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Any correspondence will be sent to the editor:
INSTITUTUL DE ARHEOLOGIE ȘI ISTORIA ARTEI
Str. M. Kogălniceanu nr. 12–14, 400084 Cluj-Napoca, RO
e-mail: choprean@yahoo.com

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THE USEFULNESS OF INTERDISCIPLINARY STUDIES: PALAEOECOLOGICAL AND ARCHAEOLOGICAL ASPECTS FROM NW ROMANIA*

Roxana Grindean, Vlad-Andrei Lăzărescu, Andrei-Cosmin Diaconu,
Coriolan Horațiu Opreanu, Sorina Fărcaș, Ioan Tanțău

Abstract: *The combined investigation of both archaeological and palaeoecological data can offer significant input into the characterization of many aspects of past cultures and the impact that human activities have induced onto the natural environment over time. The present study is based on the correlation of palaeoenvironmental records of pollen, non-pollen palynomorphs (NPP), fungal spores and micro-charcoal with archaeological data, and a statistical approach, from the NW part of Romania, since the Late Neolithic era. The results suggest an increased human pressure on the landscape during phases of higher inhabitancy in the area (Late Neolithic and Eneolithic, Roman period, Medieval period), as well as intervals with less habitation but an increased human impact which can be explained by a possible over-exploitation of natural resources through intense and regular usage of a single agricultural practice (e.g., grazing during Hallstatt, La Tène). Climate was also an important factor that could have influenced the extent of the level of anthropogenic impact in the area.*

Keywords: *palaeoecology, archaeology, anthropogenic indicators, elevational level, settlement pattern*

Introduction

The long term anthropization of natural habitats is visible through the human selection and exploitation of cultivated plants and weeds over the millennia, as well as rearing of animals¹. Palaeoecology analyzes environmental evidence to assess the impact of natural events and human activities on landscape, climate and the changing environments. Using fossil data (e.g. pollen, spores, plant and insect remains, algae, charcoal) and sediments, palaeoenvironmental studies complement archaeological evidence and can aid to determine seasonality of site occupation, presence or absence of agricultural practices or products, as well as the management of natural and cultural heritage.

Palynology is one of the most effective and used tools to reconstruct past environment. Lake sediments and peat bogs are particularly valuable for preserving pollen grains not only because they are chemically suitable but also because they accumulate over time. The study of fossil pollen spectra aims to establish the anthropogenic influences on vegetation, like the

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¹ BIRKS ET ALII 1988; FAEGRI/IVERSEN 1989; MARINOVA ET ALII 2012; MERCURI ET ALII 2013.

presence and development of human activities or stages of abandonment². The pollen types which reflect human occupation and land-use are usually grouped in i) crop and associated fallowland plants, ii) ruderal flora and iii) pasturage indicating taxa. The development and employment of different agricultural implements has changed the floristic composition and richness of the weed communities³.

The palaeoenvironmental indicator value of fungal spores and various other non-pollen palynomorphs (NPP) has proven to be significantly useful in recent years⁴. Spores of coprophilous fungi, such as *Cercophora*-type, *Podospora*-type *Sporomiella*-type, were used to infer the presence of domestic stock and/or grazing herbivores⁵. It has also been emphasized that the local distribution of coprophilous fungi and abundance of spores is influenced by the number of herbivores in the area⁶.

A method to reconstruct local or regional fire history is provided by charcoal particles preserved in peat⁷. Both pollen and charcoal suggest climate conditions non-/suitable for fires⁸. Episodic high-charcoal abundance and episodic occurrences of fungi that develop on burnt plant remains concurring with rise in anthropogenic pollen indicators and archaeological evidence from an area could be associated with increase in human impact and suggests that many of the fires were started by humans⁹.

Recent palaeoecological studies conducted in the Transylvanian Plain, have pointed out that the extensive forests which dominated the area during the early and middle Holocene, have been subjected to extensive deforestations after 1750 BC, with the earliest evidence of agricultural landscape (Cerealia pollen) being recorded at ca. 5050 BC¹⁰. Signs of agro-pastoral practices in NW Romania were noted from about 4650 BC, which were only substantial during the last 300 years¹¹.

Investigations on the vegetation, climate and fire history in the Apuseni Mountains¹² have mentioned anthropogenic pressure on the mountainous landscape and its adjacent lowlands starting from 5000 /4850 BC with the first occurrence of Cerealia pollen and increased percentage values of plants like wormwood (*Artemisia*), species of goosefoot (Chenopodiaceae) and grasses (Poaceae). The different changes in forest and grasslands dynamics that were associated with phases of human impact were also attributed to the different cultures that are known to have been present in the areas nearby (e.g. Gura Baciului, Ocna Sibiului, Starčevo-Criș III–IV).

In Romania, research papers that deal with the evolution of cultural landscapes during the Holocene in agreement with both palaeoecological and archaeological data are scarce¹³.

² BRUN 2009; BRUN 2011.

³ BERGLUND ET ALII 2008; BRUN, 2009; FEURDEAN ET ALII 2013a; FEURDEAN ET ALII 2015; TANȚĂU ET ALII 2014.

⁴ LOPEZ-SAEZ/LOPEZ-MERINO 2007; SCHOFIELD/EDWARDS 2011.

⁵ VAN GEEL ET ALII 2003; MARINOVA/ATANASSOVA 2006; VAN GEEL/APTROOT 2006; INNES ET ALII 2010.

⁶ RAPER/BUSH 2009; EKBLUM/GILLSON 2010.

⁷ WHITLOCK/LARSEN 2001; FEURDEAN ET ALII 2012; FEURDEAN ET ALII 2013b.

⁸ HIGUERA ET ALII 2009; BLARQUEZ/CARCAILLET 2010; RIUS ET ALII 2011; FEURDEAN ET ALII 2012; FEURDEAN ET ALII 2013b.

⁹ FEURDEAN ET ALII 2009; MAGYARI ET ALII 2010; FEURDEAN ET ALII 2013b; MARINOVA ET ALII 2012.

¹⁰ FEURDEAN ET ALII 2013a; FEURDEAN ET ALII 2015.

¹¹ FĂRÇAȘ ET ALII 2003; FEURDEAN ET ALII 2001; TANȚĂU ET ALII 2006; TANȚĂU ET ALII 2014.

¹² BODNARIUC ET ALII 2002; JALUT ET ALII 2003; FĂRÇAȘ ET ALII 2005; FĂRÇAȘ ET ALII 2007; FEURDEAN/WILLIS 2008; FEURDEAN ET ALII 2009; FEURDEAN ET ALII 2012; GRINDEAN ET ALII 2014; GRINDEAN ET ALII 2015.

¹³ DARÓCZI 2012a; DARÓCZI 2012b; FĂRÇAȘ ET ALII 2003; FEURDEAN ET ALII 2012; FEURDEAN ET ALII 2013a; FEURDEAN ET ALII 2015; TANȚĂU ET ALII 2006.

These papers offer valuable insight into how human pressure has become a considerable cause of vegetation changes and trends in land use starting mainly with the Bronze Age. However, such multidisciplinary studies which offer an overall trend of the impact of human occupation and land-use in our study area have not yet been developed.

The main aim of our present study is to provide an example of how archaeological information can be better integrated into palaeoecological studies, and vice versa, in order to attain an outcome which better reflects the evolutionary tendency of the climate – vegetation – human relationship from the Neolithic onward. In pursuance of this objective, we have synthesized the aspects of vegetation history, fire activity and human impact from a peat sequence located in the lowlands of the NW part of the Apuseni Mountains, and the abundance of recorded settlements for each chrono-cultural phase in the area starting with the Late Neolithic.

Study area

The Iaz peat bog is located on the western edge of the Şimleu Depression, at the bottom of the eastern slope of the Plopiş Mountains (Fig. 1). It is part of the Nature Reserve “Mlaştina de la Iaz” and it is surrounded by an alluvial forest and several other forested habitats which provide protection and preservation of the meso-oligotrophic vegetation. There are two main woodlands in the reserve, one dominated by alder (*Alnus glutinosa*) and the other by beech (*Fagus sylvatica*), sessile oak (*Quercus petraea*) and hazel (*Corylus avellana*)¹⁴. Based on studies on pollen productivity and dispersal in temperate forested landscapes and the fact that peat bogs are depositional basins with higher income of pollen¹⁵, the small basin size allows us to distinguish between local (few kilometres) and regional vegetation. Moreover, the pollen curves¹⁶ display many common features with other available pollen records in NW Romania¹⁷ and thus, it is likely that the pollen source area at the study site was much larger than several kilometers.

The Şimleu Depression is confined between the Plopiş (in the W and SW) and the Meseş Mountains (in the E and SE), in the NW part of Romania (Fig. 1). The local rivers form terraces as wide as 2–3 km in some areas, which made this mainly hilly region habitable since prehistoric times¹⁸. The main tree taxa in the regional forests are: beech (*Fagus sylvatica*), hornbeam (*Carpinus betulus*), and species of oak (*Quercus petraea* and *Q. cerris*), ash (*Fraxinus excelsior*) and

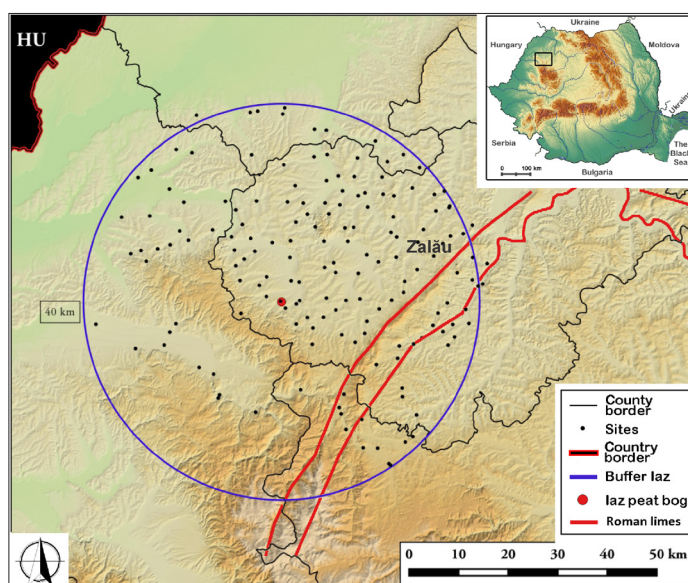


Fig. 1. Location map and spatial distribution of the studied sites.

¹⁴ INSTITUTE OF BIOLOGICAL RESEARCH, 2012.

¹⁵ JACOBSON/BRADSHAW 1981; SUGITA 1994; SUGITA 2007.

¹⁶ GRINDEAN ET ALII 2014.

¹⁷ FĂRCAŞ ET ALII 2005; FEURDEAN AND WILLIS, 2008; FEURDEAN ET ALII 2007; FEURDEAN ET ALII 2008; FEURDEAN ET ALII 2013b.

