



THE ENVIRONMENT AS AN ARCHIVE OF PAST HUMAN ACTIVITIES

ED. TOMASZ KALICKI

KIELCE-BIAŁYSTOK 2022

Reviewer:

Prof. Uł Dr hab. Zbigniew Rdzany

Scientific editor:

Prof. UJK Dr hab. Tomasz Kalicki

All rights reserved. No part of this book may be reproduced or distributed using electronic, mechanical, copying and recording devices and others - without the written consent of the author and publisher.

©Tomasz Kalicki and Ośrodek Badań Europy Środkowo-Wschodniej 2022

Publisher:

Ośrodek Badań Europy Środkowo-Wschodniej, Białystok



Wydanie publikacji zostało dofinansowane przez Uniwersytet Jana Kochanowskiego w Kielcach
The publication was co-financed by the Jan Kochanowski University in Kielce.



Ministry of Education and Science
Republic of Poland

Płatne ze środków Ministerstwa Edukacji i Nauki
na podstawie umowy nr DNK/SP/513743/2021 z dnia 03.03.2022;
nazwa projektu: Conference of Environmental Archaeology CEA/AEA 2022, Poland;
kwota środków 25 080 zł.

Paid by the Ministry of Education and Science
under contract No. DNK/SP/513743/2021 of 03/03/2022;
project name: Conference of Environmental Archeology CEA/AEA 2022, Poland;
the amount of funds PLN 25.080.

ISBN 978-83-958357-8-0

Prepress:

 Visual Arts biuro@v-arts.pl

TABLE OF CONTENTS

Preface	5
ALLUVIAL AND URBAN GEOARCHAEOLOGY	
<i>Ondřej Mlejnek, Libor Petr</i> The Loučná River valley (eastern Bohemia) on the onset of the Holocene	9
<i>Tomasz Kalicki, Piotr Biesaga</i> Alluvial fans as indicator of human impact: case study of Mozgawka and Nida River valleys (Polish Uplands) ..	13
<i>Tomasz Kalicki, Sławomir Chwałek, Jani Puntos Konstantinovski</i> Environmental conditions of the location and functioning of ancient cities in the SW Cyprus	17
<i>Piotr Kalicki</i> Fields in the fog: land use changes and landscape transformation in Lomas de Lachay, central Peru	23
<i>Lenka Lisá, Jana Mazáčková, Petr Žaža, Miriam Fišáková Nývltová</i> What is the role of kitchen waste in the environment of a Medieval castle? Case study Rokštejn	27
GEOARCHAEOLOGY OF NE AND N POLAND	
<i>Adam Wawrusiewicz</i> Subneolithic – an alternative lifestyle. The last hunter-gatherers on the border between Eastern and Western Europe	33
<i>Marcin Frączyk, Adam Wawrusiewicz, Tomasz Kalicki, Iga Szwed</i> Stratigraphy and palaeoenvironmental context of the archaeological site of the Niemen culture – case study at Lipsk site (NE Poland)	37
<i>Krzysztof Żurek, Tomasz Kalicki, Adam Wawrusiewicz</i> Human-environment interactions in NE Poland during the Lusatian culture	43
<i>Małgorzata Karczewska, Maciej Karczewski, Tomasz Kalicki, Paweł Przepióra, Sławomir Chwałek, Krzysztof Żurek, Karolina Fularczyk</i> GPR surveys of historical cemeteries at Białogóry, Giżycko, Sośnia in north-eastern Poland	49
<i>Ewa Kołaczowska, Anna Kowalska, Michał Słowiński, Agnieszka Halaś, Krzysztof Szewczyk, Dominika Łuców, Agnieszka Mroczkowska, Mateusz Kramkowski, Jerzy Jonczak, Vincenzo Barbarino, Aleksandra Chojnacka</i> Can current vegetation serve as an indicator of historic charcoal production in pine forests?	55
GEOARCHAEOLOGY OF OLD-POLISH INDUSTRIAL DISTRICT	
<i>Tomasz Kalicki, Piotr Kusztal</i> Role of natural and anthropogenic small retention water systems in the Holocene evolution of small river valleys: case study from Czarna Konecka River (Holy Cross Mts. region, central Poland)	61

Karolina Fularczyk, Tomasz Kalicki, Piotr Kusztal

The hydrographic confluence in Sielpia as an archive of natural and anthropogenic processes from the beginning of the 19th c. (Old-Polish Industrial District, Poland) 65

Paweł Przepióra, Tomasz Kalicki, Geoffrey Houbrechts

The historical metallurgical activity recorded in alluvium of small river valley: case study from Kamionka River (Holy Cross Mts., central Poland)..... 69

Paweł Rutkiewicz, Tomasz Kalicki

Relict charcoal hearths as an archives of past human activity (examples from Poland) 73

REPORT

Tomasz Kalicki, Paweł Przepióra

Conference on Environmental Archaeology CEA/AEA 2022 April 4-6, Kielce-Suchedniów, Poland 79

Marta Błaut, Karolina Fularczyk, Tomasz Kalicki, Paulina Kurpińska, Marcelina Maturlak, Paweł Przepióra, Krzysztof Żurek

Photo album. 81

Sponsorship and patronage 97



PREFACE

The CEA 2022 book is a collection of 14 articles. These are selected works from over 25 presented in oral and poster form at the CEA/SAS conference on 4-6.04.2022 in Suchedniów near Kielce. That is why the volume ends with a short report from this conference along with photographic documentation of this event.

The articles in this monograph have been divided into three thematic parts. It begins with the part on alluvial and urban geoarchaeology, in which the works cover the territory of the Czech Republic, Poland, Cyprus and Peru.

Articles about Poland were collected in the following sections. The first one, concerning the NE and N of Poland, presents various geoarchaeological problems from the Subneolithic to the present day. The second part contains articles on the area of the Old-Polish Industrial District and various geoarchaeological aspects caused by the development and decline of the metallurgical industry since the Middle Ages.

Tomasz Kalicki



THE ENVIRONMENT AS AN ARCHIVE OF PAST HUMAN ACTIVITIES (ED. T. KALICKI)



ALLUVIAL AND URBAN GEOARCHAEOLOGY

THE LOUČNÁ RIVER VALLEY (EASTERN BOHEMIA) ON THE ONSET OF THE HOLOCENE

Ondřej Mlejnek¹, Libor Petr²

¹Excellent Research Centre of Archaeometry, Archaeological Centre Olomouc, mlejnek@erca.cz

²Department of Botany and Zoology, Faculty of Science, Masaryk University, Brno, petr.libor@gmail.com

ABSTRACT

In the year 2018, several rescue archaeological excavations were performed in the surrounding Uhersko village in eastern Bohemia in a proposed highway alignment D35. One of these sites (Městec/Ostrov) was dated to the Early Mesolithic. The archaeological excavations were complemented with the environmental research focused mainly on the fluvial sediments in the Loučná River valley. In this paper, the results of the archeological excavation of the Městec/Ostrov site will be connected to the results of the environmental research, which will help to improve our knowledge concerning the period of the Pleistocene/Holocene climatic shift in this region.

Keywords: Loučná River Valley, Mesolithic, Preboreal, lithics, pollen analysis

INTRODUCTION

In this presentation, we would like to present the results of the archaeological and environmental research in the surrounding of the Loučná River valley near the Uhersko village in eastern Bohemia (Fig. 1). Our results will not be presented as separate outcomes, but we would like to use the archaeological as well as environmental data to depict the history of local landscape during the Late Glacial/ Early Holocene climatic shift circa 11,650 cal. years BP.

RESULTS OF THE ARCHAEOLOGICAL EXCAVATION

In this chapter, the main results of an excavation of the Early Mesolithic site Městec/Ostrov will be presented. This site is located near the railway station Uhersko on the cadastral territories of villages Ostrov and Chroustovice-Městec in Eastern Bohemia (Mlejnek, Záhorák 2020, Mlejnek et al., in prep.). The site was excavated from May to October 2018 as a rescue archaeological project located in a proposed highway alignment (R35-section 6c). The excavation was conducted by the Archaeological Centre in Olomouc.

A total of 4986 lithics were found in a circa 30 cm thick plow horizon. Another 141 lithics were collected nearby during surface surveys. An area of 343 m² (Fig. 2) was unearthed in a grid and all the sediment was wet-sieved using sieves 2x2 mm mesh size, which made it possible to find even the tiniest artifacts.

The raw material spectrum is quite varied. Ústí nad Orlicí type semi-local Cretaceous chert dominates,

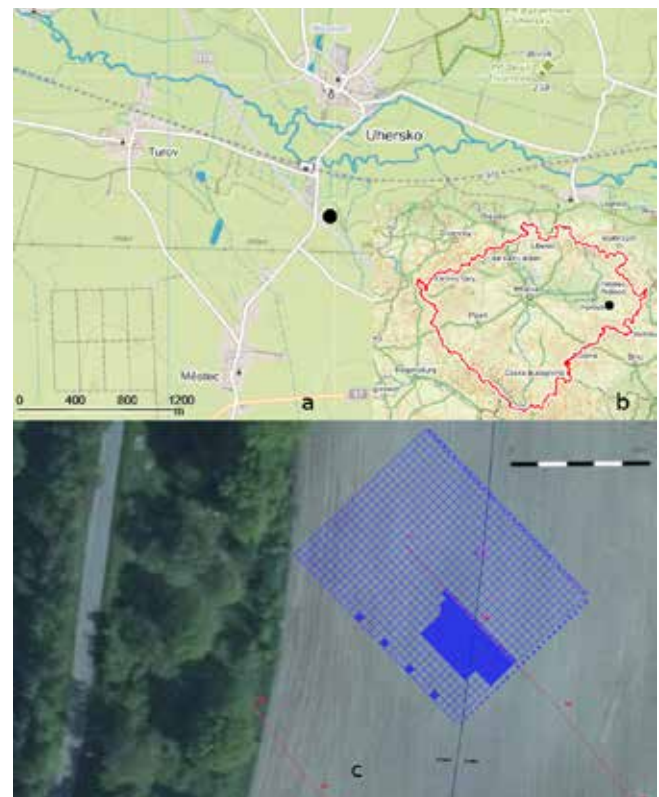


FIG. 1. Location of the Městec/Ostrov site on a map of Bohemia (b); location of the site on the map of Uhersko village and its surroundings (a), the site location is marked with a black dot; aerial photograph of the site with a grid overlay (c), blue area – excavated squares, red lines – boundaries of the D35 highway alignment

(www.mapy.cz by O. Mlejnek)

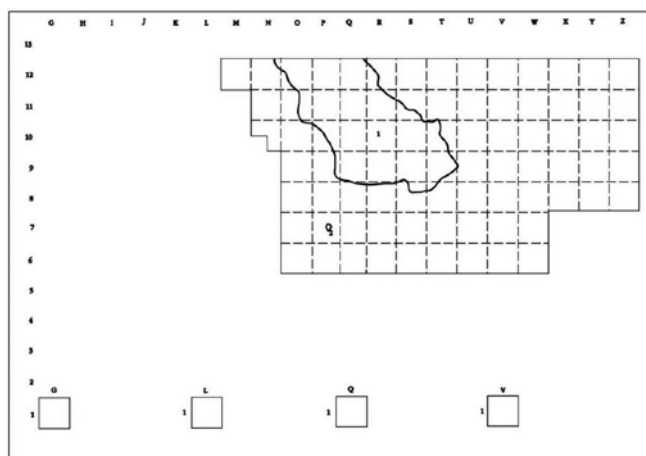


FIG. 2. Městec/Ostrov site plan with locations of Features 1 and 2 (drawing by O. Mlejnek and S. Bambasová)

however quartz, erratic flint, jasper, Bečov, and Skršín type quartzites, siliceous weathering products of serpentinite, radiolarite, porcellanite, and other raw materials are present as well (Table 1). The presence of burnt lithics indicates fire use at the site. The most common technological categories include tiny fragments, flakes, blades, bladelets, and microblades. Small, usually heavily exhausted cores are also present. Tools are represented by small end scrapers, various types of burins, backed bladelets, backed and Zonhoven type points (Vermeersch 2013), splintered pieces, microlithic triangles, and retouched flakes (Table 2, Fig. 3). A tanged tool with a retouched tip used according to the use-wear analysis as a knife and a borer is a unique find (Mlejnek, Štefanisko, in prep).

TABLE 1: MĚSTEC/OSTROV. Proportion of particular raw materials in the assemblage

Raw materials	Number of artefacts	Percentage
Spongolites (Spiculites)	3687	71.97
Quartz	509	9.94
Silicites (flints) from glaciogene sediments	292	5.70
Rock crystal	204	3.98
Quartz/Rock crystal	79	1.54
Jasper	68	1.33
Orthoquartzite, type Bečov	38	0.74
Chalcedone weathering products of serpentinites	17	0.33
Radiolarite	14	0.27
Orthoquartzite, type Skršín	12	0.23
Porcellanite	10	0.2
Other raw materials	32	0.63
Undetermined pieces	161	3.14
Total	5123	100.00

TABLE 2: MĚSTEC/OSTROV. Table of basic lithic tool types. Complete list of types will be published in Mlejnek *et al.* in prep.

Tool type	Number of specimens	%
end scraper	26	14.29
burin	26	14.29
point	9	4.95
retouched blade	28	15.38
notch	2	1.10
splintered piece	15	8.24
side scraper	1	0.55
triangle	16	8.79
bladelet with a retouched end	11	6.04
backed bladelet	22	12.09
backed bladelet with a retouched end	3	1.65
splintered piece – burin	2	1.10
retouched flake	10	5.49
tool fragment	11	6.04
total	182	100.00

TABLE 3. Radiocarbon dates from the pine charcoal found in the Feature 2 on the Městec/Ostrov site. Calibration graph in Mlejnek *et al.* in prep.

ID	Lab number	Uncalibrated date BP	Error	Calibrated age BP cal, 2 σ
M/O02	DeA-25068	9 856	38	11 376–11 253
M/O03	DeA-25069	9 744	43	11 293–11 151
M/O04	DeA-25070	9 672	39	11 254–10 850
M/O07	DeA-25071	9 852	41	11 381–11 249

The assemblage can be essentially archaeologically dated back to the Early Mesolithic. A small pit labeled as Feature 2 contained pine charcoal, which was dated with the use of the AMS radiocarbon method to the Preboreal period (ca 11,250 cal. years BP, Table 3). A Late Palaeolithic admixture in the lithic assemblage can be assumed due to the presence of a tanged tool and other slightly patinated bladelets made of erratic flint. The collection of lithic artifacts excavated at this site is one of the largest Mesolithic assemblages from eastern Bohemia. It supplements our knowledge of this period and also provides a new dataset for comparisons with other sites and regions.

RESULTS OF THE ENVIRONMENTAL RESEARCH

Paleoenvironmental research was focused on the near alluvial sediments of the Loučná River situated several hundred meters to the north of the Mesolithic site. The alignment of the D35 highway construction was

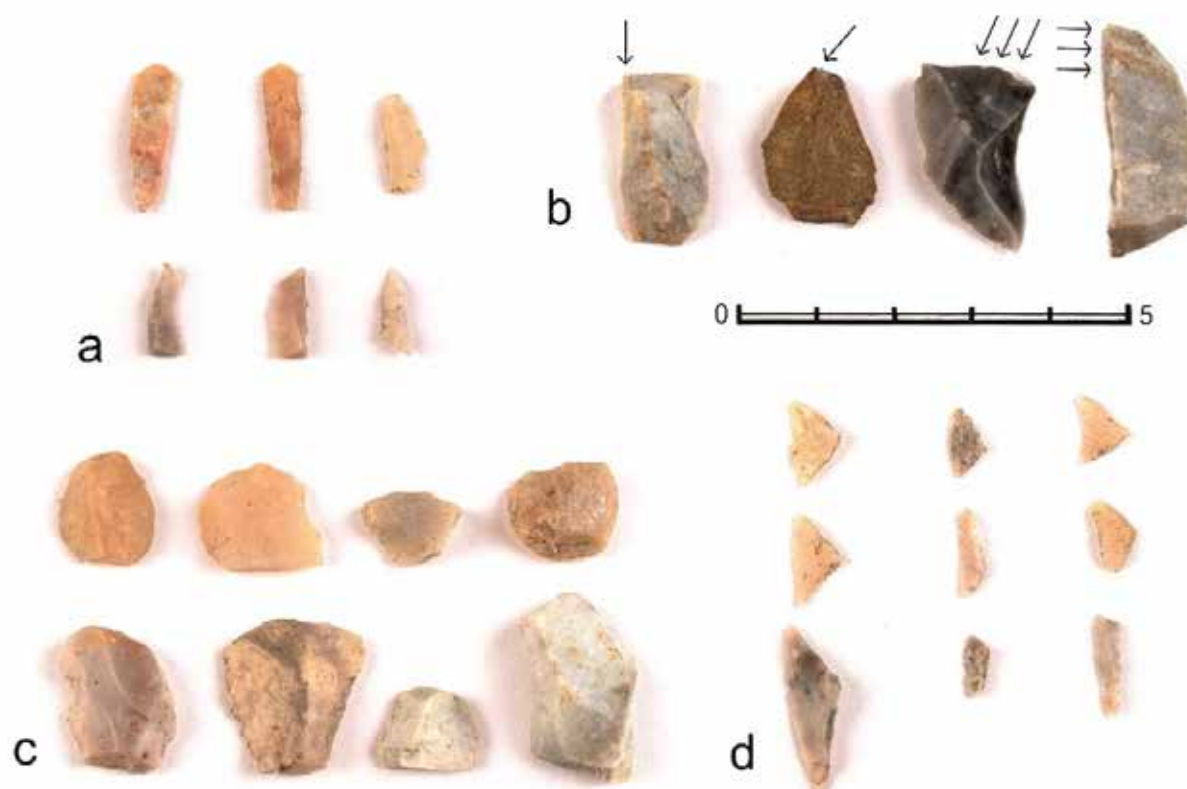


FIG. 3. Městec/Ostrov. Photograph of selected tools. a) backed bladelets b) burins c) end scrapers d) microlithic triangles (Photo. M. Kršková, processed by O. Mlejnek)

investigated by geophysical methods, handheld core drilling and several test pits conducted by mechanical excavator. Subsequently, the alluvial sediments were sampled in two profiles. The first one was a drill core labeled as Turov. It was obtained in a former oxbow of the Loučná River dated from the Late Glacial period to the Boreal period, situated near the Uhersko railway station. The sedimentary record covered Late Glacial and Early Holocene periods until the occurrence of the broadleaf trees. Analyzed pollen record indicates a presence of an open canopy pine and birch woodland with rich herbal communities in the alluvial plain (Petr, Novák 2014). The younger Holocene sequence is unfortunately decomposed due to the modern drainage systems. A peak of the microcharcoal concentration is radiocarbon-dated to the Preboreal period, such as the Mesolithic settlement Městec/Ostrov located nearby on a terrace of the Loučná River. Therefore, we suggest a hypothesis that people maintained the alluvial plain by regular fire management. This practice is known also from other Central European Mesolithic campsites.

The second profile labeled as Uhersko was sampled from a trench conducted by a mechanical excavator approximately in the middle of a flat alluvial plain. The bottom part of the profile consists of gravels and sands, which turn into the deposits of an ex-reic (open) lake. These deposits contained aquatic

mollusks. Several pine trunks were lifted by a mechanical excavator from these layers. Some drifted pine trunks were affected by a fire, which documents the importance of fire events during the Late Glacial period (Petr *et al.* 2014). Lake deposits gradually turn into peat deposits. Several pine stumps and rich rooting were preserved in the upper part of the peat layer. It evidences a shift from a continuous lake surface to a waterlogged pine woodland. The decline of the pine woods was caused by a water level transition and by a shallow water calcareous clay and concretions accumulation. According to the pollen record, we can date this event to the early Holocene period. In general, the local pollen record is dominated by pine, other plant species such as birch or herbs are rare. This is a difference from the Turov profile, which is caused mainly by different taphonomy of pollen spectrum in a water stream. Later Holocene deposits can be characterized as alluvial overbank deposits affected by modern plowing and drainage.

CONCLUSIONS

Research around the Loučná River valley provides us with an unusual insight into local human settlement and environmental changes during the Late Glacial/Early Holocene shift. Rich archaeological finds evidence of a continuity of the Early Mesolithic settlement

on the Loučná River terrace. The subsistence strategies of the local Early Mesolithic foragers were based on environmental diversity and productivity of the Loučná River alluvium. Human impact in a form of fire management of the alluvial valley is well visible in the local sedimentary record. Dynamic environmental changes during the Late Glacial and Early Holocene periods are well documented by a changing of various types of deposits, such as gravel alluvium or calcareous shallow water reservoir sediments.

REFERENCES

- Mlejnek O., Štefanisko D., in print, An Alien in the Microlithic Assemblage: Functional Analysis of the Large Tanged Tool from the Early Mesolithic Settlement of Městec/Ostrov (Czech Republic), *Anthropologie*.
- Mlejnek O., Záhorák V., 2020, Předběžná zpráva o výzkumu mezolitické a pozdně paleolitické lokality u Uherska ve východních Čechách, *Ročenka Archeologického centra Olomouc* 2018, 50–66.
- Mlejnek O., Záhorák V., Přichystal A., Nejman L., in preparation, Archaeological Excavation of an Early Mesolithic Settlement Městec/Ostrov in Eastern Bohemia (Czech Republic) Dated to the Preboreal Period, *Anthropologie*.
- Petr L., Novák J., 2014, High vegetation and environmental diversity during the Late Glacial and Early Holocene on the example of lowlands in the Czech Republic, *Biologia* 69, 847–862.
- Petr L., Sádlo J., Žáčková P., Lisá L., Novák J., Rohovec J., Pokorný P., 2014, Late Glacial and Holocene environmental history of a floodplain wetland (Elbe River, Czech Republic), a context-dependent interpretation of a multiproxy analysis, *Folia Geobotanica* 49, 137–162.
- Vermeersch P. M., 2013, An Ahrensburgian site at Zonhoven-Molenheide (Belgium), *BAR International Series* 2471, Oxford.

ALLUVIAL FANS AS INDICATOR OF HUMAN IMPACT: CASE STUDY OF MOZGAWKA AND NIDA RIVER VALLEYS (POLISH UPLANDS)

Tomasz Kalicki¹, Piotr Biesaga²

¹Jan Kochanowski University in Kielce, Institute of Geography and Environmental Sciences, Department of Geomorphology and Geoarchaeology, Poland, tomaszkalicki@ymail.com

²Jan Kochanowski University in Kielce, Faculty of Natural Sciences, Poland, PhD student, biesaga.piotr@onet.pl

ABSTRACT

During the Atlantic a maximum Holocene afforestation occurred in Central Europe and the first deforestation was human-induced by introducing Neolithic farming. During the first half of the 4th millennium BC the first farmers related with the Funnel Beaker culture (=TRB) appeared in Mozgawa and loess uplands. On the sandy alluvia of the Nida River, three alluvial cones of silty sediments were deposited, which raised the level of the floodplain by 5 to 8 m. The alluvial fans reflect deforestation in the loess uplands of the Neolithic, Roman Period and Middle Ages.

Keywords: alluvial fans, deforestation phases, human impact, Prehistory, loess, Nida River

INTRODUCTION

Rivers and river valleys are a very good indicator of various changes taking place in the environment. Changes in their sediments and fluvial relief can be observed, for example, in the amount of transported material, river course and pattern as well as the formation of alluvial fans in the mouths of tributaries or erosive cuts, which are the result of soil erosion development (e.g. Kalicki 2006).

RESEARCH AREA

The research area is located southward of the Holy Cross Mts. (Fig. 1), within the Polish Uplands in the Nida river valley (Kondracki 2002). The upland character of the relief, the compliance of the Nida Basin depression with the tectonic structure, the preservation of the Tertiary old relief, the lack of a continuous and thick cover of glacial deposits significantly altering the older relief is typical for the entire region.

Nida is created from the connection of two rivers, Czarna Nida and Biała Nida, in village Brzegi near Chęciny. The length of the entire watercourse exceeds 150 km, the basin area is 3862 km², and the average discharge is 19 m³/s. In the upper reach, the Nida flows on the Cretaceous basement, cutting into limestones, and in the middle and lower reaches, it creates gorges between the Cretaceous rocks (on the right bank) and the Neogene rocks (on the left bank). The middle Nida valley is filled with the Quaternary sediments,

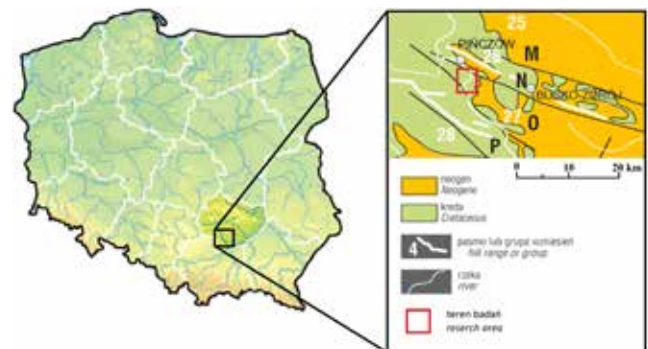


FIG. 1. Location and geological map (Urban 2014) of study area; 25 – Połaniec Basin, 26 – Pińczów Hump, 27 – Solec Basin, 28 – Wodzisław Hump. M – Połaniec Depression, N – Pińczów Horst, O – Solec Depression, P – Nida Horst

including glacial deposits, and the right-bank part of the catchment, Wodzisław Hump, is covered with loess. The hump forms an expressive, compact, upland elevation, elongated from NW to SE, about 40 km long and 10 km wide. It rises from 200 m in the east near Żłota to 368 m a.s.l. in the culmination of Góra Przygrzeb, located north of Krzeszówek near Książ Wielki. Despite the carbonate substrate, karst phenomena did not develop here, and the Cretaceous rocks on 2/3 of the hump is covered with loess and loess-like formations with an average thickness of 1–2 m (Gilewska 1972), and a maximum thickness of 20 m (Cabaj, Nowak 1986). The loess cover did not obliterate the key features of the morphology

and follows the relief of larger humps and valleys. Loess accumulated in several periods, the oldest ones come from the Odra stadial (Maruszczak 1987), but the greatest area is that of the Vistulian loess (Jersak et al. 1992). On the plateaus there is the primary loess accumulated by aeolian processes. On the slopes and in the valleys, apart from the aeolian loess, there are secondary „loess” covers formed as a result of the redeposition of primary loess by exogenous processes at various periods (Jersak et al. 1992, Śnieszko 1995).

Wodzisław Hump descends towards the Nida River valley in two erosive steps: the higher one (240 m a.s.l.) is pre-Quaternary, the lower one (185–190 m a.s.l.), probably Pleistocene, it is already in the Nida valley (Radłowska 1966, Łyczewska 1969). It descends with a steep edge of loess and loess deluvia into the valley bottom (Fig. 2).

The hump has no permanent rivers, but is densely cut with valleys of small permanent and periodic watercourses as well gullies and flat-bottom valleys. The bottom of dry valleys is filled with sandy sediments, and at their mouth there are alluvial fans (Łyczewska 1971, 1972). Here, interfinger of alluvium and slope deposits occur, which indicates the simultaneity of river accumulation and pluvial-solifluction in the periglacial environment (Cabaj, Nowak 1986). One of such watercourses is Mozgawka, which drains a large part of the hump flowing from Kostrzeszyn, through Wola Chrobberska, Zawarża to the village of Mozgawa, where it flows into the Nida.

During the Atlantic a maximum Holocene afforestation occurred in Polish Uplands and the first deforestation was human-induced by introducing Neolithic farming. The loess area was densely populated by the agricultural population of Neolithic cultures (Fig. 3) (Małęga et al. 2016, 2019). During the first

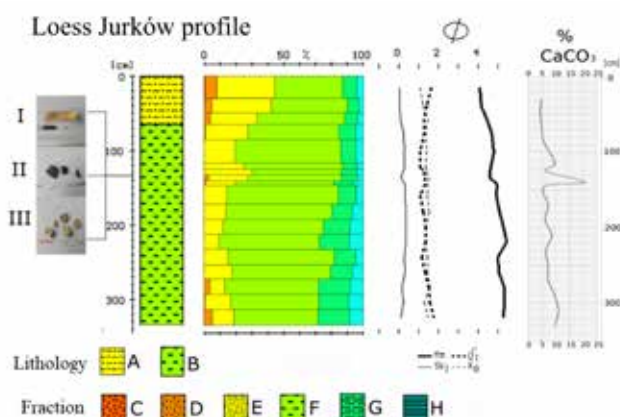


FIG. 2. Geological profile in loess edge of right slope of the Nida River valley near Jurków (Biesaga 2016); I – pig bones, II – ceramics, III – loess concretion, Lithology: A – sandy loess, B – loess, Fraction: C – coarse sand, D – medium sand, E – fine sand, F – coarse and medium silt, G – fine silt, H – Clay. Folk-Ward's (1957) distribution parameters: Mz – mean diameter, δl – standard deviation (sorting), Skl – skewness, KG – kurtosis



FIG. 3. Neolithic sites in the Nida River valley near Wiślica according to data of Archaeological Map of Poland (AZP) (Małęga et al. 2016, 2019)

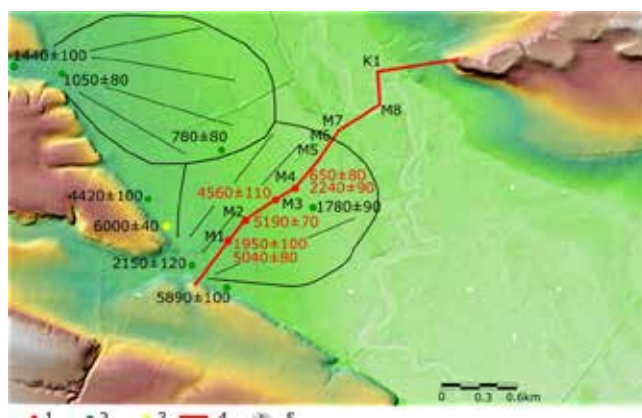


FIG. 4. Location of geological boreholes and section across the valley bottom of the Nida River on Digital elevation Model (DEM). 1 – own radiocarbon dates, 2 – radiocarbon dates from Szwarzewski (2009), 3 – radiocarbon date from Moskal-del Hoyo, 4 – cross section line 5 – alluvial fan

half of the 4th millennium BC the first farmers related with the Funnel Beaker culture (=TRB) appeared in Mozgawa and built a long-lasting settlement. It was located on a loess hill directly N of the Mozgawka estuary. During the Neolithic occupation of the Mozgawa settlement, processes of slope erosion were initiated and created the thick layer of mineral colluviums (diluvium) at the bottom of the loess hump (Moskal-del Hoyo et al. 2018). The morphology and the DEM show two alluvial fans deposited on to the bottom of the Nida valley, the first at the mouth of the Mozgawka valley and the second at the exit of the dry valley northward from the first one (Fig. 4).

AIM AND METHODS

In order to identify the structure and age of the Mozgawka alluvial cone, a number of interdisciplinary methods were used. Maps and published and unpublished materials were queried. With the use of the mechanical Cobra drill, geological boreholes were made to a depth of 700 cm, as well

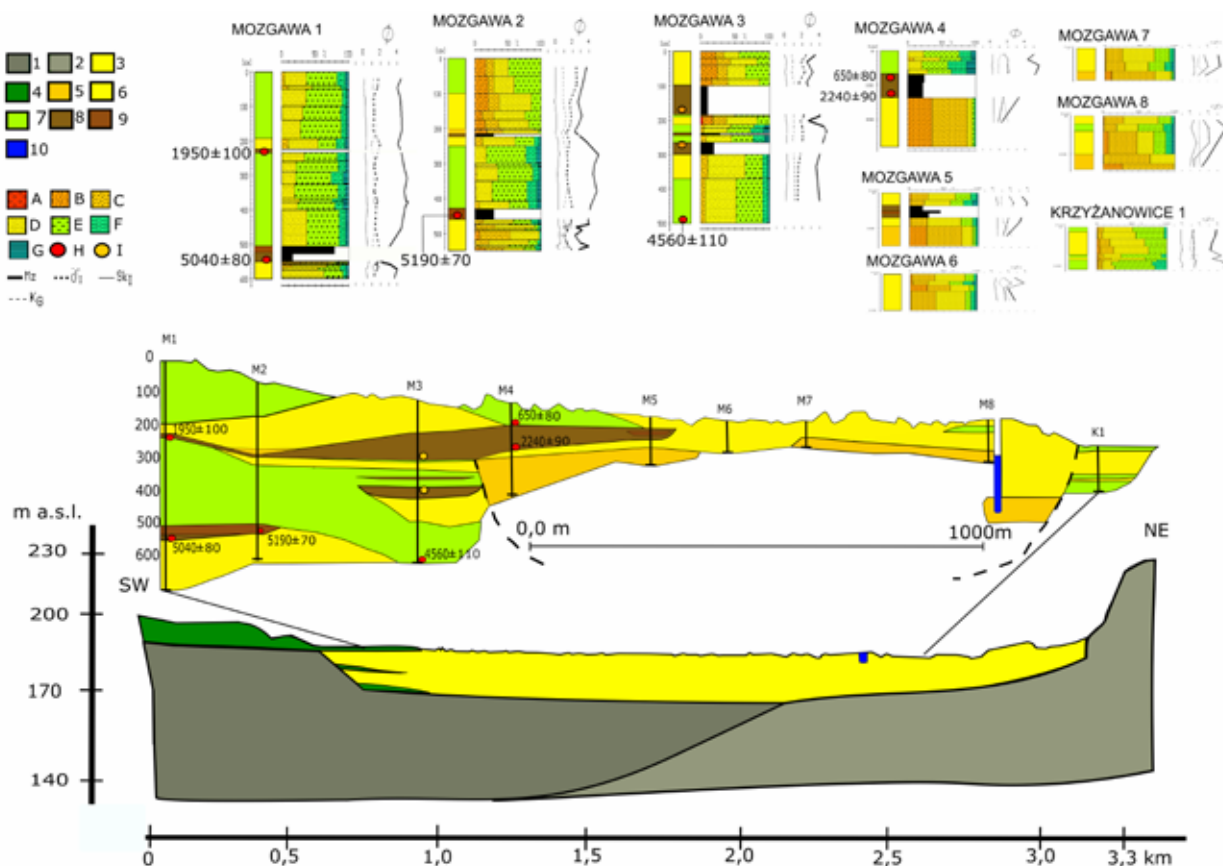


FIG. 5. Section across the Nida floodplain near Mozgawka (location see Fig. 4) and lithology and grain size of study profiles; 1 – Cretaceous limestones, 2 – Cretaceous marls and limestones, 3 – Pleistocene and Holocene sands, 4 – Pleistocene loess; Lithology in profiles: 5 – medium sands, 6 – fine sands, 7 – silts, 8 – peaty silts, 9 – clayey peats; 10 – Nida riverbed, Fraction: A – gravel, B – coarse sand, C – medium sand, D – fine sand, E – coarse and medium silt, F – fine silt, G – clay, H – ^{14}C dating, I – planned ^{14}C dating; Folk-Ward's (1957) distribution parameters: Mz – mean size, δ_1 – standard deviation (sorting), Sk_1 – skewness, K_6 – kurtosis

as exposures located on the section across the entire bottom of the Nida valley. In the laboratory of Department of Geomorphology and Geoarchaeology Jan Kochanowki University in Kielce, sediment samples collected from the cores were subjected to grain size analyzes using a Masterizer 3000 laser meter for fine fraction and a set of sieves for sands. Organic matter content was determined using the losses roasting method. Radiocarbon dating of organic sediments was also performed.

