Factors controlling the evolution of fluvial systems in C-E Europe during the last cold stage (60-8 ka BP)

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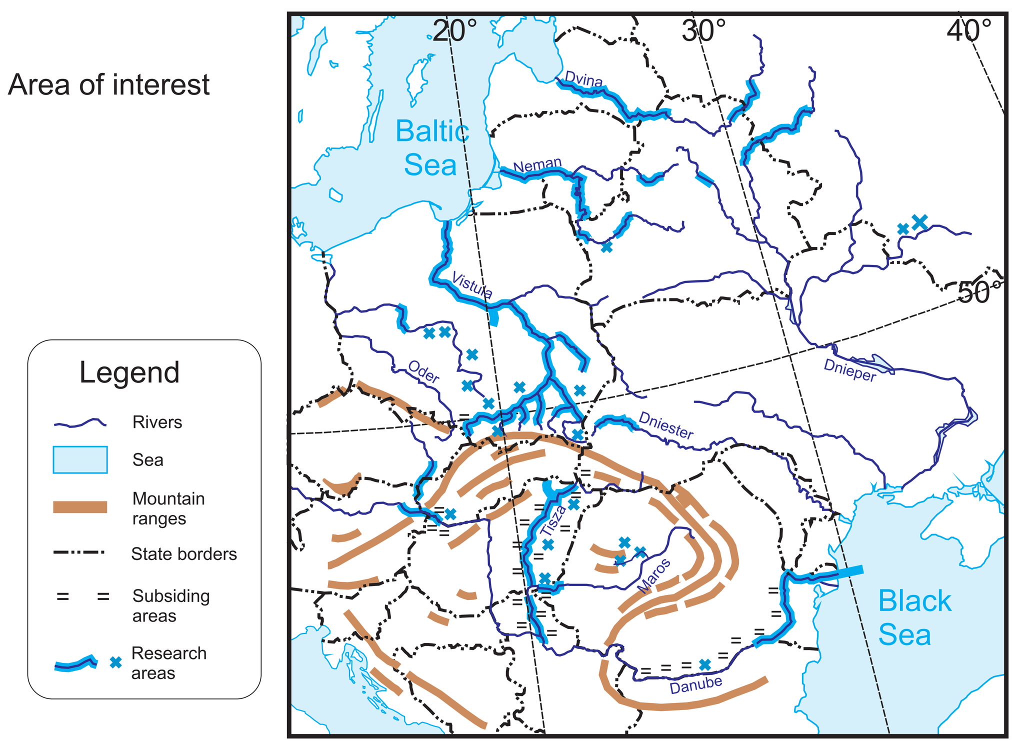
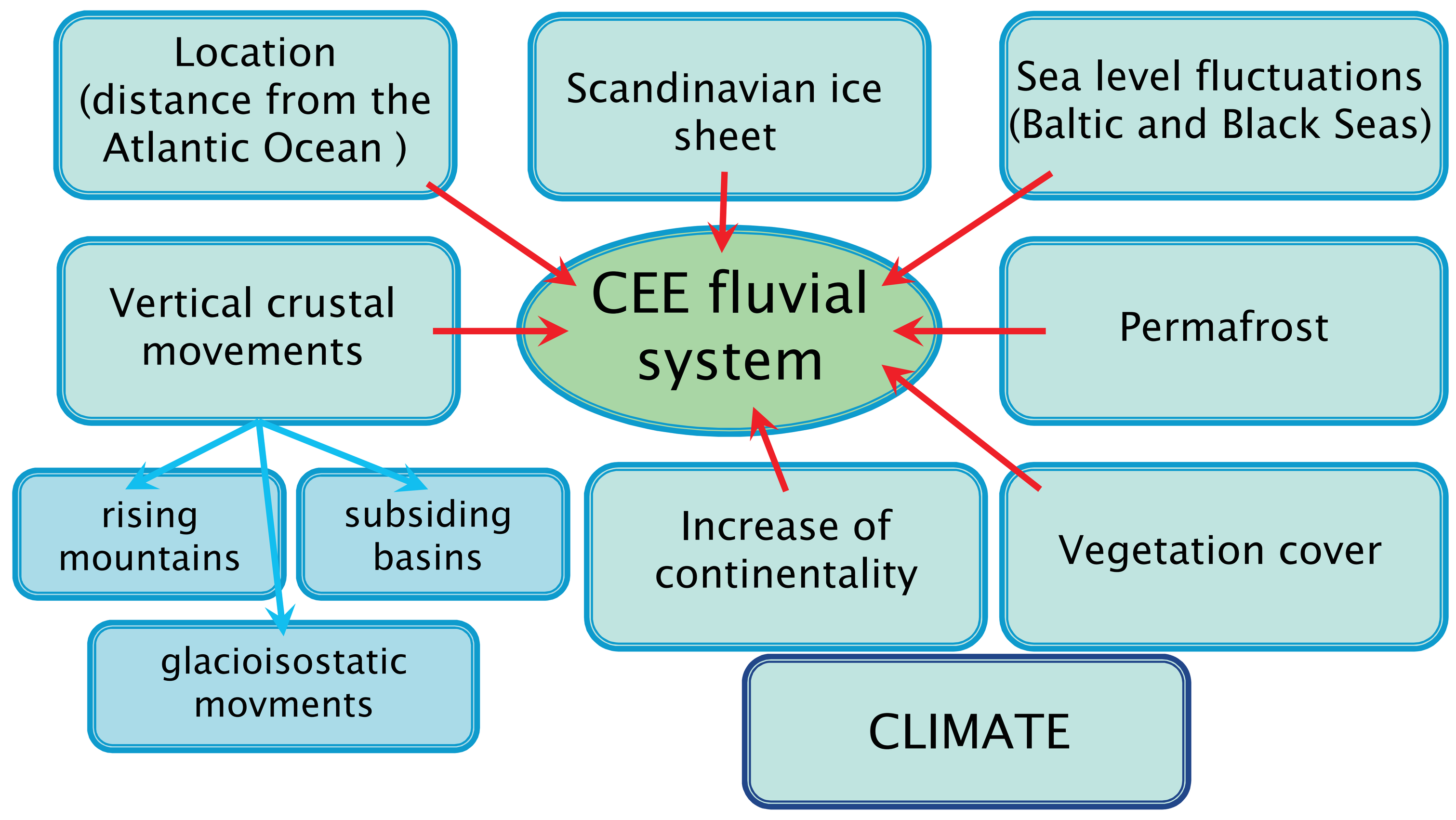
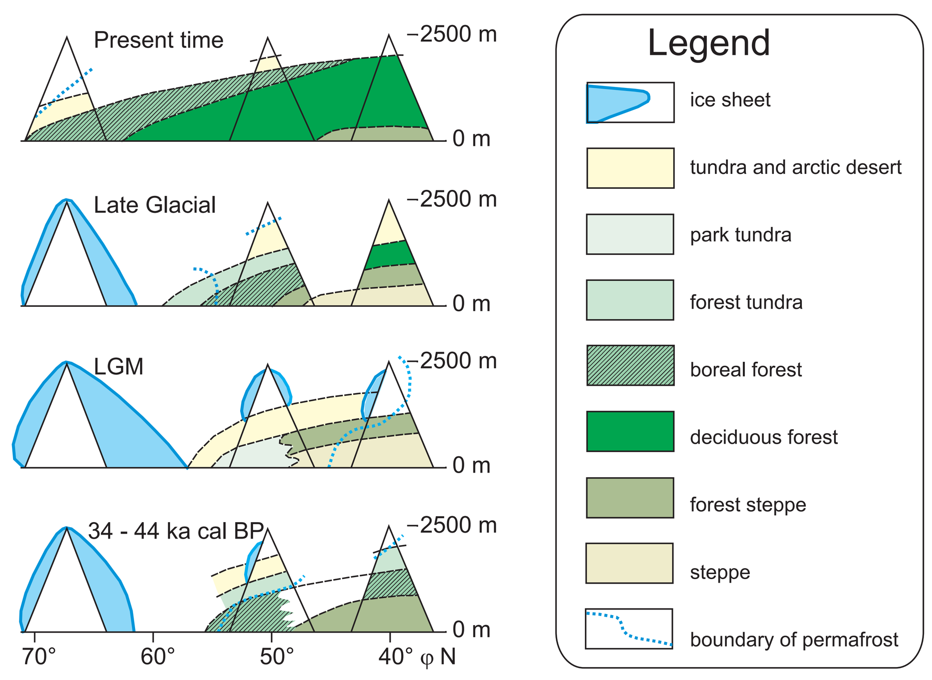
Area of interest

