Conference of Environmental Archaeology

The environment as an archive of past human activities

ABSTRACTS

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CONTENTS

EMPLOYING THE ENVIRONMENTAL DATA INTO UNDERSTANDING THE PAST LANDSCAPES: CASE STUDY OF BURIAL MOUNDS IN MARIOVO

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Keywords: landscape studies, environmental data, Prehistoric burial mounds, Mariovo

The study of the landscape and the *human perception* of it in the past has become one of the main topics of focus for archaeologists in recent decades. Environmental archaeology, on the other hand, also focuses on landscape, but in this case, human is in the role an *observer*. As a result, it is able to provide accurate numerical, measurable data. Very often, these concepts are mismatched precisely because of the nature of the data they produce in a study, nonetheless recent studies, especially addressing the settlement patterns are aware of the connection and are contributing into development of the archaeological theory. This poster is therefore to demonstrate how environmental data can be incorporated into some aspects of landscape studies, unconventionally, treating the prehistoric burial mounds. As a phenomenon they are deeply connected with the visibility which is practically one of the pillars when considering exploration of the landscape. The case study we took is from the Mariovo, a hilly region in Republic of North Macedonia where large concentration of burial mounds is observed. We worked with several environmental factors/ characteristics of the observed landscape which can help into understanding the landscape of the phenomena and the location preference.

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ARCHAEOLOGICAL INVESTIGATION OF LIKPE KUKURANTUMI EARTHWORK SETTLEMENT, GHANA: PRESENTATION OF THE RESEARCH PROJECT

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Keywords: West Africa, earthworks, palaeoethnobotany, abandoned settlement, anthracology

Ghana has witnessed massive transitions in its history from the Stone Age period to the modern era. There is quite a little research in Ghana on the Late Stone Age period, the trade networks of the sub-Saharan and trans-Atlantic trades, and colonialism compared to the Iron Age period of Ghana. The popular research on the Iron Age period has been verifying whether the invention of iron production was an independent or diffusions invention. However, little is known about the food production character of the Iron Age period in Ghana. Archaeologists cannot ignore studies on Earthworks to understand the Iron Age period of Ghana's history. This poster presents a preliminary overview of the community-collaborative archaeological research conducted at the Iron Age abandoned settlement of the Likpe Kukurantumi Earthwork in the contemporary people of Likpe in the Oti Region of Ghana. In this research, we work closely with the Laboratory of Archaeobotany and Paleoecology in the University of South Bohemia and the indigenous people. The indigenous knowledge holders are community knowledge holders of Likpe Kukurantumi. The study aimed to understand the relationship between the landscape and the human population in the early times. This study contributes new empirical evidence that documents some of the evolution of West African food tradition during the past two millennia through the analysis of archaeobotanical samples of the study area. Data from the study shows the paleoethnobotanical analysis of the archaeobotanical remains recovered from the study area. This community-collaborative research is timely because of the need to document, preserve, and conserve Likpe's cultural heritage. This research contributes to social complexities and the subsistence economy employed by a complex society during the first millennium AD in Ghana. Our research, therefore, contributes to knowledge and the discourse on the environmental archaeology of Likpe and its earthwork construction.

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

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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, it's 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 Haciłówka to Biebrza.

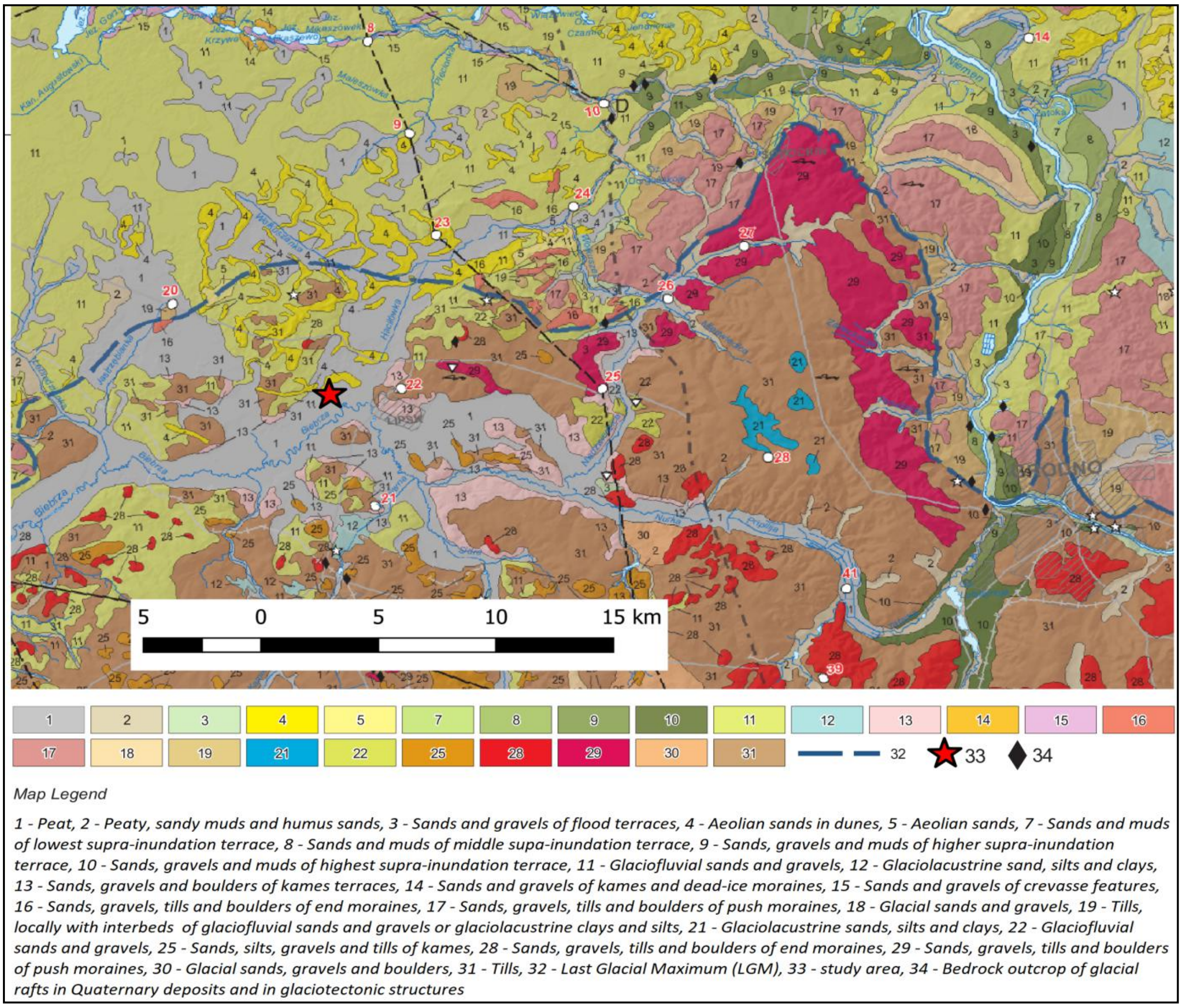

Fig. 1. Part of geological map 1:250 000 (Marks, Karabanov 2011)

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).

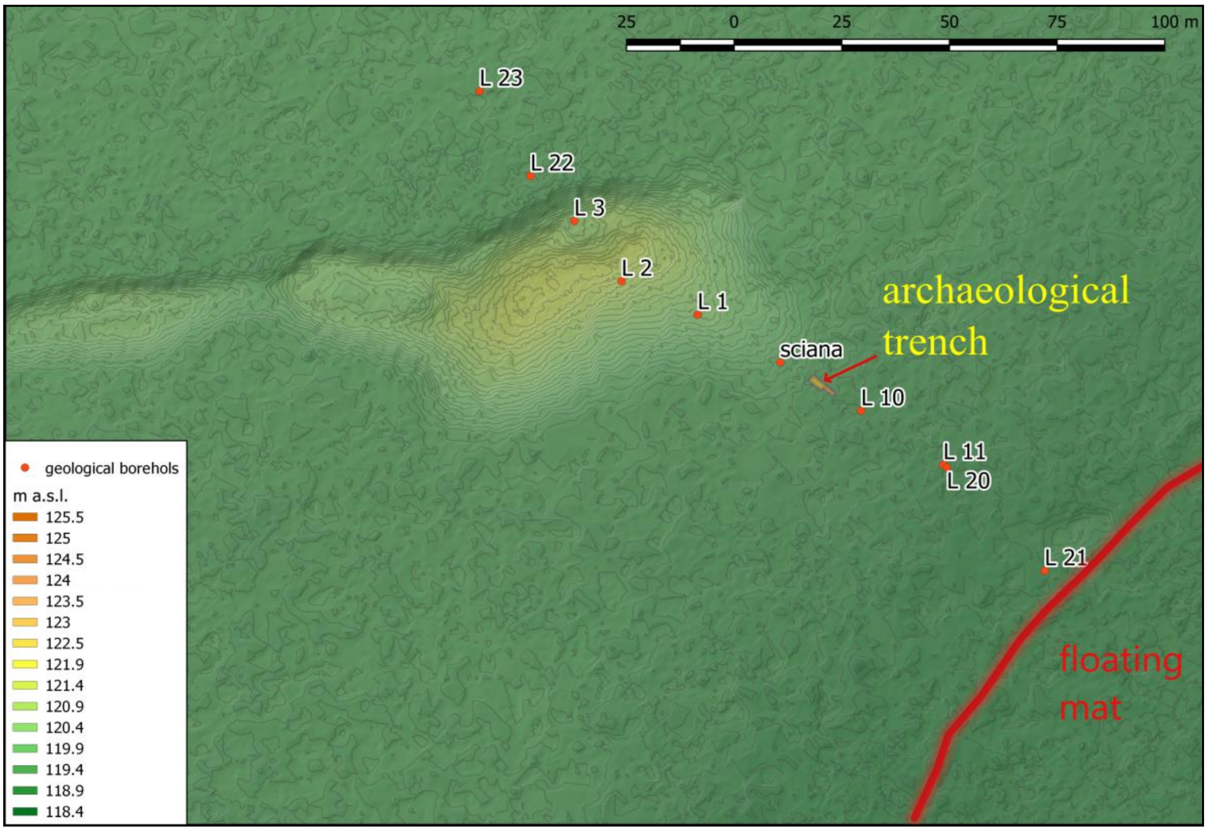

Fig. 2. Location of the geological boreholes and archaeological trench

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.

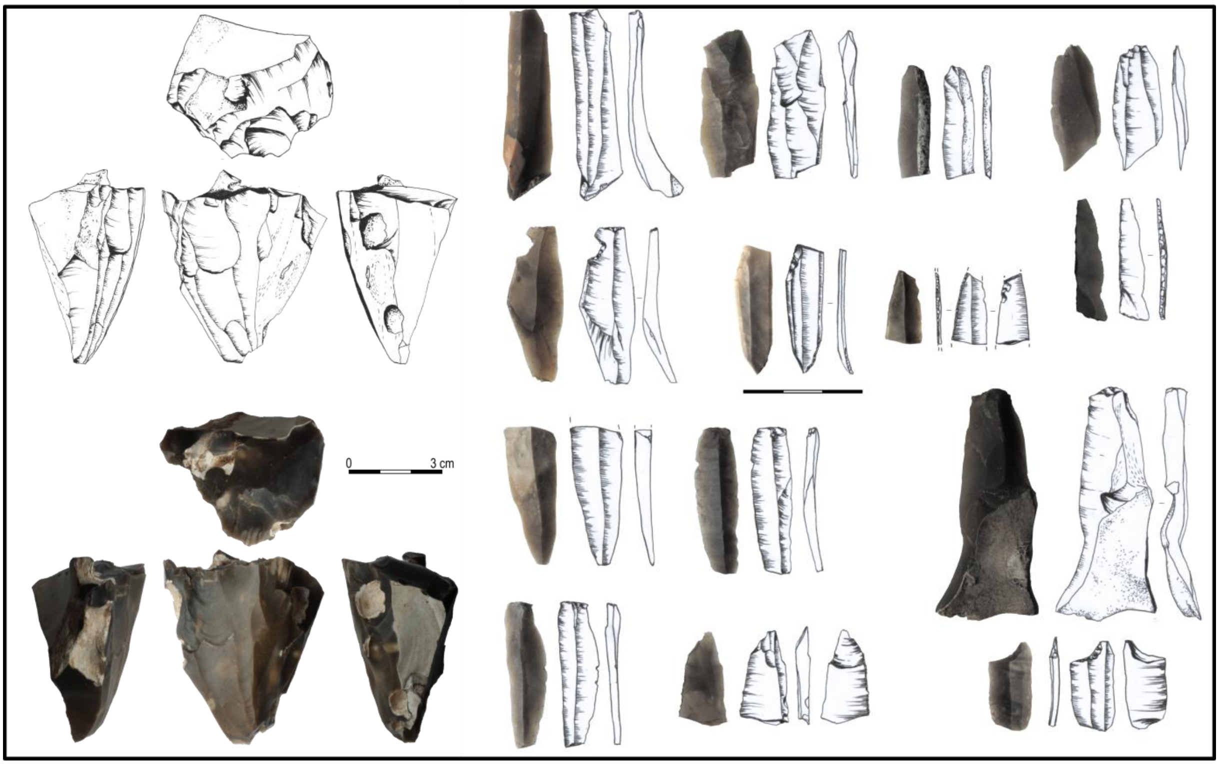

Fig. 3. Deposit of several fragments of flint blocks and cores

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.

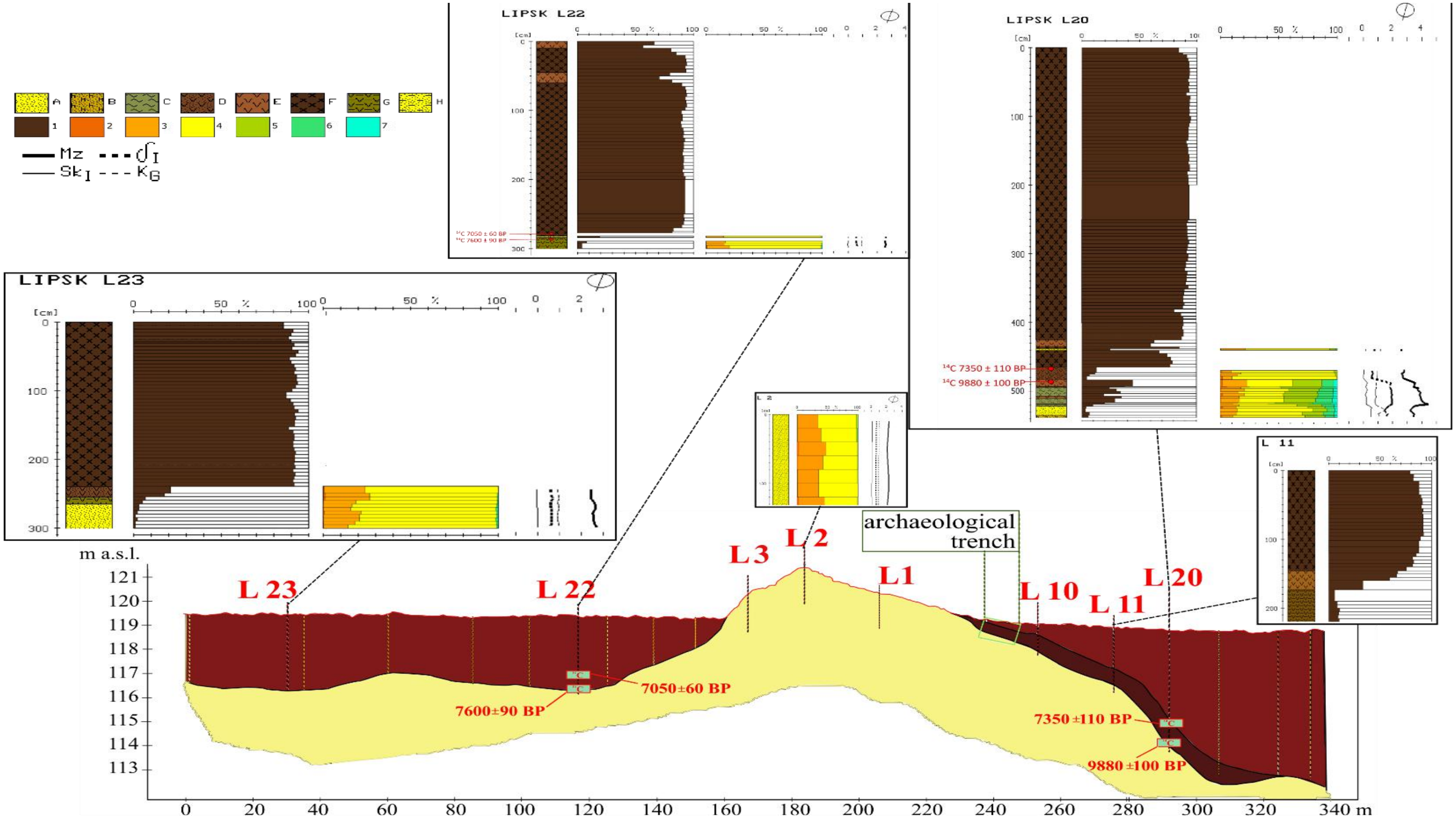

Fig. 4. Geological cross-section of Lipsk site, lithology, grain size and Folk-Ward's distribution parameters of selected profiles (Frączek et al. 2020); Lithology: A - fine sands, B - peaty silts, C - silty peats, D - peats; Fractions: 1 - coarse sand (-1 to 1ϕ), 2 – medium sand (1-2ϕ), 3 - fine sand (2-4ϕ), 4 - coarse and medium silt (4-6ϕ), 5 – fine silt (6-8ϕ), 6 - clay (above 8ϕ), 7 - organic content; Folk-Ward's distribution parameters: Mz - mean diameter, δ_I - standard deviation (sorting), Sk_I - skewness, K_G - 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 artefacts 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).

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.

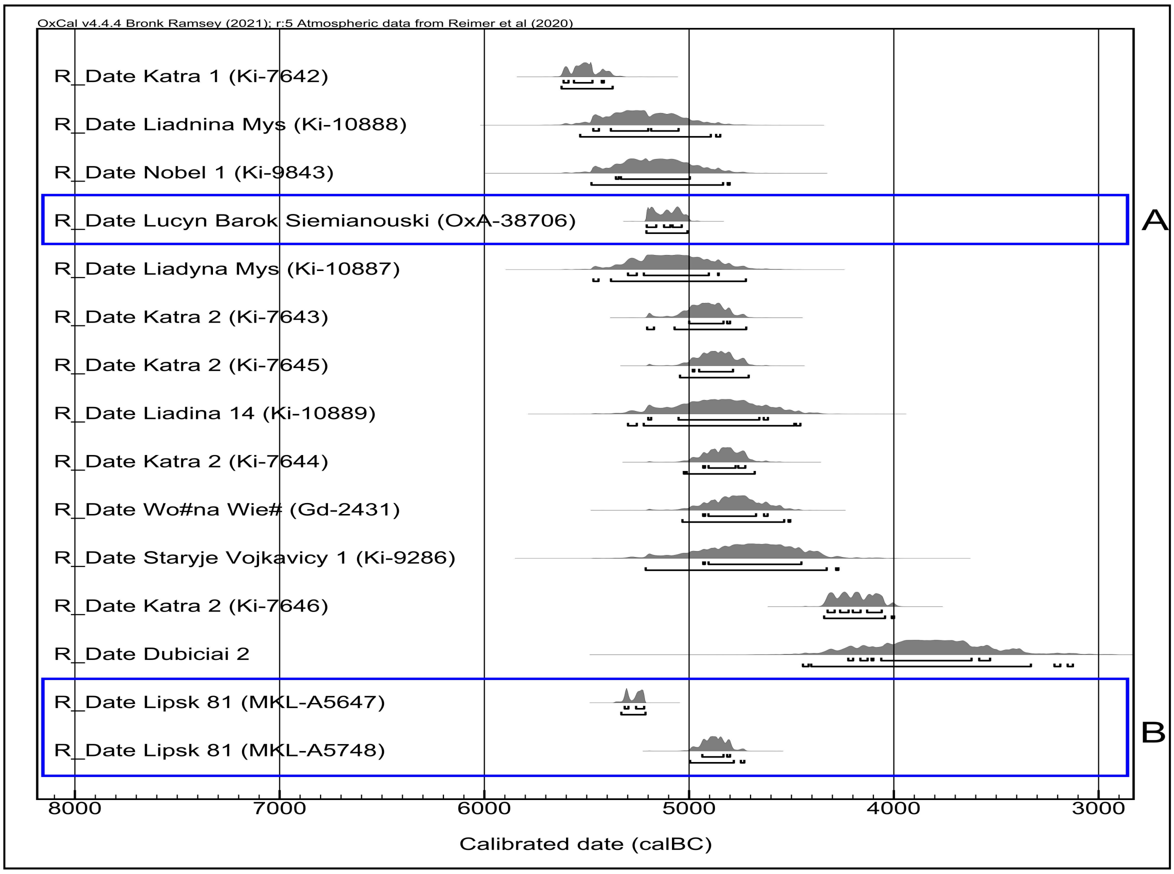

Fig. 5. Comparison of dating from the archaeological sites of the Niemen culture
A - Lucyn site in Belarus, B - Lipsk site in Poland

DISCUSSION AND CONCLUSIONS

Results of studies at Lipsk and other sites in the Biebrza Basin (Wawrusiewicz et al. 2017, Frączek 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 (Frączek 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 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±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±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 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. Frączek et al. 2018a, b).

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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)

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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 XIX, XX and XXI 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 former 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.