RESULTS

In the SW part of the cross-section, the alternating sandy and silty layers are separated by the lenses of peaty silts and clayey peats. The lowest organic level was dated to the decline of the Atlantic: 5040 ± 80 BP (MKL 5738) cal. 3976–3651 BC (95.4%) and 5190 ± 70 BP (MKL 5734) cal. 4235–3801 BC (95.4%) They are covered with a layer of dust, in the bottom of which the wood was deposited at the beginning of the Subboreal: 4560 ± 110 BP (MKL 5733) cal. 3618–2927 BC (95.4%) (Fig.5).

The higher level of peaty silts was dated to the La Tène-Roman Period 2240 ± 90 BP (MKL5736) cal. 539–44 BC (95.4%). It was covered with another

silty-sandy member in the Roman period yet at 1950 ± 100 BP (MKL-5737) cal. 197 calBC–331 calAD (95.4%) in the Mozgawka estuary, while further towards the axis of the valley, the change from organic to mineral sedimentation took place only in the Middle Ages at 650 ± 80 BP (MKL-5735) cal. 1129–1427 AD (95.4%). Within the meander belt of the Nida River there are cut and fill body of sandy alluvium (medium and fine sands) covered in the SW part by the above-mentioned organic layer. The back-swamp on the left-bank floodplain is filled with fine sands interbedded by silts (Fig. 5).

DISCUSSION

According to previous research results, the level of the flood plain in the Eoholocene was 6–8 m lower than the modern one (Moskal-del Hoyo et al. 2018), and the alluvial fan of Mozgawka River began to accumulate in the Neolithic (6000–5890 BP). However, one cannot agree with Szwarczewski's (2009) claim that, when connected to a cone located at the mouth of a dry valley north of the Mozgawka River, it formed a stagnant water area from which water could not be drained off, because the second cone from dry valley is much younger, according to the dates published

in this work. The Neolithic fan of Mozgawka River was deposited until the beginning of the Subboreal, and during this period it reached about 600 m into the floodplain, which was created by it about 3 m (Fig. 4, 5). This large horizontal and vertical extension was sufficient to create a badly drained area northward of it with a water reservoir, in which gyttja could accumulate (comp. MOZ 4/2015 profile in Moskal-del-Hoyo et al. 2018).

The next alluvial fan of Mozgawka river began to accumulate in the Roman period, but its dimensions were much smaller, both vertically and horizontally (Fig. 4, 5).

The youngest phase of the alluvial fan formation falls on the Middle Ages. At that time (1050 BP), a alluvial fans at the mouth of the dry valley northward from Mozgawka River (Szwarczewski 2009) and the youngest alluvial cone of Mozgawka were formed. Both cones joined together, covering the layer of organic sediments already within the meander belt of the Nida approx. 780–650 BP (Fig. 4, 5).

The grain size of the alluvial fan sediments is very similar to loess, e.g. at Jurków site (Fig. 2), which indicates that they were formed as a result of soil erosion in Wodzisław Hump.

CONCLUSIONS

On the sandy alluvia of the Nida River, three alluvial cones of silty sediments were deposited, which raised the level of the floodplain by 5 to 8 m. The alluvial fans reflect deforestation in the loess uplands of the Neolithic, Roman Period and Middle Ages.

REFERENCES

- Biesaga P., 2016, Rzeźba i budowa geologiczna Doliny Nidy koło Jurkowa, maszynopis pracy licencjackiej Archiwum UJK.
- Cabaj W., Nowak W. A., 1986, Rzeźba Niecki Nidziańskiej, Studia Ośrodka Dokumentacji Fizjograficznej 14, 119–209.
- Folk R.L., Ward W.C. 1957. Brazos River bar: A study in the significance of grain size parameters, *J. Sed. Petrol.* 27, 3–26.
- Gałka M., 2006, *Objaśnienia do Mapy Geośrodowiskowej Polski 1:50 000*, ark. Busko-Zdrój (917), PIG Warszawa.
- Gilewska S., 1972, *Wyżyny Śląsko-Małopolskie* [in:] *Klimaszewski M. (Ed.), Geomorfologia Polski t. 2*, PWN, Warszawa.

- Jersak J., Sendobry, K., Śnieżko Z., 1992, *Postwarciańska ewolucja wyżyn lessowych w Polsce*, *Prace Naukowe Uniwersytetu Śląskiego w Katowicach* 1227, 198.
- Kondracki J., 2002, *Geografia regionalna Polski*. PWN, Warszawa
- Łyczewska J., 1969, *Sediments et processus quaternaires dy versant cretace de la vallee de la Basse – Nida (partie meridionale de la Pologne centrale*, *Biuletyn Peryglacjalny* 18, 195–208.
- Łyczewska J., 1971, *Szczegółowa Mapa Geologiczna Polski 1:50 000*, Wydawnictwa Geologiczne 1972.
- Łyczewska J., 1972, *Objaśnienia do Szczegółowej Mapy Geologicznej Polski*, ark. Busko Zdrój, Wyd. Geol. Warszawa.
- Małęga E., Biesaga P., Kalicki T., 2016, *Neolithic settlement and relief of Nida river valley near Wiślica (Polish Uplands) – preliminary results*, *Abstracts 12 Conference Environmentalni Archeologie „Před neolitem...”*, 7–9.02.2016, Praga, Czechy, 39.
- Małęga E., Biesaga P., Kalicki T., 2019, *Neolityzacja ziem w rejonie Wiślicy w świetle badań interdyscyplinarnych*, *Międzynarodowe sympozjum „Krajobraz przyrodniczy i kulturowy w neolicie i wczesnej epoce brązu w świetle badań interdyscyplinarnych”*, 18–20 września 2019 Wrocław.
- Maruszczak H., 1987, *Loesses in Poland. Their Stratigraphy and Paleogeographical Interpretation*, *Annales UMCS, Sec. B*, 41.
- Moskal-del Hoyo M., Wacnik A., Alexandrowicz P., Stachowicz-Rybka R., Wilczyński J., Pospuła-Wędzicha S., Szwarczewski P., Korczyńska M., Cappenberg K., Nowak M., 2018, *Open country species persisted in loess regions during the Atlantic and early Subboreal phases: New multidisciplinary data from southern Poland. Review of Palaeobotany and Palynology* 253, 49–69.
- Radłowska C., 1966, *Z geomorfologii okolic Pińczowa* [in:] *Studia geograficzne w powiecie pińczowskim*, *Prace Geograficzne IG PAN*, 47, 17–37.
- Szwarczewski P., 2009, *The formation of deluvial and alluvial cones as a consequence of human settlement on a loess plateau: an example from the Chroberz area (Poland)* *Radiocarbon* 51, 2, p. 445–455.
- Śnieżko Z., 1995, *Ewolucja obszarów lessowych Wyżyn Polskich w czasie ostatnich 15 000 lat*, *Prace Nauk. UŚ* 1496, 1–124.
- Urban J., 2014, *Cechy rzeźby strukturalnej Gór Świętokrzyskich oraz południowo-wschodniej części Niecki Nidziańskiej*, *Przegląd Geologiczny* 62, nr 1, 44–50

ENVIRONMENTAL CONDITIONS OF THE LOCATION AND FUNCTIONING OF ANCIENT CITIES IN THE SW CYPRUS

Tomasz Kalicki¹, Sławomir Chwałek², Jani Puntos Konstantinovski³

¹Jan Kochanowski University in Kielce, Department of Geomorphology and Geoarchaeology, Poland; tomaszkalicki@ymail.com

²Independent scientist, Poland, slawomirchwalek@gmail.com

³Independent scientist, Poland, jkpuntos@gmail.com

ABSTRACT

The results of the research allowed to reconstruct the Quaternary evolution of the Paphos region (*off-site* area), conditioned by neotectonic movements and climate change, and to determine the state of the environment at the time of the settlement of this area by the founders of Nea Paphos („zero point”, *on-site* area). Nea Paphos is an example of a city that, despite not very favorable environmental factors was able to exist. Economic and political reasons (access to the port) were the main factors determining the founding of this city. Further research will focus on determining the environmental conditions of the ancient city’s functioning, e.g. water supply and determining the alluviation phases in the Kouris river valley, etc. This will make it possible to compare a number of geoarchaeological and palaeogeographic problems related to the location and functioning of the ancient cities of Nea Paphos and Kourion in the SW part of Cyprus, to identify similarities and differences.

Keywords: geoarchaeology, ancient cities, Nea Paphos, Kourion, Cyprus

INTRODUCTION

Cyprus is located in the eastern part of the Mediterranean Sea, in the subtropical (Mediterranean) zone (Fig. 1). In contrast to the rest of the eastern Mediterranean, the island is located between the Anatolian plateau and the foreland of the African Plate. This area is characterized by high neotectonic activity, varied relief, and subtropical climate. During the Upper Pleistocene the uplift rate of the Paphos region, calculated from the high of MIS 7 and MIS 5 maritime terraces, is 0.35–0.39 mm/year but in the Lemesos region is only 0.02 mm/year (Zomeni 2012). The uniqueness of Cyprus is partly due to the fact that as a preserved ophiolitic complex with a hydrated core it’s like a diapirically uplifting entity. Coupled with the nearshore tectonic activity of the Cyprus arc collision zone, there exists a dynamic environment of landscape evolution. Repetitive Quaternary sea level change has created coastal features that due to continuous uplift have been preserved as maritime and fluvial terraces.

The research region is located in the south-western part of Cyprus near Paphos and Lemesos. Geologically, Paphos is located in the Mammonia terran, surrounded by the Mesozoic Circum Troodos and the Troodos Mountains. The study area covers the ancient site of Nea Paphos with its immediate

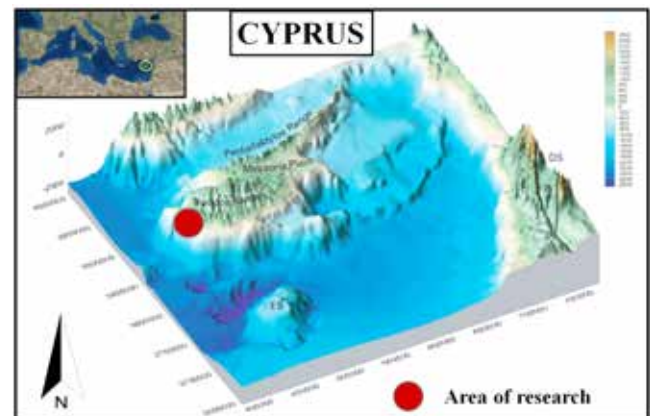


FIG. 1. Digital elevation model [DEM] of the eastern Mediterranean region combining bathymetry (in meters) and topography (“DS” – a section of the Dead Sea transform, “ES” – The Eratosthenes Seamount) (Harrison et al. 2008)

surroundings, i.e., the ancient necropolis located approx. 3 km north of Nea Paphos and the ancient port, as well as the modern city of Paphos (study *on-site*; Fig. 2:1). The second study area is located in the Ezousas River valley, approximately 6 km to the east of Nea Paphos (study *off-site*; Fig. 2:2).

The ancient city of Kourion lies near the Kuris River about 15 km westward of Limassol. It is located



FIG. 2. Study area in Paphos; 1 – *on site* area, 2 – *off site* area

on the end of the limestone/chalks plateau (Circum Troodos Sedimentary Succession of the Troodos Mountains).

AIM OF STUDY AND METHODS

The main aim is to determine the influence of the natural environment of the location and functioning of ancient cities Nea Paphos and Kurion. Particular emphasis was placed on getting to know the landscape and its Quaternary evolution as well as confronting these data with archaeological and historical sources. The project entirely refers to the Hellenistic and Roman period, when the ancient cities existed in this area. Due to their location, there were one of the most important places on the political and commercial map of the ancient. Other purposes of the research include (1) identification of the site of the second port of Nea Paphos, known from the sources of ancient writers, (2) identification of the settlement stratigraphy of Nea Paphos, (3) stratigraphy and alluviation phases in the Ezousas and Kuris rivers, (4) typology, regionalization and valorisation of geoecosystems in the Paphos and Lemesos region.

The fieldwork included geological mapping and sedimentological analysis of sandy gravel alluvium of various terrace and flood plain levels (Kalicki et al. 2018a, b, c, 2020, 2021a, Chwałek, Kalicki 2022). Grain size field analysis based on Rutkowski's (2007) method (Bluszcz et al. 1997), petrographic analysis using a polarized light microscope (Kalicki et al. 2021a), and samples for TL dating were also done. Dating of alluvium by TL method was conducted in the Geomorphological and Hydrological Laboratory of the Institute of Geography and Environmental Sciences of Jan Kochanowski University in Kielce (Kalicki et al. 2021b).

Research in Nea Paphos region has been carried out since 2014, while in Kourion and Kuris River valley in October 2021, only a field survey was carried out.

RESULTS FROM NEA PAPHOS REGION

Palaeogeographical reconstruction

The results of the research allowed to reconstruct the Quaternary evolution of the Paphos region (*off-*

site area), conditioned by neotectonic movements and climate change, and to determine the state of the environment at the time of the settlement of this area by the founders of Nea Paphos („zero point“, *on-site* area).

The Paphos region gradually emerged from the sea from the Pliocene, but the coastal area only in the Quaternary. In this period, high neotectonic activity caused the area to be raised (0.39 mm/year in the Upper Pleistocene) and the formation of subsequent ones, elevated to over 400 m a.s.l. interglacial maritime terraces (MIS 15, MIS 13, MIS 11, MIS 9, MIS 7-5) for at least more than 620 ka. These levels are one of the dominant forms of relief in the study area and are clearly marked in the coastal landscape by flattening at the height of approximately 410, 300, 190, 130, 60 m a.s.l. respectively on the foreground of the hills formed on the rocks of the Mesozoic edge of Troodos and the Mammonia terran. With the exception of the highest preserved in residual form, the others form extensive, flat, or slightly sloping plains separated by edges, the clearest in form rock walls or rock-weathered slopes with a relative height of up to 50 m between the MIS 9 and MIS 7-5 terraces.

The abrasion has cut maritime terraces in the underwent karst processes Miocene carbonate rocks of the Mesozoic Circum Troodos. On the abrasive and accumulation levels of these terraces, there were, probably aeolian, silty sediments accumulated. On the MIS 9 terrace, the silty series (aeolian?) sedimented since about 200 ka in several phases separated by the formation of fossil soils (Koskinas 2) until the end of the Pleistocene (Paphos Quarry). On the lowest terrace MIS 5 near the Nea Paphos archaeological park and the Kings Avenue Mall shopping center, there are erosive remnants of poorly lithified carbonate-sand rocks which, by weathering, provide sandy sediments that are subject to further morphogenetic processes.

Each lowering of the sea level associated with successive the Quaternary glaciations triggered karst processes at the same time. During the last maximum glaciations (LGM), at a lowered sea level (approx. 100-150 m), underground karst void (caves) formed in limestones on the MIS 5 terrace (under the Nea Paphos agora) were routes of the intensive karst water flow towards the sea. Along with the gradual rise of the sea level and a transport power decrease of karst waters, the caves were filled with „*terra rosa*“ sediments (TL data from well fill under the agora 17.9 ± 2.7 ka) wash out from the surface.

Numerous Quaternary faults in the southern part of the Mesozoic Circum Troodos occur. There are parallel to the coast in the Paphos area. The varied movements have resulted in the formation of horsts and grabens cross by large rivers flow from Troodos i.e. Ezousas. The high tectonic activity led to numerous earthquakes in the Quaternary. They are responsible for the formation of landslides and rockfalls in mountainous areas, e.g., in the Episkopi region

in the Ezousas valley about 28.6 ± 4.3 ka., and tsunami (e.g., in historical times 76–77 AD and 342 AD) attacking and flooding the coast and throwing large blocks of rocks found at two sites on the lowest maritime terrace in the Paphos area. These catastrophic events eventually led to the destruction of Nea Paphos.

River valleys are the second characteristic feature of the coastal landscape. Maritime terraces cut both short, steeply sloping watercourses springs in the Mesozoic Circum Troodos (e.g., Koskinas), as well as periodic long rivers starting in these mountains (e.g., Ezousas). In these valleys, strong alluviation was found in the Pleistocene and small in the Holocene, which was caused by climate change. Two main phases of alluviation have been distinguished: 75–48 ka and 25–13 ka (Fig. 3). At the same time, gravel inserts in the Paphos quarry document torrential flows occurring on the surface of the MIS 9 terrace several thousand years ago. This may have occurred during the younger alluvial phase when the alluvial plains accumulated in the lower part of the Ezousas river about 16.1 ± 2.4 ka. Accumulation of alluvia in the river valley, as well as the presence of torrential flows transporting gravel on sea terraces, could have been favored by climate humidity and an in-

crease in rainfall typical for the Mediterranean climate in summer.

The older phase was marked in both types of valleys, while the younger one only in large valleys (Ezousas). This may be because in small valleys during the LGM, a very large decrease in the erosion base as a result of the sea level drop by 100–120 m resulted in the intensive headward incision. Erosion has not yet reached the MIS II terrace, while on the lower terraces it has created deep gorge cut the flat abrasive surfaces of these terraces. High slope and the large transport power of these watercourses as well as the specificity of eroded sediments (silts) caused the products of this intense erosion were carried to the sea and did not form a alluvial cut and fill in these valleys. Differently, the erosion-accumulation cycles were marked in large and longer valleys, where in the upper course of the river with the predominance of erosive processes, a few alluvial covers (series) were preserved, while the sediments were deposited in the middle and lower part of the river with the dominance of accumulation.

The rapid rate of uplift meant that in the upper, mountain section, the rate of river incision in the period from approx. 60–20 ka was approx. 30 m. An erosion

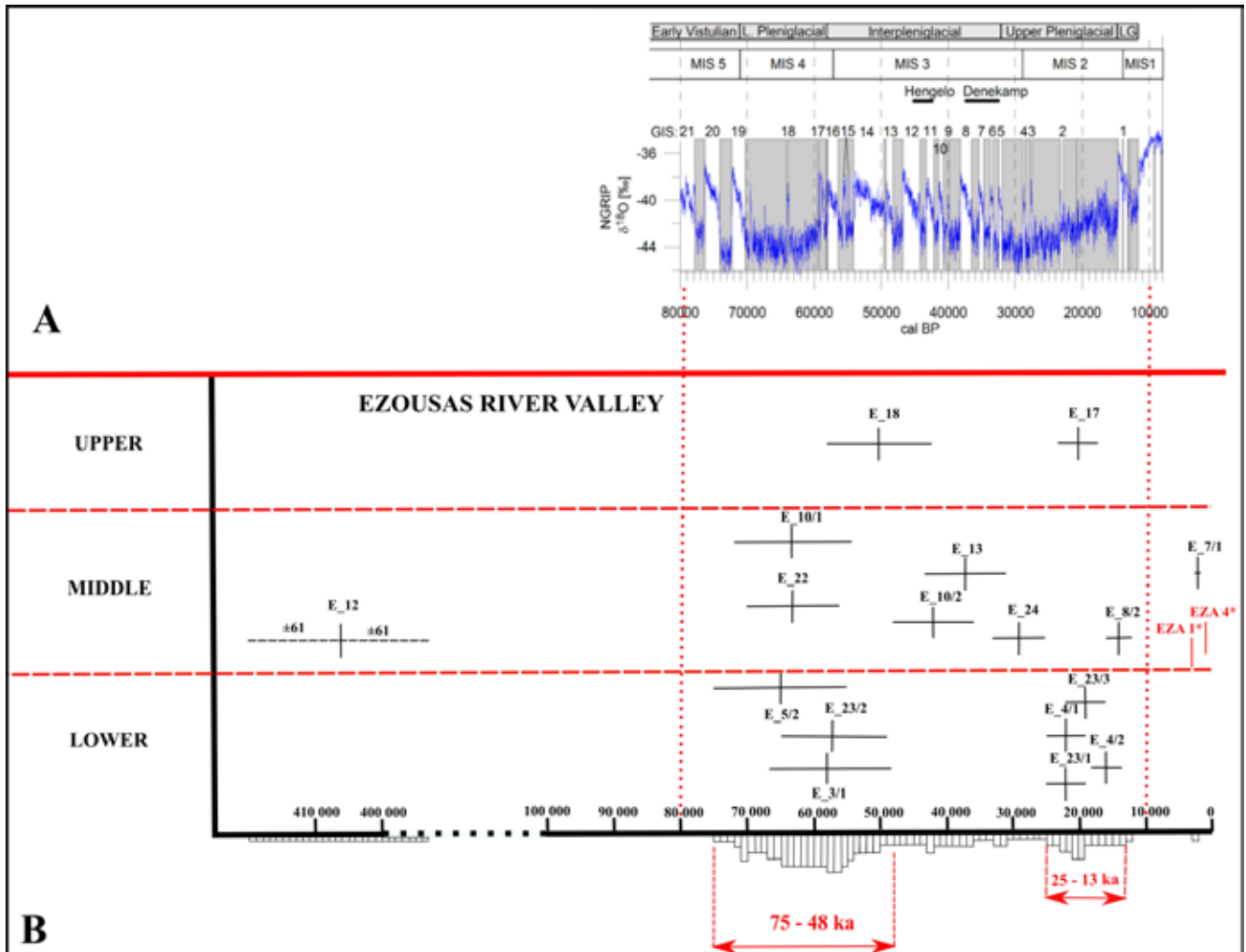


FIG. 3. Climate changes recorded in Greenland ice core (A)(Starkel et al. 2017) and TL data from Ezousas river valley (B)

and accumulation terrace were formed then, and the river reached the present level. At the same time, in the wetter period of LGM, there was a large crosswise supply to the main riverbed, both from the tributaries (alluvial cones – a coarse-clastic series with colluvium) and from the valley slopes. As the flow rate and the transport power decreased, the sediments at the valley floor were only washed and the coarse colluvia and alluvia (diameter >20 cm) lie in the riverbeds of the Ezousas spring valleys from the LGM, hindering the process of deep erosion and forcing lateral erosion of watercourses. The minor role of fluvial transport in the Holocene is confirmed by the measurements of contemporary fluvial processes, a significant share (up to 25%) of colluvia in channel sediments, as well as hydrological data.

In the Pleistocene in the foreland of the Troodos Mts. and their sedimentary margins, the sediments eroded upstream were deposited, because the valley is wider, and the river slope is clearly decreasing. In the middle section, cut and fill of different ages (from 400–2 ka) are located on almost one morphological level. Only the Medieval member are here about 2 m higher, but aggradation in the 4-phases, with flash flood and overbank accumulation in the top, did not cover the entire valley bottom in this period, but only a fragment of the alluvial plain of the braided river. In the lower part, the river crosses several tectonic horsts, which were uplifted about 30 m during the last 20 ka, and the alluvial series from the two Pleistocene alluviation phases are superposed here on the erosion-accumulation terrace. In its lowest part, the river crosses uplifted maritime terraces, and the uplift here can be estimated at about 11 m during the last 60 ka. Alluvia of different age created accumulation terraces here. In all these sections, a small role of fluvial transport in the Holocene was also found, which is confirmed by petrographic studies (the maximum length of transport is 7 km), measurements of contemporary fluvial processes (no transport of gravel, but only suspension fraction), as well as hydrological data (flows do not occur each year). Only in the lower section, the Holocene alluvia from the Roman period were found, covered with the Roman and Medieval colluvia.

While in the Troodos Mts., the climatically conditioned phase of increased mass movements has been identified, probably attributable to LGM, in their foreland, two other periods of an increased of mass movements activity occurred. The first of them, in the middle section, was related to the Interpleniglacial climate, when slope sediments dated at 63.2 ka covered alluvia. The older alluviation phase was also dated to this period in both large (Ezousas) and small valleys (Koskinas). In turn, after the LGM (after 22.5–19 ka each), a landslide was formed on the erosion-accumulation terrace in the lower reaches of Ezousas, but the factor that triggered it is unknown. The second phase of mass movements is known only from the lower part of Ezousas and was associated with

human activities in the Roman and Medieval periods. Slope sediments with a thickness of 2.5 m were covered alluvia from the Roman period. The youngest modern colluvia were recognized in the Koskinas valley.

Environmental analysis of the Nea Paphos location

An analysis of the environmental factors that could have influenced the location and functioning of the ancient city of Nea Paphos in the period 4th c. BC–4th c. AD showed that terrain type I is the most favorable in this respect, and terrain I within it. Apart from political factors and geographical location, were probably one of the most important aspects in the search for a new place for settlement, the environmental conditions of site I ensured the possibility of founder and operating Nea Paphos for many centuries. These conditions included: (1) availability of water, conditioned by the existence of periodic flow, underground karst waters, and shallow groundwater on river terraces, (2) soils suitable for cultivation and breeding in the fluvial terrace areas, (3) outcrops of older rocks that could have been used as quarries for the exploitation of building material, (4) a slight slope of the land, which it is relatively easy to build residential and other buildings related to the proper functioning of the city, (5) large physical and geographical diversity of the area.

The valuation shows that areas 1 and 2 (67% of the maritime terraces) have all the best environmental factors necessary for the location and functioning of the ancient city. In areas 3 and 4, the area of episodic watercourse geosystems is growing at the expense of periodic ones. This can cause specific problems in the water supply and thus in the agricultural and livestock activities. Therefore, these are areas less attractive for the location of a city. However, as the cities developed, they could also serve as places from which access to the mountain areas, where there were mines of mineral resources, was much easier. Terrain 5 is the area where there is the smallest number of periodic flows (2%) and the highest number of episodic flows (10%). Poor access to water and relatively steep slopes (approx. 20°) make it the least favorable area for settlement.

To sum up, areas 1 and 2 can be considered an oecumene (61% of valuation points), areas 3 and 4 as a suboecumene (23% of evaluation points), and area 5 as an anoecumene, the so-called badlands (16% of valuation points).

Ancient Nea Paphos is located on the uplifted maritime terrace MIS 5–7 in the geosystem terrain I – the lowest maritime terrace. It is located on two subtypes of forest areas 1.6 and 1.7. It is located on the sediments of maritime terraces with episodic and periodic surface watercourses and karst groundwater. The absolute height is 0–55 m a.s.l., and the slope is approx. 0–2°. In this area, there are carbonate lithosols and “*terra rosa*”. The morphogenetic processes on the subtypes include physical and chemical weathering, abrasion,

karst processes, rockfall, landslide, periodic wash out and anthropogenic processes. Subtype 1.6 also shows the greatest fragmentation (19%) in area 1 which proves the great diversity of the area.

The city was built on the bedrock with the Holocene soil in the top, without anthropogenic levels, and with the use of natural relief. The GPR echograms show a clear boundary between the anthropogenic layers and the bedrock at a depth of about 1 m, and TL dating of the karst weathered top of the limestones below the anthropogenic layers gave a result of 6.7 ± 1.01 ka.

The results of detailed interdisciplinary research both *on-site* and in its surroundings (*off-site*) unequivocally refuted the hypothesis of the existence of a second port north of Agora Nea Paphos in the quarries and the area of the modern city beach because: (1) dusty deposits on the raised sea terraces and in the pedestals of Koskinas erosion and accumulation terraces, eroded and cut from approx. 40 ka years, they were transported in suspension to the sea, where they dispersed and could not land where the ancient harbor was supposed to be, (2) the sediments in the "Kamieniotom" profile near Agora are a very young weathered cover („modern *terra rosa*") almost from the surface with fragments of limestone 8–10 cm in size. The rough and uneven limestone surface is already located at a depth of 1.2 m – 3.0 m, which contradicts the existence of port docks in this place according to the Balandier (2014) concept. GPR echograms from the so-called ramps and the quarry itself show anomalies that may be remnants of existing anthropogenic structures, not necessarily related to the port, (3) the GPR profile made on the western border of the quarry shows too shallow anomalies that could constitute a channel supplying water to the quarry where the port would be located. This contradicts the hypothesis of French archaeologists about the existence of a connection between the sea and the quarry (Balandier 2014), (4) on the city beach in Paphos, contemporary sands (AMS and TL dating) were found with algae intercalations up to a depth of about 1 m, lying on karst weathered („*terra rosa*") in the top of the carbonate bedrock (from 1.5 m deep), although locally, on the profile cuts of the beach made by GPR, the rock occurs already at a depth of 0.4 m. These sands, resulting from the destruction of carbonate, sandy erosive remnants, are washed away and deposited on the beach at the mouth of a dry valley, which is the northern border of the archaeological reserve. Then they are redeposited, on the one hand, by the undulating surface of the abrasive platform and, on the other hand, by the inland westerly winds onto the windward slopes of the MIS 5 sea terrace, which resulted in filling the test trench with 1 thick layer of aeolian sands.

Negative verification of the hypothesis about the existence of a second port, however, does not

exclude the functioning of the marina here, which could be favored by the morphology of this section of the coast and „slippery" clay deposits („*terra rosa*"), which could facilitate the transport of boats to the shore, and were covered by sands only after the fall of Nea Paphos.

PRELIMINARY RESULTS FROM KOURION

The ancient city of Kourion is located on the end of the limestone/chalks plateau (Circum Troodos Sedimentary Succession of the Troodos Mountains). From the south, its buildings reach the old sea-cliffs about 100 m high. It is further active undercut by the sea only in the SW part and transformed by landslides. Between the SW and SE headlands of this cliff, there are an old cliff faces worn back by weathering closing the „bay" between the headlands. On this slightly gentler rocky and weathered slope, traces of agricultural terraces are preserved. At the foot of the cliff there is an uplifted marine terrace (MIS5) made of sand and gravel. A cover of aeolian sands lies directly at the rock-wall. There are built by onshore winds blowing over sandy beach. The Byzantine Basilica complex (5th c. AD) was situated on the uplifted terrace. From N, a limestone plateau with ancient Kourion is limited by the vast valley of the Kouris river tributary. Within it, two fluvial terraces are preserved, indicating the gradual cutting of the plateau by a stream. The outlet of this tributary and its sediments meet the very vast alluvial plain of the Kouris River delta extending E from Kourion.

At the entrance to the city from the E side, there is an old Roman quarry, artificially undercutting the old sea-cliffs. The well-developed weathering structures on the rock surfaces testify to the antiquity of the quarry. The limestone from the quarry could be used to build the city. On the quarry walls, a 0.5 m wide fault and a 1.2 m throw is visible, probably caused by an earthquake, and extension fractures (fissures), secondary blurred by erosion.



FIG. 4. Relief of ancient Kourion region (photo T. Kalicki)

FINAL CONCLUSIONS

Nea Paphos is an example of a city that, despite not very favorable environmental factors, such as limited access to water or poorly fertile soil, was able to exist, function, and compete with other ancient cities in the Mediterranean region and beyond. In the case of Nea Paphos, the main factors determining the founding of the city were purely economic and political reasons (access to the port), on the basis of which the city developed and functioned for about 800 years. Only the two earthquakes in Nea Paphos in 342 CE and 394 AD led to the fall of this city, and the capital was moved to Salamis.

Further research will focus on determining the environmental conditions of the ancient city's functioning, e.g. water supply and determining the alluviation phases in the Kouris river valley, etc. This will make it possible to compare a number of geoarchaeological and palaeogeographic problems related to the location and functioning of the ancient cities of Nea Paphos and Kourion in the SW part of Cyprus, to identify similarities and differences.

ACKNOWLEDGMENTS

The study are part of Agora Paphos Project financed by The National Science Centre: grant NCN MAESTRO 2014/14/A/HS3/00283 „Agora oraz infrastruktura i aktywność gospodarcza Pafos, stolicy hellenistycznego i rzymskiego Cypru na podstawie badań interdyscyplinarnych”.

REFERENCES

- Balandier C., 2014., Des anciennes capitales de royaumes aux nouvelles villes portuaires: réflexions sur l'évolution du réseau urbain de Chypre à l'époque hellénistique [In:] Balandier Cl., et Chandezon Chr. (Eds.), *Les Mélanges Claude Vial. Institutions, sociétés et cultes de la Méditerranée antique. Mélanges d'histoire ancienne rassemblés en l'honneur de Claude Vial*, édité par, *Scripta Antiqua* 58, Bordeaux, 179-209.
- Bluszcz A., Starkel L., Kalicki T., 1997, Grain size composition and age of alluvial sediments in the Tista valley floor near Kalijhora, Sikkim Himalaya, *Studia Geomorphologica Carpatho-Balcanica* 31, 159-174.
- Chwałek S., Kalicki T., 2022, Evaluation of the environmental conditions of the Nea Paphos location in Cyprus (IV BC – IV AD) in the light of physico-geographical mapping of geosystems, *Acta Geobalcanica* 8-2, 53-58.
- Harrison R., Newell W., Panayides I., Stone B., Tsiolakis E., Necdet M., Batihanli H., Ozgur A., Lord A., Berksoy O., Zomeni Z., and Schindler, J. S., 2008, *Bedrock geologic map of the greater Lefkosia area, Cyprus: U.S. Geological Survey Scientific Investigations Map 3046*, 1 map, scale 1:25,000, 36-p. text.
- Kalicki T., Chwałek S., Frączek M., Kuształ P., Przepióra P., 2018a, *Geoarcheologia/Geoarchaeology* [In:] Papuci-Władyka E. (Ed.), *Pafos – misterium miasta Afrodyty. Dziedzictwo archeologiczne a nowe technologie/Paphos – Mystery Of The City Of Aphrodit. Archaeological Heritage Versus New Technologies*, Kraków, 162-171.
- Kalicki T., Chwałek S., Frączek M., Kuształ P., Przepióra P., Czerniak R., Chrostodolou G., 2018b, Late Quaternary phases of alluviation in the river valleys around Paphos, *Abstract Book 9th International Symposium on Eastern Mediterranean Geology*, 7-11.05.2018, Antalya, Turkey, 208-209.
- Kalicki T., Chwałek S., Frączek M., Przepióra P., Chrabąszcz M., Kuształ P., 2018c, Sediments and age of terraces and floodplains of the Ezousas river, [In:] Kleprliková L., Šamánek J., Turek T., Calábková G., Ivanov M. (Eds.), *Sbornik abstraktů 24. Kvarter*, 30.11.2018, Brno, 30.
- Kalicki T., Chwałek S., Frączek M., 2020, First results of geoarchaeological studies on site and off site in Nea Paphos [In:] Papuci-Władyka E. (Ed.), *Paphos Agora Project (PAP), Volume 1, Interdisciplinary research of the Jagiellonian University in Nea Paphos UNESCO World Heritage Site (2011-2015) – first results*, Kraków, 487-502.
- Kalicki T., Chwałek S., Przepióra P., Frączek M., Kuształ P., Chrabąszcz M., Konstantinovski Puntos C., 2021a, Sediments and age of terraces and floodplains of the Ezousas river in SW Cyprus, *Acta Geobalcanica* 7-1, 1-6.
- Kalicki T., Głuszewski W., Frączek M., Przepióra P., 2021b, Luminescencyjne datowania w badaniach geoarcheologicznych, *Postępy Techniki Jądrowej* 64, 3, 34-41.
- Rutkowski J., 2007, Uziarnienia osadów bardzo gruboziarnistych – możliwości badawcze [In:] Myciel-ska-Dowgiałło E., Rutkowski J. (Eds.), *Badania cech teksturalnych osadów czwartorzędowych i wybrane metody oznaczania ich wieku*, Wydawnictwo Szkoły Wyższej Przymierza Rodzin, Warszawa, 9-16.
- Starkel L., Michczyńska D., Gębica P., 2017, Reflection of climatic changes during interpleniglacial in the geoecosystems of South-Eastern Poland, *Geochronometria*, 44, 202-215.
- Zomeni Z., 2012, *Quaternary Marine Terraces on Cyprus: Constraints on Uplift and Pedogenesis and the Geoarchaeology of Palaipafos (a dissertation submitted to Oregon State University, manuscript)*.