¹⁸ BĂCUEȚ-CRIŞAN 2008.

pine plantations (*Pinus sylvestris*)¹⁹. The agricultural land is evenly divided nowadays between arable land (land producing crops) and natural or artificial grasslands and shrublands used for grazing livestock. The eastern side of the depression is also known as the Sylvania wine region with vineyards producing varieties of white wine. The meadows in the region are also rich in medicinal plants, like cowslip (*Primula officinalis*), chamomile (*Matricaria chamomilla*), and yarrow (*Achillea millefolium*). The climate in the area is temperate and is characterized by mean annual temperatures of 8–9 °C with mean annual precipitations between 700 and 800 mm²⁰.

The 40 km buffer zone around the site from Iaz was chosen in order to encompass a relevant number of archaeological sites from the study area (Șimleu Depression), significant enough for the analysis of the abundance of settlements, as well as providing a wider view of the various altitudinal habitats and therefore, possible source areas for the pollen producing taxa with large dispersal area before man-made plantations in recent times (e.g. *Pinus*) (see Table 1).

In order to proceed with such an analysis, we had to gather all the archaeological data that we could find by consulting the archaeological repertories that provided information regarding the focused area²¹. We must mention right from the beginning that since we were interested only in the major trends regarding the types of habitation and their chronological dynamics that could be linked with certain environmental changes, we did not approach the cultural aspects of the discoveries, a thorough chronological analysis of the sites being the subject of future studies.

Table 1. Catalogue of the studied sites

	Site	County	Elevation	Neolithic	Bronze Age	Hallstatt	La Tene	Roman Period	Migrations Period	Medieval Period	Fredman-Diaconis	Wand
1	Abbrămuș	BH	150.000	0	0	0	0	0	1	0	1	1
2	Aghireș	SJ	308.000	1	0	0	0	0	1	0	3	3
3	Agrij	SJ	305.000	1	1	0	1	1	0	1	3	3
4	Aleșd	BH	248.000	1	1	0	0	0	0	0	2	2
5	Aleuș	SJ	304.000	1	1	0	0	1	0	0	3	3
6	Aștileu	BH	271.000	0	0	0	0	1	0	0	3	3
7	Bădăcin	SJ	258.000	1	1	0	1	1	1	1	2	2
8	Badon	SJ	231.000	1	1	0	1	1	1	1	2	2
9	Bălanca	BH	338.000	0	1	1	0	0	0	0	4	4
10	Balc	BH	170.000	1	1	0	1	0	1	0	1	1
11	Bâlgheaz	SJ	315.000	1	0	0	0	0	0	1	3	4
12	Ban	SJ	348.000	0	0	0	0	0	0	1	4	4
13	Bănișor	SJ	310.000	0	0	0	0	0	0	1	3	3
14	Becheni	SM	168.000	1	1	0	0	1	1	1	1	1
15	Bic	SJ	382.000	1	0	0	0	1	0	0	4	5
16	Bicălatu	CJ	456.000	1	0	0	0	0	0	1	5	6
17	Bobota	SJ	210.000	1	1	0	0	1	1	1	2	2

¹⁹ INSTITUTE OF BIOLOGICAL RESEARCH, 2012.

²⁰ CHAMBER OF COMMERCE AND INDUSTRY SĂLAJ – http://www.ccisalaj.ro/despre_salaj_prezentare.php

²¹ DUMITRAȘCU 1974; CRIȘAN ET ALII 1992; LUCA/GUDEA 2010 as well as the National Archaeological Repertory see <http://ran.cimec.ro/>.

	Site	County	Elevation	Neolithic	Bronze Age	Hallstatt	La Tene	Roman Period	Migrations Period	Medieval Period	Fredman-Diaconis	Wand
18	Bocșa	SJ	217.000	1	1	0	1	1	1	0	2	2
19	Bodia	SJ	344.000	1	0	0	0	0	0	0	4	4
20	Bogdana	SJ	438.000	1	0	0	0	0	0	0	5	5
21	Bogdand	SM	203.000	1	1	1	1	1	1	1	1	1
22	Boghiș	SJ	254.000	1	1	0	1	1	1	1	2	2
23	Bologa	CJ	541.000	0	0	0	0	1	0	1	6	7
24	Borla	SJ	216.000	1	1	0	0	1	1	1	2	2
25	Bozieș	SJ	251.000	1	1	0	0	1	1	0	2	2
26	Bozna	SJ	363.000	0	1	1	0	1	0	0	4	4
27	Brăișoru	CJ	584.000	0	0	0	0	0	0	1	6	8
28	Brebi	SJ	296.000	1	1	1	0	1	1	1	3	3
29	Brusturi	SJ	252.000	0	0	1	0	1	0	0	2	2
30	Buciumi	SJ	376.000	1	0	1	1	1	0	0	4	5
31	Budoi	BH	231.000	0	0	0	0	0	0	1	2	2
32	Călata	CJ	599.000	1	0	0	0	0	0	0	6	8
33	Camăr	SJ	211.000	1	1	0	0	0	0	0	2	2
34	Câmpia	SJ	205.000	0	0	0	1	0	0	0	2	2
35	Carastelec	SJ	240.000	1	1	0	0	0	0	1	2	2
36	Cehăluț	SM	179.000	1	1	0	0	1	1	1	1	1
37	Cehei	SJ	222.000	1	1	1	1	1	1	1	2	2
38	Cerâșa	SJ	275.000	1	0	0	1	0	0	0	3	3
39	Chegea	SM	198.000	1	1	0	0	1	1	1	1	1
40	Chiejd	SJ	224.000	0	1	0	0	0	0	0	2	2
41	Chilioara	SJ	219.000	0	1	0	0	0	0	0	2	2
42	Ciumărna	SJ	330.000	1	1	0	0	0	0	0	4	4
43	Cizer	SJ	443.000	0	1	0	0	0	0	1	5	6
44	Coșeiu	SJ	257.000	0	0	0	0	0	0	1	2	2
45	Cosniciu de Jos	SJ	245.000	0	0	0	0	1	1	1	2	2
46	Cosniciu de Sus	SJ	248.000	0	1	0	0	0	0	0	2	2
47	Crasna	SJ	266.000	1	1	1	1	1	1	1	3	3
48	Creaca	SJ	251.000	0	0	0	0	1	0	0	2	2
49	Crișeni	SJ	238.000	1	1	0	1	1	0	0	2	2
50	Criștelec	SJ	235.000	0	0	0	1	0	0	1	2	2
51	Cuceu	SJ	308.000	1	1	0	0	1	1	1	3	3
52	Cutiș	SJ	447.000	0	0	0	0	0	0	1	5	6
53	Deleni	SJ	237.000	0	0	0	0	1	0	0	2	2
54	Derna	BH	225.000	0	0	0	0	1	0	0	2	2
55	Derșida	SJ	200.000	0	1	0	1	0	0	0	1	1

	Site	County	Elevation	Neolithic	Bronze Age	Hallstatt	La Tene	Roman Period	Migrations Period	Medieval Period	Fredman-Diaconis	Wand
56	Doba Mare	SJ	251.000	0	0	0	0	0	0	1	2	2
57	Doba Mică	SJ	256.000	0	0	0	0	0	0	1	2	2
58	Dobricionești	BH	309.000	1	0	0	0	0	0	0	3	3
59	Doh	SJ	258.000	1	1	0	0	1	1	0	2	2
60	Drighiu	SJ	278.000	0	0	0	0	1	1	1	3	3
61	Făgetu	SJ	580.000	0	1	0	0	0	0	0	6	8
62	Fetindia	SJ	344.000	1	0	0	0	1	0	0	4	4
63	Fildu de Jos	SJ	372.000	1	0	0	0	0	0	0	4	4
64	Firminiș	SJ	322.000	0	0	1	1	0	0	0	3	4
65	Fizeș	SJ	344.000	0	0	1	0	0	0	0	4	4
66	Gârceiu	SJ	258.000	1	1	1	0	1	0	0	2	2
67	Ghenetea	BH	201.000	0	0	0	0	1	0	0	1	1
68	Giorocuta	SM	174.000	1	0	0	0	0	0	0	1	1
69	Giurtelecu Șimleului	SJ	212.000	1	1	1	1	0	1	1	2	2
70	Guruslău	SJ	241.000	0	0	1	0	0	1	1	2	2
71	Halmășd	SJ	338.000	1	1	1	1	1	1	1	4	4
72	Hereclean	SJ	222.000	1	1	0	1	1	1	0	2	2
73	Hodișu	CJ	608.000	0	0	0	0	1	0	0	6	8
74	Hodod	SM	266.000	1	1	0	0	0	0	0	3	3
75	Horoatu	SJ	290.000	1	0	1	1	1	0	1	3	3
76	Huedin	CJ	568.000	0	1	1	0	1	1	0	6	8
77	Hurez	SJ	386.000	0	0	0	0	1	0	0	4	5
78	Huseni	SJ	316.000	0	1	1	0	1	0	0	3	4
79	Huta	SJ	510.000	0	0	0	0	1	0	0	6	7
80	Iaz	SJ	305.000	1	0	0	0	0	1	0	3	3
81	Ilișua	SJ	225.000	1	0	0	0	0	0	0	2	2
82	Ip	SJ	219.000	1	1	1	0	0	1	1	2	2
83	Jac	SJ	266.000	1	0	0	1	1	0	1	3	3
84	Lelei	SM	260.000	1	0	0	0	0	0	0	2	3
85	Leșmir	SJ	186.000	1	0	0	0	0	0	1	1	1
86	Lompirt	SJ	217.000	1	1	0	1	1	1	0	2	2
87	Lorău	BH	404.000	0	1	0	0	0	0	1	5	5
88	Mălădia	SJ	241.000	0	0	0	0	0	0	1	2	2
89	Marca	SJ	222.000	1	1	1	1	1	1	1	2	2
90	Marghita	BH	161.000	1	0	0	0	0	0	0	1	1
91	Margine	BH	183.000	1	0	0	0	0	0	0	1	1
92	Marin	SJ	348.000	1	0	0	1	1	0	0	4	4
93	Meseșenii de Jos	SJ	327.000	1	1	0	0	0	0	0	4	4

