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Impact of Middle Pleistocene (Saalian) glacial lake-outburst floods on the meltwater-drainage pathways in northern central Europe

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The regional meltwater-drainage system and the landscape evolution along the southwestern margin of the Middle Pleistocene (Saalian) Fennoscandian ice sheet in northern central Europe were strongly impacted by the formation and drainage of ice-dammed lakes. Ice–sheet advances repeatedly led to the blockage of the fluvial- and meltwater-drainage systems and the formation of extensive ice-dammed lakes. Between the Lower Rhine Embayment in the west and the continental drainage divide between the Atlantic and the Black Sea in eastern Poland, meltwater drainage along the ice-sheet margins was controlled by the ice-dammed lakes. The location and extent of these lakes depended on local topography and the presence of ice dams. Ice-margin retreat changed the lake configuration and opened lake overspills, leading to the successive drainage of the lakes. Glacial lake-outburst floods occurred when large overspills were suddenly opened. To re-open the drainage routes towards the west and northwest a successive opening of the ice dams and the drainage of the ice-dammed lakes was required.
At least three major outburst floods from different ice-dammed lakes in northwestern and central Germany have been reconstructed, which were triggered by the failure of ice dams in bedrock-outlet channels and released ~20 to ~200 km^3 of water. The flood pathways are characterised by erosional features like plunge pools, trench-like channels, megaflutes, scour pools and streamlined hills and flood-related deposits, including large-scale sand and gravel bars and fields of sandy bedforms deposited by supercritical to transcritical flows.
To quantify the flow characteristics during glacial lake-outburst floods numerical flow simulations were conducted for different ice-dammed lake configurations and boundary conditions, including the lake volume, flood hydrograph and basal topography. Subsequently the model results were compared to the sedimentological and geomorphological evidence of the lake-drainage events in order to estimate the most likely flood pathways and the impact of the floods on erosion, sediment distribution and post-glacial landscape evolution. The incision of deep and broad channels by the glacial-lake outburst floods provided an efficient meltwater-drainage network during the ice-sheet decay and re-advances. Partly, the flood-related channels became part of the post-glacial fluvial-drainage system.