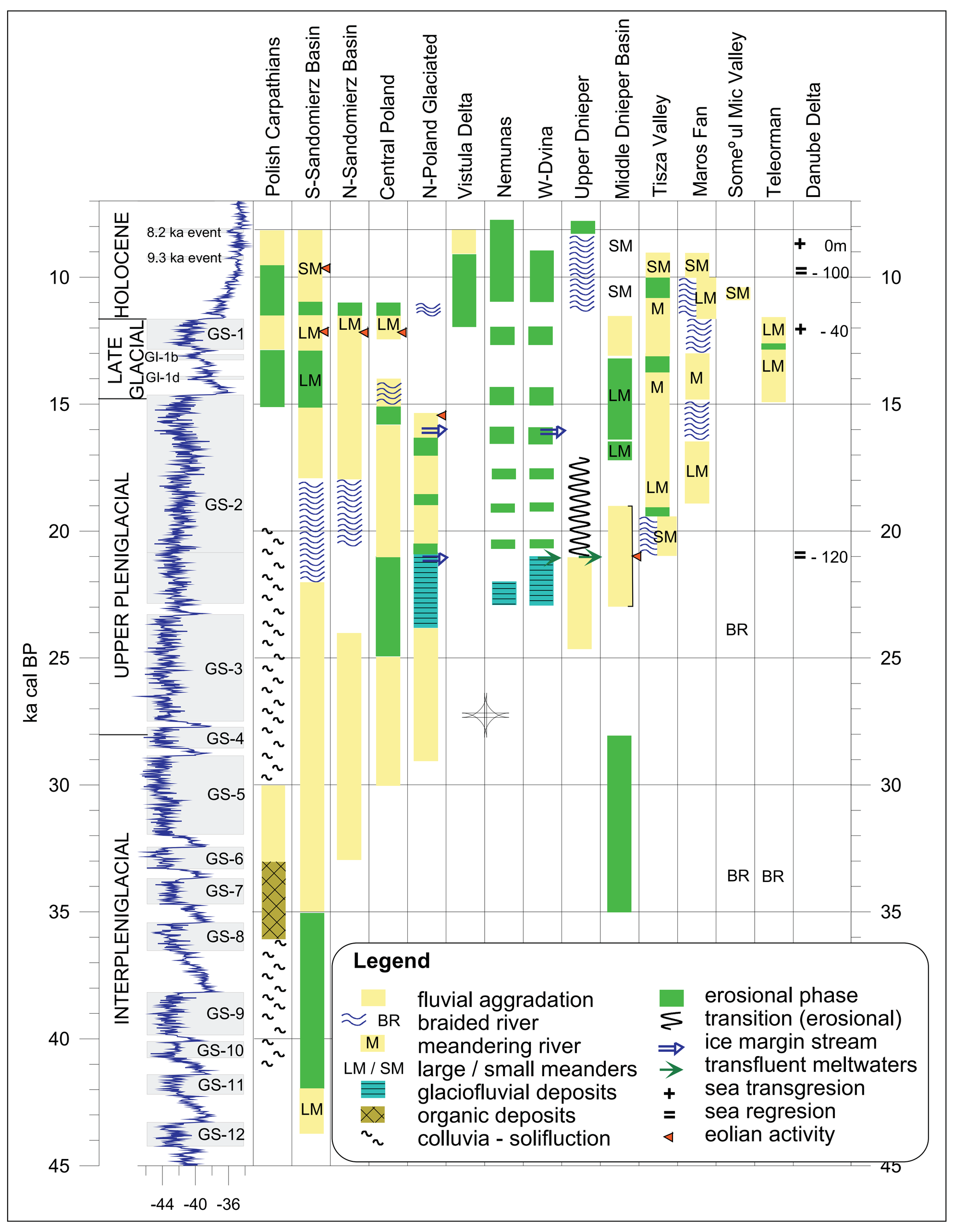




Global and regional factors influencing the evolution of the fluvial systems in C-E Europe.



Changes in the vertical zonality of the vegetation cover during the last 44 ka cal BP (simplified).



The evolution of fluvial systems in Central-Eastern Europe reflects in general a sequence of climatic changes registered on Greenland in ice cores and the isotopic $\delta^{18}O$ curve. But in C-E Europe region we observe several deviations connected with different factors.

The C-14 and TL/OSL data helped to recognize the role of the second order climatic fluctuations in the mountains and their forelands, change in longitudinal valley profiles and superposition of other factors – like tectonic component uplift or subsidence, blocking by Scandinavian ice sheet (or crossing of interfluves), marine regression or transgression as well as connected with diachronous expansion of forest vegetation and change in temperature and humidity in north-south and east-west transects.

The long Interpleniglacial (58-28 ka cal BP) is represented in the mountains and plateaus by thick slope deposits interfingering with alluvia rich in organic remains (peat layers). Large alluvial fans are extending at the outlet from the mountains. In these fans, 2-3 cuts and fills were registered at several localities. These are especially well recognized in the Sandomierz Basin (S Poland). Rapid cooling and the increase of continentality caused expansion of permafrost and a change, which preceded the maximum advance of Scandinavian ice sheet and caused the covering of the interpleniglacial alluvial plains by thick younger loess. That Interpleniglacial period, with frequent climatic fluctuations, was the time of deposition of deluvial and colluvial silts and sands up to 20 m thick, and in smaller valleys dissecting loess plateaus. Only in the subsiding Pannonian Basin we observe permanent trend to aggradation.

During maximum extend of the ice sheet, ice-dammed lakes and ice-marginal valleys were formed. Also glaciofluvial fills were formed during the transfluence into the Black Sea (area). Braided rivers at the mountain forelands formed incised lower alluvial fans. Strong eolian activity caused the formation of dune fields, especially extensive in the western elevated part of the Pannonian Basin (Transdanubia) build of sands probably blown out from glaciofluvial fan of Danube at its outlet from the Alps. Wind activity was very high in some intramountain depression (like Jasło-Sanok Doły) where deflation eroded shallow depressions and coarser Carpathian loess has filled some valley floors.