FIELDS IN THE FOG: LAND USE CHANGES AND LANDSCAPE TRANSFORMATION IN LOMAS DE LACHAY, CENTRAL PERU

Piotr Kalicki

Institute of Archaeology, Jagiellonian University, Krakow, Poland; kalickipiotr.kr@gmail.com

ABSTRACT

Large-scale systems of agricultural terraces was constructed by the Lima culture groups in the Lomas de Lachay. The terraces are usually located in the channels of the dry river valleys. Main water source for the fields was shallow ground water. The agriculture was intensive, community-managed and infrastructure-based. Despite significant land-use changes and landscape transformation the agricultural terraces were abandoned due to decrease in water availability related to decrease in the frequency of El Niño events.

Keywords: agriculture terraces, Lima culture, water management, desert agriculture

INTRODUCTION

Lomas de Lachay are located on the Central Coast of Peru, approximately 100 km north of Lima and ca. 10 km from the shoreline (Fig. 1). They are situated on the low ridges (max. altitude ca. 1130 m a.s.l.) between two valleys of perennial rivers: Río Chancay (ca. 25 km to the SE) and Río Huaura (ca. 30 km to the N). The study area is located in drainage basins of Quebrada Río Seco de León and Quebrada Doña María, which are both episodic rivers active only during El Niño episodes. Environmental studies (Kalicki et al. 2014; Kalicki, Kalicki 2020) indicate that there were no perennial rivers in the study area since the end of the last glacial.

Despite being located far from the perennial rivers, a relatively abundant vegetation developed in Lomas de Lachay due to *garúa* phenomenon (Rundel, Dillon 1998, Rundel et al. 2007). During austral winter due to the cold Humboldt Current flowing alongside Peruvian coast the humidity condensates creating a layer of thick and low *Stratus* clouds. They over land forming thick fog (*garúa*), which deposits humidity on first, low ridges of the Andes (Rundel, Dillon 1998, Dillon et al. 2003). During the humid season (June to November) the relative humidity is usually about 100%, the average temperature is below 15°C, and the precipitation sum is ca. 120 mm (about 75% of the annual sum of precipitation). During the dry season (December to May), the relative humidity reaches 82%; the average temperature is about 20°C, and the precipitation sum is extremely rare (ca. 40 mm). This pattern is modified by strong El Niño episodes, which bring



FIG. 1. Location of the study area. LSA – limits of the study area; 1 – Río Huaura, 2 – Lomas de Lachay, 3 – Río Chancay. The sources of the satellite image of South America is Wikipedia and of zoomed fragment of terrain is Google Earth

torrential rains doubling the annual sum of precipitation (to ca. 320 mm) with maximum precipitation (ca. 50%) in the middle of dry period (January–February) (Ordoñez, Faustino 1983, Shoobridge 2003).

Lomas de Lachay is covered by fog-dependent vegetation forming the *lomas ecosystems*. Due to the influence of the altitude and relief on frequency, duration and thickness of the fog there are many types of *lomas*: cacti *lomas* on low-lying (below 200 m a.s.l.) or leeward slopes; herbaceous *lomas* on the valley bottoms and on the slopes; shrubby and park-like *lomas* in the narrow gullies and windward slopes between 400 and 600 m a.s.l.; and *Bromeliaceae lomas* on rocky cliffs (Rundel, Dillon 1998, Dillon et al. 2003). The vegetation attracts many

species of invertebrates, birds and mammals (Andean deer, Andean foz, guanaco).

Archaeological survey discovered abundant traces of pre-Hispanic human activity in the study area (Kalicki et al. 2014). There were at least six settlement phases separated by hiatuses. During two of them, Lima (200 BC–500/800 AD) and Inka (1450–1550 AD), permanent settlements were present in the study area. In Lomas de Lachay there are traces of large-scale agricultural infrastructure, mainly (ca. 93%) channel type of agricultural terraces (Engel 1987).

RESULTS

The most common form of agricultural infrastructure in the study area are complexes of agricultural terraces (henceforth “CATs”). Although such features are popular in the Central Andes (Brooks 1998, Denevan 2001), unlike the famous terraces from the Colca valley or Urubamba valley, almost all (ca. 93%) of the terraces from Lomas de Lachay are channel terraces, located in the dry channels of the narrow gullies and ravines. Only some are located on the broad valley floor (ca. 1%) and on the lower parts of the slopes (ca. 6%) (Fig. 2). Basing on the scarce pottery sherds and spatial association between the CATs and settlements, the CATs most likely correspond to the Lima culture.

No traces of irrigation canals were found in the study area. In the Holocene the climate of the Lomas de Lachay was relatively stable and resembled contemporary conditions, where there is virtually no precipitation during years without El Niño events. The possible water sources are thus hypothetical natural watercourses, direct absorption of humidity brought by the fogs or ground water. No traces of perennial or seasonal rivers from the Holocene were found in the *lomas* area. Location of agricultural terraces in the channels also makes improbable presence of running surface water, which would have eroded the structures. The preferred location of CATs is below the zone of the most frequent fogs, which

doesn't support direct deposition of water by the fogs as primary water source. Preferred localization of CATs in the lowest parts of the river valleys, preference for the upper parts of the tributary valleys, preference for the location of CATs on rocky and waste-covered surface, and location of the majority of the CATs below the zone of the most frequent fogs (Fig. 2a) or even below the fog zone at all, indicate that the shallow ground water was the most probable water source for the agriculture. It was alimented both by seasonal fogs and catastrophic rains during El Niño events, which is supported by the concentration of the CATs on the windward slopes in the *lomas* ecosystem and correspondence between preferred exposition of the CATs, (W–SW–S, 69%) and dominant wind directions (S and SW).

Despite large scale of the CATs there are no traces of central management of the agricultural infrastructure. The CATs follow natural relief of terrain and often have dendritic pattern. Most of them have relatively small area (Fig. 2b). They have no sectors and tend to incorporate natural features (large boulders, rocky outcrops, steep sections of channel) into construction. The construction technique is opportunistic, using local raw material (irregular, angular, non-standardized and unworked stones) without using mortar (Fig. 3). Little attention has been paid to visual appearance of the retaining walls, which seem to be purely practical constructions. There are no traces of repairs, rebuilding or enlargement of the CATs, which may suggest relatively short period of use. The CATs are often associated with settlements and sometimes also with the rock art sites. Presence of many broken grinding stones on the surface of the agriculture terraces far from the settlements may suggest middening. This characteristic suggests community-managed agriculture without the involvement of the social elites. The agriculture was probably oriented towards subsistence economy without creating significant surplus. However, scale of terracing and construction of agricultural

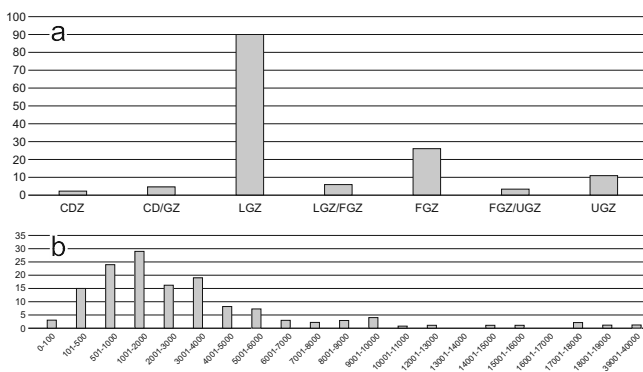


FIG. 2. Distribution of CATs by the fog zone (a) and by the area in m² (b) CDZ – Coastal Desert Zone (below 200 m a.s.l.), CDZ/LGZ – CATs located both in the CDZ and LGZ, LGZ – Lower Garúa Zone (200–400 m a.s.l.), LGZ/FGZ – CATs located both in the LGZ and FGZ, FGZ – Frequent Garúa Zone (400–600 m a.s.l.), FGZ/UGZ – CATs located both in the FGZ and UGZ, UGZ – Upper Garúa Zone (600–800 m a.s.l.)



FIG. 3. Reattaining wall of a CATs in the Lomas de Lachay

terraces in the steep ravines and valleys indicates intensive agriculture with high social demand for the cultivated land, which in turn suggests that either the population was relatively high or the productivity of the fields was low.

The CATs were constructed in the Lima phase, when there were permanent settlements between 200 BC–500 AD. Appearance of the early Lima groups in the Lomas de Lachay was probably associated on the one hand with phase with increased frequency of El Niño events alimenting local springs (Kalicki et al. 2014) and the period of socio-political instability on the Central Coast. Probably more humid conditions allowed for the soil formation. The total terraced area in the Lomas de Lachay is 490 702.3 m², and in drainage basins varies between 1–7% of the total area. The CATs were constructed in the most biologically productive areas, replacing natural vegetation. It probably disproportionately affected park-like and shrubby *lomas*. However, no traces of increased erosion were found in the study area.

Probably, the CATs were abandoned ca. 500 AD due to decrease in El Niño frequency. Less frequent El Niño events decreased alimentation of the local springs, which dried or at least stopped being active during the dry season. Consequently, permanent settlements had to be abandoned and CATs were too far from the Lima group centers in the valleys of perennial rivers to be cultivated after abandonment of the *lomas* settlements. After abandonment of the CATs natural vegetation reoccupied agricultural terraces, but most of the structures are still clearly visible on the surface.

CONCLUSIONS

During the Lima phase (200 BC–500/800 AD) specialized, intensive agriculture developed in the Lomas de Lachay. It required construction of large-scale infrastructure, which significantly modified natural landscape and land-use. The main water source was ground water alimented by the seasonal fogs and El Niño-related rains. Despite the scale of the infrastructure and the fact that it was constructed in a relatively short time, the agriculture was community-managed and oriented towards subsistence economy of individual communities. The CATs were located in the most biologically productive ar-

eas, replacing natural vegetation, mostly park-like and shrubby *lomas*.

Construction of the agricultural infrastructure significantly modified natural landscape, creating relatively large patches of “engineered” landscape. Cultivating the fields affected also land-use replacing important natural ecosystems. However, due to character of the infrastructure and particular characteristics of the local environment, construction of the CATs didn’t trigger erosion. Due to stability of the local geosystem, the remains of the CATs are relatively well-preserved creating fascinating fossil cultural landscape.

REFERENCES

- Brooks S., 1998, Prehistoric agricultural terraces in the Rio Japo Basin, Colca Valley, Peru. The University of Wisconsin-Madison.
- Denevan W., 2002, Cultivated landscapes of native Amazonia and the Andes. Oxford, Oxford University Press.
- Dillon O. M., Nakazawa M., Leiva G. S., 2003, The lomas formation of coastal Peru: composition and biogeographic history, [In:] Haas J., Dillon O. M. (Eds.), El Niño in Peru: Biology and Culture over 10,000 Years, Botany New Series 43, 1–9.
- Engel F., 1987, De las begonias al maíz: vida y producción en el Perú antiguo, Universidad Nacional Agraria La Molina, Lima.
- Kalicki P., Kalicki T., Kittel P., 2014, The influence of El Niño on settlement patterns in Lomas de Lachay, central coast, Peru, IANSA Interdiscip, Archaeol. Nat. Sci. Archaeol, 5, 147–160.
- Kalicki T., Kalicki P., 2020, Fluvial activity in the Lomas de Lachay during the upper Pleistocene and Holocene, Geomorphology 357, 107087.
- Ordoñez, C. J., Fautino, M. J., 1983, Evaluación del potencial hídrico en lomas costeras del Perú (Lomas de Lachay-Iguanil), Zonas Áridas 3, 32–50.
- Rundel W. P., Dillon M., 1998, Ecological patterns in the Bromeliaceae of the lomas formations of Coastal Chile and Peru, Plant Systems and Evolution 212, 261–278.
- Rundel P., Villagra P., Dillon M., Roig-Juñent S., Debandi G., 2007, Arid and semi-arid ecosystems. [In:]
- Veblen, T., Young, K., Orme, A. (Eds.), The Physical Geography of South America, Oxford, 158–183.
- Shoobridge, D., 2003, Lachay National Reserve Park Profile (ParksWatch – USA).

WHAT IS THE ROLE OF KITCHEN WASTE IN THE ENVIRONMENT OF A MEDIEVAL CASTLE? CASE STUDY ROKŠTEJN

Lenka Lisá¹, Jana Mazáčková², Petr Žaža², Miriam Fišáková Nývltová³

¹*Institute of Geology of the Czech Academy of Sciences,*

Rozvojová 269, Prague 6, 165 00, Czech Republic, lisa@gli.cas.cz

²*Department of Archaeology and Museology, Faculty of Philosophy, Masaryk University, Arna Nováka, 1/1, 602 00, Brno, Czech Republic*

³*Department of Physiology, Faculty of Medicine, Masaryk University, Kamenice 753/5, 625 00 Brno, Czech Republic*

ABSTRACT:

Waste is an integral part of the functioning of human society. However, the places where it is deposited are often different, and especially in the Middle Ages, differences between waste disposal between urban and rural environments can be observed. Based on micromorphology, the paper discusses the possible detection of kitchen waste and its informative value in the context of castle archaeology.

Keywords: castle dark earth, micromorphology, Medieval, kitchen waste

The definition of kitchen waste itself is not a very common topic. Usually, it is vaguely defined by the presence of mainly pottery and bone fragments, yet it is not taken into account how the waste management of the living society transformed individual waste materials, and how post-depositional processes formed the final archaeological layers, archaeologists interpret as kitchen waste.

Food preparation, and thus kitchens, belong to everyday human activities across time and space, yet on many occasions, archaeology has very limited opportunity to study these activities (cf. Beranová 2005, Graff–Rodríguez–Alegría eds. 2012). Castle kitchens on the other hand represent few instances when archaeology can shed light into medieval cuisine, as the whole operation around food preparation is taking place in specially selected area/building, which itself is delineated by the castle walls. This also indicates the general area of waste management, together with the daily life of castle inhabitants. And yet, this opportunity has not fully been utilized in the study of daily life and waste management.

Castle kitchens were firstly archaeologically studied mainly from their architectural aspect with no connection to the kitchen's daily operation or kitchen waste management. Czech archaeology has mainly presented only individual case-studies of castle kitchens (Slavík, 2008). A complex analysis of kitchenware, osteological material and spatial dispositions

is still lacking (cf. Durdík 2010, 47). The state of research in the rest of the Europe is very similar to the Czech situation (Schillito, et al. 2014, Banerjee, 2019). Syntheses are often focused on evaluating the castle site itself, its construction and management changes (e.g., Brown–Pluskowski 2013, Sikora et al. 2019). Only minimally are these studies considering the reconstruction of kitchen operations and waste management and are usually focused on construction aspect of the kitchen, or basic analysis of osteological material (Fisher–Thomas 2012, Chantran 2018, Lallau 2019; Šimunková–Beljak Pažinová 2018).

Whereas the question of waste management in archaeology has been complexly studied mainly in prehistoric archaeology (cf. Kuna et al. 2012), or in general view (most recently Sosna–Brunclíková ed. 2017), in medieval archaeology, the focus lies predominantly on town cesspits (e.g., Čapek et al. 2015; Tichý–Lisá–Dohnálková 2010, Orna–Dudková 2016). Towns pose a different way of waste management, as garbage is discarded mainly in cesspits, as opposed to managing waste from castles, where cesspits are missing which indicates different waste management, and most probably represents only moving the garbage and waste in general around the castle allotment. Is there possible to track the different "use/distribution" of the waste, i.e. its incorporation into the archaeological record of castles stratigraphy? Is it possible to detect from formation processes

of the sedimentary record the use of the space and the composition of the primary kitchen waste? How differ corridors in the castles from the other “dumping?” parts? Is there possible to link the kitchen waste with the agricultural management inside the walls of the castle?

One of the well-studied examples of medieval castle which may serve as a case study for above mentioned topics is the Rokštejn Castle in Vysočina Region, Czech Republic. The castle itself is situated in south-western part of the Bohemian-Moravian Highlands on the Moravian side of the land border between the historical Kingdom of Bohemia and the Margraviate of Moravia. The castle origins relate to the final phase of colonization of the area close to the land border during the late 13th century where the Střížovic family had established its fiefdom, and soon after, they called themselves “de Ruthenstein” (Mazáčková 2012, 2017; in print). The Castle Rokštejn stands almost alone in the region, even though the closest castle is located in the town of Brtnice (4 km), it is younger in its origins, and later replaced Rokštejn as the seat of power. Yet, farther castles are beyond 20 km radius, which only accentuates the status of the Brtnice and Rokštejn castles in the central Highlands. Rokštejn Castle has been archaeologically studied since 1981 and can be used as evidence of fast, distinctive construction changes inside the castle allotment, by using different building structures and efficient use of limited space given by the bedrock. The existence of the castle dates from the 1270s to the 1467, when it was destroyed in a military action, and the fiefdom centre moved to Brtnice, as mentioned before (Měřínský-Plaček 1989, Měřínský 2007, Mazáčková 2017).

The identification of the kitchen waste starts already during the archaeological research, but it is often limited to the macroscopical findings of the pottery shreds and bone fragments. The additional use of micromorphology combined with another chemical and magnetic proxies can be very helpful (Macphail, Goldberg, 2018, Nicosia, Stoops, 2017). The area of Rokštejn castle provided us different types of the space use, i.e. the different type of the waste distribution/management. The macroscopical interpretation of the archaeological context is crucial for this type of study. Therefore, there were sampled situation corresponding for example to the dump areas, open space corridors, house floors, surroundings of oven areas as well as the horizons interpreted as unknown origin. Up today 11 mammoth sized thin sections is available for such study. The first results show that there is possible to detect clear differences between different type of living space within the castle. There were detected floors with floor plasters of noble houses with very limited appearance of kitchen waste represented only by microcharcoal, while floors of normal houses are represented by the oriented matrix and the appearance of charcoal, egg shells, bone fragments in quite limited

amount. The material above the floors interpreted often as the destruction contain usually much more organic waste than the floor itself. The appearance of kitchen waste is quite common in open space corridors. The matrix of these sediments is often oriented with low porosity and dusty clay coatings. The dump areas around the ovens are often typical mainly by the microcharcoal and the matrix is often granular with the high porosity. The most interesting part of the study was the evaluation of the infill of the area, originally interpreted as a dump area. The reason was, that the space was originally used as the ditch prepared for further construction works at the castle, but plans were obviously changes and the area stayed abandoned (Mazáčková, Lisá, 2016). Dark organic layers excavated in this area revealed, that the sediments, or better to say, the archaeological soils deposited/developed there contain high amount of kitchen waste missed with the calcareous construction material. The internal structure of the matrix is granular with high bioturbation. These layers can be interpreted more likely as the result of agricultural management at the castle, i.e. anthropogenically developed soil.

Finally, it can be said, that the micromorphology showed to be useful tool in kitchen waste research. It was possible to see clear differences between the living spaces originally divided according to macroscopical observations. Moreover, the micromorphological study add additional information about detail formation processes of these environments. It is possible clearly set, how much kitchen waste is incorporated in different types of the anthropogenic sediments what is its composition as well as what is the state of its decomposition. It was possible to add new interpretation of the area of the castle originally interpreted only as the dump area and also to suggest how important the kitchen waste might play a role in the agricultural background of the castle itself.

ACKNOWLEDGEMENT

This study was supported by the project GA22-02149S (Reconstruction of Medieval Castle Kitchen Operation in Relation to Waste Management on Rokštejn Castle Example), funded by The Czech Science Foundation (GA ČR) and by the internal program of the Institute of Geology CAS in Prague No. RVO 67985831.

REFERENCES

- Banerjea, R. Y. et al., 2019, Geoarchaeology and Castles-capes: Heritage Management Case Studies in Spain and the Eastern Baltic, *Landscapes* 20/2, 178–201.
- Beranová, M., 2005, *Jídlo a pití v pravěku a středověku*, Praha.
- Brown A., Pluskowski, A., 2011, Detecting the environmental impact of the Baltic Crusades on a late-medieval (13th–15th century) frontier landscape: palynological analysis from Malbork Castle and hinterland,

- Northern Poland, *Journal of Archaeological Science* 38/1, 1957–1966.
- Čapek L. et al., 2015, Středověká odpadní jímka domu čp.7 v Krajinské ulici v Českých Budějovicích ve výsledcích rozboru artefaktů a environmentálních analýz, *Archeol. výzkumy v jižních Čechách* 28, 227–252.
- Durdík T., 2010, Několik poznámek k české hradní každodennosti, *Archaeologia Historica* 35, 45–61.
- Fisher A. Thomas R., 2012, Isotopic and zooarchaeological investigation of later medieval and post-medieval cattle husbandry at Dudley Castle, West Midlands. *Environmental Archaeology* 17/2, 151–167.
- Graff S., Rodríguez-Alegría E., (Eds.), 2012, *The Menial Art of Cooking: Archaeological Studies of Cooking and Food Preparation*, Boulder.
- Lallau É., 2019, Coucy-le-Château-Auffrique (Aisne), *Cuisine du duc d'Orléans à Coucy*, *Archéologie médiévale* 49, 314–315.
- Macphail R. I., Goldberg P., 2018, *Applied Soils and Micromorphology in Archaeology*, Cambridge University Press, New York.
- Mazáčková J., 2012, Militária z hradu Rokštejna v širším střeoevropském kontextu, Doctoral thesis at the Department of Archaeology and Museology, Masaryk University, Brno.
- Mazáčková J., 2017, Nástin procesu zanikání sídel ve středověku na panství Brtnice v územním rozsahu k roku 1538, *Archaeologia historica* 42/2, 745–771.
- Mazáčková J., in print, *Castle as a Military Player in its Landscape. Military Equipment of the Rokštejn Castle*, Brill Publishing.
- Měřínský Z., 2007, Hrad Rokštejn, Dějiny, stavební vývoj a výsledky čtvrtstoletí archeologického výzkumu 1981–2006, Brtnice–Brno.
- Měřínský Z., Plaček M., 1989, Rokštejn, středověký hrad na Jihlavsku (jeho dějiny, stavební vývoj a výsledky archeologického výzkumu 1981–1989), Brno – Brtnice.
- Nicosia Ch., Stoops G., 2017, *Archaeological soil and sediment micromorphology*, Wiley Blackwell, Oxford.
- Orna J., Dudková V., 2016, Možnosti přiřazení předmětů z odpadních jímek v Plzni konkrétním obyvatelům města, *Archaeologia Historica* 41/2, 363–374.
- Sikora J. et al., 2019, A palaeoenvironmental reconstruction of the rampart construction of the medieval ringfort in Rozprza, Central Poland, *Archaeological and Anthropological Sciences* 2019/11, 4187–4219.
- Šimunková K., Beljak Pažinová N., 2018, Konzumácia mäsa na hradoch vo vrcholnom stredoveku: prípadová štúdia z hradu Pe uša, *Archaeologia Historica* 43/2, 503–517.
- Slavík J., 2008, Vizmburská kuchyně – Die Rauchlochküche Vizmburk, *Castellologica Bohemica* 11, 287–295.
- Schillito L. M. et al., 2014, Micromorphological and geochemical investigation of formation processes in the refectory at the castle of Margat (Qal'at al-Marqab), Syria, *Journal of Archaeological Science* 50, 451–459.
- Sosna D., Brunclíková L. (Eds.), 2017, *Archaeologies of waste, Encounters with the unwanted*, Oxford–Philadelphia.
- Tichý R., Lisá L., Dohnálková H., 2010, Odpadní jámy nebo blátivé louže? Zaplňování archeologických objektů/vznik výplní jako klíčový faktor pro širší interpretace, *Živá archeologie, (Re) konstrukce a experiment v archeologii* 11, 138–142.



THE ENVIRONMENT AS AN ARCHIVE OF PAST HUMAN ACTIVITIES (ED. T. KALICKI)



GEOARCHAEOLOGY OF NE AND N POLAND

SUBNEOLITHIC – AN ALTERNATIVE LIFESTYLE. THE LAST HUNTER-GATHERERS ON THE BORDER BETWEEN EASTERN AND WESTERN EUROPE

Adam Wawrusiewicz

Muzeum Podlaskie w Białymstoku, Polska, e-mail: a.wawrusiewicz@muzeum.bialystok.pl

ABSTRACT

The beginning of the Neolithic in Poland (around 5400 BC) is a migration from the south. Few Neolithic enclaves are surrounded by a vast forests – the domain of the Mesolithic hunters, who survived subsequent colonization actions undergo gradual neolithization only in the first half of 4th millennium BC. However, not everywhere. In the vast areas of the Russian Plain, of which NE Poland is a part, the climate and the shorter growing season limited the possibility of a new lifestyle – farmers. Until the beginning of the Bronze Age (3th/2nd millennium BC), groups of hunter-gatherers dominated here. However, that doesn't mean there haven't been any changes. In the middle of the 5th millennium BC, concurrently with the "invasion" of the Neolithic, groups of hunter-gatherers begin to a transition – subneolithization. Continuing the old systems of economy, settlement and flint industry, they begin to produce pottery – specific vessels with a sharp bottom. The popularization of ceramics could be related to a change in diet, the spread of soups, that helped the survival of children. The subneolithic process probably did not mean distant strait migration or physical cultural expansion, as it was in the neolithization. Rather, it is the result of the gradual acculturation of different groups of hunters, which have never resulted in monolithics cultural structures. Rather, subneolithized cultures share common sense with very high local variation. These groups were associated with the exploitation of specific, relatively stable microregions.

Keywords: Subneolithic, neolithization, hunter-gatherers, lifestyle

"In the south, our land is limited by the terrifying High Mountains covered with dark forest. Others – mute-ness, live behind those mountains. From time to time, they send shady people to us, perhaps, they are interested in something on our land..." (Kozłowski, Nowak 2019).

Is this how the beginning of the Neolithic looked like from the perspective of the Mesolithic inhabitants of the Vistula basin? Around 5400 BC, the vast expanses of Atlantic forests inhabited by a small number of hunter-gatherers became the colonization arena. However, neolithization is limited in scope. Farmers from the south, choose only the fertile areas of Lesser Poland, Silesia and Kujavia, which were the most similar to the familiar areas of the Danube south (fig. 1A: A). Few Neolithic enclaves are surrounded by a vast forests—the domain of Mesolithic hunters, who survived subsequent colonization actions undergo gradual neolithization only in the first half of IV millennium BC (Fig. 1B: A) when agrarian Funnel Baker Culture was formed in its final form.

The influx of settlers, cultural impulses and inspiration from the Neolithic south was not the only alternative to development for local hunters. The success of the new lifestyle was uncertain and dependent

on many, mainly environmental, conditions. The mild, Atlantic climate of the Central European Lowlands favoured the manufacturing economy and neolithization much more than in the Northeast. In the vast areas of the East European lowland, the harsher continental climate and shorter growing season limited the possibility of the success of the new lifestyle (Koško, Szmyt 2014). Despite various attempts at agrarian colonization of these areas (Rybicka, Wysocki 2002, Wawrusiewicz 2011), until the beginning of the Bronze Age, i.e., around 2000 BC, they remained the dominance of hunter-gatherer groups. This does not mean, however, that there have been no changes. In the middle of the 40th century BC, in parallel with the Neolithic "invasion", groups of hunter-gatherers inhabiting the basin of the Narew River, Biebrza River and Niemen River begin to undergo an alternate change – subneolithization (Fig. 1A: B). This phenomenon has recently been strongly signalled (Jordan, Zvelebil 2010). This phenomenon includes genetically diverse groups of hunter-gatherers inhabiting vast areas of the forest and forest-steppe zones of Eastern Europe. Subneolithization's main marker is the appearance of ceramic vessels, made differently from those of the south. The idea of Subneolithic ceramics,

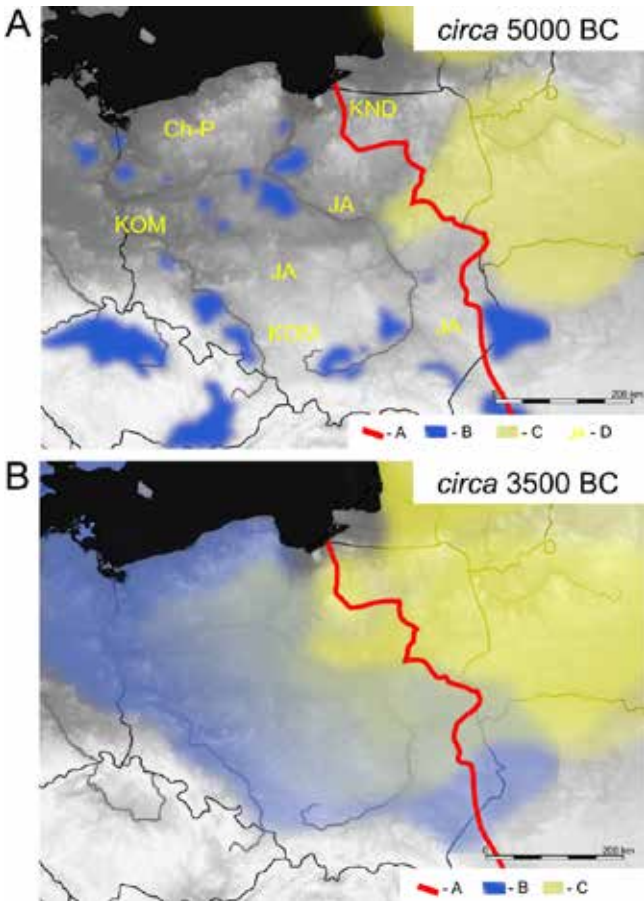


FIG. 1. Cultural situation on the border of the Eastern and Western Europe. A – period around 5000 BC: A – physiogeographical border of the West and East Europe (A); Enclaves occupied by the Linear Band Pottery Culture communities (B); settlement range of subneolithic cultures (C); The Late Mesolithic cultural groups (D). B – period around 3500 BC: A – physiogeographical border of the Western and Eastern Europe (A); Enclaves occupied by the Funnel Beaker Culture communities (B); settlement range of subneolithic cultures (C) (after Kozłowski, Nowak 2019 with author's changes)

however, can go back even to the 8th millennium BC (Gronenborn 2010).

However, ceramics are not only an object. The popularization of ceramics could be related to a change in diet, the spread of soups, that helped the survival of children (Courel et al. 2020). As a consequence, the change of diet had an impact on the demographic growth and stabilization of settlement. Although not very different from the old one (Mesolithic), the new way of life was certainly attractive to the inhabitants of the borderland. Around the middle of the 4th millennium BC, in parallel with the expansion of the TBC, an increase in the settlements of Subneolithic groups can be observed even in the basin of the middle Odra and in Lesser Poland. The hunters, although equipped with ceramics, still operate on the outskirts of the agricultural world. However, the areas of north-eastern Poland remained their absolute dominion (Fig. 1B: B).

The Subneolithic lifestyle is evident in choosing space and localization of settlements. The way

of life was determined primarily by the ecosystem and previous customs. The borderland of Eastern and Western Europe consists of three biomes. In the south, it is an old-glacial landscape, where the hunters' life was based on river valleys. The seasonal camps were most often located on isolated, heights situated in river valleys (Fig. 2), especially in the mouth of smaller rivers (Fig. 2: B). The Sand formations – dunes were preferred (Kempisty, Więckowska 1983, Frączek et al. 2016, Wawrusiewicz et al. 2017). When that pattern was absent in river lowland, the encampment was placed on the edges of overwater routes (Fig. 2: C, E), although such a location may result from the seasonality function of the sites (Manasterski et al. 2021). As extraordinary attractive were considered a bottleneck of a river basin, Fig. 2: D, as can be seen, in the vicinity of Złotoria and the central Narew River (Kittel et al. 2014). Examples of the land interior infiltration are limited to small camps located at the sources of smaller watercourses (Fig. 2: G) (Wawrusiewicz 2012). State of recognition suggests that sub-neolithic hunters avoided stagnant water reservoirs here – like lakes. In a different way, can be seen in young glacial lake districts. Here, camps were located at river estuaries or on islands near the littoral obligatory bank (Fig. 2: H, I) (Sulgostowska, Kempisty 1991, Gumiński 2004).

