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Predictive archaeological modelling in Somogy county

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FEKETE, CS.: *Predictive archaeological modelling in Somogy county.*
Abstract: In this paper a GIS model, based on the physical parameters of the geographical enviroment of Somogy county archaeological sites, is described.

Keywords: GIS, terrain, watercourse, relief

Introduction

One of the main challenges of archaeology is to define the characteristic geographical enviroment, where the sites could be predicted. The huge investments (motorways, junctions), being done for more than a decade, have the proceeds of systematic archaeological research of extensive areas. Its very first step is to explore the potential sites. The insurmountable obstacle of fieldwalking is the plenty of time that needed. Based on the topographical features of a well-defined geographical unit, there could be tightened the area, where sites could be located. Hence, these subjective experiences have not been systematize geometricaly.

The spatial appearance of the sites has ceratin rules. For example, the fortresses were built on well-defendable location, protected by natural features (steep slope, river, etc.), as well as the middle-age churches were located on the highest spot of the former villages. This fact influences the aspect of the settlements (location of the houses and the cemetary). In this study I try to collect and explain the geometrical principles of the location of the archaeological sites.

The goal of the study is to create a predictive archaeological model, that helps to define the areas, where the sites could be presumed.

The elements of the model are some measurable physical parameters of a well-defined sample area:

1. the distance from watercourses
2. the aspect of the terrain
3. the slope of the terrain
4. soil types

All human settlement depends on water. The existence of civilizations has been based on the posession and efficient utilization of waterflows. It is obvious that the sites have been attached to the streams and rivers. They are especially abundant where the different branches of flows are met. The features of the terrain have the same effect on the development of the sites. The dwelling and economical objects were built on such adventageous surface, that had good microclimatic conditions. The type of the soil is also a good indicator of the location of the sites. Some types offer better conditions of settling and agriculture, while others make it impossible.

The universal use of the model is uncertain, because the different geographical environments offer different alternatives to dwell.[1]

The sites included into the modelling are restricted to the settlements, because the cemetaries could hardly be identified by the surface finds and their location had different logic.

I would like to emphasize that involving GIS into the topographical research does not mean the neglecting of fieldwalking. GIS is an alternative solution to help field-survey.

Choosing the sample and control area

The studied area must be well-searched, because this fact has an important effect on the accuracy of the model. Another criteria is to choose such an area, whose physical features are heterogeneous, in order to part the cathegories of site and non-site. The ideal area has diverse features of the terrain, varied water output and it is richly spiced with watercourses. The size of the area is also an important factor. It should be small enough in order to be able to make the model and, on the other hand, it should be large enough to make sure the model is reliable.

Making the model I chose the villages of Somogyjád, Bodrog, Somogyfajsz, Csombárd, and Pusztakovácsi in Somogy county. The area was topographicly searched by fieldwalking between 1999 and 2004, led by Dénes Jankovich-Bésán. The control area was determined by two guidelines: it must had the same geographical environment as the sample area did and it also must had been searched in order to check the authenticity of the model. This solution is not as smart as if I chose a „virgin" area, but field-survey could not have been done. The control area includes the western part of Bodrog, the northern part of Somogyfajsz and the eastern part of Pusztakovácsi.

On the territory of these five settlements, the sandy area of Inner-Somogy and the hills of Outer-Somogy meet along the Pogány-víz and the Hetes watershed. Our territory is bordered from the north by the longest and broadest ridge of the hills of Outer-Somogy (Gamási–hát). Its southern-eastern part stretches over the

[1] There are lowlander, hilly and mountain environment, that need different approach to use the model elements.

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loessy area of Southern Outer-Somogy, while its western part ranges into the silty area of Inner-Somogy.[2]

The waterparting of the Kapos and the Balaton is nearly N-S directed here. On the eastern part of the inspected territory the surface consists of strongly segmented meridional ridges that rise towards north. They are segmented by emphasised stream basins, the Deseda and its side-branches. The watershed can be kilometres wide at certain places, while elswhere it only extends to a few hundred metres. It is a lower, less segmented territory with a thick loess cover, which is well outlined by the lack of archaeological sites as well. West of it, the valley of the Pogány-víz can be found, which is another strongly segmented region with densely distributed stream basins.[3]

The territory of Outer-Somogy is covered by loessy soils that developed during the last Ice Age, which are only sporadically covered by brown forest soils of a chernozem character. The main soil type of the vast, alluvial cone of Inner-Somogy and the sandy valleys of Outer-Somogy is the brown forest soil mixed with clay, evolved on sand. The area was mostly covered with beech and oak before the significant human activity.[4]

Field-survey

The National Office of Cultural Herritage and the Somogy County Museum Archaeology Department launched a joint project in the spring of 1999 with the purpose of the complex exploration of the environment of the iron metallurgical sites in Somogy county with fieldwalkings. As the purpose of the field work was to authenticate the sites in the course of systematic fieldwalking and to explore every pontential new sites, the extensive method was chosen. The available areas of the fields of the individual villages were inspected at least once, and fairly often repeated it more times. Regrettably, significant territories remained unattainable during the five-year-research, because they were covered and not ploughed. Initially we chose the systematic method of field-walking, that meant each approachable field was inspected with the participants walking 50 meters from one another. After knowing the geographical characters of the region this method was given up and we only surveyed systematicly the areas, that seemed to be suitable for settlements and took samples from the rest of the territories.[5]

A short archaeological introduction of the inspected area

Drawing the prehistoric cultural picture is the hardest task because the number of the sites that cannot certainly be associated with any of the cultures is extremely high. Hence, it is sure that the density of the prehistoric sites is diverse, which matches the above-mentioned features of the natural environment: the greatest density was found where the largest open territories could be observed (Somogyjád), while the lowest density appeared where extensive forests cover the area even to date (Somogyfajsz, Pusztakovácsi).

