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Lateglacial/early Holocene fluvial reactions of the Jeetzel river (Elbe valley, northern Germany) to abrupt climatic and environmental changes

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ABSTRACT

Mechanisms of climatic control on river system development are still only partially known. Palaeohydrological investigations from river valleys often lack a precise chronological control of climatic processes and fluvial dynamics, which is why their specific forces remain unclear. In this multidisciplinary case study from the middle Elbe river valley (northern Germany) multiple dating of sites (palynostratigraphy, radiocarbon- and OSL-dating) and high-resolution analyses of environmental and climatological proxies (pollen, plant macro-remains and ostracods) reveal a continuous record of the environmental and fluvial history from the Lateglacial to the early Holocene. Biostratigraphical correlation to northwest European key sites shows that river system development was partially out of phase with the main climatic shifts. The transition from a braided to an incised channel system predated the main phase of Lateglacial warming (~14.6 ka BP), and the meandering river did not change its drainage pattern during the cooling of the Younger-Dryas period. Environmental reconstructions suggest that river dynamics were largely affected by vegetation cover, as a vegetation cover consisting of herbs, dwarf-shrubs and a few larger shrubs seems to have developed before the onset of the main Lateglacial warming, and pine forests appear to have persisted in the river valley during the Younger Dryas. In addition, two phases of high fluvial activity and new channel incision during the middle part of the Younger Dryas and during the Boreal were correlated with changes from dry towards wet climatic conditions, as indicated by evident lake level rises. Lateglacial human occupation in the river valley, which is shown by numerous Palaeolithic sites, forming one of the largest settlement areas of that period known in the European Plain, is assigned to the specific fluvial and environmental conditions of the early Allerød.

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1. Introduction

Over the last two decades numerous studies have improved the knowledge on the late Quaternary evolution of river systems in several European landscapes and sediments in river valleys have increasingly been used as archives of climate change (e.g. Starkel, 1982-1996; Frenzel et al., 1995; Van Balen et al., 2003). Based on these case studies, various models of fluvial activity for the glacial–interglacial cycles in Europe have been introduced (Vandenberghe, 1995; Starkel, 2000; Bogaart et al., 2003; Vandenberghe, 2008; Błaszkiewicz, 2010; Van Balen et al., 2010; Kaiser et al., 2012). Conceptual models characterise periods of instability with erosion of the river bed, followed by aggradation and transformation of river channel patterns both at the transitions from cold to warm periods and vice versa. During the Late Pleistocene models generally show channel incision and development from a braided river with many shallow channels to a meandering river with a single, deeper channel.

However, accurately dated Lateglacial sequences that provide links between the transformation of river systems and climatic

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change at a high temporal resolution are still scarce. Furthermore, each river presents a unique system, with potentially different responses, depending on a multitude of factors such as river-bed gradient, basin size, sediment load, distance to sea level, position of ice sheet margins and climatic variations in the catchment area. For instance, comparing the response of rivers Maas and Warta to the Younger Dryas cooling, Vandenberghe et al. (1994) showed that one river remained in a meandering stage, while the other changed to a braided river channel pattern. For large systems differences in fluvial regime even within a drainage basin have been described (Buch, 1989; Vandenberghe, 1995; Starkel, 2000).

Previous studies on the fluvial history of the Elbe river catchment concentrated on local (glacio-) fluvial stratigraphies, landforms and large scale shifts of river valleys over the last two glacial–interglacial cycles (e.g. Illies, 1954; Klafs, 1965; Schröder, 1988; Mol et al., 2000; Tyráček, 2001; Thieke, 2002), with recent, detailed studies primarily focussed on the glacial landscapes of northeast Germany (e.g. Kühner et al., 1999; Juschus, 2003; Terberger et al., 2004; Börner, 2007; Kaiser et al., 2007, 2012; Schatz, 2011). Only few sequences composed of Lateglacial and early Holocene sediments have been investigated and dated (e.g. Kloss, 1987; Hiller et al., 1991; Litt, 1992; Mania et al., 1993; Caspers and Schwarz, 1998). Compared with other large European rivers, responses of the Elbe system to Late Pleistocene climate change are basically unknown. The following results from the river Jeetzel, a tributary of the Elbe, give first insights into the Late Pleistocene–early Holocene evolution of an immediately adjacent tributary catchment in lowland Germany.

