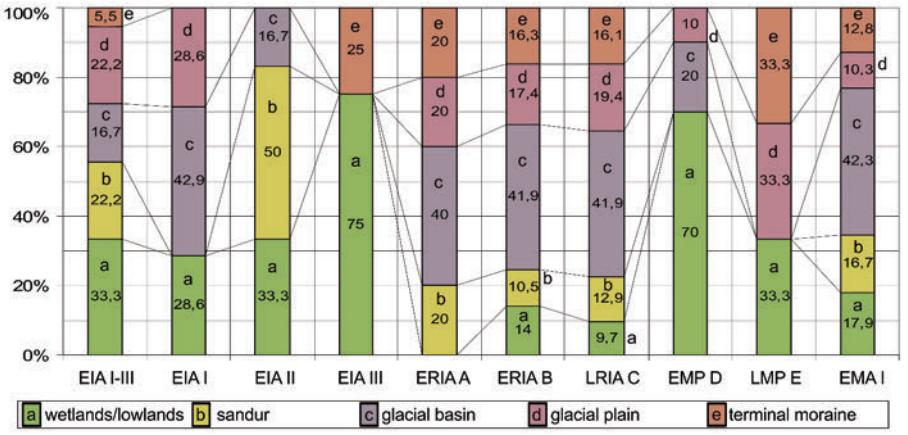


Fig. 6. In addition to the 17 other mapping variables used in this study, this example shows percentages of geomorphological units in the settlement surroundings. The drastically varying quantities of settlements in the humid floodplains are clearly visible; these were appropriate settlement sites only in dry conditions. These indirect indicators of palaeoclimate, e.g., of the relative increase or decrease of the humidity index, were utilized to calculate curve and weight by significance (see Volkmann 2013a, pp. 213-218). Legend: EIA = Early Iron Age phases I-III; ERIA = Early Roman Iron Age phases A-B; LRIA = Late Roman Iron Age phase C; EMP = Early Migration Period phase D; LMP = Late Migration Period phase E; EMA = Early Middle Ages (author credit).

boundaries as a geoarchaeological synthesis (Goldberg, Macphail 2006), a database and a catalogue. In the course of this endeavour, an intensive examination of the source material was carried out, as many sites from the Migration Period were often not recognised as such. Thus, an entirely new and amazingly comprehensive picture of the archaeological sites emerged. It was also possible to gain access to several thesis catalogues which could be included for purposes of comparison (Leube 2009; Machajewski 1999, 2002; Schach-Dörges 1970; Voß 1986; Kirsch 2004). However, for all sites, the type of site and its dating were checked thoroughly, as the most finely detailed dating possible was an imperative foundation for the subsequent environmental analyses.

Thus, a revised chronology system was developed in Periods A–C for the Roman Iron Age, Periods D–E for the Migration Period and Period EMA for the (Slavic) Early Middle Ages which also permits analogies to be made with reference to the technical literature on the area being studied. Besides the very important dating of the sites, the place and circumstances of their discovery were also critically examined and corrected for accuracy, as these selective factors have a powerful effect on the profile

of the site in the section of the study on settlement archaeology. Within the framework of this critical assessment of sources, the research history, which fundamentally shaped the status of research, was also examined. In this context, the most recent examinations of the development and construction of settlements during the Migration Period in the Oder region were also presented on the micro-scale level.

The subsequent analysis in a geographical information system (GIS) was divided into four methodological approaches. 1) A site catchment analysis of the topographical setting, the soil and broader parameters was conducted as a first GIS examination, in which the spatial data information in a probable operating radius around the respective settlements of the individual periods was collected and evaluated statistically (Herzog 2012; Münch 2003). In this way, statistically significant climate proxies on the relative humidity index and temperature pattern of the paleoclimate could be demonstrated. In addition, the deciding location factors of the soil and the geoecological environment of the settlement as well as distortionary anthropogenic and natural superimpositions were discussed. The ecological indicator values were rearranged into concise categories in a transformation process in consideration of their usability and informative value for matters concerning prehistoric, agronomically orientated cultures and checked for climate signals. In order to guarantee traceability and the ability to clearly document results, more complex, analytically descriptive, stochastic processes were dispensed with. Therefore, the identified climate signals do not represent absolute data, but rather indirect, relative data, which permit comparative statements concerning the previous and subsequent level. 2) In the second part of the GIS examination, cartographic research was conducted on the location of the archaeological site, in each case, in accordance with the individual types of sites in the respective time levels in the geographic area. In this way, the trends of settlement dynamics and the resulting pattern of individual settlement clusters are recorded by mapping the archaeological sites. 3) The third part of the GIS is an analysis based on the Voronoi diagrams of the sites mapped as prehistoric space models, the concepts of space as time elapsed (Ducke, Kroefges 2008). In a cartographic reconstruction of settlement clusters, the relationship between the anthropogenically influenced agricultural area and extensive natural forest areas was visualised graphically. 4) As a fourth part of the GIS analysis, the use and the potential of remote sensing methods and historical cartography were studied. Finally, with the use of comparative climate research, palynology, dendrochronology, the status of glaciers, river levels and models for the calculation of the paleotemperature, the

climate signals that were produced in the context of the GIS environmental analysis could be verified. In this way, the probability and conciseness of the environmental analysis developed here and its particularly detailed chronological value were substantiated. Subsequent geoarchaeological and cultural-historical results concerning settlement and the environmental conditions of the Oder region could be clarified.

