River Lugg, Hereford and Worcester

[SO 466 612]

Highlights

The flood alleviation scheme on the River Lugg represents one of the pioneering approaches to adopt a more sympathetic approach to the control of overbank flooding, by designing a scheme based upon a knowledge and understanding of the catchment geomorphology.

Introduction

The sympathetic approach to river management illustrated on the River Lugg represents a move away from the traditional engineering approach to one which considers integrating natural features such as pools and riffles, berms and benches and meanders while still achieving flood control objectives. By adopting an approach that aims to work with the river rather than against it, many of the adverse impacts of channelization (see Brookes, 1988, for examples) will hopefully be minimized. At this site such effects have been recognized by integrating morphological and ecological aspects of management in the scheme through the following concepts (Lewis and Williams, 1984):

1. a stream and its floodplain are parts of the same open system;
2. a balanced view must be taken of economic, fluvial and ecological values;
3. incorporation of existing research knowledge should be undertaken.

The important aspects of fluvial geomorphology and hydrology to be included in the design include the existence of convergent-divergent flow; the complex relationships of sediment transport in streams; and the existence of geomorphic thresholds.

Description

The River Lugg floodplain was often inundated by prolonged flooding, reducing the productivity of the floodplain (RSPB *et al.,* 1994). One reach was characterized by an active meandering system which increased downstream sediment load and led to sedimentation downstream at Leominster, associated with a subsequent reduction in gradient. In order to address these problems, a number of features were included in the scheme, which was constructed in 1980–81:

1. Low, flat, roll-over embankments set well back from the river channel to allow meander migration using spoil from the reprofiling of the land intervening between the riverbank and embankments (Figure 6.46). This provides a sufficient cross-sectional area to convey the 1 in 5 year flood.
2. Meander re-profiling, where no meanders were removed, but the inside of each was reprofiled to a natural shoal (Figure 6.48) and on active bends willows were planted to stabilize exposed banks and assist in habitat creation (Figure 6.47).
3. Low stone weirs (Figure 6.49) and (Figure 6.50): four of these were constructed entirely of rock with relatively flat aprons. They were designed to reduce flood velocities by creating still-water reaches upstream to dissipate energy in the river. Secondly, they are attractive landscape features, and they provide a new stable rocky habitat in a stretch which otherwise is composed of unstable sediments. Each weir was separately designed, varying according to both the location and the size of available materials. A typical plan and section is shown in (Figure 6.49), illustrating the apron of blocks, shallow crest and long downstream glacis, with an end sill and several stones raised above the general level as breakwaters, the whole contained within blockstone wing-walls. The weirs are uncemented, and consist of armouring stones and gravel over either permeable or impermeable membranes.

The approach taken along the Lugg was not universal, with areas of high ecological interest being excluded from the scheme while others received higher standards of protection for flood control (RSPB *et al.,* 1994). For example, upstream of the reach in (Figure 6.47), traditional engineering approaches were used to construct concrete weirs with fish passes, and channel straightening was undertaken to create long sinuous curves of trapezoidal cross-sections.

Interpretation

An appraisal of the scheme was undertaken in 1993, confirming that the primary aim of reducing flooding incidence had been achieved (RSPB *et al.,* 1994). The embankments downstream of Lugg Bridge (Moreton-on-Lugg) had been overtopped occasionally but without undermining stability; however, floodgates have been added to allow the water to return to the river as the discharge recedes. The hydraulic performance of the schemes has also been studied on behalf of MAFF (MAFF/UEA 1991; MAFF/HR Ltd FR312 Nov. 1992 — cited in RSPB *et al.,* 1994).

Upstream of Leominster, above the reach illustrated in (Figure 6.47), the channel has remained featureless, with the fish passes prone to blockage by debris. In the lower section (Figure 6.47) major pools have developed below each weir with associated downstream riffle formation; in some cases it has been necessary to remove shoals which have been created. Upstream of the weirs, the slower-flowing water has allowed habitats in the form of reed and 'withy' beds, marginal wetlands and backwaters to develop (Figure 6.51).

Hey *et al.* (1994) examined habitat changes in the lower reach (Figure 6.47) in comparison with a control reach. The study reach had more species than the control reach, and an increase in river cliffs and berms above 1 m was observed, while reductions occurred in the amount of stable vegetated bank, shingle margin, mud, shrubs and tall grass present.

One of the reasons for the success of the scheme results from designing the channel with nature in mind. This is because, firstly, the resulting stability minimizes maintenance costs necessitated by silting or erosion. Secondly, the aesthetics of the channel are enhanced (Leopold, 1969) and, thirdly, the aquatic ecology can be preserved by maintaining the range of ecological niches found in natural streams with spatially varying depth, velocity and bed material (Keller, 1976).

