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Catastophic flooding origin of channel systems and streamlined hills in the Münsterland Embayment, NW Germany

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During the Early Saalian glaciation numerous glacial lakes formed at the southern margin of the Scandinavian Ice Sheet. Ice-damming of the Upper Weser Valley led to the formation of glacial Lake Weser. During the maximum lake-level highstand of approximately 200 m a.s.l. the lake covered an area of at least 1700 km2 with more than 100 km3 water stored in the lake basin. The spillway system was through a series of valleys in the Teutoburger Wald Mountain over an altitude range of 40-215 m a.s.l., through which the proglacial lake drained southwestward into the Münsterland Embayment. The lake drained catastrophically into the Münsterland Embayment as the western ice dam failed, releasing up to 70 km3 of water within a few days. The drainage routes are characterized by the occurrence of streamlined hills, oversteepened channels and trench-like incised valleys, cut into bed rock and older Quaternary deposits.

Streamlined hills occur in front of two lake overspills and are 6-12 m high, 600-3000 m long, and 300-1000 m wide, forming fan-shaped arrays of hills, covering an area of approximately 200 or 300 km2, respectively. Most of these hills trend NE-SW and have quadrilateral, elongate to lemniscate shapes with a common width to length ratio between 1:2 to 1:4. They consist of meltwater sand, overlain by relics of diamicton and partly resemble crag and tail features and features produced by currents around obstacles. The “obstacle” is a plug of more resistant diamicton and the tail is composed of sand, representing relics of older meltwater deposits and sand bars formed in the lee of streamlined hills during flood. The channels between the streamlined hills are 5-9 m deep, 50-500 m wide and filled with sand and pebbly sand, mainly representing younger fluvial deposits.

These streamlined hills have formerly been interpreted as drumlins. However, the anastomosing channels are scoured into the Saalian deposits and hills therefore mainly represent eroded remnants of a once continuous cover of diamicton and meltwater deposits. Our hypotheses is that in the early stages of the lake outburst flood, a system of anastomosing channels and streamlined hills was eroded in front of lake overspills. Subsequently a central channel was cut, leaving erosional remnants of the earlier anastomosing channel system and streamlined hills in the outer zone. The flow became increasingly focused in the inner channels, causing deep incision. In downflow direction the central channels evolve into straight 1-2 km wide, 5-7 km long and 10-20 m deep incised valleys, trending approximately E-W. These trench-like, straight valleys are mainly filled with younger Late Pleistocene and Holocene fluvial deposits and are now occupied by small underfed streams flowing into the River Ems. The River Ems has also an unusually straight valley in this area, about 15 km long and 2 km wide.

We suggest that the post-Saalian (Pleistocene) landscape evolution of the Münsterland Embayment has considerably been influenced by catastrophic floods of glacial Lake Weser near the end of the Early Saalian glaciation. These drainage events resulted in the formation of streamlined hills, anastomosing channels, and trench-like incised valleys, which modified the existing drainage ways and subsequently became the new site of fluvial systems.