3. Results

Climate instability, since the end of the Late Iron Age, also continued still at the beginning of the Early Roman Iron Age. In Period A of the Early Roman Iron Age, humidity increased very dramatically in an extremely short period of time of only a very few decades. Cultivation of land was now possible directly on the frequently severely draining sandy soils of the area being studied, in many locations which had previously been unsuitable before. With increasing land cultivation, animal hus-

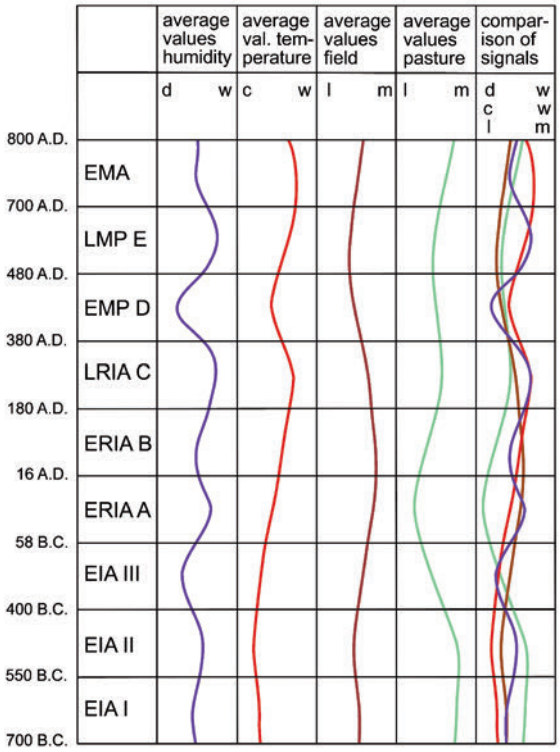


Fig. 7. The diagram on the right shows the curve interpolation of the spectra of various geological factors of the respective bar graphs (cf. fig. 6) with notes on palaeoclimatic humidity conditions from 700 BC to 800 AD (from bottom left to top left) and the relative decrease (d = dry) or increase (w = wet) indicated. On the far right is the summary of the individual curves of all palaeoclimate proxies in a single calibrated humidity curve (c = cold, w = warm; l = less, m = more). On the left is the average of the temperature curve (red) from the signals of exposure and microregional temperature (author credit; see Volkmann 2013b).

bandry became less interesting as a form of gainful economic activity. As there are only very few excavations of settlements from Period A in the region being studied, very little can be revealed about their internal structure. Comparisons with neighbouring areas reveal a great similarity to settlement findings of the subsequent Period B. Apparently, however, there was not a real break in the continuity of the Early Iron Age settlement tradition, as, on the one hand, continuous use of the burial grounds is documented and on the other hand, settlement findings indicate that they were in geographical proximity to previous settlements. However, the settlements and therefore, the population also, withdrew to the spaces that were favoured climatically and biogeographically, where a steep decline in population numbers in Period A seems to be realistic – despite methodological problems such as dating capability and questions about the lack of certainty that some individual settlements were contemporaneous as well as the varying length of the absolute time spans of the periods being compared. In the course of this, there was heavy reforestation of land that had already been developed and cultivated previously. The unstable climatic conditions of Period A caused the abandonment of and a shift in settlements and resulted in a wave of migration probably into the temporarily more clement climate of the Elbe-Havel area.

In the advanced Early Roman Iron Age (Period B) there was intensive settlement of the eastern and western Oder region by bearers of the Lübsow-Group, which was attended by the development of settlement clusters, which are clearly separated by open ground. Some of the boundaries of these settlement clusters are not only determined naturally and geographically by areas of less potential, but are also anthropogenic, where, in the second case, no disfavoured location can be identified. Furthermore, within the settlement clusters, one can detect a clear connection of the settlements to smaller waterways. The few archaeological sites from Period A are thus to be viewed as "germ cells" of this intensive land cultivation where we can proceed on the assumption that a positive development of population occurred indigenously, without a significant influx of non-stationary groups, due to good economic conditions. In the construction of the settlements some longhouses (dwellings or barns), rather square (residential) buildings and smaller storage sheds as well as a few *Grubenhäuser* (sunken huts) are documented. In principle, however, there are only a few excavations of settlements from the Early Roman Iron Age that cover a wide area.

At the beginning of the late Roman Iron Age (Period C), we note a clear break in settlement, and this is reflected in the dismantling and shifting of many settlements. On the one hand, there was a considerable