The primary aims of our research on the Jeetzel floodplain are (1) to reveal structures/forms and sediments of a fluvial/lacustrine (palaeo-) environment, (2) to reconstruct the fluvial evolution from the late Pleniglacial to early Holocene, (3) to detect changes in river regime, periods of incision and aggradation, and (4) to analyse the correlation to climate and environmental change. In order to relate river system evolution with other records and to detect responses of river systems to climate change, reliable dating of sediments is crucial. Therefore multidisciplinary chronological tools (radiocarbon-dating, OSL-dating, archaeological artefacts) as well as biostratigraphical proxies (pollen analysis, ostracods, palaeobotanical remains) and high resolution spatial analyses (drillings, archaeological survey, digital elevation models) are used to establish a sound chronological framework.

This paper demonstrates how the drastic climatic changes during the Late Pleistocene–Holocene transition affected geomorphic processes and ecosystems – including human activities – in lowland river valleys in northern Germany.

2. Regional setting

The Jeetzel is a small, western tributary of the Elbe in the lowlands of northern Germany with a length of 73 km and a catchment of 1928 km^2, covered mainly by Pleistocene glacial sediments. Originating at 61 m a.s.l. in the Altmark, a till-dominated landscape formed during the Saalian glaciation, the Jeetzel enters the Elbe valley near Lüchow and flows through the western fringe of this glacial valley below 20 m a.s.l. (Fig. 1). After pre-site surveys an area of 2 × 1.5 km next to the village of Grabow was chosen for a small-scale survey on river system evolution (Fig. 2). Here, the topmost glacial fluvial sediments of the Elbe river plain are dominated by horizontally bedded, fine to medium sand.

The study area includes an unusually high number of archaeological surface sites dating from the Late Palaeolithic to the

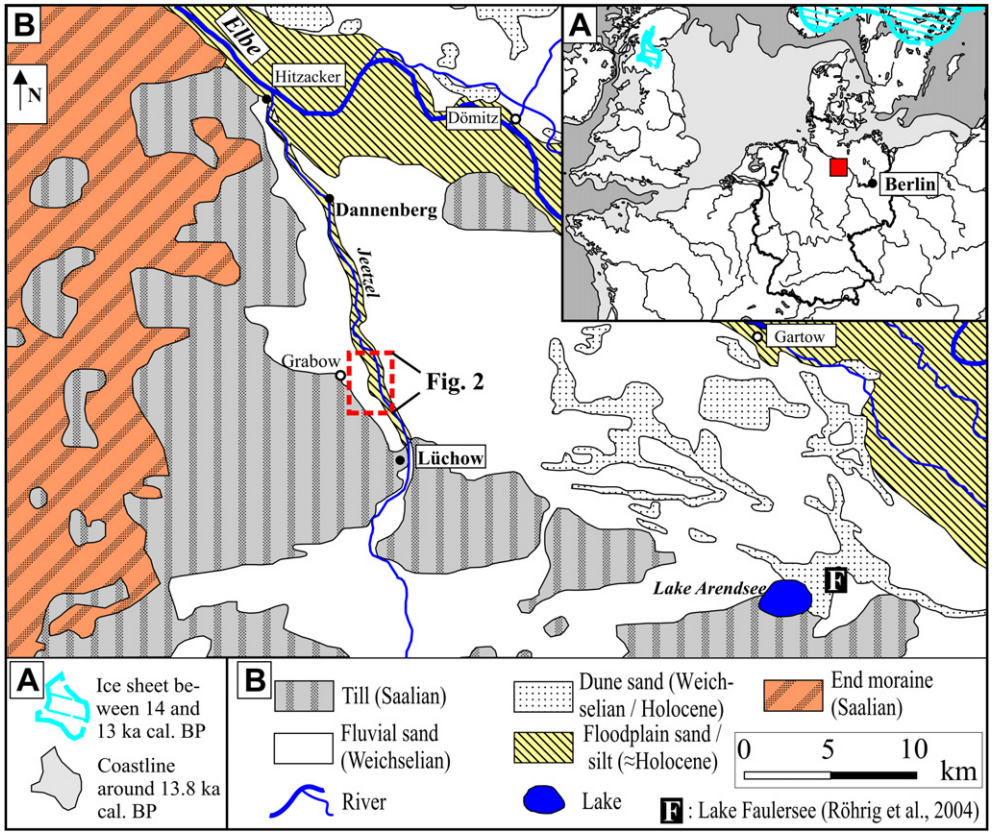

Fig. 1. A) Location map of the study area of the Jeetzel river. B) General geological setting of the middle Elbe river valley.

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