	Site	County	Elevation	Neolithic	Bronze Age	Hallstatt	La Tene	Roman Period	Migrations Period	Medieval Period	Fredman-Diaconis	Wand
94	Meseșenii de Sus	SJ	341.000	1	1	1	1	1	0	1	4	4
95	Mesteacănu	SJ	446.000	0	0	0	0	1	0	0	5	6
96	Mirșid	SJ	292.000	0	0	0	1	1	1	1	3	3
97	Mișca	BH	188.000	1	1	1	0	1	1	0	1	1
98	Moiad	SJ	202.000	0	0	0	0	0	0	1	1	1
99	Moigrad-Porolissum	SJ	503.000	1	1	1	1	1	1	1	6	7
100	Morlaca	CJ	552.000	0	0	0	1	1	0	0	6	8
101	Naimon	SJ	224.000	1	0	1	0	0	0	1	2	2
102	Negreni	CJ	485.000	0	1	0	0	1	0	0	5	6
103	Nușfalău	SJ	232.000	1	1	0	1	1	1	1	2	2
104	Ortelec	SJ	330.000	1	0	0	1	1	1	0	4	4
105	Panic	SJ	254.000	1	1	1	1	1	1	0	2	2
106	Păușa	SJ	317.000	1	0	0	0	0	0	0	3	4
107	Peceiu	SJ	294.000	1	0	0	1	1	0	1	3	3
108	Pericei	SJ	234.000	1	1	1	1	1	1	1	2	2
109	Peștiș	BH	264.000	1	1	0	0	0	0	0	3	3
110	Petreu	BH	146.000	0	1	0	0	0	0	1	1	1
111	Plopiș	SJ	301.000	1	1	0	0	1	1	1	3	3
112	Poarta Sălajului	SJ	286.000	0	1	0	0	1	0	0	3	3
113	Poiana Măgura	SJ	268.000	0	0	0	1	0	0	0	3	3
114	Poieni	CJ	536.000	0	0	0	0	1	0	0	6	7
115	Popeni	SJ	255.000	0	1	1	0	0	1	0	2	2
116	Popești	BH	194.000	0	0	0	0	1	0	0	1	1
117	Porț	SJ	186.000	1	1	1	1	1	1	0	1	1
118	Preoteasa	SJ	396.000	1	0	0	0	0	0	0	4	5
119	Pria	SJ	420.000	0	0	0	0	1	0	0	5	5
120	Puini	CJ	541.000	1	0	0	0	0	0	0	6	7
121	Răstoilțu Deșert	SJ	319.000	1	0	0	0	0	0	0	3	4
122	Răstoilțu Mare	SJ	380.000	1	1	0	0	0	0	0	4	5
123	Ratin	SJ	288.000	1	0	0	0	1	0	1	3	3
124	Recea	SJ	255.000	0	1	0	1	1	1	1	2	2
125	Românași	SJ	286.000	0	1	1	1	1	0	0	3	3
126	Romita	SJ	260.000	1	0	0	0	1	0	0	2	3
127	Săcălășău	BH	206.000	1	1	0	1	0	0	0	2	2
128	Săcălășău Nou	BH	292.000	0	1	0	1	0	1	0	3	3
129	Săcășeni	SM	177.000	0	0	0	0	0	0	1	1	1
130	Sâg	SJ	387.000	1	0	1	0	0	0	1	4	5
131	Sălăjeni	SJ	201.000	0	0	0	1	0	0	0	1	1

Materials and methods

A single core was collected from the centre of the Iaz peat bog reaching a length of 540 cm. The sediments were described and afterwards sub-sampled (1 cm³) at 5 cm intervals for the entire length. The sample preparation followed the standard procedures: acetolysis for peat and flotation with ZnCl₂ for clayey samples. Microscope slides were prepared from the residue and scored for pollen, NPP and micro-charcoal. The basal samples (first 20 cm) were palynologically sterile because of the abundance of mineral matter. For each pollen slide, a minimum of 350 terrestrial pollen grains and micro-charcoal particles longer than 10 µm were counted. Pollen keys and illustrations from Reille (1995, 1998, 1999)²² were used for pollen identification. The nomenclature for vascular plants follows *Flora Europaea*²³. The synthetic diagram was drawn using the TILIA software²⁴.

Percentages of selected pollen taxa and NPPs were used in order to investigate the degree of human impact in the study area. The selection and grouping of these human activity indicators were based on the type of anthropogenic signal that these species can provide for our research.

Thus, the percentage curves of trees and shrubs can help identify disturbances in the forest cover in the area that could be linked to human agro-pastoral activities (expansion of the farmland through fire and deforestation and/or wood exploitation). This category includes: i) beech (*Fagus sylvatica*) and hornbeam (*Carpinus betulus*) as the main tree species that dominated the regional landscape throughout most of the vegetation history in our sequence, as well as hazel (*Corylus avellana*) and members of the *Quercetum mixtum* (oak – *Quercus*, lime – *Tilia* and elm – *Ulmus*); ii) the secondary forest curve which consists of the percentage sum of tree taxa (birch – *Betula*, pine – *Pinus*, ash – *Fraxinus* and dogwood – *Cornus*-type) which replace the main forest species during disturbances in the forest evolution; iii) grapevine (*Vitis*) and fruit trees, like walnut (*Juglans*) and chestnut (*Castanea*).

The herbs category comprises the pollen percentage curves of: i) crops – cultivated plants (cereals – Cerealia; vegetables – Solanaceae) and weeds growing on the farmed land (e.g. cornflower – *Centaurea cyanus*²⁵); ii) ruderals – weeds colonizing areas that have been disturbed, as by fire or cultivation and human settlement (Poaceae, Polypodiaceae, *Scabiosa*-type, *Senecio*-type, *Ambrosia*, *Astragalus*, *Arctium lappa*, *Urtica*²⁶); iii) pastures – herbs growing on pasturelands and meadows (e.g. Apiaceae, Asteroideae, *Plantago lanceolata*, *Artemisia*, *Rumex*, Caryophyllaceae, Chenopodiaceae)²⁷.

The NPPs selected for this study include: i) spores of fungi growing on animal dung and associated with grazing livestock (e.g. *Sporomiella*-type, *Podospora*-type, *Cercophora*-type) and ii) fungi occurring on burnt plant remains (e.g. *Neurospora*-type).

Additionally, the abundance of micro-charcoal particles from pollen slides (< 150 µm) was used as proxy for regional biomass burning.

Climate is widely recognized as one of the main factors favouring the shaping of the cultural landscape as well as economic reforms and/or shifts²⁸, or sacred and cultural regulations²⁹. Moreover, climate variability can in many instances amplify or override the effects of human pressure on a local, regional or global scale.

²² REILLE 1995; REILLE 1998; REILLE 1999.

²³ TUTIN ET ALII 1964–1980.

²⁴ GRIMM 1992.

²⁵ BRUN 2009; BRUN 2011; FEURDEAN ET ALII 2013a.

²⁶ BRUN 2009; FEURDEAN ET ALII 2013a.

²⁷ BRUN 2009; FEURDEAN ET ALII 2013a.

²⁸ BERGLUND 2003; DE BEAULIEU ET ALII 2005; BERGER/GUILAINE 2009.

²⁹ ROSE 1922; BINFORD 1971. For a more recent discussion regarding the relationships between the environment and the cultural factors that shape the identity of a community see SPORN/LADSTÄTTER/KERSCHNER 2015.

Any palaeoecological study requires an accurate and precise chronology which provides time-scales for events, and thus rates for processes³⁰. Seven samples of bulk peat from the Iaz sequence were dated by the AMS method at the Radiocarbon Laboratory in Poznań (Poland). The AMS¹⁴C measurements were converted into calendar years BP via the Clam software³¹ using the INTCAL13 data set of REIMER ET ALII 2013. In the same process, age-depth curves were repeatedly drawn through point estimates sampled from the dates which eventually led to an age-depth based on a smoothing spline model (with 0.3 smooth; 1000 iterations). Dating error ranges and a ‘best’ age-model were calculated. Ages are calculated at a 1 cm resolution by default, from the shallowest to the deepest dated depth of the peat core³².

For a better understanding of the data offered both by the environmental analysis and by the distribution patterns of the archaeological sites, we needed to establish relevant elevation groups based on the distribution of the elevations of the studied sites. By doing so, correlation between altitudinal distribution through time with climate changes can also be detected. Several statistical tests were used in order to determine the grouping of the already mentioned data taking into account also the range of the data that we needed to analyse³³. The most suitable results were those obtained after using the “Freedman – Diaconis rule”³⁴ and the “Wand rule” already embedded in the PAST statistical package software³⁵. Therefore we obtained different groupings for our dataset that allowed us to analyse and visualize the different distributions of the sites from each period in accordance with the above mentioned groupings.

Results

Litostratigraphy and chronology

A simplified stratigraphy for the analysed sequence (0–520 cm) can be seen on the lithology column in the synthetic diagram (Fig. 3). The bottom 20 cm of the sequence consists of clayey gyttja followed by clayey peat between 520–420 cm. The remaining top 420 cm of the sequence are composed of peat with various degrees of humidification and composition. The topmost part of the sequence (0–60 cm) consists of undecomposed peat.

Uncalibrated and calibrated ¹⁴C ages are provided in Table 1. We suspect a possible hiatus at around 520 cm, which led to the exclusion of the radiocarbon date of 8380 ± 50 BP³⁶. We have used known pollen stratigraphic markers from nearby sites to assign the beginning of the peat sedimentation in our sequence to a given age. Thus, our pollen record from the Iaz peat sequence starts at about 5050 BC³⁷.

³⁰ BENNETT 1994.

³¹ BLAAUW 2010.

³² CLAM 2.2 MANUAL – <http://chrono.qub.ac.uk/blaauw/clam.html>

³³ We chose this type of approach due to the homogeneity of the data that we have worked with; we needed to observe discrete beaks in our series that we might test against the environmental changes. Because the typical geographic divisions yielded very large groupings (basically 2 groups; group 1 < 300 m and group 2 > 300 m) and therefore unusable from our point of view, several statistical tests were used such as the “Sturges rule” (a formula that assumes an approximately normal distribution of the data see STURGES 1926 and for a critique of this method see HYNDMAN 1995) and “Scott’s rule” (a formula that introduces into the equation the standard deviation of the sample see SCOTT 1979). Although both these formulas were adapted to the data range of our sample, due to their nature, they too offered large groupings that in our case were unreliable.

³⁴ The “Freedman-Diaconis rule” is more suitable to our interests as well as to the type of data that we are using due to the fact that it is less sensitive than the “Sturges’ rule” to outliers in the data because it uses the interquartile range instead of the standard deviation as a basis for the algorithm see FREEDMAN/DIACONIS 1981.

³⁵ As well as the “Freedman-Diaconis rule”, the “Wand rule” offered also very good results in better illustrating breaks in our dataset that we may interpret as defining different groups. This algorithm uses both the standard deviation and the interquartile range, therefore obtaining better groupings see WAND 1997 and HAMMER 2015 for its implementation in the PAST statistical package software.

³⁶ GRINDEAN ET ALII 2014.

³⁷ GRINDEAN ET ALII 2014.

Table 2. AMS 14C measurements, calibrated years (BP), and the ages used for the age depth model for the Iaz sequence.

