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1 **Neo-Eneolithic settlement pattern and salt exploitation in Romanian Moldavia**

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34

35 **Abstract**

36 Romanian Moldavia is the focus of a study, initiated in 2005, on Neolithic-Eneolithic (6000-3500 BC) settlement
37 dynamics and salt exploitation. The underlying hypothesis is that exploitation of salt, along with that of copper and
38 gold, contributed to the emergence of developed Eneolithic societies from the beginning of the 5th millennium BC.
39 By approaching this process through its geographical dimension, from the beginning of the 6th millennium BC, one
40 can measure the simultaneity of certain facts, be they social (the affirmation of elites), territorial (the appearance
41 of controlling sites), or technical (first copper metallurgy, intensification of salt exploitation).

42 The sub-Carpathian region of eastern Romania is particularly interesting, as the density of salt springs is much higher
43 than elsewhere, salt exploitation dating to the Early Neolithic (Criş) and the region subsequently develops into an
44 Eneolithic cultural centre (Precucuteni and Cucuteni) of unequalled wealth and importance.

45 After a decade of research on the nature and use of the salt resources, together with the creation of an
46 archaeological database covering the period from 6000 BC to 3500 BC, we can now undertake a preliminary
47 assessment of the territorial strategies implemented by these societies in the eastern Carpathian region.
48 Archaeological and ethnographic approaches are enhanced by use of powerful tools such as GIS and the application
49 of spatial analysis methods (kernel density, total viewshed, predictive modelling) thus enabling us to model
50 settlement patterns and dynamics.

51 Following on from these analyses, several results emerge. A coherent settlement model is observed for the Early
52 Neolithic : the sites, which are often grouped together and inter-visible, are located in valley zones and on modest
53 terraces close to minor water courses. With the appearance of the Linearbandkeramik (LBK) culture, this situation
54 evolves: now much more dispersed, the settlements are established in more open environments where the field of
55 vision is much wider.

56 In the first half of the 5th millennium, we witness a radical change in preferred topographical contexts: high- and
57 mid-altitude terraces are favoured, a trend which is reflected in the establishment of settlements on open
58 promontories which provide particularly commanding views over the wider area. Following a marked diversification
59 in the forms of land use in the second half of the 5th millennium, the beginning of the 4th millennium is characterised
60 by a densification of population centres and a strengthening of territorial control.

61 Analyses of the accessibility of salt springs allow these observations to be further developed. Firstly, we note a
62 significant increase in sites located close to salt springs in the period spanning the second half of the 5th millennium
63 and the first half of the 4th millennium. It is precisely during these two phases that the exploitation of salt appears
64 to increase. Secondly, the numbers of important fortified sites and prestige goods (copper axes) occurring close to
65 salt springs illustrates the polarising role of salt resources, the control exerted over these resources and their
66 capacity to stimulate population movements.

67 Thus we investigate a number of aspects of territorial organisation and resource management that have become
68 crucial issues in prehistoric archaeology: procurement, accessibility and availability of mineral, lithic and agricultural
69 resources; diffusion of raw materials; inter-site relationships; territorial delimitation; construction of territories.
70 The research presented here forms part of this dynamic as it seeks to improve our vision of the relationships and
71 interactions between society and environment over time.

72 **Keywords**

73 Eastern Carpathians; Prehistoric settlements; Salt resources; GIS; Spatial modelling.

74 **Highlights**

- 75 - Most comprehensive archaeological database ever established in Eastern Europe
- 76 - New insights into the territorial implications of the salt exploitation
- 77 - Use of locational-, density-, viewshed- and geostatistics analysis to model Neolithic dynamic
- 78 - Unique large-scale study on the polarising role of salt during Later Prehistory

79 **1. Introduction**

80 The subject of this research is the pattern of land occupation and the dynamics of Neolithic and Eneolithic (c. 6000-
81 3500 BC) site networks in Romanian Moldavia. Using a comprehensive data base and applying spatial analysis
82 methods, the aim is to investigate how salt resources and their exploitation affected settlement strategies. Between
83 1950 and 2000, several researchers forwarded the hypothesis that salt resources promoted stability and the
84 development of late prehistoric communities in the Carpathians (Nandriş 1987; Harding, Kavruc 2013; Lazarovici,
85 Lazarovici 2015), particularly in Moldavia where salt springs are plentiful and accessible (Şandru 1952; Ellis 1984;
86 Monah 1991; Ursulescu 1995). In the foothills of the Eastern Carpathians, excavation of the earliest salt exploitation
87 sites (Ursulescu 1977; Dumitroaia 1987; Munteanu et al. 2007; Nicola et al. 2007; Weller, Dumitroaia 2005; Weller
88 et al. 2015) led on to use of GIS-based spatial analysis, initially focusing on central Moldavia (Weller et al. 2011;
89 Brigand, Weller 2012; Brigand, Weller 2013) and then on the region as a whole (Brigand, Weller 2015).

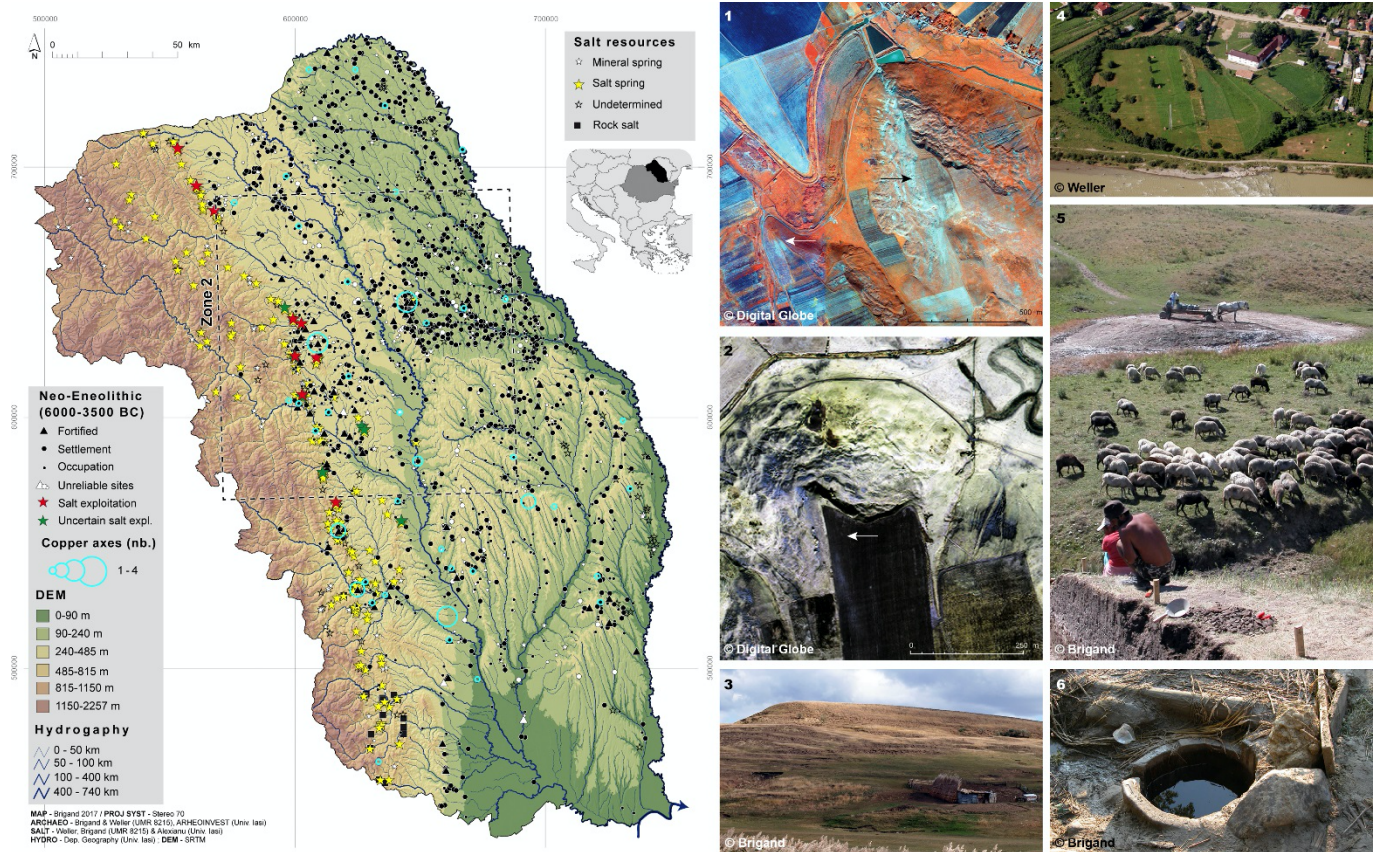
90 Our research falls within the revival of the ecological paradigm within human and social sciences acknowledged
91 since the appearance of the first studies dealing with the spatial relationships maintained by sites and site networks
92 (Hodder, Orton 1976). An initial overview of the use of GIS in archaeology (Allen et al. 1990), followed by specific
93 applications particularly in continental Europe (Gaffney, Stančič 1991) and then in southern France
94 (ARCHAEOMEDES 1998; van der Leeuw et al. 2003), have provided a decisive boost to the development of spatial
95 archaeology. Following these initial experiments, spatial analysis and modelling were widely developed in European
96 archaeology. The publication of several manuals and text books (Wheatley, Gillings 2002; Conolly, Lake 2006; Rodier
97 2011), and the multiplication of research programmes associating spatial analysis and remote sensing in a GIS
98 environment have bolstered the development of spatial analysis in a region of Europe as yet little influenced by
99 processual archaeology.

