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THE NATURAL AND ANTHROPOGENIC EVOLUTION OF THE BIEBŁA RIVER VALLEY AND THE RECORD OF ENVIRONMENTAL CHANGES IN ITS ALLUVIA - PRELIMINARY RESULTS

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Abstract

The studied Biebła river valley is located in NE Poland in the Podlasie Voivodeship. This left tributary of Brzozówka river has very anthropogenic transformed riverbed. It flows in depression of SW-NE orientation between the Goniądz Upland and Suchowola-Janów Upland. It is currently a peat plain.
The aim of the research is to identify the changes in the paleoenvironmental conditions that occurred in the Biebła river valley.
Four phases of the Biebła valley evolution could be distinguished: the Pleistocene erosion phase after the Warta Cold Stadial, transformation of river pattern from braided to meandering one in the turn of the Late Glacial and the Holocene, phase of intensive peat-bog development since Preboreal to Subboreal period and phase with anthropogenic catchment deforestation and an increase of overbank deposition in the peats on flood plain.
Research on this tributary is carried out as part of a wider synthetic reconstruction of the environmental conditions of the mesoregion of the Bronze Age settlements, which functioned during the environmental transformations at the end of the Subboreal and beginning of the Subatlantic.

Keywords Biebła valley, Podlasie, palaeoenvironment.

INTRODUCTION

The Biebła river is a 5th order river with a length of 9.36 km and catchment 14.43 km2. Its source is in the Goniądz Upland microregion, then it flows through Dolistowo Upland, and its mouth is in the Biebrza Valley, where it flows as a left tributary into the Brzozówka river (Białystok Upland mesoregion, Podlasie Lowland macroregion, Belarusian-Eastern Lowlands sub-province of Belarusian-Belarusian Lowland) [1]. The area was formed by the last two glaciations – Middle Polish (cold Warta stadial) and the Vistulian glaciation [2], [3], [4] (Fig. 1A).

Between the area of the belt of terminal moraine hills there is a zone of hollow depressions, used by the Biebła River (Fig. 1B and C).

The geomorphological and geological analysis of the upland area allows us to attribute these depressions to the character of terminal depressions (ice-melt) and probably to the local extension of the front of the ice sheet during its recession [3].

The river itself was strongly anthropogenically transformed in the 20th c. At present, it has channelized and regulated a straight riverbed.

