FOLIA QUATERNARIA 85, KRAKÓW 2017, 65–79 DOI: 10.4467/21995923FQ.17.003.8145
PL ISSN 0015-573X

ABIOTIC ENVIRONMENTAL CONDITIONS OF FORMER SETTLEMENT IN THE VICINITY OF ULÓW IN ROZTOCZE (SE POLAND)

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A b s t r a c t. The paper presents the environmental conditions of the location of a multicultural settlement functioning from the Palaeolithic to the modern times in an area of an alleged settlement void. The location of the settlement was evaluated in terms of transport and communication possibilities at the regional scale and local environmental conditions. Field research was conducted, as well as the analysis of the hydrogeological and geomorphological conditions in the context of water supply and soil conditions for the development of agriculture. The detailed analysis applied an ALS (Airbone Laser Scanning) image and geological-soil coring. The study area is located on the crossing of prehistoric transport routes the course of which depends on the variability of the natural environment at the regional scale. At the local scale, settlement was favoured by abiotic parameters of the natural environment: easily arable soils, beneficial microclimate, and hydrogeological conditions providing for the presence of water in the plateau area.

K e y w o r d s: natural conditions of ancient settlement, environment of Roztocze

INTRODUCTION

The communities of prehistoric and historic cultures chose settlement areas based on different needs, usually depending on the type of settlement and economy (Domańska et al. 2009). Sometimes, however, settlements are continuously inhabited by the communities of different subsequent cultures. This is exemplified by the vicinity of the Ulów village located in Roztocze, where the occurrence of remains of many cultures from different time periods was recorded over a small area (Niezabitowska-Wiśniewska 2008, 2017).

Before the commencement of the archaeological research in Ulów, Roztocze was commonly assumed to be an area unfavourable for prehistoric settlement due to the land relief, scarcity of surface waters, and difficult access to groundwaters. This particularly concerns Central Roztocze, where high forest cover made it difficult to conduct surface research in the scope of the Archaeological Inventory of Poland (Machnik 1961).

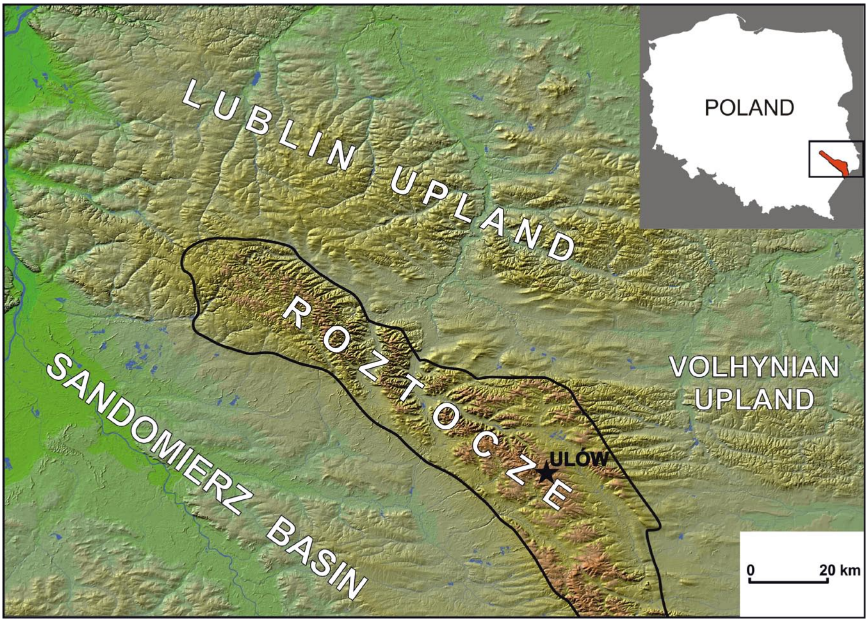

Fig. 1. Location of Ulów at the background of the DEM model (Gawrysiak 2004)

Gradual identification of the multicultural complex of sites in the vicinity of Ulów and lack of traces of prehistoric settlement apart from the discussed cluster, raised a question about the reason for choosing this place for settlement by the communities of almost every archaeological culture known from the territory of Poland. Particularly favourable natural conditions were assumed to contribute to the situation. They permitted water supply and land management in different economic models (e.g. in the case of agricultural cultures the quality of soils and possibility of their cultivation). The occurrence of water as well as the types of soils depend on the geological structure and land relief. Therefore, the objective of this paper is to determine natural conditions in the area of the settlement complex of Ulów – based on results of geomorphological-geological research, as well as to answer the question to what degree they could have affected the continuous character of settlement in the area (*vide* Pelisiak, Gębica 2007).

