Towards the Bronze Age Settlement Models of a Northern Apennines Valley (Val di Vara, La Spezia, Italy)

M. TREMARI

Direzione Regionale per i Beni Culturali e Paesaggistici della Liguria. m.tremari@tiscali.it

ABSTRACT

The article describes the results of Landscape Analysis carried out in several Bronze Age settlements in Vara Valley, East Liguria, Italy. Some of the settlements analysed in this context were known through surface research, while others have been inquired through excavation.
Aim of this work is to analyse the Bronze Age settlements in connection with their environment, in order to understand the settling choices and the physical aspects of the environment that could have influenced them as regards populating dynamics. In order to go on along this direction, we have decided to elaborate data using Landscape Analysis supported by the use of GIS tools.
In particular, Site Catchment Analysis has been applied on each of the settlements chosen so that we could compare the results and obtain a basis for further valuations. On the ground of these results, we have used the environment aspects that emerged as important and connected with possible settling choices to create a model of the valley territory that highlights the areas with the same physical features. This model (also reproduced into a cartographical map) can now be used as a ground for further researches to discover new archaeological settlements that show similar features and, above all, as a sensible factor in territorial planning.

INTRODUCTION

This work is concerned with a kind of GIS application directed to analyse the connections between human settlements and physical environment. In particular, here are shown the results of spatial analyses carried out using GIS tools in Late and Last Bronze Age settlements in a valley in the Eastern Ligurian Appennino called Val di Vara (Vara Valley), which is located in a mountain environment.
Its basic aim was to understand how the territory surrounding the settlements would conform, on the basis of some physical environment features chosen a priori. We have decided to use Site Catchment Analysis, which, supported by GIS application, has been able to offer an objective basis of data suitable to considerations concerning the settling character of the territory. Once observed the conformation of the territory surrounding the settlements, we wanted to verify whether there were some constant features, which could be interpreted as the result of voluntary choices made at the moment of the settling solution. In order to understand whether behind every settlement we could find these kind of voluntary settling choices, also based on the physical conformation of the territory, we took into account not only the place where the settlement stood, but also the whole territory surrounding its neighbourhood. We have in fact considered that, in the context of the subsistence economy practised by the communities of the Ligurian mountains in the Bronze Age, the territory surrounding the settlements could have a basic influence on the settling choice, offering the resources necessary to the survival of the community itself.
Obviously, all the considerations made in this direction could only concern physical environment features, excluding all the social and ideological factors, which surely led also to the settling choice.
The physical base for the data was obtained from the DTM of the considered territory and from a geological map of the valley.
In order to locate the part of territory surrounding the settlements, we have decided to use Cost Surface Analysis, through which we have been able to reckon the areas concerned on the basis of on-foot moving times.
The data obtained from spatial analysis have been used to create a preliminary model of the valley, which shows both some features connected with settling choices and the areas susceptible of greater archaeological risk in connection with settlements whose features are similar to those of the analysed ones.
Archaeological context: the Vara Valley
The valley of the Vara river runs parallel to a long stretch of the Eastern Ligurian coast and, though being just a few kilometres away from the sea, it shows those mountain features typical of the whole Ligurian Apennine inland, whose highest peaks are more than 1700 high on the sea level.
The area considered in this work (Fig. 1) concerns the high part of the valley, which covers an extent of about 360 squared Km and which is also the archaeologically best known part, where the highest number of archaeological settlements have been discovered thanks to deep researches carried out during the last thirty years. For our spatial analyses, among the amount of prehistoric settlements known in this area we took into account the ones of the Late and Last Bronze Age (that means six settlements) and one "off site". This last one, called Piana D'Amisa, is a wide grassy tableland, which is the last result of intense shepherd and agricultural activities starting from the Bronze Age (Maggi and Campana, 2000).
These settlements show the same features, similar to those of the main part of contemporaneous settlement in the Ligurian

inland. They are located on heights overlooking wide parts of surrounding territory, they are small in dimension and built up of a few huts, and thus inhabited by a very short number of people. Some of them appear to be steady, while some of them seem to be temporary, probably inhabited only during the summer and connected with pasture activities. This kind of settlement is generally called "castellaro", although its location on heights would exclude a defensive choice and appears more connected with the exploitation of the territory and with the control of the surrounding grazing grounds. (Maggi, 1997b).