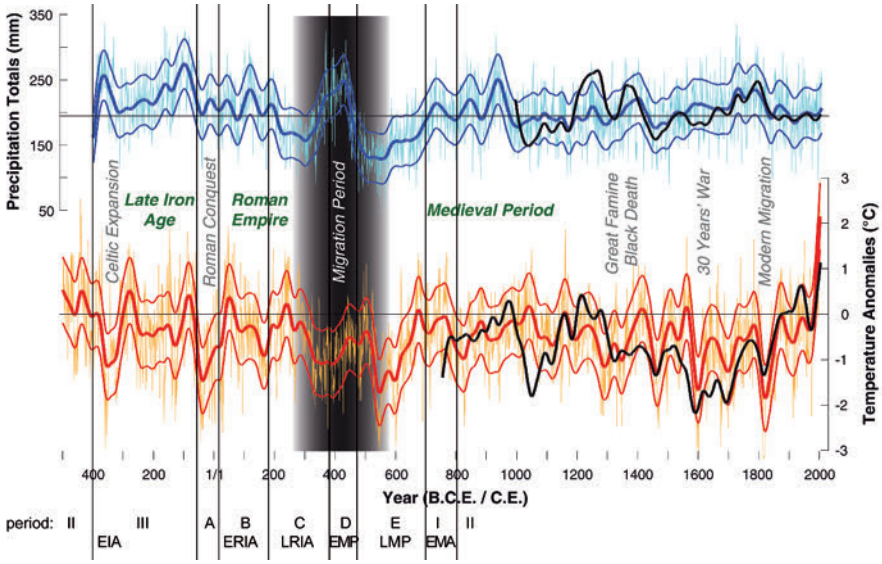


Fig. 8. Palaeoclimate humidity and temperature from the Early Iron Age to modern day. The reconstructed precipitation totals (top) and temperature anomalies (bottom) are based on actual recorded values only from 1901-2000 AD (from Büntgen *et al.* 2011; author in preparation). The thin bars show considerably oscillating annual fluctuations in precipitation and temperature derived from values of the dendrochonological calibration curve of oak in central Europe. The thick black lines show the precipitation and temperature reconstructions from independent palaeoclimate studies in Germany and Switzerland beginning in the year 1000 (top) and 750 AD (bottom). The thick gray lines represent smoothed curves of precipitation and temperature in 60-year averages; these lie within the range expressed by the thin gray lines (not including the peaks of statistical outliers in the bars). Apparently periods of demographic expansion, economic prosperity, and social stability as well as of political turmoil, cultural change, and population were in close relationship with phases of respectively stable or unstable climates. Compared to the scientific climate research, which was first published after the completion of the work upon which this article is based, agreement with the humidity and temperature changes of the Oder region as determined by the Site Catchment Analyses is apparent (fig. 7), clearly supporting the basic functioning of the methods applied here. More specifically however there are some contradictory assertions about the humid or dry phases in the Migration Period for regional and multiregional contexts. So in a direct comparison of both studies there remain partly contradictory statements as in the Early Migration Period (EMP D) for which the Oder region was in a dry phase but is depicted as humid according to the averaged data for central Europe (fig. 8). Similarly in opposition are the findings on paleoclimate of the Late Migration Period (LMP E). This disagreement is however not necessarily irreconcilable for two reasons: firstly, the respective databases are completely different. One is comprised of absolute dates derived from calibrated C14 dendrochronological data from central Europe, whereas the other is based on relative dating of archaeological finds from the Oder region. Therefore problems remain in the absolute dating of climate fluctuations in the Oder region as there are only very few scientifically measured absolute dates available. Secondly, the regional factor must also be considered, as the averaged values for all regions have been statistically smoothed in the above diagrams for central Europe. Despite these problems of scale however both studies show clear and distinct climate fluctuations during the Migration Period. Whether the dry phase occurred during the Late Roman Iron Age (LRIA C) (fig. 8) or the EMP D (fig. 7) is largely inconsequential as it is the drastic climate change that is important and which, regardless of whether humidity increased or decreased dramatically, would have deprived agrarian communities of their livelihoods and thereby been a contributing factor for migration.

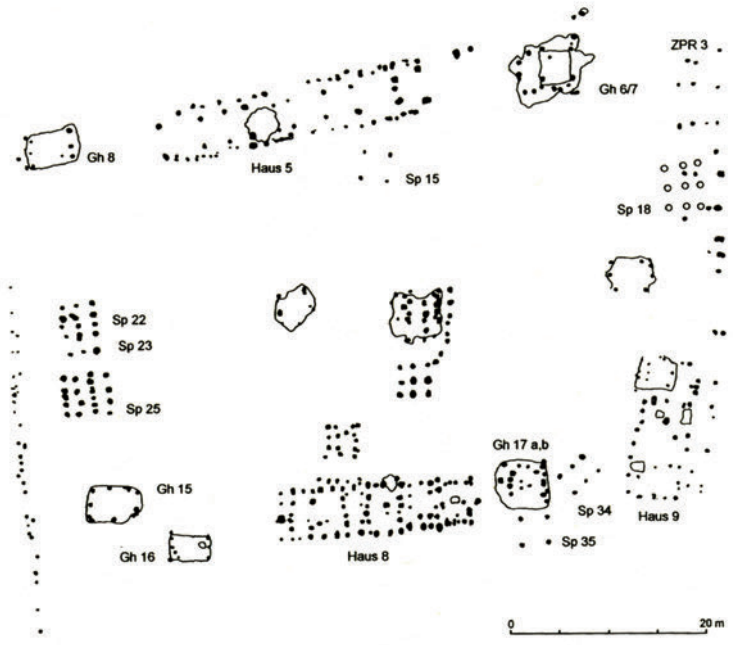


Fig. 9. Phase 3 of stages C2-D2 of the fenced farm at Herzsprung, abandoned in the late 5th century like many other settlements in the Oder region. The settlement was continuously in use from stages B2 to D2, from the late 2nd to 5th centuries AD in at least three settlement phases (Schuster 2004, p. 220, fig. 99). A very similar fenced farm complex including a longhouse and associated outbuildings is known from Vorbasse (Jutland, Denmark) and dated to the 4th to 5th centuries also through three settlement phases (Hvass 1980, pp. 168-170, fig. 3). This indicates this type of settlement was widespread in multiple regions.

influx of bearers of the Wielbark culture from the East (from Pomerania) already in the second half of the 2nd century AD, which is reflected in the relevant archaeological material, but which also can be explained, to some extent, by interactive acculturation. On the other hand, it can be verified that the events of the Marcomannic Wars also had effects on the population of the Oder region (e.g. this is obvious from the increase in imported Roman goods), so that regrouping of the population was caused due to migration and positive influx of population. The great wealth of the so-called "princely graves of the Haßleben-Leuna-Häven-Group" (Voß 1994; Bemmann, Voß 2007) in the northwest of the area being studied is founded based on plundering and mercenary expeditions, and also on a flourishing economy of trade and exchange of goods including iron, salt, slaves and natural products, such as pelts and honey from

the Oder region. In the late Roman Iron Age there is no difference that can be recognised between Period C and Period B, if construction is used as a tool of comparison, although in Period C, *Grubenhäuser* are more common than before. Presently, there are considerably more and more extensive Period C excavations. Thus, most of the settlements that were used only for a relatively short time in Period B were used for a longer time in Period C and apparently, the average size of a settlement grew considerably. Assertions about the type of settlement can also now be made. The Late Roman Iron Age settlements suggest village-like structures, where a distinction should be made between (Leube 2009, pp. 169-171):

1. Multipurpose settlements with dwelling and production areas, which are separated systematically by spaces and often arranged in a (semi-) circle around an open area.
2. Series of settlements with parallel rows of houses and /or courtyards and micro regional relief orientation of the buildings
3. Group or hamlet-like settlements with scattered huddles and unsystematically distributed agricultural buildings and functional units.
4. An individual farmyard as an isolated operating agricultural unit, simply designed, scattered farm buildings with associated outbuildings and partial fencing.