.00 By focusing on the eight districts of Romanian Moldavia, a total area of 46 000 km² delimited on the west by the
.01 Eastern Carpathians and on the east by the River Prut (Fig. 1), the present study highlights, at a new scale, the
.02 territorial choices made by the first agro-pastoralists while also underlining the way in which nascent social
.03 complexification is reflected in specific forms of land occupation and resource exploitation.

.04 **2. Materials and methods**

.05 *2.1. Archaeological and copper axe database*

.06 The construction of an archaeological map of the Neolithic and Eneolithic of North East Romania (6000-3500 BC)
.07 has been made possible by the creation of a geo-referenced database which brings together all the available
.08 relevant archaeological documentation (Zaharia et al. 1970; Marinescu Bîlcu 1974; Chirica, Tanasachi 1984-1985;
.09 Monah, Cucuş 1985; Cucuş 1999; Popovici 2000; Văleanu 2003; Boghian 2004; Bem 2007; Garvăn 2013; Şovan 2013;
.10 CCA 2001-2015).



11

12 Fig. 1. Left, map of archaeological sites and salt resources. Right, Eneolithic sites and saline water sources: 1- Dealul
 13 Mare (black arrow) and South West Dealul Mare (white arrow), Bălțați (Iași); 2-3- Dealul Pandele, Zmeu (Iași); 4-
 14 Cetățuia, Văleni (Neamț); 5- Hălăbutoaia salt spring (in the background) and salt exploitation site during
 15 archaeological excavations, Țolici (Neamț); 6- Salamura, Bogdănești (Bacău). (1-2 Satellite images courtesy of the
 16 DigitalGlobe Foundation).

17 The database contains a total of 2034 sites, 2013 of which are habitation sites and temporary settlement sites.
 18 When duplications, uncertain and unlocated sites are excluded, we are left with a total of 1658 sites (Fig. 1). Analysis
 19 of settlement dynamics can only be based on sites with a known, accurate chronology, i.e. 76% of the site corpus.
 20 Table 1 illustrates their distribution according to period. The proposed chronological framework is based on
 21 specialised publications (Mantu 1998; Lazarovici, Lazarovici, 2006).

			<i>n</i>	<i>% excavated</i>
Neolithic	I	Criș	189	21.7
		Boian I	2	100
	II	LBK	53	34
		Boian II-III	6	83.3
Neolithic nd			17	5.9
Eneolithic	I	Precu	122	43.4
		Boian IV	1	100
	II	Cucuteni A	599	24.4
		Stoicani-Aldeni	44	31.8
	III	Cucuteni A-B	151	41.1
	IV	Cucuteni B	371	29.1
Eneolithic nd			383	7.3

22 Table 1. Numbers of archaeological sites per period.

23 Sites from the end of the Moldavian Eneolithic (Cucuteni B) are grouped together with sites from the Cucuteni A-B
 24 phase because, in the absence of detailed investigations, the characteristics which allow us to discriminate between

these two periods are almost impossible to define solely on the basis of surface finds (Table 1). Researchers have previously observed that the small number of sites attributed to the Cucuteni A-B (151 certain sites) is more a reflection of difficulty in identification than of a retraction of settlement during the period (Zaharia et al. 1970; Boghian 2004; Petrescu-Dîmbovita, Văleanu 2004). In parallel, a copper axe data base (57 objects listed) was constructed on the basis of published works on the copper metallurgy of the Eastern Carpathians (Mareş 2002; Mareş 2012).

2.2. Salt resources

The transition zone between the Eastern Carpathians and the Sub Carpathians is marked by the outcropping of Aquitanian and Tortonian salt-bearing horizons (Velcea, Savu 1982). The salt resources of this region (sodium chloride springs, rock salt outcrops, saline soils), among the most abundant in Europe (Meruțiu 1912), have been systematically surveyed and have been the subject of bibliographical and cartographical research since 2005 (Weller et al. 2007; Weller et al. 2010; Weller, Brigand 2017). To date, 461 sites have been documented. Of these, 256 have been investigated, analysed and georeferenced using GPS (Table 2).

	<i>n</i>	<i>% surveyed</i>
Mineral springs (non-saline water)	98	50
Salt springs	189	89
Mineral springs nd	96	32.3
Rock salt	19	79
Saline soils	50	4
Halotoponyms without salt	9	66.5

Table 2. Salt resources in Romanian Moldavia.

The outcrops of rock salt are essentially located in the southern arc of the Carpathians. Salt springs, where the water table is in contact with underlying salt deposits and whose salinity levels can be up to 10 times that of sea water, are distributed throughout the foothills of the Eastern Carpathians. Numerous brackish mineral springs are documented on the Moldavian Plain. Furthermore, on the plain, various soluble minerals (chlorides, sodium-, calcium- and magnesium sulphates) derived from loess clays and marls, concentrate on the surface to form saline soils.

In this article we concentrate on salt springs of geological origin, directly linked to the deposits in the foothills, and whose use in recent times (for food preservation, fodder and therapeutic purposes) is well attested in ethnographic studies (Alexianu et al. 2011; Alexianu et al. 2016). The only known spring on the Moldavian Plain has been excluded, namely the spring located close to the thermal spa site which shares the same name as the Cucuteni Culture (Weller et al. 2007). Our systematic surveys of the salt resources of the Moldavian Carpathians have allowed us to double the number of known prehistoric salt exploitation sites (Monah 2002). Out of 189 salt springs, 21 have yielded evidence of Neolithic and Eneolithic exploitation. 8 deposits remain uncertain and need to be confirmed by archaeological testing and radiocarbon dating (Tab. 3).

			<i>n (reliable)</i>	<i>n (unreliable)</i>
Neo.	I	Criș	3	1
	II	LBK	2	0
Neolithic nd			0	2
Eneolithic	I	Precucuteni	5	0
	II	Cucuteni A	5	1
	III	Cucuteni A-B	3	0
	IV	Cucuteni B	7	3
Eneolithic nd			2	0
Neo-Eneolithic nd			0	1

Table 3. Salt exploitation according to period.