The conclusions of the settlement history of the Celtic-Roman Age uncover deeper connections. Farmstead-like units of both dwelling and economic functions were the basic constituents of the celtic settlements. They were either independent units or stood in a cluster forming a rural settlement (vici). In our region, settlements of this character appeared in a string along the stream valleys. The farmsteads stood at a few hundred metres or, maximum, a few kilometres apart from each other. Sherds could be collected in the area of 50–200 m of the one-time manors.

The Romans deliberetly chose the best fields and it did not settle on territories on poor, barren sandy soils. The results of the field survey support this observation since only two sites could be registered on the sandy territory west of Bodrog village.

The number of the sites dated from the Migration Period is the lowest. The Avar sites were mostly found at the feet of the N-S extended hill ranges, on the banks of watercourses or next to springs.

Huge number of Middle Age sites were found on the inspected territory. Relatively few of them contained finds from the early Árpádian Period, in contrast with this many sites were contained finds from the later phases of the Middle Ages. They could be found everywhere where the environment was suitable for settlements, which suggests that there were still many temporary, scattered settlements, which occured not only around villages with churches but everywhere.

It is worth to mention the iron metallurgical sites that can be found on the banks of shallow streams or springs, where meadow ore can the easiest be found. Another important condition was the proximity of forests where raw material could be obtained for charcoal. Practically the entire Somogy county met these demands in the Middle Ages.[6]

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2 This territory – is known as Southern-Outer-Somogy depression – used to have a dipped basin-like surface that can hardly be recognized because it is covered by thick loessy soil accumulated on the surface, which towers above the floodplain of the river Kapos nowadays.

3 Szilárd 1967, 57–58, 93–98, 100–104.

4 Pécsi 1981, 254.

5 It is an important fact that the extension of the sites, identified by surface finds, do not surely correspond with the extension identified by a possible excavation. The extension on the surface can become distorted because of ploughing and natural erosion. However, this feature is not so significant. According to the experiences of the M0 motorway fieldwalking and preliminary excavations, in the case of the 80% of the sites their extensions determined first on the surface and than by excavation were corresponded with each other. (By the oral message of Edit Tari)

6 Fekete–Honti–Horváth–Jankovich–Korom–Költő 2005, 94–105.

Used softwares

I used fGIS (forestry GIS) to digitize and edit vector data and represent raster result maps. It is a free, compact shape file editing software and has the advantage of its small size and portability.[7]

I used GRASS 6.0 (Geographic Resources Analysis Support System) to transform the different raster data (military surveys, topographical maps) into projection and create the releif map and the terrain model. This software is also free, open source, its updated version can be downloaded from the Internet.[8]

Used data and maps

I used the VIII/23 and VIII/24 sections from the First Military Survey and the XXVI/59, 60 and the XXVII/59, 60 sections from the Second Military Survey.

As a soil map I used the map on the scale of 250 metres to the centimetre of Kreybig's map. This map is the only one of its kind, which is large scale and covers the whole territory of Hungary to date. The relevant section, transformed into the EOV projection, was given by RISSAC[9] GIS Laboratory.

As topographical map I used the following sections from the EOV projection: 23-121, 23-122, 33-332, 33-334, 33-343 and 33-344.

Steps of defining the inhabitable areas

Parameterizing of EOV projection could not directly be carried out in GRASS because the geodesic datum and the ellipsoid of EOV cannot be found on the parameterizing list. I used the Swiss Oblic Mercator projection (its ellipsoid: grs 67), which is the most similar to EOV. Its rotating and shoving parametres compared to WGS84 was given according to the parametres of HD72 geodesian datum (dX: +57, dY: -70, dZ: -9).[10]

The very first step of GIS work was to transform the different maps into the same (EOV) projection. After digitizing the EOV sections I georeferred them with the help of the coordinate-pairs of the four sections' corners. The fitting of the EOV sections is about 1 metre. The military survey's maps were fitted into projection with the help of common joining points that can be found on both the EOV and the old military maps. The fitting of the First Military Survey was not as accurate as in case of the Second Military Survey, because the first one has no projection. The first one was transformed with about 100 metres error, while the later one was transformed with less than 50 metres error.

As for the vector data, I started digitizing the contour lines of the topographic map. Where the model needed higher accuracy I digitized the contours by two metres. In some cases – because of the altitude data was not given or could not be deduced -there was not enough contour data so I digitized every single lines whose height data was known. In those cases, where this accuracy was not needed, the contour lines were digitized by four-five metres. The altitude value of some contour lines was not integer, in these cases their *z* data were rounded. (e.g. 132,5 → 133)

The physical parametres of the sample area was defined that the deduced raster elements could cover the sites' polygons in the largest possible percentage.