The Voronoi diagram of the Thiessen polygons of the late Roman Iron Age sites shows a clear breakup of the settlement clusters, i.e. a decrease in settlement density. It is difficult to formulate a clear assertion concerning possible migration processes, as the absolute population figures do not necessarily have to decrease, even if there is a relative reduction in the number of settlements, due to internal concentration. However, transregional comparisons and information from written sources reveal that it was extremely likely that there was a north-eastern Germanic influx into the Rhine region. If one considers the favourable moist and warm phase of Period C in the Oder region, the result was a large population surplus for groups with agrarian economies. Thus, despite a possible partial migration, a steady high population in the Oder region was not a contradiction. Interestingly, however, the importance of land cultivation as an agrarian basis increased in the course of the Roman Iron Age and animal husbandry declined. It is possible that signs of social disintegration are already appearing and that the most mobile, powerful people had a tendency to migrate more often. The late Roman Iron Age settlement clusters tie in quite clearly with those of Period B,

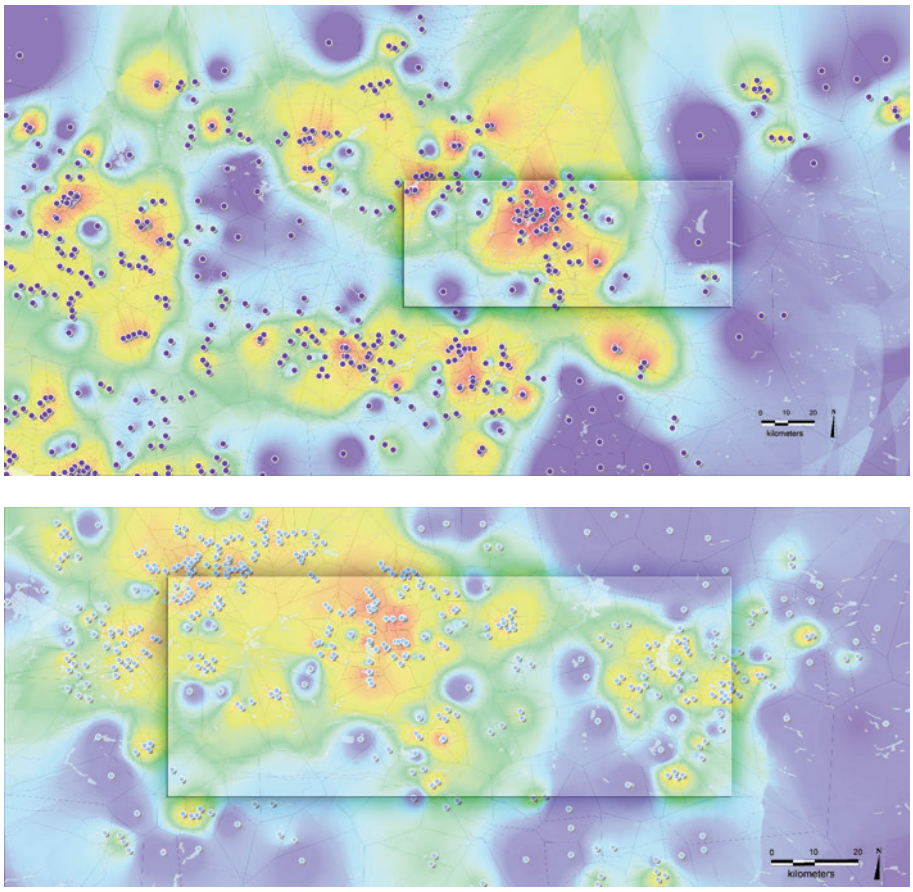


Fig. 10. Site intensity and Voronoi cells of the Oder region in comparison to the Migration Period D–E of the 5th-6th centuries (above) and the Early Middle Ages Period I of the 8th-9th centuries (below). It becomes clear that, although while on a small scale settlements were sited partly in identical areas, the broader view indicates very different regions were used either more or less intensively and this is rooted in fundamentally different spatial development concepts and uses. In the background of the map are waterways and lakes. For reference the region in focus has been marked on both sides of the Oder with a rectangle (GIS author); see the map of the Voronoi diagram of the late Roman Iron Age sites Period C in Volkmann 2013a (p. 456, fig. 247) or on web-page: http://www.germanistik.uni-wuerzburg.de/lehrstuehle/computerphilologie/mitarbeiter/volkmann/projekte/galerie2/

but they are now more clearly differentiated from each other spatially in Period C by processes of concentration.

Identification of iron production was difficult to arrange using the moist soils, which, because of their pedogenesis, come into consideration as potential small bog iron ore storage areas. In many gleys, there may be iron sediment which may disintegrate, where clear containment

Fig. 11. Among the otherwise rare finds from the Migration Period, most of which were grave goods from very artifact-poor graves, are "Niemberger brooches" of Type B from Phase D1, precisely dateable to the first quarter to the first half of the 5th century AD. Here are two well-preserved examples from Klessin (Märkisch-Oderland County) recovered from a biritual cemetery on the fluvial terrace above the Oder where they were discovered as grave goods (Kranendonk, Trier 1998, p. 54, fig. 5). Niemberger brooches are locally-produced products in *Barbaricum* and were traded far and wide within Germania but only in exceptional cases within the Roman Empire.

was not possible. As a result, no assertions could be made about this with respect to the importance of iron smelting in the Oder region in the Migration Period. Plentiful iron production such as what took place in Lower Lusatia in Periods C–D, could not be documented based on the material found on the site. Possible "ecological overexploitation" through extensive deforestation for ore mining, iron smelting, and charcoal oven could not be documented up to now on any colluvium, although, possibly, there is a methodological problem due to the subsequent intensive superimposition processes.

In the Early Migration Period (Period D), the climate worsened dramatically and weather became very cool and dry in the course of only a few decades. This resulted in very poor conditions for land cultivation and animal husbandry and in many places threatened the livelihood of the population groups engaged in subsistence agriculture. On this limited scale, this could be buffered by more intensive trade, like the piled material found on the site and documented by geomorphology on the aforementioned trade and transit routes. Settlements in locally favoured areas with a guaranteed supply of water such as kettle lakes, for example, were able to continue to exist. Spatial analysis shows a strong shrinking of the settlement clusters to remaining areas in which agricultural activity was still possible. Thus, there is a great disparity of a juxtaposition of extremely unequal small scale economic potential, which led to the wide-