3. Density and proximity analysis

3.1. Aggregation index

Despite limitations related to the nature of archaeological investigations in Moldavia, it is possible to characterise and compare the degree of settlement clustering by applying the “nearest neighbour” method. The method is based on the characteristics of the spacing between points and has been applied since the 1950s by ecologists (Clark, Evans 1954; Haggett 1965) and somewhat later by spatial archaeologists (Hodder, Hassal 1971; Hodder 1972). For each chronological period (Criş/Boian I, LBK/Boian II-III, Precucuteni/Boian IV, Cucuteni A/Stoicani-Aldeni, Cucuteni A-B and B), it involves calculating the aggregation index as defined by Clark and Evans (R):

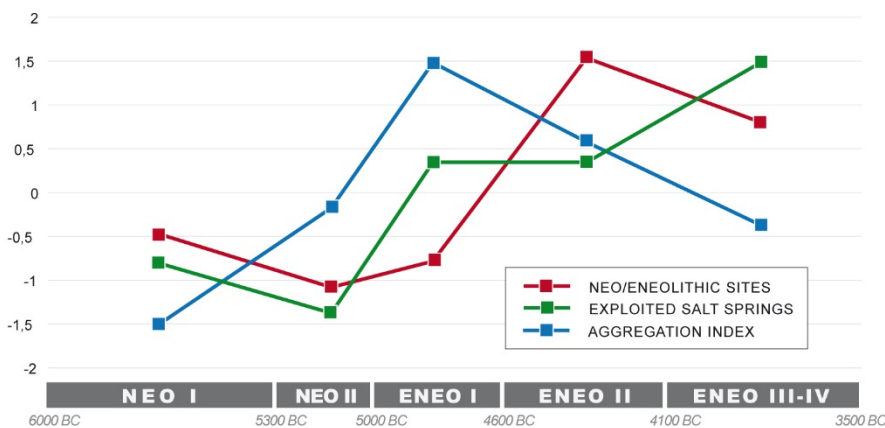
$$R = \frac{\bar{r}_a}{\bar{r}_e} \text{ where } \bar{r}_e = \frac{1}{2\sqrt{\frac{N}{A}}}$$

Where \bar{r}_a stands for the mean of the distances from the sites to their nearest neighbours, and \bar{r}_e is the mean distance to nearest neighbour in a completely random site distribution of density N/A , where A = Moldavian study area (46 260 km²) and N = number of archaeological sites. Usually, the interpretation of R values is as follows: $R > 1$ if the pattern has a tendency towards regularity, $R = 1$ if it is completely random (Poisson process), and $R < 1$ if there is clustering in the pattern.

The results obtained (Table 4) are also set against the settlement and salt exploitation dynamics (Diag. 1). The values are normalised so as to represent comparable trends that reveal the long-term settlement dynamic.

	N	R	\bar{r}_e	\bar{r}_a
Neo. I	191	0.5461	7773.2699	4244.7355
Neo. II	58	0.6140	14106.0829	8660.5368
Eneo. I	123	0.6982	9686.5221	6762.9940
Eneo. II	626	0.6522	4293.7155	2800.5171
Eneo. III-IV	466	0.6038	4976.5397	3004.7587

Table 4. Characterisation of the distribution of sites.



Diag. 1. Diagram illustrating the dynamics of settlement and salt exploitation (normalised values).

3.2. Kernel density estimation and transition maps

Kernel density estimation (KDE) is used in order to move beyond the discrete distribution of sites and to enable us to work on a continuous surface that reflects the intensity of the occupation of the space. The KDE method provides an estimation of the site density, defined by a moving window. The density value obtained takes into account the size of the neighbourhood. This method is well known (Silverman 1978; Silverman 1986; Wand, Jones 1995; Zaninetti 2005) and has been used for archaeological applications, in particular for intra-site analysis (Baxter et al. 1997; Beardah 1999).

.80 The choice of the radius (h) is an important parameter because h determines the degree of smoothing. Using too
.81 small a radius will produce an irregular surface that is problematic, especially when the total number of points is
.82 relatively small. On the contrary, too large a radius will result in a loss of precision, favouring general trends. In our
.83 case, the search radius (bandwidth) is 5000 m.

.84 A major problem emerges when we apply this method to archaeological data: sites for which the chronological
.85 calibration is insufficient (24% of the total) are not taken into account in the density calculations per period. Thus,
.86 in order to take account of these poorly calibrated sites, we have decided to attribute a weighting in line with the
.87 duration of each period. For example, a value of 1 is attributed to a site that is well calibrated. However, poorly
.88 calibrated sites in the Cucuteni are attributed a value of 0.45 for the Cucuteni A and 0.55 for the Cucuteni A-B and
.89 B. The same protocol is used for poorly calibrated sites in the Neolithic and Eneolithic.

.90 These maps of density per period are used to create maps of density difference that allow us to perceive the
.91 evolution- non-existent, negative or positive- between two chronological sequences. The method is based on map
.92 algebra, i.e. mathematical combination of a raster grid cell by cell (Tomlin 1990). A combination is proposed in order
.93 to evaluate the difference between two density maps. It builds on the methodological advances of the *Archaedyn*
.94 program (Nuninger et al. 2012). This method exploits the relative difference in settlement density through the use
.95 of Normalised Differential Ratio (*NDR*), which is defined in the same way as the Normalised Difference Vegetation
.96 Index, i.e.:

.97
$$NDR = \frac{(T1 - T0)}{(T1 + T0)}$$

.98 When set against salt resources (Fig. 2) this cartographic formula allows us to visualise and compare the settlement
.99 dynamic between two chronological sequences and thus to distinguish between the areas that are most attractive
.00 (from 0.33 to 1), most stable (from -0.33 to 0.33) and those that have fallen into decline/disuse (from -1 to -0.33).

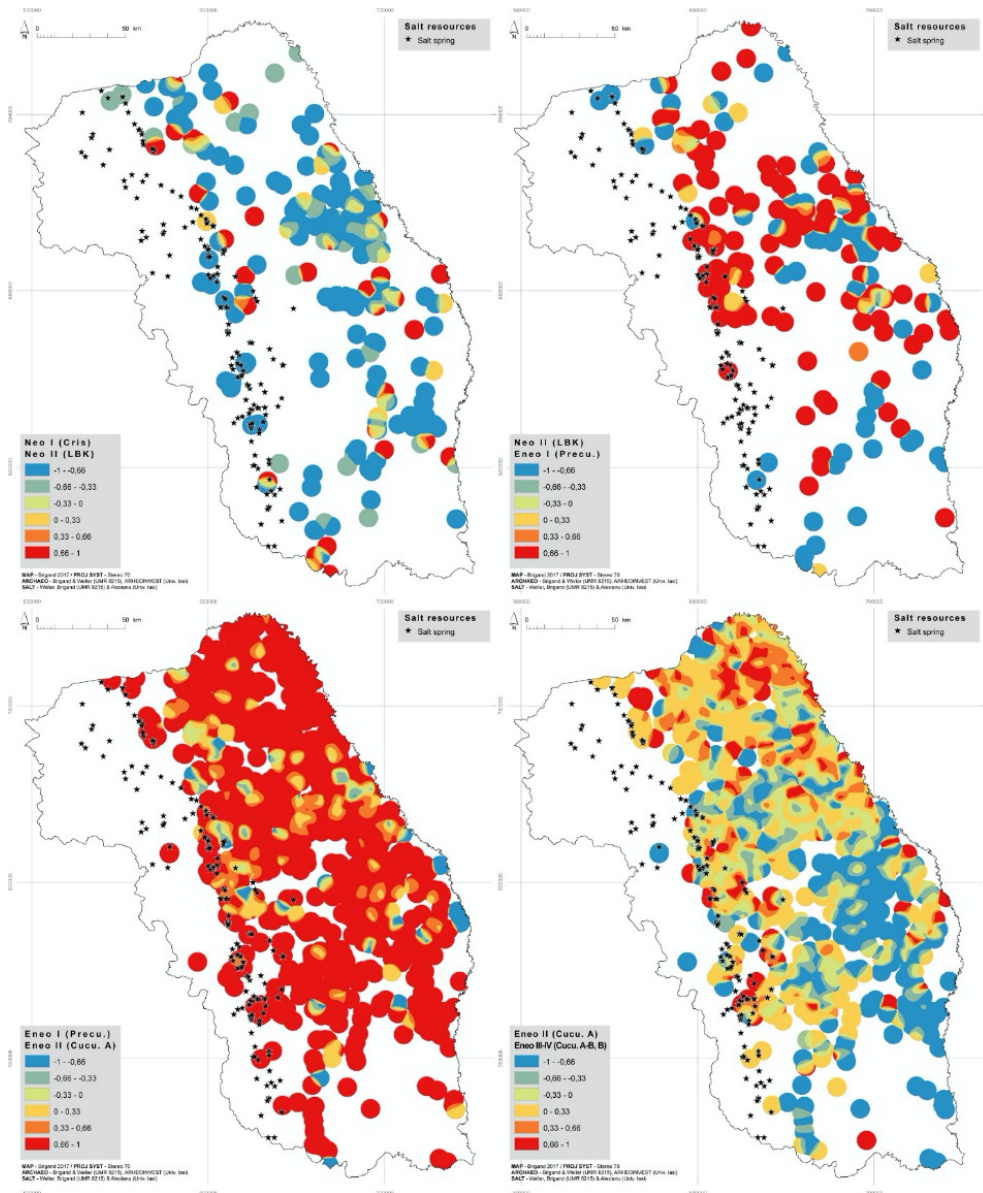


Fig. 2. Maps illustrating the settlement dynamic (transition maps) and salt springs.