MATERIAL AND METHODS

Characteristics of the study area

Ulów is located in the centre of Tomaszów Roztocze, a mesoregion occupying the middle section of the Roztocze macroregion, an elevation with a width of 14–28 km extending in an arch towards NW-SE along a section of 180 km (Fig. 1). Roztocze is confined to tectonic edges reaching a height of up to 100 m (Maruszczak 1972; Buraczyński 2002). It connects the Polish Uplands to NW with the Ukrainian Uplands to SE, and separates the Basin of Northern Subcarpathia from mesoregional Sandomierz Basin within the Metacarpathian Uplands (Maruszczak, Sirenko 1989/90). The boundary of landscape areas of West and East Europe runs along a large portion of Roztocze (Kondracki 2009). The Polish-Ukrainian border runs through the region. The majority of Roztocze is located on the Polish side.

The elevation above the surrounding land experiences consequences in terms of climate – it is the coldest area of the Lublin Region, with mean annual air temperature amounting to 7°C. The snow cover persists for more than 80 days here. The vegetative season is relatively short (approximately 210 days). The highest annual precipitation total in the Lublin region is recorded on the south-western boundary of Tomaszów Roztocze (>700 mm). Precipitation in the north-eastern part of the mesoregion is lower by 100 mm (Kaszewski 2008). As a consequence, river water runoff in the south-western zone of the boundary exceeds 220 mm, and on the opposite side it is lower by 100 mm. Roztocze is an important watershed and a separate hydrographic region with scarce water network and waterless watershed areas. This results from high permeability of cover formations and bedrock (Michalczyk, Wilgat 2008).

Roztocze is composed of silicate-carbonate marine deposits of the Upper Cretaceous, namely opokas and gaizes – which do not contain any flint (Maruszczak 1998, 2002). On dissections and faults with NW-SE, NE-SW, and N-S orientations, valleys developed, dividing Roztocze into isolated blocks (Brzezińska-Wójcik 2013). One of them is the Ulów block, covering the study area (Fig. 2). Opokas

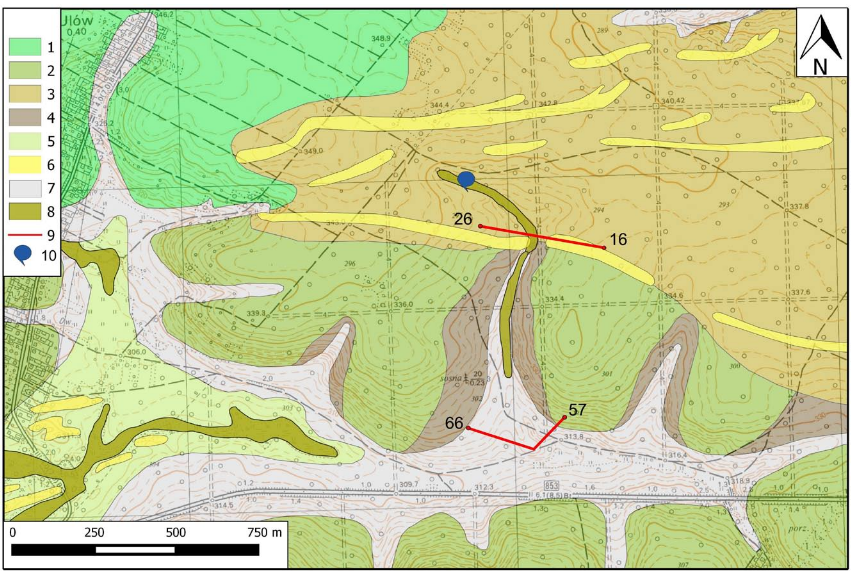

Fig. 2. Geological sketch of the Ulów area (based on Buraczyński et al. 2002, highly modified, after Rodzik et al. 2017). Maastrichtian: 1 – silicate-carbonate rocks; 2 – marly silicate-carbonate rocks; Weichselian Glaciation: 3 – aeolian sand on clay and bedrock, 4 – slope sand on clay, 5 – fluvio-periglacial sand; Late Glacial: 6 – aeolian sand in dunes, 7 – colluvial sandy clay; Holocene: 8 – peaty mud; 9 – cross-sections in Figs 6 and 7, 10 – spring

and gaizes of the Lower Maastricht outcrop in its northern part, and gaizes and marly opokas of the Upper Maastricht in the southern part (Buraczyński et al. 2002). The former ones are characterised by variable, but relatively high compression strength (8.2–39.0 MPa). The latter type of rocks shows lower compression strength (6.0–10.0 MPa), resulting from lower content of silica, and higher content of carbonates (Wyrwicka 1977a, b).

The primary element of land relief is so-called higher planation surface, shearing Upper Cretaceous rocks at an altitude of 340–350 m a.s.l. (Fig. 3). It is dissected by dry or moderately wet valleys located at an altitude of 305–320 m a.s.l. (Buraczyński, Chabudziński 2014). A system of such valleys dissects the south-western part of the study area where the bedrock includes gaizes and marly opokas. The valleys developed on the lines of cracks and faults, as suggested by their orientation and asymmetry of slopes (Fig. 4), i.e. features typical of the valleys of Roztocze (Buraczyński 2002; Brzezińska-Wójcik 2013). The valley floors particularly include Pleistocene sand and silt deposits (Buraczyński et al. 2002), and in wet areas – Holocene peat silts. In the NE part of the area, where the bedrock contains resistant opokas, the dissection with valleys is inconsiderable. This relatively flat surface extends both towards WNW and ESE (Buraczyński 2013). The surface is partly dissected by a small wet valley with a spring in its upper part (Fig. 3). It is located in the centre of the study area, and plays an important role for the studied settlement complex.