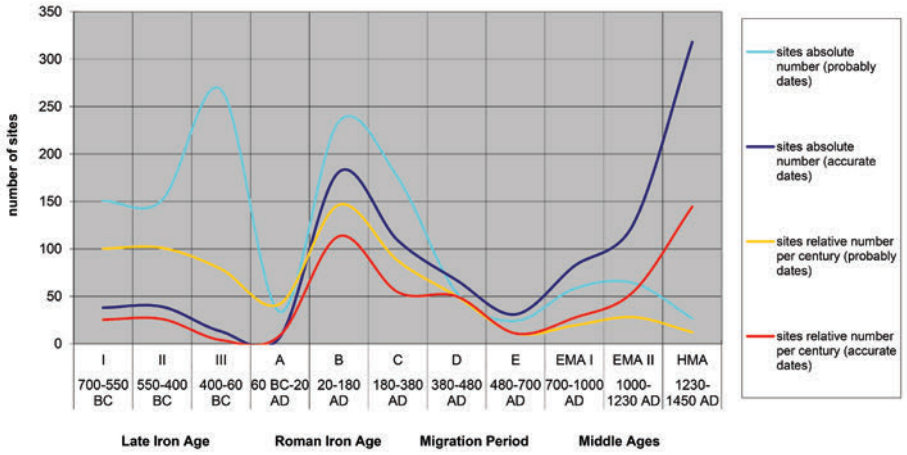


Fig. 12. Shown are the numbers of sites in the area under investigation at the Oder from the Early Iron Age (phases I-III) through the Roman Period A-C, and Migration Period D-E to the Early Middle Ages, and High Middle Ages (author credit). Here the absolute numbers of sites are represented by the two upper curves (from definite and probability dates) which refer to the phases of various durations. The two lower curves represent the relative numbers of sites (similarly from definite and probability dates) in standardized and therefore comparable time intervals of 100 years.
Like in the late Migration Period E, the widespread desettlement of the region at the beginning of the Early Roman Period A is also assumed which, in comparison with the preceding and following temporal phases, can be deemed consistent with migration. At the same time in these phases drastic climate changes are indicated (figs. 7 and 8), a contributing factor in conjunction with socioeconomic reasons which caused waves of migration from the Oder (Volkmann 2013a, pp. 214-216, figs. 228-230). This also clarifies the analysis of the periods of activity in cemeteries which, along with the settlements, were no longer in use and show no increase in numbers of individuals (see fig. 14).

spread disintegration of settlement clusters and the accompanying dismantling of settlements in the subsequent late Migration Period (Period E). Simultaneously, the areas of the extensive natural – potential forest communities that are not influenced by humans – increased greatly, and in Period E only "islands of remnant settlements" still existed in the surrounding woodlands. These types of settlements are the same as those identified since the late Roman Iron Age, but they degenerated to a very large extent. Likewise, the parallels in settlement conception are striking, but the construction of long houses – that were used by a larger settlement community – is very rare. In contrast, smaller residential buildings or barns and storage sheds are frequently in post construction as well as upright and probably log construction. They were used by smaller family alliances, often as individual hamlets.

In this way, the migration from the Oder region can be viewed as being organised into at least three main phases:

1. Already in the late Roman Iron Age there was a substantial migration in spite of the moist, warm climate of the favourable phase, which was triggered by the political weakness of the Roman Empire (the imperial crisis of the soldier emperor with the fall of the Upper Germanic and

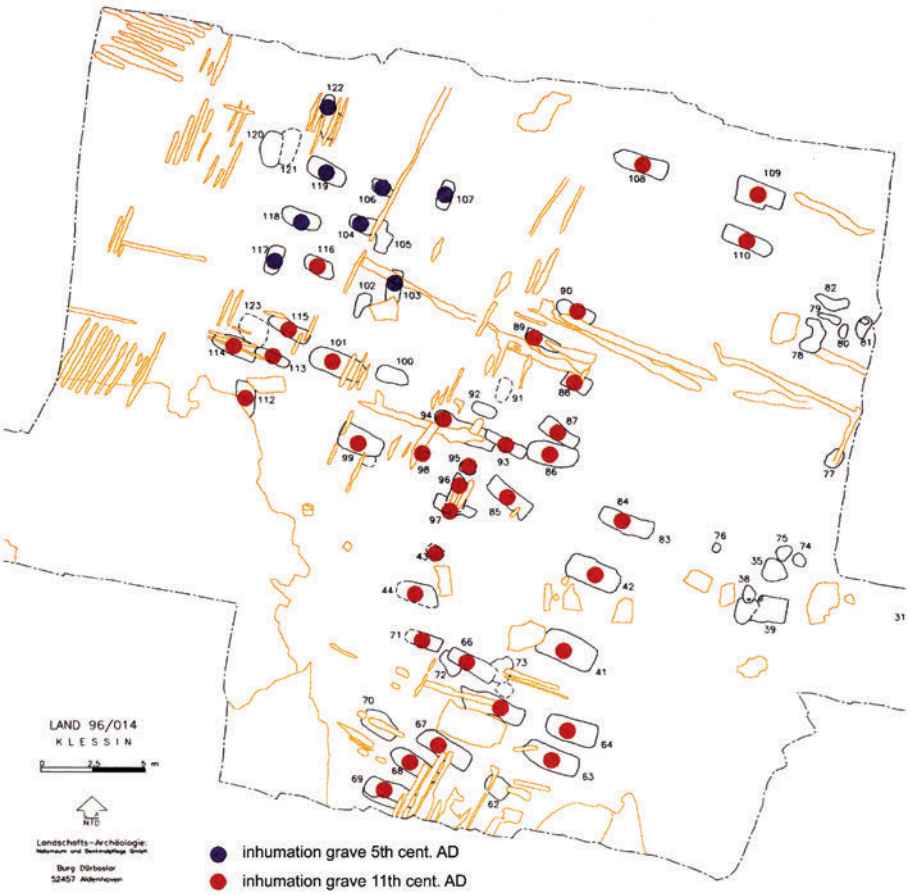


Fig. 13. The inhumations from the Migration Period (end of the 4th to middle of the 5th centuries AD) and the Early Middle Ages (11th century AD) in Klessin (Märkisch-Oderland County) were located in the same cemetery, meaning the hypothesis can be postulated that the early medieval settlers were aware of the old graves and, thus oriented, the ancient cemetery was again brought into use (Kranendonk, Trier 1998, p. 53, fig. 2). As a result however the ritual context is entirely unclear.