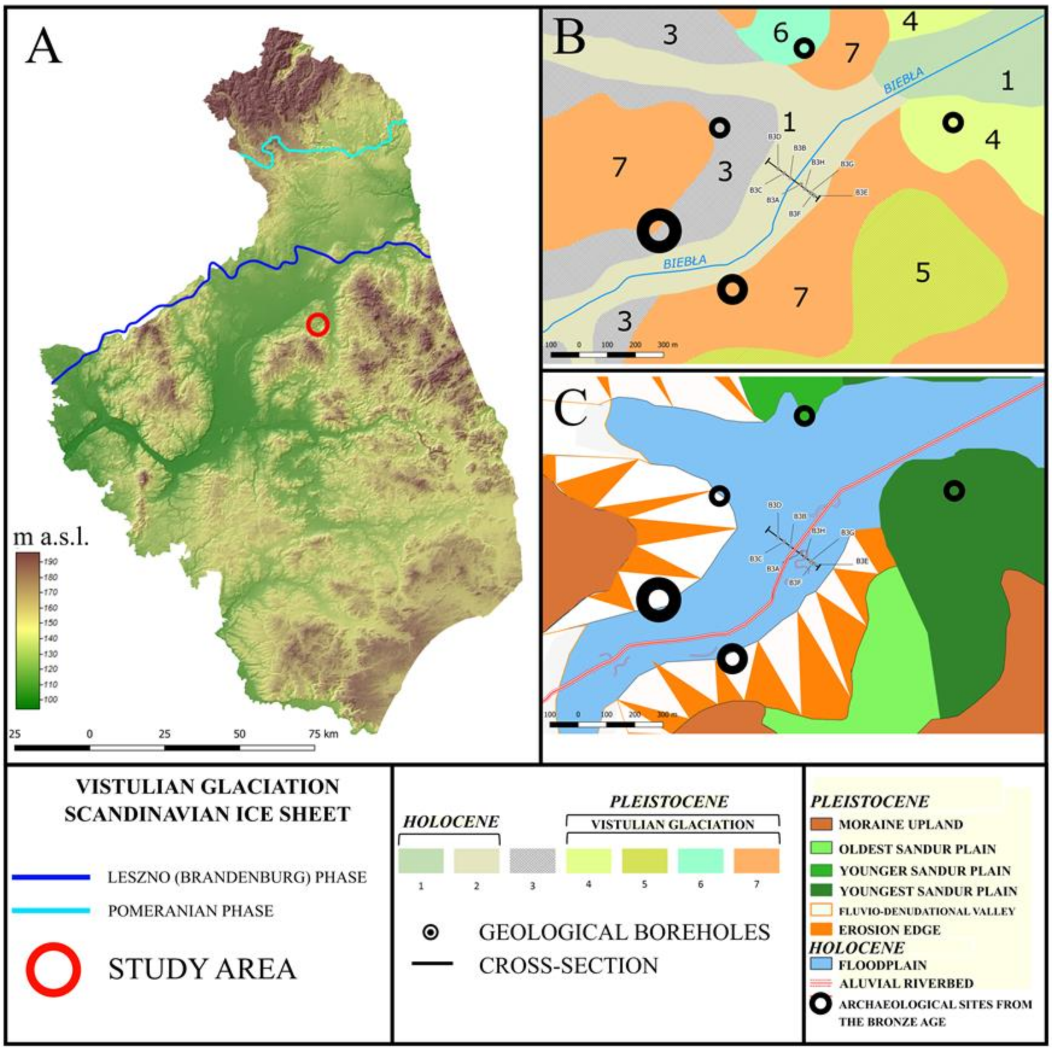

Figure 1. Location of the study. A – Hypsometric map of Podlasie Voivodeship with glaciation ranges (compiled after [4]); B – Geological map of the study area (compiled after [2].; C – Geomorphological map of the study area (by T. Kalicki, M. Frączek). 1- peats on glaciofluvial sands; 2 - peaty silts; 4 - glaciofluvial sands; 5 - glacial sands and gravels; 6 - limnoglacial silts and sands; 7 – tills

AIM OF STUDY AND METHODS

The aim of this study is to identify environmental changes occurred in the Biebła river valley and to determine the phases of high and low dynamic of fluvial processes and phases of peat bog initiation as well as the natural and/or anthropogenic reasons for these changes. Eight geological boreholes were made crossing the entire valley bottom in a NW-SE orientation from a length of approximately 200 m. Sedimentological analyses were performed at the Geomorphological and Hydrological Laboratory of the Institute of Geography and Environmental Sciences, Jan Kochanowski University in Kielce (Poland). The sieve method and the mineral sediment laser method were used. The content of organic matter was determined by the loss on ignition method. The obtained results were presented graphically in GRANULOM software together with calculated of the Folk-Ward parameters. Standard 14C dating of organic material from borehole B3A were done in the Absolute Dating Laboratory at Skała. Based on results of these analyzes a cross-section of the Biebła valley was created.