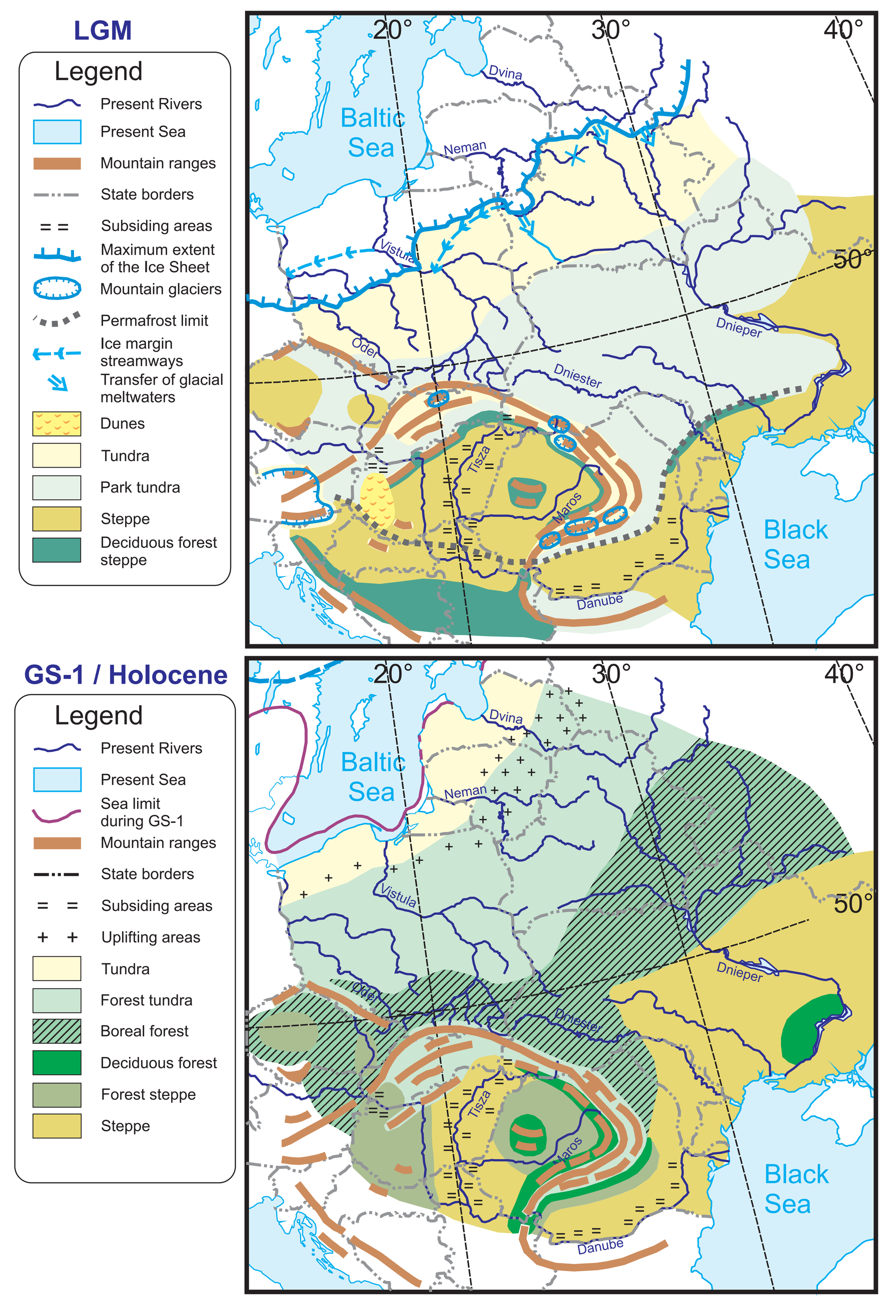
During the ice-sheet recession, there has been gradual downcutting, supported by glacioisostatic uplift. The erosion was going down several tens meters below the present-day Baltic Sea level, and it was stopped by the Littorina transgression in the mid-Holocene. From about 18 ka cal BP, a gradual expansion of boreal trees from the East and the reduction of the sediment load started.

Only the greatest rivers, as the Danube and Tisza in the subsiding depressions far from supplying mountain areas preserved meandering channels during the whole time. In most river valleys gradual change from braided channel to meandering ones was typical. There were two warmer phases when followed formation of great palaeomeanders: 19-17 ka cal BP (Sagvar – Lascaux interstadial) and 14.7 – 11.7 ka cal BP (Bølling – Allerød – Younger Dryas. The large palaeomeanders of the older phase are developed over boreal forests-steppes of northern Ukraine and southern Russia, along tributaries of Tisza, and very rare in other regions. After next cool phase (equivalent of Pomeranian glacial advance) followed second warmer phase of Late Glacial, when great meanders developed, which are better expressed north of the Carpathians where advance of forest stabilized the outflow. That system was abandoned during Younger Dryas and changed to stable discharges reflected in small scale palaeomeanders.

Much greater diversity has been registered after Upper Pleniglacial on the extensive alluvial fan of Maros River surrounded by permanently subsiding areas. Here frequent channel avulsions reflected the changes in hydrological regime of the headwater area.