COST SURFACE ANALYSIS

For Catchment Area we mean the area surrounding a settlement, which offers those resources exploited by the people dwelling in the settlement itself. The study of this supplying area for such farmers' societies is usually considered as corresponding to the territory reachable in an hour walking from the settlement or included in a 5 km radius circle, in an ideal plain situation. Such estimates have been carried out through ethnographical comparisons with nowadays societies showing similar features to those of the ancient societies we are studying (Renfrew and Bahn, 1995).

In this work we have considered as a settlement supplying area the one reachable in an hour walking from the settlement. We have decided to estimate the Catchment Area in this way because, though the concerned settlements carried out mixed subsistence activities, among which stock-rising was undoubtedly basic, we have proof of agricultural activities carried out in the settlement's neighbourhood (Castelletti 1974, Maggi and Nisbet, 1990).

GIS analysis tools allowed us to use a calculation algorithm in order to shape the one-hour field on the real territorial morphology; thus we could avoid approximations, for example the ones resulting from using a 5 km absolute radius, which, in a completely mountain territory as the one of inland Liguria, could have turned out to be too misleading.

However, we have to specify that also this algorithm represent an approximation of reality, based only on the territorial morphology and so on DTM. Actually, the problem of analysing moving in a territory is still open, because there are many factors influencing distances and thus moving capabilities, among which, for example, vegetation, rivers and the perception of the landscape (Forte, 2000).

We chose to use as algorithm for the Cost Surface Analysis, expressed as the time taken to walk across a certain stretch of territory, the Tobler Function, summoned up in the following formula:

$$V = 6\, e^{-3.5|s + 0.05|}$$

Reading as follows:

V = walking speed
e = basis of natural logarithm
s = slope

This algorithm creates a map of on-foot moving speed in a certain territory and it is based on the topography of the land to which it corresponds as a starting point, the slope map (*Tobler, 1993*). The resulting moving-speed map is to be turned into a running-times map, considering that:

$$t = d/v$$

and:

t = time required for the journey
d = distance to be covered
v = moving speed

The areas so obtained have an irregular shape, influenced by the actual territorial morphology (Fig. 2 and Fig. 3).

SITE CATCHMENT ANALYSIS

The supplying fields of all the concerned settlements, obtained with the use of Cost Surface Analysis, have been intersected with thematic maps, previously prepared and elaborated, which represent the environment features taken into account. For environment features we mean those territorial specific characters, which connected with human settlements, could have offered some information about the consistency and the conformation of the territory surrounding them.

We have considered four features to be intersected with the area surrounding the archaeological settlements:

1) Altitude
2) Slope
3) Aspect
4) Lithology

Each map has been classified again in order to shift from fair values to values lead back into specific territorial classes, thus making easier elaboration and intersection operations. As regards the altitudes map, we created eight classes, one for every 200 mt-height band; as regards slopes, we created five classes; aspects were matched to four classes, following the cardinal points; as regards the last one, we created seven lithological classes, obtained from the most complex territorial geology.
Crossing these four environment features with the limits of each settlement's Catchment Area, we obtained four thematic maps for each of them, which highlight the surrounding territory according to its different features (See, for example, Fig. 4 and Fig. 5).
The areas so obtained were then expressed by a percentage for each environment feature and then represented in per cent-bar graphs (An example in Fig. 6).
In order to make some considerations about the results of the analyses, for each environment feature we compared the percentages of each territorial classis's areas that appear inside the settlement's Catchment Area.
In all the four cases we also compared the peculiar situation of each environment feature emerging inside the settlements' Catchment Area with the general situation of the whole territory of the valley (An example in Fig. 7).
This further data control aimed at verifying whether the territorial classes, which had turned out to be predominant in those Catchment Areas, would not just reflect the normal territorial conformation of the valley, regarding that peculiar feature.
Actually, when a class appearing in a settlement's Catchment Area exceeds the same class' percentage inside the territory of the valley, in some cases we have been able to interpret this datum as a voluntary settling choice.
The features, which have been able to offer a meaningful result as regards our aim, were altimetry and aspect. The per cent distribution of the different altitude and aspect classes inside the Catchment Areas shows a situation of greater homogeneity as regards these two features, evidently different from the actual distribution of the classes themselves in the territory of the whole valley.
Moreover, we can grasp some constant division of the classes of these two environment features inside the supplying area of almost all settlements. As regards some classes, we can observe a considerable shifting from the percentages of distribution inside the territory of the whole valley, which can make us think of a voluntary choice instead of an accidental situation.
The most represented altimetric bands are those from 200 mt to 800 mt above sea level, with a clear and evident prevalence of the intermediate one between 400 mt and 600 mt above sea level.
The prevalence of this last altimetric band seems to be "wanted", as it is not typical of the most of the territory of the all valley, instead it compares percentages not different from those of some other bands.
The sides, which play a most considerable role inside all settlements' Catchment Areas, turn out to be those towards South and West, with a much less considerable presence of those towards North. In this case, too the per cent distributions of the classes seem to be meaningful and point out some will of inclusion inside the settlements supplying areas, because the distribution of the four classes inside the whole of the valley appears to be homogeneous.
On the other way, the results emerged from the per cent distributions of slopes and lithologies seem to reflect more the actual distribution of the different classes inside the territory of the all valley, and thus were not considered as particularly meaningful.

DISCUSSION

The Site Catchment Analysis carried out on the six settlements allowed us to know the conformation of their supplying territory under different characteristics.
As regards altimetry and aspect, it seems we can grasp some constant division of the classes of these two environment features inside almost all settlements' supplying areas.
This datum seems to be meaningful most of all if considered in connection with knowledge already gained from studies regarding the Bronze Age in Liguria. In this period the Ligurian mountain communities' economic system is a mixed subsistence system, which at the same time exploited agricultural resources, a kind of transhumant stock-raising and natural resources offered by woods, with a partial role played by hunting activities (*Maggi and Campana, 2000*).
In such a kind of economy, which tries to exploit best all the resources offered by the environment, we can suppose that the choice of a territory showing the most suitable and best exploitable (with a minimum expense of energy) physical features could weigh heavily propitiously on the general productive yield.
On the basis of spatial analyses' results, we can connect the features of the settlements' surrounding territory, here meant as the Catchment Area, and the kind of activities there carried out.
As we have already noticed, the dwellers of these settlements used to carry out some kind of agricultural activity, and we can say that such an activity had to depend most on the kind of environment in which it was carried out. Moreover, it is reasonable to think that their agriculture depended more on environment physical factors than on other subsistence activities.
Also breeding and transhumant stock-raising practices played a basic role for Bronze Age dwellers' subsistence, but it is likely that they depended less on the territorial morphology. Actually, if the environment couldn't offer suitable pasture areas, it was always possible to create and keep them artificially, using fire, as it often occurred. Such a practice of creating artificial pastures under the natural line of those of high mountain, using controlled fires, is well-known and proved in the Ligurian mountains at least from Late Neolithic or Copper Age (Lowe, Davite, Moreno, Maggi, 1995).
On the basis of such considerations, we can state that, among the different ideological and environment factors concurring