Depth (cm)	Laboratory number	¹⁴ C yr BP	Cal. yr BP (2σ)	Ages used to reconstruct chronology (cal. yr BP)	Cal. yr BC/AD
12–14	Iaz I13	121.04 ± 0.36	44–153	75	1875 AD
132–134	Iaz I133	1150 ± 30	1004–1173	1078	872 AD
212–214	Iaz I213	1805 ± 30	1673–1861	1776	174 AD
282–284	Iaz I283	2520 ± 35	2064–2569	2343	393 BC
342–344	Iaz I343	2395 ± 35	2530–3145	2724	774 BC
442–444	Iaz I443	4090 ± 35	4627–4670	4647	2697 BC
520	pollen		7000		5050 BC
532–534	Iaz I533	8380 ± 50	–	Not used	–

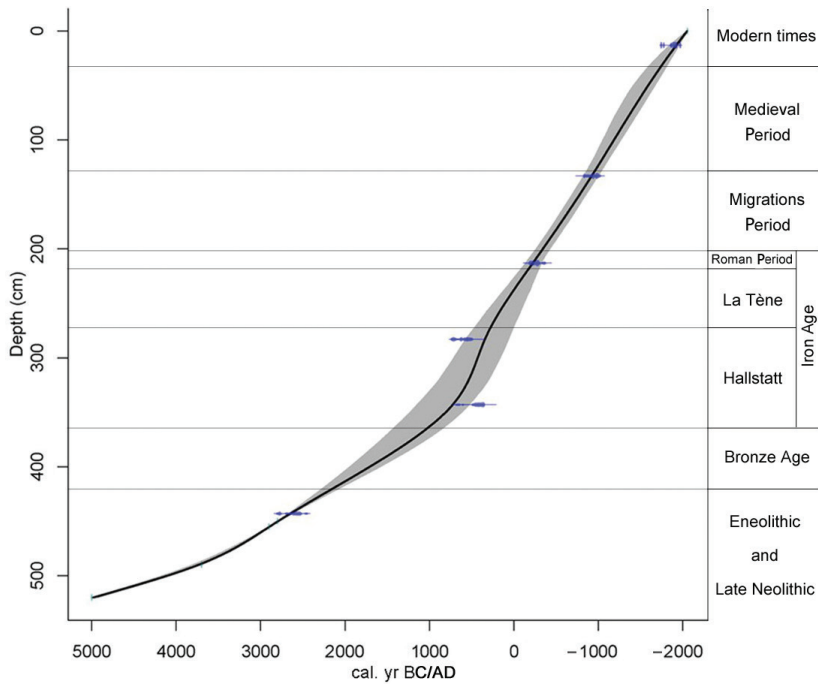


Fig. 2. Age-depth model for the Iaz sequence with dating error bars (grey). Blue – data points used for the construction of the age-depth model; green – pollen stratigraphical markers used to adjust the age-depth.

Pollen analysis

For the Iaz sequence, 109 pollen spectra were analysed and 71 taxa were identified. The 6 local pollen assemblage zones (LPAZ 1–6) were established by comparing frequencies and dynamics of the main pollen taxa and thus facilitating the description and interpretation of the diagram regarding changes in vegetation (Table 2).

Elevation groups

We can easily see that there are some discontinuities in our data especially during the Bronze Age, Roman period and the Medieval period, periods in which we can discern a higher density of sites at altitudes between 300–400 meters as well as periods in which the settlements are not situated on altitudes greater than 300 meters (Table 3 and Fig. 4–5). The results that this analysis has offered were afterwards cross referenced with the climatic realities yielded by the pollen analysis to verify whether or not these two datasets are correlated.

Table 3. Correlation of vegetation dynamics and anthropogenic indicators in the study area.

Depth (cm)	LPAZ	Vegetation dynamics	Age (cal BC/AD yrs)	Archaeological period	Anthropogenic indicators
0-90	6	<ul style="list-style-type: none"> Rather open forest dominated by <i>Fagus sylvatica</i> and secondary forest taxa Establishment of arable fields and expansion of pastures nearby 	1700 AD - present	Modern times	<ul style="list-style-type: none"> Drastic changes in the forest composition: secondary forest same proportion as main forest Increased occurrences of walnut (<i>Juglans</i>) Maximal expansion of crop, ruderal and pasture communities Increase of fungi growing on animal dung Increased fire activity
90-212	5	<ul style="list-style-type: none"> Gradual opening of the <i>Fagus sylvatica</i> and <i>Carpinus betulus</i> forest, with increasing participation of secondary forest taxa and <i>Quercetum mixtum</i> + <i>Corylus</i> Increasing land-use for crops and grazing 	900 – 1700 AD	Medieval Period	<ul style="list-style-type: none"> Further decline/degradation of the main beech-hornbeam forest (<i>Fagus sylvatica</i> - <i>Carpinus betulus</i>) which benefits the secondary forest Scattered occurrences of walnut (<i>Juglans</i>) Increase of crop, ruderal and pasture communities
212-290	4	<ul style="list-style-type: none"> Dense forest of <i>Fagus sylvatica</i> with <i>Carpinus betulus</i> Rapid regeneration of the forest following the anthropogenic pressure 	271 – 900 AD	Migrations Period	<ul style="list-style-type: none"> Deterioration of the main beech-hornbeam forest (<i>Fagus sylvatica</i> - <i>Carpinus betulus</i>) Maximal occurrence of <i>Vitis</i> (grape vine) Low values of coprophilous fungi Occurrences of fungi feeding on burnt wood/ground
290-435	3	<ul style="list-style-type: none"> Dense forest dominated by <i>Fagus sylvatica</i> with <i>Carpinus betulus</i> and <i>Quercetum mixtum</i> + <i>Corylus</i> and taxa of the secondary forest group Oscillations in land-use: between farming crops, viticulture and pasturage 	1200 BC - 274 AD	Roman Period	<ul style="list-style-type: none"> Gradual decline of main tree taxa Increased values of pasturage and ruderal taxa Increasing <i>Vitis</i> (grape vine) values
435-490	2	<ul style="list-style-type: none"> Dense forests mainly composed of <i>Carpinus betulus</i> and <i>Quercetum mixtum</i> + <i>Corylus</i> with secondary forest taxa Introduction of arable land for the cultivation of crops 	106 - 271 AD	La Tène	<ul style="list-style-type: none"> Short-term declines of the beech (<i>Fagus sylvatica</i>) forest High values of dung fungi Several peaks of microcharcoal and presence of fungi feeding on burnt wood/ground Increasing <i>Vitis</i> (grape vine) values Isolated pollen grains of crop plants
490-520	1	<ul style="list-style-type: none"> Rather open forest dominated by <i>Quercetum mixtum</i> + <i>Corylus</i> and secondary forest tree taxa Land primarily used for pastoral activities with the gradual implementation of cultivation of crops 	1200 BC - 450 BC	Hallstatt	<ul style="list-style-type: none"> Short-term declines of the beech (<i>Fagus sylvatica</i>) forest High abundance of coprophilous fungi Continuity of <i>Vitis</i> (grape vine) percentage values
			2200 – 1200 BC	Bronze Age	<ul style="list-style-type: none"> Isolated higher values of <i>Vitis</i> (grape vine) Isolated peaks of microcharcoal Increasing values of pastureland taxa
			6000 – 2200 BC	Enolithic and Late Neolithic	<ul style="list-style-type: none"> Short-term declines in the main forest Occurrence and expansion of crop plants Expansion of ruderal and pastureland taxa Increasing occurrences of coprophilous fungi spores High then decreasing microcharcoal values

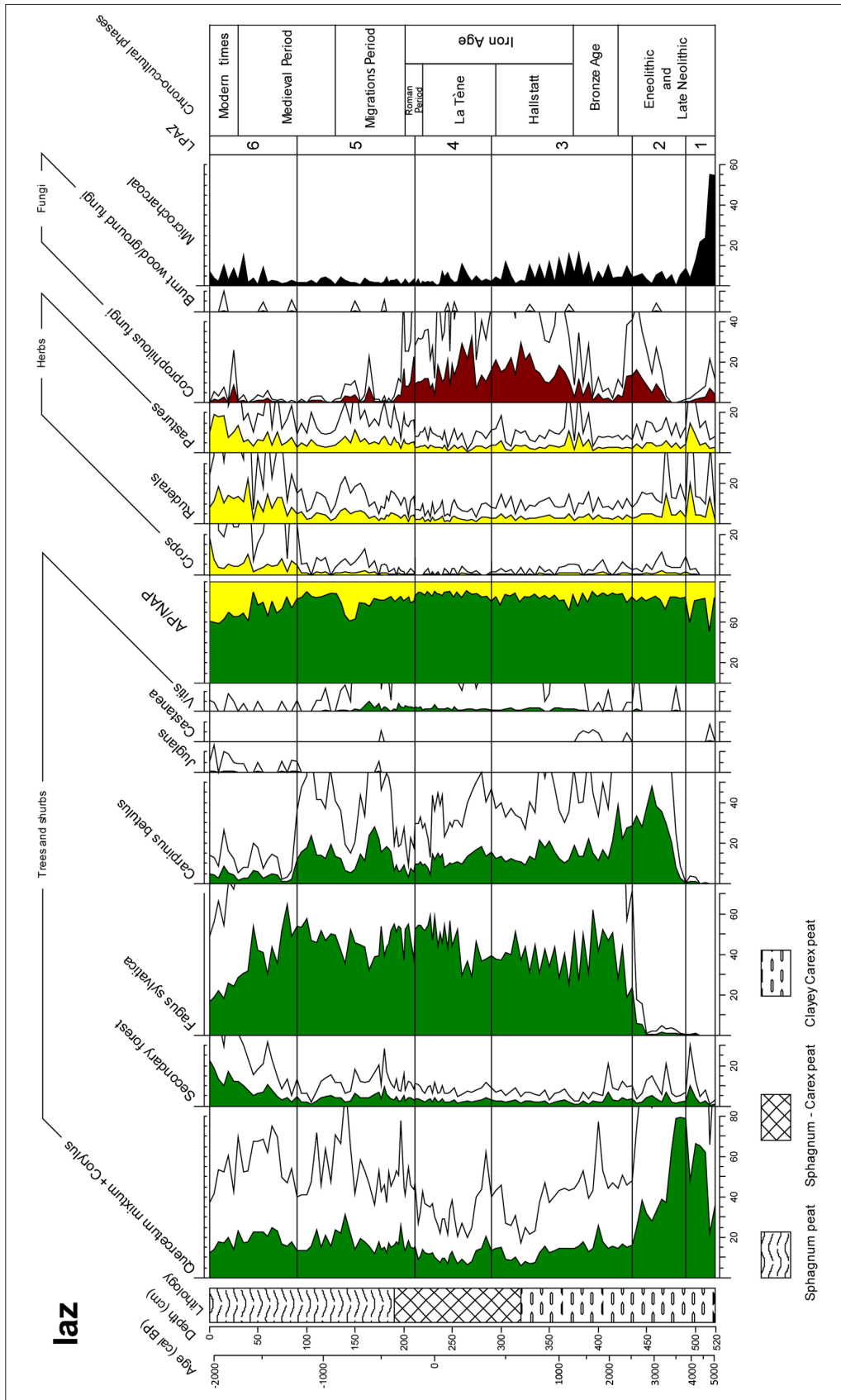


Fig. 3. Percentages of selected pollen, spores and micro-charcoal at Laz; AP – arboreal pollen, NAP – non-arboreal pollen.