Rhaetian Limes in 254 AD and the subsequent withdrawal of the border in the Rhine and Danube area) in the 3rd century AD and the related opportunities for plundering. This pull factor of the Roman Empire continued as a domino effect into the eastern *Barbaricum* in the Oder area. The migration is not just to be viewed as directed towards the southwest, however, as some people turned back again in a single cycle, as individual groups with particularly valuable pieces of furniture in late burial grounds indicate (the so-called "princely grave group of the Haßleben-Leuna-Häven type").

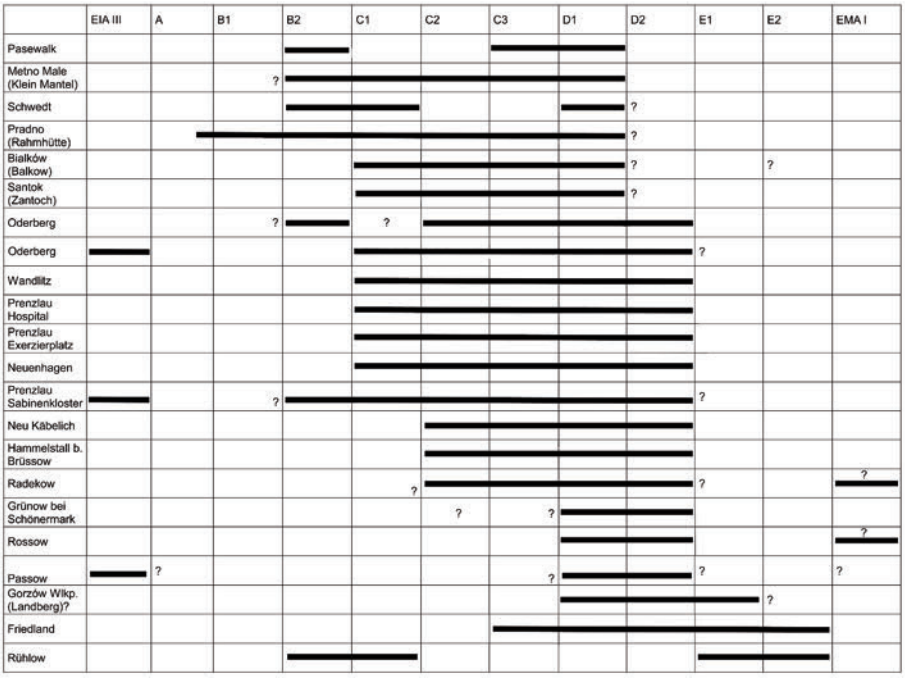
2. In the Early Migration Period, there is a dramatic worsening of the climate, which withdrew the foundation of the subsistence economy from large sections of the population which were characterized by agriculture. However, the political circumstances of the declining Roman Empire with the possibilities of seizing land and the existence of continuing opportunities to plunder increased the very intense migration of the population from the Oder, mainly from Period D2, as numerous sites from Period D1 are known. The high density of settlements in the moist Spree-Havel region, which was used as an intermediate stage in the south-westerly direction of the wave of migration is noticeable. The magnetic effect of the Roman Empire with its impressive, high-quality cultural assets in combination with the worsening climate triggered an economically orientated wave of migration, which reached its peak in the 5th century AD (due to the simultaneous, political and military weakness of the Roman Empire). Without doubt, there was a heightened potential for conflict at the peak of the drought period, as is revealed by the incursions of "Germanic peoples" into the Roman Empire.

3. Despite the sharp rise in rainfall numbers in the late Migration Period (Period E), there was no certainty that grain could be harvested in the Oder region. On the one hand, the further reaching climate instability did not facilitate this due to torrential rain followed by temporary periods of drought and, on the other hand, it must be assumed that there was an immense loss of expertise due to the preceding migration, particularly of the elite, younger and flexible sectors of the population. These problems were intensified even more by the heavy encroachment of scrub and the reforestation or partial desertification of the agricultural areas that were previously forsaken during Period D, as there was no potential labour force available for the agronomic re-cultivation of these fallow lands for labour intensive forest clearance measures (e.g. due to a positive population balance or birth surplus). Now, due to the relative in-

crease in humidity as well, the Spree-Havel area, which had proven to be a favoured settlement area during the dry phase of Period D2, was of no agronomic interest. Up until Period E2 there was an almost complete dismantling of settlements. Only in the northern part of the study area, an isolated remnant of population whose economic basis can be viewed as being linked to trade with Scandinavia to compensate for its non-productive agriculture is still also sporadically tangible in the 7th century AD (Period E3). In addition, however, all "remnants of Germanic traces" are located in only one diagonal strip of the very fertile marly soil which runs from north to south and is composed of a greatly varied biogeographical potential, which enabled flexible agriculture to be the primary source of income. These sites are on both sides of the Oder in regions where there is black earth, with the most fertile soils and above all, an optimal groundwater level is of note. In addition, outside of the area under examination, as in the Magdeburger Börde, in the Thuringian Basin (*Thüringer Becken*) or in the Wetterau, an elevated incidence of finds from Period E is noted in these basin landscapes that are moulded by a relatively dry continental climate. There is a clear connection between the spatial distribution of the black earth (Chernozems) and the late Migration Period sites. The Period E moist climatic phase is also confirmed by scientific analysis across various regions.

The time of the so called "Slavic immigration" (Early Middle Ages) can be dated around 700 AD at the earliest, although it is extremely difficult to record the earliest immigration based on the typically non-specific ceramics and the lack of other discoveries. As the existing dry phase does not represent any potentially favourable provisions for the conservation of construction timber at the beginning of the Early Middle Ages, one reason for this could be that dendrochronology and C14 dating cannot (or can barely) record this period either. This is also the case for the whole Migration Period with unstable climatic conditions and severely fluctuating groundwater levels, which strongly favour the decomposition of organic traces of settlements or artefacts that are stored in the ground such as wooden plates and organic material, and thus have a negative effect on the preservation of the find.