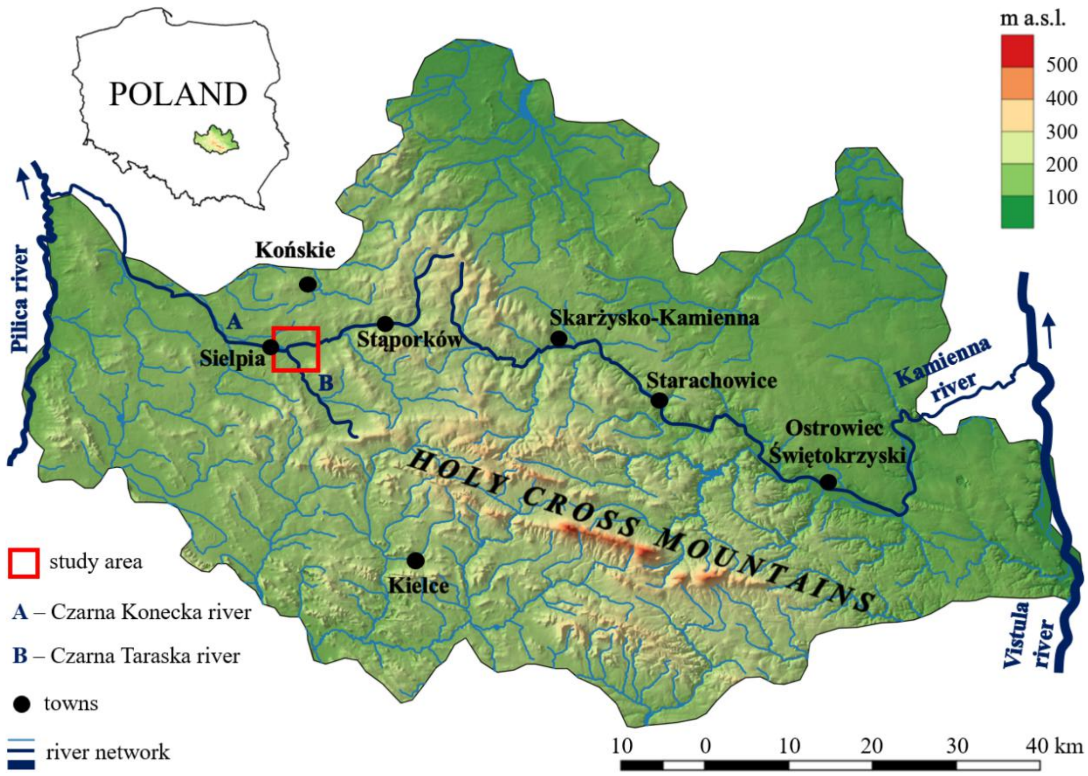
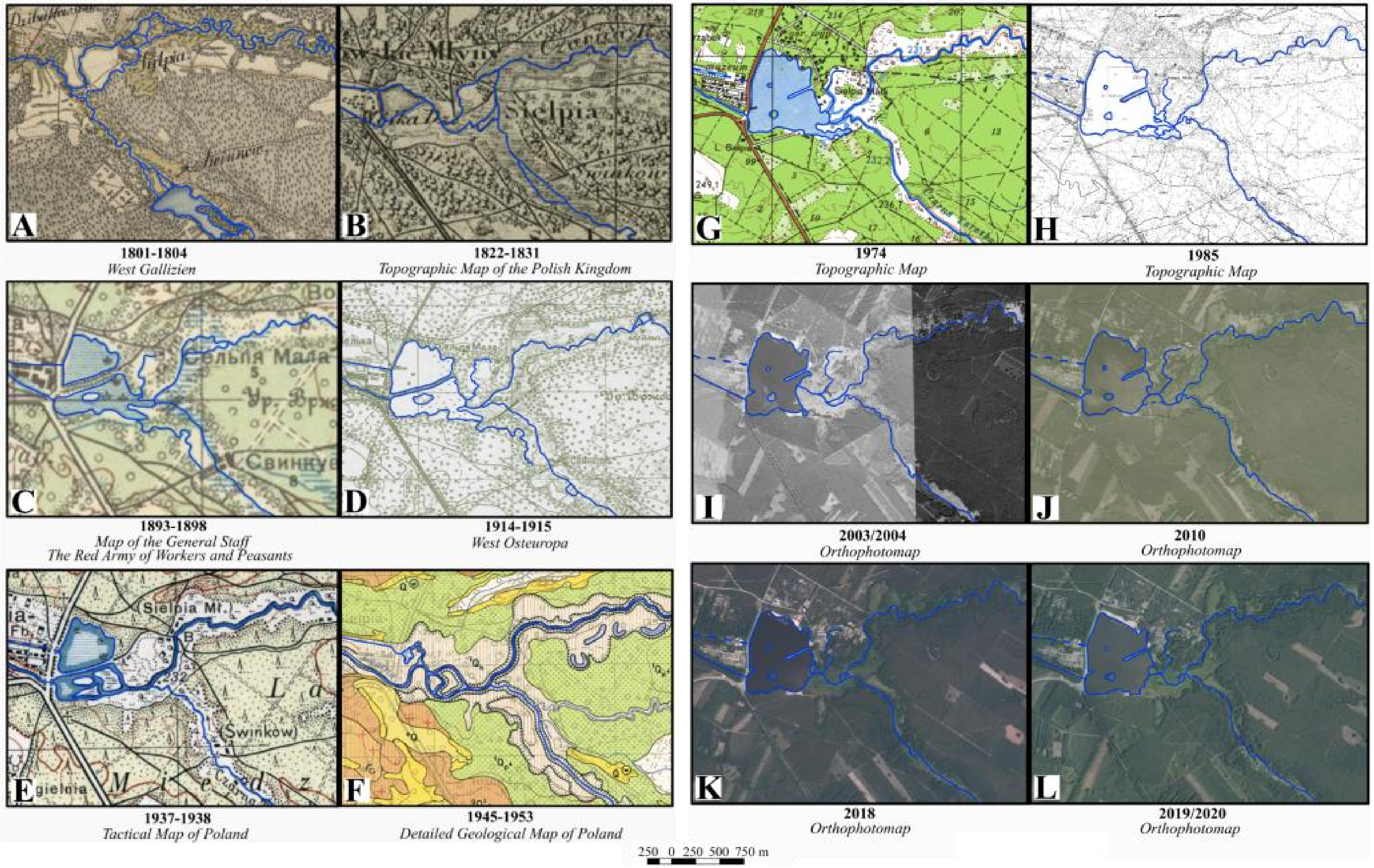


Fig. 1. Location of the study area on the Digital Elevaton Model (DEM) of Old-Polish Industrial District (Fularczyk et al. 2022)

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



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

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 at al. 202b).

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 at al. 2019, 2020, Fularczyk at al. 2020ab). 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 at al. 2020). The anthropogenic impact on hydrographic confluences in such valleys can be very large (Martinson 2010, Plit 2016, Biesaga, Kalicki 2021).

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

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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: channel terraces, Lima culture, agricultural infrastructure, 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. They are situated in the desert area between two valleys of perennial rivers: Río Chancay (ca. 25 km to the SE) and Río Huaura (ca. 30 km to the N). Despite being located far from the perennial rivers, they are covered by dense vegetation due to humidity brought by dense, advective fog (called *garúa*) common in the humid period (ca. June to October). Environmental studies (Kalicki et al. 2014; Kalicki and Kalicki 2020) indicate that there were no perennial rivers in the study area since the end of last glacial.

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).

There are some key questions concerning agricultural infrastructure in the Lomas de Lachay. Firstly, how the fields were cultivated despite lack of atmospheric precipitation and active rivers? Secondly, who constructed and used those agricultural terraces? Thirdly, how construction and use of fields affected local environment? Last, but not least, why such large-scale agricultural system has been abandoned?

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%). 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 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. 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. 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 maddening. 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 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 m^2, 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 areas, 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.

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

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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.

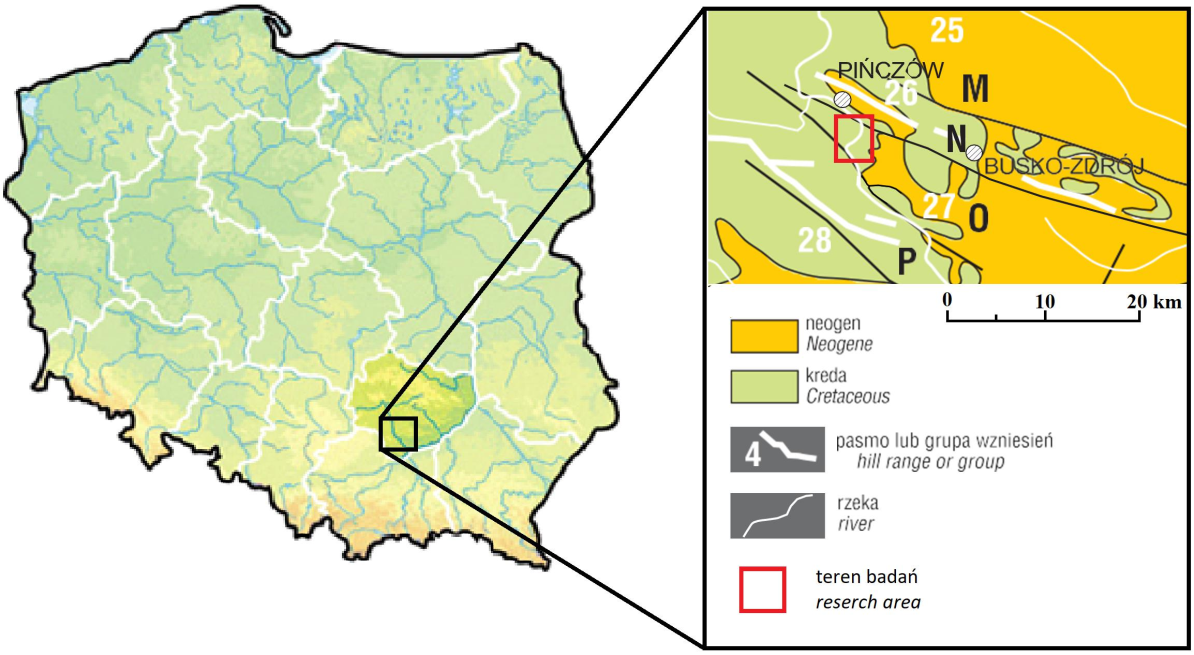

Fig. 1. Location and geological map (Urban 2014) of study area
25 – Połaniec Basin, 26 – Pińczów Hump, 27 – Solec Basin, 28 – Wodzisław Hump. M – Połaniec Depression, N –Pińczów Horst, O – Solec Depression, P – Nida Horst

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 km^2, and the average discharge is 19 m^3/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, 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 Złota 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 stadium (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).

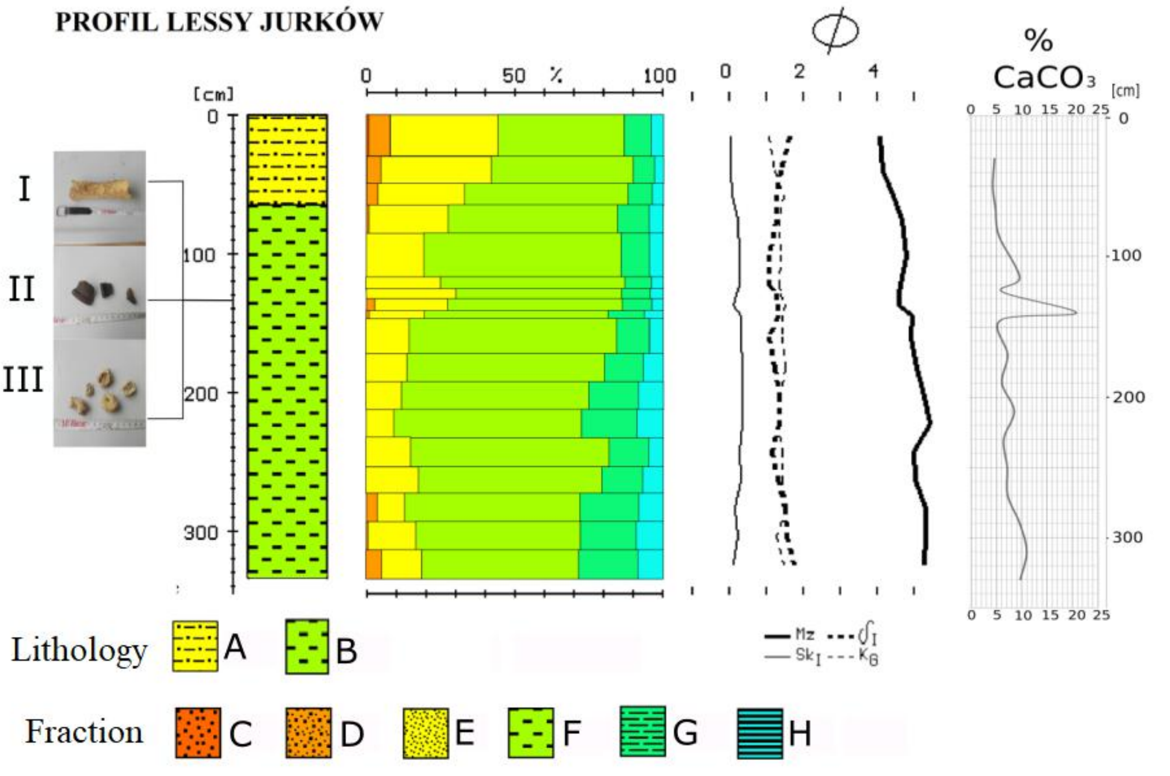

Fig. 2. Geological profile in loess edge of right slope of the Nida river valley near Jurków (Biesaga 2016)
I - pig bones, II – ceramics, III -loess concretion, Lithology: A- sandy loess, B –loess, Fraction: C - coarse sand, D- medium sand, E- fine sand, F-coarse and medium silt, G-fine silt, H- Clay.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

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-soliflucation 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 Chroberska, Zawarża to the village of Mozgawa, where it flows into the Nida.

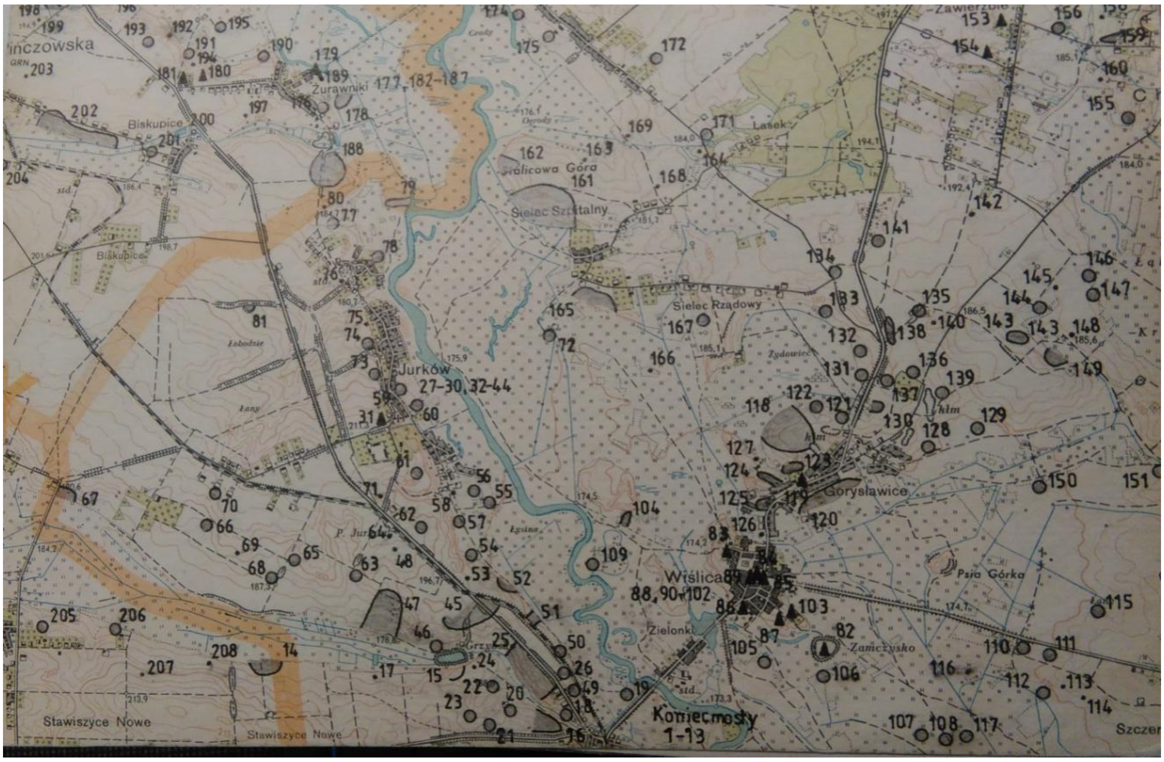

Fig.3. Archaeological sites in the Nida river valley near Wiślica according to data of Archeological Map of Poland (AZP)(Malęga et all. 2016, 2019)

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) (Malęga et all. 2016, 2019). During the first half of the 4th millennium BC the first farmers related with the Funnel Beaker culture (=TRB) appeared in Mozgawa and built a long-lasted 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).

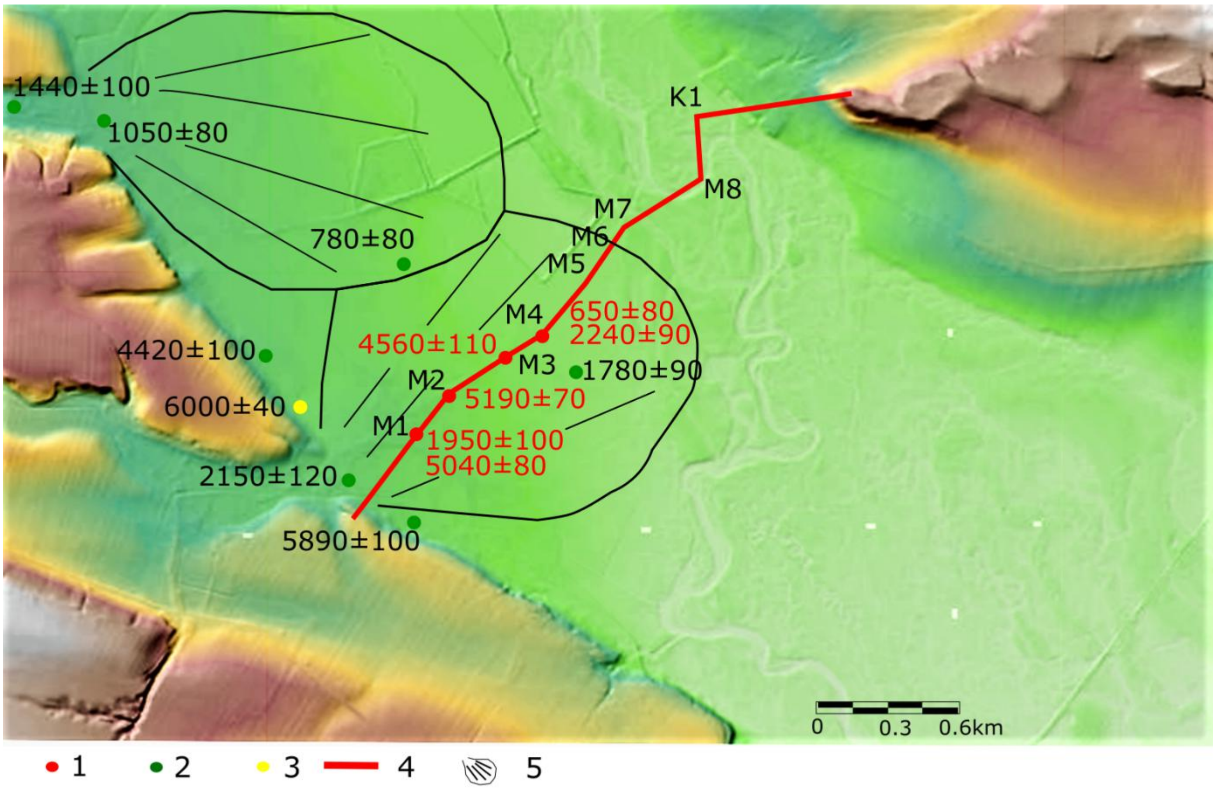

Fig. 4. Location of geological boreholes and section across the valley bottom of the Nida river on Digital elevation Model (DEM). 1-own radiocarbon dates, 2- radiocarbon dates from Szwarczewski (2009), 3- radiocarbon date from Moskal del Hoyo, 4- cross section line 5 - alluvial fan

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 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 Loosses 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).

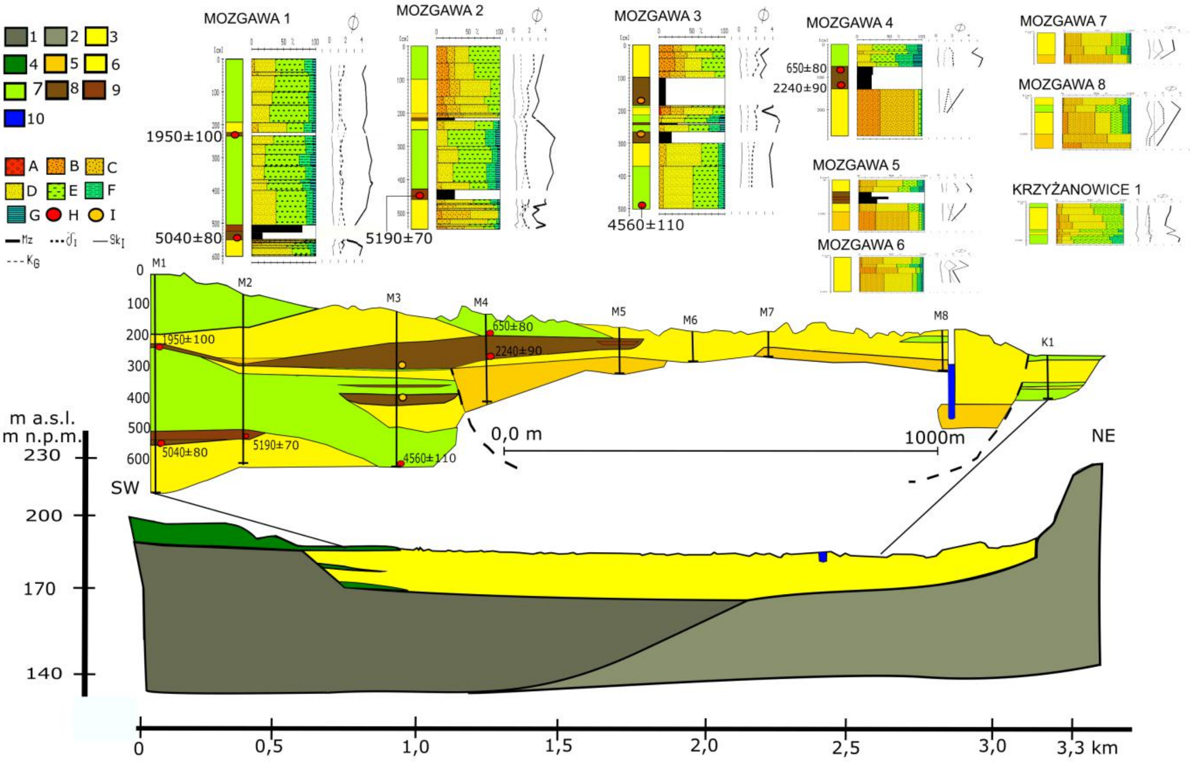

Fig. 5. Section across the Nida floodplain near Mozgawa (location see Fig. 4) and lithology of study profiles

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_I - standard deviation (sorting), Sk_I - skewness, K_G – kurtosis

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 backswamp on the left-bank floodplain is filled with fine sands interbeded 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 acumulate 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 Mozgawa 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 acreated 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 gyttia could accumulate (comp. MOZ 4/2015 profile in Moskal-delHoyo 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.