The Subneolithic process probably did not mean distant strait migration or physical cultural expansion, as it was in the neolithization. Rather, it is the result of the gradual acculturation of different groups of hunters, which have never resulted in monolithic s

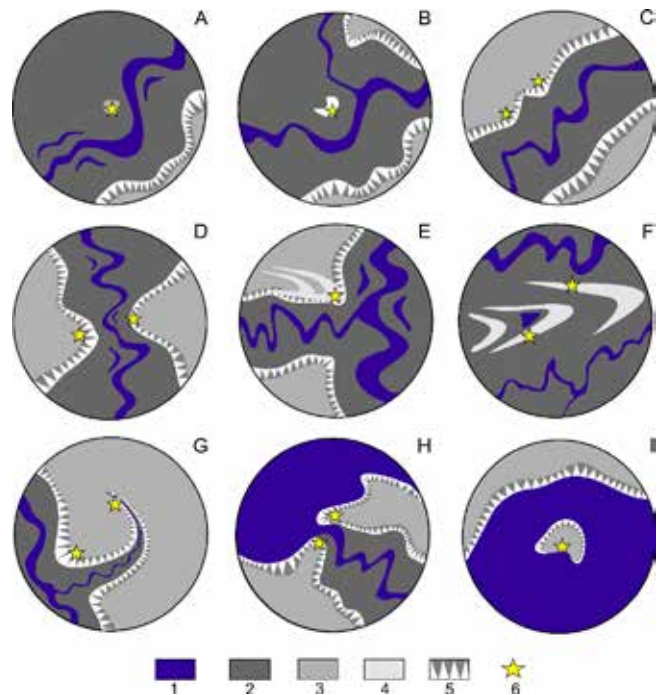


FIG. 2. Scheme of the location of the Subneolithic campsites 1 – rivers, lakes, 2 – river valleys, 3 – terraces and uplands, 4 – dunes, 5 – upland edges, 6 – site locations

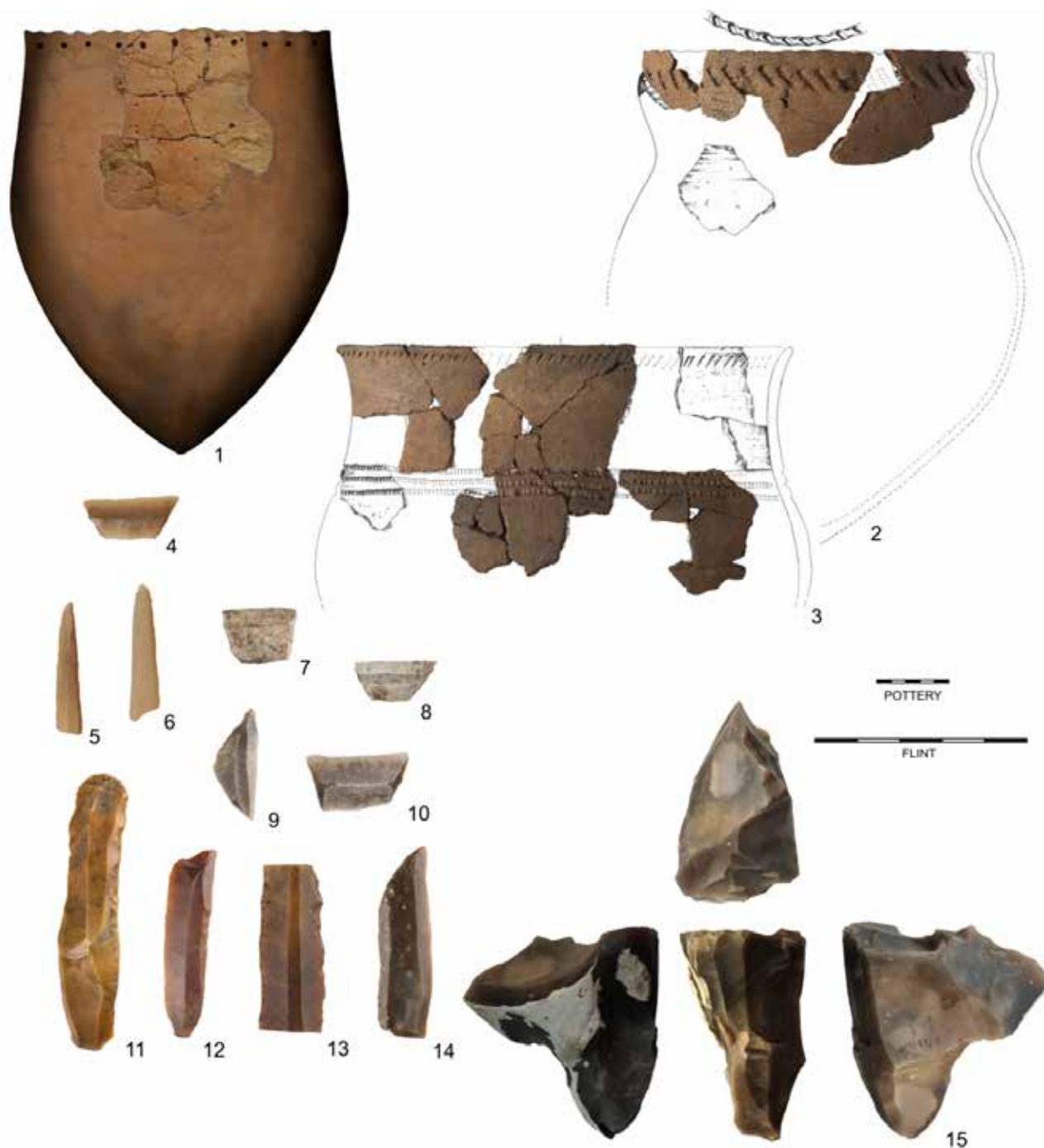


FIG. 3. Examples of subneolithic ceramics and flint products from sites located in the Narew and Bug basins: Brańsk 22 (1), Grady-Woniecko 1 (2-6), Sośnia 1 (7-14), Lipsk 81 (15); (by A. Wawrusiewicz, H. Lepionka)

cultural structures. Rather, subneolithized cultures share common sense with very high local variation. These groups were associated with the exploitation of specific, relatively stable microregions. These attributes are reflected in the strong diversity of documented ceramic artefacts, characterized by significant regional and chronological variability (Fig. 3). A permanent element, however, is the tools and flint production, which replicates the previous traditions, developing previous Mesolithic know-how (cf. Wawrusiewicz et al. 2017, Kozłowski, Nowak 2019) (Fig. 3). The Subneolithic is an alternative to the clas-

sical, agrarian Neolithic lifestyle based on hunting, gathering and fishing. Its genesis is related to the fairly wide influence of cultural impulses from Eastern Europe, creating a stable but extremely diverse community of hunters funded on the of local Mesolithic groups. In the borderland areas of Eastern and Western Europe, it survived unchanged until the beginning of the Bronze Age. As for the model of life, it also turned out to be more stable than the „classical” model of the Neolithic, which in its career underwent numerous transformations, stages of development and declines.

REFERENCES

- Courel B., Robson H. K., Lucquin A., Dolbunova E., Oras E., Adamczak K., Andersen S. H., Astrup P. M., Charniauski M., Czekań-Zastawny A., Ezepenko I., Hartz S., Kabaciński J., Kotula A., Kukawka S., Loze, I., Mazurkevich A., Piezonka H., Piličiauskas G., Sørensen S. A., Talbot H. M., Tkachou A., Tkachova M., Wawrusiewicz A., Meadows J., Heron C. P., Craig O. E., 2020, Organic residue analysis shows sub-regional patterns in the use of pottery by Northern European hunter-gatherers, *R. Soc. Open Sci.* 7: 192016. <http://dx.doi.org/10.1098/rsos.192016>
- Gumiński W., 2004, Szczepanki 8. Nowe stanowisko torfowe kultury Zedmar na Mazurach, *„Światowit”* 5 (46) –2003/B: 53-104, pl., 15-38.
- Gronenborn D., 2010, Transregional Culture Contacts and the Neolithization Process in Northern Central Europe, [In:] Jordan P., Zvelebil M. (Eds.), *Ceramics Before Farming, The Dispersal of Pottery Among Prehistoric Eurasian Hunter-Gatherers*, Walnut Creek, 527-550.
- Jordan P., Zvelebil M., 2010, Ex Oriente Lux: The Prehistory of Hunter-Gatherer Ceramic Dispersals, [In:] Jordan P., Zvelebil M. (Eds.), *Ceramics Before Farming. The Dispersal of Pottery Among Prehistoric Eurasian Hunter-Gatherers*, Walnut Creek, 33-89.
- Jóźwiak B., 2003, Społeczności subneolitu wschodnioeuropejskiego na Niżu Polskim w międzyrzeczu Odry i Wisły, Poznań.
- Kempisty E., Sulgostowska Z., 1991, Osadnictwo paleolityczne, mezolityczne i paraneolityczne w rejonie Woźnej Wsi, woj. łomżyńskie, Warszawa.
- Kempisty E., Więckowska H., 1983, Osadnictwo z epoki kamienia i wczesnej epoki brązu na stanowisku 1 w Sośni, woj. łomżyńskie, Wrocław-Warszawa-Kraków-Gdańsk-Łódź.
- Kittel P., Błaszczak K., Cywa K., Pawłowski D., Romanow M., Stachowicz-Rybka R., Wacnik A., Zawilski P., 2014, Wyniki badań przyrodniczych na stanowiskach archeologicznych w Złotorii, gm. Choroszcz nad Narwią (północno-wschodnia Polska), [In:] Karczewski M., Smolska E., Kalicki T. (Eds.), *Środowisko przyrodnicze, gospodarka, osadnictwo i kultura symboliczna w V w. p.n.e. – VII w. n.e. w dorzeczach Odry i Wisły, Białystok-Warszawa-Kielce*, 61-82.
- Koško A., Szmyt M., 2004, Problem wschodniej rubieży kultur neolitycznych Niżu Środkowoeuropejskiego: IV – III tys. BC, [In:] Koško A., Kalečyc E. (Eds.), *Wspólnota dziedzictwa kulturowego ziem Polski i Białorusi*, Warszawa, 80-98.
- Kozłowski S. K., Nowak M., 2019, I przyszli ludzie zza Gór Wysokich, *Ziemia Polskie od VI do IV tysiąclecia BC*, Rzeszów.
- Manasterski D., Januszek K., Wawrusiewicz A., Klecha A., 2021, A Ritual Feature with Bell Beaker Elements in a Late Neolithic Hunter-Gatherer Campsite in North-Eastern Poland, *European Journal of Archaeology*, 24, 2, 226-248. doi:10.1017/ea.2020.52.
- Nowak M., 2009, *Drugi etap neolityzacji ziem polskich*, Kraków.
- Rybicka M., Wysocki P., 2004, Materiały kultury późnej ceramiki wstęgowej z Równiny Dolnej, st. III, gm. Korsze, woj. warmińsko-mazurskie (wyniki badań w 2001 roku), *Prace i Materiały Muzeum Archeologicznego i Etnograficznego w Łodzi, seria archeologiczna*, 42 (2002-2003), 79-108.
- Wawrusiewicz A., 2011, Okres neolitu i wczesnej epoki brązu na Podlasiu. Stan i perspektywy badań, [In:] Stankiewicz U., Wawrusiewicz A. (Eds.), *Na rubieży kultur. Badania nad okresem neolitu i wczesną epoką brązu*, Białystok, 13-36.
- Wawrusiewicz A., 2012, Osadnictwo społeczności kultury niemieńskiej w Jeronikach, stanowisko 2, gm. Choroszcz w województwie podlaskim, *Studia i Materiały do Badań nad Neolitem i Wczesną Epoką Brązu na Mazowszu i Podlasiu*, II, 49-93.
- Wawrusiewicz A., Kalicki T., Przeździecki M., Frączek M., Manasterski D., 2017, Grądy-Woniecko. Ostatni łowcy-zbieracze znad środkowej Narwi, Białystok.

STRATIGRAPHY AND PALAEOENVIRONMENTAL CONTEXT OF THE ARCHAEOLOGICAL SITE OF THE NIEMEN CULTURE – CASE STUDY AT LIPSK SITE (NE POLAND)

Marcin Frączyk¹, Adam Wawrusiewicz², Tomasz Kalicki¹, Iga Szwed³

¹Jan Kochanowski University in Kielce, Institute of Geography and Environmental Sciences, Department of Geomorphology and Geoarchaeology, Poland, mfraczek@ujk.edu.pl, tomaszkalicki@ymail.com,

²Podlachian Museum in Białystok, Poland, adamwawrusiewicz@op.pl

³University of Warsaw, Department of Archaeology, Poland

ABSTRACT

The study area is located in the NE part of the Biebrza Basin (ice-marginal valley on the borderland between Central and Eastern Europe in NE part of Poland) in Podlasie voivodeship. The region was an oecumene of hunting and gathering communities during the Neolithic period. Their lifestyle was inextricably linked to the vast valley area and connected to the climate fluctuations. These communities were in constant motion and did not develop an established lifestyle. Results of the studies at Lipsk, and other sites in the Biebrza Basin, indicate some periods of climatic changes and an increase of morphogenetic processes activity. Presence of peats dated at 7050 ± 60 BP (MKL-4798) cal. 6033–5789 BC on sandy sediments in profile L22 could be correlated with the older colluvial deposits at Lipowo site. In profile L20 on the Preboreal peats enters the Boreal or Early Atlantic sandy sediments, which were covered by the Atlantic peats. The aeolian activity could have led to the appearance of sands at the bottom of the L20 profile between 9880 ± 100 BP (cal. 9803–9182 BC) and 7350 ± 110 BP (cal. 6425–6026 BC).

Keywords: Podlasie region, Biebrza Basin, Niemen culture, Subneolithic hunter-gatherer communities

INTRODUCTION

Relief of this region was formed during Middle Polish (Saalian) Glaciation – Warta Cold Stage. During the next ice-sheet advance until the Pomeranian phase of last glaciations, about 16.2 ka BP (Kozarski 1995) or 15.5–15.0 ka BP (Val'chik 1992), outflow from Naroch-Wilia and Skidel dam lakes and river waters of the upper Neman river followed Łosośna River valley, its tributary Tatarka river breakthrough Pripilin-Nurki gap section to Biebrza and Narew River valleys (Val'chik 1992, Żurek 1994, Kalicki 2006). Therefore the Biebrza is underfit river with vast peat-bogs on its valley floor. However, in the close vicinity of the archaeological site, we can find traces of a now non-existent watercourse, which could be connected with LGM (Fig. 1) only in a short distance from Hacıłówka to Biebrza.

AIM OF STUDY

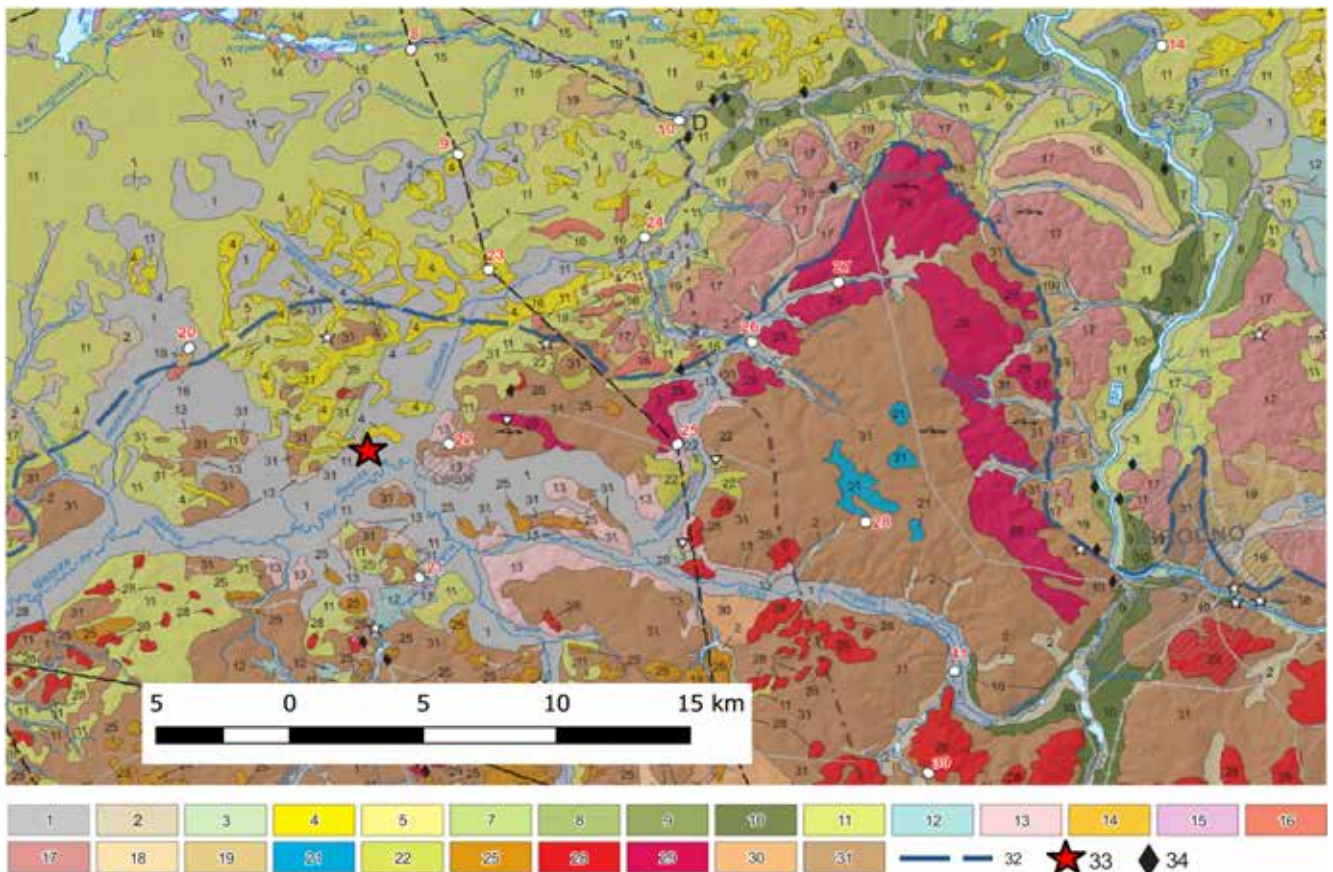
The main aim of this work is to present the results of geoarchaeological studies of the Lipsk area and the reconstruction of selected components of the environment from the time span of the Niemen culture. The study includes the archaeological site (*on-site* study) and surroundings (*off-site* study).

GENERAL OVERVIEW OF THE SITE

Nowadays the archaeological site is a well-exposed dune-like elevation with an area of about 1 ha, in the central part of a large peat-bog. From the south, it adjoins the modern Biebrza riverbed. On the eastern side of the elevation, at a distance of about 100 meters, there is an oxbow lake with is the remnant of a now non-existent watercourse, whose relic is the extensive (about 0.5 ha) old lake partial covered by the floating mat (Fig. 2). In the depression, there are peats and peaty silts with a thickness of up to 6 meters in borehole L21 (Bęben 2020). In the archaeological trench (Fig. 2) excavated at this site dominates flint material (over 90%) (Fig. 3).

RESULTS

Based on *off-site* studies it was possible to create schematic geological cross-section for the surrounding area (Fig. 4) and more detailed for the archaeological site and part of the dune. Within the site and its surroundings can be distinguished several geological segments of different age. The first one is an elevation built of aeolian fine and medium sands. The second one, located at the foot of the elevation, is a part of the sandy alluvial plain of a braided river.



Map Legend

1 - Peat, 2 - Peaty, sandy muds and humus sands, 3 - Sands and gravels of flood terraces, 4 - Aeolian sands in dunes, 5 - Aeolian sands, 7 - Sands and muds of lowest supra-inundation terrace, 8 - Sands and muds of middle supra-inundation terrace, 9 - Sands, gravels and muds of higher supra-inundation terrace, 10 - Sands, gravels and muds of highest supra-inundation terrace, 11 - Glaciofluvial sands and gravels, 12 - Glaciolacustrine sand, silts and clays, 13 - Sands, gravels and boulders of kames terraces, 14 - Sands and gravels of kames and dead-ice moraines, 15 - Sands and gravels of crevasse features, 16 - Sands, gravels, tills and boulders of end moraines, 17 - Sands, gravels, tills and boulders of push moraines, 18 - Glacial sands and gravels, 19 - Tills, locally with interbeds of glaciofluvial sands and gravels or glaciolacustrine clays and silts, 21 - Glaciolacustrine sands, silts and clays, 22 - Glaciofluvial sands and gravels, 25 - Sands, silts, gravels and tills of kames, 28 - Sands, gravels, tills and boulders of end moraines, 29 - Sands, gravels, tills and boulders of push moraines, 30 - Glacial sands, gravels and boulders, 31 - Tills, 32 - Last Glacial Maximum (LGM), 33 - study area, 34 - Bedrock outcrop of glacial rafts in Quaternary deposits and in glaciotectonic structures

FIG. 1. Part of geological map 1:250 000 (Marks, Karabanov 2011)

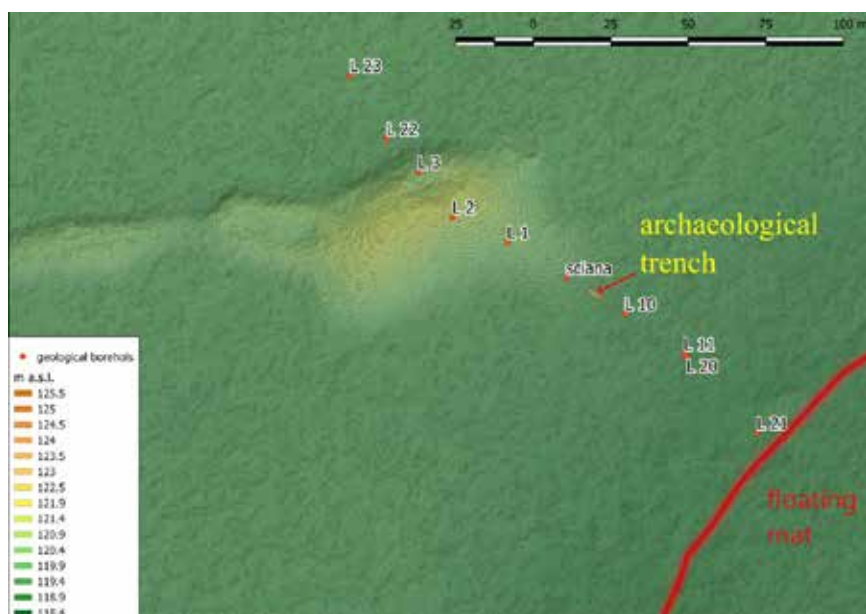


FIG. 2. Location of the geological boreholes and archaeological trench

A beginning of peat accumulation in the valley floor (L20 borehole) was radiocarbon dated at 9880 ± 100 BP (cal. 9803–9182 BC) (Fig. 4). In the next stage occurred beginning of peat accumulation, near an archaeological site at Lipsk, which was radiocarbon dated at 7600 ± 90 BP (cal. 6633–6254 BC) in the bottom of L22 profile (Fig. 4). Around the same time, 7350 ± 110 BP (cal. 6425–6026 BC), peats enter on aeolian deposits in L20 profile (Fig. 4). After that, 7050 ± 60 BP (cal. 6033–5789 BC), on the same kind of sediments enters peats in profile L22 (Fig. 4). After that event, at both profiles, starts the accumulation of undisturbed peats.

Correlating these archaeological data with the stratigraphic layers of the excavation profile, it can be assumed that these materials could be mixed by the slope processes, probably during the Subatlantic. It caused the dislocation and mixing of archaeological material associated probably with the existence marks of encampments or settlements located in higher parts of the dune. Below this stratigraphic segment, homogeneous archaeological material, related to the settlement and economic activity of the Subneolithic hunter-gatherer communities (Neman culture), was documented. Most of the artefacts discovered here have been preserved *in-situ*, including a deposit of several fragments of flint blocks and cores (Fig. 3).

At this level, fragments of ceramic vessels have also been registered. One of them was dated on 5987 ± 60 BP (MKL-A5748) cal. 4996–4782 BC (Fig. 5).

This date correlates very well with the Lucyn archaeological site in Belarus. The dating of artifacts from another archaeological sites of Nieman culture from Belarus contains a large margin of error (Fig. 5), what makes it impossible to narrow down the chronology of it. Older flint materials were found along with the younger material. The presence of several products of the Late Palaeolithic origin is unclear. These artefacts were found in the lowest strata of anthropogenically transformed position. They may not be as obvious proof of the old settlement. There are many examples when the old flint artefacts/products were transferred and used in much later times.

DISCUSSION AND CONCLUSIONS

Results of studies at Lipsk and other sites in the Biebrza Basin (Wawrusiewicz et al. 2017, Frączyk et al. 2018a, b) indicates some periods of climatic changes and an increase of morphogenetic processes activity. Presence of peats dated at 7050 ± 60 BP (cal. 6033–5789 BC) on sandy sediments in profile L22, in the initial stage of interpretation, was correlated with the older colluvial deposits at Lipowo site deposited after 7020 ± 70 BP (cal. 6016–5746 BC), which have been covered with peat-bog during the next humid period at the end of the Atlantic (Frączyk et al. 2018b). After detailed analyzes, they should be connected with the aeolian activity (Bęben 2020). In profile L20 we are dealing with different age sequence. On the Preboreal peats enters the Boreal or Early Atlantic sandy

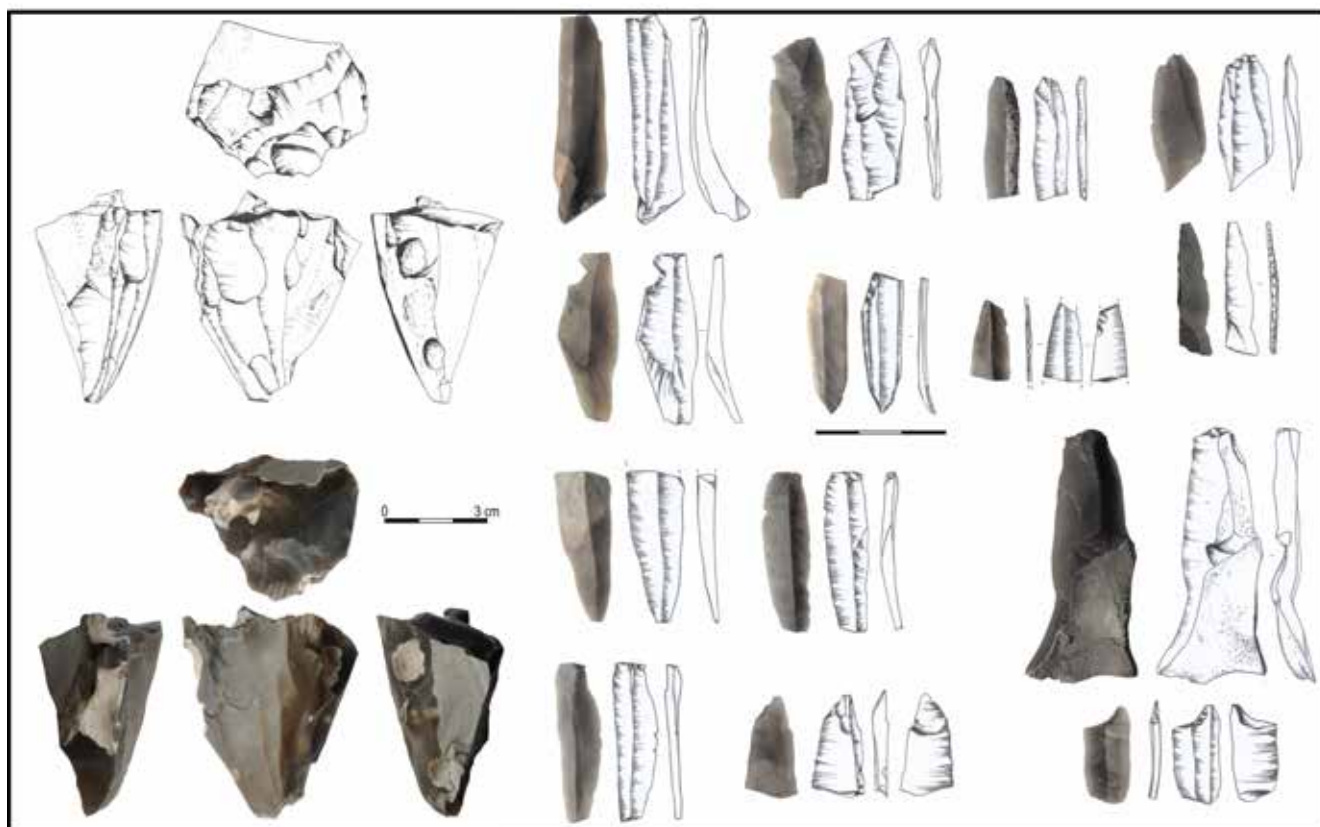


FIG. 3. Deposit of several fragments of flint blocks and cores

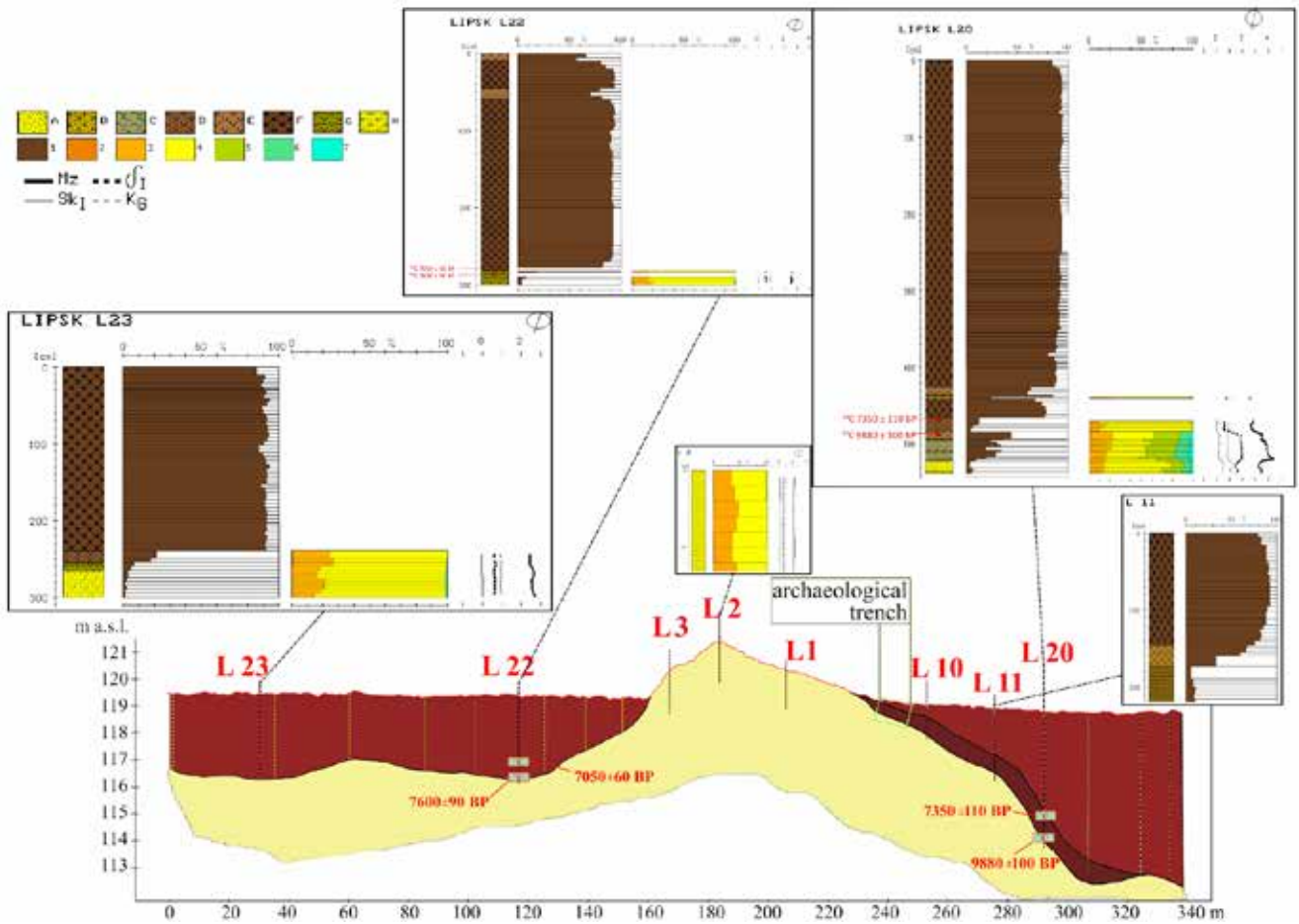


FIG. 4. Geological cross-section of Lipsk site, lithology, grain size and Folk-Ward's distribution parameters of selected profiles (Frączyk et al. 2020); Lithology: A – fine sands, B – peaty silts, C – silty peats, D – peats; Fractions: 1 – coarse sand (-1 to 1ϕ), 2 – medium sand ($1-2\phi$), 3 – fine sand ($2-4\phi$), 4 – coarse and medium silt ($4-6\phi$), 5 – fine silt ($6-8\phi$), 6 – clay (above 8ϕ), 7 – organic content; Folk-Ward's distribution parameters: Mz – mean diameter, δ – standard deviation (sorting), Sk – skewness, K_c – kurtosis. The archaeological trench was located on the south-eastern site of the dune at a distance of about 10 m from the currently visible slope of the dune (Fig. 2, yellow box). This area was chosen because of the possibility of capturing well-preserved stratigraphic systems that can be correlated with specific settlement phases in the palaeoenvironmental context. During the archaeological research in the 2019 season, nearly 2000 artifacts were documented. Most of the Prehistoric material discovered at this site was flint material. Fragments of ceramic vessels represent only 10% of this collection. The artifacts were in all explored layers. The first, few finds were recorded at a depth of about 0.2 m, in the bottom of the peat. Up to a depth of about 0.5 m, these elements were clearly culturally incoherent. In the same stratigraphic system, flint products characteristic for the Preboreal period (Kunda culture) and the Atlantic period (Janisławice-Neman culture) coexisted. They were also accompanied by fragments of ceramic vessels from different periods. The youngest of them should be dated at the beginning of the Subatlantic (about 2500–2000 BP)

sediments, which were covered by the Atlantic peats. Aeolian activity during this period was also confirmed (Bęben 2020). Around the same time, that kind of activity took place near Grzędy site (Wawrusiewicz et al. 2017). Within the non-fluvial segment of Wizna Basin, the dune complex is surrounded by peats whose thickness reaches 2 m and the bottom was ^{14}C dated at $10\,135\pm 90$ BP (cal. 10 143–9396 BC). The surface under the peats was transformed by aeolian processes at the end of the last glaciation and the Younger Dryas cooling resulted, in probably, that the complex of parabolic dunes was still active at the end of the Late Glacial and Early Holocene. After the Preboreal warming started the accumulation of peats but with short-time an increase of aeolian processes activity at the beginning of the Atlantic – 8320 ± 80 BP (cal. 7542–7141 BC) (Wawrusiewicz et al. 2017). These

phenomena could have led to the appearance of sands at the bottom of the L20 profile between 9880 ± 100 BP (cal. 9803–9182 BC) and 7350 ± 110 BP (cal. 6425–6026 BC). Due to results of detailed sedimentological analyses, we can connect it with aeolian activity (Fig. 4 – L20 and L22 profiles) (Bęben 2020). Around the same time cut off macromeanders at Ruś site was ^{14}C dated at 9900 ± 90 BP (cal. 9762–9231 BC) and the beginning of peat accumulation on calcareous gyttja at Włochówka site ^{14}C dated at $10\,290\pm 120$ BP (cal. 10 593–9664 BC) in the Wizna Basin (Wawrusiewicz et al. 2017).

The elevated form located near Lipsk certainly belongs to one of the most interesting archaeological sites in the Biebrza Basin. Its size and variety of documented settlement phases forces discussion mainly about the role it played in the context

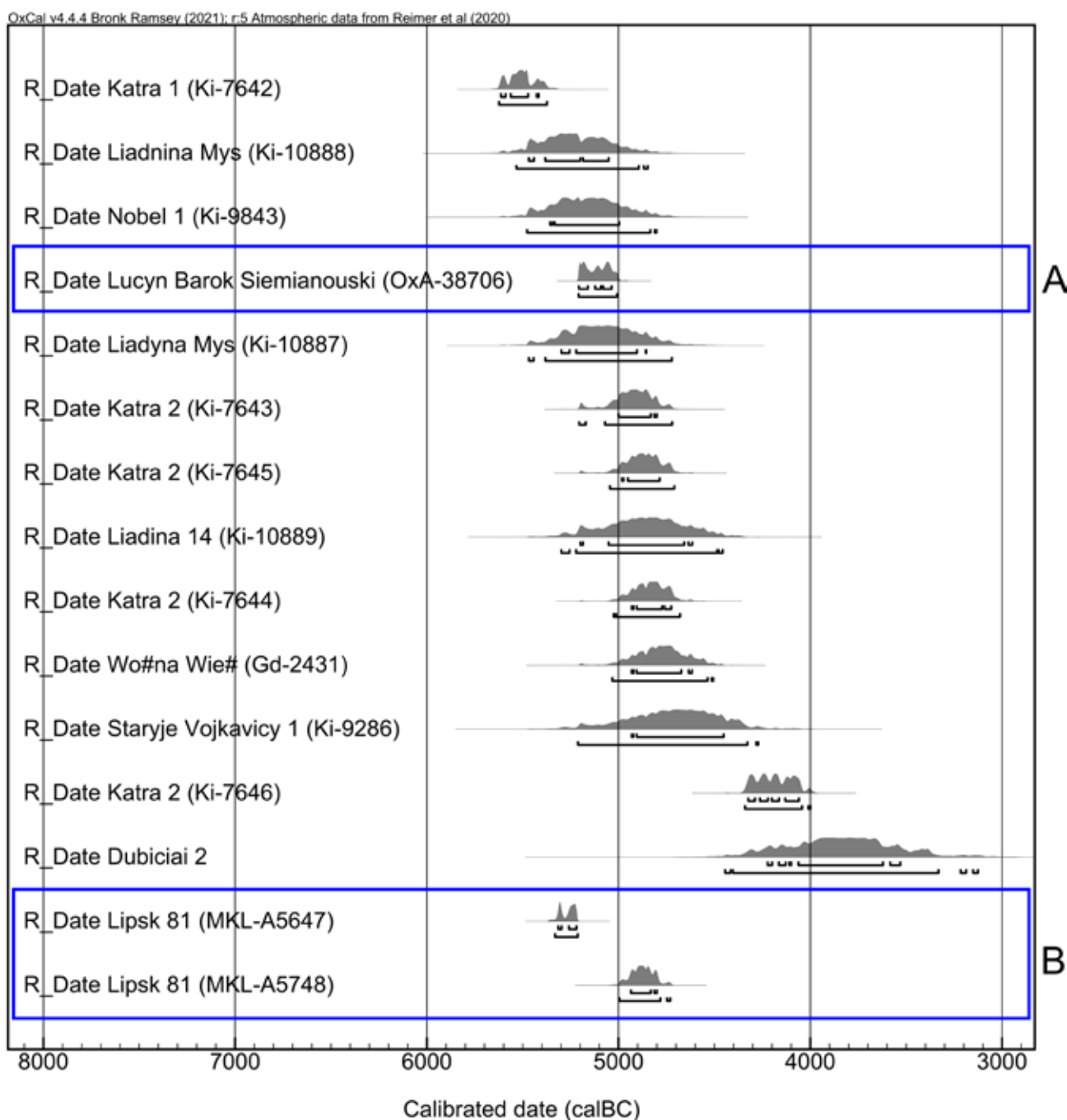


FIG. 5. Comparison of dating from the archaeological sites of the Niemen culture; A – Lucyn site in Belarus, B – Lipsk site in Poland

of environmental conditions determining the lifestyle of hunting and gathering communities. The technological and morphological characteristics correspond to the general „idea” of the Late-Mesolithic lithic technology of hunter-gatherer communities from the areas of north-eastern Poland from the beginning and the first half of the Atlantic (comp. Frączyk et al. 2018a, b).

