Upper Elan upstream of Craig Goch Reservoir at Bodtalog, Powys

[SN 865 746]

G. Higgs

Highlights

This upland valley floor displays characteristic infilling of superficial deposits, but has been trenched by an active meandering stream. The site constitutes a type example of confined meandering.

Introduction

The upper Elan upstream of Abergwyngu [SN 871 736] provides an excellent example of the response of an upland stream to confinement on a low-relief floodplain. It shows contrasting planform types within a relatively limited area. Lewin and Brindle (1977) suggest that lateral growth, loop expansion and relative stabilization, against a confining northern valley wall and southern terraces are the dominant channel change characteristics here. A 250 m reach within this section of the Elan was extensively studied in 1974–75 in order to identify the main characteristics of confinement in such an upland environment. This study included the analysis of channel bed, bar, overbank and terrace deposits, the analysis of channel change through maps and aerial photography, and the measurement of bank erosion rates. It was concluded that confinement can be an important factor in controlling both channel planforms and sediment dynamics of a river system (Lewin and Brindle, 1977).

Description

The Afon Elan rises at just over 500 m on the eastern slopes of the Cambrian Mountains and for approximately 4 km it flows in a generally west-east direction, before assuming a north-south direction on entering the Craig Goch Reservoir downstream of Pont ar Elan [SN 904 714]. The Elan illustrates a variation in the type and extent of confinement such that, for example, upstream of Pont ar Elan, the river meanders across a 200–300 m floodplain before entering the reservoir in a confined rock channel. At this point, resistant beds of rock provide a series of local knickpoints or base levels, creating rapids.

(Table 3.1) Confinement materials on an 8 km reach of the Upper Elan. (After Lewin and Brindle, 1977.)

Confinement materials on an 8 km reach of the Upper Elan

	Right bank (km)	Left bank (km)	Average (%)
Rock	0.53	0.53	29.0
Solifluction deposits	0.75	0.74	40.1
Fluvial gravels	—	0.25	6.8
Sections of complex superficial deposits	0.52	0.34	24.1
Total	1.80	1.86	100.0

In contrast to rock-confined sections such as at [SN 883 728], the section of the Elan near Bodtalog [SN 864 748] is confined largely by unconsolidated superficial deposits. These, it was suggested, were dominated by material of a glacial or periglacial origin, so that on an 8 km reach studied by Lewin and Brindle (1977), 3.68 km was confined by such deposits and by rock (Table 3.1). This confinement was seen to have important implications for the development of channel planforms, for example, typical meander planforms have been distorted, such as at [SN 863 749]. There are at least seven points within the section where the present channel impinges on the superficial deposits, and although the degree of erosion varies from bank to bank, these materials form *an* active input to the system. There is evidence to suggest that some of these deposits remain within the reach as gravel bars, and transport processes are dominantly by bedload, with finer sediment being transported in more extreme events (Lewin and Brindle, 1977). In addition, there are terrace bluffs away from the present channel, which may previously have provided an important source of material. Channel change is evidenced by old channel beds [SN 865 747] and channel traces, which are now recognized by boggy conditions and marsh vegetation.

There is evidence of local slumping into the main channel that is aided by the undercutting of banks, which tend to be dominated by coarser materials at the base with finer-grained upper units. The cantilever collapse of such banks, as in lowland sections of major rivers such as the Severn (Thorne and Lewin, 1979), is apparently important for the input of sediment to the system. Such bluffs are 3–4 m high in places and are dominated, at least above the level of the main channel, by coarser materials in a fine matrix. The coarse materials are mainly angular and range up to 90 cm in length, and are suggested by Lewin and Brindle (1977) to be largely composed of solifluction material. There are areas of alluvial deposits on the valley floor, including gravel point and side bars and also sheets of overbank gravel in places, which are deposited in flooding events.