4. Environmental data and terrain analysis

4.1. Terrain analysis

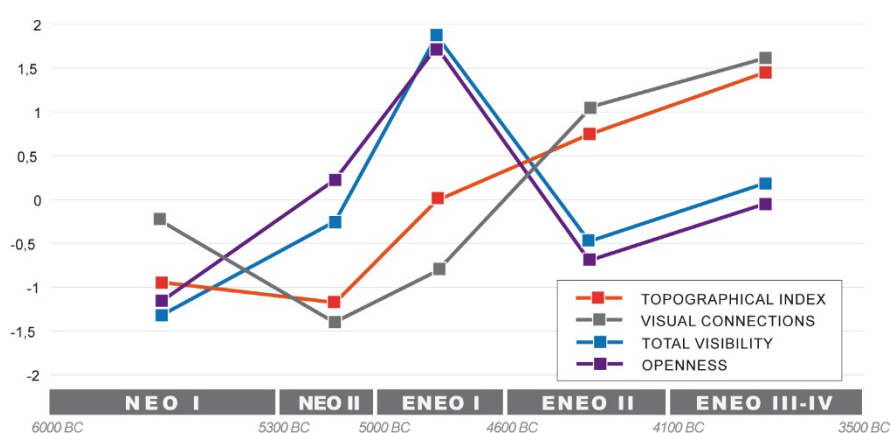
This study relies on the use of a mid-resolution altimetric model (SRTM 90 m, cleaned, smoothed and then re-sampled) covering the entire area of Moldavia. Various treatments are used to monitor several natural processes. The methodology, including calculation methods, has been widely described in specialist publications (Wilson, Gallant 2000; Conolly, Lake 2006). A spatial link between the archaeological site and the various rasters produced allows us to describe site contexts in greater detail. The results are divided by the number of archaeological sites (Table 5 and Diagram 2).

1. *Positive openness* is a morphometric analysis that provides a valid view of the principal landforms (Yokoama et al. 2002). It involves taking into account the line-of-sight over 8 azimuth ($r = 10\ 000\ m$) and the angle of convexity or concavity for each pixel. 2. The *Topographical Index* (TPI) is a comparison of the elevation of each cell with the average for a given area surrounding it (500 m); a negative index indicates areas that are lower than the surrounding area (valley, thalweg), while a positive value indicates the opposite (crest). 3. *Total visibility* defines, for each individual pixel, the number of pixels from which it can be seen (Llobera 2003). Over the whole landscape, this analysis produces a visibility potential that will determine whether a pixel is located in an open or closed visual environment. As it is particularly time-consuming and requires a rarely available level of computing power, we have decided to apply this calculation to a regular distribution with points every 2000m and for a visibility radius of 10km.

4. We have also calculated the number of visual connections in a situation of intervisibility ($r = 10\ 000\text{ m}$; $h = 1.70\text{ m}$) according to the method used by Z. Cučkovic (2015). The number of visual connections is divided by the number of archaeological sites per period in order to obtain a better assessment of the degree of visual organisation. The results are presented in Table 5 and Diagram 2 (normalised values).

	<i>n</i>	<i>Altitude</i>	<i>Total Visibility</i>	<i>TPI</i>	<i>Openness</i>	<i>Visual connections</i>
Neo. I	191	179.13	21.56	-0.0043	1.5184	1.13
Neo. II	58	193.33	25.85	-0.0296	1.5239	0.413
Eneo. I	123	192.16	33.55	0.0976	1.5300	0.78
Eneo. II	626	207.78	24.60	0.1804	1.5202	1.942
Eneo. III-IV	466	197.97	27.27	0.2577	1.5228	2.182

Table 5. Summary of analyses based on topography.



Diag. 2. Summary diagram of the evolution of site contexts (normalised values).

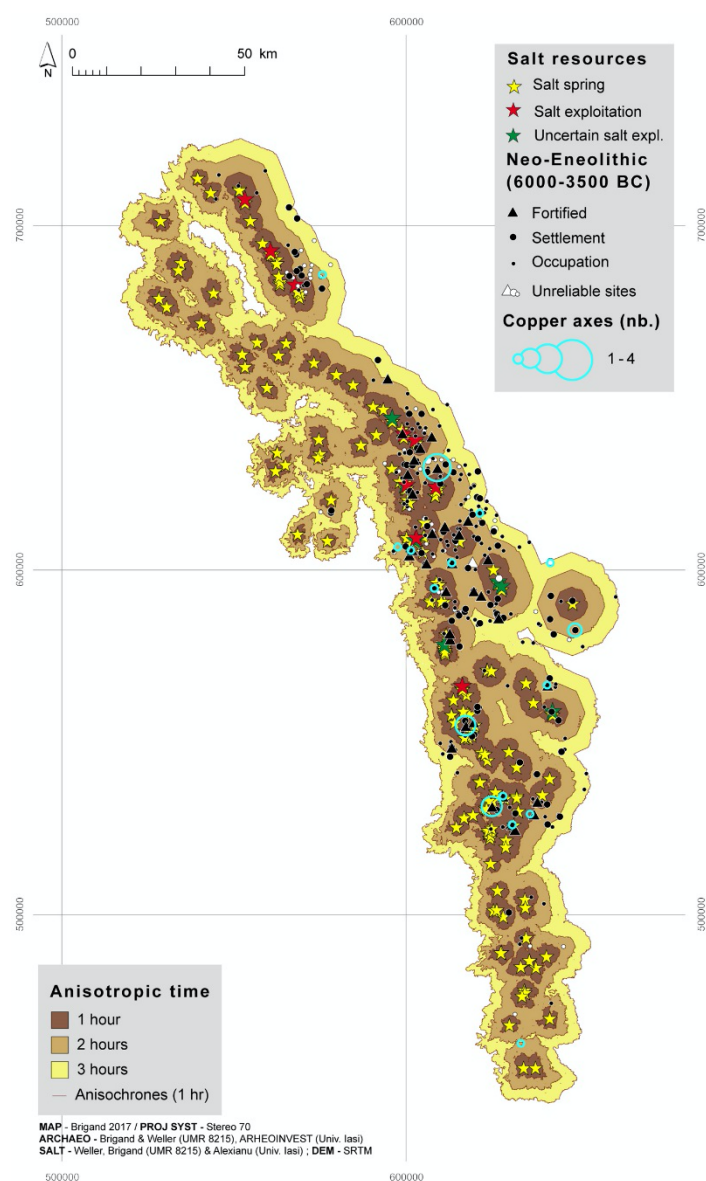
4.2. Accessibility of salt springs

The aim here is to propose a map of accessibility to salt springs in the Sub Carpathian zone. Our approach uses various landscape elements - topography and land occupation - to calculate the time required to access the salt springs in the foothills. The procedure uses the path distance function of ArcMap. This methodology, which results in the creation of a "least cost catchment", was one of the earliest GIS applications to be used in archaeology (Gaffney, Stančić 1991) and it has been widely used since (see for instance Barge, Chataignier 2004; Murrieta-Flores 2012; Herzog 2013). It can be summarised as a number of steps:

First, a friction surface is defined that fixes the level of constraint affecting movement. Its cost in terms of energy depends on the slope value and on the vegetation cover value. Thus, we consider that upland forest bordering the west of our study area constituted an impediment to movement during later prehistory (see also the palaeoecological data in Tanțau et al. 2003; Tanțau et al. 2011).

Thus, the resulting constraint surface (*input cost*) includes an estimated 20% forest cover (f), based on *Corine Land Cover*. Therefore, 80% of the friction surface is made up of the topographical surface (slope, p). The slope and the ground occupation, which has already been classified, are associated so as to determine a cost surface (c) weighted as follows: $c = 0.008 p + 0.002 f$. It is then classified into four different constraint categories.

.42 Then, *Tobler's Hiking Function* (Tobler 1993) is used to obtain an anisotropic time estimate (the direction of
 .43 movement is taken into account, in this case towards the source). The DEM (input surface) is used as a vertical
 .44 factor to raise or reduce the cost involved in crossing each pixel: a 0° gradient represents the lowest cost and,
 .45 conversely, a slope value above 70° represents the highest cost. The standard speed of movement used is 5 km/h
 .46 (Fig. 3).