At first an aspect map of the sample area (Figure 1.) was created with the help of the terrain model (Figure 2.). The northern direction was determined between 315° and 45°, the eastern between 45° and 135 °, the southern between 135° and 225° and the western between 225° and 315°. Most of the sites of the sample area (23 sites entirely, 31 partly) can be found on the terrain with southern-eastern aspect, while only 6 can be discovered on norhern-western aspect. More than 75% of the sites can be recognized and identified with their parts falling to southern-eastern aspect.

The next step was to measure the distance between the sites and the watercourses. At first I specified the distance from living waters where can be hardly found any sites out of. The buffer zone of the streams, where all sites can be identified, is approximately 600 metres. This distance would set too large limits to the indicated area, so I chose such a buffer zone, where not all of the sites were within but most of them. The distance of 300-400 metres seems to suit the model's requirements. 44 out of 60 sites can be found within the 300 metres buffer zone with their entire area. 11 sites are partly located within this buffer and there are only 5 sites whose entire area are out of this range. 92% of the sites can be identified within this range if those sites are also considered to be recognizeable that are only with their parts within the 300-metre-buffer. Without these sites the probability of the sites being identified is still 75%.

At second I determined the distance from living waters where no sites can be found within. This zone is approximately 60-80 metres from the watercourses, which is equal to the humid, reedy, marshy region that, in fact, is the border of the flood area. Within this zone sites could hardly be located. I chose the 70-metre-buffer that almost entirely free from sites. Only one site can be found within this distance with its entire area and there are merely 3 sites that are located within this zone with their area bigger than their half. Most of the sites (more than 90%) are out of the 70-metre-buffer.[11] (Figure 3.)

Afterwards I created a map of the slope cathegories that was generated from the terrain model. (Figure 4.) Six different cathegories were distinguished: 0-3%,

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7 The software was originally developed for the Wisconsin State Forestry handling natural resource data.

8 Originally developed by the U.S. Army Construction Engineering Research Laboratories as a tool for land management and environmental planning by the military.

9 Research Institute For Soil Science And Agricultural Chemistry Of The Hungarian Academy Of Sciences

10 The projection parametres was determined by Gábor Tímár. (TÍMÁR 2003, http://sas2.elte.hu/tg/hd72.htm)

11 Only a few sites are located within 70 metres with very little parts. They do not influence the formation of the model.

3-6%, 6-9%, 9-12%, 12-15% and above 15%. Most of the sites are located on the slope that are less than 12%. None of the sites can be found on the slope above 12% with their whole territory and there are only 7 sites that are partly situated there.

At the end I digitized some elements of the soil map. Because of the scale of 250 metres to the centimetre, the soil map does not fit into the topographical map with larger scale. I only digitized the polygons of the alluvial deposit that typical of the inundation area, which surprisingly fit into the 70-metre-bufferzone measured from the watercourses.[12] (Figure 5.) The data of the soil map was only used in part for the model because of the already mentioned inaccuracy of the map and partly because the sites do not seem to prefer only one or some soil type. Less than 2/3 of the sites can be found on the same soil environment. This result does not make the whole soil map suitable to be integrated into the model, hence its conclusions are detailed in the next chapter.[13]

The final result map indicates the areas that has southern-eastern aspect, that are within 300 metres, but out of 70 metres, measured from the waterflows and that can be found on the slope less than 12%. (Figure 6.)

The probability model, based on the archaeological sites of the sample area and the physical parametres of the geographical environment, covers the whole territory of 14 and partly 33 sites. 2 out of the 47 modelled sites are hardly recognizable from their parts affected by the model. Whereby there are 45 sites (out of 60) on the sample area that identifiable fit into the predicted territory with archaeological interest. This means 75% probability. (Table 4.)

The conclusions of resctricting the areas with archaeological interest

Some regularity can be drawn from the analysis of the location of the archaeological sites. Much more sites can be found on the surface with southern-eastern aspect, which means that humans preferred the windless, sunny surfaces to settle down.[14] This fact can be explained by the dominant wind direction of eastern Transdanubia[15] and the N-S course of the valleys of Somogy county. Most of the sites, located on northern-western aspect terrain have finds from more ages, but almost all of them has Middle Age surface finds (Árpádian Period, late Middle Ages). These sites appear to group in a comparatively confined area, which could possess favourable settling conditions despite of its aspect.

