Chapter 5 Fluvial geomorphology of north-east England

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Holocene fluvial development in north-east England

Introduction

The principal river systems of north-east England are the Tyne, the Wear and Tees, and the Cheviot rivers in the northern part of the region (Coquet, Aln, Till) that flow eastwards to the North Sea (Figure 5.1). The sites described in this chapter, with the exception of two upland streams in the Yorkshire Dales (Shaw Beck) and Cheviot Hills (Harthope Burn), however, all lie within the watershed of the River Tyne and its major tributaries. This uneven distribution of sites reflects, primarily, the considerable amount of fluvial geomorphological research that has been undertaken in the Tyne basin, but also the lack of similar investigations in the Tees and Wear river systems, which, despite their size and propensity to flooding, have been little researched. Nevertheless, the Tyne basin does contain a diverse range of physiographic and geological terrains with contemporary and Holocene channel forms, and alluvial deposits, representative of north-east England in particular, and northern England as a whole.

North-east England was ice-covered during the Last Glacial Maximum, at around 18 000 BP, and glacial erosion and sedimentation from this and earlier glaciations have strongly influenced Holocene river development in the region. In response to declining sediment supply after deglaciation, and glacio-isostatic adjustments, upland (e.g. Aspinall *et al.,* 1986) and piedmont (Passmore *et al.,* 1993) reaches of many rivers in the region have entrenched their valley floors in postglacial times, forming well-developed flights of river terraces. In some upland catchments, most notably in the Cheviot Hills, partial refilling of valley floors has occurred more recently, following major deforestation in the prehistoric and early historical periods (Macklin *et al.,* 1991; Tipping, 1992). In contrast, the vertical tendency of channels in the lower Tyne, Wear and Tees valleys during the Holocene has been one of episodic, progressive alluviation. This was in response, principally, to rapid sea-level rise in the early Holocene and anthropogenically induced accelerated catchment erosion in more recent times (Passmore *et al.,* 1992).

The Tyne catchment (drainage area 2927 km^2, basin relief 893 m) is developed predominantly on Carboniferous sandstone, limestone and shale, with igneous outcrops in the headwaters of the North Tyne and along the lower part of the South Tyne valley. The geology of the North Tyne catchment compared with the South Tyne catchments (the principal tributaries of the River Tyne), however, differs in detail; the South Tyne and its tributaries (Black Burn, Nent, West and East Allen) drain the Northern Pennine orefield, which was once the most productive lead and zinc mining area in Britain (Dunham, 1990). Fine-grained sediment from the South Tyne basin has a distinctive geochemical signature that can be recognized in Holocene alluvium downstream in the Tyne valley. Investigations of the dispersal of 19th and early 20th centuries mining waste in the region's rivers have been especially valuable in this context, enabling long-term (Macklin *et al.,* 1992c; Macklin *et al.,* 1994a; Passmore and Macklin, 1994) and large-scale (Macklin and Dowsett, 1989; Macklin, 1992) fine sediment transport processes and storage patterns to be studied.

As in many other base-metal mining areas in Britain (Lewin and Macklin, 1987; Macklin, 1996), historical mining activity significantly increased sediment delivery to rivers in the Tyne catchment, and resulted in widespread contamination of the South Tyne and Allen systems, and much of the Tyne River, downstream as far as Newcastle (Macklin, 1992). The input of coarse material took place mainly in the 17th and 18th centuries primarily through a primitive, but very effective form of hydraulic mining called 'hushing'. Headwater streams in the mining areas of upper Tynedale, Weardale and Teesdale were most affected, with hushing causing localized river aggradation and channel planform change. The impact of the more easily dispersed finer metal-rich wastes was more widespread. Being phytotoxic, high levels of lead, zinc and cadmium in this material severely impaired vegetation growth (Richards *et al.,* 1989; Macklin and Smith, 1990), reducing bank stability and colonization rates of gravel bars, promoting river instability and braiding (Macklin, 1986; Macklin and Lewin, 1989; Passmore *et al.,* 1993).

Present river channels in the Tyne basin are inset either within Pleistocene glacial and glaciofluvial deposits, Holocene alluvium or bedrock. Holocene river sediments range from coarse gravels in the Northern Pennine uplands (Macklin *et al.,* 1992b) and piedmont (Passmore *et al.,* 1993), deposited by laterally and vertically active near-braided channels, to sandy and silty alluvium in the lower (Macklin *et al.,* 1992a) parts of the basin, characterized by vertical accretion and relatively low rates of channel migration. Local differences in valley slope, degree and nature of channel confinement and the calibre of bed and bank sediment have, however, engendered considerable diversity in both Holocene sedimentation styles in the Tyne basin and present-day river channel patterns and bar development. To represent the spatial and temporal variability of river development in the Tyne basin fully, a suite of sites has been selected in order to include, as far as possible, the full range of fluvial environments and histories found in the catchment. The majority of sites are located in the upper part of the South Tyne basin within (Black Burn, Garrigill, The Islands, Blagill, Thinhope Burn and Blackett Bridge), and fringing (Lambley), the Northern Pennine Hills (Figure 5.1). This is because contemporary river processes are particularly active in this area, and also Holocene river sediments and, especially, landforms (e.g. river terraces and palaeochannels) tend to be well-preserved.

Although river channels are less active, and bar-forms are more poorly developed, at Farnley Haughs and Low Prudhoe downstream in the Tyne valley, the importance of these sites lies in their longer and more complete Holocene fluvial sedimentary records.