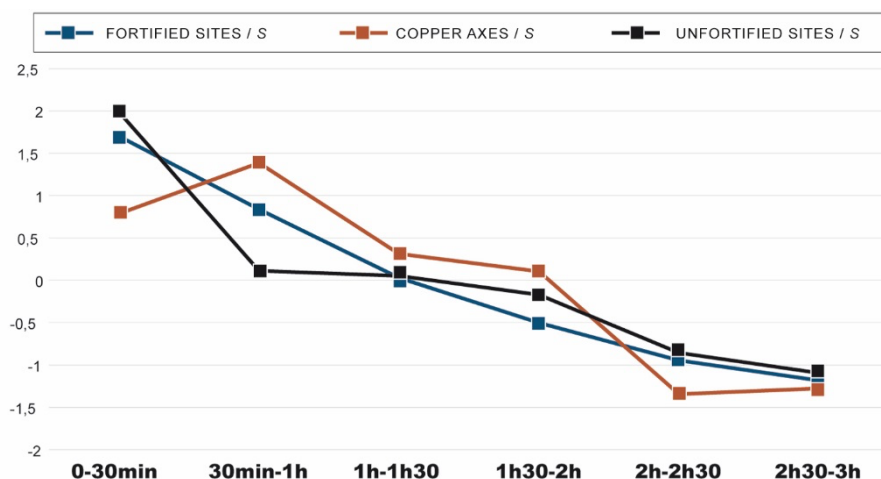


.47 Fig. 3. Travel time to salt springs.

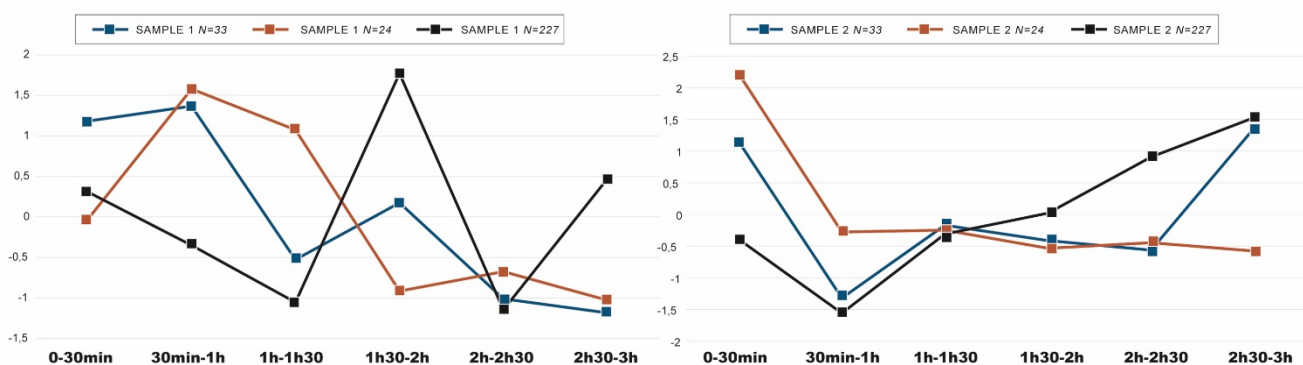
.48 The map of access times is limited to three hours. Within this overall radius we have counted the number of fortified
 .49 settlements, unfortified settlements and copper axes for each 30 minute walking distance interval (Table 6). Given
 .50 that the surface area of the various time intervals is different, and that this probably affects the number of sites
 .51 contained within each, two additional analytical steps are conducted: firstly, values are weighted using the ratio of
 .52 the number of sites and copper axes to the surface area of each time interval (Diag. 3); secondly, a similar analysis
 .53 is conducted on two random sets of data (Diag. 4).

	0-30min (s=1038 km ²)	30min-1h (s=2240 km ²)	1h-1h30 (s=2544 km ²)	1h30-2h (s=2355 km ²)	2h-2h30 (s=2066 km ²)	2h30-3h (s=1681 km ²)	Total
Fortified sites	8 (11.6%)	12 (17.4%)	8 (11.6%)	4 (5.8%)	1 (1.4%)	0	33 (47.8%)
Copper axes	3 (5.3%)	8 (14%)	6 (10.5%)	5 (8.8%)	1 (1.8%)	1 (1.8%)	24 (41.1%)
Unfortified sites	41 (2.6%)	48 (3%)	53 (3.3%)	44 (2.8%)	25 (1.6%)	16 (1%)	227 (14.3%)

Table 6. Number of copper axes, fortified and unfortified sites within 3 hours of a salt spring.



Diag. 3. Number of copper axes, fortified sites and unfortified sites situated within a three-hour walking distance from a salt spring weighted by the surface area of each time interval.



Diag. 4. Number of random dots within a three-hour walking distance from a salt spring weighted by the surface area of each time interval.

Finally, in order to evaluate the settlement dynamics in the vicinity of the salt springs in the foothills, we present a table displaying the number of sites located within a three-hour radius of a salt spring (Table 8).

		<i>n</i>	%
Neo. I	Criş/Boian I	18	9.4
Neo. II	LBK/Boian II-III	8	13.8
Eneo. I	Precu./Boian IV	28	22.8
Eneo. II	Cucu. A/Stoicani-Aldeni	91	14.5
Eneo. III-IV	Cucu. A-B/Cucuteni B	88	18.9

Table 8. Settlement sites situated within three hours of a salt spring.

5. Predictive modelling

5.1. Study area and environmental data set

The aim of the predictive model developed in this project is to identify the relationships between an archaeological data set and a landscape delineated by a certain number of environmental variables. The method used is inductive, i.e. it is guided by statistical testing. The analysis focuses on a limited area of Moldavia (Zone 2, Fig. 1) for which we have a high resolution (20 m) digital elevation model produced by colleagues in the University of Ljubljana: the model is based on ERS radar images. It covers 14 400 km² of Moldavia and includes the zone where recorded sites are most numerous (49% of sites are contained within a zone comprising 31% of the area) and most reliable. Seven of the eight environmental predictors are based on the topography.

Total visibility is calculated using a regular grid of points located every 400 m, i.e. over 90 000 points, with a field of vision of 10 km. The *topographical index* is calculated on the basis of a neighbourhood of 200 m; *landscape openness* is based on a sight-line calculated over 10km. The construction of distances to watercourses is based on several treatments of the elevation model: 1. Calculation of flow directions and then of cumulated flows; 2. extraction of the hydrographic network at a high level of detail; 3. calculation of the lowest cumulative cost distance taking vertical cost factors into account. We also used a 1:200 000 soil map which was digitised from the soil map of Romania. Since the aim was to provide an initial classification of the qualitative variables, the 25 soil types were grouped into 4 categories which relate to different agronomic activities. These variables are classified into a limited number of groups so as to determine their surface area, the number of archaeological sites that they contain and the expected value (E), i.e. the number of sites per category in the case of a uniform distribution.

5.2. Methods applied and model performance

The Chi2 test is used to determine if the observed site distribution for a variable can be considered as being equivalent to a theoretical distance. This tool allows us to measure if a variable is statistically significant, provided that the categories contain at least five sites. In certain cases, particularly for the periods where the numbers are low, the Yates correction has been added. A critical value of 0.001 signifies that there is a 99.9% probability that the site distribution is not uniform. In practice, a critical value of 0.05 is largely sufficient (95% probability). The ratio of the percentage of the number of observed sites (p_s) over the percentage of the surface area (p_a) is an initial method for obtaining information regarding the significance of certain units for the positioning of sites. It was systematically calculated. For significant units, whose statistical gain is high ($G = p_s - p_a$), we have used the K_j parameter (Wansleben, Verhart 1992; Verhagen, Berger 2001; Verhagen 2007) which allows us to characterise the importance of one category for the positioning of sites:

$$K_j = \sqrt{p_s * (p_s - p_a)}$$

The resulting value is used to weight the cartographic units added in the GIS. It is displayed with the variables considered in the Tables 8 and 9. Units associated with the higher values are considered the more significant in terms of human settlement and are consequently attributed a greater weight. Here, the weighting of cartographic units is guided solely by statistical tests (K_j) and is in no way the result of a deductive approach, which might attribute a weight to a unit on the basis of scientific knowledge regarding the settlement strategies for the period in question. As regards evaluation of the performance of the model, we use the statistical gain formula proposed by Kvamme (1988). This is the most widely used method for estimating the robustness of a model, after it has been categorised into three cartographic units of low-, medium- and high probability. The gain is defined as $G = 1 - p_s/p_a$ where p_s is the proportion of known sites in an area of probability, and p_a is the proportion of the surface area.

