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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 photos, 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



Fig.1. Location map.

Site 1 - Rivers Seim and Svapa; Site 2 - the Khoper River

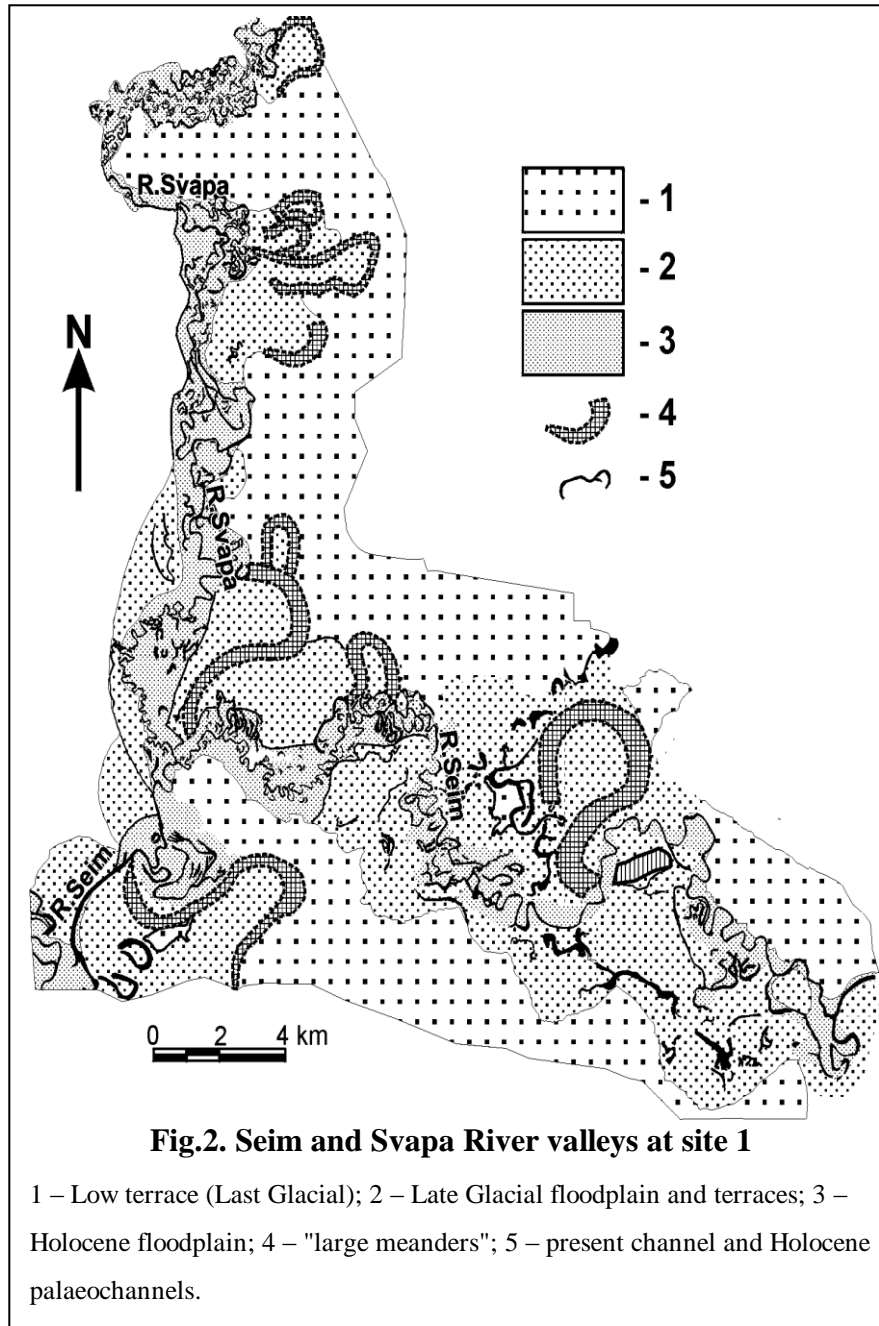
following results were obtained.

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



(Seim: 9240 ± 80 , Ki-6993; Svapa:

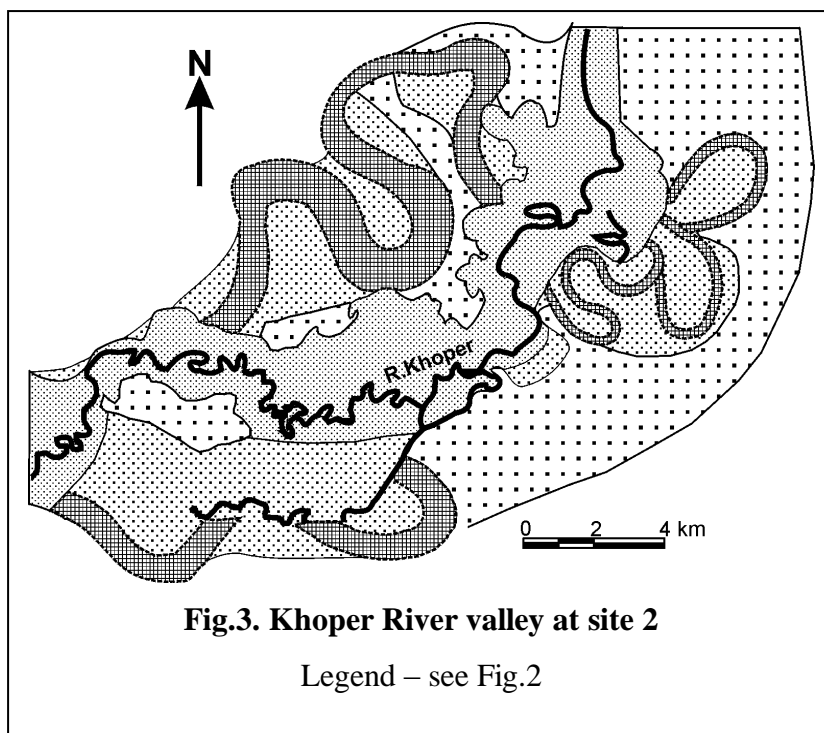
9830 ± 70 , Ki-7004).

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 upstream from its confluence with the Vorona 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 palaeochannels are similar to the present-day river.



Quantitative 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 $L > 500\text{m}$). 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.