RESULTS

Some abandoned channels are visible in relief of the valley bottom. There are filled with organic sediments with overlying fine- to coarse-grained sands (B3B; B3E; B3H) or sandy gravels (B3D, B3C) (Fig. 2). The irregular, undulated top of the sandy gravel series is evidenced at various depths (e.g. 60 cm in profile B3B, 135 cm in profile B3A and 225cm in profile B3G). Two sections with different structure could be distinguished across the valley bottom. The border between them runs near the present-day riverbed. North of the riverbed the sand and gravel series is very shallow and covered only by a layer of peaty silts up to 0.3-0.4 m trick. In the vicinity of the riverbed in the abandoned channel fill, clayey peats are covered with sandy-gravel insert, indicating that the palaeochannel was reactivated. The whole is covered with a layer of peaty silts, analogous to the B3D and B3C drilling. These peaty silts fossilize and blur the older relief of the valley bottom.

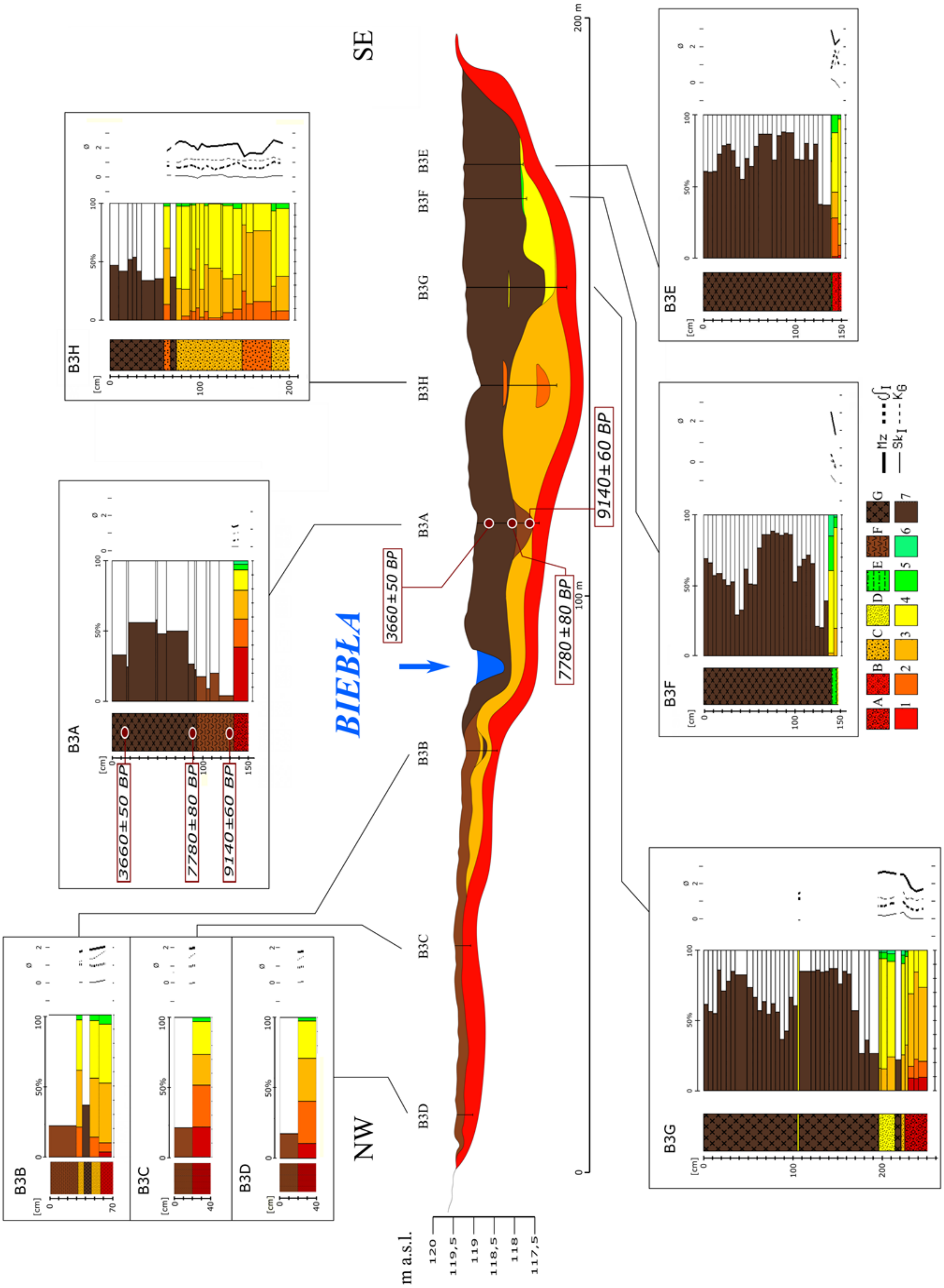