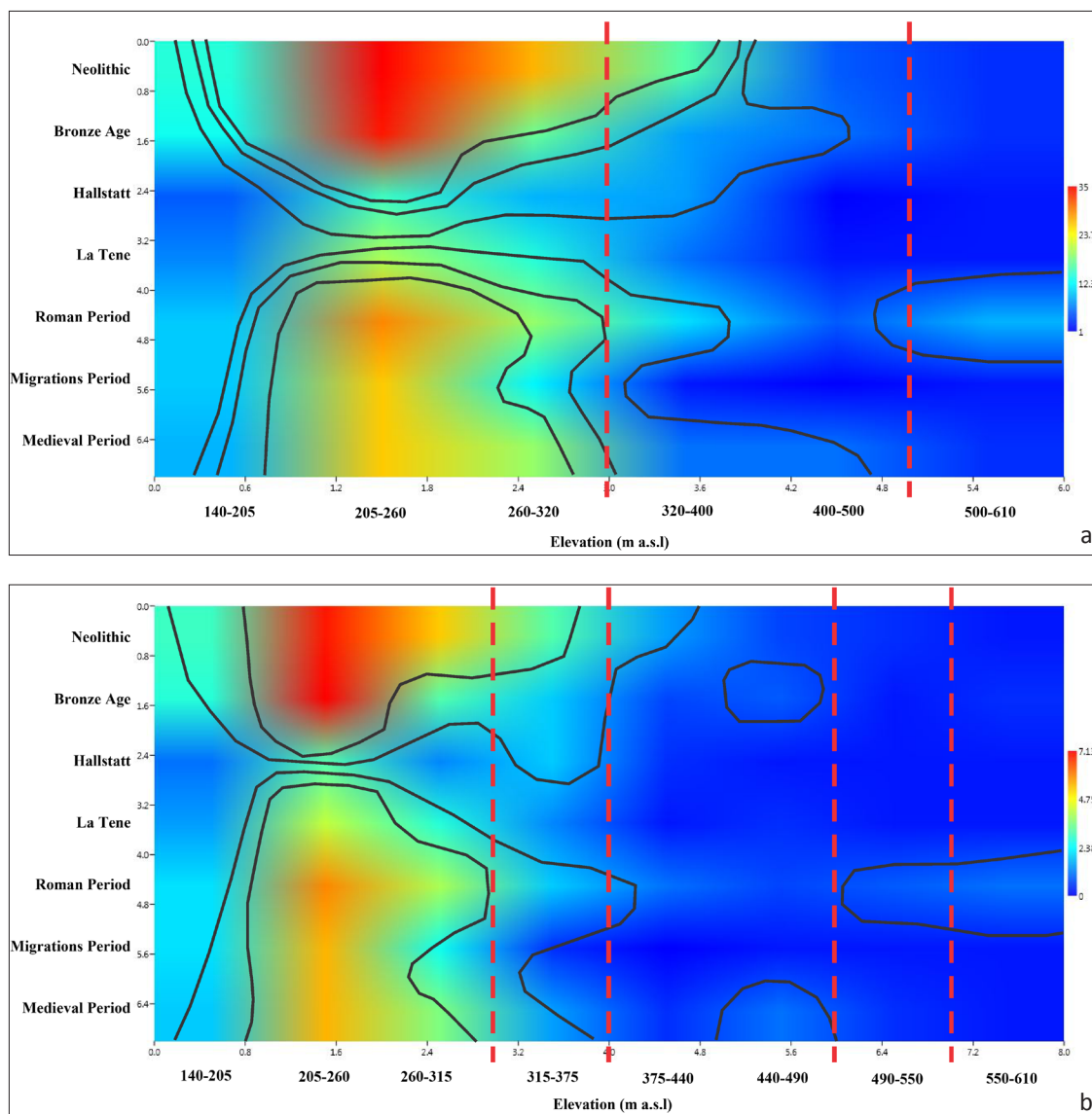


Fig. 4. Elevation groups and the abundance of sites derived from the “Freedman-Diaconis rule” (a) and the “Wand rule” (b) statistical analysis.

Discussion

*Late Neolithic and Eneolithic (5050–2200 BC)*³⁸

Starting with the Neolithic, the agricultural system was gradually based on exploiting the environment, rather than adapting to the ecosystem (e.g., foraging, forest grazing) as during the Paleolithic³⁹. Up until 3700 BC several short-term declines and discontinuity in the development

³⁸ For consistency reasons as well as for simplicity reasons we were not interested in this case in establishing clear chronological borders for the chronological intervals discussed further on. This means that we do not intend to engage ourselves in highly specialized and difficult discussions regarding such chronological systems and that our dating should be regarded as highly general. Taking into account the fact that each chronological system has only regional value it is not our purpose here to discuss such topics (for those interested in a general picture of such problems especially during Prehistory, see GOGÂLTAN 1999; VISY ET ALII 2003; BĂCUEȚ-CRIȘAN 2008; SAVA 2008 to cite only few of the numerous contributions related to such topics).

³⁹ BĂCUEȚ-CRIȘAN 2008.

of the mesothermophilous forests (*Quercetum mixtum* + *Corylus*) in our study area can be noticed (Fig. 3). These could either be connected to warm/dry and cold/wet climate oscillations (Fig. 5) or could be considered evidence of substantial deforestations by the population at that time, in order to provide new and larger terrains for implementing new agricultural techniques (e.g., primitive ploughing) as well as accommodation for the abundance of settlements (Table 4; Plate 1.2). The latter cases are supported especially starting with 4300 BC when cultivation of crops occurred and expanded (Fig. 3; Table 3). Human pressure on the woodlands through agricultural development also favoured the short-term invasion of the secondary forest and the spread of various ruderal and pasture taxa. The declining values of dung fungi as the crops develop, indicate the cultivation of plants as the main pursuit of the human groups in the area up until 3700. Throughout the rest of the Eneolithic (3700–2200 BC), increasing occurrences of coprophilous fungi spores and a reduction of cultivated plant values indicate a high abundance of grazing animals in the area. The colder conditions recorded between 2800 and 2400 BC could have influenced the undertaking of pasturing as a primary agricultural activity. Wild *Vitis* species were probably used as a food source by the Neolithic people⁴⁰. Fire activity was very intense at the beginning of the period, which again may be due to climatic conditions as previously reported in other parts of NW Transylvania⁴¹, but the rapid development of Neolithic communities throughout the study area and the local colder and wetter conditions could point to the burning of the forest by humans (Fig. 3; Table 3). Furthermore, higher micro-charcoal values and occurrence of fungi growing on burnt plant remains were recorded just before the human communities started to re-engage in pastoral activities during the final part of this cultural phase. Such a reality could be explained both by the changes that occurred at the palaeo-environmental level as well as due to the remarkable and profound changes that took place during the transition phase from the Neolithic to the Copper Age⁴².

Bronze Age (2200–1200 BC)

Fagus sylvatica becomes the dominant tree species favoured by the moist and colder climate conditions generally characterizing the first part of the period (2200–1600 BC). Its expansion suppresses to a certain degree the impact of the agro-pastoral practices in the area (Fig. 3; Fig. 5). The most noticeable feature of the human presence in the area at that time were the isolated higher values of *Vitis* pollen which coincide with isolated peaks in micro-charcoal values (Table 3). Although not visible on the AP/NAP ratio, fires could have been manually placed in the forests and/or on abandoned farmlands in order to start viticulture. It is assumed that the cultivation of grapevines and wine making on Romanian territory started during the Bronze Age, which then could have possibly quickly turned it into a well-known and prosperous vineyard region⁴³. The increased abundance of settlements (Plate 2.1) and level of habitation (Fig. 4; Table 4) in the area during this time correlated with a lower degree of human impact, could be due to the changes in agricultural practices following the adaptation to the shifts in the vegetation pattern.

The interval from 1600 BC up until the end of the Bronze Age, had warmer and less moist conditions and a more visible impact of the human pressure in the region (Fig. 3; Table 3)⁴⁴. Fire was used to enlarge open areas for the expanding viticulture as the micro-charcoal, *Vitis* percentage values and declining arboreal pollen values suggest. The cultivation of plants might have entered a new development (e.g., primitive rotational crops agriculture) as the increasing

⁴⁰ MARINOVA ET ALII 2013.

⁴¹ FEURDEAN ET ALII 2013b.

⁴² SAVA 2008; GYUCHA/PARKINSON/YERKES 2011; POPA 2012, 189–191.

⁴³ WINETASTE.RO – <http://www.winetaste.ro/vinul-si-omul/11-romania-viticola-repere-istorice.html>.

⁴⁴ Interesting conclusions regarding the changes that occurred at this stage were proposed by FISCHL/REMÉNYI 2013.

values of pastureland taxa and dung fungi might indicate the use of the fallow land for temporary management through controlled grazing. The agricultural management might also explain the spreading of settlements on higher grounds in order to provide more suitable terrain for the new crops (Fig. 4; Table 4). At the same time as the development of viticulture, plantations of *Castanea* could have also been introduced (Fig. 3).