to the settling choice, the favourable position of the areas where agricultural activities were carried out had surely to play a most considerable role. This environment choice, on which the most of resources that allowed the community to survive had to depend, had to be made valuing carefully which were the best territorial conditions, at least as regarded aspects and heights suitable for agriculture.
It is possible to make a further consideration looking at the special distribution of the six settlements analysed with their respective Catchment Areas, in connection with times taken for moving. The situation shown in Fig. 2, shows spatial distribution of the settlements in the territory.
The supplying fields highlighted in the picture, as we have already said, correspond to the territory reachable in an hour walking from the settlement to which they refer.
We can notice that the Catchment Areas of the five settlements intersect each other. It is reasonable to think that the spatial distribution of these known settlements can represent a picture of the settlements' actual distribution during the Late and the Last Bronze Age, at least in some areas of inland Liguria.
The intersection of supplying fields is also connected with the journey-times that subtended the different settlements, and, as it results from the spatial model created, the distances among these settlements, measured in terms of time taken for moving, were very short.
Actually, the time required to run the distance between those settlements furthest from each other among those we have taken into account is about a little bit more than two hours, while the journey-times between a settlement and its nearest neighbour are of about an hour walking and even less in some cases. Considering such evidence, we can understand how the different villages and settlements kept always in contact with each other[1].
These considerations allow us to suppose that such settlements, connected by very short distances, were an integrating part of a more complex settling system than that concerning the single village.
This hypothesis can be supported by the evidence that there were settlements with different functions. There are some signs of such a functional diversification in the settlements which show how some settlements were inhabited only in some seasons, such as Castellaro di Zignago, while others had a stability character, for example Castellaro di Vezzola, Novà-via Larga. The "off site", the pasture area of Piana D'Amisa, was also included inside some settlements' Catchment Areas.
It is maybe possible to see in these villages located at a short distance among them people belonging to a same community that, because of the needs connected with the features of a mountainous and quite poor in resources territory, joined in small settlements close to each other, in order to exploit best the environment resources. Such a careful exploitation of resources is expressed at a territorial level in the very close distribution of small villages where only a few people lived (Maggi and Campana, 2000).
A territorial reorganisation in the Ligurian Mountains in comparison to previous periods has already taken place starting from the Middle Bronze Age and was characterised by the settlements' greater stability, by a lowering of the heights in which they stood and by an at-intervals distribution in the territory (Maggi and Nisbet, 1990).
All these aspects can be clearly noticed observing the settlements' distribution and their Catchment Areas' overlap, during the periods immediately following the Middle Bronze Age, also as regards the situation inquired in the territory studied in this work.

TOWARDS A PREDICTIVE MODEL

Considering the data emerged from spatial analysis, we wanted to create a preliminary model that showed the areas inside the valley presenting similar features to those of the concerned settlements' Catchment Areas. Building up this model we have by now taken into account only the two environment features which have given favourable and suitable to the context results that are altimetry and aspect.
In connection with these two features we chose the most represented classes among the settlements' Catchment Areas, that are altimetric bands between 200 mt and 800 mt and, in particular, that between 400 mt and 600 mt, and sides towards South and West.
The result (Fig. 8) represents at the same time a tool for further studying and for territorial protection, highlighting those areas which show the highest level of archaeological risk as regards settlements of similar kind to those analysed in this work.

REFERENCES

ALLEN, K. M. S.; GREEN, S. W.; ZUBROW, E. B. W., Eds. (1990) – *Interpreting Space: GIS and archaeology,* London.

BAMPTON, M. (1997) – *Archaeology and GIS. The view from outside,* in: "Archeologia e Calcolatori", 8. Firenze, p. 9-26.

BELL, T.; WILSON, A.; WICKHAM, A. (2002) – *Tracking the Samnites: Landscape and Communications Routes in the*

1 We must specify that the contemporaneity of these settlements covers a time of some centuries and so it is not proved that all the five of them were present at the same time. However, it is sure that at least a part of them was present in the same period and so the distances among the different settlements must have been very close anyway

Sangro Valley, Italy, in: "American Journal of Archaeology", 106, No. 2, p. 179-186.

CASTELLETTI, L. (1974) – *I resti vegetali del Castellaro di Zignago,* in "Atti della XVI Riunione Scientifica dell'Istituto It. di Preistoria e Protostoria in Liguria", Firenze, 175.