Figure 2. Schematic geological cross-section of the Biebła valley. Lithology: A - sand with gravels, B - sands with single gravels, C - medium-grained sands, D - fine-grained sands, E - silts and clays, F – peaty silt, G – peats; Fractions: 1 – gravel, 2 - coarse sand, 3 - medium sand, 4 - fine sand, 5 - silt and clay, 6 - clay; Folk-Ward's distribution parameters: Mz - mean diameter, δl - standard deviation (sorting), Skl - skewness, KG -kurtosis

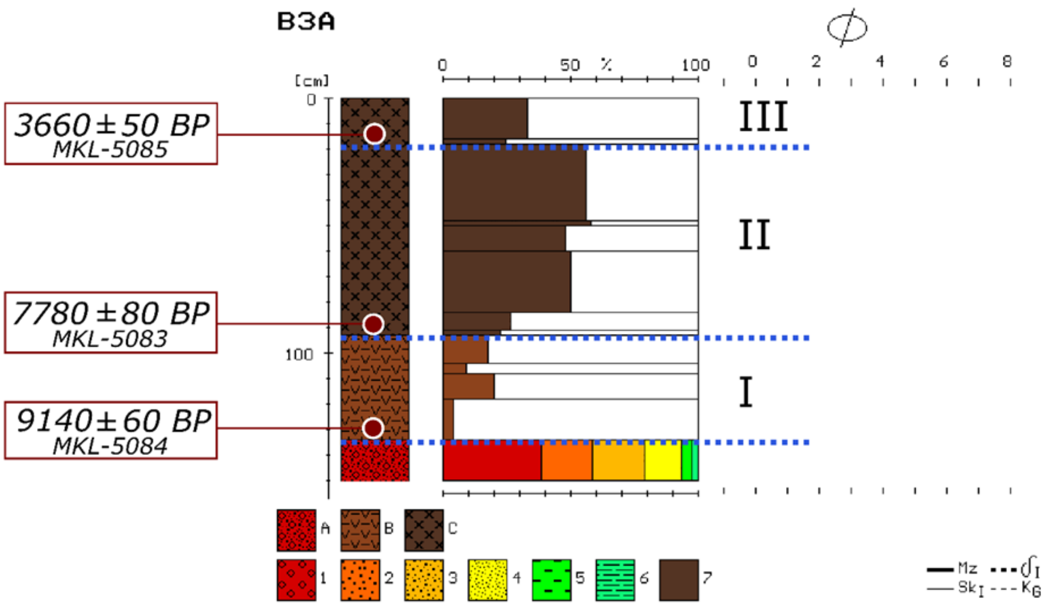

Figure 3. Borehole BR17 with designated stages of the Biebła valley development. Lithology: A - gravels with sand, B - peaty mud, C - peats; Fractions: 1 – gravel, 2 - coarse sand, 3 - medium sand, 4 - fine sand, 5 - silt, 6 – clay, 7 - peats; Folk-Ward's distribution parameters: Mz - mean diameter, δl - standard deviation (sorting), Skl – skewness.

South of the riverbed, the top of the sand and gravel series is much lower (1.35-2.25 m). A sandy series was deposited on it, the thickness of which can reach 1.2 m (B3H). It consists of well-sorted channel sands with two layers (lower and upper) of fine sands and coarser sands in the middle. There is a clear fining upward in the upper layer.