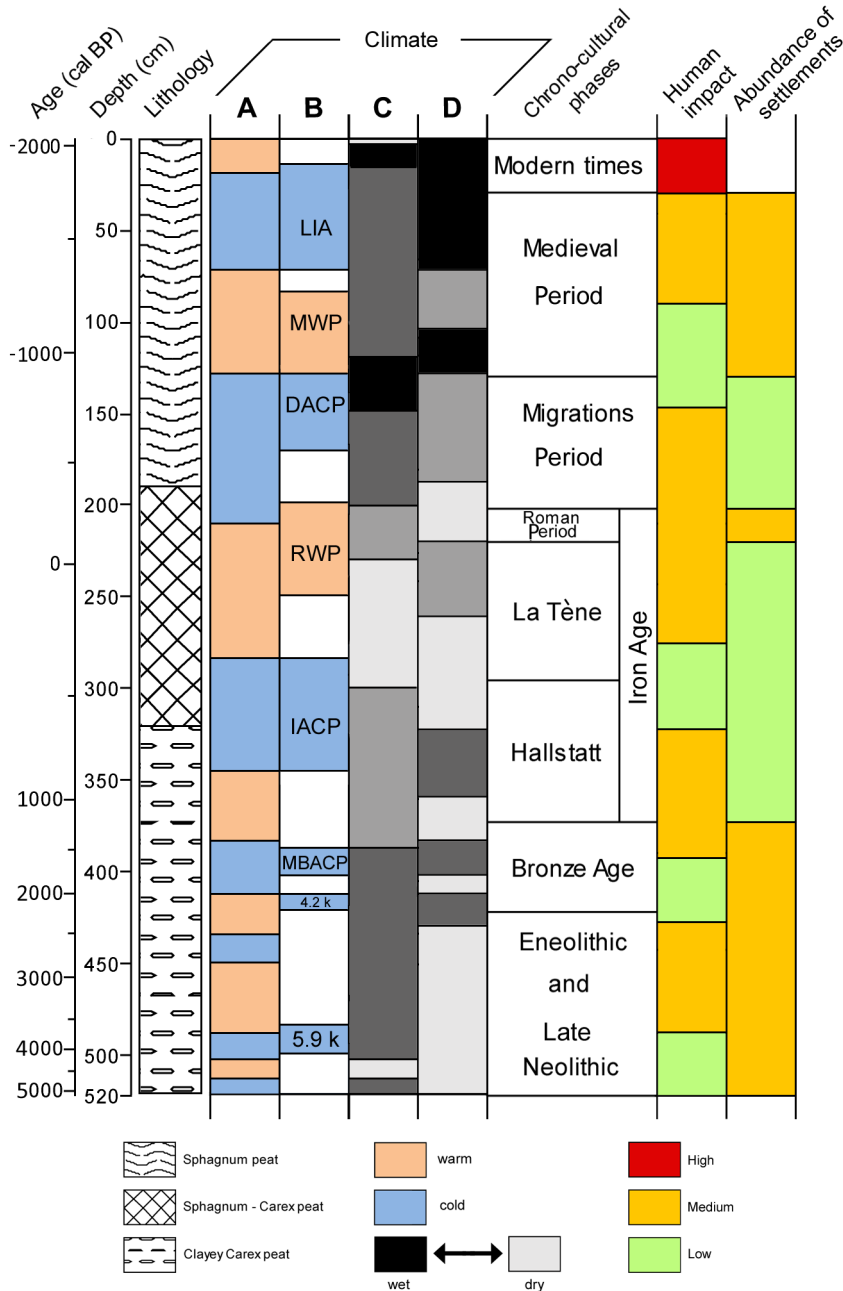


Fig. 5. Synthesis of environmental, human impact and archaeological evidence: climate – (A) cold/warm periods as inferred from the Iaz pollen record (GRINDEAN ET ALII 2014), (B) global climatic anomalies (BOND ET ALII 1997; MAGNY ET ALII 2003), (C) wet/dry periods as inferred from the pollen (GRINDEAN ET ALII 2014) and testate amoebae (DIACONU ET ALII 2016) records from the Iaz peat bog, (D) Lake Știucii lake level and wetland wetness fluctuations (FEURDEAN ET ALII 2013b); degree of human impact as inferred from the anthropogenic pollen indicators; abundance of settlements derived from the “Freedman-Diaconis rule” and the “Wand rule” statistical analysis.

*Iron Age (1200 BC – 106 AD)**Hallstatt (1200–450 BC)*

The period had drier and/or fluctuating moisture levels⁴⁵. The high abundance of coprophilous fungi spores indicate pasturing as the main agricultural pursuit during this phase. The low values of pastureland plant species may be due to the intensive grazing which does not allow many plants to reach full maturity before being nibbled (Fig. 3; Table 3). Up until 600 BC, the degree of human impact is still well noticeable (Fig. 5). The destruction of the *Fagus sylvatica* forest continued, mainly through controlled fire as charcoal values and presence of fungi feeding on burnt wood suggest (Fig. 3; Table 3). However, fire was probably mainly used for providing larger grazing areas. Land was also being used for the ongoing cultivation of grape vine in the region. The limit of 600 BC also marks a change in the lithology of the peat sequence, which could be a result of changes in moisture level and/or human activity (Fig. 5).

The scale of human impact during the last stage of the period (600–450 BC), is relatively less visible probably suppressed by climate aspects as well (Fig. 5). AP values decline, as well as cultivated plant percentages, which might suggest that woodlands were exploited for raw material and fire was mainly used for managing pasturelands (Fig. 3). Grazing was still practiced extensively and viticulture remained a continuing practice in the area (Table 3).

The lower amount of settlements (Plate 2.2) and habitation at much lower altitudes (Fig. 4) could be linked to climate conditions as well as the pursuit of different types of economical ventures (e.g., metallurgy) which could not provide the sufficient volume of raw material needed from this area.

La Tène (450 BC–106 AD)

The wood taxa recovered during the warmer phase of this period, with *Fagus sylvatica* thriving during the later stage when conditions become more damp (Fig. 3; Fig. 5). Pasturing seems to have remained the main farming practice as the high abundance of coprophilous fungi suggest. The grazing grasslands were probably expanded at the beginning of the period by setting the *Fagus sylvatica* forest on fire and later on maintained by the nomadic people through subsequent burning of the vegetation between 450 and 120 BC (Fig. 3). These features of the human activity are supported by the noticeable peaks of micro-charcoal, presence of spore corresponding to fungi feeding on burnt wood and/or ground and a short-term decline of the beech percentage values (Table 3). Viticulture was a productive and more undertaken agricultural activity in the area rather than farming of crops, as rising values of *Vitis* and isolated occurrences of crop plants suggest during this period (Fig. 3; Table 3). The level of habitation and settlement abundance remains low and is probably influenced by the presence of mainly nomadic communities in this region (Fig. 4; Plate 3.1).

Roman period (106–271AD)

The main features of the period as derived from the synthetic diagram are: i) decline of main tree taxa, ii) rise of taxa related to grazing and ruderal surroundings and iii) continuous increase in grape-vine (*Vitis*) percentage values (Table 3). Although, in general, the demand for wood during this historical stage was high⁴⁶, the warm and mild climatic conditions supported the amelioration of the forests in the study area which could have also overshadowed the effects of anthropogenic pressure (Fig. 5). However, the increase of pasturing taxa and spores of dung fungi suggest that large areas were designated to pastoral activities and animal husbandry, followed by the administration of vineyards. The cultivation of crop plants was probably not as much implemented in the study area at that time (Fig. 3). By taking in consideration the location of the region in relation to the Roman *limes* and the diverse habitation level (Fig. 4)

⁴⁵ DIACONU ET ALII 2015.

⁴⁶ FEURDEAN ET ALII 2013a.

and settlement abundance (Plate 3.2) than in the previous zone, we could assume that aside the agricultural practices, the area was probably favourable for other sorts of economical endeavours (e.g., trading, merchandising etc.).

Migration period (271–900 AD)

Following the Roman withdrawal from the province of Dacia, significant changes in the cultural landscape took place. The decline of the AP curve was a probable cause of both colder climate conditions (Fig. 5) and/or recurrent deforestations in the woodlands. The period is generally associated with deforestations on a large scale and high fire abundance⁴⁷. The wetter and cooler climate could have also influenced the rise of ruderal and pasturage species. However, the lower level of habitation at that time (Fig. 4) and settlement abundance (Plate 4.1) could suggest that this was due to the abandonment of the former cultivated terrains at higher altitudes and/or their reuse as pastoral grounds or for viticulture. Towards the end of the period, grape vine (*Vitis*) percentages drop while crop plants and ruderal taxa values increase which indicate that the management of vineyards gradually diminished, giving way to the expansion of farm land in the region (Fig. 3; Table 3). The occurrence of *Castanea* and *Juglans* pollen suggest possible attempts at arboriculture at that time as well.

Medieval period (900–1700 AD)

Between 900 and 1200 AD, the warm and wet climate favoured the expansion of forest taxa which also might have partially concealed the effects of human pressure in the area (Fig. 5). Afterwards, main tree taxa declined and occurrences of cultivated crops and pasturage taxa increased (Table 3). Secondary forest species started to develop and replace wood species like *Fagus sylvatica* and *Carpinus betulus*. New developments in agricultural practice could have triggered the destruction of the woodlands in order to enlarge the areas needed for the cultivation of crops and grazing livestock in order to sustain the growing population (Fig. 3; Fig. 4; Fig. 5; Plate 4.2). Cultivated tree taxa (*Juglans* and *Castanea*) also occurred more regularly, while grape vine pollen grains (*Vitis*) were scarce. Percentage values of coprophilous fungi spores drop while pasturage taxa values rise (Table 3). Thus, the area gradually turned into arable fields with few vineyards and orchards, and also field parts which were maintained as fallow land without grazing. The colder climate might have worsened the decline of main wood taxa and favored the development of grasslands. Fire was probably mainly used as a means of preserving the agricultural landscape⁴⁸.

Modern times

Nowadays the farm land in the region is almost equally distributed between arable land (cultivation of plants) and pastures. Vineyards are mainly used for the production of wine rather than fruit consumption⁴⁹. The region's development over the last 650 years can be traced in the continuous change of the vegetation in the area. Forest clearance, spreading of cultivated fields and tree plantations (*Pinus* plantations) have led to a severe change of the autochthon woody species and grasses⁵⁰. Maintenance of agricultural fields and pasturage grounds over the last half century was managed through the seasonal burning⁵¹.

⁴⁷ CHEW 2007.

⁴⁸ FEURDEAN/WILLIS 2008.

⁴⁹ CHAMBER OF COMMERCE AND INDUSTRY SĂLAJ – http://www.ccisalaj.ro/despre_salaj_prezentare.php

⁵⁰ GRINDEAN ET ALII 2014.

⁵¹ FEURDEAN/WILLIS 2008.

Conclusions

Our composite study involving palaeoenvironmental and archaeological data from the sub-mountainous part of NW Romania, provides a high resolution evolutionary trend of the cultural landscape in this area starting with 5050 BC.

The main outcome of the agricultural developments through time, was the destruction of the available deciduous woodland in order to provide larger areas for arable land and pastures. These factors often coincide with an increased number of settlements and habitation at various altitudes (Late Neolithic and Eneolithic, Roman period, Medieval period) and thus, might explain the need for mass production. The metallurgical progress starting with the Bronze Age throughout the Iron Age might have led to a gradual abandonment of settlements in favour of a nomadic lifestyle in search of source areas for metal. As such, the agricultural system was mainly based on pastoral activities and arboriculture. Also, viticulture proved to be an important and profitable activity up until the middle of the Migrations period. Transitional phases between chrono-cultural periods were generally characterized by an interruption of the sedentary lifestyle and the adaptation to pastoral-nomadic activities.

Ocasionalmente the climate had influenced the clarity and true extent of the human impact in our sequence. Warmer and wetter/drier conditions had favoured the amelioration of the forest cover (La Tène, Roman period). This was also probably favoured by the reduction of human occupation in the area in some periods (second stage of the Iron Age). Colder climate could have also influenced the higher values of grasses and weed percentages in the sequence (Hallstatt, Migrations period). The AP curve might have also been slightly overestimated due to the two dense forests in the very proximity of the peat bog.

Taking into consideration the drastic changes inflicted on the landscape in the study area during the last 300 years, it seems that the knowledge of how human societies from the past have shaped the landscape is an imperative measure in order to better understand the contemporary and near future forms of development and implementation on the natural and cultural landscape.