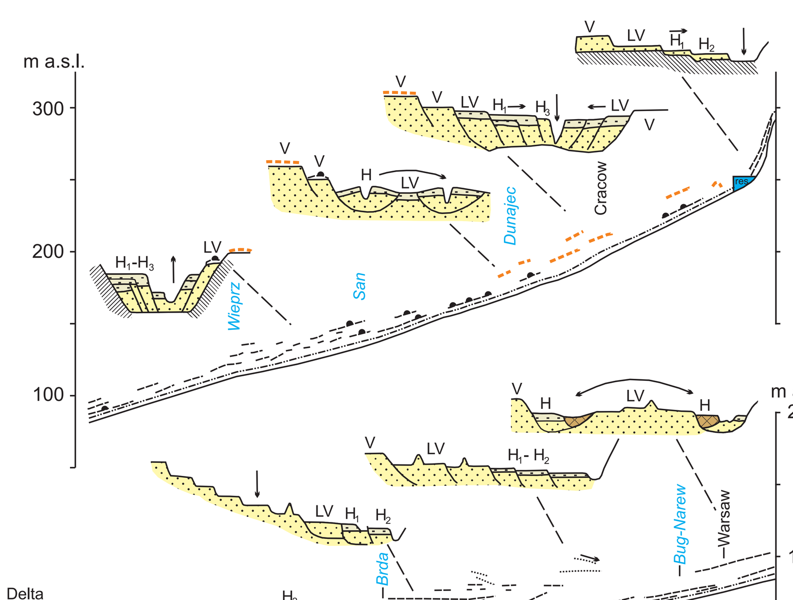
During the early Holocene, under dense forest, which climbed up to 1500-2000 m a.s.l., relatively low discharge and sediment load was characteristic of rivers, especially in the Pannonian Basin, still occupied partly by steppe vegetation.

The climate has changed about 9.5 ka cal BP when followed the phase of frequent floods and expansion of deciduous trees, reflected in minerogenic layers in peatbogs and avulsions of river channels even with local tendency to braiding.

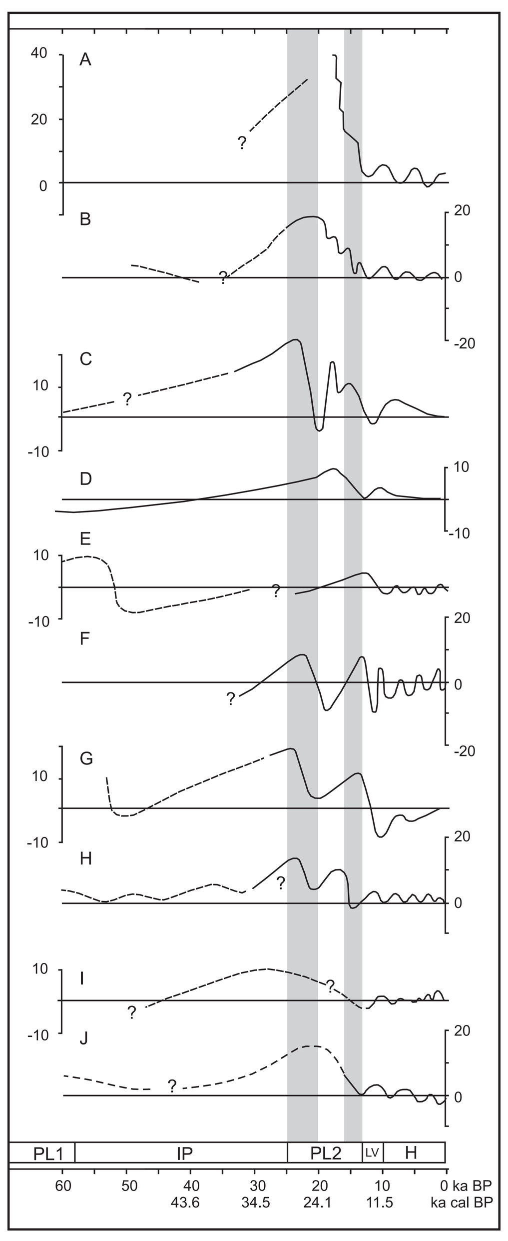


Palaeogeographic maps during LGM and GS-1/ Holocene transition (simplified).

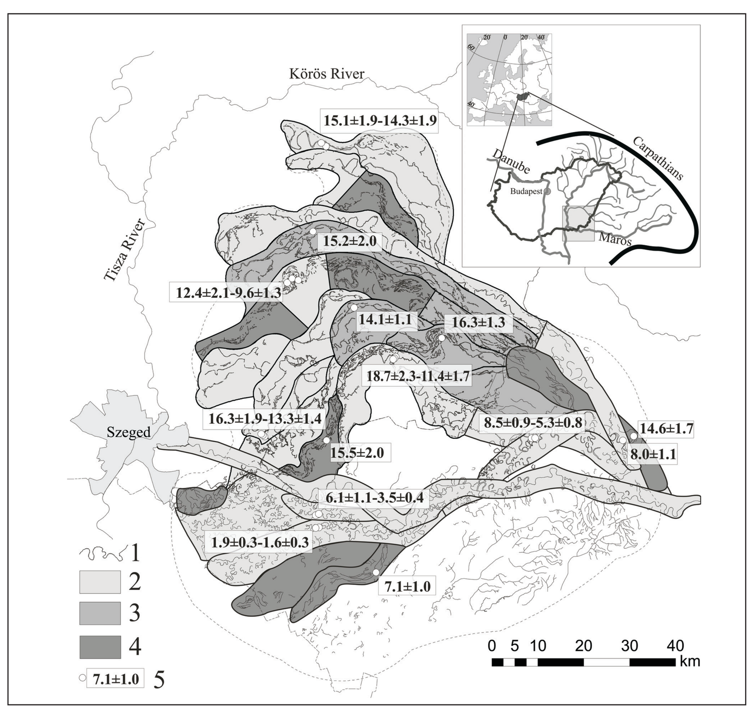
Data from different river valleys:



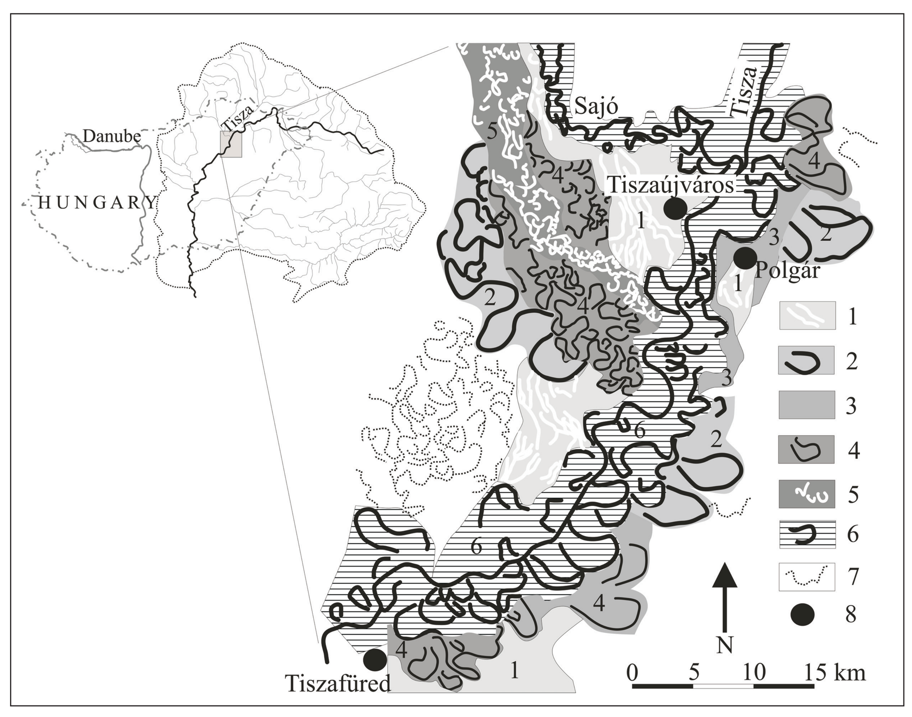
VISTULA. Longitudinal profile and schematic transversal profiles of the Vistula River valley (after Starkel 2007, changed): 1 – longitudinal channel profile, 2 – fluvial terraces, 3- glaciofluvial terraces, 4 – Vistulian terrace with dunes, 5 – Vistulian terrace with loess cover, 6 – channel facies, 7 – overbank facies, 8 – organic deposits, 9 – marine deposits, 10 – bedrock. Used abbreviation: V – Vistulian, LV – Late Vistulian, H – Holocene, res – water reservoir. Name of the Vistula catchments are in italics.



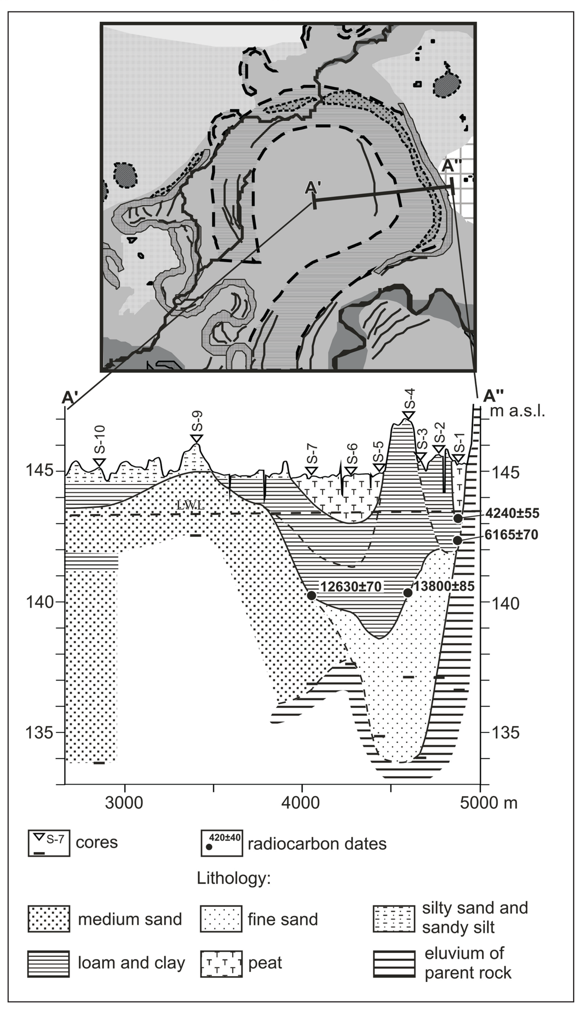
VISTULA. Fluctuations of the channel level during the last cold stage along Vistula River (after Starkel et al. 2007, changed). Grey rectangles show the main phases of climatically controlled erosion in most regions of the former periglacial zone in southern and middle Poland. A. The Lower Vistula valley in the Toruń Basin B. The Vistula valley in the Warsaw Basin, C. Middle course of the Prosna valley, D. The Mroga valley on the Łódź Plateau, E. Belnianka valley (after Ludwikowska-Kędzia 2000) and Bierawka valley, F. The Vistula gap through uplands, G. Middle course of the Wieprz valley on Lublin Plateau, H. General scheme of channel fluctuations in the Sandomierz Basin, I. Upper Vistula in the Oświęcim Basin, J. Lower course of the Carpathian valleys.