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

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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.

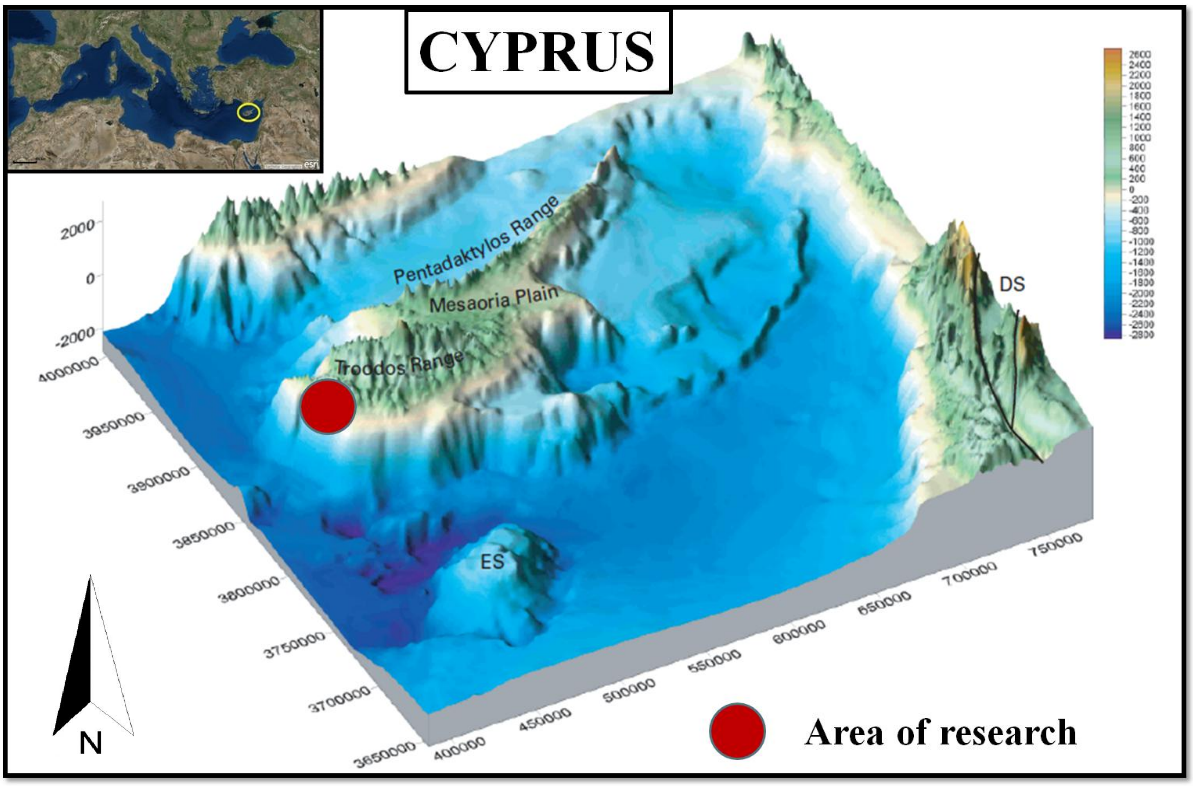

Fig. 1. Digital elevation model [DEM] of the eastern Mediterranean region combining bathymetry (in meters) and topography (“*DS*” - a section of the Dead Sea transform, “*ES*” - The Eratosthenes Seamount) (Harrison et al. 2008)

The research region is located in the southwestern 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 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).

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

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

Paleogeographical 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 Circuum 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 Circuum 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 Circuum 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 increase in rainfall typical for the Mediterranean climate in summer.

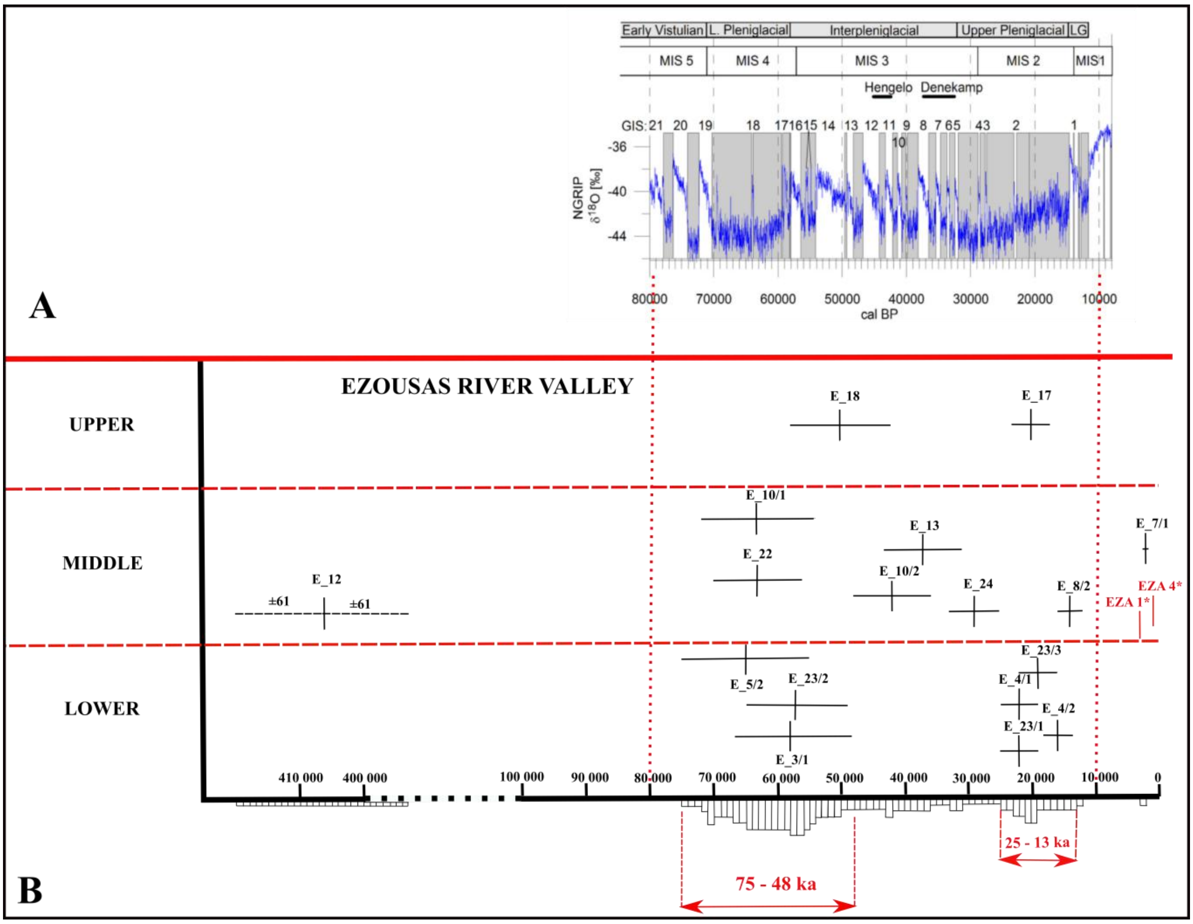

Fig. 3. Climate changes recorded in Greenland ice core (A)(Starkel et al. 2017) and TL data from Ezousas river valley (B)

The older phase were 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 11 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 and accumulation terrace was 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 alluvi. 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 1 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 1 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^{o}) 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 1 - 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^{o}. 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 "Kamieniołom" 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.

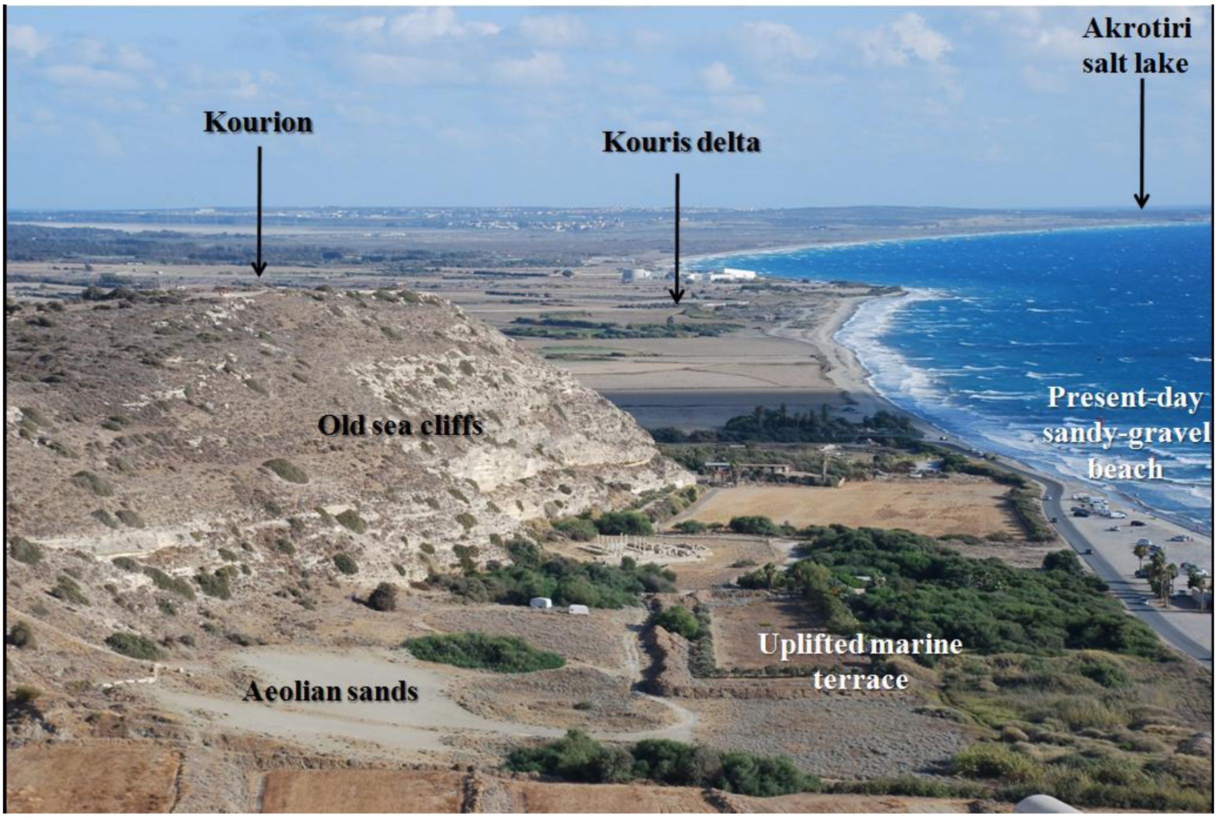

Fig. 4. Relief of ancient Kourion region

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.

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.

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

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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 Sielpia 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 km^2. 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.

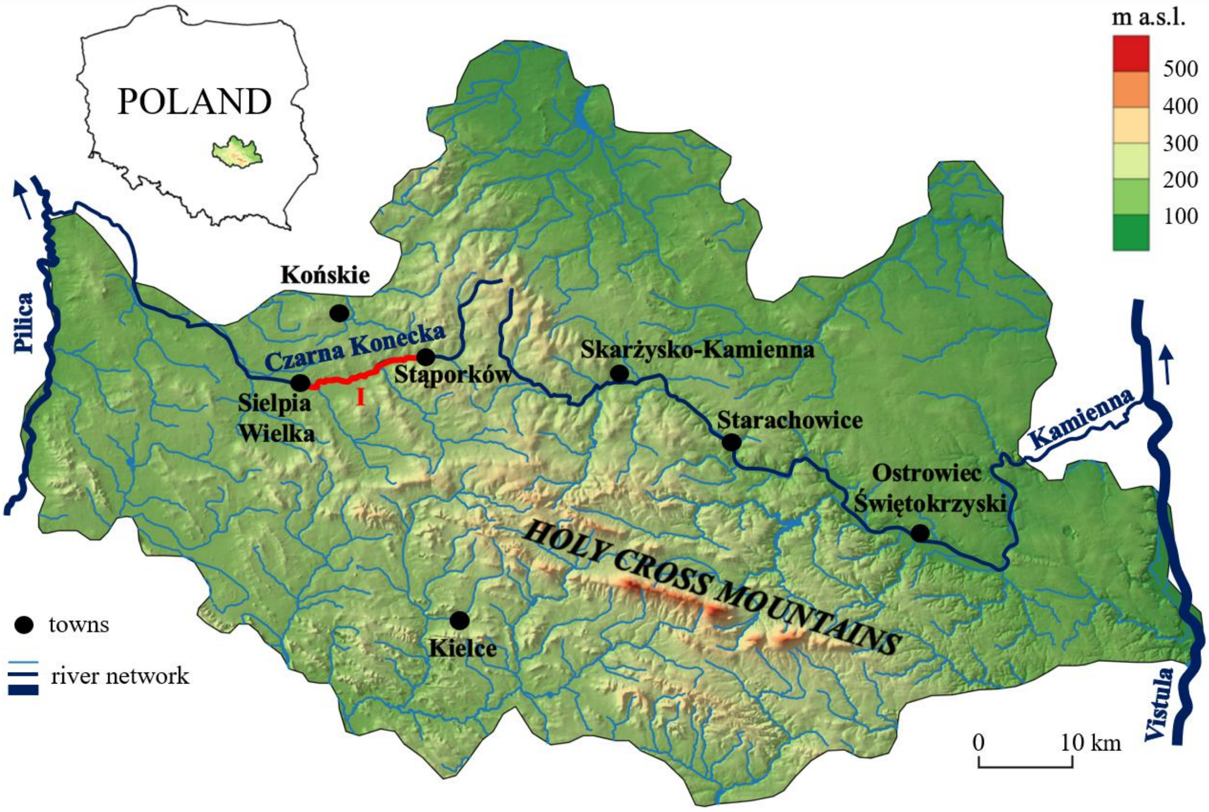


Fig. 1. Location of study area (red line) on Digital Elevation Model of the Old-Polish Industrial District area (Fularczyk et. al. 2020, changed)

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, ^{14}C 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. 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.

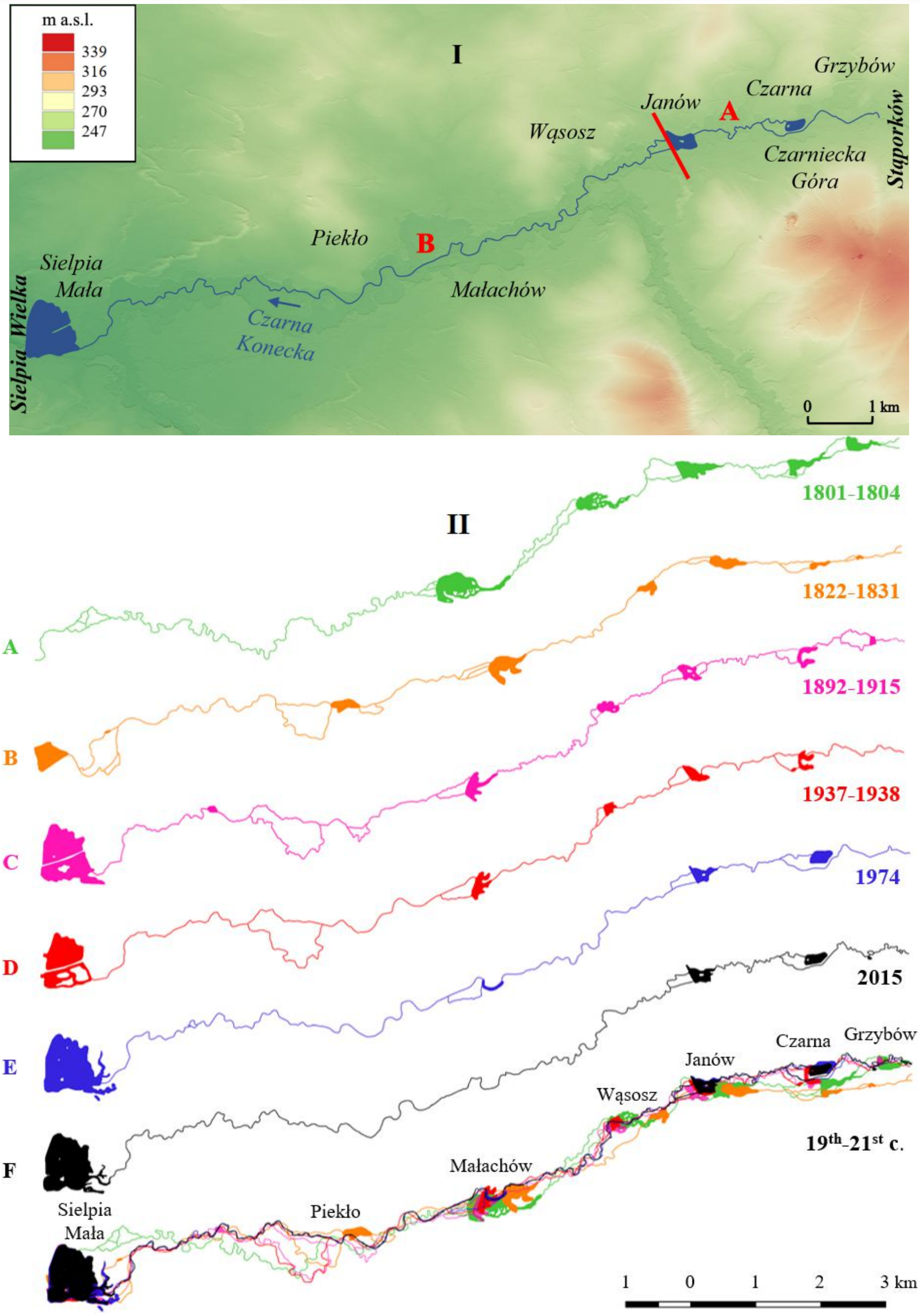


Fig. 2. Study section upstream (A) and downstream (B) of Janów dam on DEM (I) and changes of river course and ASWRS (II) in the last centuries based on cartographic sources (by K. Fularczyk, P. Kusztal)
Maps: A - West Gallizien, B - Topographic Chart of the Kingdom of Poland, C - Karte des Westlichen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

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 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).

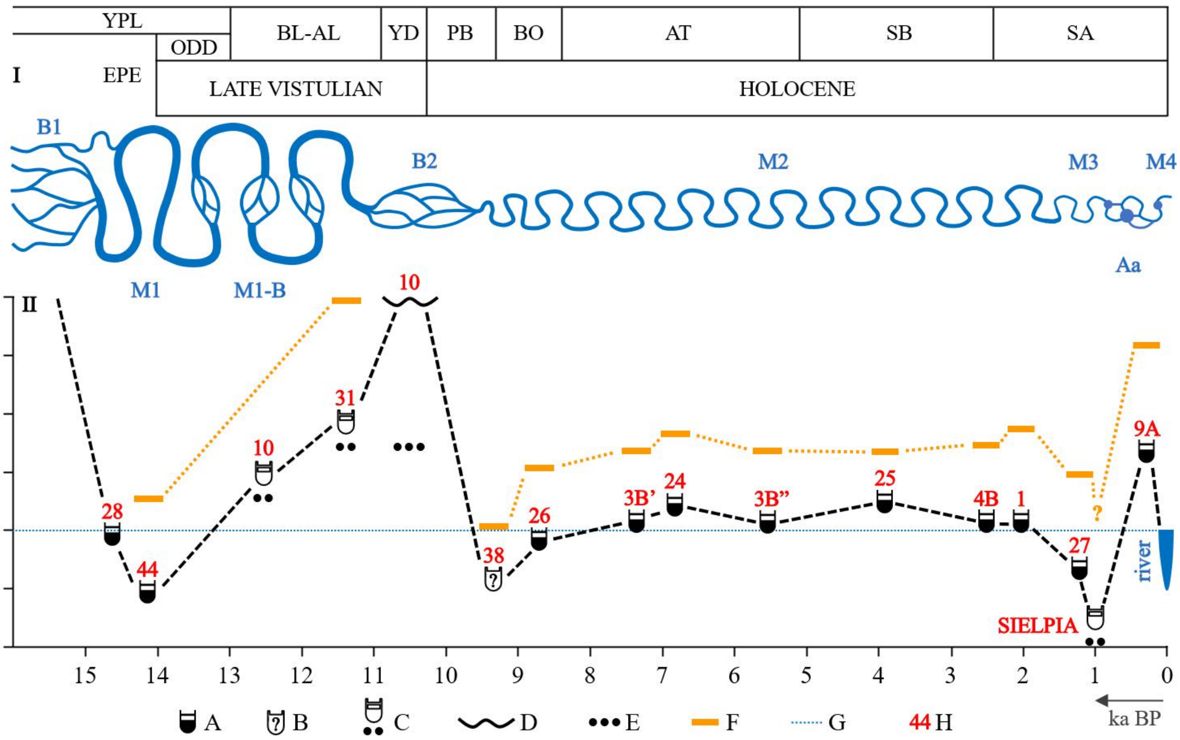


Fig. 3. Changes of river pattern and parameters (I) and riverbed level (II) since Young Pleniglacial

I: B – braided river with wide (B1) and narrow (B2) alluvial plain, M-R – meandering-braided (transitional) river, M – meandering river (M1 – macromeanders, 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

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.