ROXANA GRINDEAN, ANDREI-COSMIN DIACONU, IOAN TANȚĂU

Babeş-Bolyai University, Department of Geology, M. Kogălniceanu Street 1,
400084, Cluj-Napoca, Romania;
roxana.grindean@ubbonline.ubbcluj.ro; andreicosmind@yahoo.com
ioan.tantau@ubbcluj.ro

VLAD-ANDREI LĂZĂRESCU, CORIOLAN HORĂȚIU OPREANU

Institute of Archaeology and History of Art Cluj-Napoca, Romanian Academy
Cluj Branch, M. Kogălniceanu Street 12–14, 400084, Cluj-Napoca, Romania
lazarescu_vlad@yahoo.com; choprean@yahoo.com

SORINA FĂRCAȘ

Institute of Biological Research, Branch of the National Institute of Research
and Development for Biological Sciences, Republicii Street 48, 400015
Cluj-Napoca, Romania
soryna_001@yahoo.com

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Management Plan for the “Mlaștina de la Iaz” Natural Reservation, <http://www.mmediu.ro/beta/wp-content/uploads/2012/07/2012-07>

CLAM 2.2 MANUAL

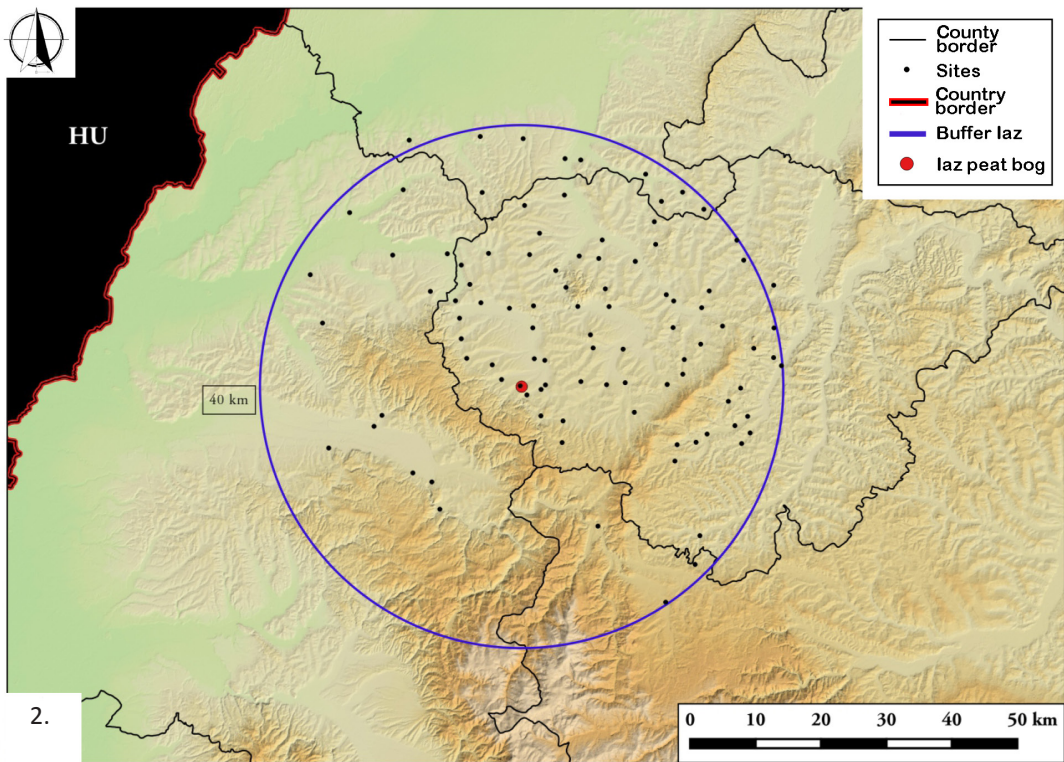
