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Abrupt river regime changes at the Pleistocene - Holocene transition in the South of the East-European Plain

The present research aims at estimating chronology of high-amplitude hydrological changes in the southern half of the East-European Plain through a study of palaeochannels preserved on river floodplains and low terraces. The research schedule includes (1) identification of palaeochannels on topographic maps (1:25000 - 1:100000) and aerial photoes, measuring palaeochannel parameters (width, meander wavelength and curvative) and grouping them into separate age generations; (2) studying palaeichannel geological composition and establishing their depth and active section area by making boreholes and examination of natural exposures; (3) establishing absolute age of palaeochannels through radiocarbon dating of organic matter from different alluvial facies (active channel alluvium, base of palaeochannel infill); (4) estimation of river discharge changes in the past from the transformation of palaeochannel parameters with time. Detailed investigations were completed at two key sites located within the present-day belt of forested steppes characterised by moderate continental climate (Fig.1). The following results were obtained.

Fig.1. Location map.
Site 1 - Rivers Seim and Svapa; Site 2 - the Khoper River

Site 1 - River Seim (the Dnieper River Basin) in the middle course and lower stretches of its tributaries - R.Svapa and R.Prutische (Table). The rivers have different hydrological characteristics (Table) but they are rather similar in valley morphology. Valdai

Table. Hydrological and morphological characteristics of investigated rivers

Characteristic	River			
	Site 1			Site 2
	Prutische	Svapa	Seim	Khoper
Basin area, km^2	530	6310	10 800	19 100
Contemporary discharges, m^3/s : Mean annual Mean maximum Maximum measured	 2,34 48,3 143	 23 480 1700	 42,5 745 2400	 67,8 991 2910
Floodplain width, km	0,5-1,5	0,5-6	2-8	1-12
Bankful channel width, m: Contemporary Holocene Late Glacial ("large meanders")	 10-15 - 100-150	 15-60 20-60 300-400	 20-100 20-80 500-1000	 20-100 20-80 1000-1500
Meander half-wavelength, m: Contemporary channel Holocene palaeomeanders Late Glacial "large meanders"	 40-120 - 300-700	 70-300 100-300 1000-1200	 100-500 80-400 1700-3000	 100-500 100-500 2500-3000
Palaeodischarges during the period of "large meanders", m^3/s : Mean maximum Maximum	930	1800 5200	3600 14500	4200 18000

(Vistulian) alluvial plain makes a low terrace 10-15-m high and up to 5-6 km wide, marked with abundant relic thermokarst depressions. Floodplain is very broad – 50-200 times as wide as river channels (Table). Most part of the floodplain was constructed by a meandering channel by an order as large as the present river (Table). Large abandoned palaeomeanders are distinguishable on aerial photoes and in many cases make broad curved depressions on the floodplain. Several large palaeomeanders were studied by boring. Palaeochannels are filled by clays (3-4m) covered by a peat layer up to 2 m thick. Radiocarbon dates from the base of palaeochannel fill (Seim: 13800±85, Ki-6984; Svapa: 14030±70, Ki-6997; Prutische: 13510±85, Ki-6991) show that large meanders were abandoned appr. 14 ka BP. The next floodplain generation is marked by palaeomeanders which parameters are similar to the present channel (Table). The oldest small meanders were abandoned in Preboreal or by the beginning of the Boreal