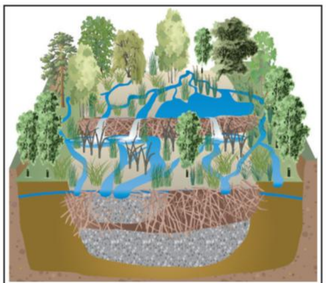
STAGE I LATE VISTULIAN	**STAGE II** PREBOREAL – SUBBOREAL	**STAGE III** SUBATLANTIC	
NATURAL FACTORS		**INCREASING ANTHROPOPRESSION** influence	
CLIMATE CHANGES	**LOCAL CONDITIONS**	**INDIRECT** BEFORE DEVELOPMENT OF THE OPID	**INDIRECT** AND **DIRECT** IN THE PERIOD OF DEVELOPMENT AND COLLAPSE OF THE OPID
• INTERSTADIAL-STADIAL CYCLE	• LARGE AFFORESTATION • NSWRS  Figure by Pollock et. al. 2014	• DEFORESTATION • EXTERMINATION OF BEAVERS AND DESTRUCTION OF THE NSWRS	• DEFORESTATION AND AFFORESTATION • CONSTRUCTION AND DEGRADATION OF THE HYDRO-TECHNICAL INFRASTRUCTURE OF THE ASWRS

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

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. (terrastralization 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 (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.

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

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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 Germans 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-Pieresławcew, 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 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.

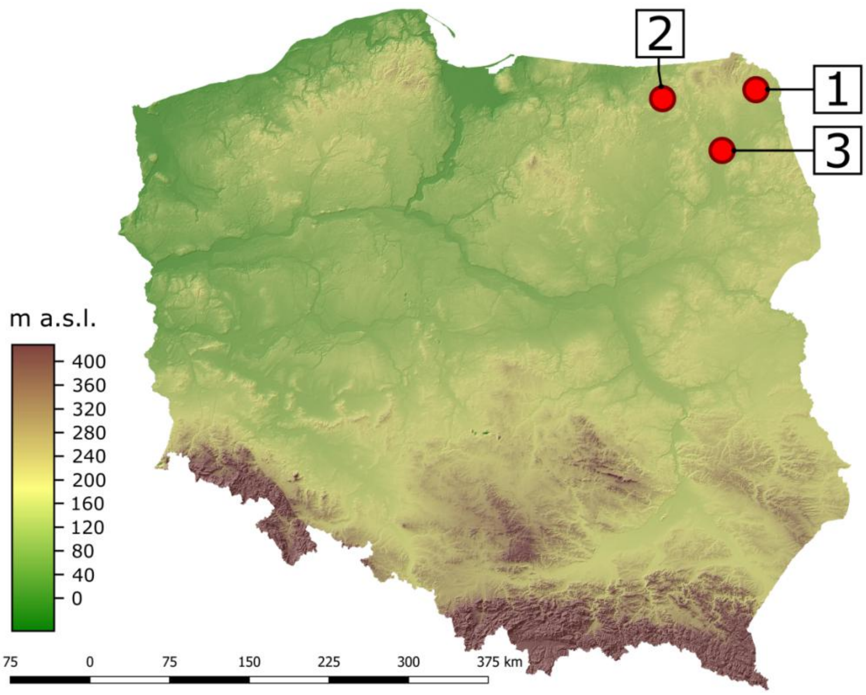

Fig. 1. The location of cemeteries (GUGiK data)
1- Białogóry, 2 – Giżycko, 3 – Sośnia

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 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 Poviat 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.

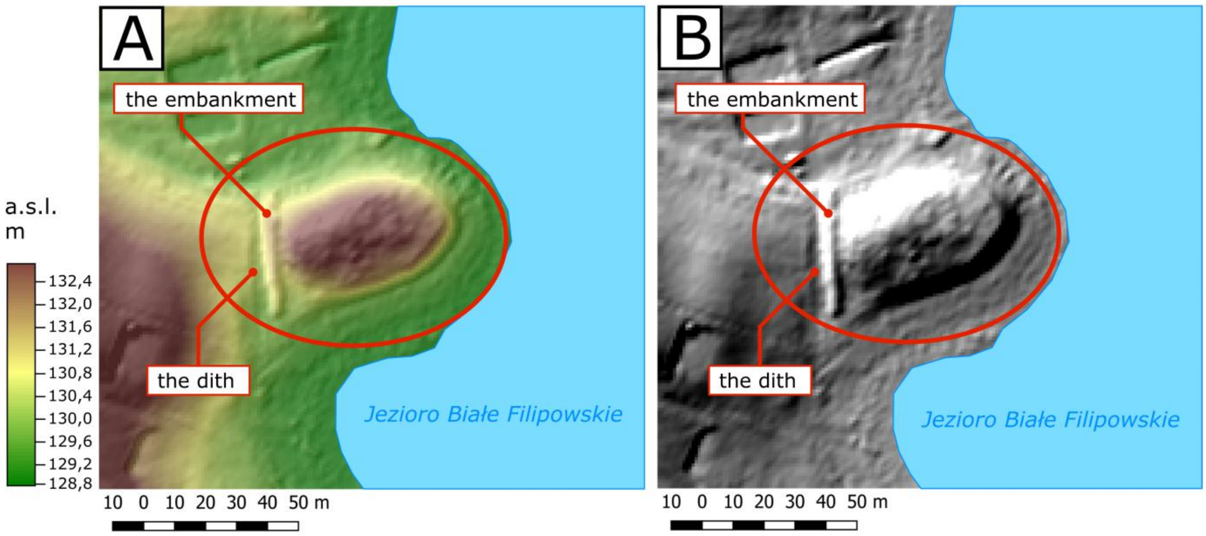

Fig. 2. A - The DEM with hypsometry and marked cemetery space, the embankment, and the ditch; B - analytical hillshading with marked cemetery space, the embankment, and the ditch; (GUGiK data)

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).

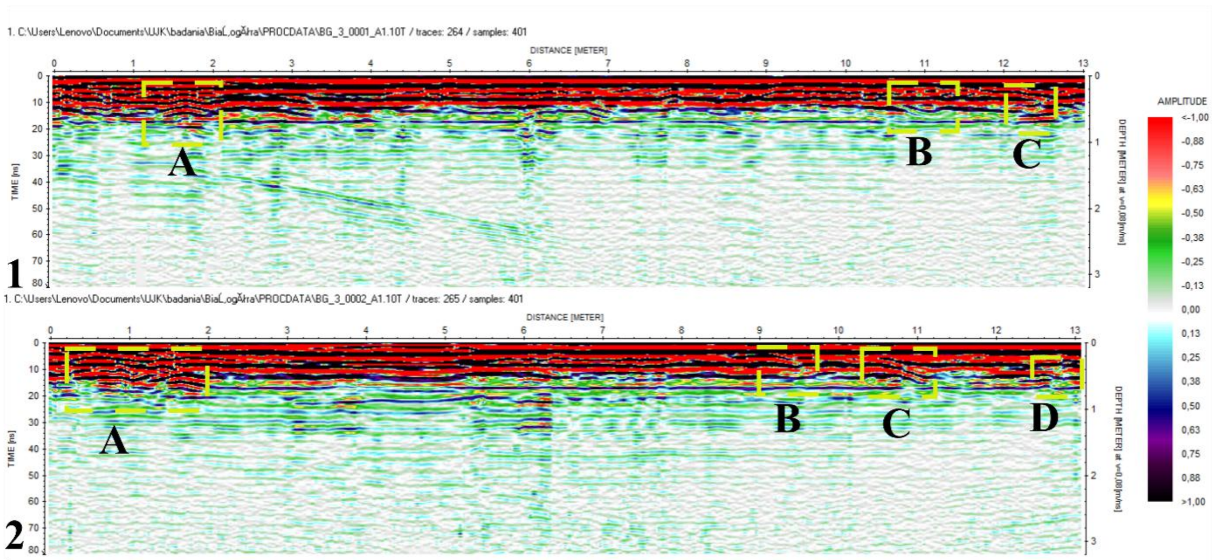

Fig. 3. Echograms with marked anomalies (A, B, C, D) corresponding to the shape and size of the burial pits (by S. Chwałek)

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.

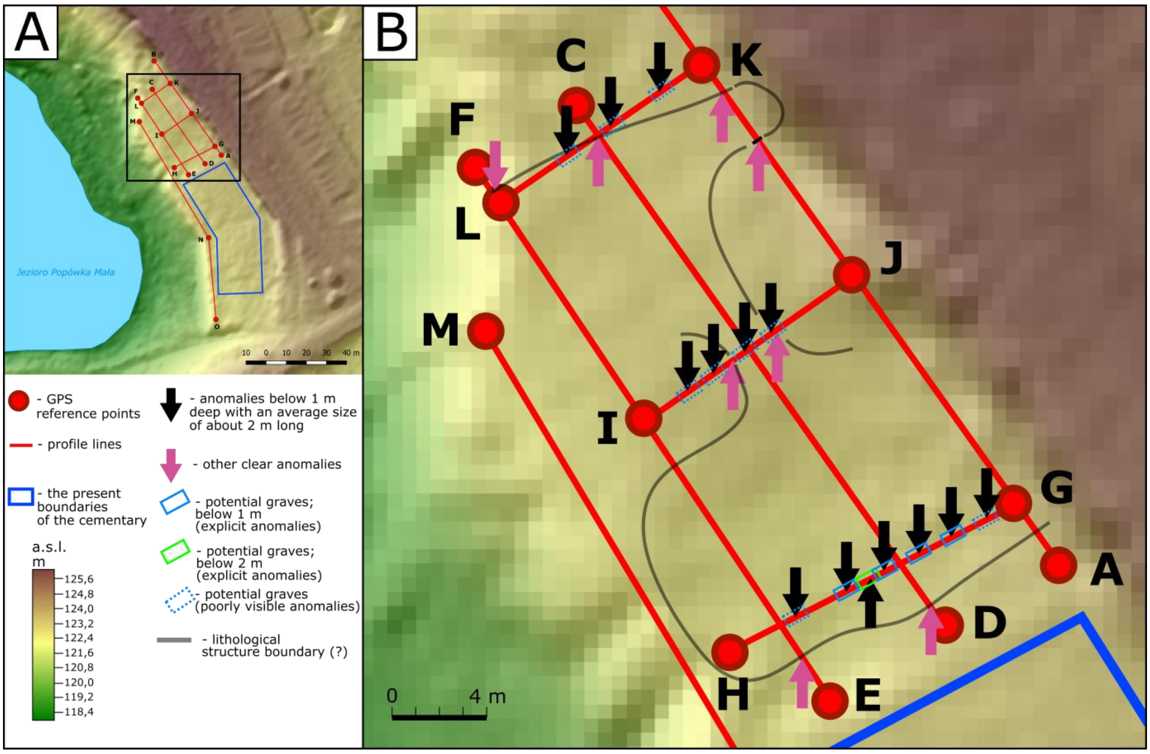

Fig. 4. The DEM with the research area location and distribution of measurement points and echograms (GUGiK data)

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).

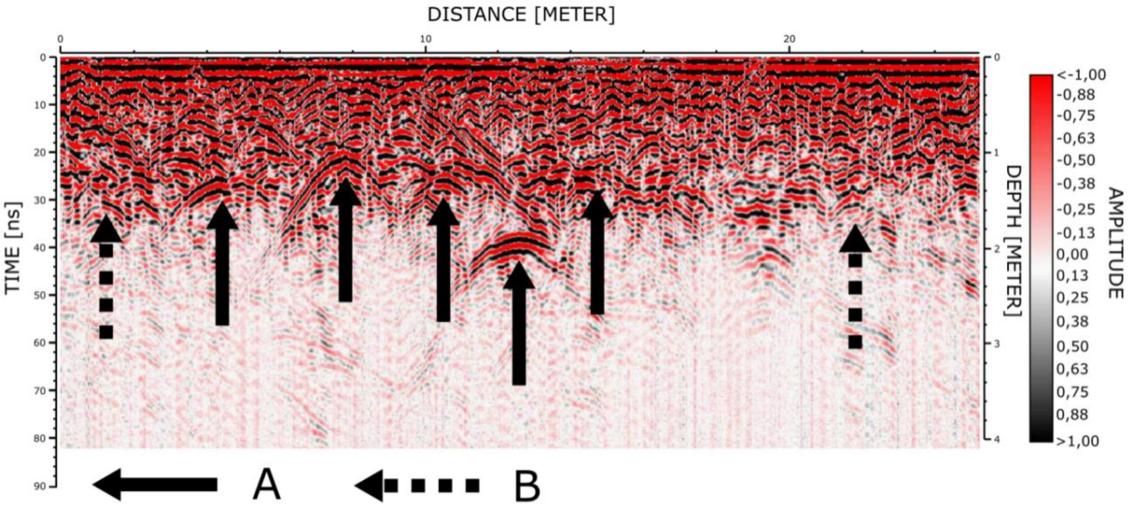

Fig. 5. The echogram of the profile G-H with visible anomalies; A - anomalies with clear boundaries (grave?), B - anomalies with blurred boundaries (potential grave?)

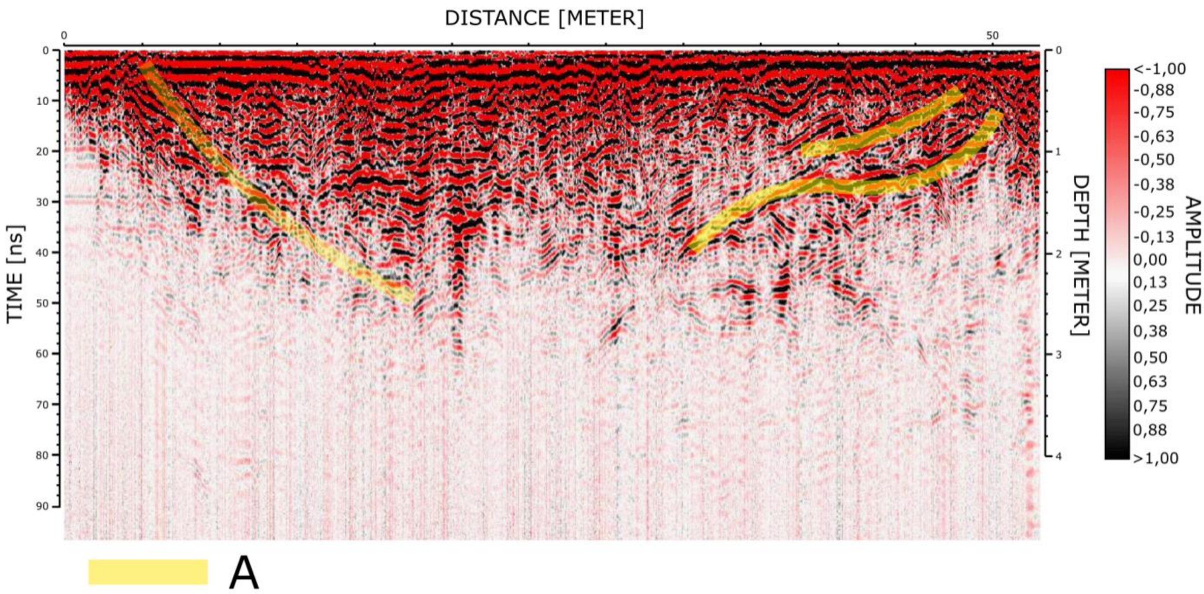

Fig. 6. The echogram of the profile E-F with visible anomalies; A - geological layering

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 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).

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)

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).

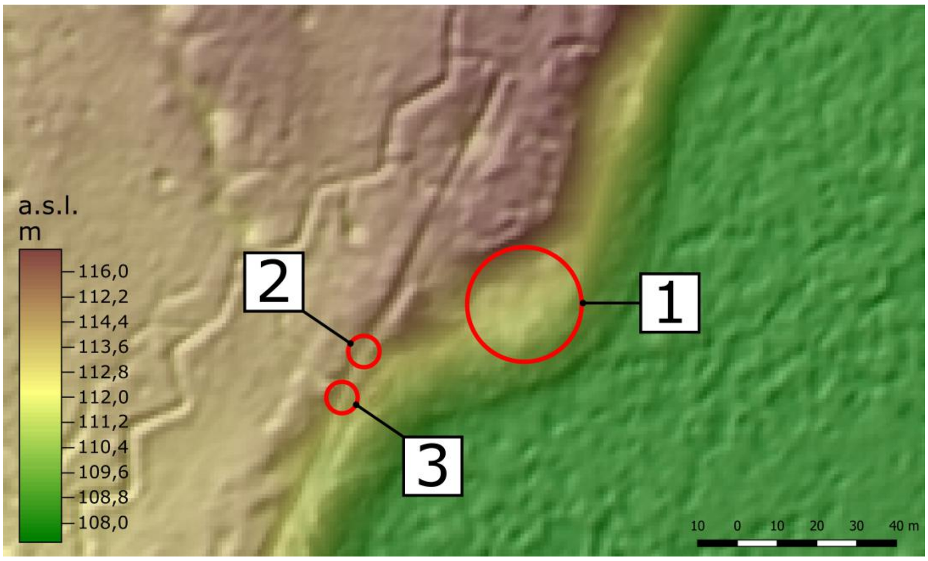

Fig. 8. The DEM of study area (GUGiK data)
1 - the alleged location of mass grave, 2 – smaller mass grave?, 3 – larger mass grave?

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

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.

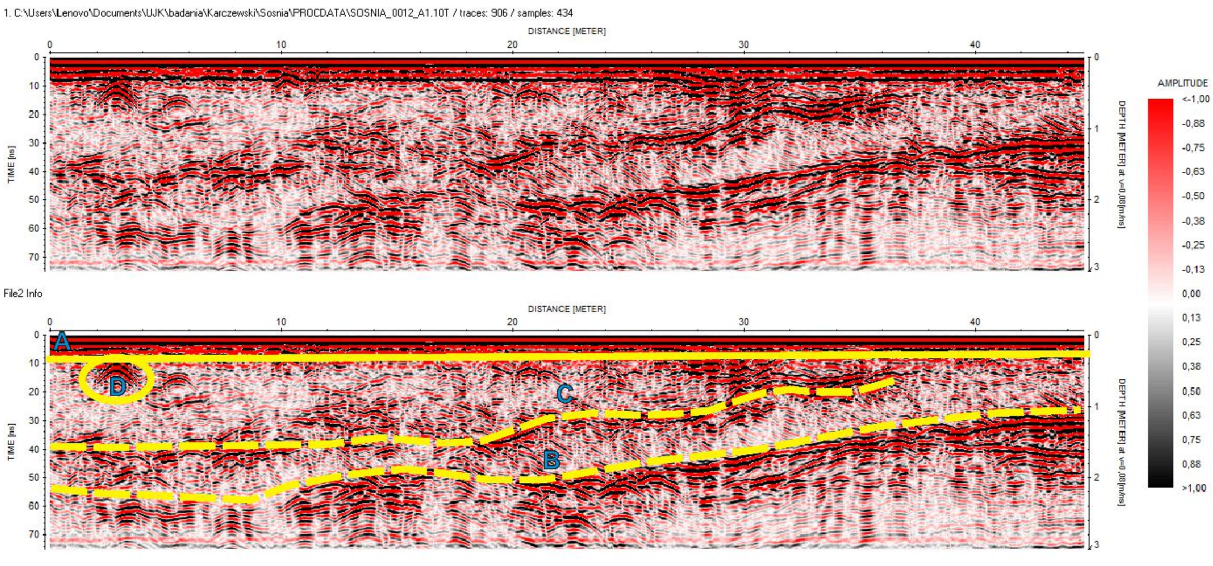

Fig. 10. The echogram of the profile along the forest fire road in the area of the location of relics of both mounds, with visible anomalies B, C, D (by S. Chwałek)

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.

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

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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 thousands of objects have been identified in forests throughout the northern and central parts of Poland (Fig. 1).

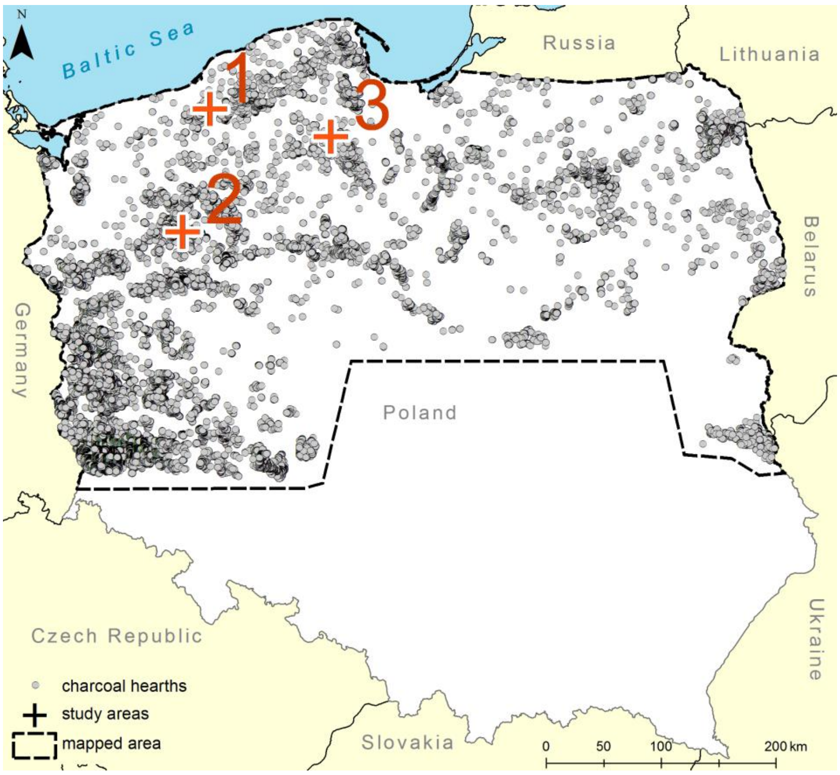

Fig. 1. Location of charcoal hearth remains in northern Poland recognized from LiDAR images. The crosses indicate the study areas: 1 - Wysoczyzna Polanowska, 2 – Pojezierze Wałeckie and Równina Drawska, 3 – Bory Tucholskie

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),
- 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).