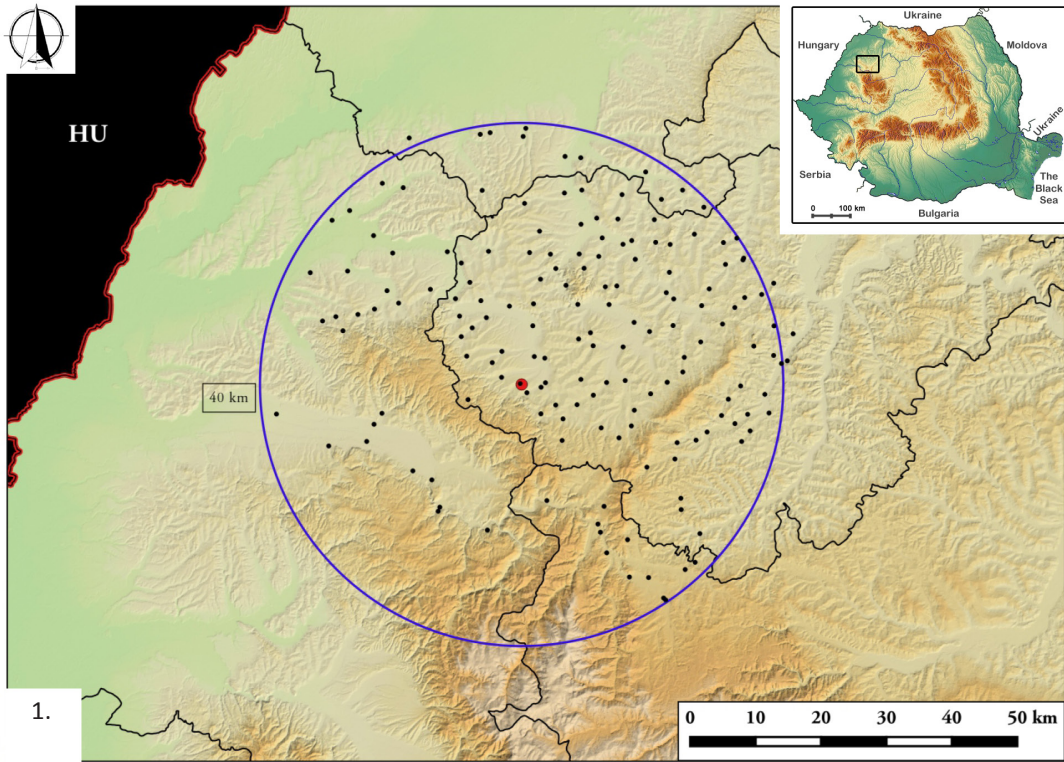
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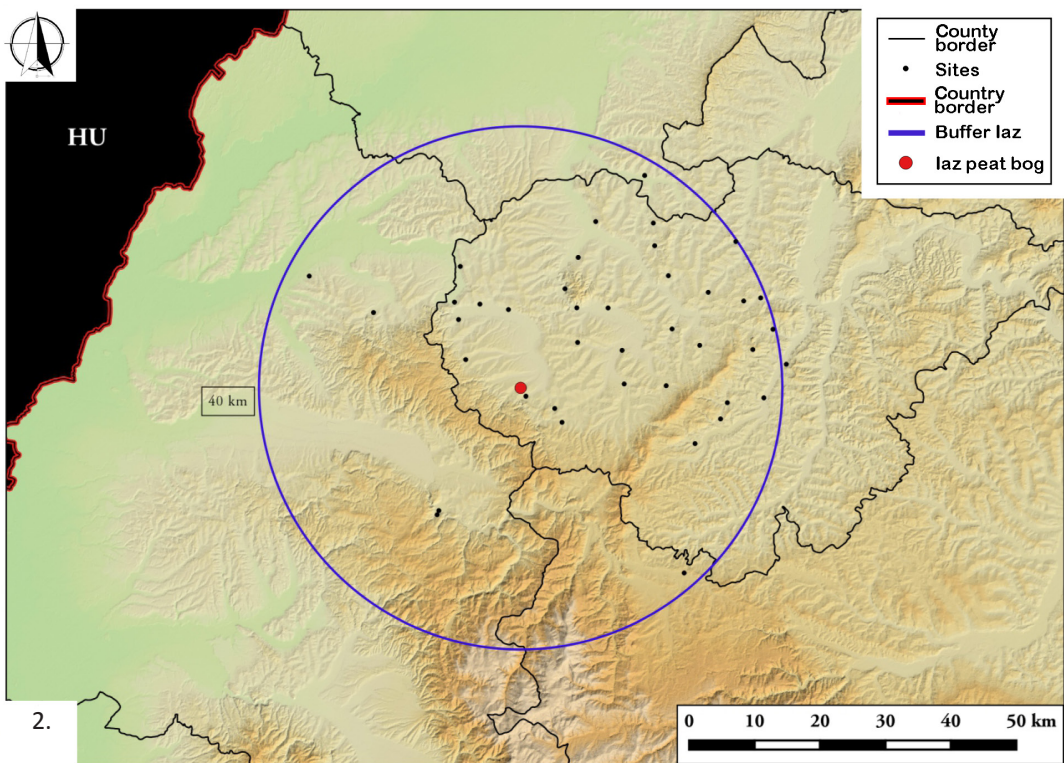
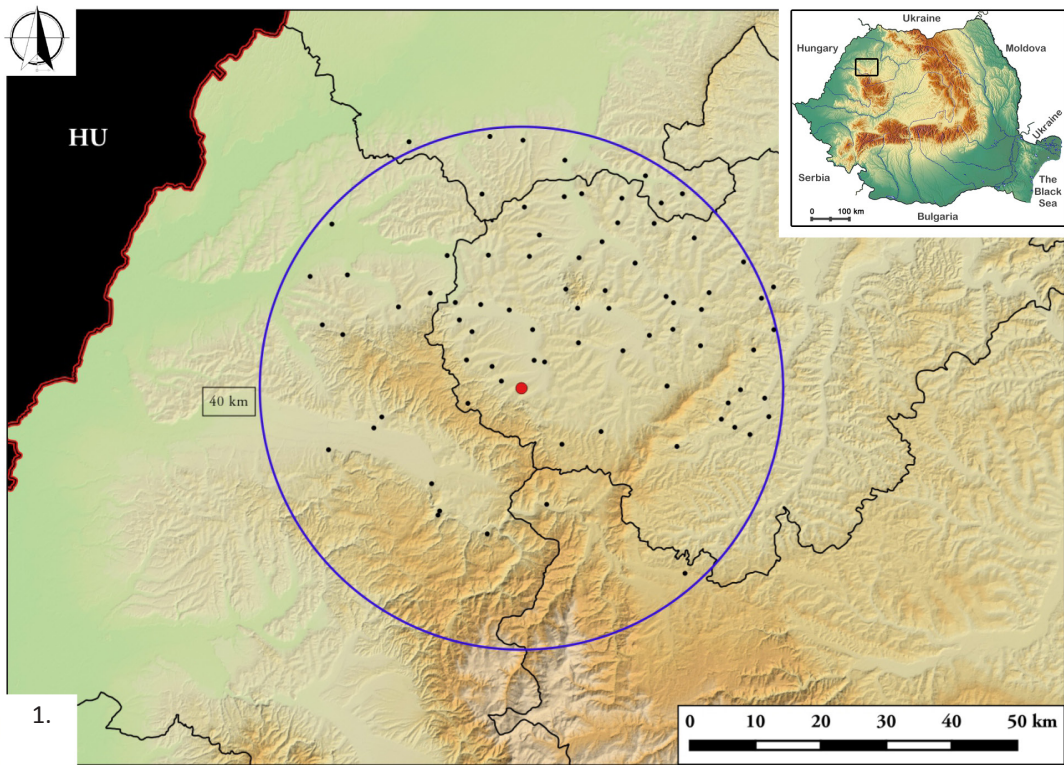
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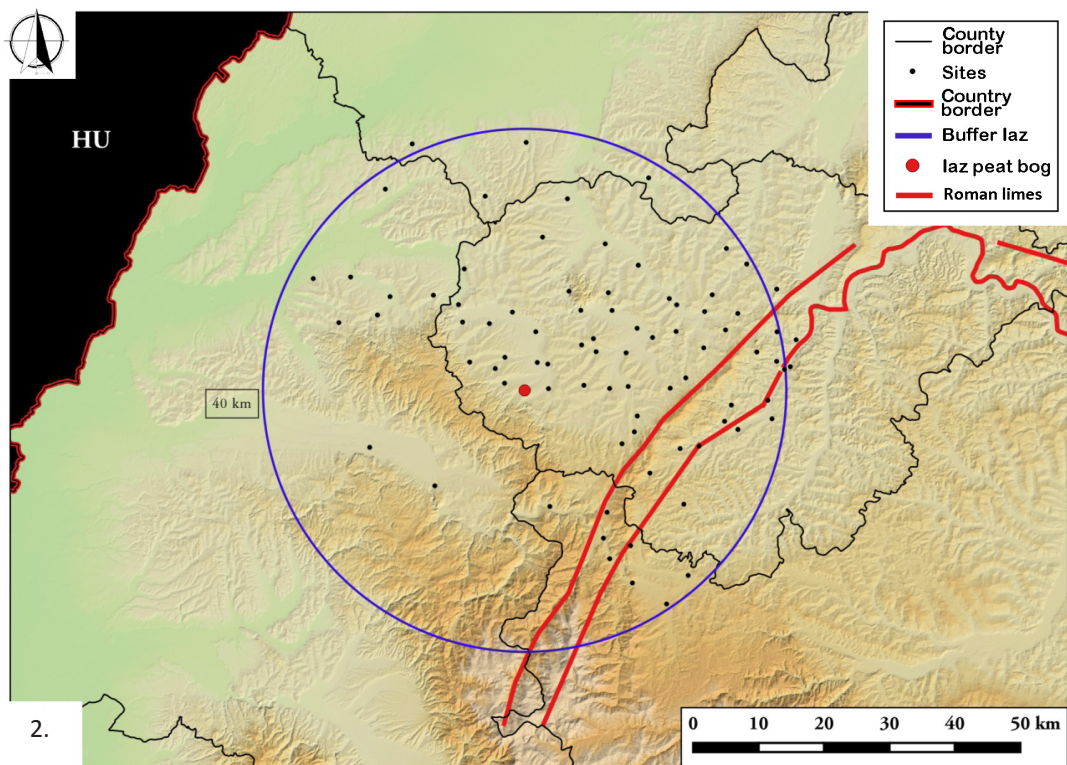
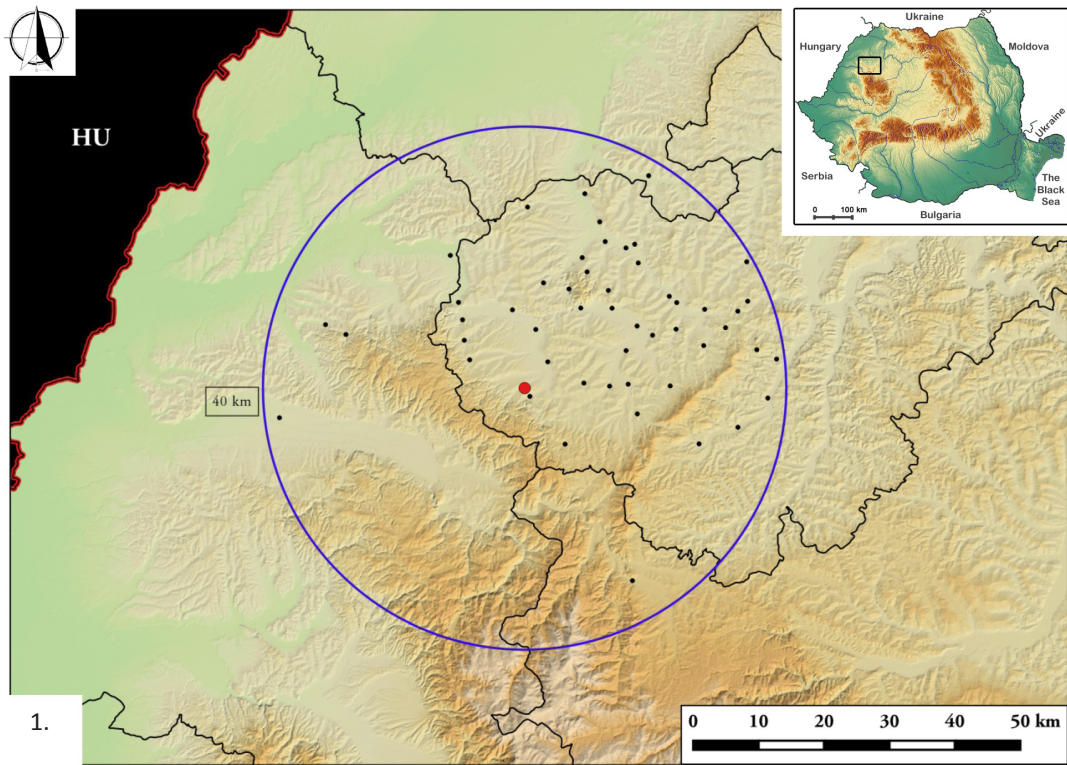
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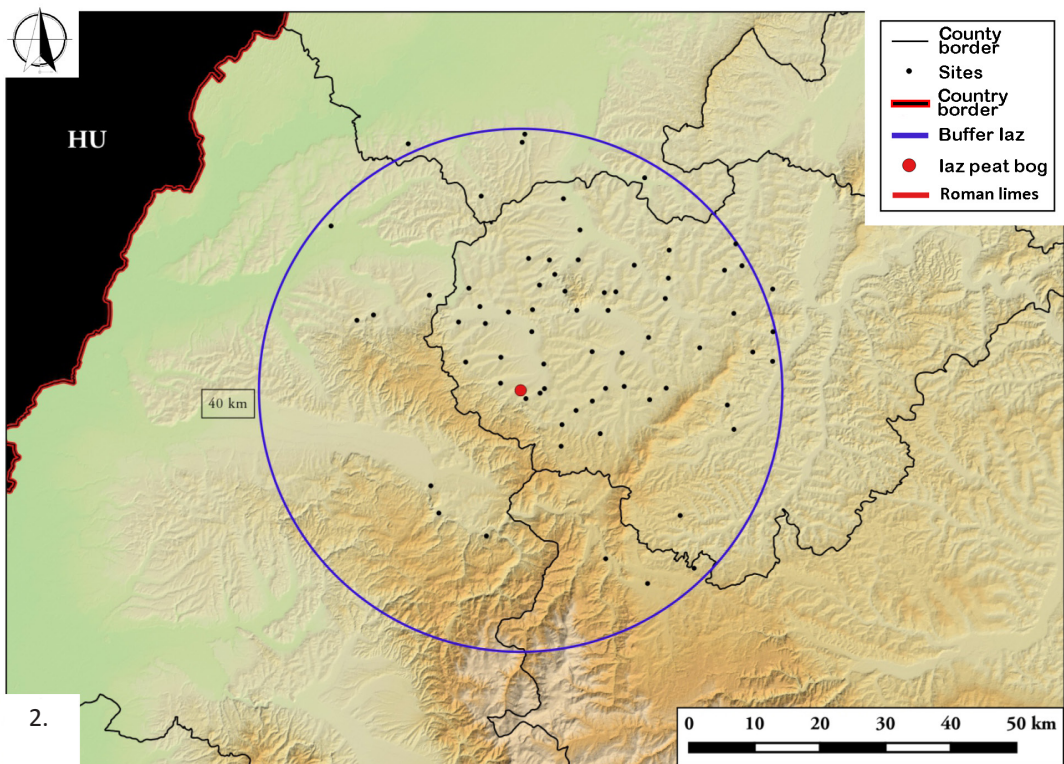
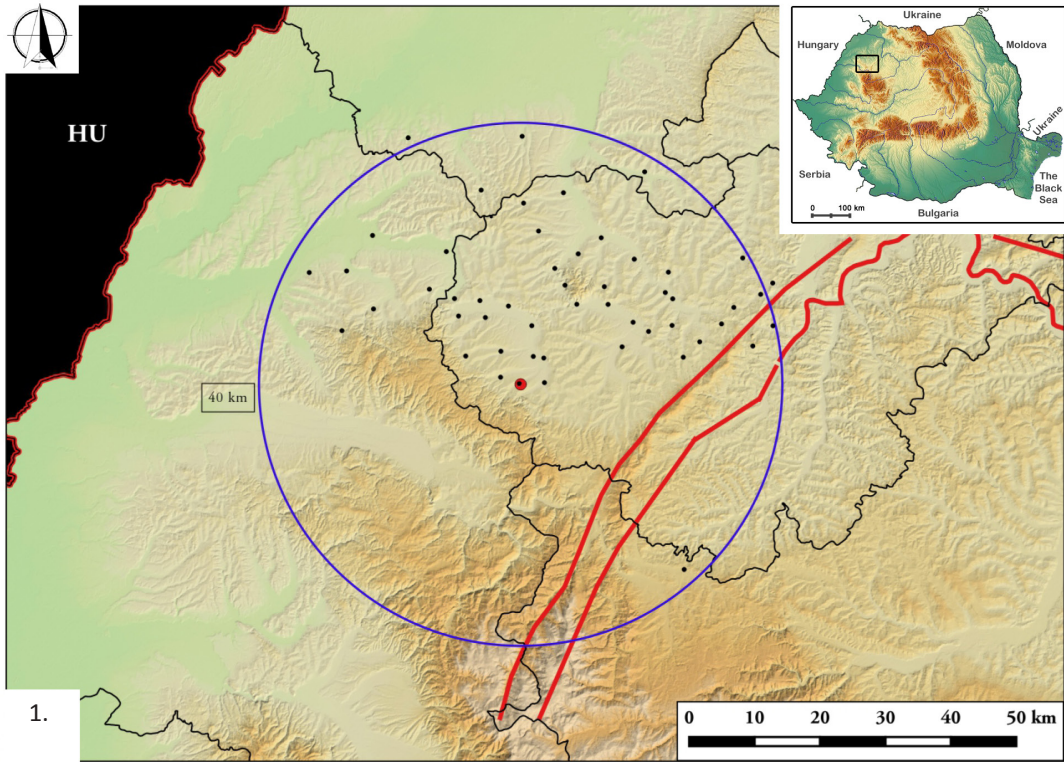
Pl. 1. 1. Spatial distribution of the analyzed sites (see Table 1);
2. Spatial distribution of the Late Neolithic and Eneolithic sites.



Pl. 2. 1. Spatial distribution of the Bronze Age sites;
 2. Spatial distribution of the Early Iron Age (Hallstatt) sites.



Pl. 3. 1. Spatial distribution of the Late Iron Age (La Tène) sites;
2. Spatial distribution of the Roman sites.



Pl. 4. 1. Spatial distribution of the Migrations Period sites;
 2. Spatial distribution of the Medieval sites.