Results from bed material sampling (using bed-load traps), suspended sediment calculations, and from the measurement of bank erosion rates, suggest that confinement within the reach controls the major source for sediment within the study reach (Figure 3.27) (Lewin and Brindle, 1977). In all, five confined loops and one unconfined loop were studied in this reach. Map evidence suggested that rates of movement of three loops (C, D and E on (Figure 3.27)) were slow (no major change in position was noted since 1885) suggesting ' … relative stabilisation against the confining media' (Lewin and Brindle, 1977). Examination of bank erosion rates revealed a great deal of spatial variation, with an average loss of only 1.4 mm in the study period (April 1974 to May 1975). The highest rates, however, occurred in confined reaches (Figure 3.28), where slumping of material into the main channel — especially during flooding events — was seen to be important (e.g. loop D of (Figure 3.27)). In the latter case, this has led to the creation of in-channel bars, which in some cases have been colonized by vegetation. The input of finer sediment to the system tends to be spatially and temporally irregular. Thus … the sediment yield can be highly variable when measured downstream of all but a few active sediment sites' (Lewin and Brindle, 1977). These are generally washed through the system, although there ark- local deposits of finer silt-sized material. The evidence suggests, therefore, that here the process of confinement has led to meander loops developing within the confining media such that the terrace bluffs, it was calculated, provide 0.02 m^3 of sediment per metre of bank per annum.

This has meant that meander loops in such places are not as distorted as, for example, those patterns noted on the Rheidol and Ystwyth (Lewin and Brindle, 1977), Tywi (Lewin and Hughes, 1976; Lewis, 1982) and Dyfi (Lewin and Hughes, 1976), where more complex patterns of meander growth have resulted from the confinement of river channels owing to human activities, such as railway onstruction. On the Elan, it is suggested that individual confined loops have remained in their position for a century or more.

Interpretation

The Upper Elan provides an excellent example of the response of a river to varying degrees of confinement. This contrasts with those downstream sections of the Elan between Abergwngu and Pont Elan, where the river broadens out across a wider floodplain and creates a range of depositional features characteristic of more lowland streams, and also with the confined rock channels preceding the entry of the river into the Craig Goch Reservoir. Downstream meanders expand laterally as the degree of confinement decreases. The section also provides an important contrast to meandering sections of confined streams in lowland situations, where such confinement is induced by human activity and where there has been modification to the pattern of meandering. In the case of the Elan, terrace bluffs made up of glacial and periglacial deposits are still providing active inputs of material into the system, resulting in an ensconcement of the meander loop within the confining deposits. There is evidence of cutoffs and abandoned channels on the floodplain. This site thus illustrates the importance of confinement on a river's development through influences on the planform and sediment dynamics.

