River Exe at Brampford Speke, Devon

[SX 930 986]

Highlights

The River Exe at Brampford Speke illustrates a case in which the dominant channel processes are controlled by river flows that have a return period of once every 2–5 years. Flows of larger magnitude and of higher return period have less erosive impact as floodplain inundation occurs, dissipating excess energy. The site also exhibits river-channel planform change.

Introduction

Bank erosion occurs under a range of discharge conditions but few systematic studies of bank erosion have been made in which a comprehensive set of factors likely to control erosion has been analysed (Wolman, 1959; Twidale, 1964; Walker and Arnborg, 1966; Harrison, 1970). Most studies of river-channel adjustment have stressed the importance of the mean annual flood (Dury, 1961), but Harvey (1975) remarked on the effectiveness of intermediate discharges.

This reach of the River Exe is important in illustrating two mechanisms of floodplain development, both influenced by small-scale, high-frequency discharge events. The floodplain has developed firstly through lateral meander movement and channel accretion, and secondly by overbank sedimentation, including that in abandoned palaeochannels. Detailed study of one compound meander bend has shown that maximum erosion occurred during discharge events with a recurrence interval of 2–5 years. Evidence of large-scale flood erosion is absent.

Description

Hooke's (1977) study of the site was designed to relate the amounts of erosion measured to the meteorological and hydrological conditions in the intervening period. The factors considered in this study were as follows:

1. Parameters of river discharge conditions and hydrograph characteristics;
2. Storm rainfall characteristics;
3. Time between peak flows;
4. Soil moisture conditions;
5. Temperature, especially frost.

At the meander site the drainage area is 620 km^2, and the channel width is 30 m. Here the gravel bed-channel is wide and flows through an open floodplain. This site includes some of the more active reaches available, and exhibits processes and conditions of channel adjustment more clearly and frequently than other reaches of the Exe.

Four sections were instrumented on a compound meander bend (Figure 6.9) which has developed a secondary lobe, a common feature on channels of Devon rivers. The four sections were as follows: A, a long straight section with a low bank and gravel layer at the base; B, a stretch with irregular plan profile due to embayments gouged out by the river; C, a long straight section experiencing a high rate of bank erosion; D, the inside of a sharp bend where erosion takes place at high flows.

At section A, minimum prior discharge and API (Antecedent Precipitation Index), emerged as the most significant variables, explaining 78% of the variation in mean erosion, reflecting the influence of soil moisture conditions. At section p large amounts of erosion appear to be closely related to API, and this is consistent with the type of erosion observed. Rainfall intensity is also important here. At section B, preceding peak discharges were important, possibly due to the alteration of the bank configuration and the weakening of the bank material that took place. Next in importance in

explaining mean and maximum erosion at this site is peak discharge. API is significant in relation to the proportion of bank eroded. This pattern also occurs at section C, where peak discharge is the most important control on amounts of erosion, and API influences exactly where it occurs. At C the bank line was eroded by just over 7 m over 2.5 years.

The predominant sedimentological unit in meandering streams is the point bar, which is represented in the site. Point bars differ in form, sediment size and structure, both between and along streams, as sediment supply and bend sinuosity vary. A typical bar comprises two elements: the basal platform of gravel, which varies little around the curve, is subject to modification only in extreme events and is laterally continuous with the riffle; and the supraplatform deposits. These are falling stage deposits of the bar head current and are more variable in space and time. Sediment size declines from bar head (gravel) to bar tail and structures change in successive floods.

The river channel has continued to adjust and aerial photographic evidence illustrates the position of the low-flow channel in 1989 (Figure 6.9). Riparian habitat classification of the reach has recently been undertaken by Hooper (1992).

Interpretation

Hooke (1977, 1980) found that changes around bends tend to be gradual and consistent in time, taking place by progressive erosion and deposition rather than by catastrophic change that causes cutoffs. Stream size and sediment characteristics influence the spatial distribution of the rates of erosion, although not generally the relative amount of erosion in each event. Events on the Exe in which the maximum amounts of erosion occurred (including bank retreat of 3 m at one point) had a 2.5 year return period. The characteristics of the site are important. The magnitude of the erosion rate is most closely related to catchment area (as a surrogate of discharge and width). Two types of erosion were identified: firstly corrasion, influenced by river flow level; and secondly slumping, influenced by antecedent precipitation.