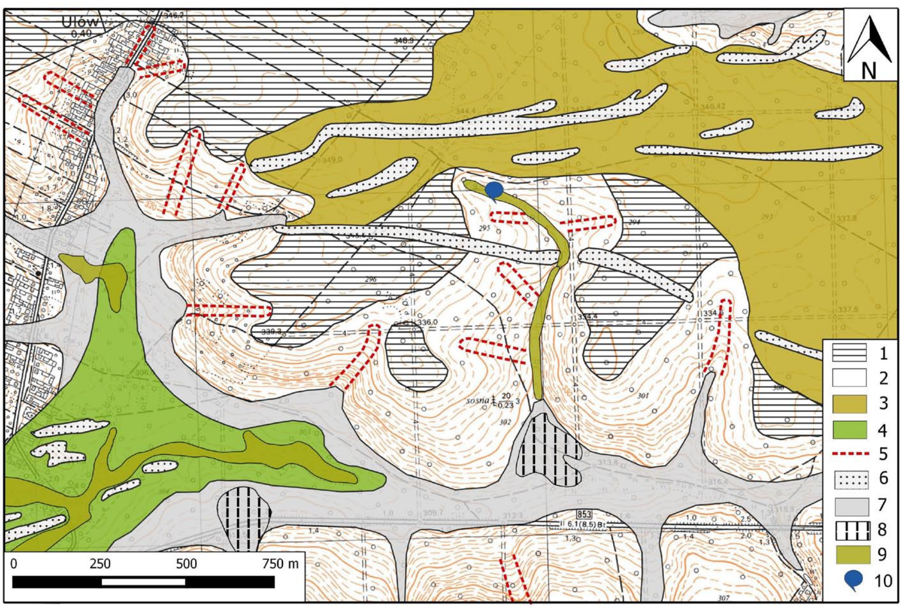

Fig. 3. Geomorphological sketch of the Ulów area (based on Buraczyński, Chabudziński 2014, modified, after Rodzik et al. 2017). Pliocene forms: 1 – planation surface 340–360 m a.s.l.; Pleistocene forms: 2 – slope, 3 – aeolian plain, 4 – terrace, 5 – trough-like valley; Late Glacial forms: 6 – dune, 7 – washing accumulation plain, 8 – alluvial fan; Holocene: 9 – peaty-muddy plain, 10 – spring

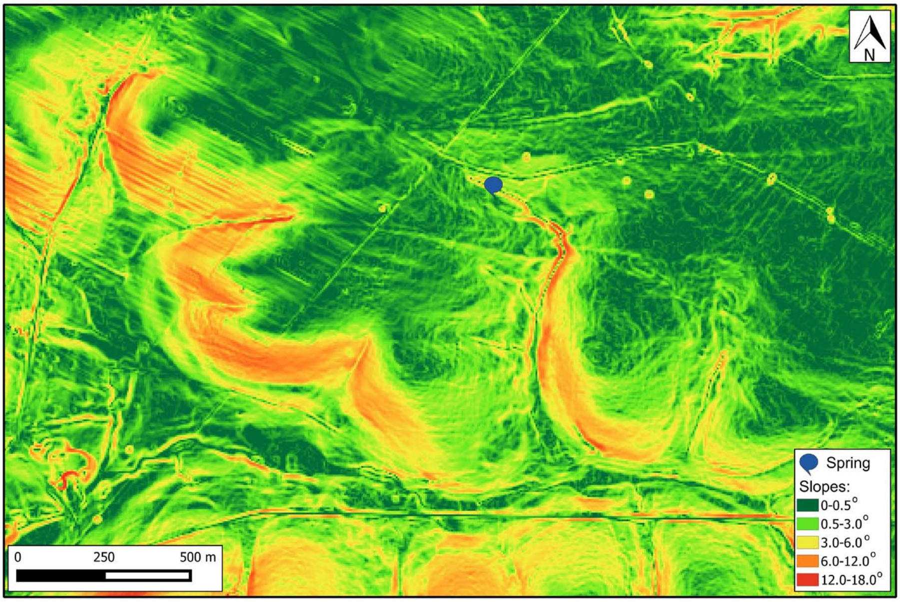

Fig. 4. Inclinations of slopes in the vicinity of Ulów (made of the basis of DTM)

Sequence of archaeological cultures

In forests located east of Ulów, historical material was discovered dated from the Late Palaeolithic to the 17th–18th century. Palaeolithic and Mesolithic settlement is represented the weakest. Considerably more historical objects date back to the Neolithic, where the Lublin-Volhynian, Funnel Beaker, and Corded Ware cultures are abundantly represented. The remains of settlement of the cultures of the Bronze Age were also found, namely the Mierzanowice, Trzciniec, and Lusatian culture. Traces of the settlement of the late Roman Period and early phase of the Migration Period are abundant (from mid 3rd to the end of the first half of the 5th century after Christ). Historical material from the Middle Ages is scarce. Remains of the modern settlement from the 17th–18th century are well represented (Niezabitowska-Wiśniewska 2008, 2017).