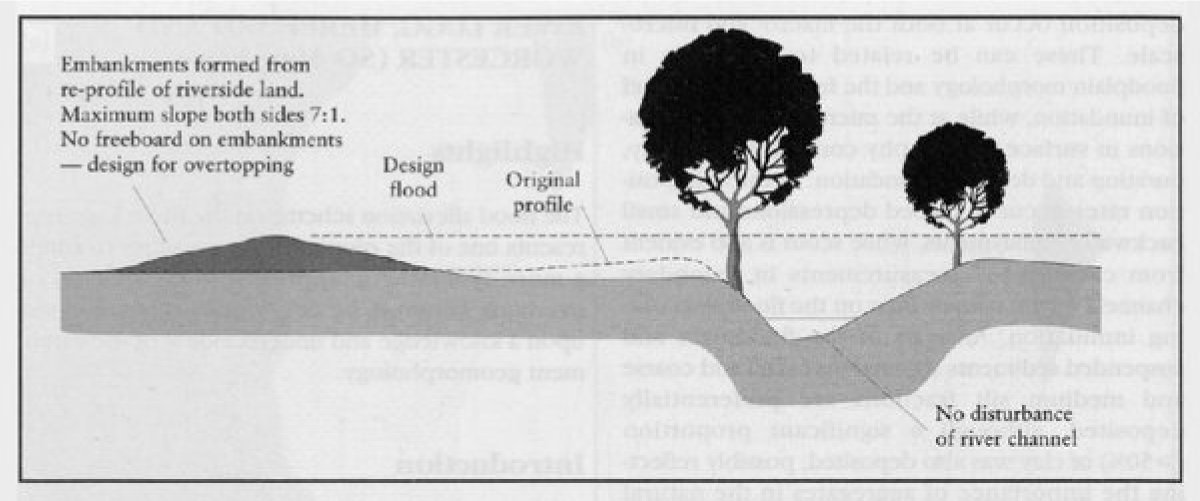
River channel size and shape at any point along a river will reflect the balance between discharge and sediment supplied from upstream and the characteristics of bed and bank material, vegetation and slope at that point. Discharge will depend upon the size of the drainage area, the frequency and char acter of precipitation as rain- and snow-fall and the drainage basin characteristics of rock, soil, land use, vegetation and topography. The interaction of such drainage basin characteristics determines how rapidly climatic effects are translated into a pattern of discharge that will affect the river channel. These characteristics also affect the sources of sediment and sediment delivery rates to river channels. Channel characteristics can be considered as degrees of freedom which may adjust. It is now comparatively easy to say how these change, but not so easy to determine the exact place, time and duration of change.

The recognition of the importance of geomorphology in river-channel management and design is increasingly being appreciated. A fluvial audit (Sear and Newson, 1991), which provides a geomorphological methodology for identifying and solving river-channel management problems, has now been adopted by the National Rivers Authority. This now means that geomorphological approaches to many river-channel management problems and river restoration projects will increasingly become the norm.