Two distinct depressions have been identified in the top of this sandy series, which can be interpreted as palaeochannels (Fig. 2). The shallower of them (B3A) are filled with peaty silts (5-20% of organic matter), which started to accumulate at 9140±60 BP (MKL–5084) cal. 8466-8256 BC (member I). In the Atlantic from 7780±80 BP (MKL–5083) cal. 6830-6444 BC, peats with an organic substance content of 50-60% (member II) began to grow in the abandoned channel. After 3660±50 BP (MKL–5085) cal. 2147-1897 BC, the content of clay in peats clearly increases, as the content of organic matter in them drops to 40% (member III) (Fig. 3). The deeper of them (B3G) was initially filled with clastic sediments, and then peats with a very high content of organic matter (over 80%) began to grow in it. At a depth of about 1 m, there is a thin layer of sands that can be correlated with the sand-gravel insert at a similar depth in the B3H drilling. This change in sedimentation type indicates some catastrophic event in the valley, possibly a very large flood. The peats lying above are much more diverse with the content of organic matter varying widely between 35 and 85% (Fig. 2).

DISCUSSIONS AND CONCLUSIONS

The results of the research allowed to identify several phases of the valley's evolution.

Two levels of sand-gravel series occurrence in Biebła valley floor are a record of the erosion phase that took place after the Warta cold stadial. This incision phase may be related to the Eem or to the Younger Pleniglacial/Late Vistulian. The latter was very clearly and universally marked in the valleys of Central Europe ([5] therein references).

The ca.100 m wide erosion cut was filled with a sandy series, probably by the braided river, although the highest member in this series with fining upward sequence was already assembled under the conditions of a gradual concentration of flows and the formation of a single-channel system. This may have occurred at the turn of the Late Glacial and Holocene, since the organic deposits in the bottom of the shallow palaeochannel that formed this bar were dated at 9100 BP. In the Holocene, deeper channels (B3G), probably meandering, functioned, which made it possible peat bog development in the valley bottom during the period of full afforestation in the Atlantic (since 7780 BP). The negligible soil erosion in the catchment area resulted in the fact that the content of organic matter in the peats near valley slope reaches 80% (B3G-B3E), and in the valley axis (B3A) it exceeds 50%. The increase clay content in peat towards the valley axis indicates that during the flood the peat-bog on the floodplain was flooded and accumulated overbank sediments, which are a mineral admixture in the peats. A catastrophic event also occurred in the catchment, which deposited a sandy-gravel (B3H) or sandy (B3G) layer in the peats. The age of this event is as yet difficult to determine, but the depth of this mineral insert is close to the level in B3A dated to the beginning of the Atlantic (7780 BP). It is possible, however, that this phenomenon is younger and did not occur during the period of full afforestation of the catchment area.

According to archaeological data from the Archaeological Map of Poland the human activity in the catchment area began in the Subboreal. Five the Bronze Age archaeological sites in the lower part of the river basin occurred. There is a marked decrease in the content of organic matter in the peats since 3660±50 PB, cal. 2147-1897 BC (B3A). This is likely to be evidence of deforestation of the catchment area, associated with Prehistoric human activity, probably by Lusatian Urnfield culture communities known from this area (Fig 1C), [4], [6], [7]. The deforestation caused soil erosion, and the washed-out material was delivered to the riverbeds and deposited on the Biebła river floodplain as overbank sediments constituting a mineral admixture in peats. This admixture near the riverbed is almost 50-60% (B3A, B3H), and further from the riverbed it drops to 30-40% (B3G, B3F, B3E). It is possible that anthropogenic changes in the water cycle in the catchment also caused an increase of the flood size, and as a result, cut flood channels on a higher step of the gravel-sand series (B3B). The peaty silts (B3D, B3C, B3B) covering this step are the result of an increased overbank accumulation and washing out material from the deforested valley slopes during the Subatlantic.

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