Sites of all of the aforementioned cultures are usually concentrated on the plateau, near the upper section of the valley with a spring (Fig. 5). Some of them (Corded Ware culture, Trzciniec culture) are more dispersed and have their sites on the plateau at a distance of several hundred metres from the spring, and on the terrace in the bottom of the main valley even at a distance of up to 2 km. All of the discovered archaeological sites, however, are distributed over a small area of approximately 2 km^2. Except for this cluster, no traces of prehistorical settlement occur within a radius of at least 3–5 km, or they are limited to single objects, particularly fragments of ceramics (Niezabitowska-Wiśniewska 2008, 2017).

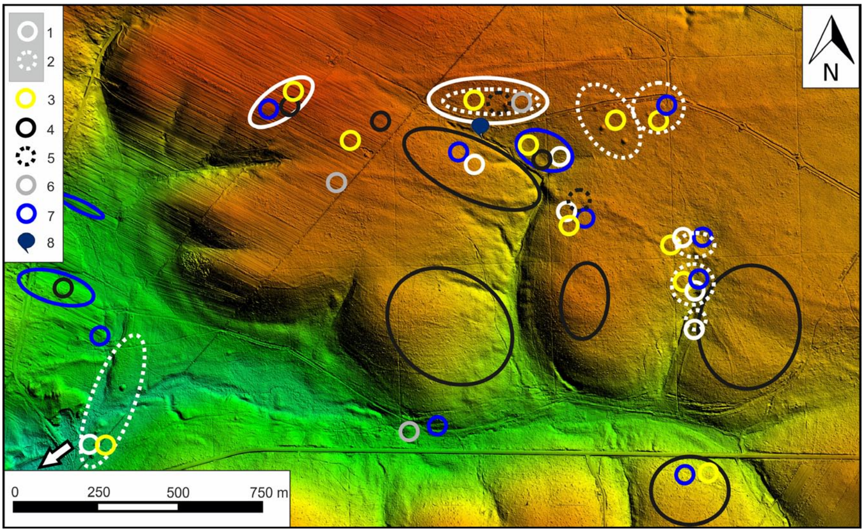

Fig. 5. Distribution of prehistoric and historic settlement sites in the vicinity of Ulów (the arrow indicates one Stone Age site in 0.3–0.4 km distance) at a background of the DTM hillshade and 1:10 000 topographical map: 1 – Stone Age settlements, 2 – Stone Age cemeteries with barrows, 3 – Bronze Age settlements, 4 – Roman and Migration Periods settlements, 5 – Roman and Migration Periods cemeteries, 6 – Middle Ages settlements, 7 – Modern Period settlements, 8 – spring

Research methods

The characteristics of the geological structure were prepared based on a detailed geological map of Poland 1:50 000, sheet Tomaszów Lubelski, and explanations to the map (Buraczyński et al. 2002). Its fragment from the vicinity of Ulów was verified and detailed during field research. The same procedure was applied in the case of a fragment of the Geomorphological map of Roztocze 1:50 000, sheet Tomaszów Lubelski (Buraczyński, Chabudziński 2014) providing the basis of the characteristics of the land relief. Detailed identification of sediments performed in valley floors in the vicinity of Ulów by Harasimiuk et al. (2008) was also used. The primary objective of the geological and soil coring was to verify the range of surface formations and their thickness, determine the type of soils developed on such formations, as well as the genesis and age of landforms. They were also used for the determination of the composition and structure of small anthropogenic landforms (barrows). Moreover, sand samples were subject to mineralogical analysis to determine their genesis.

In order to meet the assumed objectives, approximately 150 geological and soil corings were performed up to a depth of 1–3 m, located in several cross-sections through characteristic landforms. The corings were performed by means of a manual corer *Eijkelkamp* with a sampler collecting a core with an undisturbed structure. In the cores, deposit layers were identified, as well as soil horizons and state of their preservation. This provided the basis for the determination of Holocene changes in land relief, whereas soil was treated as a benchmark of changes in location of the topographic surface (*vide*: Rodzik et al. 2014; Rodzik, Mroczek 2015).

The presentation of the general land relief was based on the Topographic map of Poland at a scale of 1:10 000. It served as a working version in field works and a background for resulting maps imaging surface formations and landforms. The map has a contour interval of 1.25 m, and does not present details of land relief, particularly in forest areas. A detailed image of land relief was therefore obtained from the Digital Terrain Model (DTM) performed based on ALS (Airbone Laser Scanning). It was prepared based on measurement data from the point cloud with mean density of 4 points per square metre. A DTM was generated with a resolution of 0.5 m. It provided the basis for the performance of cross-sections through the main landforms. Points representing results of geological and soil corings were marked on them.