REFERENCES

- Bęben A., 2020, Kontekst środowiskowy subneolitycznego stanowiska Lipsk w Kotlinie Górnej Biebrzy, Maszynopis pracy magisterskiej, Uniwersytet Jana Kochanowskiego w Kielcach, Kielce.
- Frączyk M., Kalicki T., Wawrusiewicz A., Sanko A. F., 2018a, Kontekst środowiskowy i stratygrafia stanowiska archeologicznego Lipowo w Kotlinie Biebrzy (NE Polska), *Acta Geographica Lodziensia*, 107, 25–37.
- Frączyk M., Kalicki T., Wawrusiewicz A., Sanko A.F., Małęga E., 2018b, The hunter-gatherer communities from Upper Biebrza Basin – environmental context, Case study from Lipowo site (NE Poland), *Geobalcanica Proceedings*, 87–93.
- Frączyk M., Bęben A., Żurek K., Kalicki T., Wawrusiewicz A., Szypul W., Kasprzyk P., 2020, New results of the palaeoenvironmental and archaeological research of the subneolithic hunter-gatherer communities of the Niemen culture case study for Lipsk

- site (NE Poland), *Acta Geobalcanica*, 6-3, 137-144, DOI: <https://doi.org/10.18509/AGB.2020.15>.
- Kalicki T., 2006, Zapis zmian klimatu oraz działalności człowieka i ich rola w holocenijskiej ewolucji dolin środkowoeuropejskich, *Prace Geograficzne IGIPZ PAN* 204.
- Marks L., Karabanov A. K., 2011, Geological map of Polish – Belarusian cross-border area, Sokółka and Grodno area, MNiSW, PIG-BIP, Warszawa.
- Kozarski S., 1995, Deglacjacja północno-zachodniej Polski: warunki środowiska i transformacja geosystemu (~20KA→10KA BP), *Dokumentacja Geograficzna* 1.
- Val'chik M. A., 1992, Razvitie dolinno-rechnoy seti Belorussii i Pribaltiki v sviazi s degradaciey valdayskogo lednikovogo pokrova [In:] Shirokov L. M. (Ed.), *Gidrographicheskaya set' Belorussii i regulirovanie rechnogo stoka.*, Universitetskoye. Minsk. 3-10.
- Wawrusiewicz A., Kalicki T., Przeździecki M., Frączyk M., Manasterski D., 2017, Grądy-Woniecko. Ostatni łowcy-zbieracze z nad środkowej Narwi, Muzeum Podlaskie w Białymstoku, Białystok.
- Wawrusiewicz A., Kalicki T., Frączyk M., Bęben A., Kasprzyk P., Szypul W., Żurek K., 2019, Wyspa wśród bagien. Pierwsze wyniki badań archeologicznych i paleogeograficznych nad osadnictwem społeczności subneolitycznych w Lipsku nad Górną Biebrzą, 9-12.12.2019, Konferencja "Przeszłość ma przyszłość!/ The past has a future", Instytutu Archeologii Uniwersytetu Warszawskiego, 32-33.
- Żurek S., 1994, Geomorphology of the Biebrza valley [In:] *Towards protection and sustainable use of the Biebrza Wetlands: Exchange and integration of research results for the benefit of a Polish-Dutch Joint.*

HUMAN-ENVIRONMENT INTERACTIONS IN NE POLAND DURING THE LUSATIAN CULTURE

Krzysztof Żurek¹, Tomasz Kalicki¹, Adam Wawrusiewicz²

¹Jan Kochanowski University in Kielce, Institute of Geography and Environmental Sciences, Department of Geomorphology and Geoarchaeology, Poland, chrisu.zurek@gmail.com; tomaszkalicki@ymail.com

²Department of Archaeology, Podlaskie Museum in Białystok, Poland, adamwawrusiewicz@op.pl

ABSTRACT

This paper presents the results of research into the context of human-environment interaction at the archaeological site at Jatwieża Duża, which is representative of the entire sites network of Late Bronze Age/Early Iron Age. Two geological sections across were made for this survey. One through the main depression of the microregion of the site in which the Brzozówka River flows, and the other in the left tributary of the Biebla River.

Keywords: Podlasie; Jatwież Duża site; geoarchaeology; Holocene; Bronze Age

INTRODUCTION

The research region is located in NE Poland in Podlasie Voivodship (Fig. 1). The functioning of the Late Bronze Age and Early Iron Age structures in the northern Podlasie region is a new issue, the knowledge of which is the result of only of the last few years of research. The breakthrough in archaeology brought about by the spread of laser scanning imaging made it possible to discover and inventory 27 such structures located in the Biebrza and upper and middle Narew River valleys (Fig. 1). All of them showed many similarities from their spatial location to their form, type of construction and dimensions (Żurek et al. 2020, Wawrusiewicz et al. 2022).

This region dominated for ages by groups of communities with a hunter-gatherer economy only at the turn of the Subboreal and Subatlantic becomes an oecumene of the Lusatian culture. It seems that this community is the first a centre of coherent network of sites, which can be associated with a stable settlement network and intensive agricultural use of the environment (Żurek et al. 2020, Wawrusiewicz et al. 2022).

The network of these Prehistoric, Late Bronze Age and Early Iron Age structures has relatively uniform location and structure. They are mainly located in the basins of the two main rivers of the region Biebrza and Narew. In terms of their construction, they have a circular arrangement with two areas: a protective area consisting of a system of ditches and embankments and a central area consisting of a flat central square (Żurek et al. 2020, Wawrusiewicz et al. 2022).

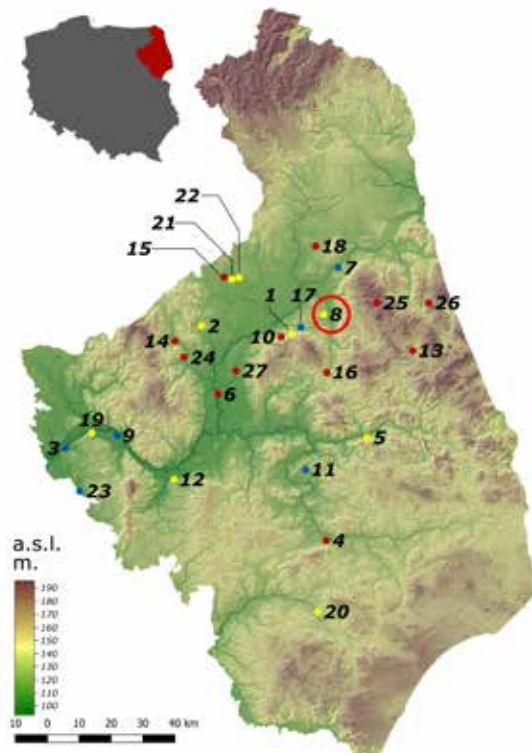


FIG. 1. Location of the research area and Jatwież Duża site (red circle) with the network of similar sites in Podlasie (GUGiK data, DEM 100×100). 1 – Białosuknia, 2 – Brzozowo, 3 – Czartoria, 4 – Filipy, 5 – Nowodworce, 6 – Gugny, 7 – Horodniana, 8 – Jatwież Duża, 9 – Jednaczewo, 10 – Klewianka, 11 – Kościuki, 12 – Koty, 13 – Kraśniane, 14 – Ławsk, 15 – Miecze, 16 – Milewskie, 17 – Moniuszki, 18 – Motułka, 19 – Nowogród, 20 – Pace, 21 – Pieńczykowo I, 22 – Pieńczykowo II, 23 – Podosie, 24 – Rydzewo-Pieniążek, 25 – Sławno, 26 – Zalesie, 27 – Wilamówka

AIM OF STUDY AND METHODS

To determine the environmental context of functioning of the Jatwież Duża site, a series of geological boreholes was made across the bottom of the Brzozówka and Biebla River valleys adjacent to the site (Fig. 2).

Sedimentological analyses were made in the Geomorphological and Hydrological Laboratory of the Department of Geomorphology and Geoarchaeology in Jan Kochanowski University in Kielce. The used methods included grain size of mineral sediments with the sieve method and laser method. The content of organic matter was determined by the loss on ignition method. The obtained results are presented in graphical form in the GRANULOM program together with calculated Folk-Ward's (1957) parameters. Standard ^{14}C dating of organic material from the boreholes was carried out in the Laboratory of Absolute Dating at Skala (Walanus, Goslar 2009).

On the basis of results of these analyses the cross sections of the Brzozówka and Biebla River valleys were determined. The mapping of the Archaeological Map of Poland (AMP) data was carried out to determine the potential settlement of both areas during different periods.

RESULTS

The archaeological site is located on a sandur plain elevated 117–123 m a.s.l. (Fig. 2). Southward of the site the sandur plain is cut by a dry fluvial-denudational valley, eastward it borders a vast (3–4 km wide), floodplain valley of Brzozówka (a fourth-order river, left-bank tributary of the Biebrza River), westward – a flat

moraine plateau (Banaszuk 2004, Kozłowski 2005). The main relief features are derived from the frontal and areal deglaciation during the Cold Warta phase (Falkowski 1970, Mojski 1972, Musiał 1992, Lindner, Marks 2012, Żurek, Kalicki 2021). There are evidenced by numerous smaller forms of rift accumulation (crevasse feature), e.g. sand and gravel kames and eskers to the SW of the site.

The Pleistocene relief of the Brzozówka depression was transformed during the Late Glacial and Holocene. Probably as a result of the capture, the direction of flow was reversed, and Brzozówka River began to flow northward into Biebrza River. Headward erosion begun because Brzozówka referred to the lower erosion base of the Biebrza. At present, the river has a meandering character and the glacial depression of the Brzozówka is fill with peat bogs (Fig. 2) (Kozłowski 2005, Żurek, Kalicki 2021)

The Jatwież Duża site is characterised by an oval form of anthropogenic origin, which indicates its permanent or temporary exploitation in the Prehistory. This form is built by two distinct shape rings separated by embankment and a central flat elevation with about 60 m diameter. Archaeological excavations were made in the NW direction. It was 25 m long and 2 m wide trench, which crossing the embankment and both moats (Fig. 3). In the course of excavations discovered 10 archaeological resource objects with 79 fragments of ceramics and 83 flint tools.

In the Brzozówka River depression 23 geological boreholes were drilled, which is directly adjacent to the Prehistoric site (Fig. 2A, 4). Three segments of different structure and origin we can distinguish within the Brzozówka depression (Fig. 4).

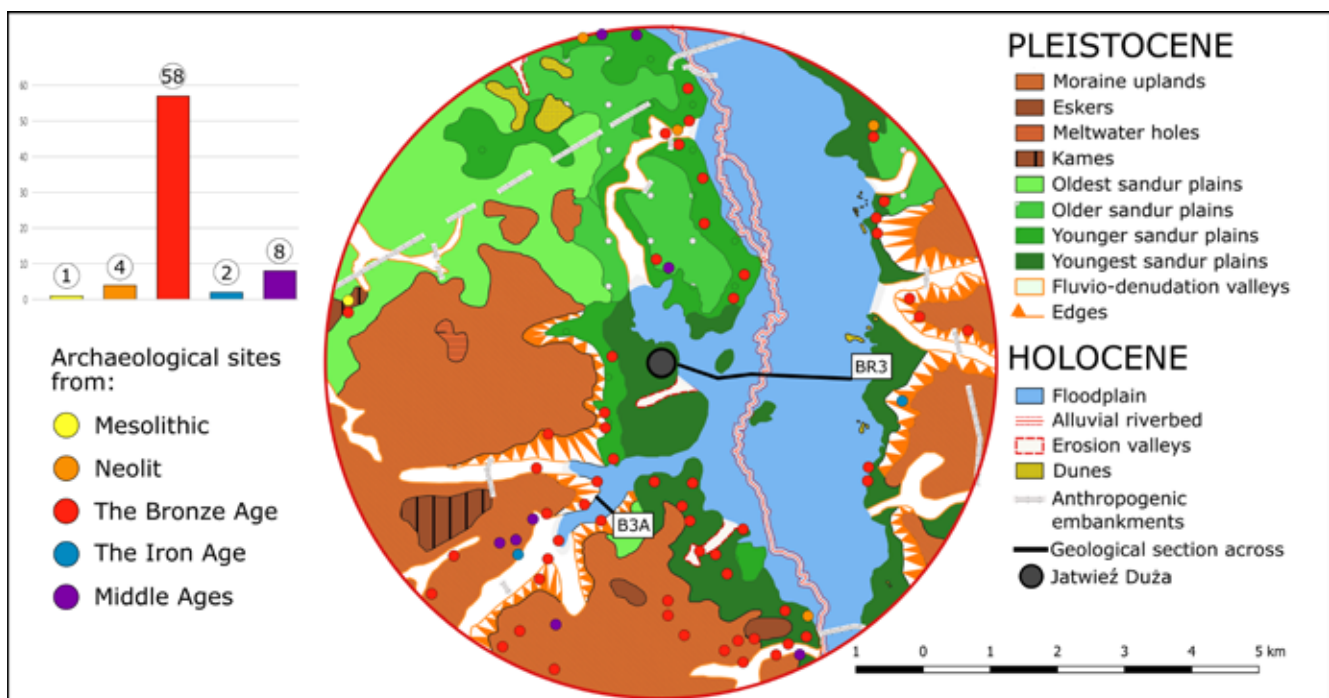


FIG. 2. Geomorphological map with archaeological points of AMP (by M. Frączek, T. Kalicki, modified)

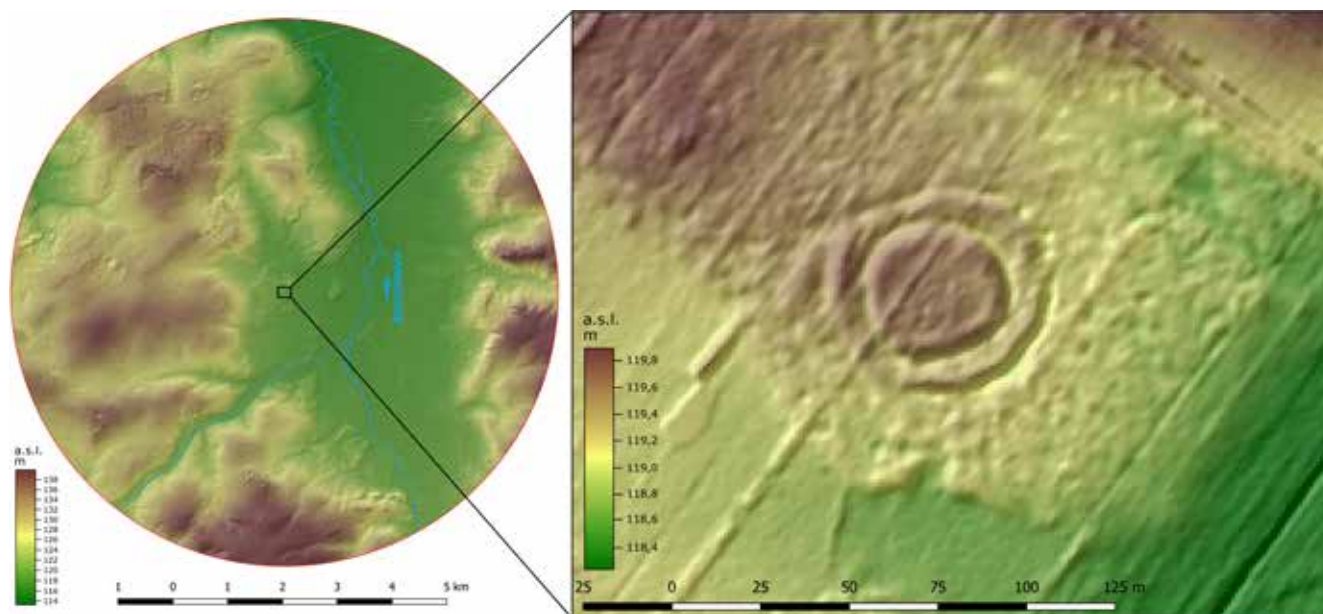


FIG. 3. Jatwież Duża archaeological site on digital elevation model (DEM)

Eight geological drillings were made in the Biebła River valley (Fig. 2B, 5), which is a left-side tributary of the Brzozówka River. The asymmetric valley bottom made up of gravels and sands is filled with a compact peat cover. In borehole B3A we can distinguish 3 levels of organic deposits, which started to grow from the Early Holocene to the Atlantic. Since 3 660 BP onwards there is a decrease in organic matter content (Fig. 5). It is most likely related to the settlement of the catchment area during this period. Decrease in organic matter may be caused by deforestation of the drainage basin and initiation of soil erosion processes.

Data from the Archaeological Map of Poland from the microregion of the Jatwież Duża site (radius 5 km from the site) indicate that this area was settled mainly in the Bronze Age. In this area 64 points of presence of Bronze Age communities were recorded, 1 from Mesolithic, 4 from Neolithic, 9 from Iron Age and 1 from Medieval period (Fig. 2).

CONCLUSIONS

This settlement has led to a precipitation of the natural environment from entropy and its transformation. The use of natural resources for the needs of this community can be observed in the drainage basins of the Brzozówka River and its left-bank tributary Biebła River. Intensive deforestation of the area caused a decrease of organic matter content in peats, which have been growing in both valley floors since the Preboreal (9770–9180 BP). This change took place after 3 660±50 BP (Biebła) and after 1 870±60 BP (Brzozówka).

Determining the function of the sites in this network is extremely difficult. There are many indications that we are dealing here rather with a type of site of an economic nature, which concentrated the population of the Lusatian ash-field culture dispersed in the microregion.

However, it is not possible to exclude other functions it may have had such as an administrative, social and cultural centre.

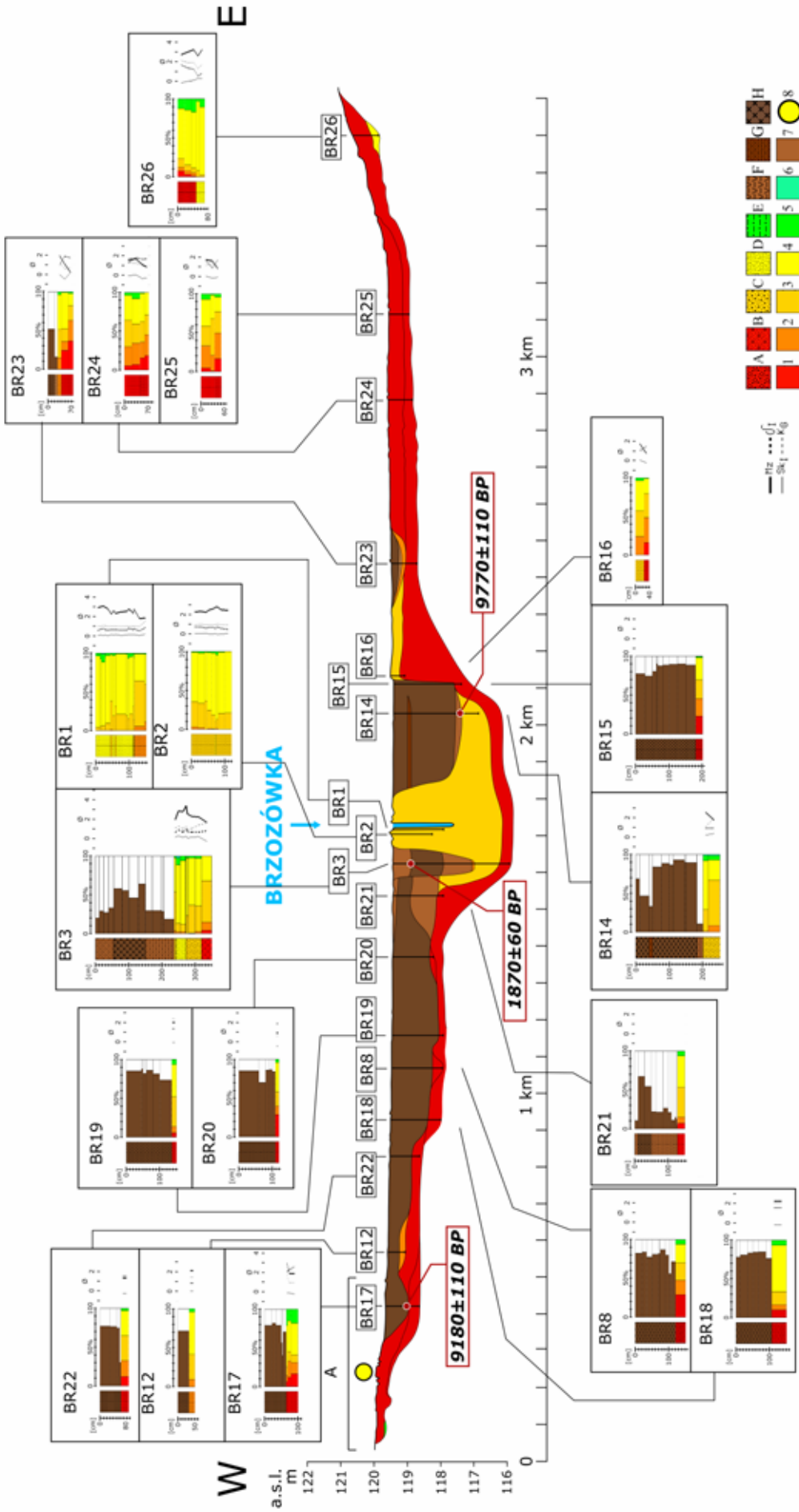


FIG. 4. Geological section across the Brzozówka River valley. Lithology: A – sands with gravels, B – medium sands, C – fine sands, E – silts and clays, F – sandy peats, G – peaty silt, H – peats; Fractions: 1 – gravel (below -1φ), 2 – coarse sand (-1-1φ), 3 – medium sand (1-2φ), 4 – fine sand (2-4φ), 5 – silt (4-8φ), 6 – clay (above 8φ), 7 – content of organic matter, 8 – Jatzwież Duża site; Folk-Ward’s (1957) distribution parameters: Mz – mean diameter, δ₁ – standard deviation (sorting), Sk – skewness, K_g – kurtosis

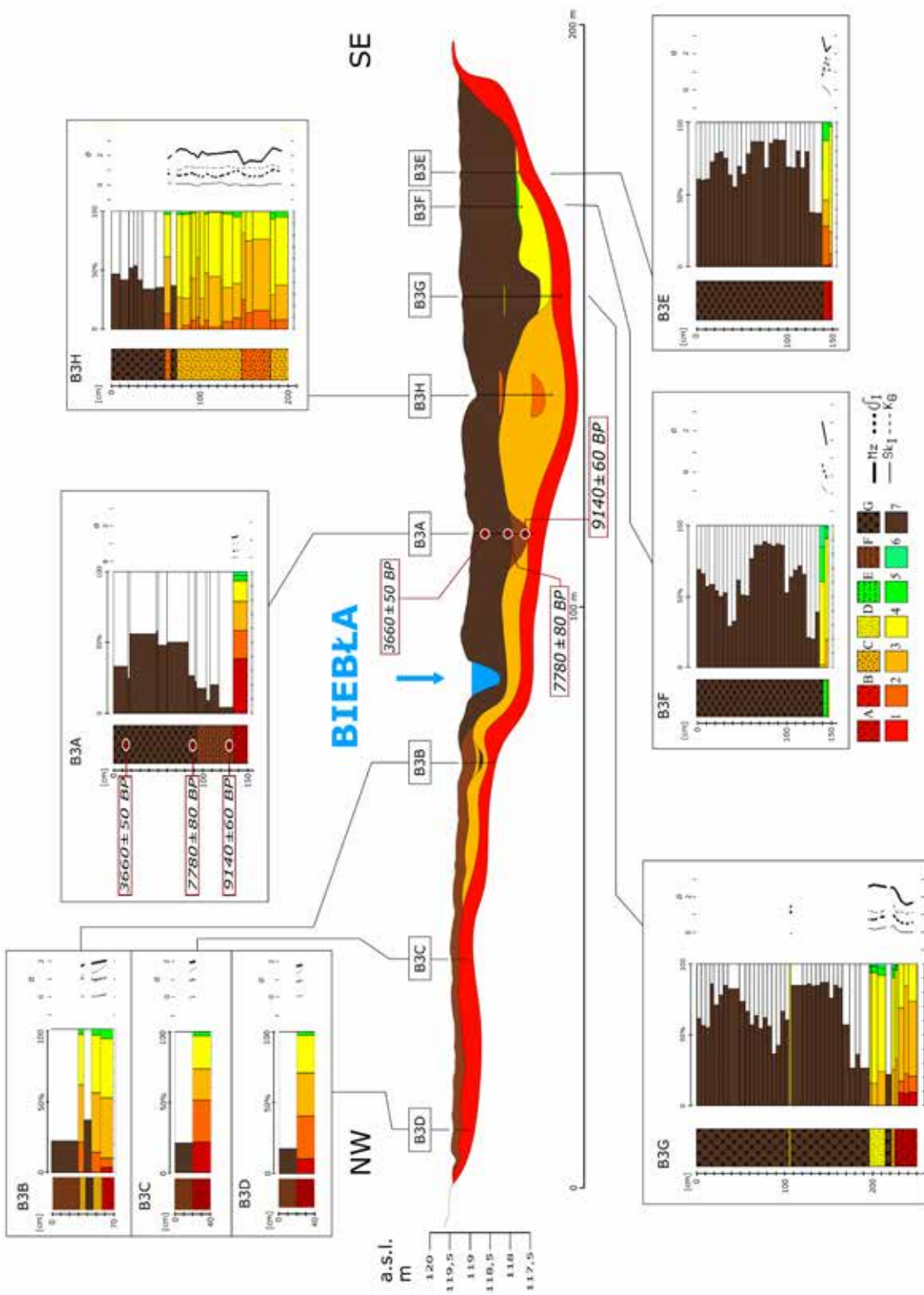


FIG. 5. Geological section across the Biebla valley. Lithology: A – sands with gravels, B – sands with single gravels, C – medium sands, D – fine sands, E – silts and clays, F – peaty silts, G – peats; Fractions: 1 – gravel (below -1ø), 2 – coarse sand (-1-1ø), 3 – medium sand (1-2ø), 4 – fine sand (2-4ø), 5 – silt (4-8ø), 6 – clay (above 8ø), 7 – content of organic matter; Folk-Ward's (1957) distribution parameters: Mz – mean diameter, δ1 – standard deviation (sorting), Sk₁ – skewness, K_G – kurtosis. There are (1) terrace segment built of sandy and gravel sediments, width ca. 1 600 m, (2) peat plain segment with 0.5 to 2.0 m thickness of organic sediments which started to grow since the beginning of the Holocene on uneven mineral substrate, which may be a remnant of palaeochannels of the former meltwater system, width: about 1 800 m, (3) alluvial segment accompanying the present-day riverbed, built up from sands of meandering River deposits, 200–300 m wide.

REFERENCES

- Banaszuk H., 2004, Ogólna charakterystyka Kotliny Biebrzańskiej i Biebrzańskiego Parku Narodowego [In:] Banaszuk H. (Ed.), *Kotlina Biebrzańska i Biebrzański Park Narodowy. Aktualny stan, walory, zagrożenia i potrzeby czynnej ochrony środowiska*. Monografia przyrodnicza, Wyd. Ekonomia i Środowisko, Białystok, p. 19–98.
- Falkowski E., 1970, Historia i prognoza rozwoju układu koryta wybranych odcinków rzek nizinnych Polski, *Biuletyn Geologiczny* 12, 5–121.
- Folk R. L., Ward W. C., 1957, Brazos River bar: a study in the significance of grain size parameters, *Journal of Sedimentary Petrology* 27, 3–27.
- Kozłowski I., 2005, *Objaśnienia do Szczegółowej Mapy Geologicznej Polski*, ark. Suchowola, PIG, Warszawa.
- Lindner L., Marks L., 2012, O podziale klimatostratygraficznym kompleksu środkowopolskiego w plejstocenie Polski, *Przegląd Geologiczny* 60, 1, 36–45.
- Mojski J. E., 2005, *Ziemie polskie w czwartorzędzie, Zarys morfogenezy*, PIG, Warszawa.
- Musiał A., 1992, *Studium rzeźby glacialnej północnego Podlasia*, Rozprawy Uniwersytetu Warszawskiego, Warszawa.
- Walanus A., Goslar T., 2009, *Datowanie radiowęglowe*, Wyd. AGH.
- Wawrusiewicz A., Piasecki A., Kalicki T., Żurek K., Niebieszczanski J., 2021, Trzy linie wałów a wewnątrz pustka... Wyniki badań wykopaliskowych obiektu o charakterze obronnym w Kościukach, pow. białostocki, woj. Podlaskie, Abstr. of XXXVI Lubelska Konf. „Badania Archeologiczne w Polsce Środkowo Wschodniej, Zachodniej Białorusi i Ukrainie”, 26–27.05.2021, Lublin, 32–33.
- Żurek K., Kalicki T., 2021, Budowa doliny Brzozówki w świetle wyników badań geofizycznych i geologicznych, Polska NE, *Acta Geographica Lodziensia* 111, 59–69.
- Żurek K., Kalicki T., Przepióra P., Frączek M., Niebieszczanski J., Bahyrycz C., Chwałek S., Piasecki A., Wawrusiewicz A., 2020, Preliminary results of the geophysical surveys of the network of defence settlements from the Bronze Age between the Biebrza and Narew (NE Poland), *Acta Geobalcanica* 6, 2, 57–64.

GPR SURVEYS OF HISTORICAL CEMETERIES AT BIAŁOGÓRY, GIŻYCKO, SOŚNIA IN NORTH-EASTERN POLAND

Małgorzata Karczewska¹, Maciej Karczewski², Tomasz Kalicki³, Paweł Przepióra³,
Sławomir Chwałek⁴, Krzysztof Żurek³, Karolina Fularczyk³

¹ *Central and Eastern Europe Research Centre, Poland, obeswbialystok@gmail.com*

² *University of Białystok, Faculty of History and International Relations, Poland, barbaricum@wp.pl,*

³ *Jan Kochanowski University in Kielce, Institute of Geography and Environmental Sciences,
Department of Geomorphology and Geoarchaeology, Poland, tomaszkalicki@ymail.com,
pawelprzepiora1988@gmail.com, chrisu.zurek@gmail.com, fularczykkarolina@gmail.com*

⁴ *Independent scientist, Poland, slawomirchwalek@gmail.com*

ABSTRACT

The results of GPR surveys made in historical cemeteries at Białogóry, Giżycko and Sośnia (NE Poland) confirm the usefulness of this research method in preliminary recognition of these kinds of sites. In the case of cemeteries destroyed on the ground surface, they enable quick initial recognition in terms of their extent and layout. It should be stated that this method is indispensable as an introduction to the archaeological research of historical cemeteries.

Keywords: GPR surveys, historical cemeteries, north-eastern Poland, Białogóry, Giżycko, Sośnia

INTRODUCTION

Historical cemeteries are one of the most significant elements of the national heritage. They form an important part of the basis for the national, social and community identity as well as for the memory of societies and communities. But not all of them. There are some kinds of historical cemeteries which were or still are the neglected and unwanted heritage. Such a situation appears as a result of political or/and social changes, and also economic changes resulting from previous causes. The 20th century history of Poland has brought several reasons for the effacement of some kinds of historical cemeteries from the Polish cultural landscape.

Just after World War I and the regaining independence by Poland process of destruction and blurring of war cemeteries located nearly all over the country have started. These cemeteries, built by German troops were regarded as alien relicts of the partitioning states (Karczewska 2017). They were not part of the founding myth of the reborn Polish state. This myth did not take into account the contribution of Great War (World War I) to regaining independence. But after 100 years, when the memory of Great War was strengthened or restored all over Europe also Polish society and citizens has started to explore the heritage of the Great War, including war cemeteries. Even earlier, since the 90ties of the 20 century,

Polish monument protection services started to include war cemeteries from Great War as protected monuments (Karczewska 2017). But at that time, the ground level part of most of these cemeteries was already more or less destroyed. So, their layout, range of graves, kinds of tombstones, alley layout, and other elements, in many cases were not possible for the complete identification. For the identification of many war cemeteries of the Great War non-invasive and invasive archaeological methods are now necessary.

To another kind of endangered historic cemeteries belongs cemeteries of communities which were forced to leave their homes and lands during and short after the World War II (WW II). Many cemeteries of Evangelic and Old Believers belong to this kind in the area of north-eastern Poland. In the year 1941, on the agreement between Nazis and Soviets communities of Old Believers were resettled from the territory of Suwałki and Sejny regions to the territory of today's Lithuania, then the part of the Soviet Union (Jaroszewicz-Pierestawcew, Potaszenko 2006, 2008). At the end of WW II, most inhabitants of East Prussia ran away from their homeland or were forced to leave during the next few years (Sakson 1987, Kacprzak 2010). Cemeteries of Old Believers left unattended by their communities in the next decades were officially classified as non-agricultural green areas. This made it possible to trade these cemeteries

ies as land for recreation or for development. Evangelical cemeteries were taken over by other religious communities or were left without any care and devastated.

A separate category of war cemeteries are cemeteries of German soldiers fallen during WW II. Many of them were placed just next to the Great War cemeteries. And even when the Great War cemetery was preserved, the WW II cemetery located next to it was obliterated. As a result, their areas are currently used in various ways, not as cemeteries.

All mentioned kinds of cemeteries belonged or still belong to the neglected and unwanted category. But according to Polish law, they meet the criteria of the monument (historic Evangelical and Old Believers cemeteries) or the monument and war cemetery (Great War cemeteries). The legal status of graves

and cemeteries of German soldiers who died during WW II, located on the territory of Poland, is regulated by an agreement between the government of the Republic of Poland and the Federal Republic of Germany concluded in the year 2003 (Umowa... 2003).