Determining the distance from the watercourses needed a strongly compromised solution. Neither the 70-metre-buffer that reflects to the humid, marshy region, nor the 300-metre-buffer that reflects to the maximum distance from the watercourses, cannot consider adequate answers. The first one seems to be more appropriate because its distance equals to the uninhabited zone, marked by the alluvial deposit of the floodplain. It is more a hard task to determine the zone where is no site out of. Some of the sites are, partly or entirely, out of the 300-metre-zone, still this is the best possible solution to narrow the inhabited area. There is no point in considering a distance less than 300 metres, because of the increasing loss of the sites that would have been suffered. I created a map with 400-metre-buffer, which produced a hardly better result, but there were significantly larger areas without sites too. A few of the sites that are out of the 300-metre-zone (Bodrog 8., 9., 10.) might have slipped out of the predicted area because of the defective hydrographical data. According to the observation of fieldwalking there used to be a spring in this territory. Its former existence can be proved by a group of willow that hides in a wet depression. This feature is also marked on the topographical map. Analysing the releif map confirms this conclusion: a small and deep basin connects to the valley of Pogány-völgyi-víz from the NE. It is an important common denominator of these 3 sites (and one more that situates NE direction from them) that all of them possess remains of metallurgical dross, which is the unambiguous evidence of iron metallurgy. The 4 sites of the sample area, which are away from watercourses have only scattered finds, mostly from the Middle Ages. These sites could be dwelled for short period and used only as temporary accomodation, so the proximity of the watersupply was not needed for their development.

Between the slope of the terrain and the inhabitable areas have a strong connection. After some pouring rain mud runs down on the surface, whose slope above 12%. This is the area that is unsuitable for settlements because the sides of the valleys, which rise above the more or less flat floodplain of the streams, are the most sloping.

There are areas that are fit for settling in every respect, but no sites can be found on them presumeably because of the significant slope.

The soil map classifies the soil types according to their chemical reaction, water accomodation and water content attributes, so did I. (Table 3.)

As for the reaction attribute, 34 sites of the sample area can be found on slightly acidic soil, 16 on neutral soil, 1 on strongly acid, calciferous soil, while 6 on the alluvial deposit of the floodplain. The chemical reaction of the soil has a strong effect on plants and it determines the variety of them. The neutral reaction offers the best options for the nutrition income of plants and the microorganisms living in the soil.[16] The chemical reaction of

[12] The process of the soil formation was prevented by the periodically repeating floods and the their sediment.

[13] The statistical distribution of the parametres can be seen in Table 1.

[14] Outer-Somogy has the favourable condition, related to the character of the terrain, that its long, sloping surfaces with southern aspect are windless.

[15] One of the most significant feature of Hungary's wind climate is that the dominant wind directions are affected by the Alps and the Carpathians. The dominant wind courses of western and middle Hungary are northern and northeastern. In: PÉCZELY 1979, 263.

[16] STEFANOVITS 1975, 100–101.