RESULTS

The corings showed that Cretaceous rocks outcrop on culminations of intervalley elevations and on their slopes, particularly those with considerable slope inclination. Decayed rocks were usually encountered in the form of decalcified fragments of gaizes or opokas, but in several cases, in horizon 332–337 m a.s.l., the occurrence of loamy carbonate weathered marly opoka was found (Fig. 6). On weathered Upper Cretaceous silicate-carbonate rocks, brown soils usually developed, decalcified up to a depth of 0.5–0.8 m. They are currently dominated by the Carpathian beech forest assemblage *Fagetum carpaticum*.

Together with a decrease in inclination of slopes of intervalley elevations, an increasingly thick sandy-silty colluvial sediments appear on decayed rock. On gentle slopes with an inclination not exceeding 5°, the cover usually begins in mid-slope, and on steeper slopes it only occurs at the foot of the slopes (Fig. 2). Arenosols and spodic soils developed on them. The habitat is overgrown by highland fir mixed forest *Abietetum polonicum.*

On the plateau and slope flattenings, the decayed rock of the Cretaceous bedrock is covered by sandy Young Pleistocene sediments. They have a thickness of up to several metres, and are usually bipartite. Their lower layer is composed of deluvial, layered loamy sands and silts. The upper layer is usually composed of aeolian sands, massive, fine- and medium-grained, well sorted. They are dominated by quartz, but feldspars also occur. Long, narrow, and low dune banks developed locally in the sands, very weakly distinguishable in the terrain (Fig. 3). Their length reaches several hundred or more metres, their width amounts to approximately a dozen metres, and the height rarely exceeds 1 m. Aeolian sands are covered by podzol with development of spodic soil or arenosol. Where the sandy cover reaches more than 2 m, spodic soils occur, and the tree stand is dominated by pine. Where the thickness of sands is lower and the bedrock has a shallow location, arenosols are overgrown by highland fir mixed forest assemblage *Abietetum polonicum.*

In floors of the largest valleys in the SW part of the study area, fluvial-periglacial sands are deposited, forming a terrace from the period of the last glaciation. The tree

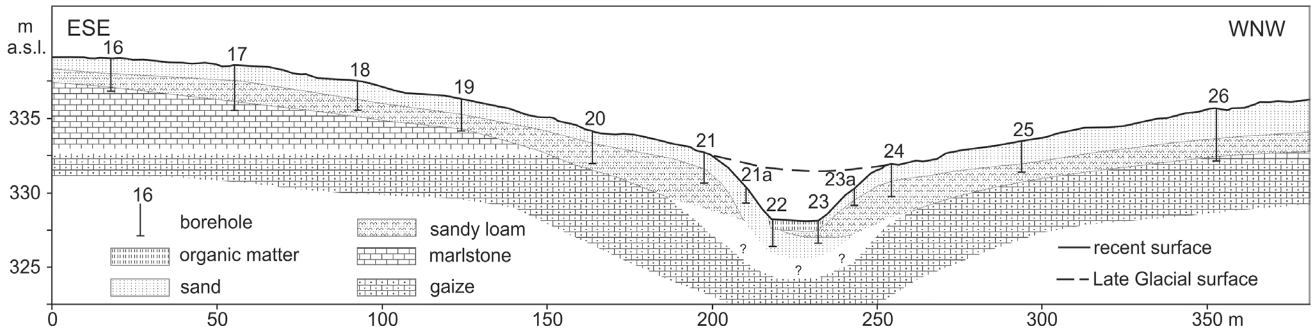

Fig. 6. Geological section across the valley with spring (location at Fig. 2)

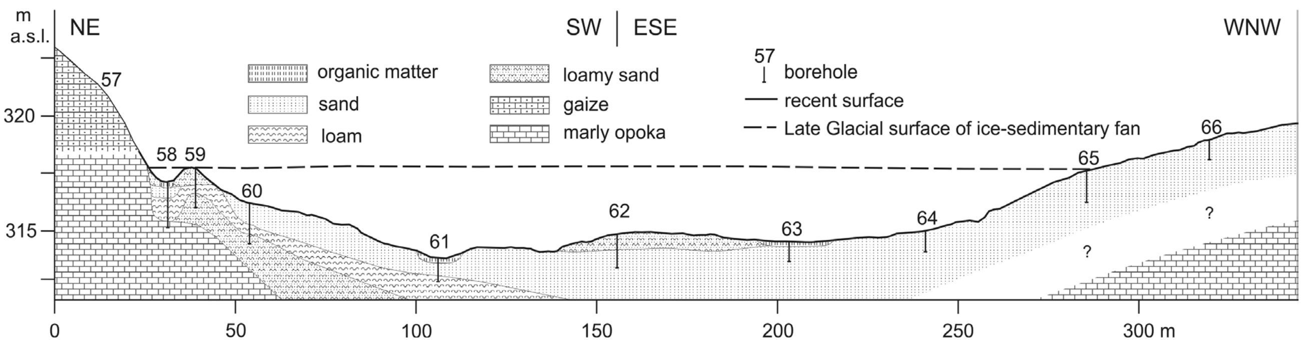

Fig. 7. Geological section across the fan in the mouth of valley with spring (location at Fig. 2)

stand on spodic soils is dominated by pine. Sands locally form dunes, whereas the aeolian landforms reach up to several metres in height.