The known Early medieval settlements Phases I generally have an extremely disorganised heap-like structure, with numerous *Grubenhäuser*, although they can also have a formidable settlement area of a much larger settlement community. Most of the early so called "Slavic Grubenhäuser", in contrast to the so called "late Germanic" ones, have an indoor fireplace. Because of the very questionable contemporaneity of the respective settlements of the region, analyses concerning the structure



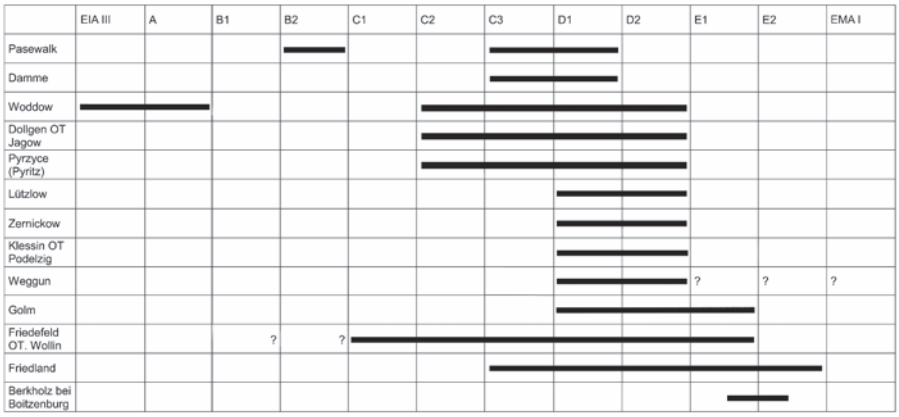


Fig. 14. Above are listed periods of activity of cremation cemeteries in use during the Migration Period in the Oder region. In addition to these buried cremated remains (as examples of the investigations), numerous inhumations from the Migration Period have also been recovered (below). Some of these inhumations are from the same cemetery as the cremation burials. These biritual cemeteries are typical for the so-called "Odergermanische Group" of the region under consideration (Volkmann 2013c).
Legend: EIA = Pre-Roman Iron Age; A–C = Roman Iron Age; D–E = Migration Period (which in some chronologies is designated Early Middle Ages); EMA = Early Middle Ages; see timeline in Volkmann 2013a, pp. 41-44 (author credit).

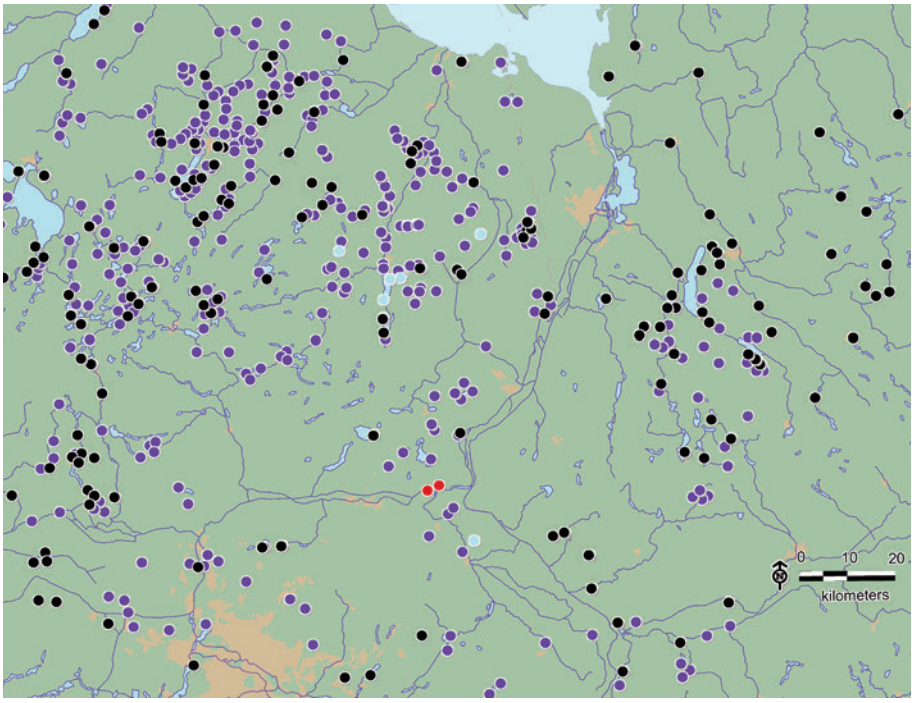


Fig. 15. Mapping of the early medieval sites phases I of the 8th to 10th centuries AD by type; GIS author (Volkmann 2013a, pp. 421-432 catalog).
Legend: light blue dot = single find/indeterminate; dark blue dot = settlement; black dot = fort; red dot = graves.

of settlements are quite hypothetical. Without doubt, intensive settlement occurred early on in the course of the 8th century AD, after only a short phase of consolidation, which can only be explained plausibly by a heavy influx of groups from the eastern Baltic hinterland (Pomerania) and the river Warta region located in the southeast, in the Wielkopolska region of today. The early land seizure occurred sporadically and was not wide-ranging in the 8th century AD. Individual landscapes, i.e. regions that were favourable to settlement, were only patrolled and were not yet developed. The latest remnant settlements are also located in the regions that favour settlement of the earliest land seizure without there inevitably having to be real contact between the two groups – but there could have been low-level contact. The Early Middle Ages phases I settlement space pattern of the Thiessen polygons of the Voronoi diagram seems to tie in with the Roman Iron Age model of spatially separated settlement clusters, which are not only determined by their biogeographical potential, but some of which were created artificially by humans, as

deliberately delineated units of space. Here, group units of alliances from a tribal society are probably reflected, as settlement clusters indicated efficient "space administration units", which simultaneously had internal cohesion and a clear external boundary. The great similarity in the design for space improvement cannot be explained exclusively by the similar farming methods of Late Migration Period and Early Middle Ages peoples and the almost identical location factors required for settlements. It could possibly be a question of processes of a western-orientated acculturation in the course of the expansion of the Merovingian Empire to the Northeast, where (direct or indirect) contacts undeniably existed through trade and communication. However, there are also some tangible deviations from the Late Migration Period concept of space. Thus, particularly lakeside and promontory locations become more attractive and this is connected to a heightened need for the protection of the locations, which were frequently selected for their fortification aspects. In comparison to the Migration Period, both land cultivation and animal husbandry become much more important and similar to that of the late Roman Iron Age (Period C).