The collaboration between the Department of Geomorphology and Geoarchaeology of the Jan Kochanowski University in Kielce and the NGO – Centre for Central and Eastern Europe Research, serve the search and study of the aforementioned categories of historical cemeteries. The basic tool for these activities is the GPR survey. These researches brought the expected results – the location of cemeteries and the recognition of their underground structures – in all cases of the examined historical cemeteries.

METHODS

The GPR model used in all surveys during the research was a Mala GeoScience ProEx System. It is a two-channel radar with improved measurement parameters. The set uses a shielded antenna with a frequency of 500MHz, which is the best application for archaeological research (Karczewski 2007). The georadar profiling was based on defined traverses forming a dispersed grid in order to cross-check potentially occurring anomalies. Each point of the traverse line has GPS coordinates in order to set the GPR results in geographical space.

RESULTS

Białogóry, community Giby, Podlaskie Voivodeship, the Old Believers historical cemetery (Fig. 1)

The GPR survey was conducted in the frame of an archaeological investigation conducted in October 2020 as part of the preparation of an expert opinion

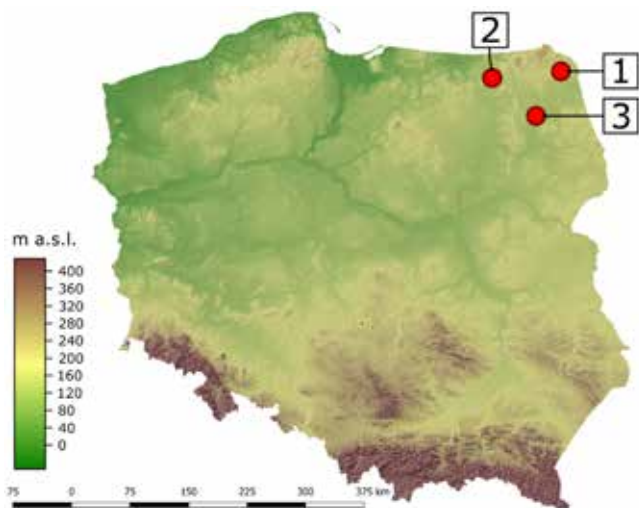


FIG. 1. The location of cemeteries (GUGiK data); 1- Białogóry, 2 – Giżycko, 3 – Sośnia

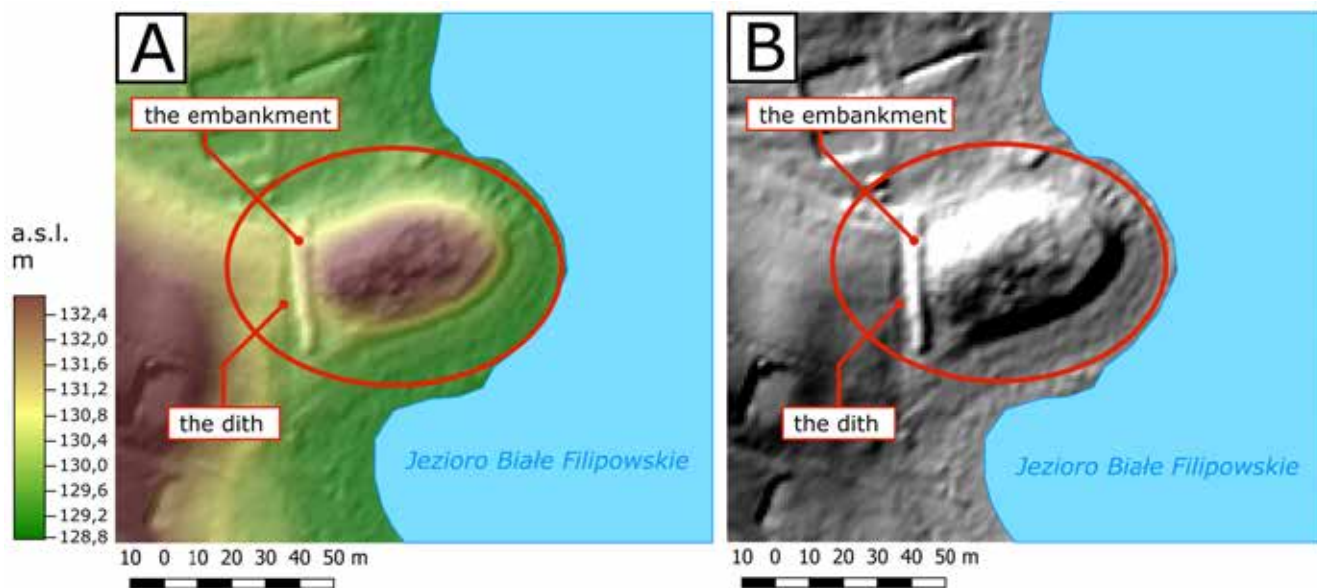


FIG. 2. A – The DEM with hypsometry and marked cemetery space, the embankment, and the ditch; B – analytical hillshading with marked cemetery space, the embankment, and the ditch (GUGiK data)

in the field of archaeology on the insult of the resting place of the deceased in the Białogóry village. The expertise was commissioned by the Poviát Police Headquarters in the Sejny town. The earthworks and construction work carried out here two months earlier destroyed some of the graves and obliterated the remaining graves on the ground. The embankment and the ditch marking the western border of the cemetery were also levelled at that time (Fig. 2). The perpetrators claimed that there was no cemetery and no graves there.

The purpose of GPR research was to confirm or deny: (1) the existence of burial pits on the cemetery hill and (2) the existence of relics of the ditch marking the western border of the cemetery. Echograms were made along the north-south axis. The distance between the individual measurement lines was 2 m. This direction and distribution of measurement lines resulted from the correct layout of historical Christian cemeteries of various confessions, with a row arrangement of graves. The rows of graves were oriented approximately along the north-south axis, while the graves in individual rows were oriented approximately along the east-west axis. The length of the burial pits was usually about 2 m, the width up to about 1 m, and the distance between the individual graves was about 40–50 cm. The arranged at two-meter intervals of the measurement lines guaranteed registration of burial pits on echograms (Fig. 3).

The GPR survey brought registration of anomalies corresponding to the shape and size of both the burial pits and the destructed trench marking the western border of the cemetery. The researchers confirmed that the cemetery occupied the entire hill, and the layout of the graves was in accordance with the Christian funeral rite.

Giżycko, community Giżycko, Warmian-Masurian Voivodeship, the German soldiers cemetery from WW II (Fig. 1)

The GPR survey was conducted in November 2018. The aim of the research was to verify the hypothesis that there are graves north and west of the Great War cemetery (Fig. 4). According to information from the inhabitants of the Giżycko town, these are graves of German soldiers who died during WW II in the hospital in the Feste Boyen.

GPR surveys indicated the presence of a number of anomalies occurring at various depths and with varying legibility. 13 of these may be associated with immovable objects – graves (profiles: G-H, I-J, K-L). They appear in research sections C-D, E-F, G-H and I-J (Fig. 5). They occur mainly below 1 m and are about 2 m wide and spaced about 1 m from each other. 5 of them have clear signal boundaries, the others and 8 boundaries are poorly visible (Fig. 4).

The remaining anomalies should be interpreted as geological or root related layering. Their layering descending at an angle of approx. 60 degrees may also indicate the occurrence of a pick – which was reclaimed for a cemetery (?) (Fig. 4, 6).

Sośnia, community Radziłów, Podlaskie Voivodeship, the Great War cemetery (Fig. 7)

The GPR surveys of the Great War cemetery in the Sośnia village was a part of detailed inventory of Great War cemeteries in the foreground of the Osowiec Fortress (Karczewscy 2015). They were conducted in August 2019. The cemetery in the Sośnia village is known from historical sources and information from the villagers. The cemetery of the soldiers of the tsarist army who died during the German gas attack on August 6, 1915, consists of two mass graves. Both graves were covered with earthen mounds with high wooden Russian crosses. The mounds and crosses have

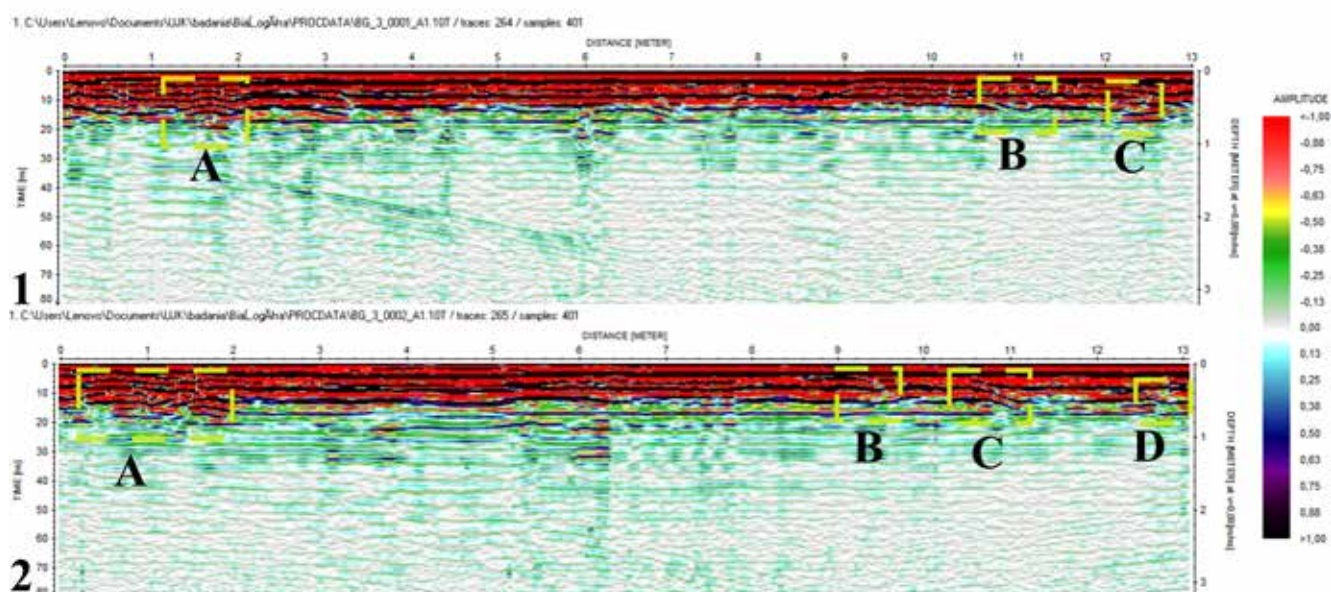


FIG. 3. Echograms with marked anomalies (A, B, C, D) corresponding to the shape and size of the burial pits (by S. Chwatek)

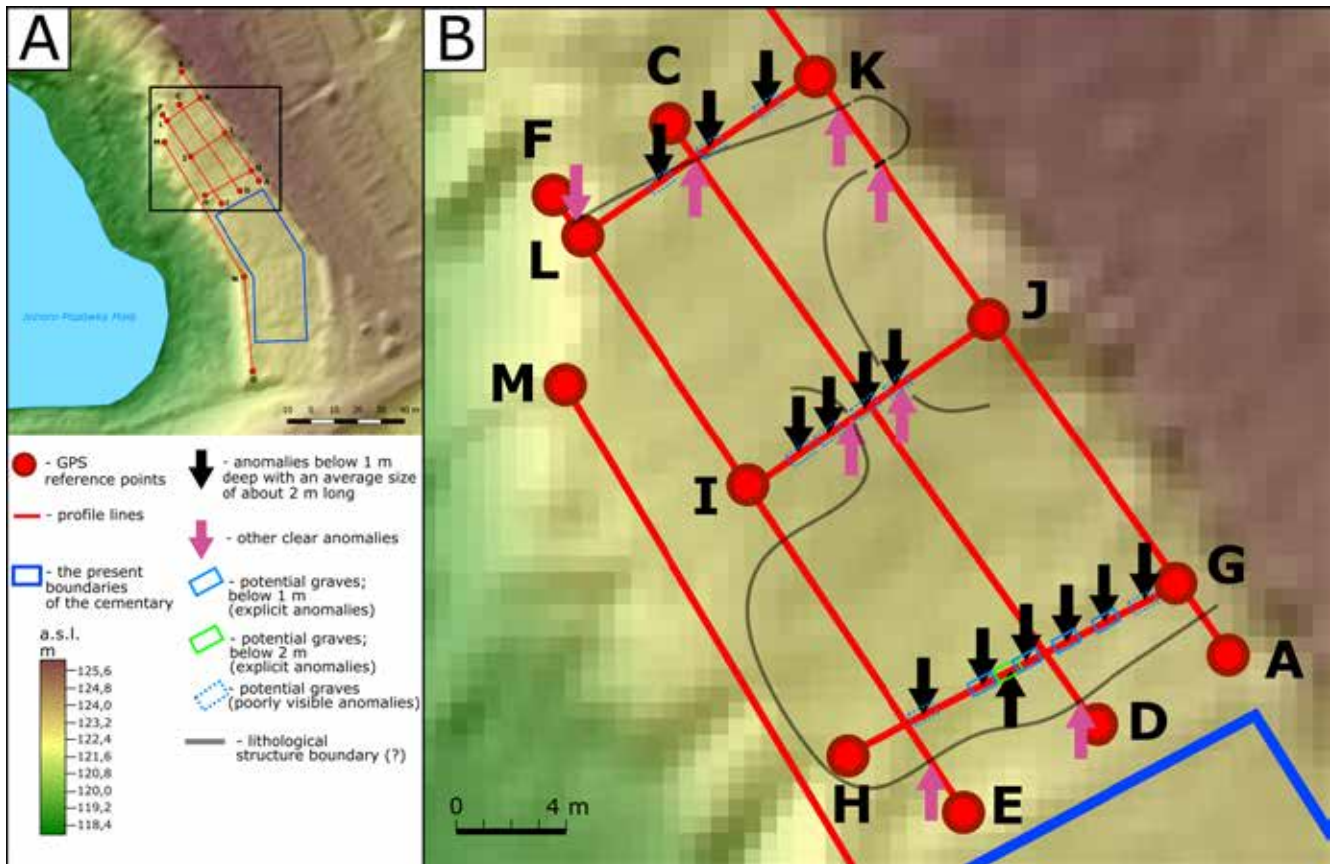


FIG. 4. The DEM with the research area location and distribution of measurement points and echograms (GUGiK data)

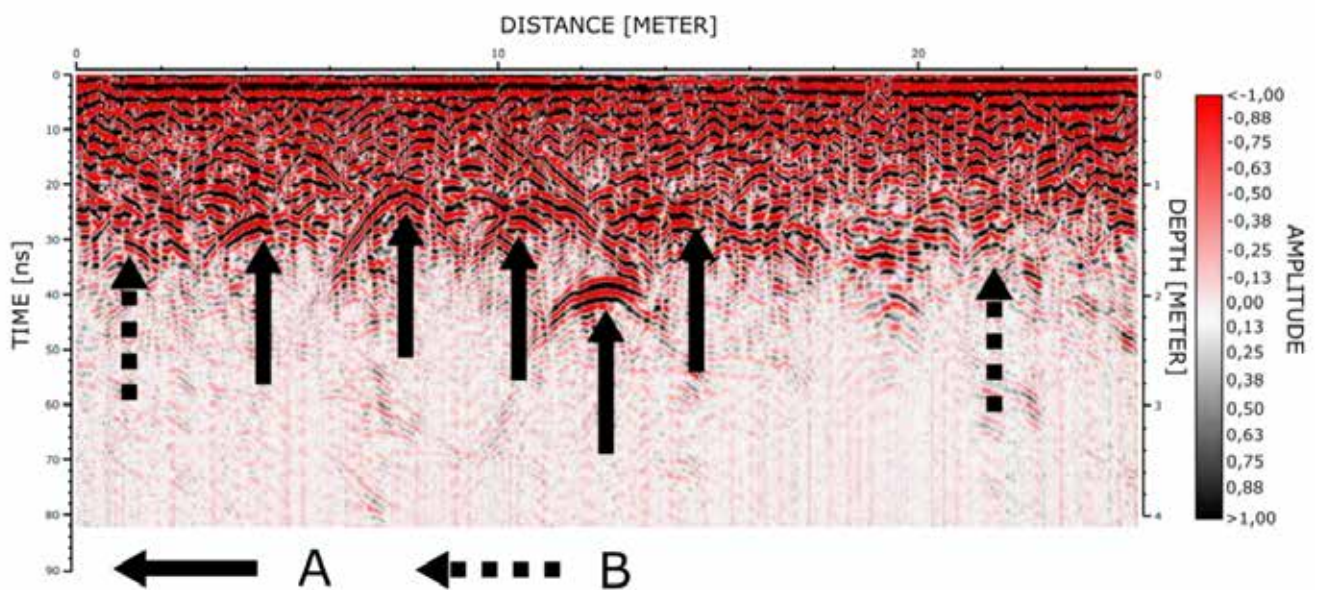


FIG. 5. The echogram of the profile G-H with visible anomalies; A – anomalies with clear boundaries (grave?), B – anomalies with blurred boundaries (potential grave?)

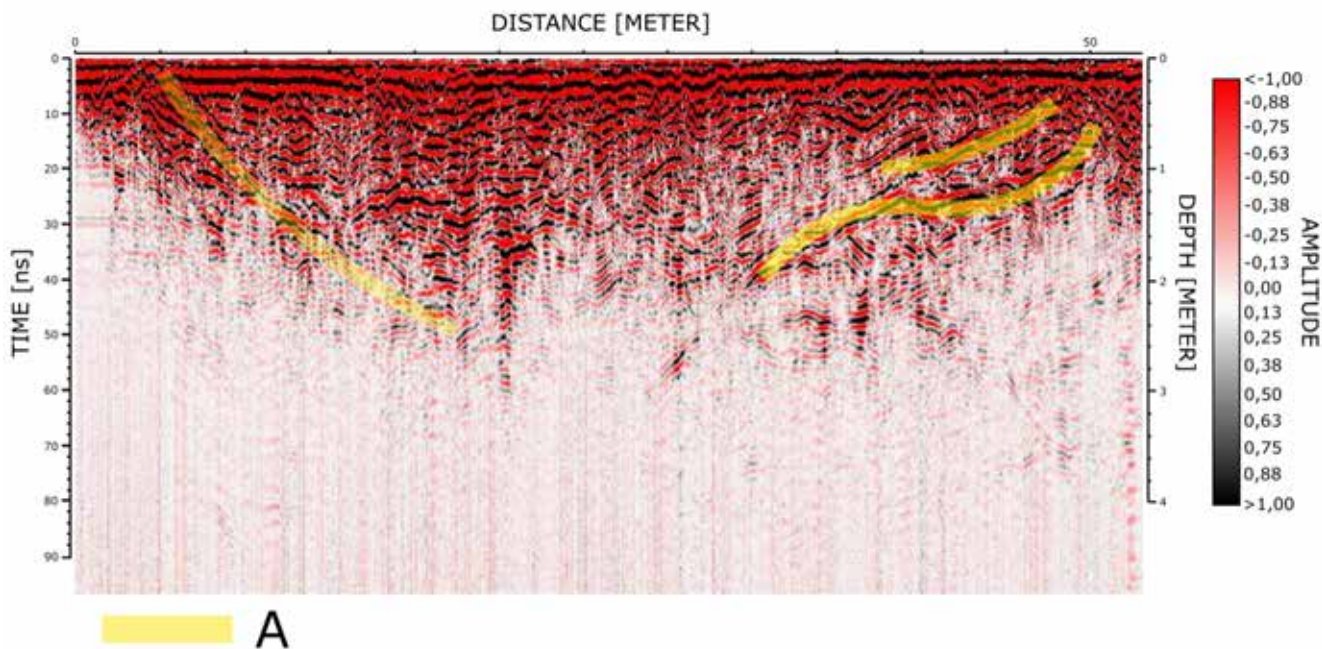


FIG. 6. The echogram of the profile E-F with visible anomalies; A – geological layering



FIG. 7. The monument at the site of the alleged location of mass graves and the space covered by GPR research at the first stage of works (photo M. Karczewska)

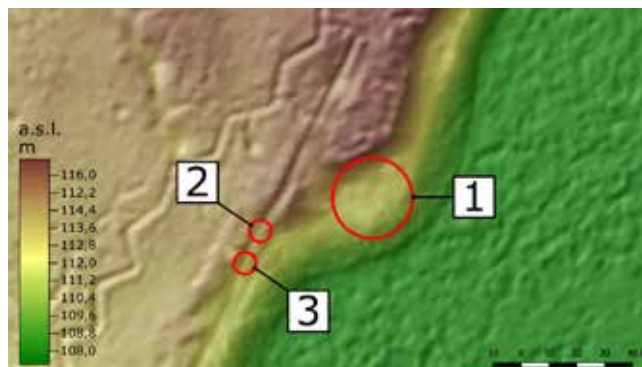


FIG. 8. The DEM of study area (GUGiK data); 1 – the alleged location of mass grave, 2 – smaller mass grave?, 3 – larger mass grave?

not survived. According to local tradition, both graves were located at the base of the dune embankment. This place was commemorated in the 1980s (Fig.7).

The result of GPR research in this area was negative. But the detailed archaeological superficial survey of the surrounding area brought identification of another location of this cemetery in close vicinity of the place of commemoration. Relics of mounds of both mass graves were identified on the top of the same dune embankment. Both mounds were cut and partially destroyed by a forest fire road (Fig. 8, 9).

The GPR survey covered the forest fire road in the area of the location of relics of both mounds. It showed the disturbances of sediments up to the depth of ca 40 cm in the area of the larger mound (Fig. 10). The second stage of the identification and recognition of both mass graves must be the excavation. They will ultimately confirm or negatively verify the results of the GPR survey.



FIG. 9. Relics of the earth mound above the larger mass grave (?), view from NE to SW (photo M. Karczewska)

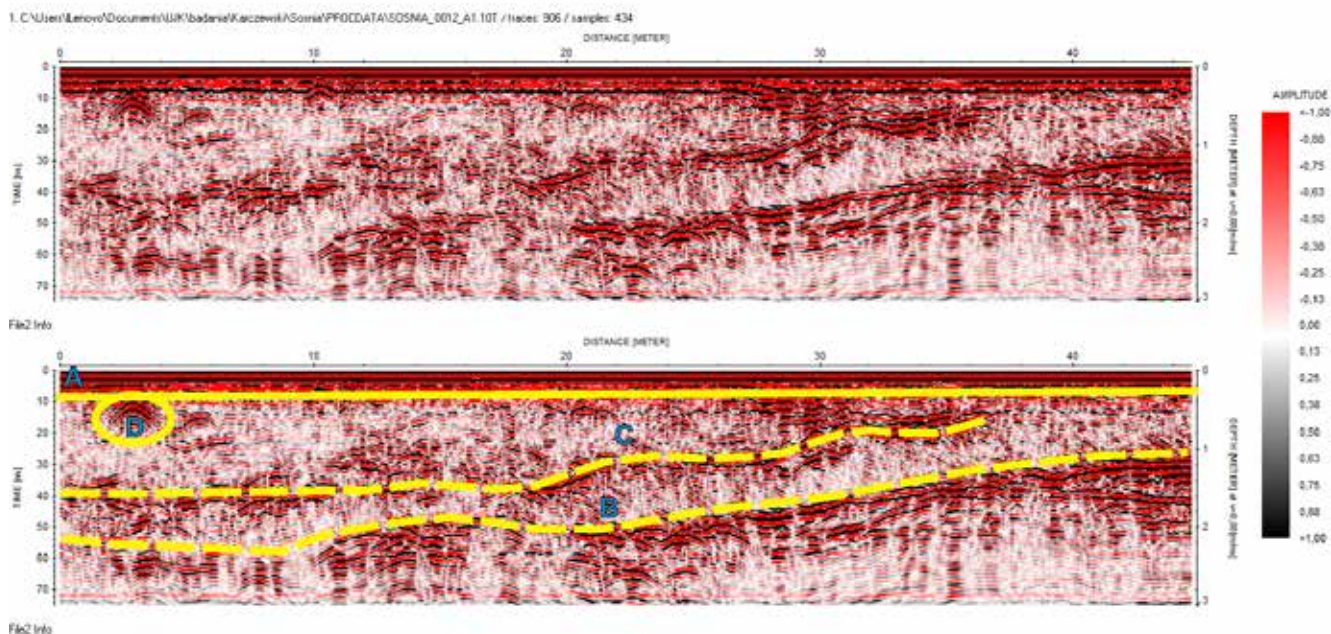


FIG. 10. The echogram of the profile along the forest fire road in the area of the location of relics of both mounds, with visible anomalies B, C, D (by S. Chwałek)

CONCLUSIONS

All the presented examples of GPR surveys in historical cemeteries confirm the usefulness of this research method. In the case of cemeteries destroyed on the ground surface, they enable quick initial recognition in terms of their extent and layout. It should be stated that this method is indispensable as an introduction to the archaeological research of historical cemeteries.

ACKNOWLEDGMENTS

Special thanks to Michał Aksamit and Łukasz Podrzycki for help in field work.

REFERENCES

Jaroszewicz-Pierestawcew Z., Potaszenko G., 2006–2008, Przesiedlenia staroobrzędowców z Suwalszczyzny na Litwę w 1941 r., „Almanach Sejneński”, 241–255.

Kacprzak P., 2010, Polityka władz polskich wobec ludności niemieckiej w okresie funkcjonowania Ministerstwa Ziemi Odzyskanych, „Czasopismo Prawno-Historyczne” LXII:2, 215–235.

Karczewski J., 2007, Zarys metody georadarowej, Kraków.
Karczewska M., 2017, Sto lat będą trwać bez opieki niczyjej... Cmentarze wojenne z czasów I wojny światowej w Białymstoku i powiecie białostockim, Białystok.

Karczewska M., Karczewski M., 2015, Pro Patria. Miejsca pamięci I wojny światowej na przedpolu Twierdzy Osowiec, Seria: Archeologia pamięci, t. 1, Ośrodek Badań Europy Środkowo-Wschodniej, Białystok.

Sakson A., 1987, Liczebność ludności rodzimej na Mazurach, „Komunikaty Mazursko-Warmińskie” 3–4, 483–491.

Umowa między Rządem Rzeczypospolitej Polskiej a Rządem Republiki Federalnej Niemiec o grobach ofiar wojen i przemocy totalitarnej, Monitor Polski nr 55, poz. 749, 2003.

CAN CURRENT VEGETATION SERVE AS AN INDICATOR OF HISTORIC CHARCOAL PRODUCTION IN PINE FORESTS?

Ewa Kołaczowska¹, Anna Kowalska¹, Michał Słowiński¹, Agnieszka Halaś¹, Krzysztof Szewczyk¹, Dominika Łuców¹, Agnieszka Mroczkowska¹, Mateusz Kramkowski¹, Jerzy Jonczak², Vincenzo Barbarino³, Aleksandra Chojnacka⁴

¹Institute of Geography and Spatial Organization PAS, Poland, ekolacz@twarda.pan.pl

²Institute of Agriculture, Warsaw University of Life Sciences – SGGW, Poland, jerzy_jonczak@sggw.edu.pl

³Department of Agriculture, Food and Environment, University of Pisa, Italy, v.barbarino@studenti.unipi.it

⁴Institute of Biology, Warsaw University of Life Sciences – SGGW, Poland, aleksandra_chojnacka@sggw.edu.pl

ABSTRACT

The aim of the research is to determine the impact of the historical charcoal production in charcoal hearths on the current pine forest vegetation in Poland. We present the preliminary results of interdisciplinary NCN-project *The environmental impacts of charcoal production in Northern Poland – a novel multiproxy approach* (2018/31/B/ST10/02498).

Keywords: charcoal hearth remains, current floristic composition and structure, pine forest, Poland

INTRODUCTION

The burning of charcoal in the forests of Europe was carried out on a large scale from the late Middle Ages to the end of the 19th century (Carrari et al. 2017, Hirsch et al. 2017, Raab et al. 2019, Rutkiewicz et al. 2017). Wood obtained from the immediate vicinity was burned under controlled conditions in the so-called charcoal hearths – piles of wood forming a dome, with a base diameter of several meters, covered with clay, soil or turf. The burning process lasted from several to several dozen days, depending on the type of wood, and resulted in significant changes in the physical and chemical properties of soils due to the prevailing high temperature (even up to 800°C). To this day, a several centimetres layer of burnt organic matter is visible in the soil under charcoal hearth remains (CHR), generally to a depth of several dozen centimetres. Underneath it, grains of sand are melted. Moreover, the soil under the former hearths are characterized by the high pH-value, as well as the loss of organic forms of nitrogen and phosphorus to inorganic forms (Wiłkomirski, Gutry, 2010). Such transformations of the soil environment influence the course of vegetation succession. The aim of the research is to determine the impact of the historical charcoal production in charcoal hearths on the current pine forest vegetation (*Dicrano-Pinion*) in Poland. We present the preliminary results of the geobotanical part of interdisciplinary NCN-project: *The environmental*

impacts of charcoal production in Northern Poland – a novel multiproxy approach (2018/31/B/ST10/02498).

METHODS

Charcoal hearth remains have been recognized from LiDAR images. The airborne laser scanning data were obtained from the Central Office for Geodetic and Cartographic Documentation and worked on shaded relief models using the ArcGIS and QGIS software. Having coordinates of CHR, they could be easily find in the field. Over 250 thousand of objects have been identified in forests throughout the northern and central parts of Poland (Fig. 1).

The field studies on current vegetation were carried out in three areas in north-western Poland: (1) Wysoczyzna Polanowska – WP, (2) Pojezierze Wałeckie and Równina Drawska – PW&RD, (3) Bory Tucholskie – BT in late spring and summer 2021 (Fig. 1). We collected 29 phytosociological relevés in accordance to the Braun-Blanquet methodology (1964) and measured diameter at breast height (DBH) of trees at the plots located at CHR – Fig. 2 – and at the corresponding reference plots (controls, control plots). When selecting the research sites, the following criteria were adopted:

- forest habitat type – fresh pine forest on rusty and podzolic soils,
- stand age no less than 70 years (the so-called maturing and mature stands, according to the Polish forestry standards),



FIG. 1. Location of charcoal hearth remains in northern Poland recognized from LiDAR images. The crosses indicate the study areas: 1 – Wysoczyzna Polanowska, 2 – Pojezierze Wateckie and Równina Drawska, 3 – Bory Tucholskie

- location of the CHR not next to roads, trails or the edge of the forest,
- CHR diameter over 14 m (possibility to designate a plot of 10x10 m in the centre to make a phytosociological relevé),
- no extensive disturbances in the continuity of the vegetation cover,
- the reference plot of 10x10 m located within the same forest unit, at a distance equal to the diameter of respective CHR.

The study sites were selected using cartographic data of Forest Data Bank (pol. Bank Danych o Lasach) provided by the Bureau for Forest Management and Geodesy. We also used its online mobile version in the field to find and register visited CHR. Soil cores from several places within the CHR were examined for remains of charcoal which, if present, confirm that the site actually is CHR. The same procedure was applied to confirm that a control plot is not CHR.

The statistical analysis was made using PAST 4.08.

The presented geobotanical study was accompanied by pedological, microbiological, chemical, palaeobotanical and dendrochronological studies.

RESULTS

We examined 29 sites (CHR + control plot) – 14 in WP, 5 in PW&RD and 10 in BT. In total, 35 species of vascular plants and 12 species of mosses were recorded. There are several species that were found only in one type of plot, but in fact there is only one significant difference in species occurrence between CHR and controls – *Vaccinium vitis-idaea* is more common in the control plots (Table 1).

The age of the studied forest stands ranged from 70 to 136 years and the dominating species in the high-



FIG. 2. Current vegetation on the CHR in the pine forest near Plociczno (Drawsko Plain) (Photo. E. Kołaczowska)

TABLE 1. Species occurrences at CHR versus control plots (N=29). The listed species are those with close to significant difference (p-value for Fisher's exact test <0.2) in occurrences between CHR and control plots

Species name	Vegetation layer	Control	CHR	p
Species more common at control plots:				
<i>Vaccinium vitis-idaea</i>	C	29	24	0.05
<i>Dicranum polysetum</i>	D	27	22	0.14
<i>Sphagnum sp.</i>	D	5	1	0.19
Species more common at CHR:				
<i>Betula pendula</i>	B	0	4	0.11
<i>Juniperus communis</i>	B	3	8	0.18

est tree layer (A1) was *Pinus sylvestris* and it was occasionally accompanied by *Betula pendula*. In the lower tree layers (A2, A3) occurred *Betula pendula* and *Picea abies*. There is no significant difference in DBH means between CHR and control plots (CHR mean 32.88 cm, N=101, control mean 33.48 cm, N=116; t-test $p=0.53$). However, when only the oldest stands (>100 years) are taken into account, the difference in DBH means becomes significant (CHR mean 42.21 cm, N=17, control mean 35.56 cm, N=32; t-test $p=0.005$). In the stands older than 100 years, the average DBH of trees at the CHR is 15% higher than in the control plots. However, in the control plots, there are almost twice as many trees.

The comparison of species occurrences between the CHR and their control plots having the tree stand older than 100 years (N=8) showed no significant differences. This may be due to low number of sites and the case requires closer examination.

CONCLUSIONS

1. *Vaccinium vitis-idaea*, more frequent in the control plots, seems to have some disadvantages

on CHR. Eriksson and Lundin (2021) suggest that this acidophilous species is disfavoured by the destruction of the raw humus layer associated with burning.

2. Higher DBH of trees at the CHR (especially in the oldest stands) may be associated with a higher nutrient concentrations in CHR soil compared to the control one (Mastolonardo et al., 2019). In turn, the lower number of trees at CHR plots may be evidence of unfavourable conditions for forest regeneration, e.g. lower plant water availability (Carrari et al. 2018, Buras et al. 2020).
3. Vegetation studies of CHR should be carried out in old-growth forests. The older the stand, the more likely it was that the trees currently growing were also alive when the soil was heavily affected by burning. It is also important to find out the age of charcoal hearth remains.
4. The most useful indicator species (which habitat was the most altered by the charcoal hearths) are those of long life span, e.g. trees.

REFERENCES

- Braun-Blanquet J., 1964, *Pflanzensoziologie, Grundzüge der Vegetationskunde*. 3rd Edition, Springer-Verlag, Berlin, 631.
- Buras A., Hirsch F., Schneider A., Scharnweber T., van der Maaten E., Cruz-García R., Raab T., Wilmking M., 2020, Reduced above-ground growth and wood density but increased wood chemical concentrations of Scots pine on relict charcoal hearths, *Science of the Total Environment* 717, 137189.
- Carrari E., Ampoorter E., Bottalico F., Chirici G., Coppi A., Travaglini D., Verheyen K., Selvi F., 2017, The old charcoal kiln sites in Central Italian forest landscapes, *Quaternary International* 458, 214–223.
- Carrari E., Ampoorter E., Bussotti F., Coppi A., Garcia Nogales A., Pollastrini M., Verheyen K., Selvi F., 2018, Effects of charcoal hearth soil on forest regeneration: Evidence from a two-year experiment on tree seedlings, *Forest Ecology and Management* 427, 37–44.
- Eriksson O., Lundin L.G., 2021, Legacies of historic charcoal production affect the forest flora in a Swedish mining district, *Nordic Journal of Botany*, e03312.
- Hirsch F., Raab T., Ouimet W., Dethier D., Schneider A., Raab A., 2017, Soils on historic charcoal hearths: terminology and chemical properties, *Soil Science Society of America Journal* 81 (6), 1427–1435.
- Mastolonardo G., Calderaro C., Coccozza C., Hardy B., Dufey J., Cornelis J. T., 2019, Long-Term Effect of Charcoal Accumulation in Hearth Soils on Tree Growth and Nutrient Cycling, *Frontiers in Environmental Science* 7, 51.
- Raab A., Bonhage A., Schneider A., Raab T., Rösler H., Heußner K.U., Hirsch F., 2019, Spatial distribution of relict charcoal hearths in the former royal forest district Tauer (SE Brandenburg, Germany), *Quaternary International* 511, 153–165.
- Rutkiewicz P., Malik I., Wistuba M., Sady A., 2017, Charcoal kilns as a source of data on the past iron industry (an example from the River Czarna valley, Central Poland), *Environmental & Socio-economic Studies* 5 (3), 12–22.
- Wiłkomirski, B., Gutry, P. 2010, Zmiany przyrodnicze w ekosystemach pod wpływem pożarów środowiskowych. *Rocznik Świętokrzyski, Seria B – Nauki Przyrodnicze* 31, 95–110.



