Reflection of climate changes in selected river valleys of NE Poland and W Belarus

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The main aim of this work is to present the results of geoarchaeological studies from the Biebrza and Narew river valleys (NE Poland) and Sporovsky Biological Reserve in Yasielda river valley (W Belarus). This area was occupied for a long time by the hunter-gatherer Mesolithic communities and later by the Niemen and Pripyat-Niemen cultures. These cultures only slightly changed the geographic environment in the Early and Middle Holocene. It makes it possible to trace the natural changes of geosystems during this period without the influence of an anthropogenic factor.

Relief of Upper Biebrza Basin was formed during Middle Polish (Saalian) Glaciation - Warta Cold Stage. During the next ice-sheet advance until the Pomeranian phase of last glaciation 15.5-15.0 ka BP [14], 16.2 ka BP [4] outflow from Naroch-Wilia and Skidel the dam lakes and river waters of the upper Neman river followed Łososna river valley, its tributary Tatarka river breakthrough Pripilin-Nurki gap section to Biebrza and Narew river valleys [14], [19], [5]. Therefore, the Biebrza and Narew downstream of the confluence with Biebrza are underfit rivers with vast peat-bogs on their valley floors.

Results of studies from many archaeological sites in the Biebrza Basin [2], [17], [1], as well as from Sporovsky Reserve [13] indicate some periods of climatic changes and an increase of morphogenetic processes activity.

In the Late Glacial, the river systems were transformed and the channel development changed. The flows were concentrated and the Narew flowed in large meanders. Two generations of the Lateglacial macromeanders: older, probably from Bölling (11 780±100 BP; 11 851-11 461 cal. BC) and younger, probably from Alleröd and Younger Dryas (9900±90 BP; 9762-9231 cal. BC) occurred [17]. A less sinuous pattern of older generations reflects the first stage of transformation from braided to a meandering river, similar to Warta and Maas river valleys [15]. These changes have not been found in the Yasielda valley. At that time river formed a delta and flowed through many riverbeds to the Sporovskie Lake from the end of the Younger Pleniglacial. In the Early Holocene, this lake was much larger than in present-day [13] and carbonate gyttja sedimented in it [12], similar to other lakes from Polesie and Poozerie regions in Younger Dryas and Preboreal [9]. The formation of carbonate sediments poor in the organic matter in oligotrophic-mesotrophic lakes [18], [13] reflects an important stage of lake development connected with considerable climatic warming at the beginning of the Holocene [9]. In Sporovo the sandbanks separating the channels formed the elevations within the peat bog. Later (5^{th} - 3^{th} millennium BC) these forms were settled by the communities of the Pripyat-Neman and Neman Subeolithic cultures (Kokoritsa 4 archaeological site)[13], [12].

At the bottom of underfit river valleys (in the non-fluvial segments) starts accumulation of peats (e.g. Narew - in Wizna Basin : 10 135±90 BP; 10 143-9396 cal. BC) [17]. This phase was interrupted by short-term activation of aeolian processes that were recorded as inserts of sands in peats (Narew: after 8320±80 BP 7542-7141 cal. yr BC; Biebrza: between 9880±100 BP 9803-9182 cal. yr BC and 7350±110 BP 6425-6026 cal. yr BC [17], [3].

The beginning of the Atlantic period is very well known and recognized in many regions of Central Europe [5] (including Belarus - pollen diagrams [16], BO-3; 8400-7800 BP as well as from isotope curves 8300-8200 BP after [10]) as a climate cooling and humid phase [11]. There were very clear changes in river valleys, e.g. channel changes in Neman basin [6] and in Biebrza where the beginning of peat accumulation in the valley floor and meander cut-off

was dated respectively at 8490±80 BP, 7658–7347 cal. yr BC and at 8330±120 BP, 7577–7083 cal. yr BC [1]. A phase of an increase of fluvial processes activity caused an increase in the rate of lateral migration and a rapid point bars increase [8], on which dunes could form, e.g. in the Narew valley [17]. At the same time, the increased fluvial accumulation could have contributed to the development of the Yasielda delta and the reduction of the Lake Sporovskie area - accumulation of peats on the lakustrine deposits (8190±90 BP, 7494-6866 cal. yr BC) [13] (Fig. 1).