CHRISTOPHERSON, G. L.; BARABE, P.; JOHNSON, P. S. (1999) – *Using ARC GRID's PATHDISTANCE Function to model catchment zones for archeological sites on the Madama Plain, Jordan.* URL: http://gis.esri.com/library/ userconf/ proc99/proceed/papers/pap590/p590.htm.

FORTE, M. (2002) – I *Sistemi Informativi Geografici in archeologia,* I Quaderni di MondoGIS, Roma.

GAFFNEY, V., *et al.* (1996) – *Spatial Analysis, field survey, territories and mental maps on the Island of Brac,* in: "Archeologia e Calcolatori", 7.1. Firenze, p. 24-41.

GAFFNEY, V.; STANCIC, Z. (1994) – GIS *and historical archaeology. The case of the Island of Hvar in Croazia,* in: "Archeologia e Calcolatori", 5. Firenze, p. 257-268.

GAFFNEY, V.; STANCIC, Z. (1998) – *GIS Approaches to Regional Analysis: a Case Study of the Island of Hvar.* URL: http://www.archaeology.usyd.edu.au/VISTA/gaffney_stancic.

GILLINGS, M.; MATTINGLY, D.; VAN DALEN, J.; eds. (1999) – *Geographical Information System and Landscape Archaeology*. Oxford.

JENSEN, D. E. (2002) – *Geoglyphs and GIS: modeling transhumance in northern Chile,* in: Computer Application and Quantitative Methods in Archaeology Conference, "The Digital Heritage in archaeology", 2-6 Aprile 2002, Heraklion.

KVAMME, K. L. (1997) – *Archaeological Spatial Analysis using GIS: mathods and issues,* in: Gottarelli A. (Ed.) "Sistemi Informativi e reti geografiche in archeologia: GIS – Internet", VII ciclo di lezioni sulla ricerca applicata in archeologia, Certosa di Pontignano (SI), (11-17 Dicembre 1995). Firenze, p. 20-26.

LOWE, J. J., *et al.* (1995) – *Stratigrafia pollinica olocenica e storia delle risorse boschive dell'Appennino settentrionale,* in: "Rivista Geografica Italiana", Annata CII, Fasc. 2. Pisa, p. 267-310.

MAGGI, R. (1997a) – *Uso del territorio e impatto antropico nella Liguria Orientale (dal Neolitico all'Età del Bronzo)* in: Balbi S., Mariotti M., Patrone E. (Eds.) "Insediamenti, viabilità ed utilizzazione del delle risorse nella Liguria protostorica del levante", I Quaderni della Massocca 1997. Fra mura, p. 77-100.

MAGGI, R. (1997b) – *Aspetti di archeologia del territorio in Liguria: la formazione del paesaggio dal Neolitico all'Età del Bronzo,* in: Annali dell'Istituto "Alcide Cervi", 19. Bari, p. 143-162.

MAGGI, R.; CAMPANA, N. (2000) – *La vita nell'Età del Bronzo della Liguria Orientale tra Ranches, Ranchers, e Canegrate,* in: Balbi S., Patrone E., Ribolla P. (Eds.) "Canegrate/Liguria. Cultura materiale ed ambiente dalla media età del bronzo all'età del ferro nel levante ligure", I quaderni della Massocca 2000. Framura, p. 99-113.

MAGGI, R.; MANNONI, T.; MORENO, D. eds. (1997) – *Laboratori di Archeologia Montana (L.A.M.). Studio per la conservazione, valorizzazione, e gestione turistico-culturale del patrimonio archeologico dell'Alta Val di Vara (La Spezia),* Polo etnobotanica e storia, Dipartimento di Storia Moderna e Contemporanea, Università di Genova, 2 voll. + 1 vol. cartografia scala 1/10.000.

MAGGI, R.; NISBET, R. (1990) – *Prehistoric pastoralism in Liguria,* in Maggi, R.; Nisbet, R.; Barker, G. (Eds.) – Atti della Tavola Rotonda Internazionale "Archeologia della Pastorizia nell'Europa meridionale" (Chiavari 22-24 Settembre 1989), I, in: Rivista di Studi Liguri, LVI. Bordighera, p. 265-296.