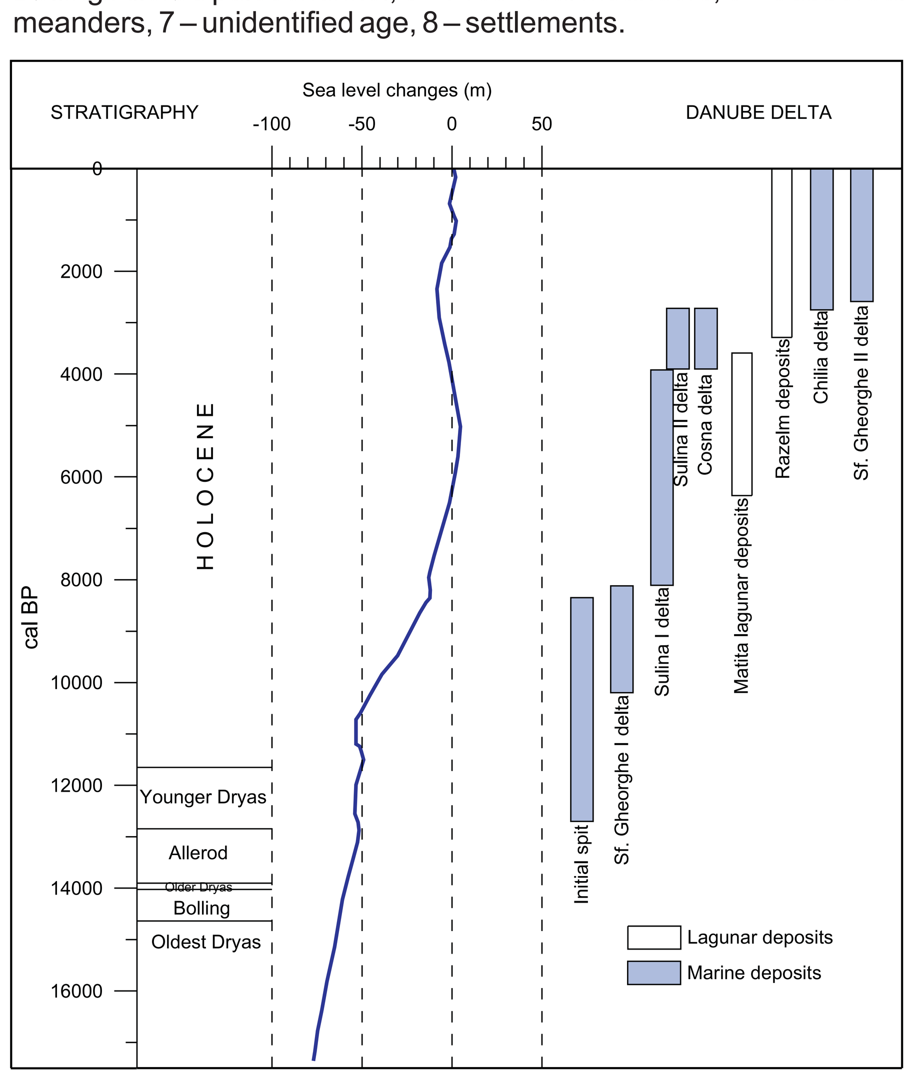
MAROS. Paleochannel generations and their channel pattern on the Maros alluvial fan. 1 – paleochannel, 2 – meandering, 3 – anastomosing, 4 – braided pattern, 5 – OSL age (ka) of the point- or mid-channel bars (after Sümeghy et al., 2013, changed).



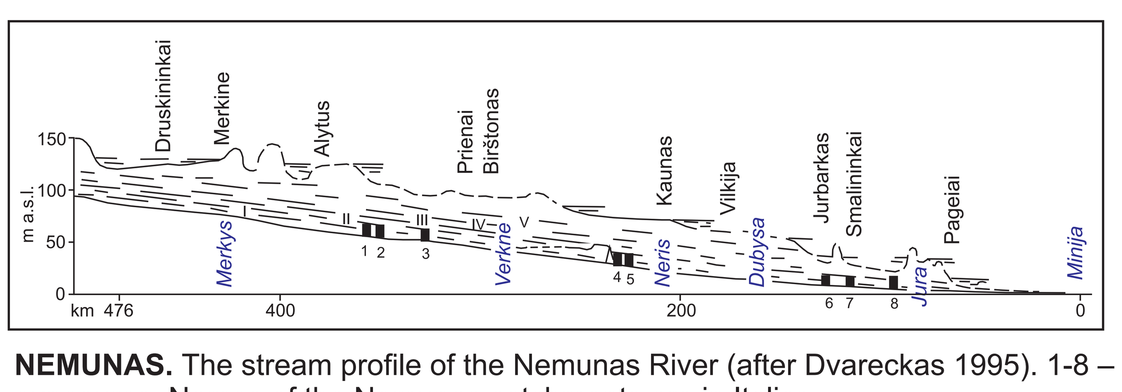
TISZA. Channel generations in the Middle Tisza and Sajó-Hernád alluvial fan region (after Gábris et al., 2012, changed). 1 – LGM braided paleochannel, 2 – paleochannel from the last interstadial of the Upper Pleniglacial, 3 – braided Oldest Dryas paleochannel, 4 – Bølling/Allerød paleochannel, 5 – Preboreal meanders, 6 – Subboreal meanders, 7 – unidentified age, 8 – settlements.