Fig. 2. Current vegetation on the CHR in the pine forest near Płociczno (Drawsko Plain); photo: E. Kołaczkowska

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:				
Vaccinium vitis-idaea	**C**	**29**	**24**	**0.05**
Dicranum polysetum	**D**	**27**	**22**	**0.14**
Sphagnum sp.	**D**	**5**	**1**	**0.19**
Species more common at CHR:				
Betula pendula	**B**	**0**	**4**	**0.11**
Juniperus communis	**B**	**3**	**8**	**0.18**

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

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EFFECTS ON THE PRESERVATION OF STARCH GRAINS IN THE SOIL ENVIRONMENT

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Keywords: ancient starch, taphonomy, morphology, degradation

Starch grains are also part of the archaeological layers. They also occur on characteristic archaeological artefacts (e.g. grinding stones). Starch grains belong to the group of plant microresidues together with phytoliths, pollen, etc. Starch is a storage polysaccharide in most photosynthetically active plants. It is a source of glucose for plants and is suitable for long-term preservation and a mixture of two homopolysaccharides (amylose and amylopectin). Major quantity of starch is stored in reserve organs in specialized cells of seeds, roots and tubers or fruits. Starch is stored in amyloplasts in form of starch grains, which are species-specific and differ in shape, size and polysaccharide ratio. These characteristics of starch grains are for the most part given genetically, but are also influenced by external factors. The most important sources of starch in human history up to the present are cereals, legumes, but also plants, which could be collectively called vegetables or root vegetables. In the case of cereals, the starch content of the grain most often ranges from 50 to 70 %, depending on the external environmental conditions in combination with the potential of the plant.

From the moment of processing the plant material, the starch grains begin to be affected by various influences that affect their preservation (mostly negatively). These processes continue after leaving the subject and during the process of taphonomy and grounding. The soil environment is diverse and depending on the location. Ancient starch grains ware exposed to different risks of damage and decomposition directly in the sediment or on artifacts surfaces located in the soil. There are varying degrees of physical, chemical, biological (soil microorganisms) and anthropogenic influence on the soil environment. The chain of these soil processes affects the preservation of starch granules and has a direct impact on the success of results including the interpretation of starch grain analysis.

The results obtained from the starch analysis should be combined with the results provided by other methods, such as palynology, phytolith analysis or analyses of plant macro-residues. Starch grain analysis is associated with answers to questions about the use and processing of plants and the composition of the plant component of human diet. This technique is also suitable for the tool function analysis, examining of the plants domestication and vegetation history.

ELEMENTAL ANALYSIS OF ARCHAEOLOGICAL SOILS MAY HELP TO EXPLAIN PREHISTORIC LAND USE – AN EXAMPLE OF LONG BARROWS IN BOHEMIA

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Keywords: anthropogenic elements, Late Neolithic, phosphorus, ritual area, zinc

Different Prehistoric land use left irreversible marks in the elemental composition of the soil. Prehistoric settlement areas could be divided into residential, agricultural, and ritual sub-areas and each left different elemental signature in the contemporary soil. Using large scale soil sampling on remains of four Prehistoric long barrows and in their surroundings we conducted a comparison with data obtained from soil samples collected within the Prehistoric residential area. In this study we tested the hypothesis that long barrows were constructed in ritual areas which were not affected by residential activities before and after construction of barrows. The natural values for anthropogenic elements (P, K, Ca, Zn, Cu, and Mn) recorded on four studied barrows and in their close surroundings are highly contrasting with accumulation of anthropogenic elements in soil samples collected from arable and subsoil layers of the Prehistoric residential area. We concluded that long barrows were constructed in sub-areas of the settlement area without residential functions before and even after their construction. It seems that within sites analysed in our project the ritual character of sub-areas with evidence of long barrows was respected even in subsequent periods.

CEA OVER THE YEARS, PAST AND FUTURE PROSPECTIONS?

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Environmental archeology in the Central European space has only gradually entered the subconscious of readers as an integral part of archaeological publications. In fact, even at the beginning of this millennium, environmental science is seen as a supplement to archaeological interpretations, often published as a separate chapters and often taken out of context. Not surprisingly, it was not customary for natural science researches to be employed at archaeological institutions. However, this does not mean that there was lack of high-quality publications at that time, where interdisciplinary approaches were very well interconnected. It was not just common. However, most of them were connected with certain periods, such as the Paleolithic and geology, or the Middle Ages and botany. Only gradually the geology, archaeobotany or archaeozoology become an integral part of the quality outputs of multidisciplinary research.

Sometime in the first decade of this century, the word multi-proxy became a very popular topic for interdisciplinary projects and a kind of incantation of their grant success. With this trend, there is also a need to present and discuss interdisciplinary outputs in the wider community. Therefore, thanks to the initiative of Petr Pokorný, the first year of the conference entitled "Archaeobotanical Working Group" was established in 2005. This connection will attract other experts and shortly afterwards, in 2010 the first annual conference of environmental archeology (KEA) took place, which was founded not only by Petr Pokorný but also by Jaromír Beneš or Jaroslav Peška, Michal Hejcman, Lenka Lisá, Miroslav Bárta, Václav Cílek and others. More and more experts were added, the scope of the presented topics expanded and people from abroad, especially from Poland and Slovakia, became regular visitors. At the same time, the idea arose to establish the interdisciplinary journal Interdisciplinaria Archaeologica Natural Sciences in Archaeology, which accompanies the KEA conference to this day.

Over time, the KEA conference grew into an international platform, and in 2015, thanks to the South Bohemian PAPAVER project, the first English version of the conference entitled "LIFE IN FLUX: Humans, animals and plants in postglacial ecosystems of Europe and Northern Africa" took place in České Budějovice. Given that the foreign audience consisted of Polish and Slovak colleagues, supplemented by several foreign colleagues from Modena, Italy, the English version caused embarrassment. Colleagues were not used to communicating with each other in English in order to create an equal level for their non-Slavic colleagues. Fortunately, these embarrassments were overcome and the conference committee decided that it made sense to hold the English version at least once every three years. Since then, the KEA conference has been held regularly in the English version called CEA. The first foreign CEA took place in Nitra, Slovakia, followed by another in Modena, Italy. She returned to the Czech Republic in the third place at the University of Agriculture in Prague. So far, the last English version of KEA is a conference organized by Polish colleagues in Suchedniów. The conference had to be postponed due to the COVID restrictions to 2022 year.

And how has the focus of environmental archeology conferences changed in the last decade? The main topics of the conferences were directed from the organization that was holding the conference. It took place several times in the Czech Republic in Prague, České Budějovice, Brno and Olomouc. The first years, which were organized a lot, for example, Petr Pokorný, Lenka Lisá, Miroslav Bárta and Michal Hejcman were focused on the development of the landscape, climate, agriculture and the intensity of the human impact associated with the collapse and regeneration of human societies. The years that Jaromír Beneš or Miroslav Bárta organized more are specific in that the topic is focused on food and drink, changes in vegetation and comparisons with North Africa, where some of the environmentalists had their projects. In recent years, the focus of the conferences has returned to the issue of landscape development and human influence. The reason is probably the effort to link the data that can be obtained from environmental archives with the clear climate change that human society is facing. It is also the main topic of the CEA conference held in Suchedniów, Poland, with the title "The environment as an archive of past human activities". Given the current events, it is likely that future years will turn to the topic of man and collapse or man and war. I hope that this topic will remain only in the theoretical levels of our conference.

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

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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., Banerjea, 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 Rokstejn 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 nobel 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 microcharcal 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. antropogenically 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 migh play a role in the agricultural background of the castle itself.

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ASSESSMENT OF FLUVIAL SEDIMENTS AND EVOLUTION OF SVRATKA FLOODPLAIN IN BRNO FROM THE PERSPECTIVE OF CHEMICAL-PHYSICAL PROXY INDICATORS

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Keywords: fluvial sediments; chemical-physical proxy indicators; pollution; Brno; paleoecology

During the rescue archaeological excavations on the grounds of the former textile factory Vlněna was uncovered vast part of original Svratka floodplain, Medieval to Modern age millrace, overbank deposits with buried soils and system of younger Late Holocene paleochannels. These findings allow us to research environment and potential anthropogenic contamination from Late Holocene up to Modern age. Archeological evidence indicates the presence of prehistoric activities dated between the Neolithic period and the Iron Age. Most precise evidence is the Middle Eneolithic (3080 – 2890 BC) burial. Part of archaeological excavations was a geoscientific survey. Within this survey we were able to partially reconstruct the system of vanished watercourses as well as interpret and date fluvial sediments. Together with these reconstructions and interpretations were also addressed environmental indicators, such as pollen record, plant macro-residues and presence of pollutants. Each sampled profile was lithosratigraphically described and graphically processed. Samples were taken into plastic bags and used for palaeoecological methods: pollen analysis, malacological analysis; chemical analyses: X-ray fluorescence, atomic absorption spectrometry, loss on ignition; and magnetic susceptibility and granulometry. Samples for radiocarbon dating and OSL dating were taken separately. Dating and consequent palaeoecological assessment of paleochannel infill was rather straightforward, but the age of the polygenetic soil and overbank floodplain sediments is ambiguous. We also used the various dating methods to divide the sediments to multiple time fazes, which were then compared in terms of contamination. Partial results from X-ray fluorescence and atomic absorption spectrometry indicate anthropogenic pollution in the millrace layers deposited in the Late Middle Ages and

Modern age. Slightly higher concentrations of heavy metals were also found in the upper layers (Late Medieval to Modern Age) of the profiles located in former floodplain. Samples taken from profiles located in the former paleochannels do not indicate any significant contamination in terms of heavy metals.

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

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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.

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.

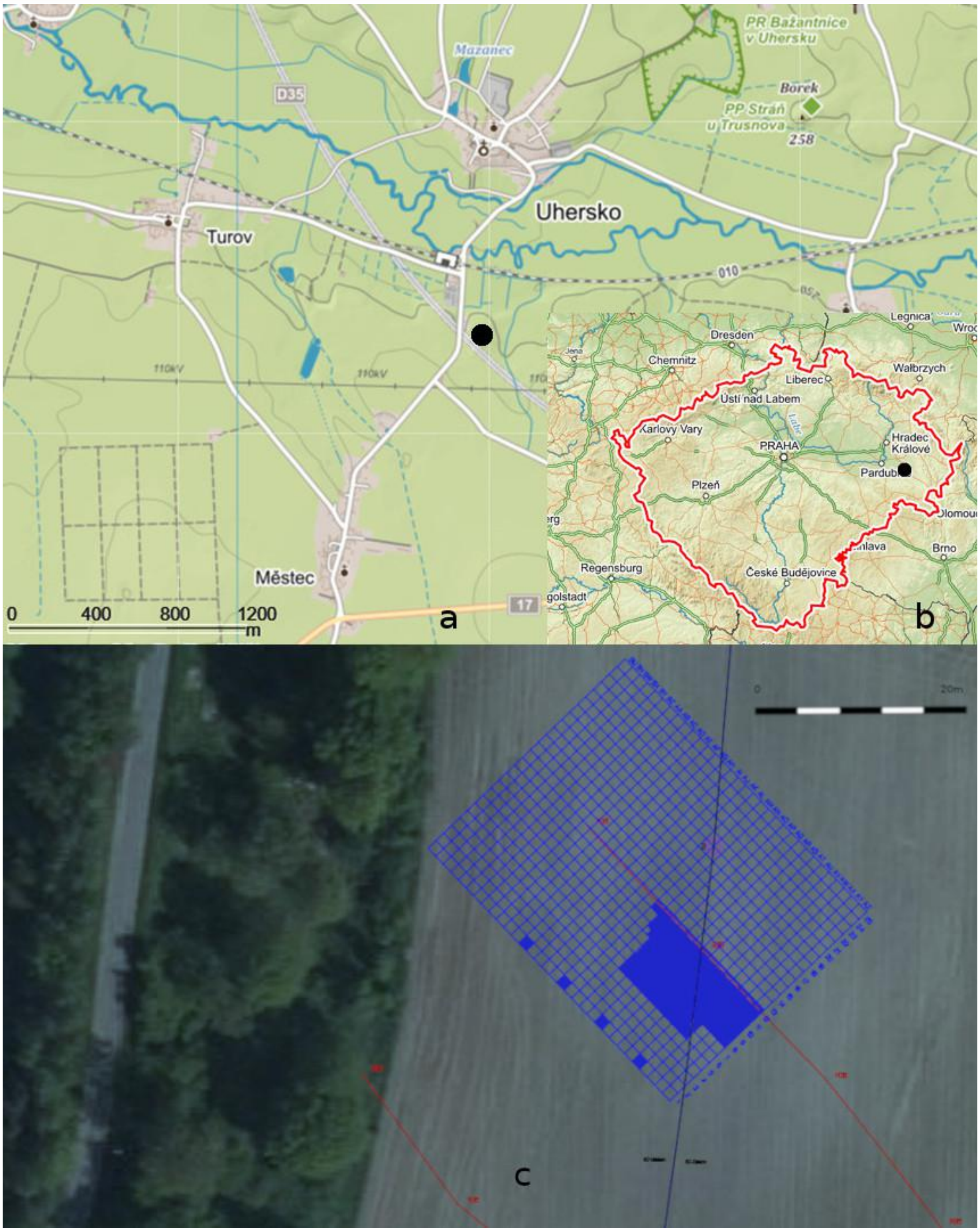

Fig. 1. Location of the Městec/Ostrov site on a map of Bohemia (b); location of the site on the map of Uhersko village and its surroundings (a), the site location is marked with a black dot; aerial photograph of the site with a grid overlay (c), blue area – excavated squares, red lines – boundaries of the D35 highway alignment.
Map source: www.mapy.cz. Processed by O. Mlejnek.

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 m^2 (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.

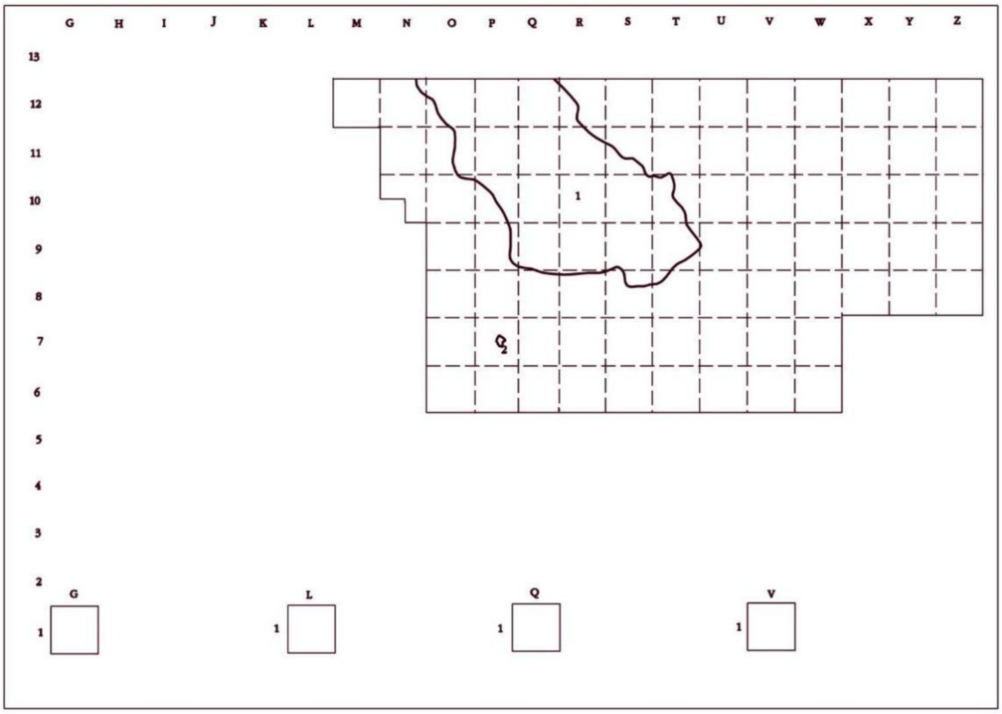

Fig. 2. Městec/Ostrov site plan with locations of Features 1 and 2.
(drawing by O. Mlejnek and S. Bambasová)

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

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 glacigene 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 3: 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

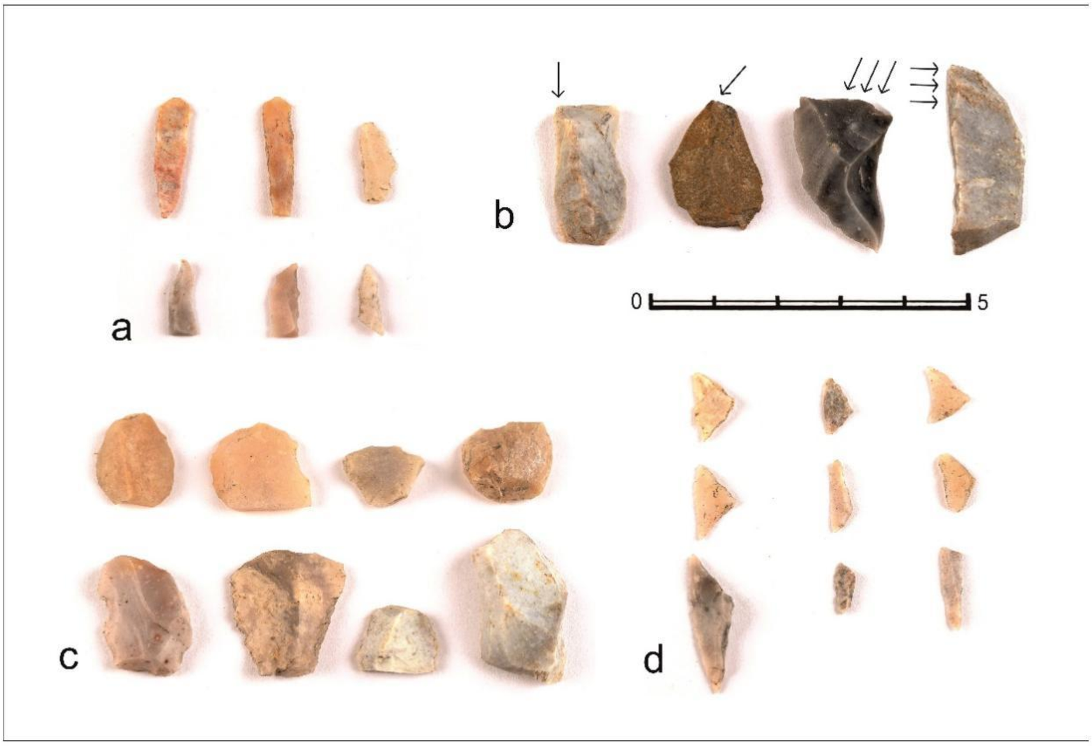

Fig. 3. Městec/Ostrov. Photograph of selected tools. a) backed bladelets b) burins c) end scrapers d) microlithic triangles. Photographed by M. Kršková, processed by O. Mlejnek.

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, 2σ
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 BP cal, 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 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 exoreic (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.

CONCLUSION

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.

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SOIL AND HUMAN ACTIVITY IN THE ROMAN IRON AGE AND THE HIGH MEDIEVAL PERIOD: A CASE STUDY FROM DEBRNÉ, CZECHIA

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Keywords: archaeology, buried soil, formation, Roman Iron age, Medieval system

A major challenge for medieval archaeologists is the integration of material remains (artifacts and features) and historical evidence. Critical interpretation of both the material remains and written texts can shed new light on the so-called Dark Ages, while geoarchaeology can answer direct questions of environmental development. The paper focuses on the research of the agricultural terrace of the high medieval field system of the village of Debrné, found in the High Medieval period. Multidisciplinary investigations of the buried soils formed on the surface of the Debrné agricultural terrace (Czechia, Northeastern Bohemia) was tied showed that the original soil cover was represented by combinations of automorphic lixisols and cambisols. These soils are also characteristic of modern biogeocenoses, which indicates a practically changeless trend of pedogenesis in the average time interval. It was determined that during the construction of the agricultural terrace and leveling of its surface the soil cover was scalped to a significant degree. Archaeological research of the agrarian terraces in Debrné has revealed construction details and determined the time of the formation of the field system. A drainage layer of stones at its base was uncovered in the first sondage. The sondage two, located closer to the core of the village, allowed dating at the beginning of major landscape transformation of the village's field system. The archaeological dating is close to the first written historical mention of the village in 1260. Surprising is the OSL date from the -70 cm level in trench 2. It shows the sediment age of 1760 BP (ca 260 AD), indicating human activity at the site from 3rd century AD. This

older dating may be related to the hitherto little-known activity in the Roman Iron Age in mountainous terrain.

BACK TO THE BRUSZCZEWO: GEOARCHAEOLOGICAL INVESTIGATIONS OF EARLY/MIDDLE HOLOCENE LAKE AND LATE HOLOCENE PEATLAND IN THE CONTEXT OF CHANGING SETTLEMENT PATTERN

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ABSTRACT

The area of an archaeological site in Bruszczewo was reinvestigated by geoarchaeological means. The non-invasive survey, combined with vibra-coring and multiproxy reconstruction, resulted in a complex view on the past landscape of human occupation over a wetland in the central part of Greater Poland.

KEYWORDS: geoarchaeology, Bruszczewo, wetland archaeology, lakeside settlements, man and environment in the past, multiproxy reconstruction

INTRODUCTION

The microregion of Bruszczewo (Fig. 1) witnessed several phases of human occupation: from occasional Neolithic habitation, through the Early Bronze Age Únětice culture fortified settlement, Late Bronze Age/Early Iron Age Lusatian ritual centre and cemetery, Przeworsk sedentary complex, up to Medieval stronghold and tar production spot. The area has been already a subject of major archaeological projects (e.g. Brzostowicz 2002; Czebreszuk et al. 2004; Muller et al. 2010; Czebreszuk et al. 2015), as well as some initial palaeoecological investigations, which indicated a presence of a lake in the centre of microregion in the past (Haas et al. 2010). Currently a new geoarchaeological project* has been undertaken to reveal the landscape changes history seen through the multiproxy reconstruction. The study aims to combine the extensive knowledge on the turning points in Greater Poland's archaeology and early history with the response of the natural environment and its evolution.