Research in the Tyne basin over the past decade has combined contemporary fluvial process studies (e.g. Sear, 1992; Sohag, 1994) with the evaluation of river response to longer-term environmental change (e.g. Rumsby, 1991; Passmore, 1994), and three broad themes have emerged from these investigations: (1) river channel, floodplain and drainage basin response to natural (principally climate) and anthropogenically induced (deforestation, changes in farming practice and metal mining) environmental change (Macklin and Lewin, 1989; Macklin *et al.,* 1992a; Macklin *et al.,* in press; Passmore *et al.,* 1993; Rumsby and Macklin, 1994); (2) identifying and dating flood units in Holocene alluvial sequences and assessing the role of large floods in valley floor development (Macklin *et al.,* 1992b,c; Newson, 1989); and (3) fine sediment provenance studies, notably the use of heavy metals as stratigraphic markers and sediment source indicators (Macklin and Dowsett, 1989; Macklin *et al.,* 1994a; Passmore and Macklin, 1994). The sites included in this review have been judiciously chosen to illustrate one or more of these research themes and to embrace some representative landforms.

Additional sites in north-east England

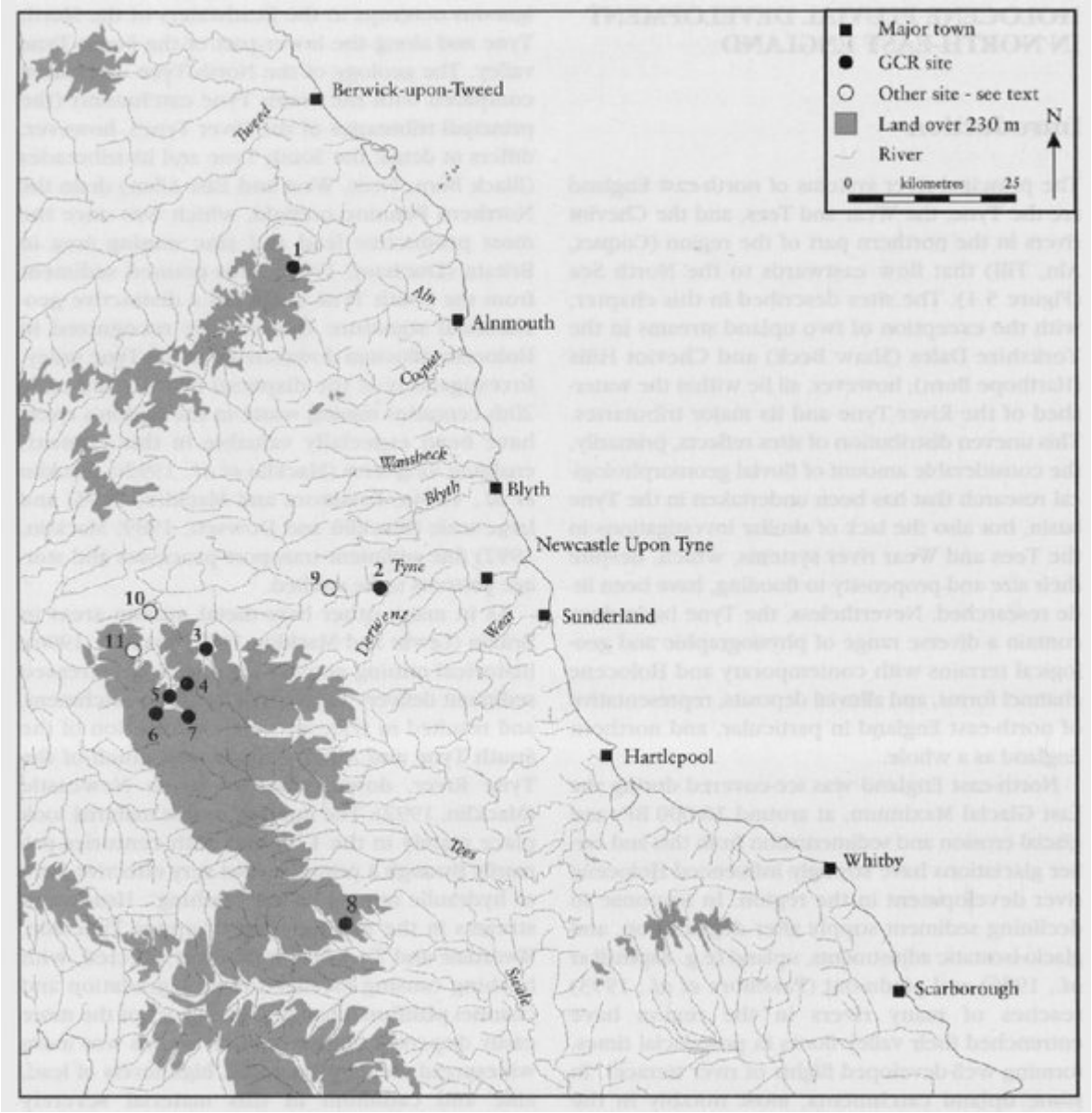
Three other potential GCR sites are considered very important in the network of sites within the Tyne basin. At the time of publication these are not established as GCR sites, but they are key to understanding the landform history, forms and processes in the region, and are considered to be of national significance because of seminal work carried out at them.

Lambley, River South Tyne

Thinhope Burn

Farnley Haughs, River Tyne

References



(Figure 5.1) The major river systems and relief of north-east England. GCR Sites: 1 Harthope Bum; 2 Low Prudhoe; 3 Blackett Bridge; 4 Blagill; 5 The Islands, (Alston Shingles); 6 Black Burn; 7 Garrigill; 8 Shaw Beck. Other sites descibed in the text: 9 Farnley Haughs; 10 Lambley; 11 Thinhope Burn.