MANNONI, T. (2000) – *Trent'anni di archeologia in Liguria. Il problema dei Liguri,* in: Balbi, S.; Patrone, E.; Ribolla, P. (Eds.) – "Canegrate/Liguria. Cultura materiale ed ambiente dalla media età del bronzo all'età del ferro nel levante ligure". I quaderni della Massocca 2000. Framura, p. 31-54.

RENFREW, C.; BAHN, P. (1991) – *Archaeology. Teories, Methods and Practice.* (tr. it. di Sfligiotti, P.; Manacorda, D.; Zanini, *Archeologia. Teorie, Metodi e Pratica,* Bologna 1995).

TOBLER, W. (1993) – *Non-Isotropic Geographical Modeling,* in "National Center for Geographic Information and Analysis", Technical Report 93-1. URL: http://www.geodyssey.com/papers/toblerr93.html.

TREMARI, M. (2003) – *Applicazione di un Sistema Informativo Geografico (GIS) per l'analisi e la spiegazione dei modelli insediativi dell'Età del Bronzo dell'Alta Val di Vara.* Tesi di Laurea, Università di Genova, p. 213.

FIGURES

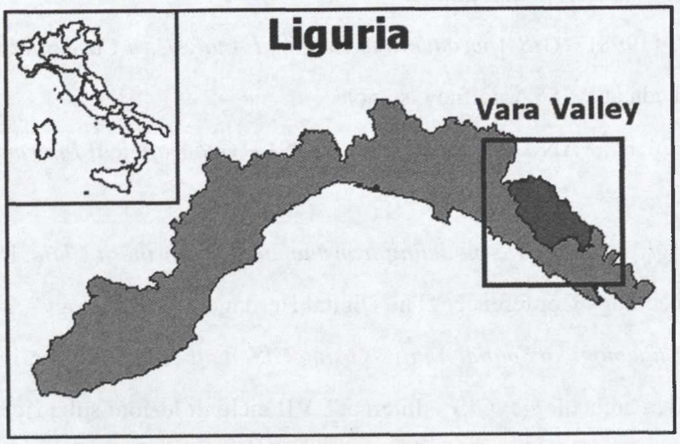


Fig. 1 – Vara Valley in Eastern Liguria.

Fig. 2 – Late and Last Bronze Age settlements with their Catchment Areas.

— CATCHMENT AREA

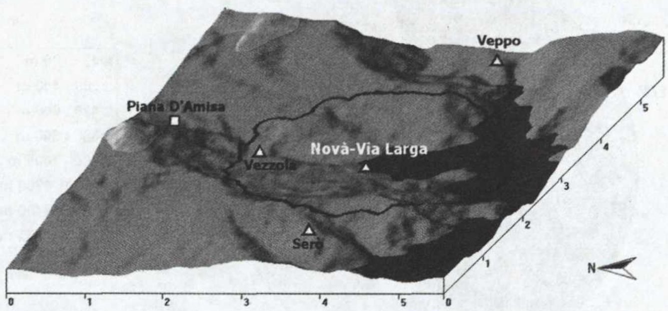


Fig. 3 – Example: 3D view of Novà-Via Larga Catchment Area.

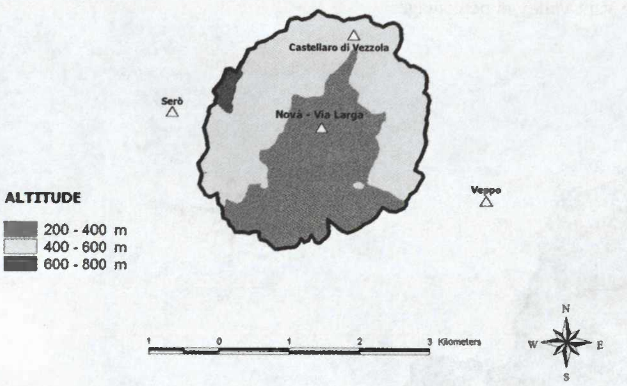


Fig. 4 – Altimetric bands inside Novà-Via Larga Catchment Area.