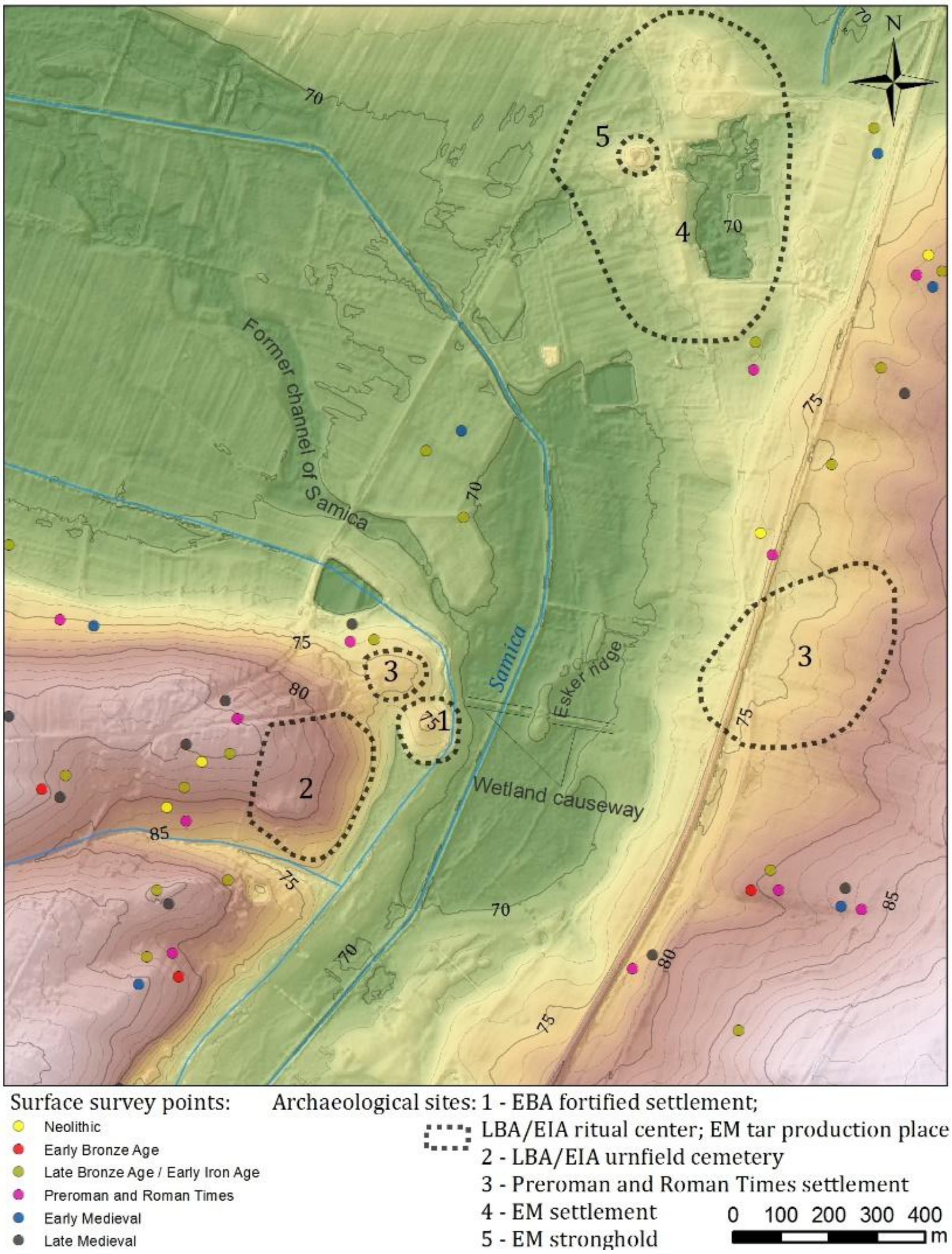

Fig. 1. Archaeological microregion in Bruszczewo (Central Greater Poland).

STUDY AREA

The Bruszczewo site no. 5, being the most focal point of this study, is located over the middle course of Samica River, a small tributary of Obra. The river in this section has adopted the glacial tunnel valley of N-S orientation, created shortly after the maximum of the Vistulian (Weichselian) glaciation around 20 000 BC (Kozarski 1988). The valley floor is currently a peat plain drained by the system of artificial channels, one of which holds the present course of Samica River. The eastern slopes of the valley are built by the ground moraine material, whereas the western by fluvioglacial sands. The main archaeological site in this microregion is positioned on a small promontory extending from the western slopes towards the peat plain. According to the previous research in Bruszczewo, gyttja deposits occur below peat, which indicates the presence of a lake in the past (Haas, Wahlmüller 2010; Kneisel 2011; Hildebrandt-Radke 2013). The lake evolution was already briefly analyzed in an initial study of a single core retrieved app. 200 m from the archaeological site. However, it represented an incomplete section of lacustrine deposits reflecting the existence of the lake between 2300 and 500 BC. In order to reconstruct the full extent of the lake and the detailed history of environmental changes of the area, a new geoarchaeological project was set.

RESULTS

So far, eight vibra-cores, supported with the extensive number of radiocarbon dates (25 dates until now) and detailed palaeoecological studies, document the existence of a vast lake occupying the Samica valley in Bruszczewo, from the retreat of the Weichselian glacier throughout the Early and much of Middle Holocene. Retrieved cores point to the presence of the basal glacifluvial sands at various levels below the ground (between 4 to 10 m b.g.l.), indicating highly inclined slopes of the former lake. This thorough lake existed in its full extent at the time of the Early Bronze Age fortified settlement of Únětice culture, thus supporting its defensive traits aside from anthropogenic installations like moat, rampart and rows of palisades (Kneisel 2011). However, the current research brought to light the evidence for lake transgression in the vital time of 1900 BC, when a peculiar shoreline wooden embankments were raised in the area of the settlement – possibly to prevent the shoreline outwash. After the abandonment of the settlement, during the Middle Bronze Age, the area witnessed a hiatus in occupation, after which the next occupation phase began around 1000

BC, however, only its beginning witnessed the lake in its full extent, as it has begun to demise at app. 700 BC, so at the onset of the Subatlantic. At this time, the microregion was settled by the Lusatian Urnfield culture's people, who had created their ritual centre, as well as a vast cremation cemetery in the area (Ignaczak 2015). The analysis of LIDAR products, as well as vibra-coring in the valley's plain, brought to light the existence of an esker's remnant, which in the light of lithological data, radiocarbon dating and the results of a surface survey of molehills, might be treated as an inhabited island in the centre of the lake. Thus, a third component of the Lusatian Urnfield cultural landscape has been discovered. During the Roman Times, when the Przeworsk settlements were spread on the valley's slopes, the inhabitants might have witnessed only a relict lake, as the last stage of the basin's overgrowth is documented to app. 300-200 BC. From that time, the Samica River have drained the entire area, creating a system of fens fed by seasonal flooding. The last archaeologically recognized stage of human presence in the area is the Early Medieval period. At that time, the northern margins of the peat plain were inhabited in a form of extensive Slavic tribes' village with a motte-stronghold, burnt in the late 10th c. AD in a probable raid of Mieszko the 1st (Brzostowicz 2003). The resulting subordination of the tribes to the Polish statehood is represented in the rise of the palaeoecological indicators of human presence and the development of farming techniques.

CONCLUSIONS

In the light of the results obtained so far, the area of Bruszczewo might serve as a key to understanding human adaptation to changing wetland conditions in Greater Poland through well-recognized settlement patterns and subsistence strategies, supported by high-resolution multi-proxy palaeoecological reconstruction. The latter comprised of magnetometry and georadar prospection, geoarchaeological coring, radiocarbon dating and modelling, sedimentological and geochemical analysis, pollen and NPP analysis, diatom studies and archaeological surface survey.

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NEOLITHIC WELLS IN EASTERN BOHEMIA AND RECONSTRUCTION OF THE PAST ENVIRONMENT

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Postglacial vegetation development in Central Europe is influenced by climate change, the survival of glacial elements and the migration of species from their glacial refugia. Humans become an important factor influencing vegetation in the second half of the Holocene. The transition to agriculture, which took place in central Europe around 7 500 years before the present in the Neolithic period, is a crucial period in the development of human society. The so-called Neolithic Revolution is very well recorded in the archaeological record, especially by the existence of pottery.

The question is the influence of farmers on the surrounding landscape and vegetation. What is seen as a revolution in the archaeological record is virtually not reflected in the palaeoecological record, including pollen profiles. This leads to two questions, namely how early farmers deforested the landscape and whether primary treeless woodland existed at this time as a refugium for non-forest species. The evidence to date suggests that the vegetation at that time was naturally loose with non-forest species, there was no intensive deforestation and human influence was relatively low.

The existing evidence of synanthropic vegetation from Neolithic archaeological situations is very sparse, with only Chenopodiaceae predominating. The discovery of unique wooden wells in Uničov (Vostrovská et al. 2020), Velim, Ostrov (Rybníček et. Al 2018) and Městec (Fig. 1) allows a much better palaeoecological record to be obtained from a waterlogged site directly on the former settlement. Many species not yet recorded in the Neolithic have been discovered. The Neolithic synanthropic vegetation consists in part of species common in the glacial period (*Urtica dioica, Chenopodium album, Plantago major*), probable migrants (*Onopordon acantium*), not to mention cultivated species (*Triticum* sp., *Physalis alkekengi*). Synanthropic vegetation in the past consists of species that are available in the surrounding environment but human settlement is an ideal habitat for them, then species brought by man, intentionally in the form of crops (*Physalis alkekengii*) or as their weeds. Natural changes in the surrounding environment, such as the expansion of forest and its denser cover in the second half of the Holocene, turn species of natural treelessness into purely synanthropic vegetation that would have a very limited niche of occurrence in the surrounding landscape. This also applies to communities dependent on human management, i.e. grasslands, meadows, so-called secondary treeless forests. Communities now considered natural but would have disappeared without human activity - artificially maintained refugia of early Holocene treeless species.

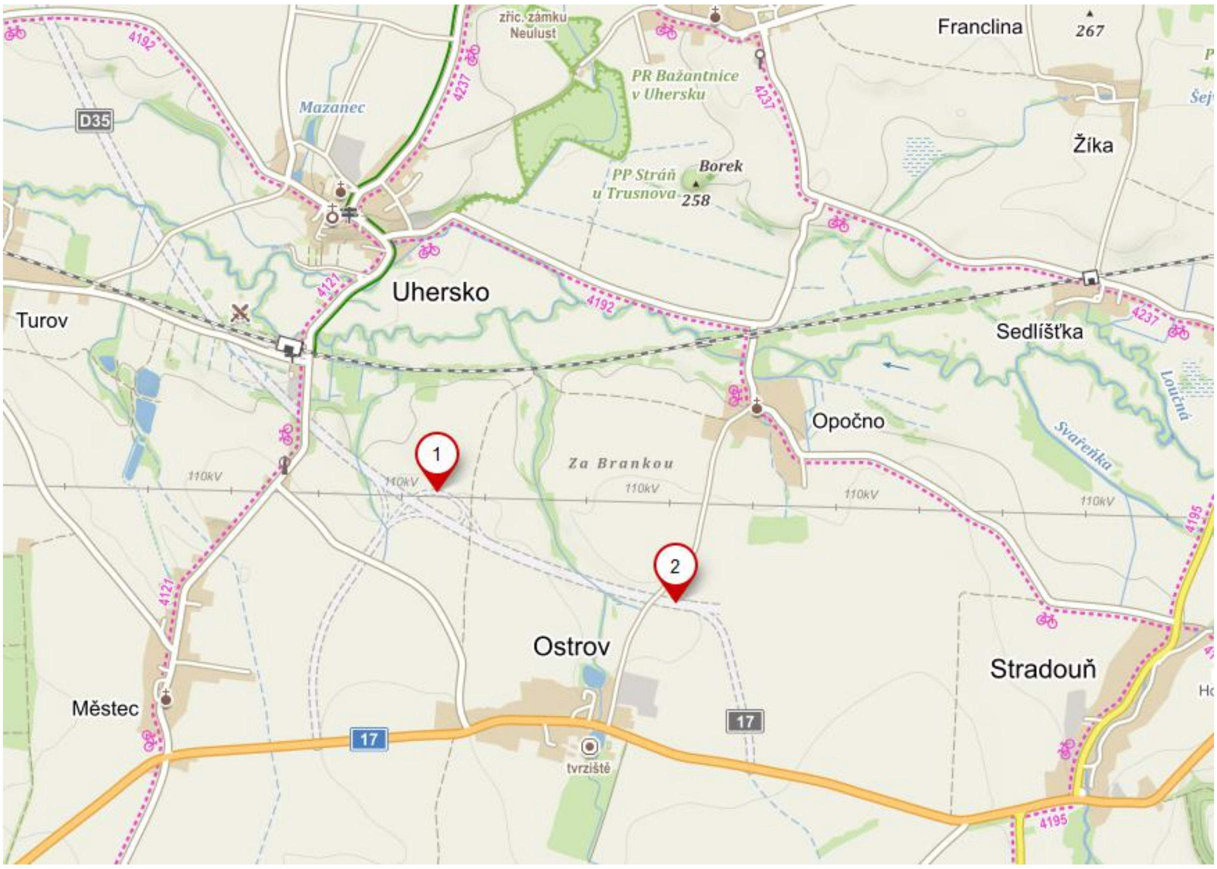

Fig. 1. Městec-Ostrov LBK wells map

Ostrov well

Construction of a motorway near the village of Ostrov, archaeologists excavated a structure of a wooden water well lining with a square base area of 80 × 80 cm and 140 cm in height (Rybníček et al. 2020). Due to the excellent conservation of the oak timbers, used trees were felled in the years 5256/55 BC, which makes this well the oldest dendrochronologically dated archaeological wooden construction worldwide. The design consists of grooved corner posts with inserted planks. Fragments of wood from the well filling show mainly oak and hazel, indicating a local forest composition.


Fig. 2. Ostrov LBK well during excavation

Neolithic well, the fills of which contained a huge amount of aquiferous plant remains, is unique in many respects. However, there is also a certain contradiction in the results of archaeobotany analyses and archaeological research. Moreover, the faint Neolithic settlement in the vicinity of the investigated well on the edge of the known Neolithic ecumene contrasts with the botanical evidence of intense human influence on the vegetation. The assemblage is dominated by plant species of open habitats and light forests (or rather a tree stands). Evidence of intensive subsidence, ruderalisation, and eutrophication of habitats around the well was also provided. Isolated diaspores of weeds (e.g., *Bromus arvensis, Fallopia convolvulus, Setaria viridis*) were introduced into the study area along with field crops (poppy, flax, single- and double-grain wheat). Most of the species are characterized by a wide ecological amplitude allowing growth in both segetal and ruderal communities.

Městec well

On the surface, the building appeared as a standard oval settlement pit, disturbed by land reclamation. However, a distinct black 'wedge' was visible on the section from the surface, which was vertically deepened into the bedrock. The feature was subsequently examined as a whole in section. The well was a hollowed-out tree trunk with one ceramic vessel.

The pollen spectrum has a high species richness, especially in the spectrum of herbs. This is a big difference compared to natural pollen profiles where woody plants or local wetland vegetation dominate. The pollen of cereals and evidence of human impact on the landscape and vegetation in the earlier Neolithic period are difficult to document. The natural dynamics of vegetation, its heterogeneity, and the actual development of wetland sites play a greater role than direct human influence.

The relatively high proportion of pine, with a share of between 10 and 15% in the object fill, can be explained by its easy dispersal compared to oak, The high representation of pine is typical for the Czech lowlands throughout the Holocene, especially in the Polabí region (Petr and Novák 2014). Otherwise, oak is dominant in the Neolithic anthracology record and also absolutely predominant in the preserved wood from the linear wells examined so far from the Czech Republic. Another important tree species is hazel typical of the Middle Holocene. Less common are lime and elm, otherwise also typical tree species for light forests of the Middle Holocene.

Relatively little cereal pollen is present, although much attention has been paid to it in identification, and the main distinguishing feature is not only the absolute diameter of the pollen grain but mainly the size of the pore. This may be related to the relatively small pollen production of wheat at that time and the generally small proportion of cereal fields in the landscape at that time. An important finding is the pollen grains of flax (*Linum*), which indicate its cultivation and processing in the vicinity of the well. It can be speculated whether or not the surrounding wetland was used for soaking flax.

Ruderal species are recorded and these are mainly indicators of trampling such as *Polygonum aviculare*, *Plantago major* and *P. lanceolata*, but also *Artemisia* and *Urtica*. Herbs such as *Campanula* or *Centaturea* indicate open habitats with species-rich grassland vegetation. The relatively high proportion of Umbelifera is interesting, but they have a wide ecological range and probably capture terrestrial as well as wetland vegetation. An important and interesting component of the pollen spectrum is several indicators of local wetland vegetation, notably the *Filipendula*, *Lythrum*, Cyperaceae, and *Polygonum persicaria*. This makes it possible to reconstruct the vegetation of the site where the well was built. It was probably a small spring or waterlogged site and the well was used to collect water that would otherwise have been less accessible or of poor quality. This shows great similarity with the nearby Neolithic well from the Ostrov and the whole system of water conduction in the spring basin at the same site dating from the Eneolithic. Captured spores of intestinal parasites (*Ascaris* and *Trichiura trichiuris*), indicate fecal contamination. The most likely interpretation of their origin is from domestic animals for which they well served as a watering hole.

CONSLUSIONS

Wells in eastern Bohemia are interesting to compare them with other pollen-analyzed Neolithic wells from the Czech Republic, which differ mainly in their location within the settlement (Uničov and Velim), where they are part of it and directly capture the settlement's own synanthropic vegetation. In contrast, the well at Ostrov and Městec was outside the settlement proper. It was probably a feature located in the site of a spring or waterlogged area where water was collected in sufficient quantity and quality for the needs of the Neolithic settlement. The intestinal parasite spores recovered can be interpreted as the presence of domestic animals such as cows. The well may have served as a watering hole for domestic animals at least at the time of its demise.

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

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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 waterpower. 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.

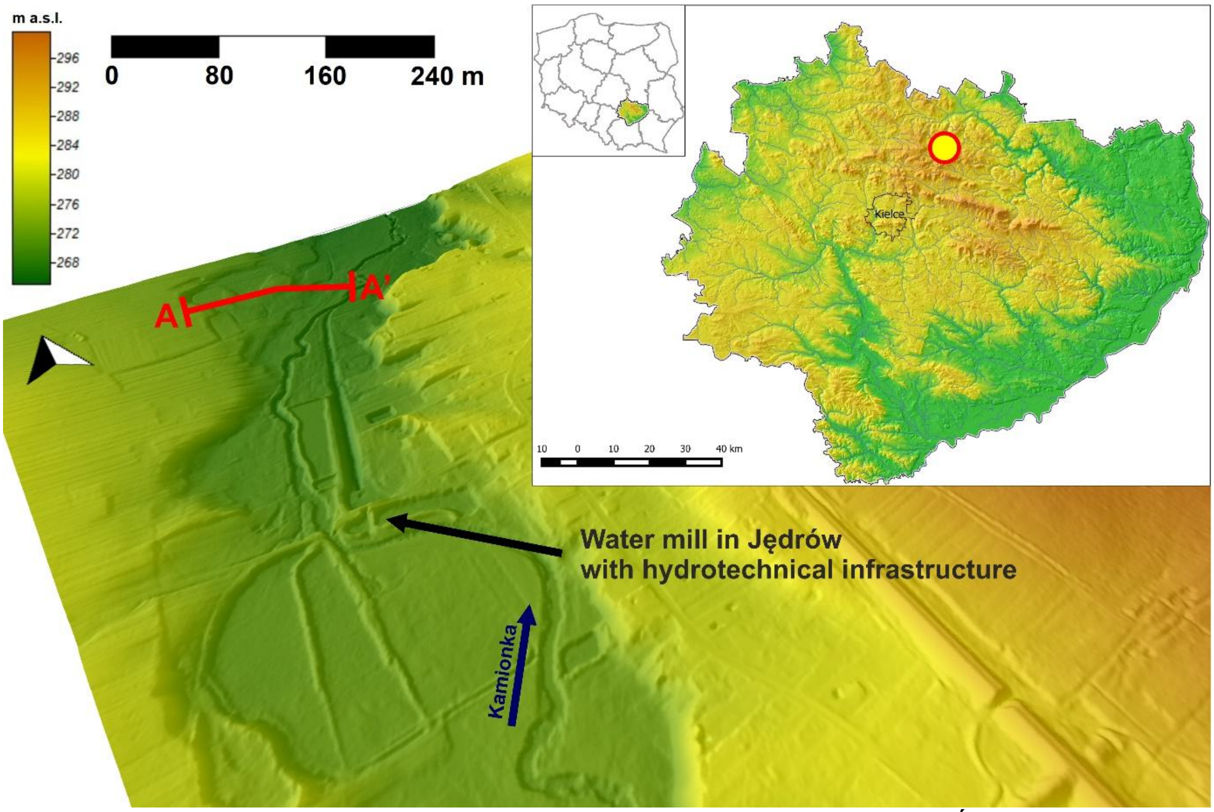

Fig. 1. Study area location on Digital Elevation Model (DEM) of the Świętokrzyskie Voivodeship in Poland and Jędrów site in Kamionka River valley (by M. Frączek based on CODGiK data; MGGP Aero agreement No. GI-FOTO.703.44.2014)

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 (Richeedeau, 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 mircoslags (with iron spherules) in sediments.

RESULTS

The MSS method enables the detection of 200-63 μm particles (hemmerscales)(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 ^{14}C 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 during 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.