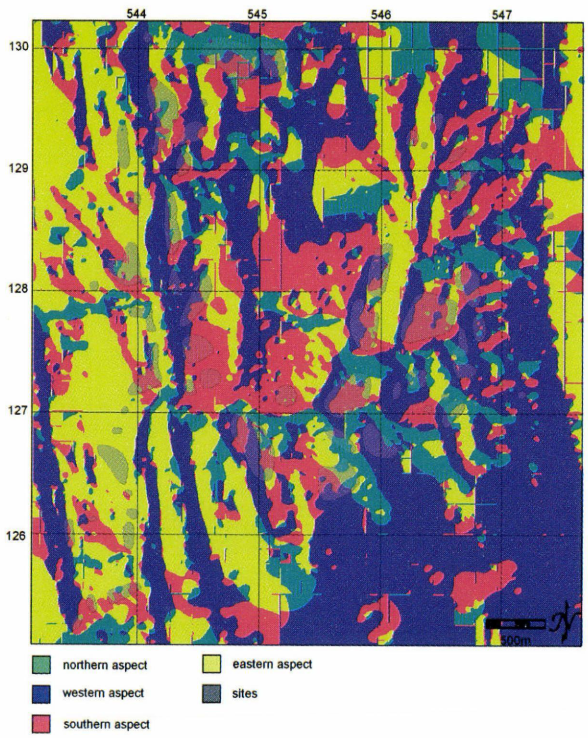

Fig. 1: The archaeological sites and the aspect conditions of the sample area

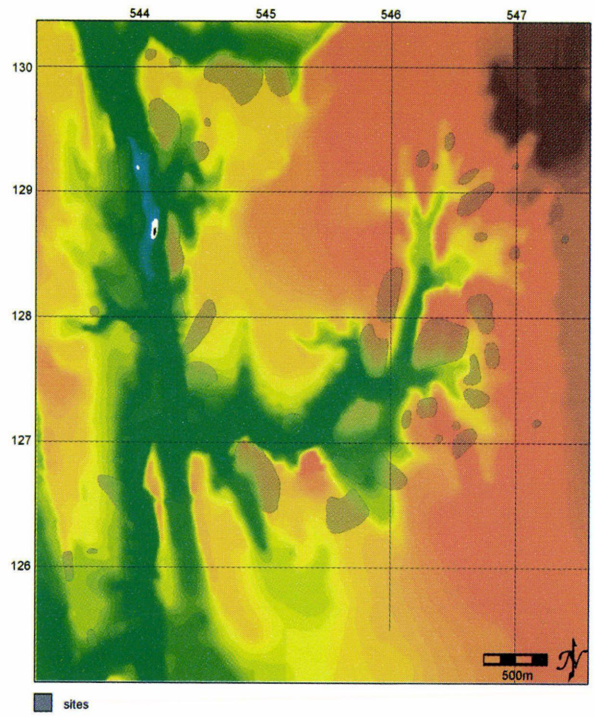

Fig. 2: The archaeological sites and the terrain model of the sample area

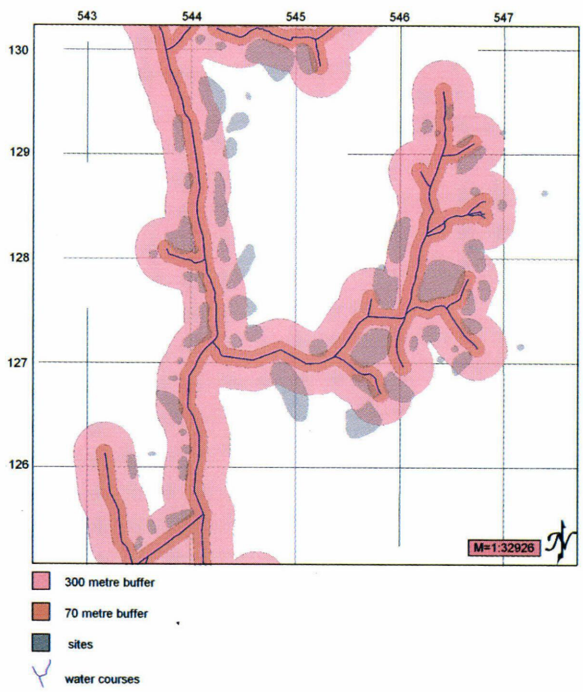

Fig. 3: Relationship of the watercourses and the archaeological sites

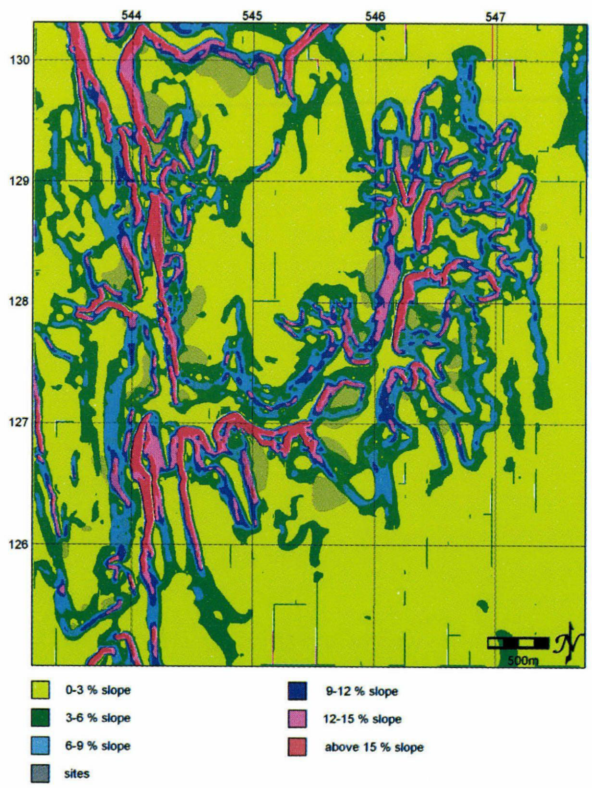

Fig. 4: Relationship of the slope of the terrain and the archaeological sites

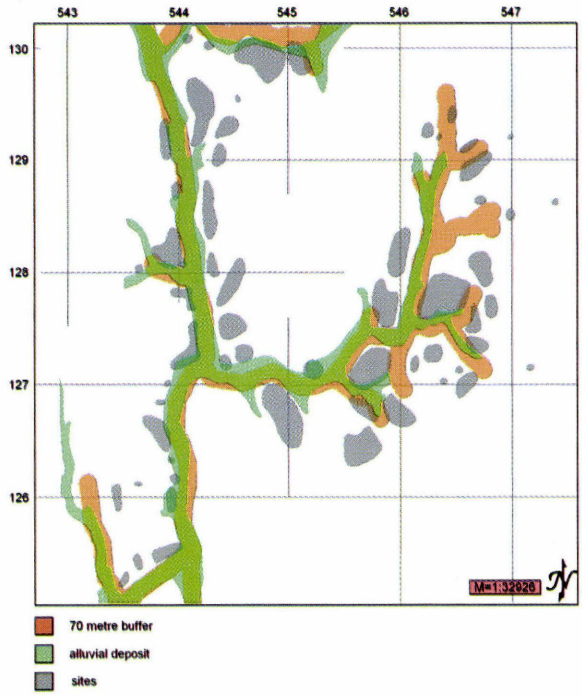

Fig. 5: The overlaping of the alluvial sediment soil and the 70-metre-buffer in the sample area