In the lowest, periodically marshy fragments of valley floors, sands and silts containing organic material are deposited, locally interlayered with peat silts and peats. This Holocene sediment series usually does not exceed 1 m thickness in floors of lateral valleys, and in floors of large valleys it reaches a thickness of 1–2 m. A small area of the sediments on peat, moor, and post-bog soils is occupied by alder forest and sedge assemblages. Rush assemblages occur in wetland areas. In exceptionally dry years, wetlands are maintained only in the upper, latitudinal section of a lateral valley with a spring.

The valley has flat, marshy (with the exception of the outlet section) floor with a width of approximately 15 m, and relatively steep (approximately 10°) slopes. It dissects the floor of the main trough valley partly filled with sandy-silty sediments up to a depth of several meters (Fig. 6). In the lower section, the dissection becomes shallower, and its dry sandy bottom at the outlet of the main valley transitions into an alluvial fan composed of sands and silts (Fig. 3). The fan has an uneven surface with longitudinal low levees and also longitudinal trough-shaped channels. The largest channel is located under a steep slope on the left slope of the fan, separated from it by a 1 m high bank. The channel floor is located 2–3 m above the fan surface (Fig. 7). It should be emphasised that over the entire fan surface (with levees and channels), as well as on the steep valley slopes, well developed Holocene spodic soil or arenosol occurs.

INTERPRETATION OF RESULTS AND DISCUSSION

Quaternary development of relief

Lack of sediments containing northern material from Scandinavian glaciations suggests that the valleys dissecting the Pliocene planation surface developed in the Younger Pleistocene (Buraczyński et al. 2002). During the Weichselian glaciation, sands washed from slopes were accumulated in valley floors. In large valleys, the sands were rinsed by periodical streams. In smaller ones, lateral transport was dominant. Therefore, they were largely filled with sandy or sandy-silty sediments, taking trough-shaped forms. Sandy-silty covers developed on the undulating plateau in the conditions of severe periglacial climate. Their content of feldspars suggests that they contain fluvioglacial material.

The covers were subject to aeolisation, although only low longitudinal dune ridges with an admixture of silt could develop from the relatively small amount of sand. According to Buraczyński (1993), such dunes developed in the first dune-forming phase at the end of the last Glacial in the period of 15 000–13 500 years BP. Their arrangement in the form of a plume is interesting, possibly referring to the systems of ends of stike-slip faults (*vide* Koprianiuk 2007). A sudden change in direction of the upper section of the valley with water occurs on the line of the longest sequence of dunes (from ESE to SSW), as well as considerable widening of the lower section of the meridional valley in Ulów (Fig. 3). This suggests an eastward shift of the block located south of the line. On lines of faults and/or lithological boundaries of the bedrock, a "plume" of long and very low dunes could have developed as a result of deposition of sand in places with higher humidity related to permeation of water.

The local aquifer on the plateau can be currently maintained on the layer of marly opoka (or marls) the location of which, between 330 and 335 m a.s.l., corresponds with the height of water outflow in the upper section of the central small valley. In Ulów, at a distance of 1400 m westwards, at the same height, water appears in basements, and seepage water in Cretaceus bedrock appear while digging holes for building foundations (K. Piechnik, resident of Ulów – personal communication). In the Late Glacial, the groundwater surface could have been located higher, fed by thawing permafrost. The effect of permafrost degradation was the development of dry valleys in the current periglacial zone (*vide* Maruszczak 1968). Pleniglacial, sandy-silty fillings of trough valleys could have been dissected then, and secondary valleys with fans could have developed, as in the case of the valley with a spring.

The effect of the dissection of the aquifer could have been water outflow and development of an ice field at the outlet of the valley in the conditions of rapid climate changes of the Late Glacial. Sandy-silty material was accumulated on the ice, protecting it during summer ablation. This could have led to the development of an ice cover persisting for many years, interlayered with mineral material. Its several-metre thickness is suggested by the location of the outflow channel on the left slope of the fan (Fig. 7). This mineral-ice conglomerate melted not later than in the Early Holocene. The current surface of the fan locally resembles the surface of a beach with "holes" in Polar areas after melting of layers of shore ice covered with sand (*vide* Rodzik, Zagórski 2009). The pre-Holocene genesis of the dissection and fan at its outlet is suggested by the presence of spodic soil or arenosol, locally with parameters of lessive soil, well developed on the valley slopes and on the fan. In the Holocene, all landforms was strengthened by forest vegetation.