A previous German-Polish research project (Volkmann 2007) explored issues concerning the movements of the Slavic population which were related to the complex, multilayered and regionally varied nature of Medieval

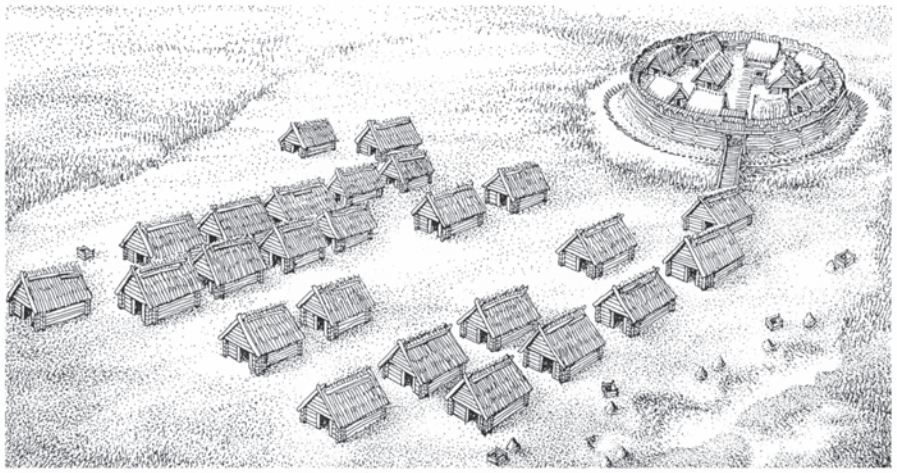


Fig. 16. Reconstruction drawing of an excavated fort with outbuilding settlement of the Early Middle Ages near Tornow in Lower Lusatia is a typical example of a settlement complex in the 10th century (Henning 1991, Abb. 7).

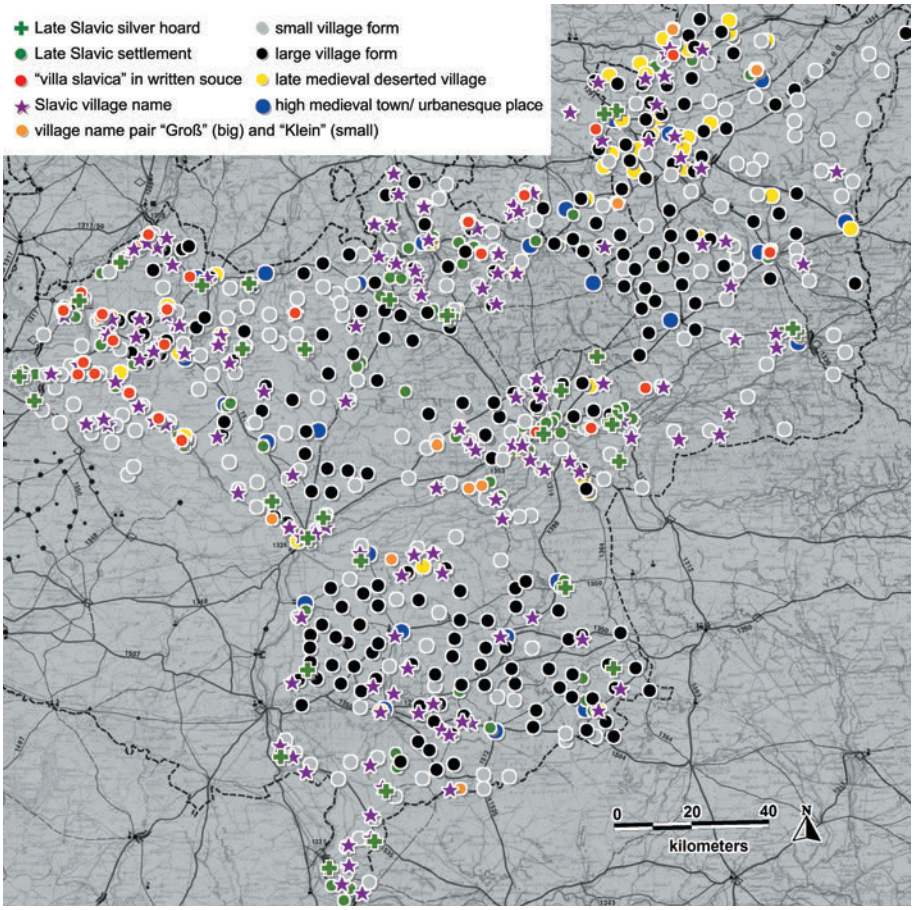


Fig. 17. Transport infrastructure network, places of the Late Middle Ages (LMA), and finding sites of the Early (Slavic) Middle Ages (EMA) in *provincia trans Oderam* around 1230 AD east of river Oder. Mapped are the information of the written sources (Volkmann 2006 and 2007) and the archive of the Brandenburgisches Landesamt für Denkmalpflege (basic map: Heinrich 1980; GIS: A. Volkmann).

land development processes in the medieval "provincia trans Oderam" between river Oder and Warthe (see fig. 17). The study was also interdisciplinary and involved the fields of settlement archaeology, geoarchaeology, regional history, historical geography and dendrochronology. To this end, a comprehensive archaeological and geographical database was established within the framework of a Geographic Information System (GIS). Through the subsequent correlation of thematic maps, processes of land development can be illustrated in the form of spatial analysis.

In the course of territorial acquisition during the High Middle Ages, existing Late Slavic settlement areas in many places were subject to systematic infrastructural annexation and settlement. The Slavic population was strongly integrated into these processes and, for the time being, was able to retain its own cultural identity. The process of concentration with respect to the establishment of permanent villages in the High and Late Middle Ages often resulted in the coexistence of old Slavic settlers and new settlers from the western territories of the Holy German Empire; evidence also exists of ethnic separation within jointly occupied settlements. Nevertheless, as the joint settlement of towns and villages progressed, an acculturation of the various ethnic groups, such as Flemings, Frisians, Franks, Saxons and Slavs occurred leading to the emergence of a new and independent identity.

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