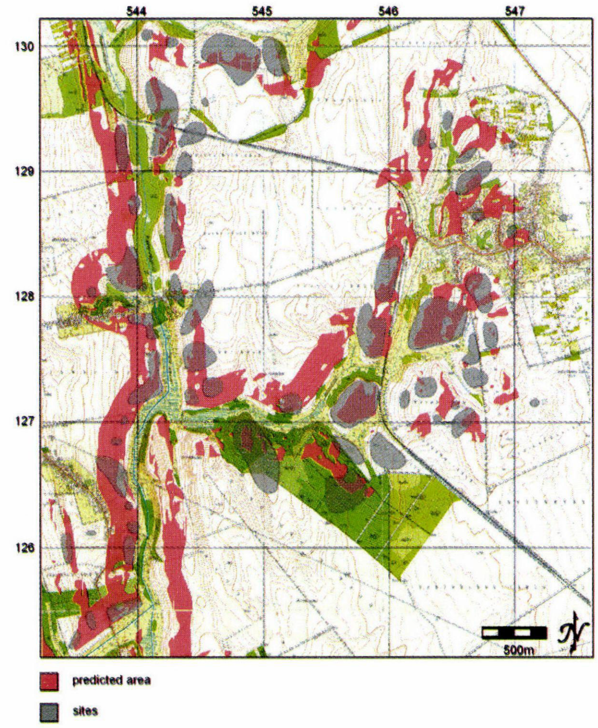

Fig. 6: Relationship of the archaeological sites and the predicted inhabitable zone in the sample area

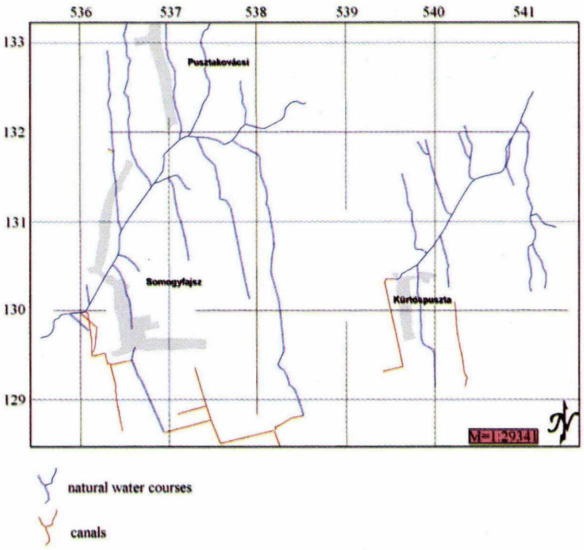

Fig. 7: Natural and artificial parts of the watercourses of the control area

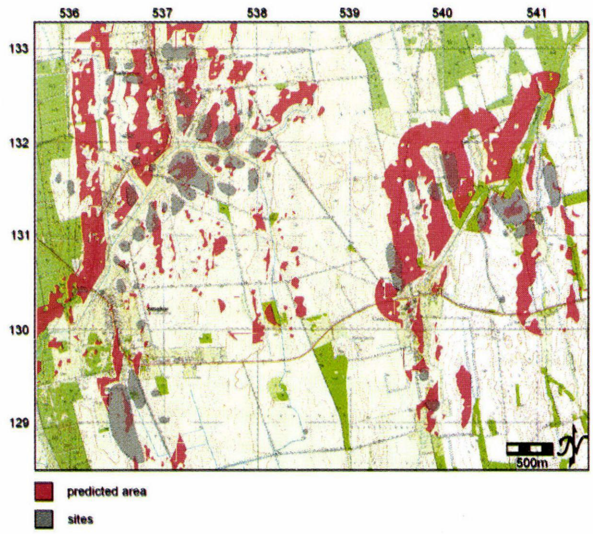

Fig. 8: Relationship of the archaeological sites and the predicted inhabitable zone in the control area

the soil is an important standard of value, which could be vital for the settled, farmer communities. The preference of the slightly acid and neutral soils shows that most of the settlements were developed on surfaces or next to them that are siutable for agriculture.

As for the physical attributes of the soil, 35 sites of the sample area can be found on the soil with strong water driving and high water content ability, 9 sites are on the soil with high water content and good water driving ability, while 7 sites are on the soil with very strong water driving and small water content ability.[17] The soil with good water content and strong accomodation ability (e.g. meadow chernozem) has good ability to supply nutrients.[18] Permanent vegetation cannot settle on the soil with very strong accomodation and slightly water content ability (e.g. shifting sands). Their ability to supply nutrients is poor, they fast swallow water and they tend to be dry out.[19] It is not surprising that there are hardly any sites in this kind of soil environment in contrast with the soil with good nutrient and water supply.

Afterall the next conclusion can be drawn: most of the sites are on the soil type with slightly acid reaction, strong water driving and average water content ability. A small but significant group of the sites are located on neutral reaction soil with strong water driving ability. The sites of the later soil type group north and south of the inner village of Somogyjád. The same type of soil on the western part of the sample area seems to be less preferred, whatsmore the sites can be found – at least as the accuracy of the soil map allows – on slightly acid surface that is got wedged in the neutral reaction patches of soil. There are hardly any sites on the strongly acid soil and on the high water content soil with poor water driving ability, as well as on the sediment of the flood area neither.