THE ENVIRONMENT AS AN ARCHIVE OF PAST HUMAN ACTIVITIES (ED. T. KALICKI)



GEOARCHAEOLOGY OF OLD-POLISH INDUSTRIAL DISTRICT

ROLE OF NATURAL AND ANTHROPOGENIC SMALL RETENTION WATER SYSTEMS IN THE HOLOCENE EVOLUTION OF SMALL RIVER VALLEYS: CASE STUDY FROM CZARNA KONECKA RIVER (HOLY CROSS MTS. REGION, CENTRAL POLAND)

Tomasz Kalicki, Piotr Kusztal

Jan Kochanowski University in Kielce, Institute of Geography and Environmental Sciences,
Department of Geomorphology and Geoarchaeology, Poland, tomaszkalicki@gmail.com; roch1990@gmail.com

ABSTRACT

The recorded development stages of the research section reflect a very large impact of the functioning and destabilization of the natural and anthropogenic small-scale water retention system on the evolution of the valley of the III. order river. Documentation of this impact is one of the few and the most detailed known from Poland.

Keywords: Holocene, small river, climate changes, human impact, beaver activity

INTRODUCTION

The study area is located in the Czarna Konecka valley between Stąporków and Sielcia Wielka in the Końskie district (Świętokrzyskie voivodship) (Fig. 1). This watercourse is a small upland river of III. order in the inter-river basin of the Vistula and Pilica rivers, with a length of approx. 90 km and a catchment area of approx. 1000 km². It drains the NW Mesozoic margin of the Holy Cross Mts. in the Kielce and Przedbórz Uplands. There are non-karst (Triassic and Jurassic sandstones) and tectonically inactive area. Czarna Konecka flows within the Old-Polish Industrial District (OPID), where, since the Late Middle Ages, iron metallurgy based on the hydropower of rivers developed.

AIM AND METHODS

The main aim of the research was to determine the main stages of the evolution of the valley of a small upland river and their natural and anthropogenic conditions. The study uses a wide range of interdisciplinary methods – geomorphologic, sedimentologic, paleogeographic, cartographic, historical, TL, OSL, ¹⁴C datings etc.

RESULTS, DISCUSSION AND CONCLUSIONS

Based on the results of interdisciplinary research, the main stages of the upland small valley evolution, beyond the Paleozoic core of the Holy Cross Mts.

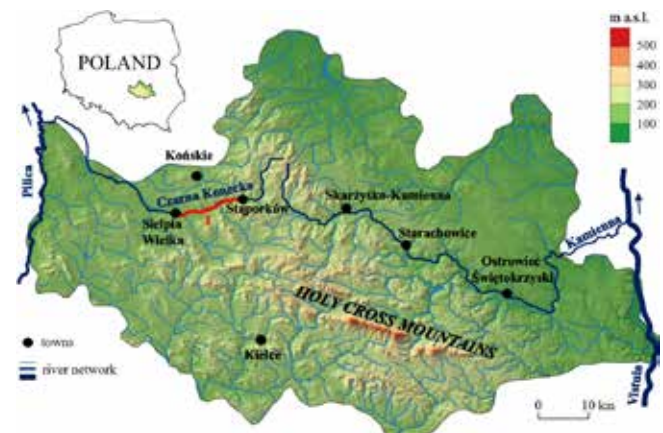


FIG. 1. Location of study area (red line) on Digital Elevation Model of the Old-Polish Industrial District area (Fularczyk et al. 2020, changed)

and within the OPID range, were identified. The influence of natural and anthropogenic factors on the Late Vistulian and Holocene transformation of the fluvial environment was indicated. The main factors were climatic changes, human activity and local conditions but the role of these factors in the evolution of the valley has changed.

In the Late Vistulian, the changes in the fluvial environment were a consequence of climatic and vegetation fluctuations, referring to the stadial-interstadial cycle. A very early river pattern transformation (one of the two oldest in Poland) from

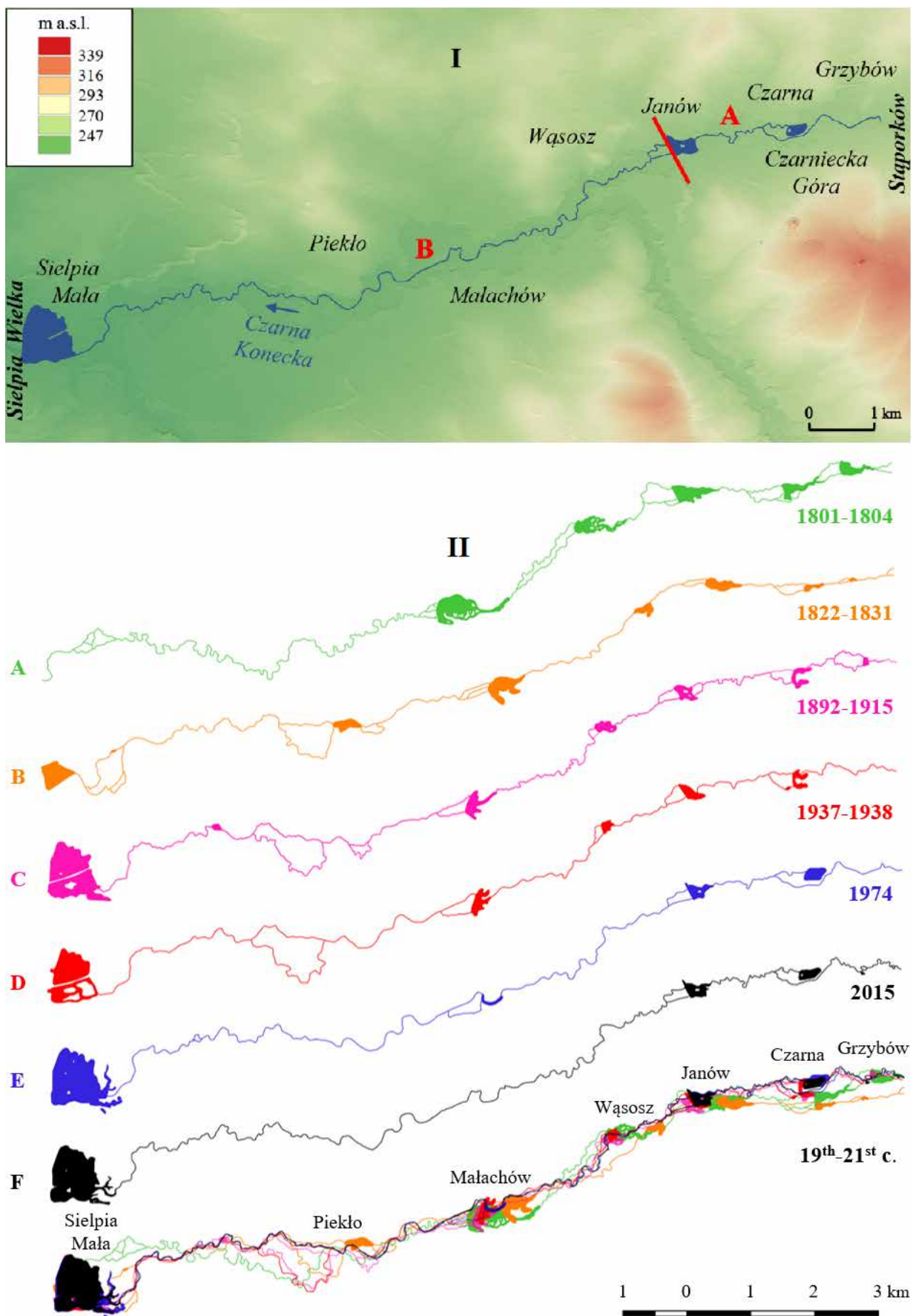


FIG. 2. Study section upstream (A) and downstream (B) of Janów dam on DEM (I) and changes of river course and ASWRS (II) in the last centuries based on cartographic sources (by K. Fularczyk, P. Kusztal); Maps: A – West Gallizien, B – Topographic Chart of the Kingdom of Poland, C – Karte des Westlichen Russlands, D – Tactical Map of Poland; E – topographic map, F – orthophotomap

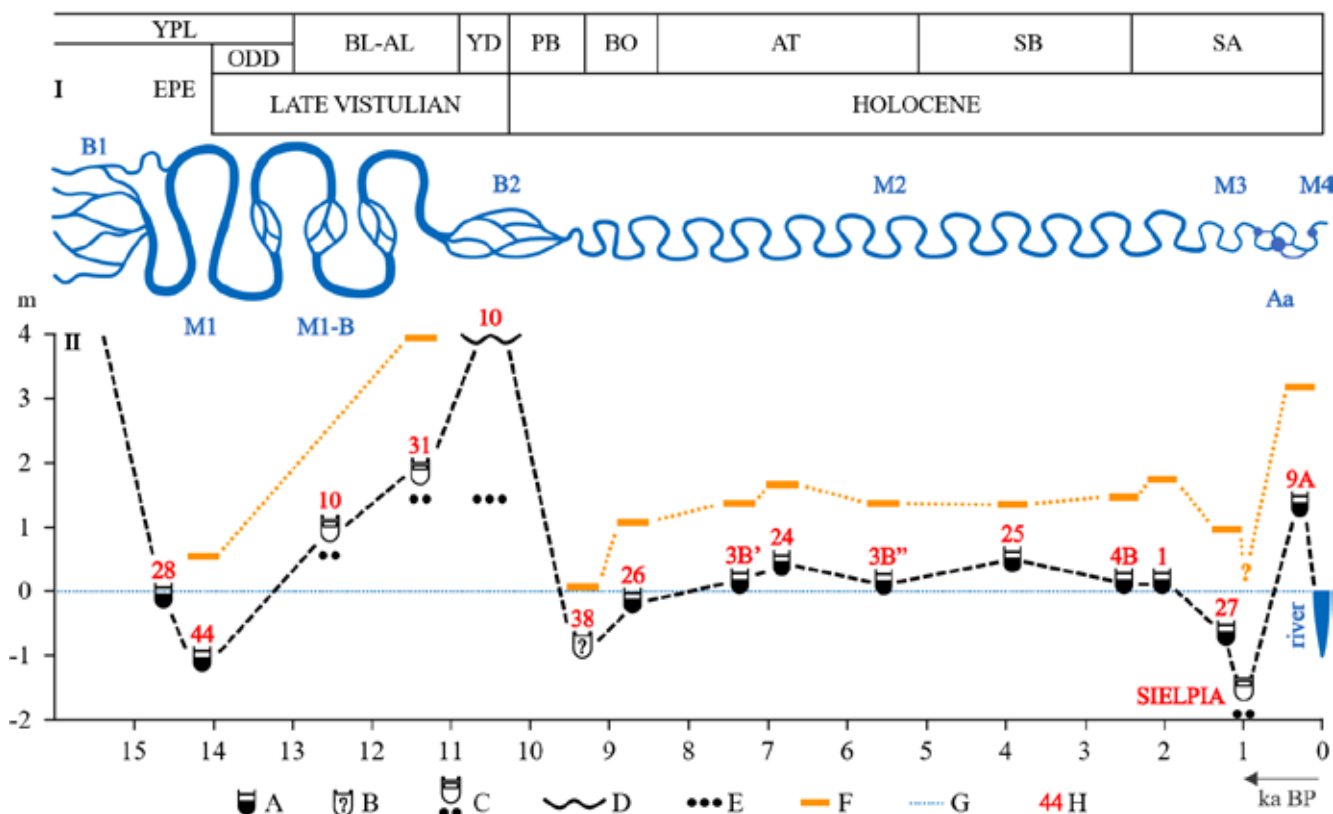


FIG. 3. Changes of river pattern and parameters (I) and riverbed level (II) since Young Pleniglacial; I: B – braided river with wide (B1) and narrow (B2) alluvial plain, M-R – meandering-braided (transitional) river, M – meandering river (M1 – macro-meanders, M2 – medium meanders, M3 – small meanders, M4 – meanders after the degradation of ASWRS), A – anastomosing river (Aa – anthropogenic anastomoses during the functioning of the ASWRS); II: A – oxbow lake fill bottom (riverbed level), B – hypothetical riverbed level, C – riverbed level interpreted from lag deposits level, D – top the alluvial plain deposits, E – lag deposits, F – top of the point bar deposits, G – the present-day average water level in riverbed, H – study sites

the braided to meandering system, as well as the related incision, could have been caused by warming (epe=Kamion phase) and local conditions. They are consistent with the Falkowski's (1970, 1975) model of the pattern changes (braided riverbeds → macromeanders) with modifications concerning the Younger Dryas aggradation by braiding system (Kalicki 1991).

Warming and afforestation in the Holocene beginning caused again the concentration of riverbed and incision. Small meanders were typical of almost the whole Holocene. Natural anastomoses functioning in the Czarna Nida River valley during the Eoholocene and Roman period (Krupa 2013, 2015) in Czarna Konecka valley did not occur. Climatic fluctuation in changes of small fluvial systems in fully forested drainage basin played a secondary role, while local conditions, including beaver activity, became the leading factor. The natural small water retention system (NSWRS) created by these animals (dams, ponds etc.) conditioned the existence of local erosion bases and regulated the discharges and outflow. Therefore, traces of the pre-Subatlantic increase of Czarna Konecka fluvial activity are only the result of extreme floods caused by meteorological events that could have occurred at any time and were not caused by the climatic trend.

The anthropopression growing since the Roman period led to deforestation, beginning of soil erosion and accumulation small alluvial fans at the foot of the terrace. There were also gradual depopulation of beavers and the degradation of the NSWRS they created. Therefore, in this short period, climate fluctuations recorded by changes in the fluvial activity are legible. In the last millennium, the development and decline of the OPID played a decisive role in the valley evolution. Indirect (deforestation of the catchment) and direct human influence on water circuit and riverbed, the construction of an anthropogenic small water retention system (ASWRS) (cascade of ponds, anthropogenic anastomoses etc.), conditioning the existence of artificial erosion bases, was conducive to intensive aggradation. The expansion and development of the hydrotechnical infrastructure from the 17th to the 19th century (an increase in its retention capacity) led to a reduction in the role of extreme events during the Maunder's and Dalton's pesimum of the Little Ice Age. The progressive destabilization and finally disappearance of the ASWRS in the 20th c. (terrastratization and overgrowing of ponds, dam breaking) in the section B contributed to the occurrence of catastrophic events (flash floods) of a scale unknown from the earlier Holocene periods and rejuvenation

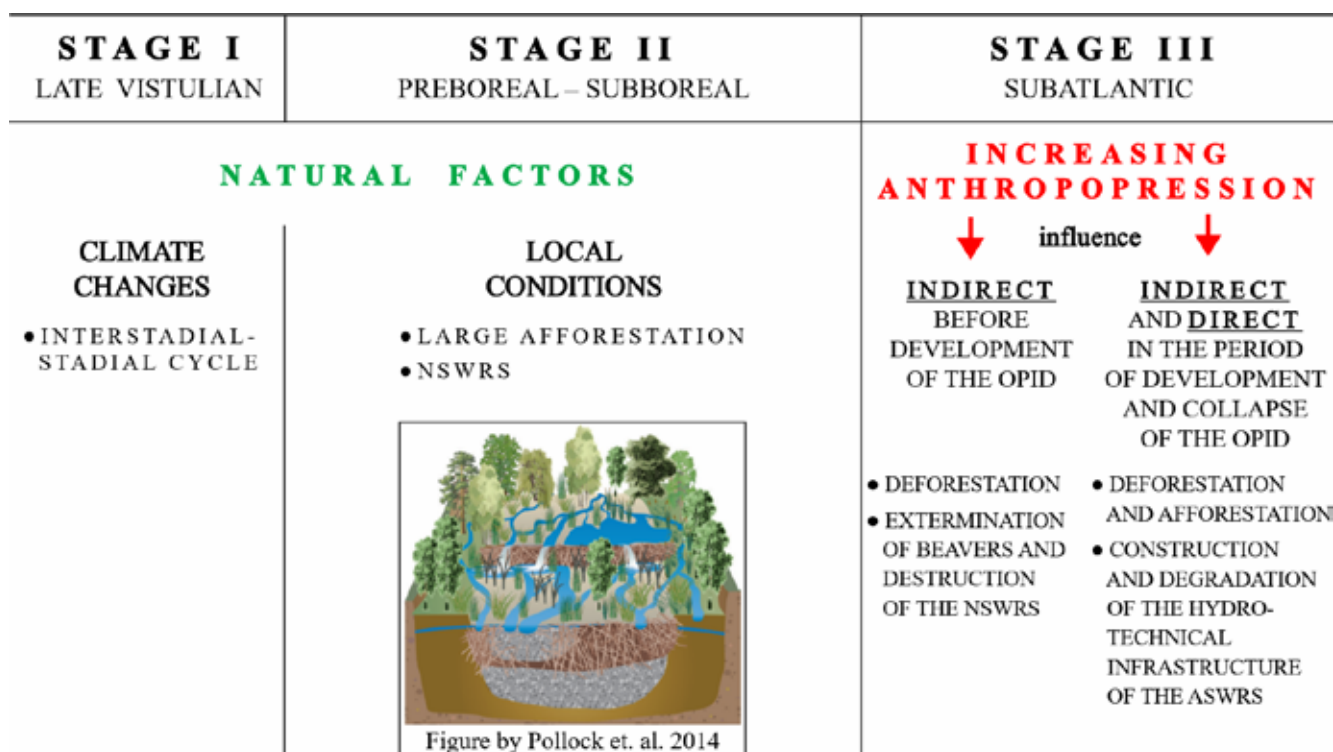


FIG. 4. Main stages and factors caused the Late Vistulian and Holocene valley evolution

(confined meanders) in the last decades of the 20th c. (Anthropocene). Such events and processes are not observed in section A upstream of Janów, where ASWRS with pond cascades is almost completely preserved until today. Pattern of Czarna Konecka in last centuries is inconsistent with Falkowski's model because multi-channel system of anthropogenic anastomosis functioned instead of the braided system, and after the disappearance of the ASWRS confined meanders.

REFERENCES

- Falkowski E., 1970, Historia i prognoza rozwoju układu koryta wybranych odcinków rzek nizinnych Polski, *Biuletyn Geologiczny Uniwersytetu Warszawskiego*, 12, 5-121.
- Falkowski E., 1975, Variability of channel processes of lowland rivers in Poland and changes of the valley floors

during the Holocene, *Biuletyn Geologiczny Uniwersytetu Warszawskiego*, 19, 45-78.

- Kalicki T., 1991, The evolution of the Vistula river valley between Cracow and Niepołomice in Late Vistulian and Holocene times, [In:] Starkel L. (Ed.), *Evolution of the Vistula river valley during the last 15 000 years, part IV, Geographical Studies, Special Issue, 6, Zakład Narodowy im. Ossolińskich, Wydawnictwo PAN, Wrocław*, 11-37.
- Krupa J., 2013, Naturalne i antropogeniczne procesy kształtujące dno doliny Czarnej Nidy w późnym wistulianie i holocenie, *Folia Quaternaria*, 81, 5-174.
- Krupa J., 2015, Natural and anthropogenic channel pattern changes in the mid-mountain valley during the Late Glacial and Holocene, *Polish Uplands, Quaternary International*, 370, 55-65.
- Pollock M., Beechie T., Wheaton J., Jordan C., Bouwes N., Weber N., Volk C., 2014, Using beaver dams to restore incised stream ecosystems, *BioScience*, 64, 4, 279-290.

THE HYDROGRAPHIC CONFLUENCE IN SIELPIA AS AN ARCHIVE OF NATURAL AND ANTHROPOGENIC PROCESSES FROM THE BEGINNING OF THE 19TH C. (OLD-POLISH INDUSTRIAL DISTRICT, POLAND)

Karolina Fularczyk, Tomasz Kalicki, Piotr Kusztal

*Jan Kochanowski University in Kielce, Institute of Geography and Environmental Sciences,
Department of Geomorphology and Geoarchaeology, Poland
fularczykkarolina@gmail.com, tomaszkalicki@ymail.com, roch1990@gmail.com)*

ABSTRACT

The case study of the hydrographic confluence in the Sielpia based on the cartographic method allowed to capture changes in the hydrographic network related to the development and decline of the Old-Polish Industrial District (OPID), which was based on the use of hydropower in iron metallurgy. The formation and disappearance of artificial industrial reservoirs and canals, and also changes of the rivers course, were reflected in cartographic materials.

Keywords: river network changes, hydrographic confluence, Old-Polish Industrial District

INTRODUCTION

The study area is located in the Polish Uplands (Solon i in. 2018), in the Holy Cross Mts. region, in the Vistula River basin (Majewski 2013). The hydrographic confluence in Sielpia is located within the Old-Polish Industrial District (OPID) where iron ores were extracted and processed on a large scale in the last centuries (Nowak, Nowak 2022). The hydropower of rivers was then used for metallurgy. The hydrographic confluence in Sielpia is located at the junction of two riverbeds (Czarna Konecka and Czarna Taraska rivers), draining the NW margin of the Holy Cross Mts. (Fig. 1).

AIM AND METHODS

The aim of this study is to determine the impact of the development and decline of OPID on the transformation of the hydrographic confluence at Sielpia in recent centuries. Were used, historical and cartographic materials from 19th, 20th and 21th century.

RESULTS

Cartographic materials show changes of the river network from the beginning of the 19th c. to the present time (Fig. 2). At the beginning of the 19th c., the Sielpia water reservoir did not exist. In the 1st half of the 19th c., two water body were created, the northern and the southern, and riverbeds were regulated. The channel of the Czarna Taraska River was moved to the east, and its for-



FIG. 1. Location of the study area on the Digital Elevation Model (DEM) of Old-Polish Industrial District (Fularczyk et al. 2022)

mer channel was activated after the construction of the southern water body in 1837. In the 20th c., during the interwar period, the western Czarna Taraska channel was cut off and the southern water body was silted. In 1938, a flood destroyed the dam, and the multi-channel system was formed in the pond basin.

In 1962, the water reservoir was rebuilt, but already in the 1980s it was silted again. At the beginning of the 21st c., the pond silting effects were visible, because there was a large inland delta at the mouth of the Czarna Konecka River. Around 2010, the inland delta was removed, but in the last years the pond was silted again. After 1962, the accumulation of deltas

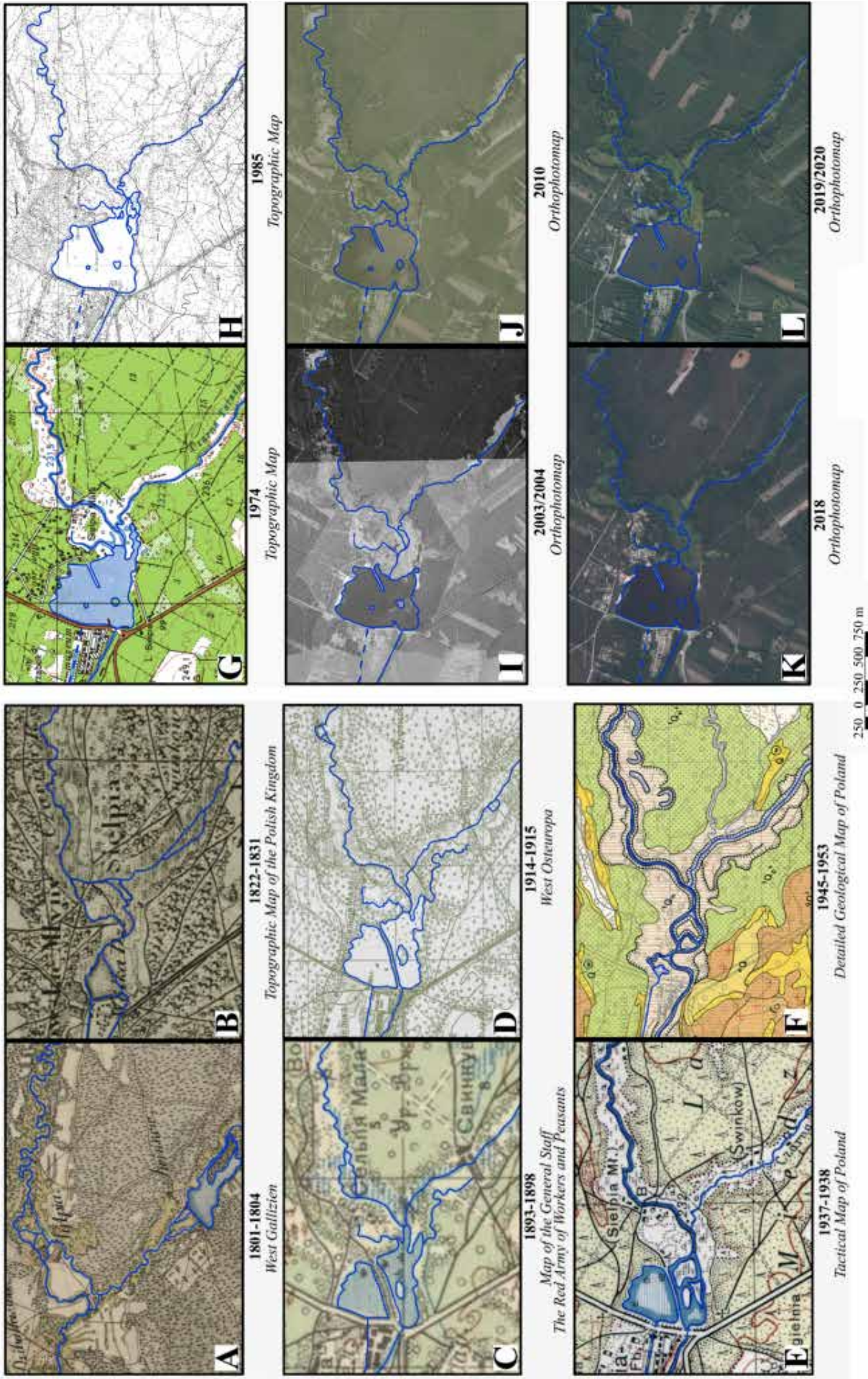


FIG. 2. Hydrographic confluence in Sielpia on cartographic materials from the last centuries

deposits was mainly due to floods, and some of these floods were caused by dam ruptures.

The silting rate of the Sielpia reservoir probably increased in the 1990s. In 2003 its entire eastern part was filled with an extensive inland delta. In the following years, this delta must have been dredged out, because in 2010 it occupies an incomparably smaller area. In the last decade the reservoir has been silted once again, although the size of the delta is much smaller than in 2003. As of 2018, sediment dredging and reservoir revitalization efforts have resumed (Fig. 2).

In the present-day, both rivers have a single-channel system. The meanders of the Czarna Konecka River do not show significant changes in the last thirty years, while the estuary section of the Czarna Taraska river has become more sinusoidal, due to natural fluvial processes leading to the transformation of a straight artificial canal into a natural meandering channel (Fularczyk et al. 2020b).

CONCLUSIONS

In the last two centuries, a transformation of the hydrographic confluence in Sielpia took place, which was associated with the development and decline of OPID and later milling (appearance and disappearance ASWRS). This transformation rested on regulation and channelization of watercourse sections, construction and disappearance of water bodies, or also changes in river patterns. Similar environmental changes have been reported also in other areas of the OPID (Kalicki et al. 2019, 2020, Fularczyk et al. 2020a, b). Some changes in the river network noted in the study area (e.g. channels straightening) are typical for highly human-transformed valleys, located in various parts of the World, especially in Europe (Lestel et al. 2020). The anthropogenic impact on hydrographic confluences in such valleys can be very large (Martinson 2010, Plit 2016, Biesaga, Kalicki 2021).

REFERENCES

- Biesaga P., Kalicki T., 2021, Estuary Nida River – cartographic and geomorphological changes – first results, *Acta Geobalcanica*, vol. 7, no. 1, 35–40.
- Fularczyk K., Kuształ P., Kalicki T., 2020a, Changes of the former pond at Furmanów (Old-Polish Industrial District, central Poland), *Cartographic and sedimentological data*, *Acta Geobalcanica*, vol. 6, no. 4, 203–210.
- Fularczyk K., Kuształ P., Kalicki T., Żurek K., 2020b, Historyczne i współczesne zmiany koryta Czarnej Taraski (Wyzyna Małopolska, Staropolski Okręg Przemysłowy), *Naturalne i antropogeniczne zmiany obiegu wody, Współczesne problemy i kierunki badań*, Bogucki Wydawnictwo Naukowe (Studia i Prace z Geografii, no. 83), Poland, 9–23.
- Fularczyk K., Kalicki T., Kuształ P., 2022, Changes of the hydrographic confluence in Sielpia from the beginning of the 19th century (Old Polish Industrial District), *Acta Geobalcanica* 8-4, 123–128.
- Kalicki T., Frączek M., Przepióra P., Kuształ P., Kłusakiewicz E. & Małęga E., 2019, Late Quaternary geomorphology and geoarchaeology in the rivers of the Holy Cross Mountains region, central Europe, *Quaternary Research*, vol. 91, no. 2, 584–599.
- Kalicki T., Przepióra P., Kuształ P., Chrabąszcz M., Fularczyk K., Kłusakiewicz E., Frączek M., 2020, Historical and present-day human impact on fluvial systems in the Old-Polish Industrial District (Poland), *Geomorphology*, vol. 357 (107062), FLAG Special Issue, 1–16.
- Lestel L., Eschbach D., Meybeck M., Gob F. 2020, The Evolution of the Seine Basin Water Bodies Through Historical Maps, *The Seine River Basin, The Handbook of Environmental Chemistry*, vol. 90, 1–29.
- Majewski W., 2013, General characteristics of the Vistula and its basin, *Acta Energetica*, vol. 2, no. 15, 6–15.
- Martinson J., 2010, Change in the course of the river Komadugu Yobe during the 20th century at the Border between Niger and Nigeria, *Master Thesis, Lund University, United Kingdom*, 57.
- Nowak S., Nowak A. Z., 2020, *Almanach Świętokrzyski*, Wydawnictwo Naukowe Wydziału Zarządzania Uniwersytetu Warszawskiego, Poland, vol. 5, 1–294.
- Plit J., 2016, *Krajobrazy kulturowe Polski i ich przemiany*, Instytut Geografii i Przestrzennego Zagospodarowania im. Stanisława Leszczyckiego PAN, *Prace Geograficzne*, no. 253, Warszawa, Poland.
- Solon J., Borzyszkowski J., Bidłasik M., Richling A., Badora K., Balon J., Brzezińska-Wójcik T., Chabudziński Ł., Dobrowolski R., Grzegorzczak I., Jodłowski M., Kistowski M., Kot R., Krąż P., Lechnio J., Macias A., Majchrowska A., Malinowska E., Migoń P., Myga-Piątek U., Nita J., Papińska E., Rodzik J., Strzyż M., Terpiłowski S., Ziaja W., 2018, *Physico-geographical mesoregions of Poland: Verification and adjustment of boundaries on the basis of contemporary spatial data*, *Geographia Polonica*, vol. 91, no. 2, 143–170.

THE HISTORICAL METALLURGICAL ACTIVITY RECORDED IN ALLUVIUM OF SMALL RIVER VALLEY: CASE STUDY FROM KAMIONKA RIVER (HOLY CROSS MTS., CENTRAL POLAND)

Paweł Przepióra¹, Tomasz Kalicki¹, Geoffrey Houbrechts²

¹Jan Kochanowski University in Kielce, Institute of Geography and Environmental Sciences, Department of Geomorphology and Geoarchaeology, Poland, pawelprzepiora1988@gmail.com, tomaszkalicki@ymail.com

²University of Liège, Unit of Physical Geography and the Quaternary Period (UGPQ), Belgium, G.Houbrechts@ulg.ac.be

ABSTRACT

The high impact of metallurgical activity was detected in the Kamionka River valley (Central Poland) using i.e., Magnetic Spherule Separation (MSS) method. Many slags were detected in the floodplain sediments near Jędrów site, which are traces of the nearby historical forge activity. The iron spherules were detected in the overbank sediments forming a distinct postindustrial layer. These results also enable the verification of historical data of the metallurgical activity in the last centuries, as well high accretion of the overbank alluvium in the floodplain.

Keywords: hammerscales, macro- and microslags, historical metallurgy, sedimentation, Kamionka River

INTRODUCTION

In many places all over Europe, there are many remnants of historical metallurgical activity. In these areas the industry depended on the abundance of local natural resources such as iron ore, forest and water-power. The Medieval and modern forges was the most common metallurgical plants located on many small watercourses i.e., in Old-Polish Industrial District (Radwan 1963). Later, technological progress led to shut down the outdated metallurgical plants and build water mills on their places. In some areas the industrial infrastructure become abandoned and completely destroyed. Therefore, the detailed location of these plants is unknown today. Renaturalization processes also blurred all traces of the historical industrial activity only leaving some markers in alluvium. This kind of metallurgical remnants can be found in Kamionka River (Holy Cross Mts., Central Poland) (Fig. 1) floodplain sediments and they can be used for detailed sedimentological and geoarchaeological analyzes.

METHODS

The aim of the study was to identify the impact of historical metallurgical activity on a sedimentation change recorded in alluvium of the Old-Polish Industrial District small river valley (Kamionka River, Central Poland).

The Magnetic Spherule Separation (MSS) method (Richeudeau, 1977, Houbrechts et al. 2004, 2020, Przepióra et al. 2019, Kalicki et al. 2020, 2021b) was used to separate of microscopic remnants of the metallurgical activity from the floodplain alluvia of Kamionka River near Jędrów water mill (Fig. 1). Also, macroscopic slag fragments were separated from the sediments and counted manually. Sections across the floodplain show lithology and grain-size of alluvia and concentration of macro- and microslags (with iron spherules) in sediments.