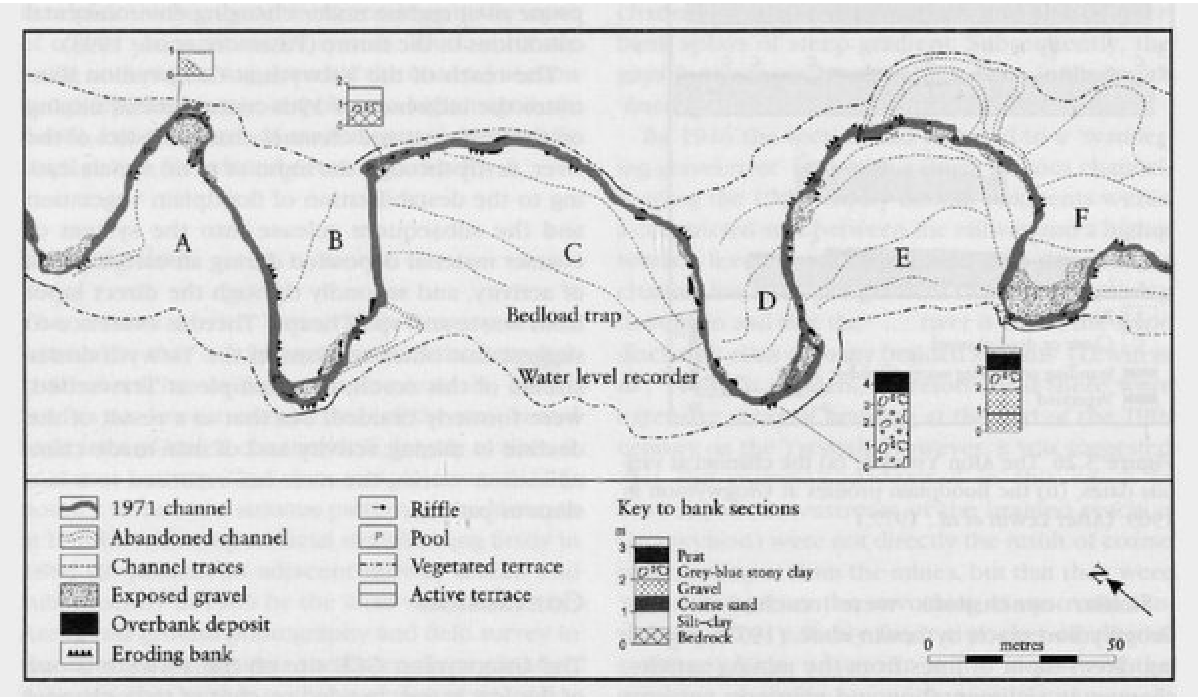
Conclusion

The upper Elan Valley exhibits a range of channel planform types within a limited reach. It contains especially good examples of confined meandering in which processes of change and sediment dynamics have been measured. The channel is confined by valley-fill deposits of various types.

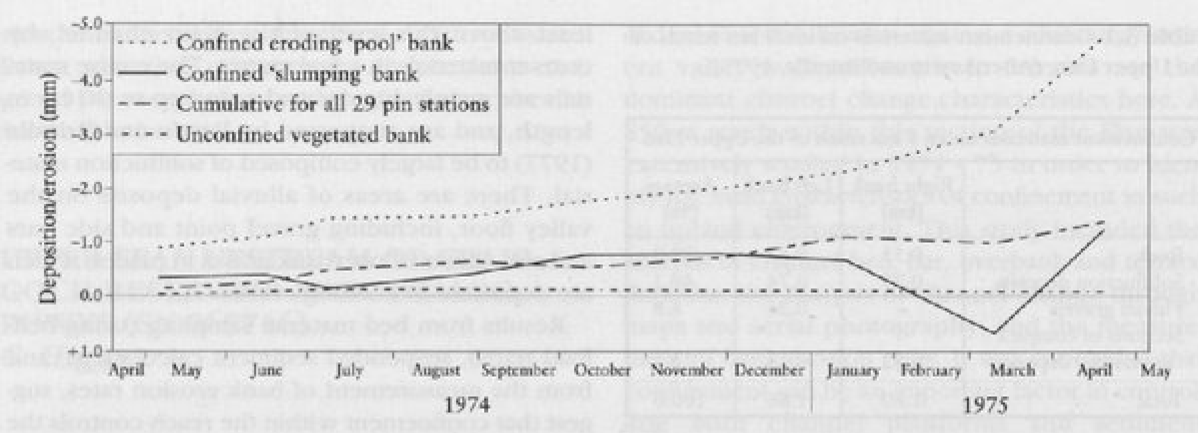
References

Confinement materials on an 8 km reach of the Upper Elan			
	Right bank (km)	Left bank (km)	Average (%)
Rock	0.53	0.53	29.0
Solifluction deposits	0.75	0.74	40.1
Fluvial gravels	–	0.25	6.8
Sections of complex superficial deposits	0.52	0.34	24.1
Total	1.80	1.86	100.0

(Table 3.1) Confinement materials on an 8 km reach of the Upper Elan. (After Lewin and Brindle, 1977.)



(Figure 3.27) The study reach on the Afon Elan [SN 864 748]. (After Lewin and Brindle, 1977.)



(Figure 3.28) Bank deposition (positive values) and erosion (negative values) between April 1974 and May 1975. (After Lewin and Brindle, 1977.)