In floors of larger valleys, a Late Glacial dissection caused drying of relatively extensive sand covers of the terrace. This allowed for the development of dunes, considerably higher than landforms on the plateau. Cold phases of the Late Glacial (Older and Younger Dryas) are considered as the main dune-forming phases in Roztocze (Buraczyński 1993). Late Glacial dissections of valley floors locally reached the local aquifer. This is suggested by the deposition of organogenic sediments, primarily peats. Their loam content and interlayers of mineral sediments suggest the intensification of washing processes in the Meso- and Neoholocene, determined by agricultural management (Harasimiuk et al. 2008).

In the Holocene, also anthropogenic landforms developed, both intentional (barrows) and those resulting from erosion processes. Some of the well preserved barrows reach even 1.5 m in height and 15–22 m in diameter. The height of the majority of barrows, however, varied from 0.20 to 0.50 m, with modern diameters of 10–12 m (Niezabitowska-Wiśniewska 2017).

Anthropogenic landforms developed as a result of erosion processes particularly include parallel road gullies with a depth of up to 1 m, dissecting Upper Cretaceus bedrock on some slopes. They are a result of a modification of the course of dirt roads following extreme erosion events. The old trees overgrowing them suggest that the landforms exceed the age of 100 years, and probably developed in the period of the 17th–19th century intensive settlement in the conditions of the unstable climate of Little Ice Age (LIA). Similar systems of dissections are described by Kroczak (2010) in the region of Ciężkowice Foothills. In loess areas of the Lublin Upland, the effect of accelerated erosion of dirt roads in Little Ice Age was the development of gully systems (Dotterweich et al. 2012; Superson et al. 2014).

Environmental conditions of settlement location

Results of research excavations in the vicinity of Ulów permitted an adjustment of the thesis on the settlement void in Tomaszów Roztocze, reflecting the state of research to date. It should be emphasised that no other traces of pre-historic settlement were found in this area. Very intensive pre-historic settlement was recorded in mesoregions neighbouring on Tomaszów Roztocze to NE (Zamość Basin, Hrubieszów Basin, Sokal Ridge, and Bełz Plain), macroregion to SW (Sandomierz Basin) and in western part of Tomaszów Roztocze, in Wieprz valley between Guciów and Krasnobród (Balcer et al. 2002). Therefore, it is of key importance to determine the causes of the repeated location of settlement in the vicinity of Ulów, evidently preferring the watershed area. Only part of objects of the Corded Ware, Mierzanowice, and Trzciniec cultures also occur in the valley floor.

It should be remembered that Tomaszów Roztocze is located in the middle section of the arch of Roztocze connecting the Lublin Upland with the Podolian Upland (Maruszczak, Sirenko 1989/90; Kondracki 2009). Areas located to SW and NE are dissected with valleys of streams flowing from Roztocze, and obstructed towards SE-NW (Maruszczak 1998). The watershed flat crest of Roztocze is therefore a natural passage along this orientation, and could be used for movement of groups of people and commercial exchange. Perpendicularly, from SW to NE, a trail could have run in valleys, connecting considerably different in terms of landscape, inhabited areas of the Sandomierz Basin in North Subcarpathia with the mesoregions of the Volhynian Upland (Fig. 8).

At the local scale, the factor determining the inhabitancy of the discussed settlement area by subsequent cultures until the 17th century could have been permanent water accessibility near the watershed, in the upper section of the valley with a spring. Settlement was favoured by relatively flat terrain and moderately fertile, but easily arable soils. The southern or near-southern exposition of the slopes is also favourable, providing for a beneficial microclimate, particularly in the upper sections of the valleys, channelling off cold air. The early medieval evident settlement crisis could have been related to the lack of water in valleys, because settlement in the Lublin region at the time developed intensively in river valley floors (Hoczyk-Siwkowa 1999).

Traces of the next settlement only come from the modern period. This may result from the economic development of the area, related to the establishment of the Zamojska Ordinance at the end of the 16th century. The Ulów village was soon established