		Neolithic															
		Cris (NEO I)								LBK (NEO II)							
	Map Unit	Sup. (km ²)	Pa (%)	n	Ps	E	Ps/Pa	gain	Chi2	Kj	n	Ps	E	Ps/Pa	gain	Chi2	Kj
Orientation	1. Flat	1183.67	8.21	8	0.082	7.962	1.005	0.040	< 0.05	0.0057	3	0.115	2.134	1.406	3.331	> 0.05	NA
	2. North	2677.50	18.57	22	0.227	18.009	1.222	4.114		0.0966	5	0.192	4.827	1.036	0.664		NA
	3. East	4342.87	30.11	36	0.371	29.211	1.232	6.999		0.1612	12	0.462	7.830	1.533	16.039		NA
	4. South	3199.47	22.19	24	0.247	21.520	1.115	2.557		0.0795	4	0.154	5.768	0.693	-6.801		NA
	5. West	3017.75	20.93	7	0.072	20.298	0.345	-13.709		NA	2	0.077	5.441	0.368	-13.233		NA
Distance to water	1. < 3 min	2910.56	20.18	27	0.278	19.577	1.379	7.653	< 0.001	0.1459	3	0.115	5.247	0.572	-8.644	> 0.05	NA
	2. < 8 min	4434.21	30.75	45	0.464	29.825	1.509	15.644		0.2694	13	0.500	7.994	1.626	19.252		NA
	3. < 17 min	3686.09	25.56	19	0.196	24.793	0.766	-5.972		NA	8	0.308	6.646	1.204	5.209		NA
	4. > 17 min	3390.19	23.51	6	0.062	22.803	0.263	-17.323		NA	2	0.077	6.112	0.327	-15.816		NA
TPI	1. Valley	3589.44	24.89	14	0.144	24.143	0.580	-10.457	< 0.05	NA	2	0.077	6.471	0.309	-17.198	< 0.001	NA
	2. Slope	7478.90	51.86	52	0.536	50.304	1.034	1.748		0.0968	10	0.385	13.484	0.742	-13.399		NA
	3. Terrace	3352.92	23.25	31	0.320	22.552	1.375	8.709		0.1668	14	0.538	6.045	2.316	30.596		0.4059
Visibility	1. Low	4752.48	32.95	27	0.278	31.966	0.845	-5.120	> 0.05	NA	2	0.077	8.568	0.233	####	< 0.05	NA

		2. Medium	4960.96	34.40	39	0.402	33.368	1.169	5.806		NA	8	0.308	8.944	0.894		
	3. High	4717.65	32.71	31	0.320	31.732	0.977	-0.754		NA	16	0.615	8.505	1.881	28.825	0.4212	
Soil	1. Valley	3088.83	21.76	41	0.423	21.109	1.942	20.506	< 0.001	0.2944	7	0.269	5.658	1.237	5.161	< 0.05	0.1179
	2. Poor	2806.82	19.78	5	0.052	19.182	0.261	-14.620		NA	1	0.038	5.142	0.194	-15.929		NA
	3. Forest	3133.94	22.08	4	0.041	21.417	0.187	-17.956		NA	2	0.077	5.741	0.348	-14.387		NA
	4. Fertile	5164.11	36.38	47	0.485	35.292	1.332	12.070		0.2418	16	0.615	9.460	1.691	25.155		0.3934
Slope	1. < 5°	7945.85	55.10	81	0.835	53.445	1.516	28.407	< 0.001	0.4870	21	0.808	14.326	1.466	25.671	< 0.05	0.4553
	2. < 13°	4665.95	32.35	15	0.155	31.384	0.478	-16.891		NA	5	0.192	8.412	0.594	-13.124		NA
	3. > 13°	1809.46	12.55	1	0.010	12.171	0.082	-11.516		NA	0	0	3.262	0	-12.547		0
Solar radiation	1. Weak	1067.04	7.40	2	0.021	7.177	0.279	-5.337	< 0.001	NA	0	0	1.924	0	-7.399	> 0.05	NA
	2. Middle	5400.66	37.45	60	0.619	36.326	1.652	24.406		0.3885	15	0.577	9.737	1.541	20.243		NA
	3. Strong	6853.83	47.53	34	0.351	46.100	0.738	-12.474		NA	11	0.423	12.357	0.890	-5.218		NA
	4. Very strong	1099.74	7.63	1	0.010	7.397	0.135	-6.595		NA	0	0	1.983	0	-7.626		NA
Openness	1. Closed	1943.93	13.48	1	0.010	13.075	0.076	-12.449	< 0.001	NA	0	0	3.505	0	-13.480	< 0.05	NA
	2. Medium	4506.02	31.25	18	0.186	30.308	0.594	-12.689		NA	3	0.115	8.124	0.369	-19.707		NA
	3. Open	7961.47	55.21	78	0.804	53.550	1.457	25.206		0.4502	23	0.885	14.354	1.602	33.255		0.5423

Table 8. Summary of significant variables for the Neolithic.

0	U	Eneolithic																					
		Precucuteni (ENE I)							Cucuteni A (ENE II)							Cucuteni A-B and B (ENE III-IV)							
		n	Ps	E	Ps/Pa	gain	Chi2	Kj	n	Ps	E	Ps/Pa	gain	Chi2	Kj	n	Ps	E	Ps/Pa	gain	Chi2	Kj	
Orientation	1	6	0.078	6.320	0.949	-0.416	> 0.05	NA	21	0.066	25.937	0.810	-1.562	< 0.05	NA	0	0.000	20.027	0.000	-8.208	< 0.001	NA	
	2	12	0.156	14.296	0.839	-2.982		NA	80	0.253	58.670	1.364	6.750		0.131	50	0.205	45.302	1.104	1.925		0.063	
	3	32	0.416	23.188	1.380	11.444		NA	80	0.253	95.161	0.841	-4.798		NA	75	0.307	73.479	1.021	0.623		0.044	
	4	15	0.195	17.083	0.878	-2.705		NA	78	0.247	70.107	1.113	2.498		0.079	60	0.246	54.133	1.108	2.404		0.077	
	5	12	0.156	16.113	0.745	-5.341		NA	57	0.180	66.125	0.862	-2.888		NA	38	0.156	51.059	0.744	-5.352		NA	
Distance to water	1	18	0.234	15.540	1.158	3.194	< 0.001	0.086	46	0.146	63.776	0.721	-5.625	< 0.001	NA	34	0.139	49.245	0.690	-6.248	< 0.001	NA	
	2	37	0.481	23.676	1.563	17.304		0.288	126	0.399	97.163	1.297	9.126		0.191	96	0.393	75.025	1.280	8.597		0.184	
	3	19	0.247	19.681	0.965	-0.885		NA	102	0.323	80.770	1.263	6.718		0.147	83	0.340	62.367	1.331	8.456		0.170	
	4	3	0.039	18.101	0.166	-19.612		NA	42	0.133	74.286	0.565	-10.217		NA	31	0.127	57.360	0.540	-10.803		NA	
TPI	1	6	0.078	19.165	0.313	-17.098	< 0.001	NA	27	0.085	78.652	0.343	-16.346	< 0.001	NA	19	0.078	60.731	0.313	-17.103	< 0.001	NA	
	2	37	0.481	39.932	0.927	-3.808		NA	105	0.332	163.878	0.641	-18.632		NA	82	0.336	126.539	0.648	-18.254		NA	
	3	34	0.442	17.902	1.899	20.906		0.304	184	0.582	73.469	2.504	34.978		0.451	143	0.586	56.730	2.521	35.357		0.455	
Visibility	1	11	0.143	25.375	0.433	-18.669	< 0.001	NA	77	0.244	104.137	0.739	-8.588	< 0.001	NA	46	0.189	80.409	0.572	-14.102	< 0.001	NA	
	2	25	0.325	26.488	0.944	-1.933		NA	95	0.301	108.705	0.874	-4.337		NA	82	0.336	83.937	0.977	-0.794		NA	
	3	41	0.532	25.189	1.628	20.534		0.331	144	0.456	103.374	1.393	12.856		0.242	116	0.475	79.820	1.453	14.828		0.266	
Soil	1	30	0.390	16.757	1.790	17.199	< 0.001	0.259	116	0.367	68.768	1.687	14.947	< 0.001	0.234	82	0.336	53.099	1.544	11.845	< 0.001	0.200	
	2	0	0.000	15.227	0.000	-19.775		NA	16	0.051	62.489	0.256	-14.712		NA	9	0.037	48.251	0.187	-16.087		NA	
	3	7	0.091	17.001	0.412	-12.989		NA	45	0.142	69.772	0.645	-7.839		NA	26	0.107	53.875	0.483	-11.424		NA	
	4	40	0.519	28.015	1.428	15.565		0.284	139	0.440	114.971	1.209	7.604		0.183	127	0.520	88.775	1.431	15.666		0.286	
Slope	1	65	0.844	42.426	1.532	29.317	< 0.001	0.497	238	0.753	174.110	1.367	20.218	< 0.001	0.390	199	0.816	134.439	1.480	26.459	< 0.001	0.465	
	2	12	0.156	24.913	0.482	-16.770		NA	78	0.247	102.241	0.763	-7.671		NA	44	0.180	78.945	0.557	-14.322		NA	
	3	0	0.000	9.661	0.000	-12.547		NA	0	0	39.649	0	-12.547		NA	1	0.004	30.615	0.033	-12.137		NA	
Solar radiation	1	1	0.013	5.697	0.176	-6.100	< 0.001	NA	11	0	23.381	0	-3.918	< 0.001	NA	3	0.012	18.054	0.166	-6.170	< 0.001	NA	
	2	34	0.442	28.836	1.179	6.707		0.172	162	0.513	118.340	1.369	13.817		0.266	128	0.525	91.376	1.401	15.010		0.281	
	3	42	0.545	36.595	1.148	7.020		0.196	136	0.430	150.182	0.906	-4.488		NA	110	0.451	115.963	0.949	-2.444		NA	
	4	0	0.000	5.872	0.000	-7.626		NA	7	0	24.098	0	-5.411		NA	3	0.012	18.607	0.161	-6.396		NA	