RESULTS

The MSS method enables the detection of 200–63 μm particles (hammerscales)(Dungworth, Wilkes, 2007) in Kamionka River floodplain downstream of the Jędrów water mill. Small iron spherules can be transported by the aeolian processes and accumulated up to 10 km from their source. In study area a fluvial process led to a further redeposition of these elements on the floodplain creating clear accumulation levels. Earlier, OSL and ¹⁴C dating of a similar postindustrial layer at this site may indicate a high accretion of these sediments and their later redeposition during last few hundred years (Przepióra 2021). Many slag fragments covered by overbank facies were also discovered. The slags forming a clear layer in floodplain alluvium, most likely created dur-

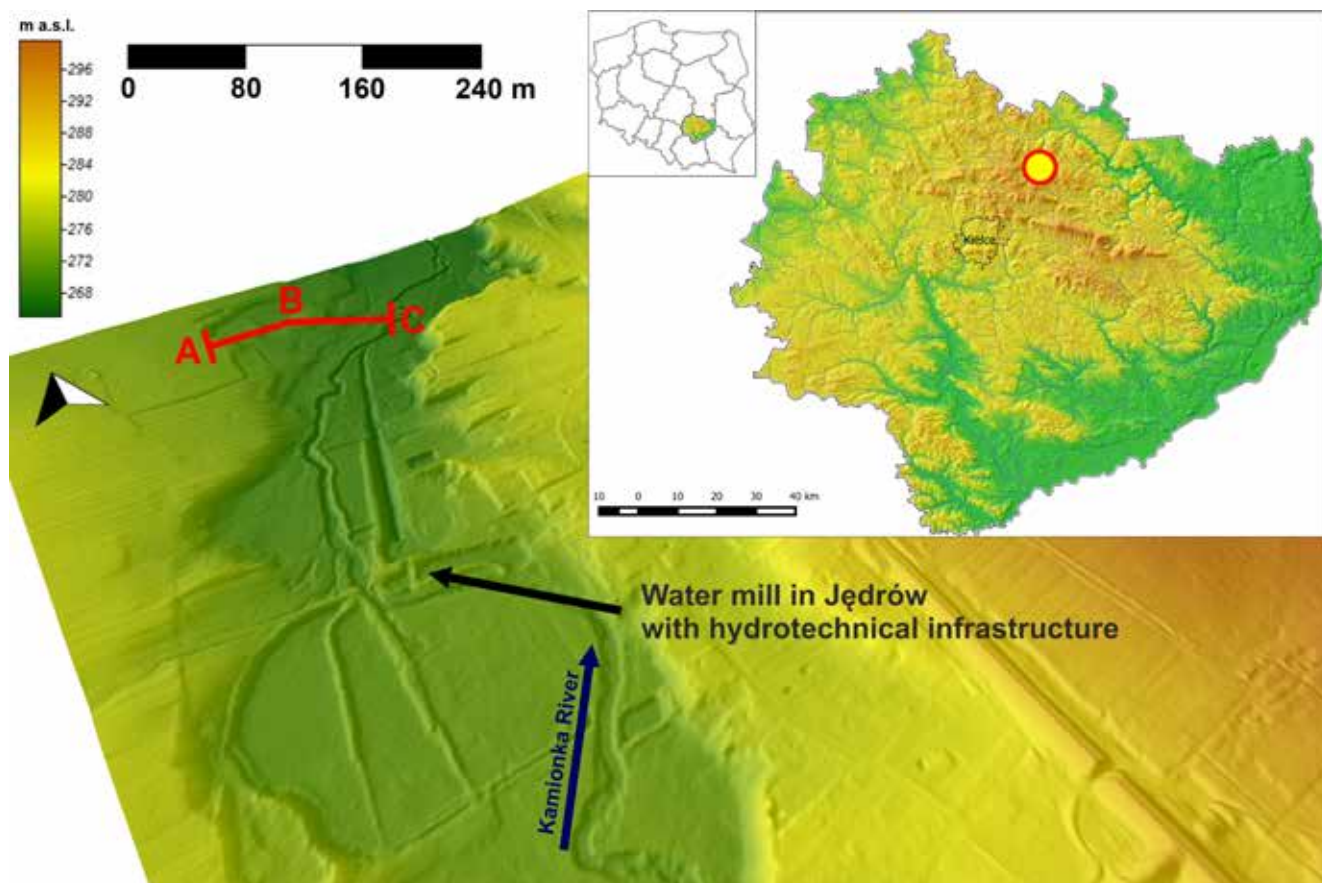


FIG. 1. Study area location on Digital Elevation Model (DEM) of the Świętokrzyskie Voivodeship in Poland and Jędrów site in Kamionka River valley (by M. Frączek based on CODGiK data; MGGP Aero agreement No. GI-FOTO.703.44.2014)

ing the nearby forge activity (Fig. 2). Most of this remain type was found on the nearby elevation, which is most likely a postindustrial mound of the former forge. Where no traces of slag have been detected, there is a high concentration of microscopic iron spherules, which are another remnant of the forge activity. They form a clear postindustrial layer, analogous to those detected in Wallonia (i.e., Houbrechts et al. 2020) or other river valleys in the Holy Cross Mts. region, e.g., Czarna Konecka (Przepióra et al. 2021) or Świślina (Kalicki et al. 2021a). These layers are probably formed during the modern forge's activity or shortly after its shutdown as a result of fluvial redeposition. Postindustrial layers are sometimes well readable in sediments, and they also contain numerous charcoals, the age of which confirms the period of metallurgical activity of the study site from last few hundred years, especially confirming the activity of the 19th c. nearby forge (Kalicki et al. 2021b, Przepióra 2021).

CONCLUSIONS

Many slags were detected in the floodplain sediments of the Kamionka River near Jędrów site, which are traces of the activity of a nearby historical forge. The iron spherules were also detected in the overbank sediments. They form a distinct postindustrial layer,

probably created during the forge activity, or shortly after it was extinguished. These results also enable the verification of historical data on the metallurgical activity in the last centuries in the Kamionka valley, as well show high accretion of the of overbank alluvium in the floodplain.

ACKNOWLEDGMENTS

Special thanks to Ellynn Bertemes, Marcin Frączek, Michał and Paulina Aksamit for help in field and laboratory works.

REFERENCES

- Dungworth, D., Wilkes, R., 2007, An investigation of hammerscale: technology report, Research Department Report 26.
- Houbrechts G., Petit F., Kalicki T., 2004, Rozwój metalurgii a sedymentacja fluwialna z ostatnich stuleci w ardeńskich doływach Mozy (Belgia), [in:] Michalczyk Z. (Ed.), *Badania geograficzne w poznawaniu środowiska*, Lublin, 192-194.
- Houbrechts G., Petit F., Notebaert B., Kalicki T., Denis A. C., 2020, Microslag as a stratigraphic tracer to quantify floodplain processes (Lienne catchment, Belgium), *Geomorphology* 360, <https://doi.org/10.1016/j.geomorph.2020.107166>, 17.03.2020.

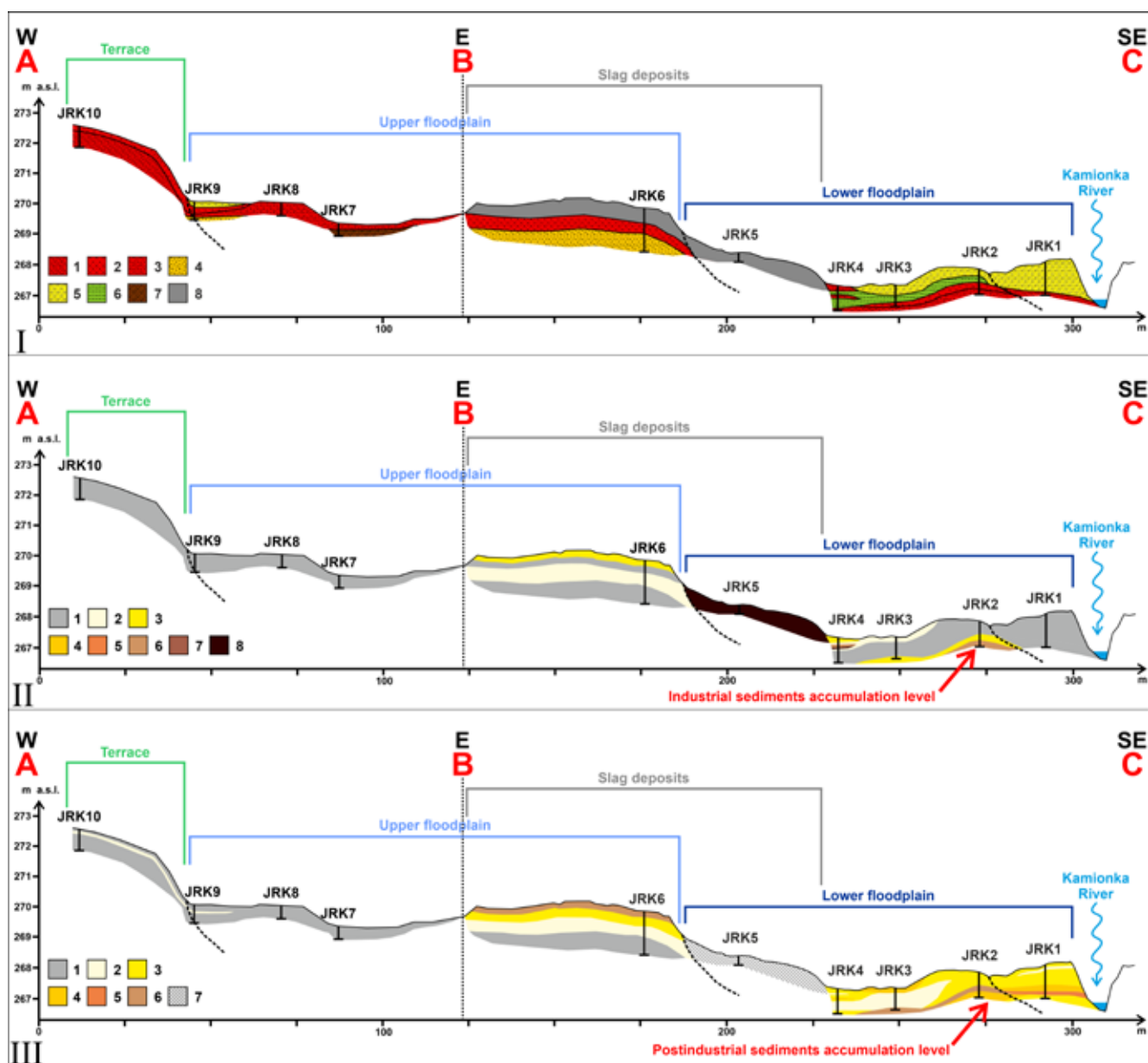


FIG. 2. A section across A-B-C the Jędrów site (Kamionka River). Lithology (I): 1 – sands with gravels, 2 – sands with single gravels, 3 – silty sands with gravels, 4 – medium sands, 5 – silty sands, 6 – sandy silts, 7 – clayey peats, 8 – embankments; Slag concentration in % (II): 9 – no slags, 10 – 1-5, 11 – 6-10, 12 – 11-15, 13 – 16-20, 14 – 21-25, 15 – 26-30, 16 – >30; Number of magnetic spherules/1 gram of material (III): 17 – 0, 18 – 1-5, 19 – 6-10, 20 – 11-15, 21 – 16-20, 22 – >20, 23 – macroscopic slag deposits without spherules

Kalicki T., Przepióra P., Frączek M., Fularczyk K., Żurek K., Pabian G., Podrzycki Ł., 2021a, Natural and anthropogenic environment changes in Świślina valley – Case study from Doły Biskupie site (Poland), [In:] Ratajczak-Skrzatek U., Kovalchuk O., Stefaniak K. (Eds.), Proceedings of INQUA SEQS 2021 Conference, Quaternary Stratigraphy – palaeoenvironment and humans in Eurasia, Wrocław, 44-45.

Kalicki T., Przepióra P., Chwałek S., Aksamit M., Grzeszczyk P., Houbrechts G. 2021b, The Jędrów historic hydro-technical system – a geoarchaeological and restoration studies (Holy Cross Mountains, Poland), *Acta Geobalcanica* 7 (3), 123-129.

Kalicki T., Przepióra P., Kusztal P., Chrabąszcz M., Fularczyk K., Kłusakiewicz E., Frączek M., 2020, Historical and pres-

ent-day human impact on fluvial systems in the Old-Polish Industrial District (Poland), *Geomorphology* 367, <https://doi.org/10.1016/j.geomorph.2020.107062>, 12.02.2020.

Kalicki T., Przepióra P., Chwałek S., Aksamit M., Grzeszczyk P., Houbrechts G., 2021, The Jędrów historic hydro-technical system – a geoarchaeological and restoration studies (Holy Cross Mountains, Poland), *Acta Geobalcanica* 7-3, 123-129.

Przepióra P., 2021, Subatlantyckie przemiany zlewni Kamionki na Wyżynie Kieleckiej, [In:] Kalicki T., (Ed.), *Monografie: Geografia i Geoarcheologia Tom I, Ośrodek Badań Europy Środkowo-Wschodniej, Kielce-Białystok*.

Przepióra P., Kalicki T., Aksamit M., Aksamit P., Fularczyk K., Kusztal P., Houbrechts G., 2021, An macro- and mi-

- crosslaga delta deposition of postindustrial water reservoir in Sielpia (Holy Cross Mts., Poland), FLAG 2021 Abstract Book, Moscow, Russia, 57–59.
- Przepióra P., Kalicki T., Chwałek S., Houbrechts G. 2019, Historyczny układ hydrotechniczny w Jędrowie (województwo świętokrzyskie) zachowany w formach i osadach – studium geoarcheologiczno-konserwatorskie, *Acta Universitatis Lodzianae, Folia Geographica Physica* 18, 5–16.
- Radwan M. W., 1963, Rudy, kuźnice i huty żelaza w Polsce, Warszawa.
- Richeedeau, E., 1977, Distribution des sphères magnétiques provenant de la sidérurgie liégeoise, dans *B.S.G. Lg*, 13, 155–165.

RELICT CHARCOAL HEARTHES AS AN ARCHIVES OF PAST HUMAN ACTIVITY (EXAMPLES FROM POLAND)

Paweł Rutkiewicz¹, Tomasz Kalicki²

¹University of Silesia in Katowice, Faculty of Natural Sciences, Poland, rutkiewiczpawel33@gmail.com

²Jan Kochanowski University, Institute of Geography and Environmental Sciences, Department of Geomorphology and Geoarchaeology, Poland, tomaszkalicki@ymail.com

ABSTRACT

The aim of this paper is to show how Relict Charcoal Hearths (RCHs) are used as an archive of past human activity. This phenomenon was presented on the basis of studies carried out for selected areas of two river basins in Poland, Czarna Konecka River basin and Mała Panew River basin. Detailed studies were carried out for two sites from the Mała Panew River basin and Czarna Konecka River basin. First goal of this study was to identify the RCHs (digital and field analysis) and to determine their morphological features and investigate their internal structure. Second goal was to determine the age of the studied forms (radiocarbon dating) and thus to determine the time of charcoal production. Another goal was to determine which tree species were used to produce charcoal (palaeobotanical analysis). First stage of work was digital identification of RCHs based on shaded relief models: 166 356 in Mała Panew basin (902 km²) and 37 733 in Czarna Konecka basin (633 km²). Next identification of selected RCHs during field studies was carried out. Selected RCHs in the study areas ranged from 9 to 15 metres in diameter. The centres of RCHs are composed of elevated mounds 0.2–0.5 m in height. Around the central mound of each RCH, the remnants of shallow hollows are present. The results of the palaeobotanical analysis allowed to establish that Scots pine wood was used to burn charcoal in the studied locations. The radiocarbon dates obtained for the RCHs analysed are likely to fall on the period of prosperity (17th–19th c.) of metallurgical activity. However, in some cases radiocarbon dates from RCHs can serve as indications that the charcoal burning and metallurgical activity could have been started earlier.

Keywords: Relict Charcoal Hearths (RCHs), human pressure, historical metallurgy

INTRODUCTION

Since the Middle Ages in Europe charcoal burnt in piles of wood placed on the ground, i.e. charcoal hearths, was the basic fuel in industrial (mainly metallurgical) human activity (Rösler et al. 2012). Charcoal was burnt on charcoal hearths until the widespread use of hard coal in industry, i.e. until the 19th century (Hirsch et al. 2020). A charcoal hearth is understood as compact, most often round piles of wood, often made of straight and relatively thin logs, branches and sometimes split trunks. The construction was covered with turf, with the air supply controlled through holes in the hearth (Groenewoudt 2007). The wood for charcoal burning was obtained from trees growing in the river valleys next to the smelters and adjacent areas. The landforms leftover charcoal burning are almost invisible in the field and have survived today where drainage, forestry or agricultural treatments are not carried out. The aim of this paper is to show how Relict Charcoal Hearths (RCHs) are used as an archives of past human activity. This phenomenon was presented on the basis of studies carried out for selected locations from the Czarna Konecka River basin and Mała Panew River

basin (southern and central Poland). In previous studies (Rutkiewicz et al. 2019) on the basis of the shaded relief models, 37 733 RCHs have been identified in an area of 663 km² along the Czarna Konecka River. Along the Mała Panew River we have identified 166 356 RCHs in an area of 902 km². This provides a great opportunity to test new other RCHs and gain more data and knowledge about charcoal burning and metallurgical activity in selected river basins. Detailed studies were carried out for two new sites from the Mała Panew River basin and Czarna Konecka River basin. New results of field investigations, radiocarbon dating and anthracological analysis for the newly selected RCHs are presented in addition to previously published results from the Czarna Konecka and Mała Panew basin areas (Rutkiewicz et al. 2019, Rutkiewicz, Malik 2019). First goal of this study was to identify the RCHs (digital and field analysis) and to determine their morphological features and investigate their internal structure. Second goal was to determine the age of the studied forms (radiocarbon dating) and thus to determine the time of charcoal production. Another goal was to determine which tree species were used to produce charcoal (palaeobotanical analysis).

METHODS

The research was carried out for two selected locations from two river basins of the Czarna Konecka River and Mała Panew River (southern and central Poland). The study locations were chosen near former smelting villages where smelting plants existed. Five RCHs were selected for each site. The selected RCHs were in close proximity to each other, ranging from a few to several metres. Preliminary identification of RCHs allowed to establish that their greatest concentrations are located relatively close to the riverbed and in modern forested areas. Then, shaded relief models covering selected areas were created using the GIS software. On the basis of digital images, RCHs were recognized. Then field studies were carried out for the selected locations. They consisted in the field verification of RCHs, previously identified on digital

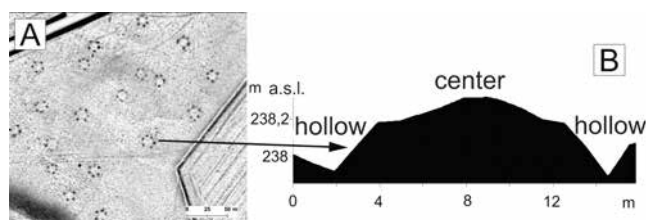


FIG. 1. A-shaded relief model with visible RCHs. B-terrain profile through the single RCH

images. Next exposures were made in the selected RCHs. From the exposures made in each RCHs, a charcoal fragment was taken from the charcoal layer for radiocarbon dating and anthracological analysis. Radiocarbon dating was performed by absolute dating laboratories in Kraków and Poznań. Anthracological analysis was carried out by Agata Sady-Bugajska, M.Sc. from the Silesian Museum in Katowice.

RESULTS AND CONCLUSIONS

Identification and measurements of RCHs during digital and field studies showed that 10 selected RCHs in the study locations ranged from 9 to 15 metres in diameter. The centres of RCHs are composed of elevated mounds 0.2–0.5 m in height. Around the central mound of each RCH, the remnants of shallow hollows are present. (Fig. 1, Tab. 1).

Charcoal fragments and coal dust mixed with sand were detected in all tested landforms, which confirms the genesis of the studied forms related to charcoal burning. Charcoal fragments and ash mixed with sand constituted a dark layer with a thickness of several to 25 cm, lying directly on the loose sands. The layer of ash and charcoal was covered with a layer of the forest litter. The charcoal fragments ranged in size from a few millimeters to several dozen centimeters.

Results of the palaeobotanical analysis (Tab. 1) allowed to establish that Scots pine (*Pinus sylvestris*) wood was used to burn charcoal in both studied lo-

TABLE 1. Results of field measurements, radiocarbon dating and anthropogenic anlage for selected RCHs

Sampled RCH	Diameter of RCH (m)	Depth of sampling (cm)	Taxa identification	Age conv. BP	Age cal AD (95,4%)	Laboratory code
Brusiek/Koszęcin villages study location – Mała Panew River basin						
RCH 1	11	20–55	Scots Pine (<i>Pinus sylvestris</i>)	755 ± 40	1191–1297	GdA-5856
RCH 2	10	30–50	Scots Pine (<i>Pinus sylvestris</i>)	270±40	1486–1676	MKL-4471
RCH 3	9	20–35	Scots Pine (<i>Pinus sylvestris</i>)	320±40	1468–1649	MKL-4472
RCH 4	15	25–45	Scots Pine (<i>Pinus sylvestris</i>)	contemporary 100.17 ± 0.91 pMC	1680–1956	GdS-4114
RCH 5	12	30–50	Scots Pine (<i>Pinus sylvestris</i>)	10±40	1694–1920	MKL-4473
Fałków village study location – Czarna Konecka River basin						
RCH 6	15	40–70	Scots Pine (<i>Pinus sylvestris</i>)	contemporary 100.87 ± 0.56 pMC	1707–1957	GdS-4111
RCH 7	14	60–80	Scots Pine (<i>Pinus sylvestris</i>)	contemporary 1103,00 ± 0,55	1955.5–1957.5	GdA-5858
RCH 8	14	40–60	Scots Pine (<i>Pinus sylvestris</i>)	5±35	1695–1919	MKL-4462
RCH 9	14	40–60	Scots Pine (<i>Pinus sylvestris</i>)	20±35	1694–1919	MKL-4463
RCH 10	12	20–30	Scots Pine (<i>Pinus sylvestris</i>)	10±35	1695–1919	MKL-4464

cations. This result proves the deliberate choice of this species for charcoal burning or the high availability of this species in the past in studied locations. In previous studies Scots pine was also a dominant recognized species used for charcoal burning with addition alder (*Alnus* sp.), birch (*Betula* sp.), oak (*Quercus* sp.), Norwegian spruce/larch (*Picea abies* / *Larix* sp.), silver fir (cf. *Abies alba*) and European ash (*Fraxinus excelsior*) (Rutkiewicz et al. 2019, Rutkiewicz, Malik 2019). Four out of ten dates obtained for the RCHs analysed are likely to fall on the period of prosperity (17th–19th c.) of metallurgical activity in studied areas (Tab. 1). Two dates (sample MKL-4471, sample MKL-4472) indicate the origin of RCHs from the beginning of metallurgical production. In three cases, the samples were identified as contemporary (Tab. 1) One radiocarbon date (sample GdA-5856) (Tab. 1) can serve as indication that the charcoal burning and metallurgical activity could have been started earlier than historical sources suggest. Together with previous studies (Rutkiewicz et al. 2019, Rutkiewicz, Malik 2019), we already have several such dates that indicate this, which greatly increases the likelihood of such a situation as described above.

ACKNOWLEDGMENTS

This study was performed within the scope of the research project no.2017/25/N/ST10/01876 funded by the Polish National Science Centre (NCN).

REFERENCES

- Rösler H., Bönisch E., Schopper F., Raab T., Raab A., 2012, Pre-industrial charcoal production in southern Brandenburg and its impact on the environment, [In:] Kluiving S. J., Guttman-Bond E. B. (Eds.), *Landscape Archaeology between Art and Science, From a Multi- to an Interdisciplinary Approach*, 167–178.
- Hirsch F., Schneider A., Bonhage A., Raab A., Drohan P. J., Raab T., 2020, An initiative for a morphologic-genetic catalog of relict charcoal hearths from Central Europe, *Geoarchaeology*, 35, 6, 974–983.
- Groenewoudt B., 2007, Charcoal burning and landscape dynamics in the Early Medieval Netherlands, [In:] Kluiving S., Guttman-Bond E. (Eds.), *Arts and Crafts in Medieval Rural Environment* 6, 327–337.
- Rutkiewicz P., Malik I., Wistuba M., Osika A., 2019, High concentration of charcoal hearth remains as legacy of historical ferrous metallurgy in southern Poland, *Quaternary International*, 512, 133–143.
- Rutkiewicz P., Malik I., 2019, Environmental effects of historical charcoal burning associated with water-powered ferrous metallurgy (Mała Panew basin, southern Poland), *Geology, Geophysics and Environment*, 45, 3, 231–240.



THE ENVIRONMENT AS AN ARCHIVE OF PAST HUMAN ACTIVITIES (ED. T. KALICKI)



REPORT

CONFERENCE ON ENVIRONMENTAL ARCHAEOLOGY CEA/AEA 2022 APRIL 4-6, KIELCE-SUCHEDNIÓW, POLAND

Tomasz Kalicki, Paweł Przepióra

*Jan Kochanowski University in Kielce, Institute of Geography and Environmental Sciences,
Department of Geomorphology and Geoarchaeology, Poland,
tomaszkalicki@ymail.com; pawelprzepiora1988@gmail.com*

„Conference Environmental Archaeologie (CEA)” is an international conference bringing together scientists involved in the study of the environment with particular emphasis on issues in the field of archaeology. This event takes place cyclically in European countries (Italy, Czech Republic, Slovakia) and is organized by the association under the same name. The latest edition in 2022 was held for the first time in Poland, in the Holy Cross Mts. region. Responsible for its organization were scientists and PhD students from the Department of Geomorphology and Geoarchaeology of Institute of Geography and Environmental Sciences of Jan Kochanowski University in Kielce and the Polish Association of Environmental Archaeology (SAS) in cooperation with the Museum of Ancient Metallurgy in the Świętokrzyskie region in Nowa Słupia and the Archaeological Museum and the „Krzemionki” Reserve. The event was held under the patronage of the Voivode and Marshal of the Świętokrzyskie Voivodeship, the City and Commune of Suchedniów and the Suchedniów Forest District. Media patronage was taken by TVP Kielce and Naszsuchedniów. blogspot.com. The conference was co-financed under the project Excellent Science: Paid from the funds of the Polish Ministry of Education and Science under the contract no. DNK / SP / 513743/2021 of 03/03/2022; project name: Conference of Environmental Archaeology CEA / AEA 2022, Poland; the amount of funds PLN 25.080.

Over 30 scientists from Poland and abroad participated in the conference. Detailed information on this year's conference can be found on the website: www.cea2022.pev.pl.

On the first day (April 4), during the opening of the conference, attended by the Mayor of the City and Commune of Suchedniów, Cezary Błach, Vice-Dean for General and Financial Affairs, Prof. UJK Dr hab. Rafał Kozłowski, and the Deputy Director for Scientific Affairs at the Institute of Geography and Environmental Sciences of the Jan Kochanowski University in Kielce, Prof. UJK Dr hab. Roman Suligowski, TVP Kielce interviewed the organizers and participants of the conference, and then lectures were given by invited guests from Poland and abroad. They concerned the current activities of plans for the future of both organizations – the Czech CEA association and the Polish Association of Environmental Archaeology. Subsequent thematic sessions concerned individual time horizons, e.g. Palaeolithic and Neolithic as well as regional issues, e.g. North-Eastern Poland from the Subneolithic until today, or the Old Polish Industrial District. There were also methodological papers on archaeobotany and pedology, as well as the results of archaeology of river valleys and cities. Some participants presented the results of their research at the poster session. The proceedings ended with a gala dinner, which was an opportunity for backstage discussions. On the last day of the conference (April 6), the archaeological elements of the cultural heritage of the Holy Cross Mts. region were presented. The Museum of Ancient Metallurgy of Holy Cross Mts. region in Nowa Słupia and the Archaeological Museum and the „Krzemionki” Reserve were visited. It is also planned to publish a post-conference publication (this monography), among others with materials presented by scientists.

ADDITIONAL MATERIALS:

Conference website: www.cea2022.pev.pl



Interview on TVP Kielce: <https://kielce.tvp.pl/59443715/czlowiek-a-srodowisko-na-przestrzeni-dziejow-konferencja-archeologii-srodowiskowej>



Photo gallery: <https://flic.kr/s/aHBqjzJQ7M>
Authors: Marta Błaut, Karolina Fularczyk, Tomasz Kalicki, Paulina Kurpińska, Marcelina Maturlak, Paweł Przepióra, Krzysztof Żurek



Promotional video from the conference: <https://youtu.be/UWDgmW0s9j0>

PHOTO ALBUM

Marta Błaut, Karolina Fularczyk, Tomasz Kalicki, Paulina Kurpińska,
Marcelina Maturlak, Paweł Przepióra, Krzysztof Żurek

*Jan Kochanowski University in Kielce, Institute of Geography and Environmental Sciences,
Department of Geomorphology and Geoarchaeology, Poland,
martablaut@op.pl, fularczykkarolina@gmail.com, tomaszkalicki@ymail.com, pauki23@wp.pl,
m-maturlak@wp.pl, pawelprzepiora1988@gmail.com, chrisu.zurek@gmail.com*



Group photo of the CEA 2022 conference participants

CONFERENCE



Volunteer students co-organizing conference at registration desk
(In picture: from left Marcelina Maturlak and Paulina Kurpińska)



Volunteer student co-organizing conference at registration desk (In picture: Marta Blaut)

CONFERENCE



On the registration desk was a lot of interesting materials available for the conference participants
(In picture: Prof. Dr hab. Sergij Bortnyk)



Conference gifts ready to be distributed to conference participants

CONFERENCE



The opening ceremony



Conference participants and co-organizers during the presentation session

CONFERENCE



Oral presentation by Dr Jakub Niebieszczański



Questions and discussion after the presentation of Dr Paweł Przepióra (on the left).
Charman of the session Dr Ondřej Mlejnek (on the right)

CONFERENCE



Part of the conference organization team (from the right: PhD student Piotr Biesaga, Dr Marcin Frączek, PhD student Krzysztof Żurek, and PhD student Piotr Kuształ)



Fervent discussion during Ice Braker Party (From left: Prof. Dr hab. Lenka Lisá and Prof. UB Dr hab. Maciej Karczewski. Prof. Dr Michal Hejzman in the background)

CONFERENCE



On-line speech of Dr Libor Petr



The poster session. Speech of Patricia Ayipey (Ghana) PhD student in University of South Bohemia

CONFERENCE



It's time for a lunch...



...and dinner

THE EXCURSION

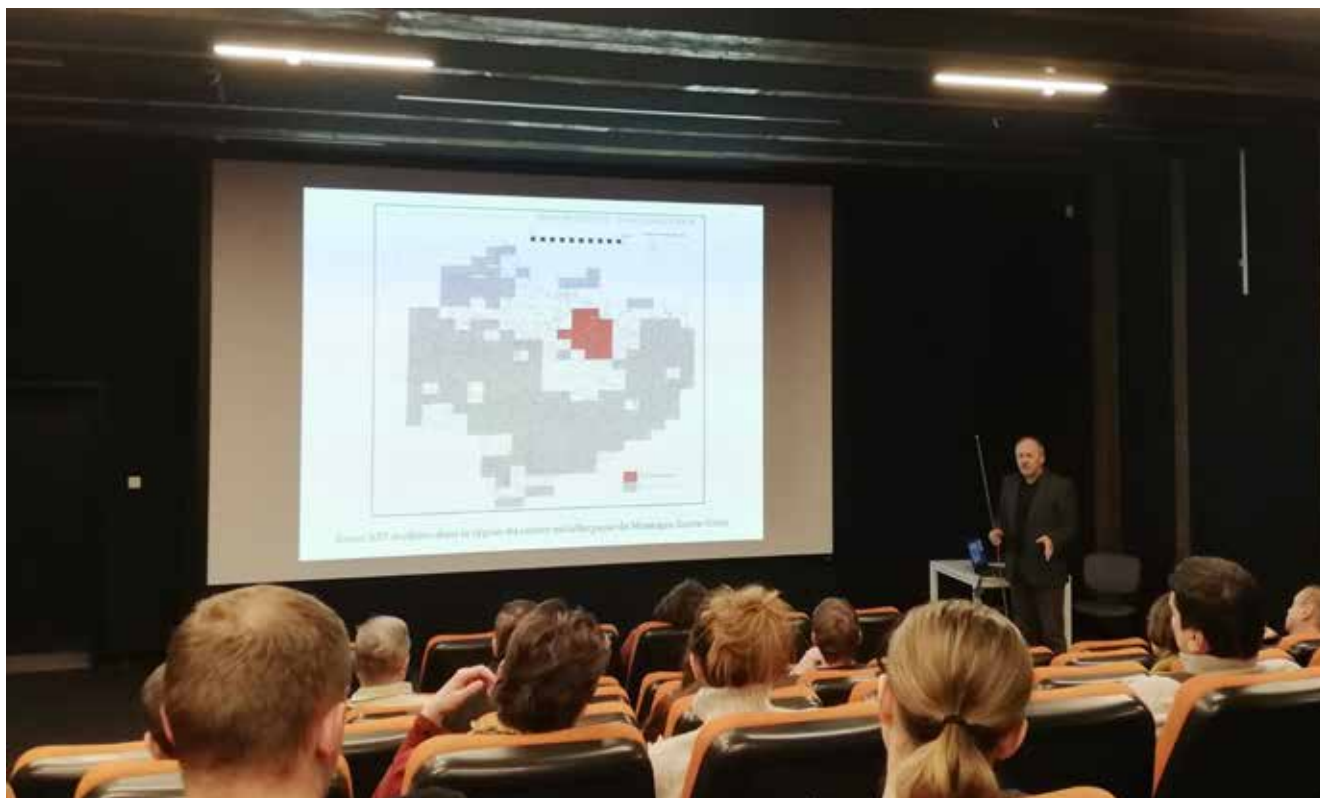


First stop, the Museum of Ancient Metallurgy in the Holy Cross Mts. region in Nowa Słupia



A group photo of the excursion participants in front of the Museum with the bloomeries slags exposition the in background

THE EXCURSION



Introduction presentation about ancient metallurgy in Holy Cross Mts. by Prof. UJK Dr hab. Szymon Orzechowski



Around the table presenting the bloomeries history by funny pictures

THE EXCURSION



Exhibition of the museum with almost like a living, the Prehistoric weaver



Bloomeries slags as souvenirs from the region's metallurgical past

THE EXCURSION



The Museum exposition presenting reconstruction of the bloomery...



...and how it works

THE EXCURSION



The second stop of the excursion, the Archaeological Museum and Reserve "Krzemionki"



A plan of the mining field in "Krzemionki" shown by the guide (The CEA 2022 logo inspiration)

THE EXCURSION



Exhibition at the Museum showing the flint processing



Part of the exhibition is located on the surface of the original Neolithic mine shafts...

THE EXCURSION



...and in the underground



In the mines are visible deposits of striped flint, which was mined by the Prehistoric man

THE EXCURSION



Striped flints left in the mine wall



Part of original tunnels of the Neolithic mine in "Krzemionki" with preserved painting

SPONSORSHIP



Płatne ze środków Ministerstwa Edukacji i Nauki
na podstawie umowy nr DNK/SP/513743/2021 z dnia 03.03.2022
nazwa projektu: Conference of Environmental Archaeology
CEA/AEA 2022, Poland; kwota środków 25 080 zł.
Paid by the Ministry of Education and Science
under contract No. DNK/SP/513743/2021 of 03/03/2022;
project name: Conference of Environmental Archeology
CEA/AEA 2022, Poland; the amount of funds PLN 25.080.

HONORARY PATRONAGE



MARSZAŁEK
WOJEWÓDZTWA
ŚWIĘTOKRZYSKIEGO

MARSHAL OFFICE OF THE ŚWIĘTOKRZYSKIE VOIVODESHIP



Świętokrzyski
Urząd Wojewódzki
Świętokrzyskie Voivodship Office



Burmistrz Miasta i Gminy Suchedniów
Mayor of the City and Community of Suchedniów



Nadleśnictwo Suchedniów
Suchedniów Forest District

MEDIA PATRONAGE



CONFERENCE VENUE



WWW.CEA2022.PEV.PL