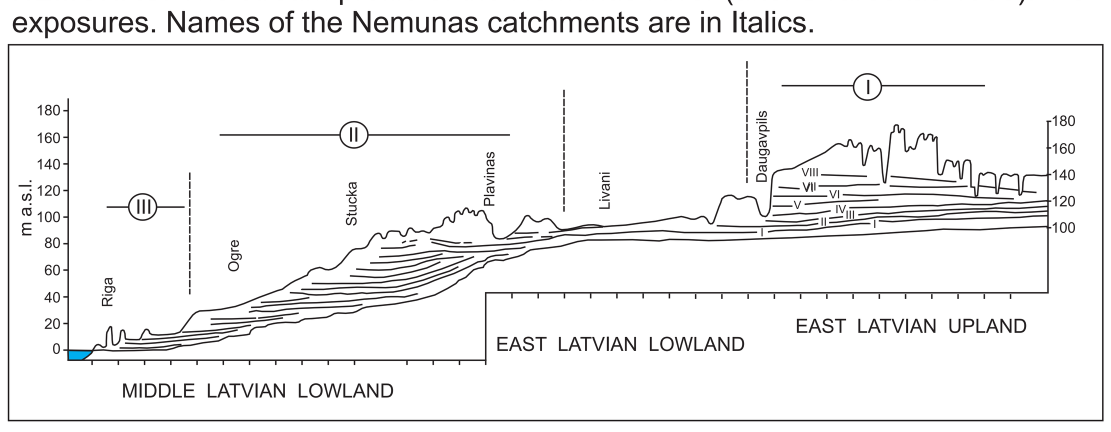
SEIM. The large meandering channel of the palaeo-Seim River near Kudintsevo village (Borisova et al., 2006; changed).



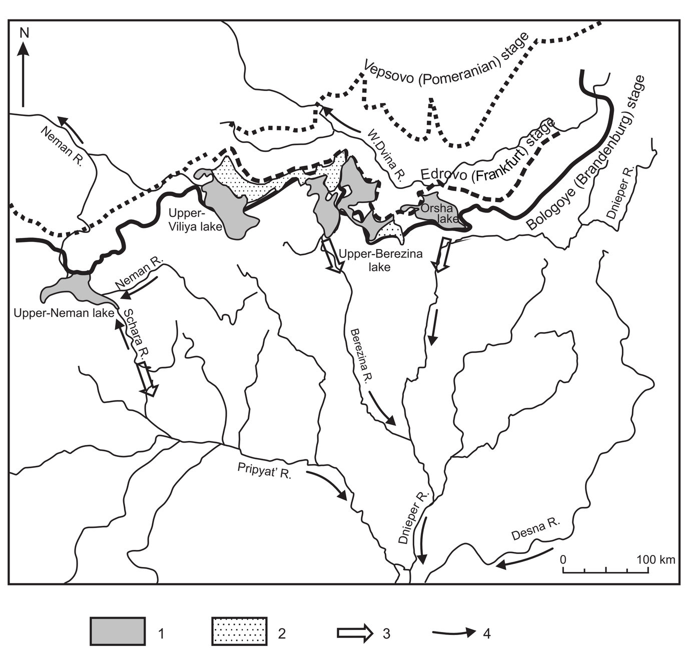
Black Sea level changes and stratigraphic sketch of the Danube delta deposits (after Ghenea and Mihailescu 1991, changed).



NEMUNAS. The stream profile of the Nemunas River (after Dvareckas 1995). 1-8 – exposures. Names of the Nemunas catchments are in Italics.



WESTERN DVINA. Terraces of Western Dvina (after Eberhards 1972).



DNIEPER. Transfer of meltwaters to Dnieper valley (after Sidorchuk et al. 2011). Legend: 1 - deposits of proglacial lakes; 2 - sandy glacio-fluvial deposits; 3- melt-water blow-out channels; 4 - present-day direction of flow.

REFERENCES:
Starkel et al., 2014. CLIMATIC FLUCTUATIONS REFLECTED IN THE EVOLUTION OF FLUVIAL SYSTEMS OF CENTRAL-EASTERN EUROPE (60 - 8 ka cal BP). *Quaternary International*, submitted; and references cited herein.

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