Openness	1	0	0.000	10.379	0.000	-13.480	< 0.001	NA	0	0	42.595	0	-13.480	< 0.001	NA	2	0.008	32.890	0.061	-12.660	< 0.001	NA
	2	7	0.091	24.059	0.291	-22.155		NA	62	0.196	98.736	0.628	-11.625		NA	32	0.131	76.239	0.420	-18.131		NA
	3	70	0.909	42.509	1.647	35.703		0.570	254	0.804	174.453	1.456	25.173		0.450	210	0.861	134.704	1.559	30.859		0.515

Table 9. Summary of significant variables for the Eneolithic.

The model is evaluated according to two criteria defined by P. Verhagen (2007): Accuracy, which corresponds to the exactness of the model and measures whether the model is correct; and precision, which relates to the degree of refinement with which the classification, statistical testing and weighting operations are carried out. Precision therefore evaluates the capacity of the model to define areas high probability. For the early Neolithic (Criş, Neo. I), the model appears very accurate since it captures 71.1% of sites in an area of high probability corresponding to 32.6% of the total (Table 10). This fine resolution reflects a clear coherence in the modalities of Neolithic settlement, which is well characterised by the delimitation of the cartographic units. In addition, it is relatively precise with a statistical gain of 0.541. The model obtained for the LBK (Neo. II) is very different (Table 11), firstly because the alluvial valleys present a very low probability of occupation – the hydrography variable has been excluded from the model because of an unfavourable statistical Chi2 test (Table 8). Even though the model lacks refinement (57.7% of the sites are within an area of high probability equivalent to 25.6% of the total) it is relatively precise with a gain 0.556. Nonetheless, the performance of the model for the LBK is questionable because of the particularly limited sample of known sites. For both periods, it should be noted that the relatively significant negative gain for the areas of low probability suggests that the model is relatively appropriate for identifying areas of low archaeological potential.

	Ps	Pa	Gain (Kvamme)
Low prob.	0.082	0.341	-3.132
Medium prob.	0.206	0.333	-0.615
High prob.	0.711	0.326	0.541

Table 10. Model performance for the Criş (Neo. I).

	Ps	Pa	Gain (Kvamme)
Low prob.	0.077	0.335	-3.356
Medium prob.	0.346	0.409	-0.180
High prob.	0.577	0.256	0.556

Table 11. Model performance for the LBK (Neo. II).

Model performances are relatively similar for the three periods of the Eneolithic, i.e. Precucuteni (Eneo. I), Cucuteni A (Eneo. II), Cucuteni A-B and B (Eneo. III-IV) (Table 12, Table 13, and Table 14). For the Precucuteni and the Cucuteni A-B and B, the results are very refined with 79.2% and 81.9% of sites for areas of high probability of 32.7% and 27.8%, respectively. They are also relatively precise, with statistical gains ranging from 0.557 (Cucuteni A) to 0.587 (Precucuteni). Cucuteni A-B and B stand out noticeably with a value close to 0.661. This high value is essentially due to the fact that the low probability is carried over into the areas of high- and medium probability. Overall, depending on the period, our predictive model is characterised by a high degree accuracy – particularly for the Criş, the Precucuteni and the Cucuteni A-B and B – but is slightly lacking in precision since gain values fluctuate around 0.55. This relatively low value is partly due to the optimisation of the model and to the weighting choices.

	Ps	Pa	Gain (Kvamme)
Low prob.	0.013	0.344	-25.506
Medium prob.	0.195	0.329	-0.689
High prob.	0.792	0.327	0.587

Tab. 12. Model performance for the Early Eneolithic (Precucuteni, Eneo I).

	Ps	Pa	Gain (Kvamme)
Low prob.	0.073	0.356	-3.893
Medium prob.	0.291	0.362	-0.243

High prob.	0.636	0.282	0.557
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Table 13. Model performance for the Middle Eneolithic (Cucuteni A, Eneo. II).

	Ps	Pa	Gain (Kvamme)
Low prob.	0	0.382	NA
Medium prob.	0.181	0.341	-0.883
High prob.	0.819	0.278	0.661

Table 14. Model performance for the Late Eneolithic (Cucuteni A-B and B, Eneo. III-IV).

6. Discussion

6.1. Settlement pattern dynamics

On the basis of the analysis presented above, we can now attempt to outline Neolithic and Eneolithic settlement dynamics in Moldavia. It should be remembered that, apart from the transition maps (Fig. 2), our analyses only include sites with an established chronology, i.e. 76% of the corpus of sites.

6.1.1. Neolithic

Settlement sites dating to the Early Neolithic (Neo. I) are rare and display a very strong tendency towards concentration (Table 4, Diag. 1, $R = 0.54$) which dissipates at the very end of the Neolithic and the beginning of the Eneolithic (Eneo. I, $R = 0.69$). This tendency towards dispersion in the distribution until the first half of the 5th millennium accompanies a clear contraction of the population, particularly during the Middle Neolithic (Neo. II) where we observe a break-up of the strong settlement nuclei: this disintegration is revealed by the high average of the observed distances ($\bar{r}_a = 8860$ m). It is exactly this process that is revealed between the Criş and the LBK by the transition map (Fig. 2). The curve for the number of salt springs exploited mirrors the settlement curve, at least until the first phase of the Eneolithic (Diag. 1).

The Early Neolithic (Neo. I) is dominated by a coherent settlement model: the sites are located in valleys and on small terraces close to minor rivers (Diag. 2, Table 5). This emerges from the very low values of the topographical index and from the total visibility and landscape openness indices. Despite this positioning within valleys, the visual connection between sites remains at a relatively high level, which suggests that particular care was taken to ensure intervisibility between the settlements that formed the settlement nucleus. This high value must be set against the high aggregation index (Diag. 1), which indicates a high population concentration.

The LBK (Neo. II) is characterised by a significant decrease in the topographical index (Diag. 2, Tab. 5). It indicates a continuing trend towards the establishment of settlements in valleys and close to rivers. However, the increase in the openness value as well as the total visibility index prompts an important observation: while the majority of sites are still located in valleys, certain sites are established in more open contexts where the field of vision is markedly broader. Nonetheless, situations of intervisibility are uncommon, notably due to significant dispersion of settlements.

At the scale of Zone 2, the construction of the predictive model allows us to go further (Table 8). Criş settlements show a preference for very gentle slopes, orientated towards the north, east and south, and for small terraces. Distance to water is a discriminant variable, particularly for time intervals of less than 8 and 3 minutes. The importance of proximity to water courses, rivers, streams or rivulets situated in open environments is also implied by the preferential occupation of valley soils. As regards total visibility, the Chi2 value is considerably greater than 0.05: we therefore have to relativize the importance of this variable for revealing Early Neolithic settlement.