The advantages and weaknesses of the model

The benefits of the model are considerable. The predicted area of the sites are almost perfectly modelled in some cases. Both their extension and their direction suit the polygons of the sites. These areas allways rise from their environment as islands or peninsulas, so they must have had favorable aptitudes to live on. In some cases those ridges of hills can be identified, where relatively many sites are in narrow, encompassable bands. These bands nicely indicate the regularity of the sites' alignment. The sites are stitched on the watercourses of the valleys with NS direction that peculiar to the Somogy-hilly country. There are some sites, whose territory hardly touch the predicted inhabitable zone, however the model still provides sufficient data to clear them up. There are some weaknesses of the model, as well. The first one is that only one physical parameter would be needed for the predicting of the sites: the distance from the watercourses. This factor is the most important one that determine the positioning of the sites.[20]

Another weakness is that the model predicts such areas – in not significant ratio – that are not justified by field data. The model makes some sites possible in a long band, in the Újfalu-dűlő of the eastern part of Somogyjád, on the eastern bank of the Pogány-völgyi-víz. This area, however, is lack of sites entirely. The same observation can be made on the northwestern bank of the Bodonkúti-árok, where there is no human settlements despite the apparently favourable conditions.

Checking the model on the control area

I chose such an area that had territories, which were rich in sites and also those that were without them. The final result is qualified by not only the most precise modelling of the sites but the predicting of the „siteless" areas, as well. The control area consists of two condensations of sites and a no man's land between them, which makes it suitable for checking the model built on the physical parametres of the sample area.

I made the same steps as in the case of the sample area with the exception that the geographycal position of the sites (71) was not included because their predicting was my aim. (Table 2.) I had to face some problems that did not turn up on the sample area, when the bufferzone of the watercourses were assigned. The Bontakeszi-árok, the Fajszi-patak and their sidebranches are densely shot with different drains. These canals are apparantly used for watering those agricultural parcels that were away from natural waters. It is very important to make difference between the natural and the artificial beds because the ditches, drained in the last few decades, did not have the same role as the watercourses used to have. One part of the drains seems to be easily identifiable because they are straight or rectangular. Another part of the drains cannot be squarely distinguished from the natural waters. In this case the military surveys and the relief model were used. With the help of the Second Military Survey I determined those parts of the beds that were made artificially. After a thorough examination some drain-like beds coul be also distinguished on the military survey. Those places, where water cannot be flown under natural circumstances, can be easily identified with the help of the terrain model. These drains were not included into the assignment of the water network of the control area. (Figure 7.)

Result of the model on the control area

If we consider only statistical viewpoints, then the priority of the southern-eastern aspect of the sample area cannot be confirmed on the control area. While 65% of the sites (with their whole or larger territory) of the sample area are located on southern-eastern aspect surface, till

[17] A couple of sites are located on forest soil and in the inner village.

[18] Stefanovits 1975, 212.

[19] Stefanovits 1975, 182.

[20] It is worth to mention that some errors could occur during the digitalizing of the hydrographic data. There could be tiny sidebranches or rills where the maps do not indicate them.

then less than half of the sites of the control area can be observed on the same aspect. The later result is more adverse than in the case of the sample area, but the majority of the sites can be identified on the control area, as well. Furthermore, the number of those sites whose territory does not touch southern-eastern aspect surface are limited on both areas: 10% and 12%. It is also noteworthy that on the vast area with relatively small difference of altitude and decisively western aspect, situated between the Fajszi-patak and the Bontakeszi-árok, there are no sites predicted by the model.

The 300-metre-bufferzone measured from the watercourses is almost statutory. 93% of the sites are located within 300 metres on the control area. There are only 5 sites (Somogyfajsz 5, 22, 23 and Pusztakovácsi 49, 50) that are out of this buffer. Their common feature is, as in the case of the sample area, that they possess very sporadic finds. It indicates that they were dwelled for a short period of time. In the case of the site of Somogyfajsz 5 is worth to mention that huge number of metallurgical dross was found, that indicates the presence of iron metallurgy. This site is situated on the eastern bank of an artificial drain, which was not included into the survey of the water network. This fact was proved by a fieldwalking observation: this site can be found next to an oval, flowless cavity.

I mentioned the importance of watersources more times in this study. This fact is also confirmed by the measuring data.

Determining the distance from living waters where no sites can be found within was not as unambiguous as in the case of the sample area. The sites are closer to the streams in the case of Somogyfajsz and Pusztakovácsi.[21] The common feature of the sites that are within the 70-metre-buffer (Pusztakovácsi 6, 16, 22, 28 and Somogyfajsz 11) is that all of them are small and have only sporadic finds. Nevertheless, these sites can be identified during a contingent field-survey, so the inaccuracy of this model element is negligible.

As far as the slope of the terrain is concerned there is a definite rule, just as in the case of the sample area: the areas above 12% slope are practically uninhabited, only a few sites are partly affected. 79% of the sites of the control area are located on the slope less than 12% with their whole territory.

After analysing the soil data of the control area the same conclusion can be drawn as in the case of the sample area: the 70 metres distance equals to the uninhabitid zone, marked by the alluvial deposit of the floodplain.

As for the chemical feature of the soil, the neutral reaction type with the most prosperous capability does not exist on the control area. 34 sites can be found on slightly acid soil, while an important number of sites can be observed on intensely acid soil.

As far as the physical attributes are concerned, most of the sites are located on the soil type with strong water driving and highly water content ability. A significant part of them can be found on sandy soil with very strong water driving and sparse water content ability.