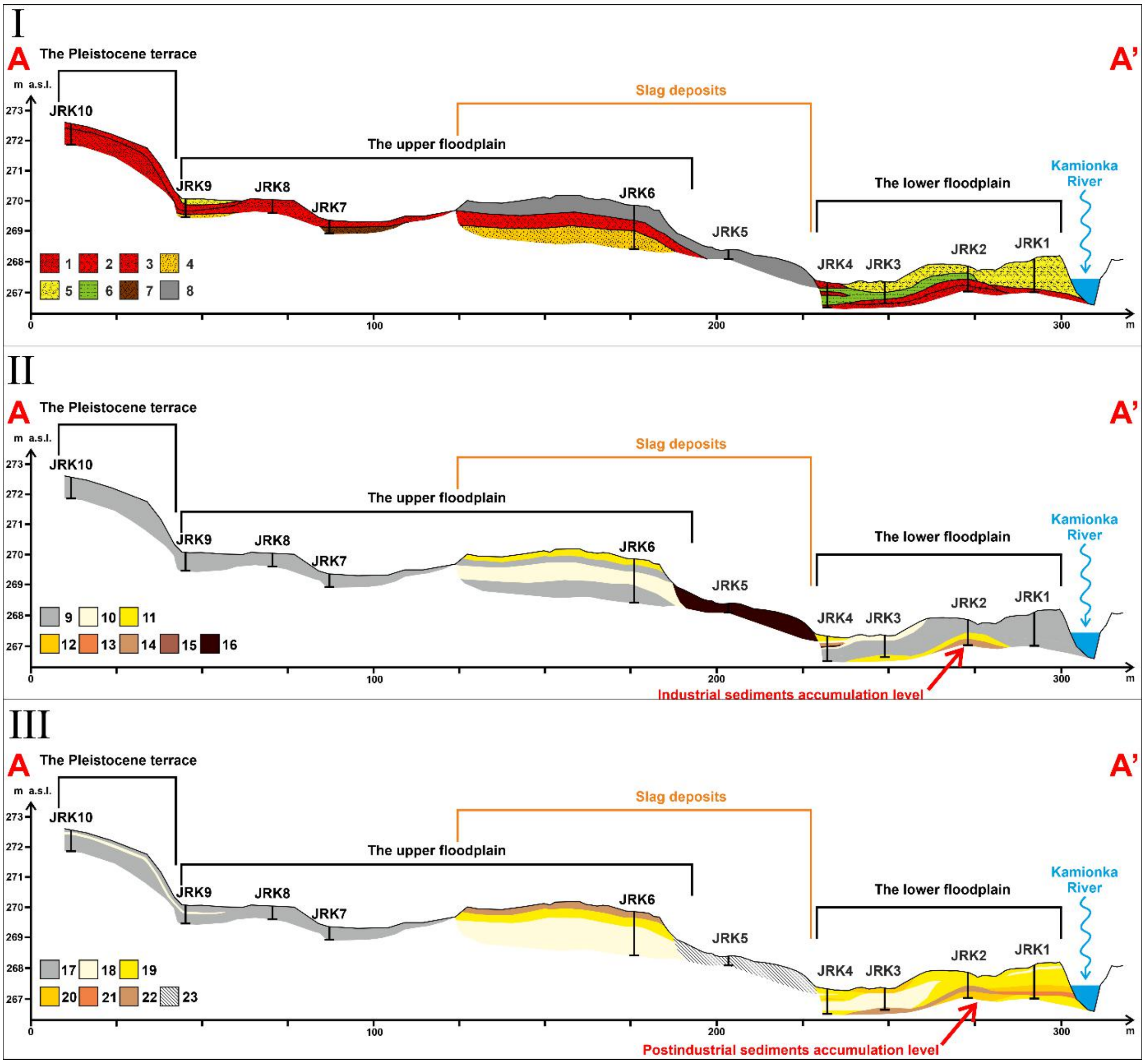

Fig. 2. A section across A-A' the Jędrów site (Kamionka River). Lithology (I): 1 – sands with gravels, 2 – sands with single gravels, 3 – silty sands with gravels, 4 – medium sands, 5 – silty sands, 6 – sandy silts, 7 – clayey peats, 8 – embankments; Slag concentration in % (II): 9 – no slags, 10 – 1-5, 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

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

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ABSTRACT

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 areas of three river basins in Poland, the Kłodnica, Czarna Konecka and Mała Panew river. In addition, in-depth studies were carried out for another two sites from the Mała Panew River basin. The aim of this study was to identify the RCHs (digital and field analysis) and to determine their number 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). On the basis of the schaded relief models we have identified 3,996 RCHs in an area of 625 km^2 along the Kłodnica River. Along the Czarna Konecka River, in an area of 663 km^2 we have identified 37,733 RCHs visible in the present topography. Along the Mała Panew River we have identified 166,356 RCHs on an area of 902 km^2. Identification of selected forms during field studies was carried out. Selected RCHs in the study areas ranged from 10 to 20 metres in diameter. The centres of all charcoal hearth remains are composed of elevated mounds 0.2–0.5 m in height. Around the central mound of each RCH, the remnants of four to nine pits (2-3 m in diameter and around 0.5 m deep) are present. The results of the palaeobotanical analysis allowed to establish that both coniferous and deciduous tree species were used to burn charcoal in the study area. Coniferous species predominate, mainly Scots pine (*Pinus sylvestris*). Most of the radiocarbon dates obtained for the RCHs analysed correspond well with historical data. However, in some cases radiocarbon dates from RCHs can serve as indications that the smelting plants may have been established 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 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 areas of three river basins in southern and central Poland, the Kłodnica, Czarna Konecka and Mała Panew river. In addition, in-depth studies were carried out for two sites from the Mała Panew river basin. The aim of this study was to identify the RCHs (digital and field analysis) and to determine their number and 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 selected areas of three river basins. Preliminary identification of RCHs allowed to establish that their greatest concentrations are located relatively close to the riverbed and in modern forested areas. On this basis, a research area was designated up to 4 km from the river bed on both banks, along its entire length. Then, shaded relief models covering selected areas were created using the GIS software. On the basis of digital images, RCHs were counted manually. Field studies were carried out in the vicinity of the chosen former metallurgical centers in three river basins and in addition, in-depth studies were carried out for two another sites from the Mała Panew river basin. They consisted in the field verification of RCHs, previously identified on digital images. Exposures were made in the selected RCHs. Charcoals were collected from the exposures for further laboratory analysis. In total, several hundred test ditches were made in order to verify the origin of landforms.

RESULTS AND CONCLUSIONS

On the basis of the shaded relief models we have identified 3,996 RCHs in an area of 625 km^2 along the Kłodnica river. Along the Czarna river, in an area of 663 km^2 we have identified 37,733 RCHs visible in the present topography. Along the Mała Panew river we have identified 166,356 RCHs on an area of 902 km^2. Identification of selected forms during field studies was carried out. Selected RCHs in the study areas ranged from 10 to 20 meters in diameter. The centers of all charcoal hearth remains are composed of elevated mounds 0.2–0.5 m in height. Around the central mound of each RCH, the remnants of four to nine pits (2-3 m in diameter and around 0.5 m deep) are present (Fig. 1).

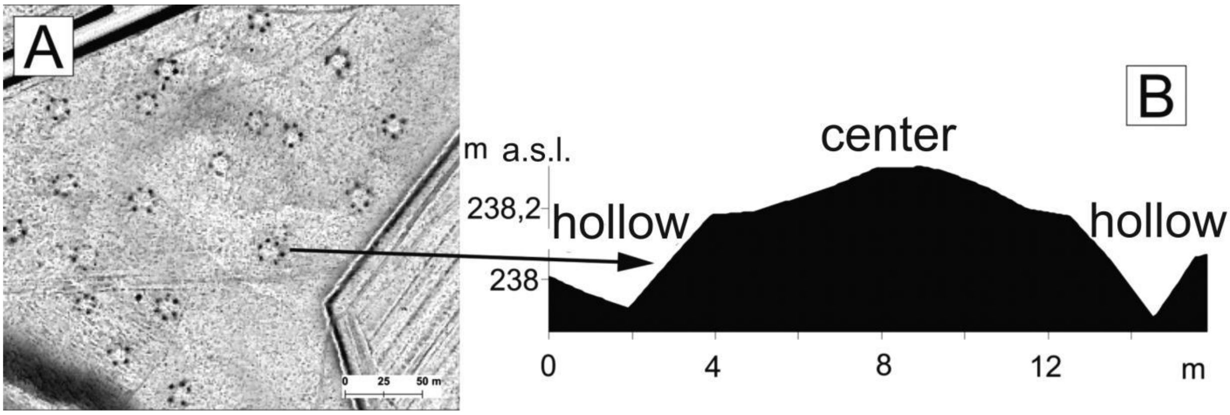

Fig.1 A-shaded relief model with visible RCHs. B-terrain profile through the single RCH.

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. The results of the palaeobotanical analysis allowed to establish that both coniferous and deciduous tree species were used to burn charcoal in the study area. Coniferous species predominate, mainly Scots pine (*Pinus sylvestris*) which proves the deliberate choice of this species for charcoal burning or the high availability of this species in the past. In addition, the following taxa were identified: 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*). Most of the radiocarbon dates obtained for the RCHs analysed correspond well with historical data on the development of the nearest individual smelting centres from the period of prosperity (17^{th}-19^{th} c.) of metallurgical activity. However, in some cases radiocarbon dates from RCHs can serve as indications that the smelting plants may have been established earlier than historical sources suggest or that charcoal was used for another kind of activity.

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HISTORICAL FIELD SYSTEMS IN THE CZECH REPUBLIC, ITS DEVELOPMENT, DATING AND PAST ENVIRONMENTAL CHARACTERISTICS FROM THE VIEW OF ENVIRONMENTAL ARCHAEOLOGY

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Keywords: pluzina, field systems, Middle Age, Czech Republic, environmental archaeology

Historical field systems in the Czech Republic are called "pluzina". These are agricultural structures of all fields, meadows and pastures connected to settlement by paths and are delimited often by hedgerows of shrubs. Its origin is usually dated from the medieval period to the early modern age. They are fundamental landscape features because of their ecological and historical value. Despite of this, they are not protected, and they are continuously destroyed by ploughing and deforestation.

Our project "Identification and protection of preserved remnants of historical pluzina system" is very complex. Aim of this project is to provide knowledge about important role of these past agrarian fields remains and to provide a basis for qualified protection of the pluzina itself, which are missing in the Czech Republic.

The crucial part of the archaeological field research is based on archaeobotanical methods. The main goal is to date chosen pluzina systems and to get other historical and archaeobotanical information. Botanical macroremains are used for the dating by radiocarbon method, sediment of profile is dated by the optically stimulated luminescence (OSL) with a control of sedimentation integrity by radionuclides ^{210}Pb and ^{137}Cs. OSL dating is used in case of presence of non-charred botanical marcoremains. All these dating methods are compared with archaeological data (archaeological dating of historical settlements; technological elements of agricultural terraces) and historical dating (written sources). Ecological and other environmental data (especially pollen analysis) are obtained to create a comprehensive overview of this landscape phenomenon and form macromodels of their development.

In this contribution we give an overview about five chosen pluzina field systems in the Czech Republic, and we present some archaeobotanical results from these sites.

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

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Keywords: Subneolithic, neolithization, hunter-gatherers, lifestyle

"In the south, our land is limited by the terrifying High Mountains covered with dark forest. Others - muteness, 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, 19).

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 (Kośko, 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. Subneolitization's main marker is the appearance of ceramic vessels, made differently from those of the south. The idea of subneolithic ceramics, however, can go back even to the 8th millennium BC (Gronenborn 2010).

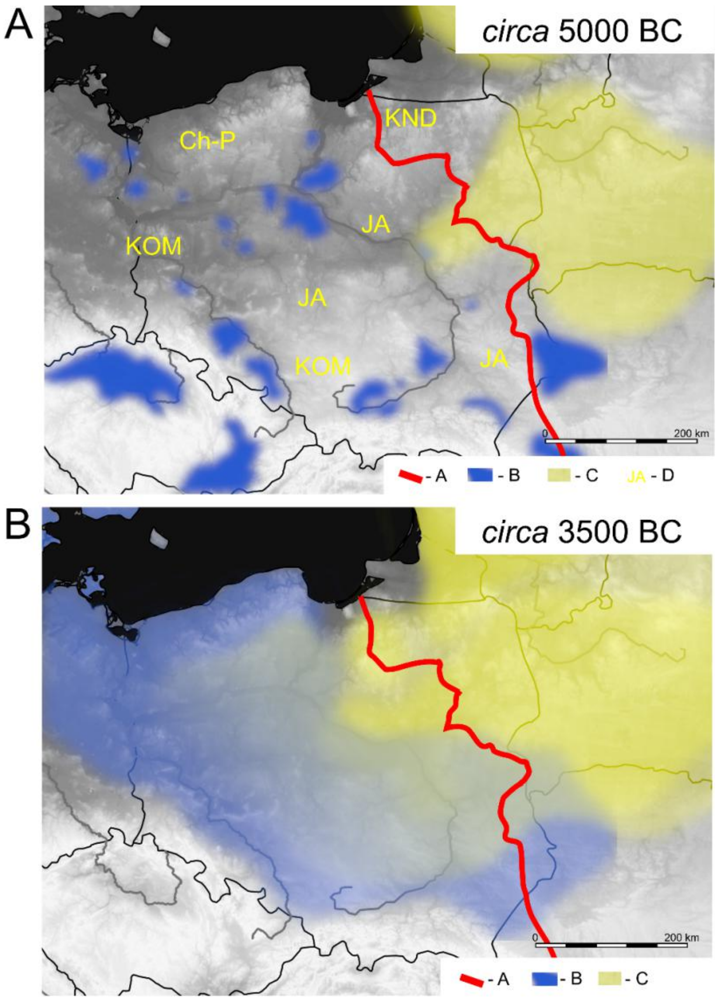

Fig. 1. Cultural situation on the border of the Eastern and Western Europ. A - period around 5000 BC: A - physicogeographocal border of the West and East Europe (A); Enclaves occupied by the Linear Band Pottery Culture communities (B); settlement range of subneolithic cultures (C); The Late Mesolithic cultural groups (D). B - period around 3500 BC: A - physicogeographocal 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, 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 all 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, is, for example, 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).

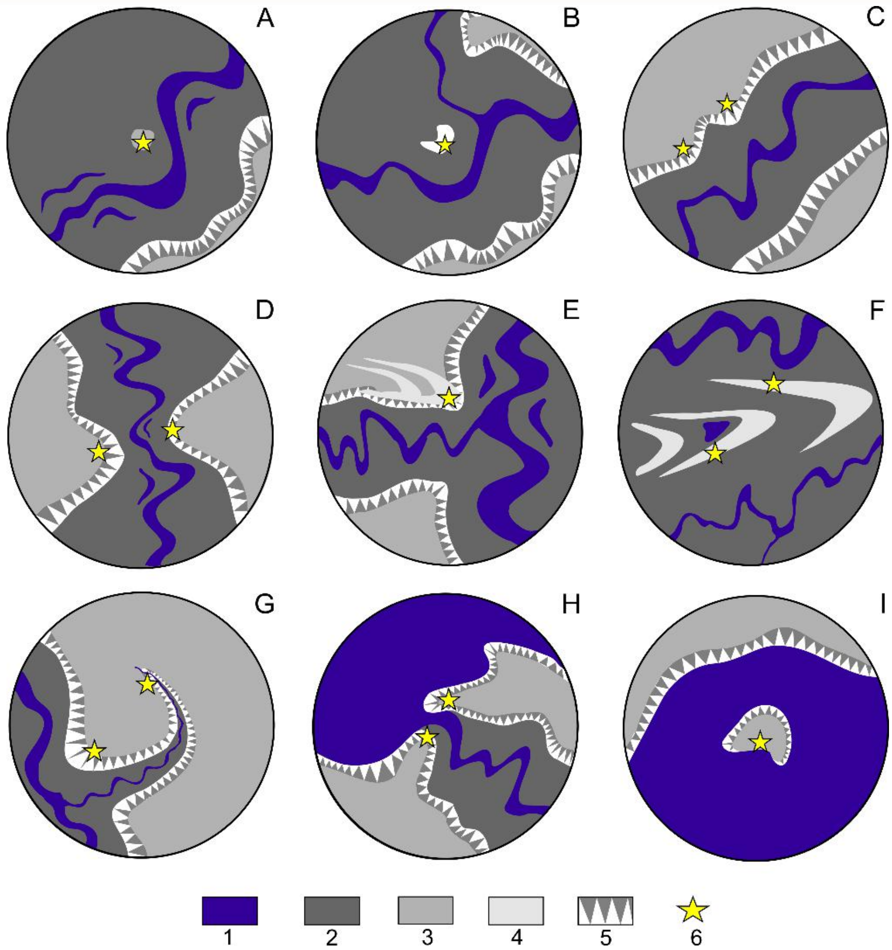

Fig. 2. Scheme of the location of Subneolithic campsites: rivers, lakes (1), river valleys (2), floodplain terraces, uplands (3), dunes (4), edges of uplands, (5) location of sites

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 cultural structures. Rather, subneolithizated 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 classical, 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.

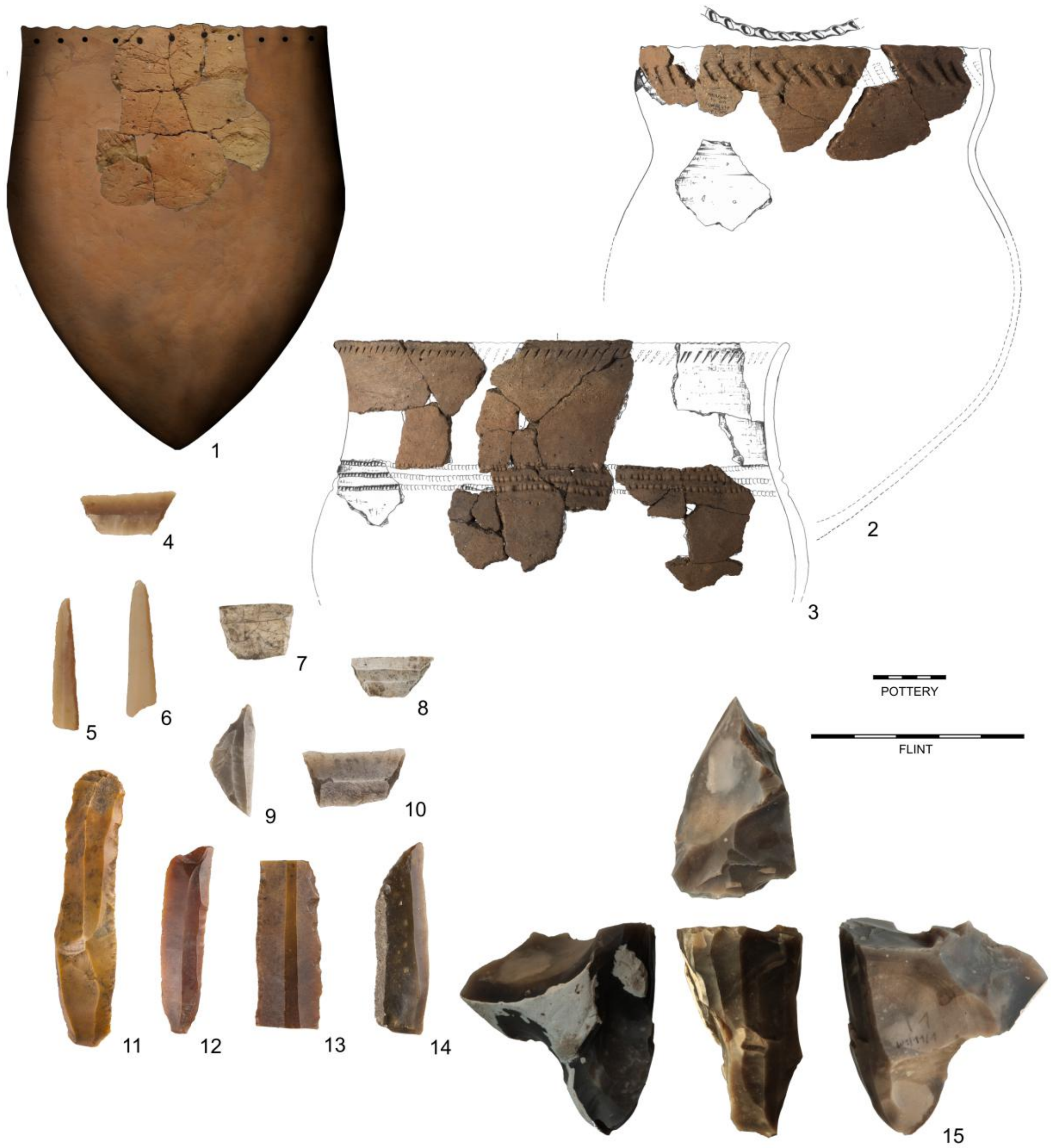

Fig. 3. Examples of subneolithic ceramics and flint products from sites located in the Narew and Bug basins: Brańsk 22 (1), Grady-Woniecko 1 (2-6), Sośnia 1 (7-14), Lipsk 81 (15) (by A. Wawrusiewicz, H. Lepionka)

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HUMAN-ENVIRONMENT INTERACTIONS IN NE POLAND DURING THE LUSATIAN CULTURE

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ABSTRACT

This paper presents the results of research into the context of human-environment interaction at the archaeological site at Jatwieza 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 Biebła river.

Keywords: Podlasie; Jatwież Duża site; geoarcheology; 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).

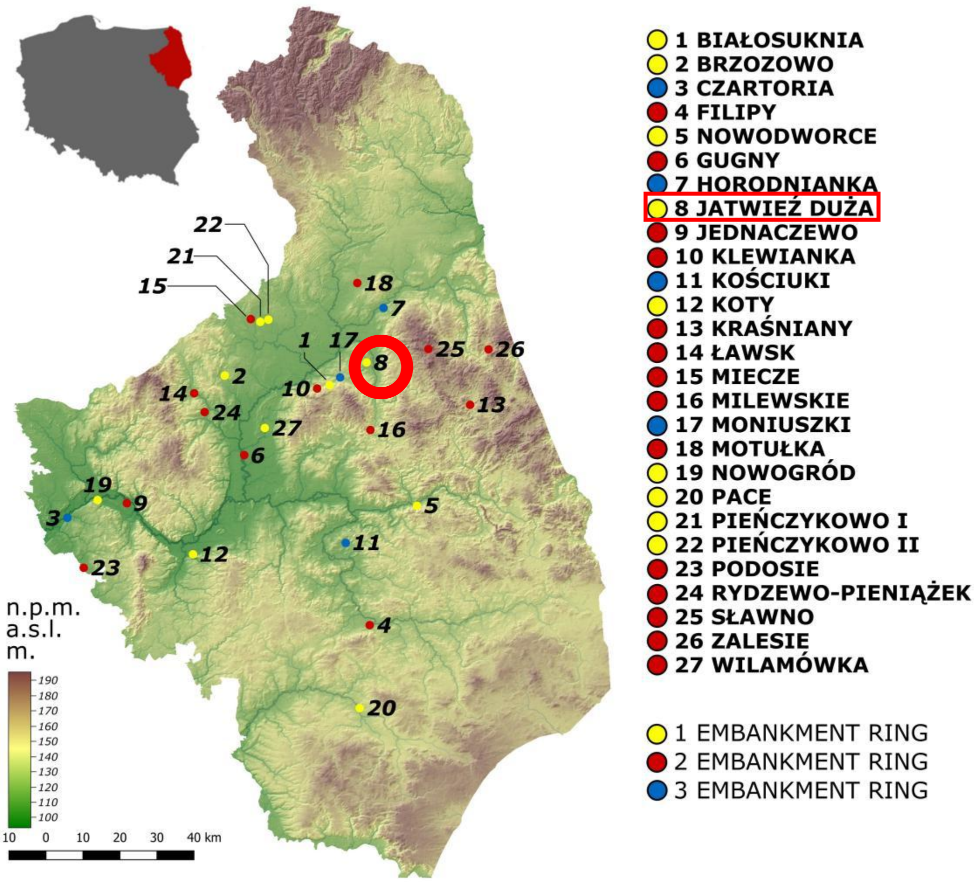

Fig. 1. Location of the research area and Jatwieź Duża site (red circle) with the network of similar sites in Podlasie (GUGiK data, DEM 100×100)

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).