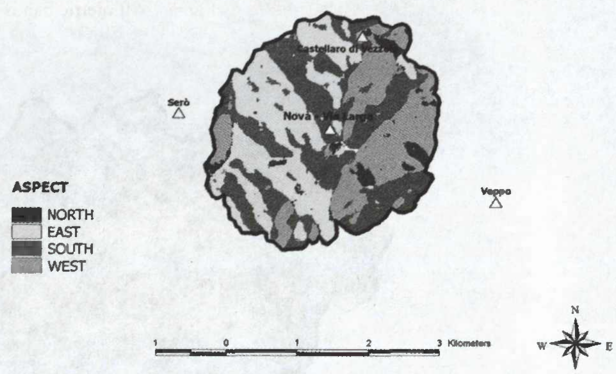
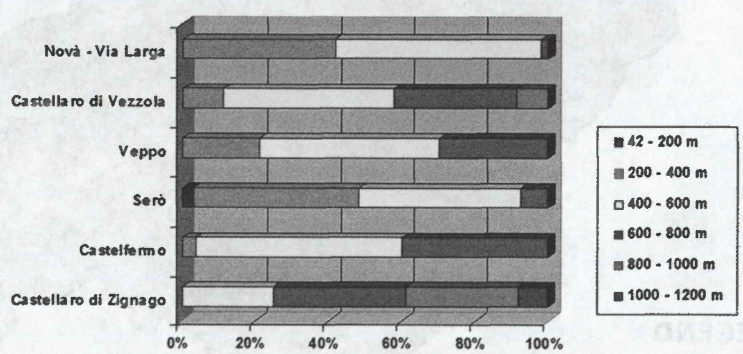


Fig. 5 – Aspect inside Novà-Via Larga Catchment Area.



	Castellaro di Zignago	Castelfermo	Serò	Veppo	Castellaro di Vezzola	Novà - Via Larga
1000 - 1200 m	8,2	0,0	0,0	0,0	0,0	0,0
800 - 1000 m	30,7	0,1	0,0	0,2	8,6	0,0
600 - 800 m	36,4	40,0	7,9	29,7	33,7	1,9
400 - 600 m	24,7	55,9	44,0	48,9	46,4	56,5
200 - 400 m	0,0	4,0	45,0	21,0	11,3	41,6
42 - 200 m	0,0	0,0	3,1	0,1	0,0	0,0

Fig. 6 – Altimetric bands inside the settlements Catchment Areas in percentage.

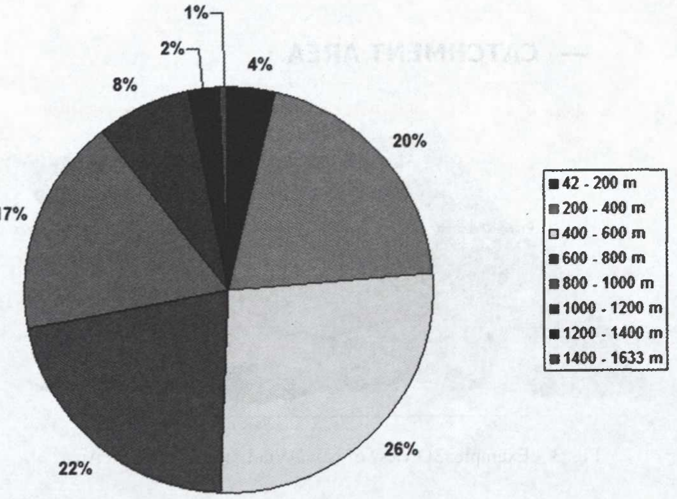


Fig. 7 – Altimetric bands inside Vara Valley in percentage.