After analysing the different physical parametres I found that the result is slightly worse on the control area than it was in the case of the sample area (Table 4.), particularly in the case of the aspect examination. Much more sites can be observed on the surface with northern-western aspect in contrast to the „expectations" of the model.

As far as the physical and chemical features of the soil are concerned I could not use a generaly true rule despite of the tendency that appeared in both main features' respect (Table 3.).

After surveying each elements the ideal inhabitable zone made probable by the model and the real geographical position of the sites can be compared. (Figure 8.), (Table 4.) 10 out 71 sites are entirely, while 7 are partly situated on the predicted area. Whereas 38 sites are located on the predicted area with less than the half of their territory and there are 16 sites that do not touch it in the least. The number of the identifiable sites are 43 (61%). This is a much worse result statistically than it was on the sample area. However there are some remarkable sameness between the ideal inhabitable zone and the archaeological sites. There are some well-modelled sites on the territory bordered by the Fajszi-patak and its different sidebranches, eastwards from the centre of Pusztakovácsi. Their extension and direction accord with the field data. This area is the most successfull one in the modelling's respect because the predicted patches are located site-like, modelling perfectly not only the sites but the empty areas among them. This feature cannot be observed on the most western and eastern (Kürtöspuszta) parts of the area, where quite large territories were predicted but they did not possess any sites.

As an experiment I examined the relationship between the archaeological sites and the ideal inhabitable zone in different ages (Table 5.). In the case of the prehistoric and Roman Age sites of the sample area the polygons of the sites fit better to the predicted zone than the Middle Age sites do. This observation is, of course, true in the case of those Middle Age sites that possess prehistoric finds. Being farther away from the ideal inhabitable zone is peculiar to those sites that have pure Middle Age archaeological finds. In the peripheral, eastren part of the sample area there are 7 sites in a group that hardly touch the predicted inhabitable zone.[22]

In the case of the control area there are worse scales in each age than they can be experienced on the sample area (74, 66, 58%). The poor fitting of the Middle Age sites is remarkable.

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[21] Only 6% of the sites of the sample area are within the 70-metre-buffer, while in the case of the control area this rate is 22%.

[22] In the case of the Migration Age sites it does not worth to examine the statistical distribition because of the limited number of sites.

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Table 1: Statistical distribution of the sites in the sample area

Sites with their whole territory on SE aspect	23	Sites with their whole territory within the 300 m buffer	44	Sites with their whole territory out of the 70 m buffer	39	Sites with their whole territory on less than 12% slope	36
Sites with their larger part on SE aspect	18	Sites with their larger part within the 300 m buffer	6	Sites with their larger part out of the 70 m buffer	17	Sites with their larger part on less than 12 % slope	24
Sites with their smaller part on SE aspect	13	Sites with their smaller part within the 300 m buffer	5	Sites with their larger part within the 70 m buffer	3	Sites with their larger part on more than 12 % slope	0
Sites with their whole territory on NW aspect	6	Sites with their whole territory out of the 300 m buffer	5	Sites with their whole territory within the 70 m buffer	1	Sites with their whole territory on more than 12% slope	0
Altogether	60	Altogether	60	Altogether	60	Altogether	60

Table 2: Statistical distribution of the sites in the control area

Sites with their whole territory on SE aspect	17	Sites with their whole territory within the 300 m buffer	63	Sites with their whole territory out of the 70 m buffer	31	Sites with their whole territory on less than 12% slope	56
Sites with their larger part on SE aspect	16	Sites with their larger part within the 300 m buffer	3	Sites with their larger part out of the 70 m buffer	24	Sites with their larger part on less than 12 % slope	15
Sites with their smaller part on SE aspect	29	Sites with their smaller part within the 300 m buffer	0	Sites with their larger part within the 70 m buffer	11	Sites with their larger part on more than 12 % slope	0
Sites with their whole territory on NW aspect	9	Sites with their whole territory out of the 300 m buffer	5	Sites with their whole territory within the 70 m buffer	5	Sites with their whole territory on more than 12% slope	0
Altogether	71	Altogether	71	Altogether	71	Altogether	71

Table 3: Distribution of the sites according to the different soil types

	Physical attributes						
	Strong water driving and high water content ability	High water content and good water driving ability	Very strong water driving and small water content ability	Inner village	Forest	Flood area	Altogether
Sample area	35	9	7	2	1	6	60
Control area	39	0	22	3	2	5	71
	Chemical attributes						
	Neutral reaction	Slightly acid reaction	Strongly acid reaction	Inner village	Forest	Flood area	Altogether
Sample area	16	34	1	2	1	6	60
Control area	0	31	30	3	2	5	71

Table 4: Distribution of the sites using the model

	Sites with their whole territory within the predicted zone	Sites with their larger part within the predicted zone	Sites with their larger part out of the predicted zone	Sites with their whole territory out of the predicted zone	Identifiable sites	Altogether
Sample area	14	14	19	13	45	60
Control area	10	7	38	16	43	71

Table 5: Relation of the sites and the ideal inhabitable zone as ages

	Prehistoric sites	Roman Age sites	Middle Ages sites
	Identifiable	Identifiable	Identifiable
Sample area	51	22	46
	41	18	32
Control area	54	18	55
	40	12	32