The numbers of sites are very low for the LBK (26). As a result, the Chi2 test is rarely dependable since the number of sites per cartographic unit is frequently less than 5. Nonetheless, the calculated values, subjected to the Yates correction when necessary, as well as the K_j values and the p_s/p_a ratio indicate that significant units for the establishment of settlements at a 95% probability level (99.9% for the topographical index) are as follows: 1. Terraces situated in alluvial valleys (Soil 1) or in very fertile valleys (Soil 4); 2. gentle slopes and very open landscapes. The performance of the model for the LBK is questionable given the particularly small sample of known sites.

6.1.2. Eneolithic

During the Precucuteni (Eneo. I), the tendency is towards dispersion with an observed average distance that is still high ($\bar{r}_a = 6762$ m) and an aggregation index that reaches its lowest level (Table 4, Diag. 1). It is interesting to note that this reorganisation of the territorial framework occurs hand-in-hand with a slight rise in the number of settlements (+65 sites) and, more especially, with a leap in the exploitation of salt as the number of salt springs with evidence for exploitation increases from 2 to 5 (Tab. 3, Diag. 1). The transition map (Fig. 2) and Table 7 support the idea of a settlement strategy linked to the control of the main river corridors.

During the first half of the 5th millennium, i.e. at the end of the Neolithic and the beginning of the Moldavian Eneolithic (Eneo. I), we see significant change in the topographical contexts (Table 5, Diag. 2). First of all, high- and mid-height terraces were favoured, reflecting a trend towards the establishment of settlements on exposed promontories with a particularly high level of visibility. We also note, however, that the number of visual links remains modest, which implies a rather wide dispersion of settlements (see also the aggregation index).

During the fully consolidated and developed phases of the Moldavian Eneolithic (Eneo. II), there is a major rise in the number of sites (+503 sites) while the level of salt exploitation remains unchanged (Diag. 1). From this time on, the territorial organisation is quite distinctive with a pattern dispersed ($R = 0.65$) and with an average distance that reaches its lowest score ($\bar{r}_a = 2800$ m). Between the Precucuteni (Eneo. I) and the Cucuteni A (Eneo. II), a few marginal sites (Fig. 2) are abandoned and, in particular, we see the establishment of a large number of new settlements throughout almost the entire study area. The expansion of the Cucuteni A is particularly evident in areas suitable for agriculture (for the entire Zone 2, see the summary of significant variables of the predictive model, Table 9) but also in areas close to salt springs. It must be noted, nonetheless, that in comparison with the preceding period, this phenomenon is less focused on salt resources and more on territorial control which extends well beyond the salt-rich valleys.

Apart from the topographical index value that continues to rise during the Middle Eneolithic (Eneo. II), implying an increase in the number of high-altitude settlements, the landscape openness and total visibility indices both drop dramatically (Diag. 2, Tab. 5). This is a consequence of the diversification in the forms of land occupation noted during the second half of the 5th millennium BC. While often sited on higher ground, Middle Eneolithic settlements henceforth occupy a very large variety of valley locations, whether the valleys be wide and visually very open, or narrow and barely visible. The number of visual links rises, reflecting a high hierarchized pattern and massive territorial investment. It also indicates a reorganisation of settlement, based on a territorial structure that clearly differs from the preceding periods. New agro-pastoral practices, with increased mobility of household units, may explain the particularly large number of Eneolithic sites, especially during the Cucuteni A.

The end of the Eneolithic (Eneo. III-IV) is marked by an intensification of salt exploitation and a noticeable contraction of the population (-160 sites) which, while still very dense ($\bar{r}_a = 3004$ m), becomes more concentrated than previously ($R = 0.60$) (Table 4, Diag. 1). The transition between Cucuteni A and Cucuteni A-B and B (Fig. 2) reveals a shift towards a more centralised pattern, with a reinforcement of previously well-established settlement networks, particularly in the salt-bearing foothills and in the north-east of the study area.

The tendency towards diversification in the ecosystems occupied is again reversed at the end of the Eneolithic (Eneo III-IV): the high values of all topographical indices seem to indicate territorial reorganisation involving a shift towards settlements on elevated sites within broad alluvial valleys and, therefore, the abandonment of marginal areas occupied during Cucuteni A (Fig. 2). This is confirmed by the rise in the number of visual links, which in turn implies a consolidation in the forms of land occupation as well as a concentration of settlement areas (see also the aggregation index which reveals a very concentrated distribution).

The results obtained for the entire Zone 2 support these initial interpretations (Table 8, Table 9). For the Precucuteni (Eneo. I), Cucuteni A (Eneo. II) and Cucuteni A-B and B (Eneo. III-IV), the significant cartographic units are more or less the same – with the exception of orientation and distance to watercourse – with the only differences being quantitative: they indicate the importance of certain units in the choices made by prehistoric communities. For example, for the early Eneolithic, the most fundamental units are terraces (or promontories) situated within very open, visible landscapes, valley wetlands and areas situated a short distance from water (less than 10 minutes). During the Middle Eneolithic (Cucuteni A), proximity to water is less sought after than elevated terraces, which were open and visible (although less so than during the Precucuteni). At the end of the Eneolithic, we note few

changes: 'very visible', 'open' and 'terraces and promontories' are the most sought after cartographic units, with a particular preference for very fertile valley soils.

6.2. Salt and settlement polarisation

The analysis of the proximity between salt resources and archaeological sites is aimed to test the relationship between the presence of high-status objects and the existence of socio-economic control. Examination of four datasets (salt water springs; fortified settlements; unfortified settlements; and copper axes) has yielded several important results.

The percentage of non-fortified settlements situated within a three-hour walking distance from a salt spring remains low (14.3%) and does not vary significantly (Table 6). However, it is worth noting that the highest value occurs for the time interval ranging from one- to one and a half hour walking distance (3.3%). The percentage of fortified settlements situated within a three-hour walking distance from a salt spring is particularly high (47.8%) which is an indication of the capacity of prehistoric communities to control salt resources. This hypothesis is confirmed by the very high percentage of fortified sites situated less than thirty minutes (11.6%), between thirty minutes and an hour (17.4%) and between an hour and an hour and a half (11.6%) from a salt source.

Regarding the percentage of copper axes (Table 6), our observations are similar and also highlight a concentration of wealth in proximity to salt resources, particularly between thirty minutes and two hours (14%, 10.5% and 8.8%, respectively).

The ratio of the time intervals to the surface area, and its representation in diagram form (Diag. 3), which is validated by comparing the results with a random distribution (Diag. 4), allows us to propose a pronounced and regular decrease in fortified settlements and copper axes with distance from the salt resource, excepting the half-hour to one hour time-interval. This result is of great significance: it illustrates the attractiveness of the salt resource, its capacity to stimulate exchange and to attract prestige goods, and also the control that was exercised over it via the high density of fortified settlements.

7. Concluding remarks

By using GIS, cartography and statistics, we have highlighted the role of salt in the territorial and economic organisation of the first agro-pastoral societies. The Early Neolithic emerges as a first phase of colonisation during which salt resources were actively sought, without being integrated within a particularly structured territorial organisation. Leaving aside the late 6th millennium, which is poorly documented, this study underlines the magnitude of the territorial modifications which began at the dawn of the 5th millennium BC.

Thus, identification of specific forms of settlement and resource exploitation furthers our understanding of the development of social complexity during later prehistory. By considering a set of parameters such as inter-site distance, the topographical or pedological context, and the evolution of visibility connections, we have been able to reveal the territorial implications of changes that were hitherto only evident in terms of domestic architecture, artefacts, and the evolution of rites and beliefs. This approach, applied for the first time to the whole of Romanian Moldavia, enables us to refine our settlement- and resource exploitation models while at the same time highlighting the main trends in territorial organisation, both in time and space.

However, our approach remains reliant on the quality of archaeological data, which are often fragmentary and incomplete. Several major hurdles are identified: the contemporaneity of known settlement sites is difficult to establish as we are often dealing with time periods of several hundred years; the identification of settlement sites is often difficult on account of investigations that are frequently too limited in extent. It is in this context that we embarked on a project focusing on predictive modelling. This has proven an effective way of moving beyond inventory maps which only represent a fraction of settlement at any given time.

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