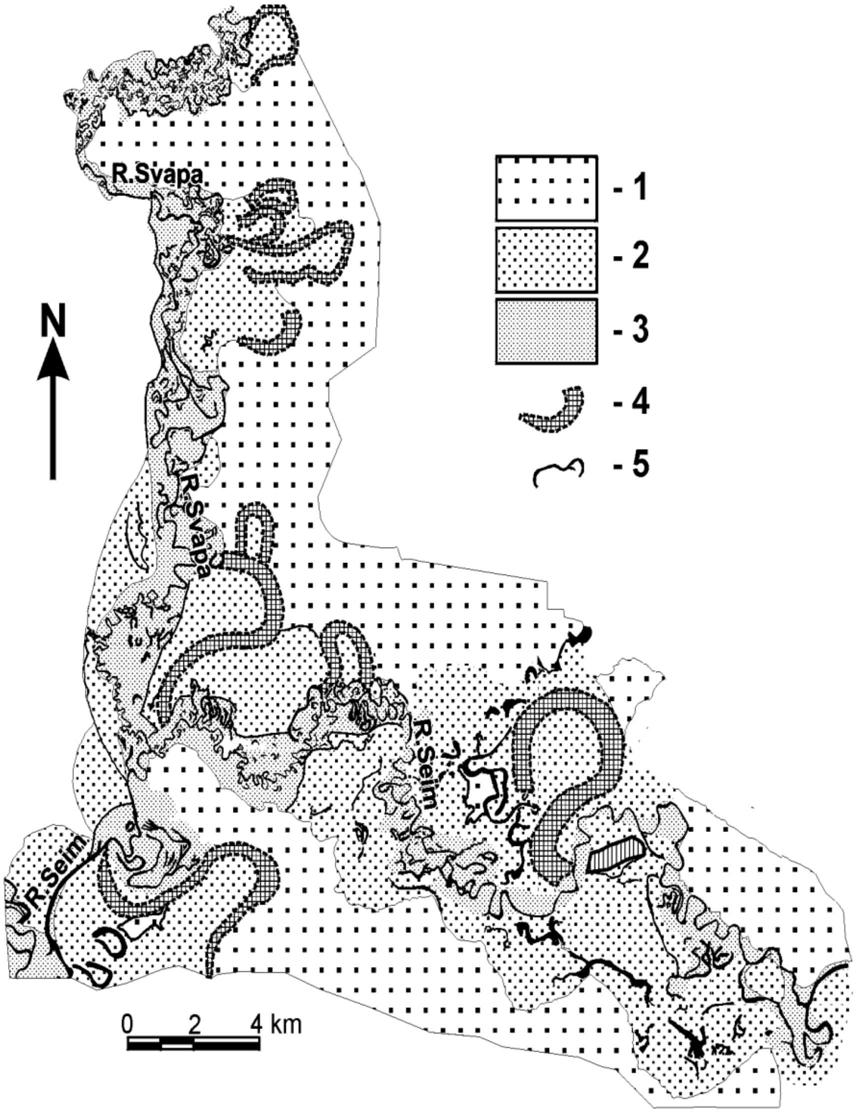

Fig.2. Seim and Svapa River valleys at site 1

1 – Low terrace (Last Glacial); 2 – Late Glacial floodplain and terraces; 3 – Holocene floodplain; 4 – "large meanders"; 5 – present channel and Holocene palaeochannels.

(Seim: 9240±80, Ki-6993; Svapa: 9830±70, Ki-7004). So, flow reduction and transformation from large to small meanders occurred at least by the beginning of the Holocene.

Site 2 - River Khoper (the Don River Basin) in the middle course up-stream from its con-fluence with the Vo-rona River. Valley floor includes a 8-15 m Valdai terrace and floodplain which broadens downstream from 1 up to 10-12 km. Similar to the above case, floodplain contains both large and small palaeochannels (Table). Time of large meander active development is estimated as 14,5(?) – 11,5 ka BP (14430±110, Ki-7694; 11325±120, Ki-7680). After 1,5 ka BP or some later the river formed meanders with half-wavelength 1000-1500 m and channel width 150-200 m, still exceeding the present channel parameters. These meanders were abandoned by the end of Preboreal (9420±90, Ki-7693). The Holocene palaeo-channels are similar to the present-day river.

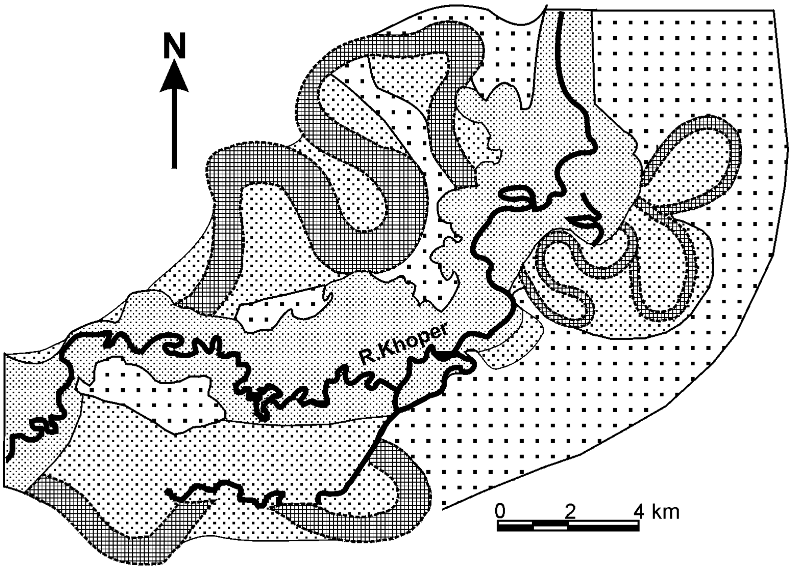

Fig.3. Khoper River valley at site 2

Legend – see Fig.2

Quantitave estimations of palaeodischarges necessary for the formation of large Lateglacial meanders have been made in two different ways (Table):

1) Calculations of maximum discharges by the Chezy formulae. The highest flood level was estimated from the assumption that the depth of floodplain inundation restricted flow velocity to a critical value for surface erosion. Active channel section was obtained from geological data. Palaeoflow slope is assumed to equal the modern floodplain slope along the axis of the palaeochannel. Estimated discharges are 3-6 times greater than modern maximum measured discharges (Table).

2) Calculation from an empirical equation for modern mean maximum discharges and meander half-wavelength: $Q_m = 2.8\ L^{0.92}$ (>50 rivers with L>500m). Mean maximum palaeodischarges calculated from mean half-wavelength of large meanders (respectively 550, 1100, 2400 and 2800 m) are from 4-5 (R. Svapa, Seim and Khoper) to 19 times (R.Prutische) greater than the present.