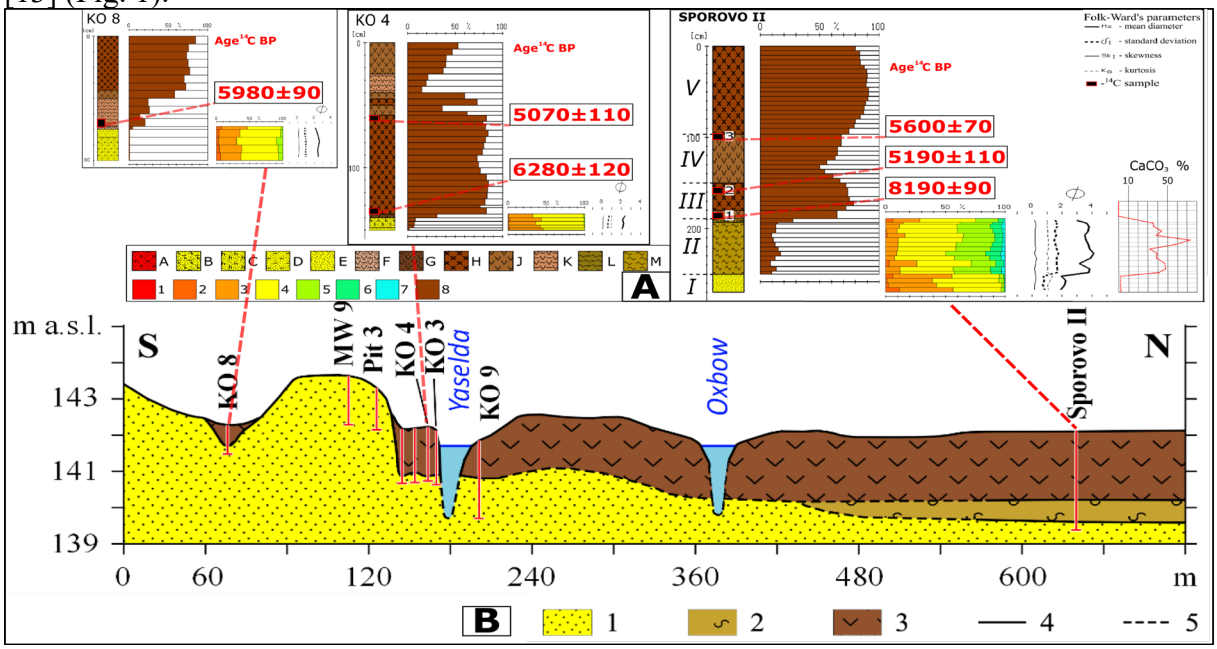

Fig. 1. Geological cross-section of the study area from Sporovo II to KO8 with lithological diagrams ([13] - supplemented), A: Lithology: A - sands with single gravels, B - humous silty sands, C - humous fine-grained sands, D - silty sands, E - fine-grained sands, F - sandy peaty silts, G - sandy peats, H - peats, J - silty peats, K - peaty silts, L - gyttja silts, M - gyttja; Fraction: 1 - medium and fine gravel (below -1ϕ), 2 - coarse sand (-1 to 1ϕ), 3 - medium sand (1-2ϕ), 4 - fine sand (2-4ϕ), 5 - coarse and medium silt (4-6ϕ), 6 - fine silts (6-8ϕ), 7 - clay (above 8ϕ), 8 - the content of organic matter B: 1 - sands, 2 - gyttja, 3 - peats; 4 - established limits, 5 - estimated limits

In the humid Atlantic period, the peat-bog in the Biebrza Valley expands covering the sands e.g. 7050±60 BP 6033-5789 cal. yr BC [3], 7020±70 BP cal. 6016-5746 BC [2]. In the Middle Atlantic (AT 2) groundwater rising in Neman floodplain caused death and tree fallen (6420±60 BP, 6100±80 BP) and an increase of fluvial activity channel caused changes its riverbed (6360±80 BP, 5480-5080 cal. yr BC)[6]. However, the floods during this period did not cover the entire fluvial segment of Narew in Wizna Basin. Therefore in its marginal parts, in the Lateglacial oxbow lake starts accumulation of peats (more than 80% of organic content)(6340±90 BP, 5481-5069 cal. yr BC) [17]. In this time groundwater rising caused peat accumulation in the Polesie region (6120±60 BP, 5260-4850 cal. yr BC)[15]. In Jasiołda valley peat accumulation starts from 6280±120 BP (MKL-5182) 5480-4953 cal. yr BC in the close vicinity of the archaeological site "Kakoryca-4" (Fig. 1). At a similar time (6170±80 BP, 5313–4911 cal BC) peat bog covers the oxbow lake at Lipowo in Biebrza valley and caused its disappearing in the relief [1]. The rising of the groundwater level must be very high if the peats started to growth in the depressions (KO8) on the sandy elevations in the Sporovo region since 5980±90 BP (MKL-5183) 5207-4621 cal. yr BC (Fig. 1). This corresponds very well with Usha river lateral migration and cut off about 5895±255 BP, 5500-4200 cal. yr BC [6]. The next humid phase occurred at the end of the Atlantic period when trees were felled in

the peat bog in the Biebrza valley at 5060±60 BP, cal. yr 3967-3712 BC. At this period trees couldn't grow on a peat-bog in the valley bottom [7] and occurred an increase in lateral migration of riverbeds in many valleys [6]. The changes in sedimentation observed in Sporovo do not have to be caused only by regional conditioning but may be related to the local situation and changes of the Yasielda riverbed. The palaeochannel of this river with water and preserved in morphology was still an active riverbed at the end of the Atlantic, located near the Sporovo II borehole up to 5600±70 BP. Later it was cut off and the river flow near the Kokoritsa archaeological site, which changed the type of sedimentation in the KO4 borehole after 5070±110 BP (MKL-5181) 4224-3642 cal. yr BC.

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