AIM OF STUDY AND METHODS

To determine the environmental context of functioning of the Jatwieź Duża site, a series of geological boreholes was made across the bottom of the Brzozówka and Biebła 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 Skała (Walanus, Goslar 2009).

On the basis of results of these analyses the cross sections of the Brzozówka and Biebła 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.

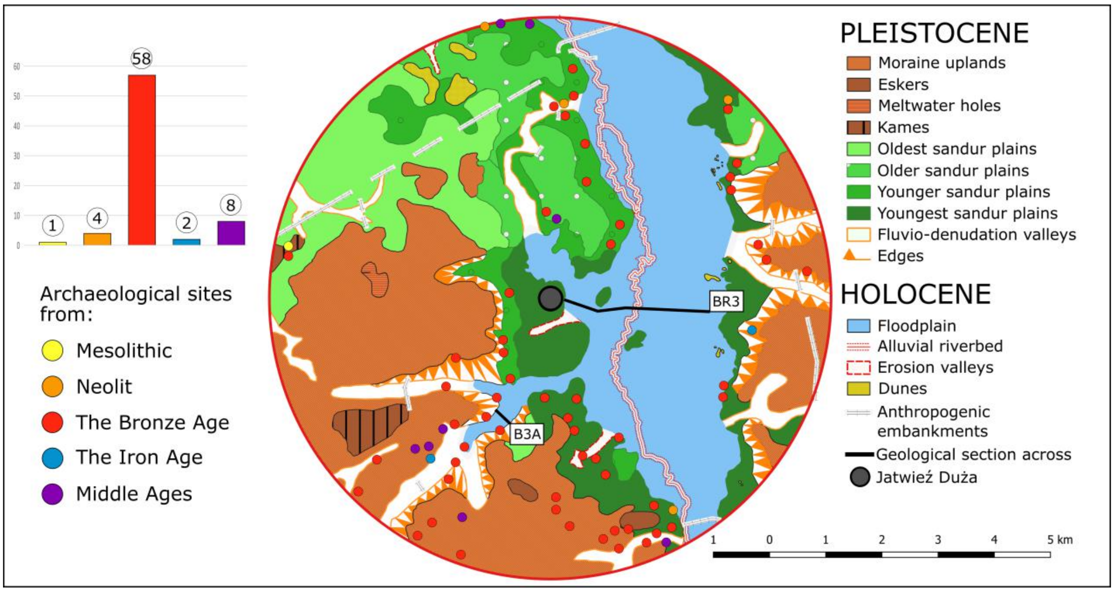

Fig. 2. Geomorphological map with archaeological points of AMP
(by M. Frączek, T. Kalicki; modified)

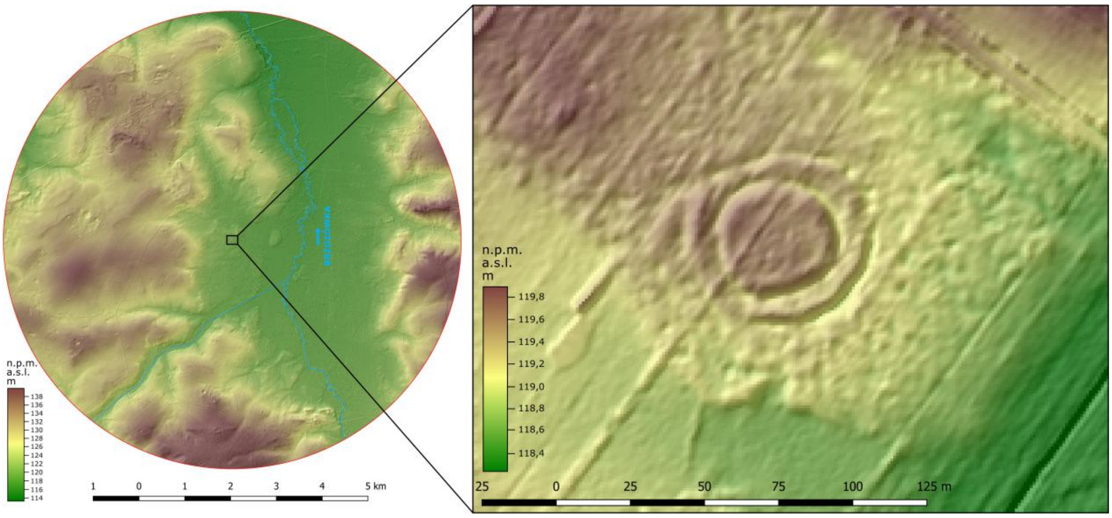

Fig. 3. Jatwież Duża archaeological site on digital elevation model (DEM)

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).

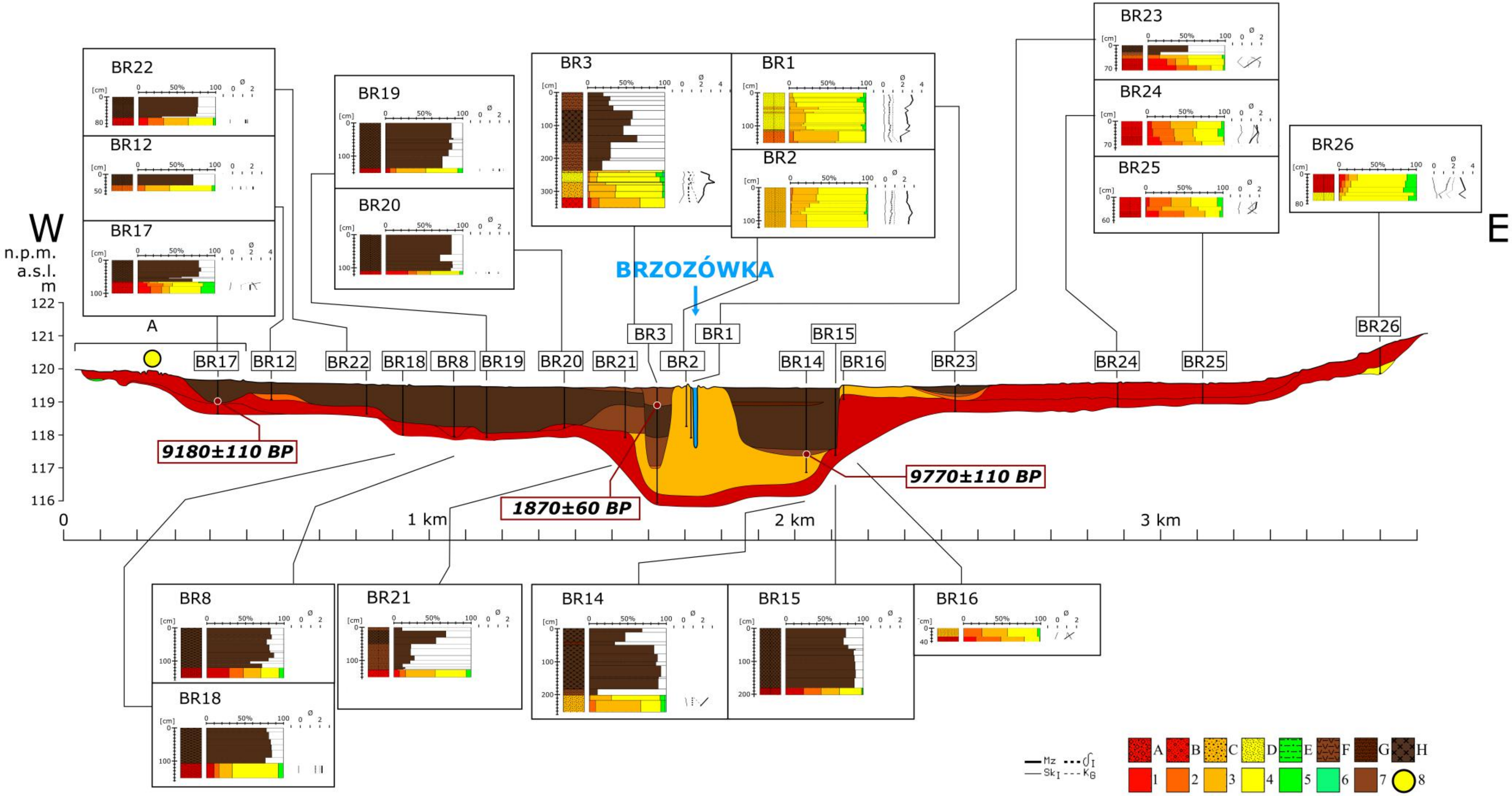

Fig. 4. Geological section across the Brzozówka river valley
Lithology: A – sands with gravels, B – sands with single gravels, C – medium sands, D – fine sands, E – silts and clays, F – sandy peats, G – peaty silt, H – peats; Fractions: 1 – gravel (below -1ø), 2 – coarse sand (-1–1ø), 3 – medium sand (1–2ø), 4 – fine sand (2–4ø), 5 – silt (4–8ø), 6 – clay (above 8ø), 7 – content of organic matter,
8 – Jatwieź Duża site; Folk-Ward's (1957) distribution parameters: Mz – mean diameter, δ_I – standard deviation (sorting), Sk_I – skewness, K_G – kurtosis

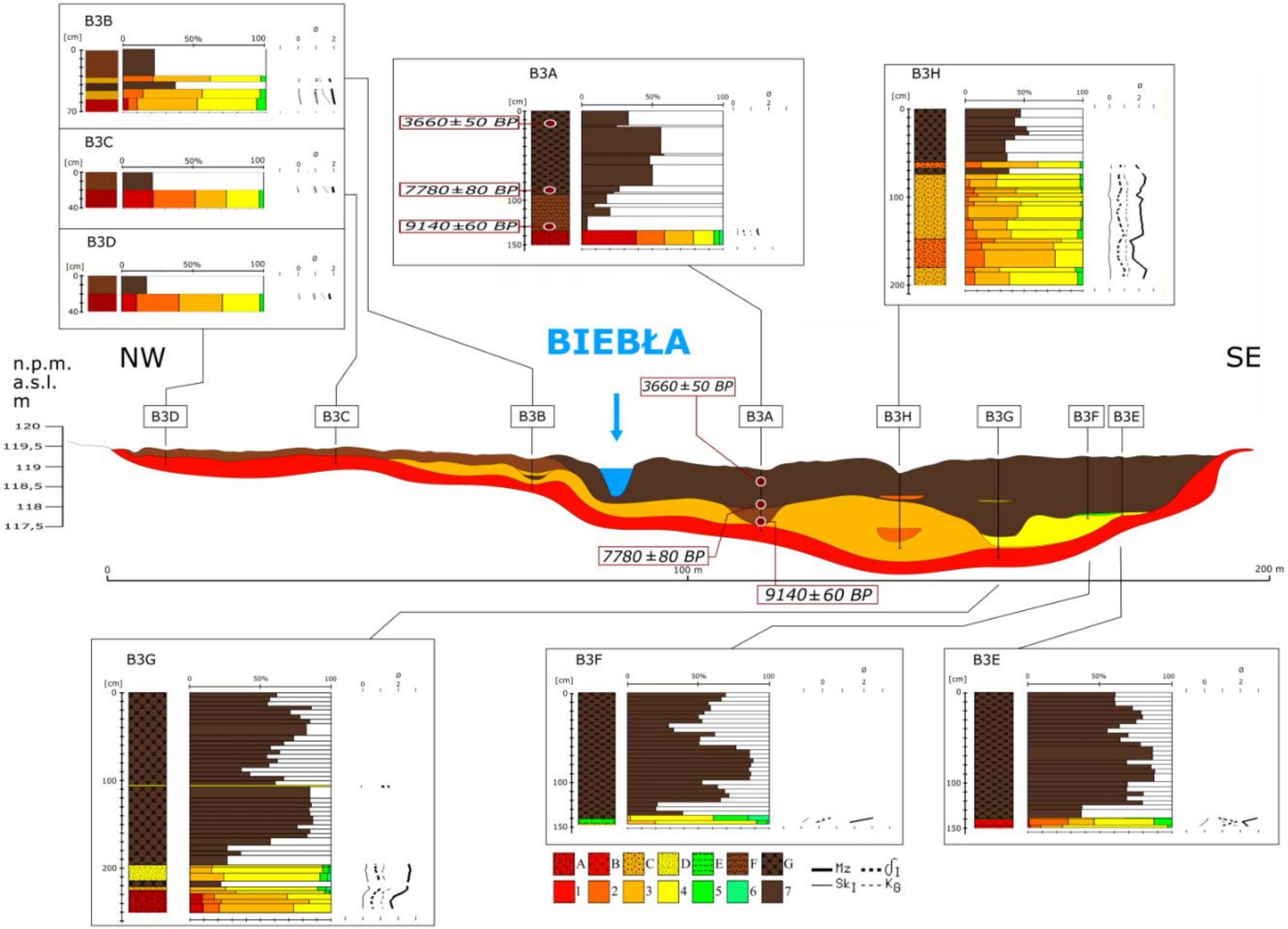

Fig. 5. Geological section across the Biebła valley Lithology: A – sands with gravels, B – sands with single gravels, C – medium sands, D – fine sands, E – silts and clays, F – peaty silts, G – peats; Fractions: 1 – gravel (below -1ø), 2 - coarse sand (-1–1ø), 3 – medium sand (1–2ø), 4 – fine sand (2–4ø), 5 – silt (4–8ø), 6 – clay (above 8ø), 7 – content of organic matter; Folk-Ward's (1957) distribution parameters: Mz – mean diameter, δI – standard deviation (sorting), SkI – skewness, KG – 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.

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 Jatwieź 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.

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TIME TABLE

FIRST DAY 4.04.2022

12:00 Registration of participants

13:00 LUNCH

14:00–14:30 OPENING CEREMONY

OPEN SESSION

14:45-15:15 **Lenka Lisa** – *Conference of Environmental Archaeology (CEA/KEA)* over the years, past and future prospections?
15:15-15:30 **Tomasz Kalicki** – *Polish Association of Environmental Archaeology (SAS) – past, present-day, future*
15:30-15:45 **Ondřej Mlejnek –** *IANSA: Interdisciplinaria Archaeologica. Natural Sciences in Archaeology*

15:45-16:00 COFFEE BREAK

SESSION I: PALEOLITHIC-NEOLITHIC

16:00-16:25 **Ondřej Mlejnek, Libor Petr -** *THE LOUČNÁ RIVER VALLEY (EASTERN BOHEMIA) ON THE ONSET OF THE HOLOCENE*
16:25-16:50 **Libor Petr, Petr Kočár, Lenka Lisá, Jaroslav Peška, Ivana Vostrovská, Aleš Bajer** - *NEOLITHIC WELLS IN EASTERN BOHEMIA AND RECONSTRUCTION OF PAST ENVIRONMENT*
16:50-17:15 **Jakub Niebieszczański, Iwona Hildebrandt-Radke, Piotr Kołaczek, Monika Karpińska-Kołaczek, Waldemar Spychalski, Monika Rzodkiewicz, Jan Romaniszyn, Cezary Bahyrycz** - *BACK TO THE BRUSZCZEWO: GEOARCHAEOLOGICAL INVESTIGATIONS OF EARLY/MIDDLE HOLOCENE LAKE AND LATE HOLOCENE PEATLAND IN THE CONTEXT OF CHANGING SETTLEMENT PATTERN*
17:15-17:40 **Tomasz Kalicki, Piotr Biesaga** – *ALLUVIAL FANS AS INDICATOR OF HUMAN IMPACT: CASE STUDY OF MOZGAWA AND NIDA RIVER VALLEY (POLISH UPLANDS)*

17:45-18:15 POSTER SESSION

Nevenka Atanasoska - *EMPLOYING THE ENVIRONMENTAL DATA INTO UNDERSTANDING THE PAST LANDSCAPES: CASE STUDY OF BURIAL MOUNDS IN MARIOVO*

Patricia Ayipey, Adela Pokorna, Dela Kuma, Samora Harry Ayivor, Amedeke Bright, Rexford Kedze, Emmanuel Ayivor, Jaromír Beneš - *ARCHAEOLOGICAL INVESTIGATION OF LIKPE KUKURANTUMI EARTHWORK SETTLEMENT, GHANA: PRESENTATION OF THE RESEARCH PROJECT*

Ewa Kołaczkowska, Anna Kowalska, Michał Słowiński, Agnieszka Halaś, Krzysztof Szewczyk, Dominika Łuców, Agnieszka Mroczkowska, Mateusz Kramkowski, Jerzy Jonczak, Vincenzo Barbarino, Aleksandra Chojnacka - *CAN CURRENT VEGETATION SERVE AS AN INDICATOR OF HISTORIC CHARCOAL PRODUCTION IN PINE FORESTS?*

19:00 DINNER AND „ICE BREAK PARTY"

SECOND DAY 5.04.2022

8:00 BREAKFAST

SESSION II: GEOARCHAEOLOGY OF NE POLAND

9:00-9:25 **Adam Wawrusiewicz -** *SUBNEOLITHIC - ALTERNATIVE LIFESTYLE. THE LAST HUNTER-GATHERERS ON THE BORDER BETWEEN EASTERN AND WESTERN EUROPE*

9:35-9:50 **Marcin Frączek, Adam Wawrusiewicz, Tomasz Kalicki, Iga Szwed -** *STRATIGRAPHY AND PALAEOENVIRONMENTAL CONTEXT OF THE ARCHAEOLOGICAL SITE OF THE NIEMEN CULTURE – CASE STUDY AT LIPSK SITE (NE POLAND)*

9:25-10:15 **Krzysztof Żurek, Tomasz Kalicki, Adam Wawrusiewicz** – *HUMAN-ENVIRONMENT INTERACTIONS IN NE POLAND TURING THE LUSATIAN CULTURE*

10:15-10:40 **Małgorzata Karczewska, Maciej Karczewski, Tomasz Kalicki, Paweł Przepióra, Krzysztof Żurek, Sławomir Chwałek, Karolina Fularczyk -** *GPR SURVEYS OF HISTORICAL CEMETERIES IN NORTH-EASTERN POLAND: BIAŁOGÓRY, GIŻYCKO, SOŚNIA*

10:40-11.15 COFFEE BREAK

SESSION III ARCHAEOBOTANY AND SOIL

11:15-11:40 **Ivana Šitnerová, Jaromír Beneš, Tereza Majerovičová, Jiří Bumerl, Veronika Komárková, Václav Fanta, Petra Marešová, Lenka Hrabáková, Kristina Janečková -** *ARCHAEOBOTANY AS A TOOL FOR THE ARCHAEOLOGY: HISTORICAL FIELD SYSTEMS IN THE CZECH REPUBLIC, ITS DATING AND PAST ENVIRONMENTAL CHARACTERISTICS*

11:40-12:05 **Jaromír Kovárník, Jaromír Beneš -** *EFFECTS ON THE PRESERVATION OF STARCH GRAINS IN THE SOIL ENVIRONMENT*

12:05-12:30 **Petr Krištuf, Martin Janovský, Jan Fišer, Jan Turek, Michal Hejcman -** *ELEMENTAL ANALYSIS OF ARCHAEOLOGICAL SOILS CAN HELP TO EXPLAIN PREHISTORIC LAND USE – EXAMPLE OF LONG BARROWS IN BOHEMIA*

12:30-12:55 **Sahar Mohammadi, Lenka Lisá, Ivana Šitnerová, Jiří Bumerl, Tereza Majerovičová, Jaromír Beneš** - *SOIL AND HUMAN ACTIVITY IN THE ROMAN IRON AGE AND THE HIGH MEDIEVAL PERIOD: A CASE STUDY FROM DEBRNÉ, CZECHIA*

13-14 LUNCH

SESSION IV: ALLUVIAL AND URBAN ARCHAEOLOGY

14:00-14:25 **Kristína Majorošová, Jan Petřík -** *ASSESSMENT OF FLUVIAL SEDIMENTS AND EVOLUTION OF SVRATKA FLOODPLAIN IN BRNO FROM THE PERSPECTIVE OF CHEMICAL-PHYSICAL PROXY INDICATORS*

14:25-14:50 **Tomasz Kalicki, Sławomir Chwałek, Jani Konstantinovski Puntos -** *ENVIRONMENTAL CONDITIONS OF THE LOCATION AND FUNCTIONING OF ANCIENT CITIES IN THE SW CYPRUS*

14:50-15:15 **Piotr Kalicki -** *FIELDS IN THE FOG: LAND USE CHANGES AND LANDSCAPE TRANSFORMATION IN LOMAS DE LACHAY, CENTRAL PERU*

15:15-15:40 **Lenka Lisá, Jana Mazáčková, Petr Žaža, Miriam Fišáková Nývltová -** *WHAT IS THE ROLE OF KITCHEN WASTE IN THE ENVIRONMENT OF A MEDIEVAL CASTLE? CASE STUDY ROKŠTEJN*

15:40-16:05 COFFEE BREAK

SESSION V: GEOARCHAEOLOGY OF OLD-POLISH INDUSTRIAL DISTRICT

16:05-16:30 **Tomasz Kalicki, Piotr Kusztal -** *ROLE OF NATURAL AND ANTHROPOGENIC SMALL RETENTION WATER SYSTEMS IN THE HOLOCENE EVOLUTION OF SMALL RIVER VALLEYS: CASE STUDY FROM CZARNA KONECKA (HOLY CROSS MTS. REGION, CENTRAL POLAND)*

16:30-16:55 **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)*

16:55-17:20 **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)*

17:20-17:45 **Paweł Rutkiewicz, Tomasz Kalicki -** *RELICT CHARCOAL HEARTHS AS AN ARCHIVES OF PAST HUMAN ACTIVITY (EXAMPLES FROM POLAND)*

17:45-18:15General discussion

19:00 CONFERENCE DINNER

THIRD DAY 6.04.2022

8:00 Breakfast

Excursion

9:00 DEPARTURE

10:00 Museum in Nowa Słupia
14:00 Archaeological Museum and Reserve in Krzemionki
18:00 return to the hotel

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