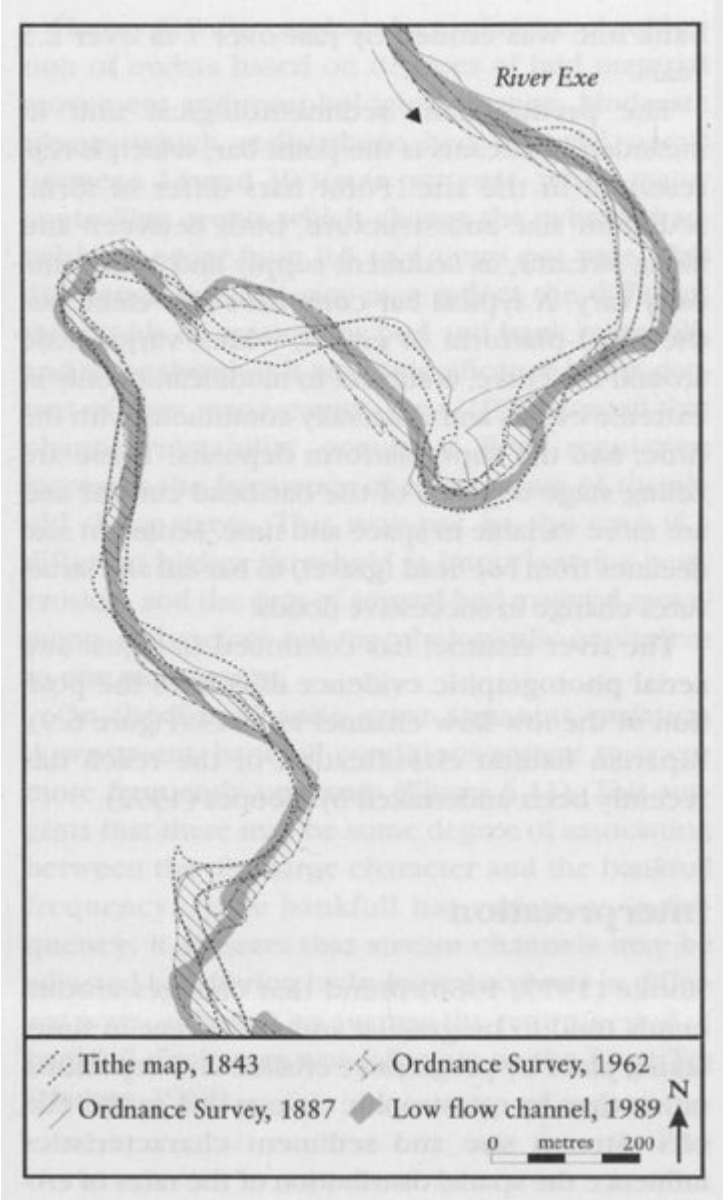
This site is an example of an active piedmont stream in which change in river meanders is progressive. Erosion and deposition take place during events of high frequency. It is a site at which such processes have been monitored in detail, and have been combined with an historical perspective on planform change.

River bank erosion is geomorphologically important as an integral part of changes in the river-channel course and in the development of the floodplain. Also instrumental in floodplain development is the concurrent growth of point bars. Together, these are amongst the most dynamic elements of the fluvial landscape, and thus an understanding of such processes is fundamental to our explanation of the development of fluvial features. As examples detailed in the research literature, the features of this site are significant in this context, and of value in the economic implications for agriculture and the construction of capital works in or near to rivers (Figure 6.10).

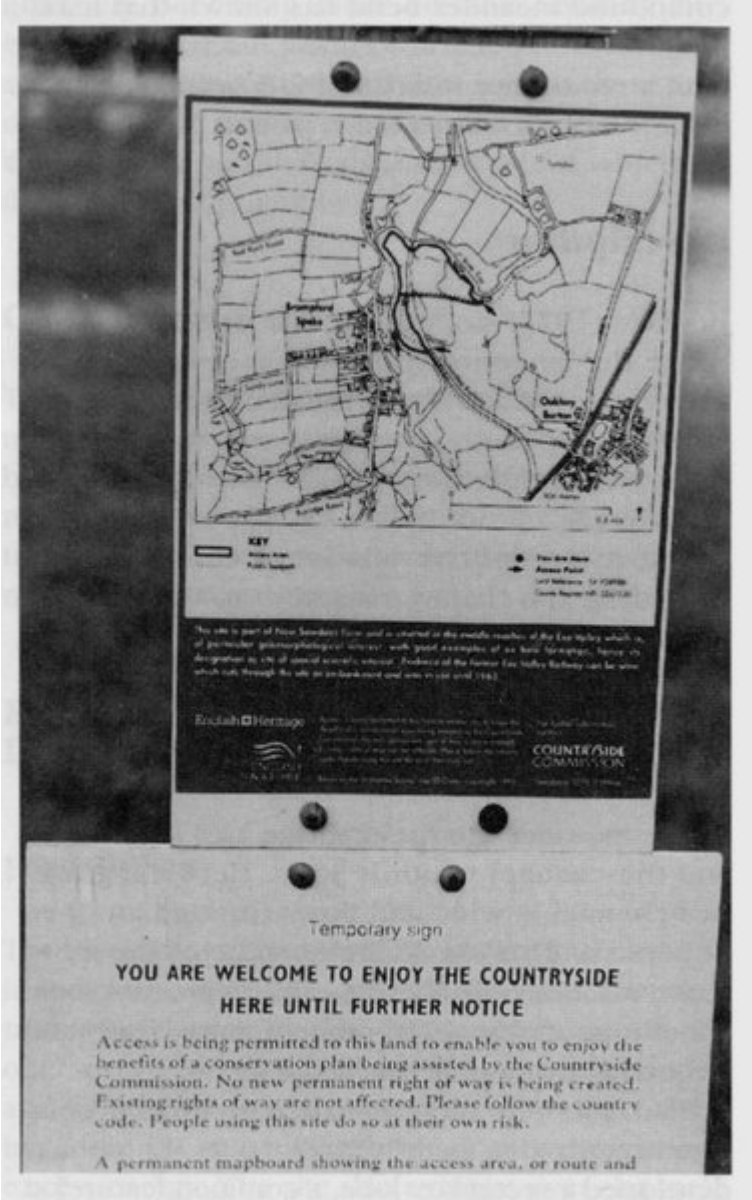
Conclusions

The Exe at Brampford Speke comprises a compound meander in an open agricultural floodplain, in which the processes of bank erosion have been measured in detail. Historical changes in planform have also been documented. The research shows the dominance of frequent events of erosion and deposition and the progressive nature of change at such sites.

References



(Figure 6.9) River channel change on the River Exe at Brampford Speke. (Modified from Hooke and Kain, 1982.)



(Figure 6.10) A temporary sign alongside the Exe. "This site is part of New Sowdens Farm and is situated in the middle reaches of the Exe Valley, which is of particular geomorphological interest, with good examples of oxbow formations, hence its designation as a site of special scientific interest. Evidence of the former Exe Valley Railway can be seen which cuts through the site on an embankment and was in use until 1963'. (Photo: K.J. Gregory.)