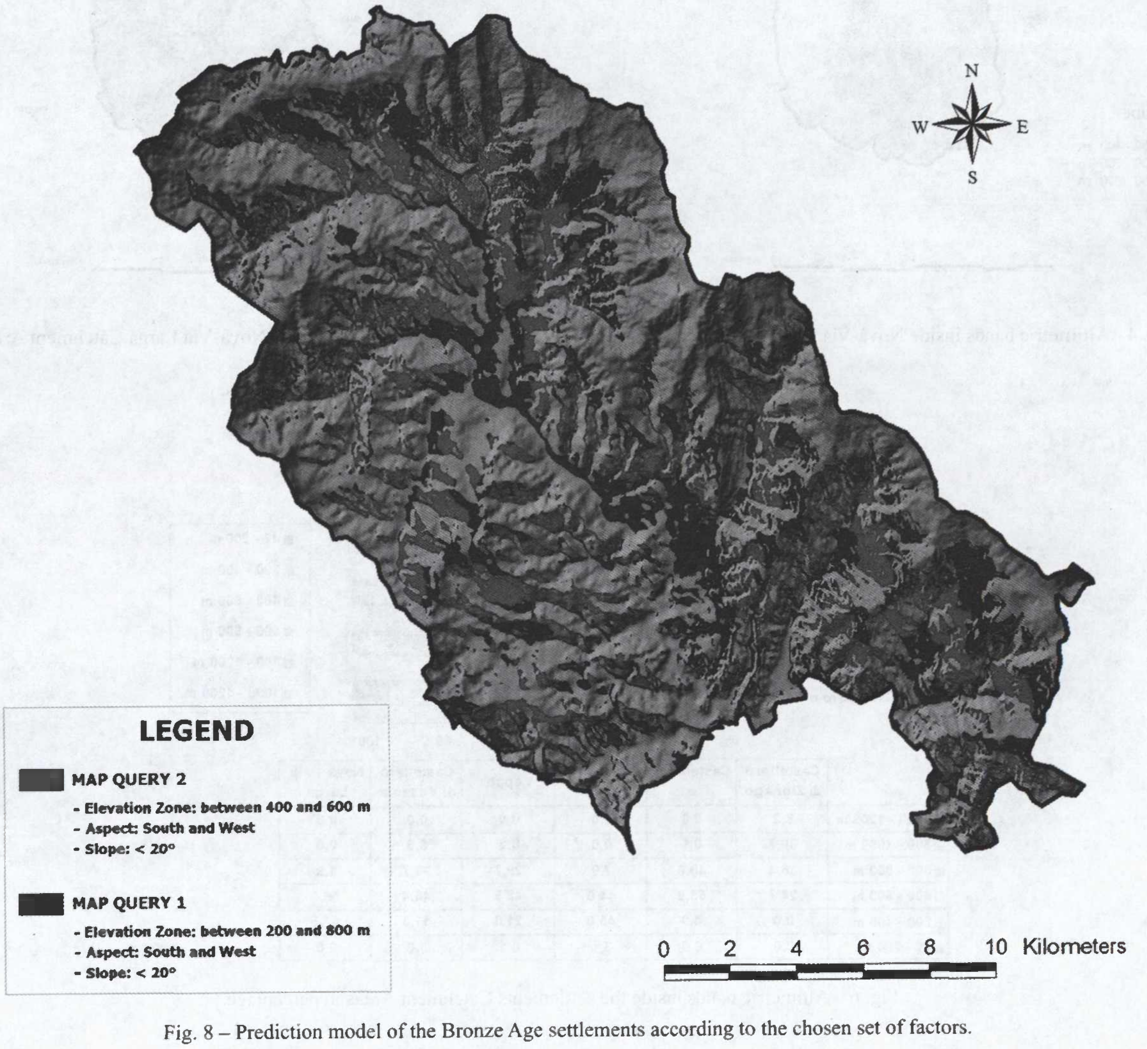


Fig. 8 – Prediction model of the Bronze Age settlements according to the chosen set of factors.