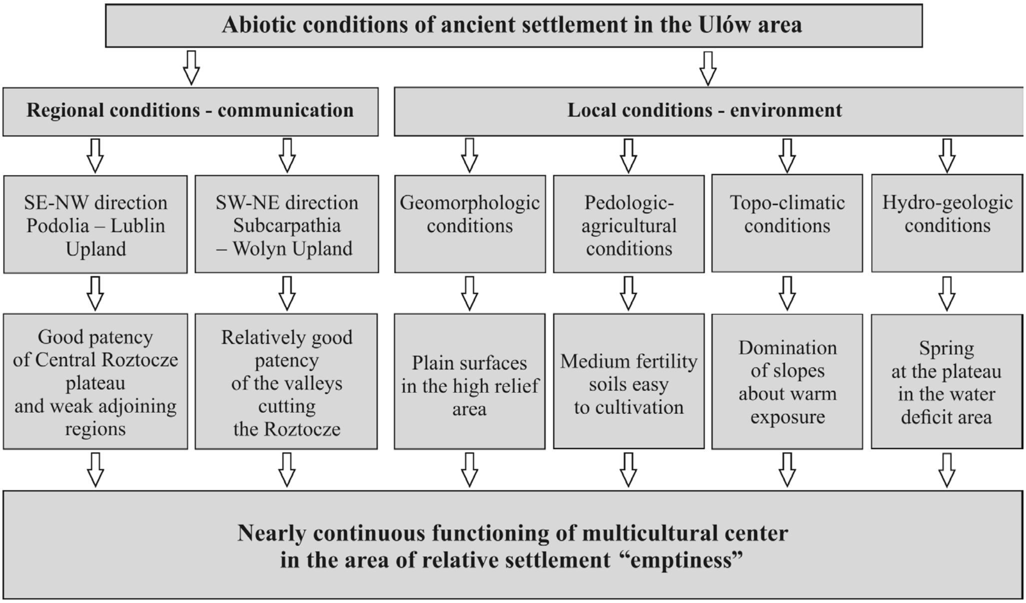

Fig. 8. Link diagram of abiotic settlement conditions in the Ulów area

at a pond located in the outskirts of the modern-day village (Chlebowski 1902). Numerous fragments of slag and glass produce were found in the region. This suggests the local existence of glassworks in the 17th and 18th century, mentioned as the "glassworks on Ulów", one of few in Roztocze (Wyrobisz 1968). The establishment of the modern Ulów village was therefore related to the sand deposits suitable for the production of glass, and the availability of fuel. The Carpathian beech forest was a source of high energy wood.

The functioning of the glassworks was certainly related to the intensification of transport. The network of road gullies related to the use of a road leading to the village from the east and running along the right slope of the main valley and its foot, among others across the fan at the outlet of the valley with a spring, probably originates from that period.

FINAL REMARKS

In spite of the common opinion, particularly resulting from the lack of archaeological research, the top area of Tomaszów Roztocze has not been a total settlement void throughout history. It included areas intensively inhabited in the pre-historic times. Excavation works in the vicinity of Ulów suggest the past existence of enclaves inhabited by a number of subsequent cultures.

Multi-cultural settlement complexes functioned at the crossing of important transport routes taking advantage of the system of physiographic objects at the regional scale. The routes connected macro- and mesoregions with different natural geological-geomorphological, climate-hydrological, and soil-vegetation conditions.

The location of settlement of subsequent cultures almost in the same place, in an area generally poor in water, resulted from specific local conditions (Fig. 8). Easily arable soils and beneficial climate conditions were important. Access to water in a relatively flat area, however, was of critical importance. The presence of water in the form of a spring in the upper section of the valley dissecting the plateau surface near Ulów is determined tectonically (strike-slip fault), lithologically (marly impermeable layer), and geomorphologically (dissection of the aquifer by an erosion-denudation valley).

The analysis of the conditions of location of particular cultures should consider not only their environmental preferences, but also location towards transport routes at the regional scale, and special conditions at the local scale. Changes in the environmental conditions could have occurred as a result of natural development, or resulted from human activity.

Acknowledgements. The work was funded by the National Science Centre (Poland) allocated for the project based on decision number DEC-2013/09/B/HS3/03352 (project manager – Dr Barbara Niezabitowska-Wiśniewska). The authors would like to thank Barbara Niezabitowska-Wiśniewska, Michał Jakubczak and Kamila Jarosz, for help in making the drawings.

SUMMARY

The paper presents the environmental conditions of location of a multicultural settlement centre near Ulów in Tomaszów Roztocze, functioning from the Palaeolithic period to the modern times. The study is based on the analysis of topographic, geological, and geomorphological maps, a detailed ALS (Airbone Laser Scanning) image, and geological-soil corings. Results of many years of archaeological research suggest that the settlement of particular cultures, particularly prehistoric cultures, was concentrated on the plateau, in an area currently overgrown by a forest.

The bedrock in the area contains siliceous-carbonate marine sediments of the Upper Cretaceous, with a higher planation surface at a height of 340–350 m a.s.l. A network of asymmetric valleys developed on numerous faults, several tens of metres deep. In the valley floors and on flat plateau areas, particularly Pleistocene sands and muds are deposited. Due to the land elevation, mean air temperature is low (7°C), the vegetative season is short (210 days), and the snow cover duration is long (more than 80 days). A precipitation gradient occurs in the study area, exceeding 100 mm over a section of 15–20 km: from > 700 mm in SW to 600 mm in NE. It corresponds with the gradient of water outflow (220–100 mm, respectively). The river network is scarce, and the watershed area is almost devoid of water resources due to the permeability of the bedrock.

The study area was determined to be located on the crossroads of prehistoric transport routes with a course depending on the variability of the natural environment at the regional scale. In direction SE-NW, a convenient transport route ran along the relatively flat watershed area, and in direction SW-NE – in valleys across Roztocze. Settlement was facilitated by easily arable soils and favourable microclimatic conditions. The deciding factor for the location of settlement of subsequent cultures in the same place, however, was access to water in a relatively flat area. Its presence here is determined by a permanent outflow (spring) in the upper section of the valley, dissecting the plateau surface. The valley developed on a strike-slip fault dissecting the layer of weakly permeable marly opoka.

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