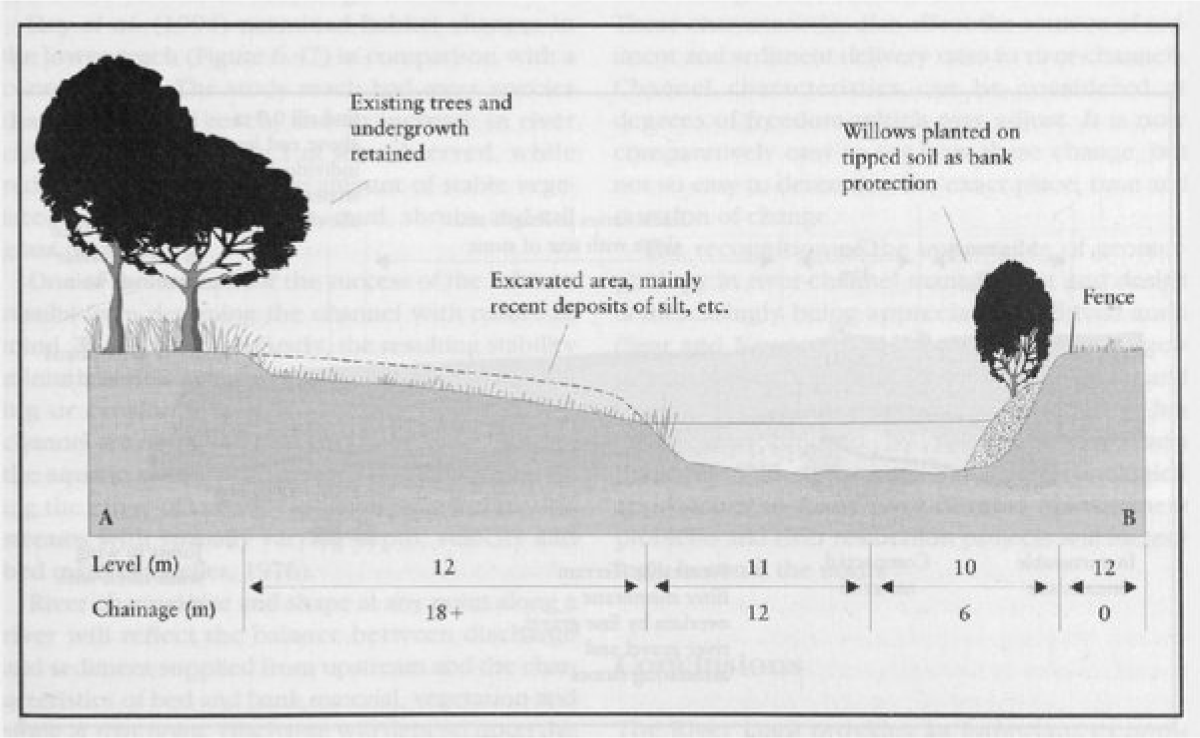
Conclusions

The River Lugg provides an important example where river management has been based on principles of fluvial geomorphology. This has been described as working with the river (i.e. in harmony with fluvial processes) rather than against it. The design of the scheme has included meander easing and construction of floodbanks in such a manner as to minimize subsequent levels of management. Post-project appraisal of the site has indicated that the scheme has achieved its objectives. This demonstrates that flood alleviation schemes can benefit from a geomorphological input which will provide the morphology of enhanced habitat formation and colonization.

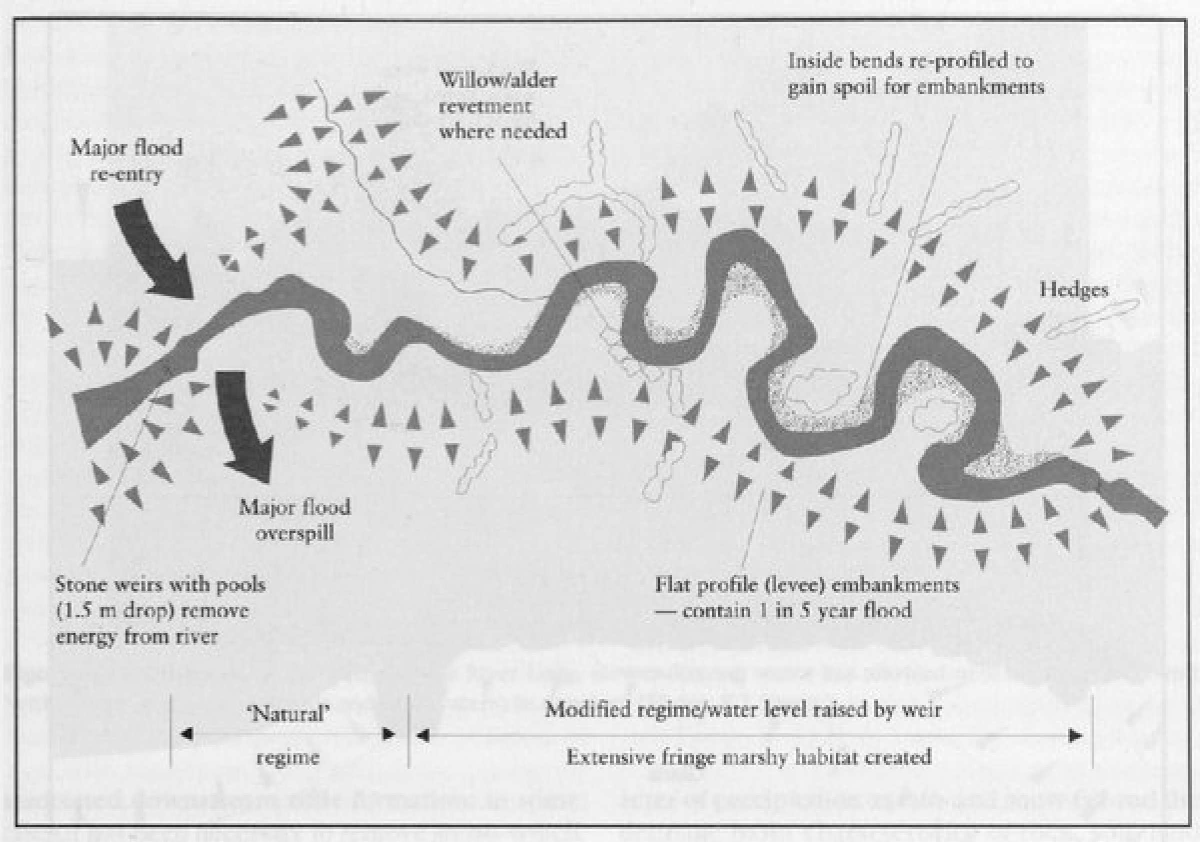
References



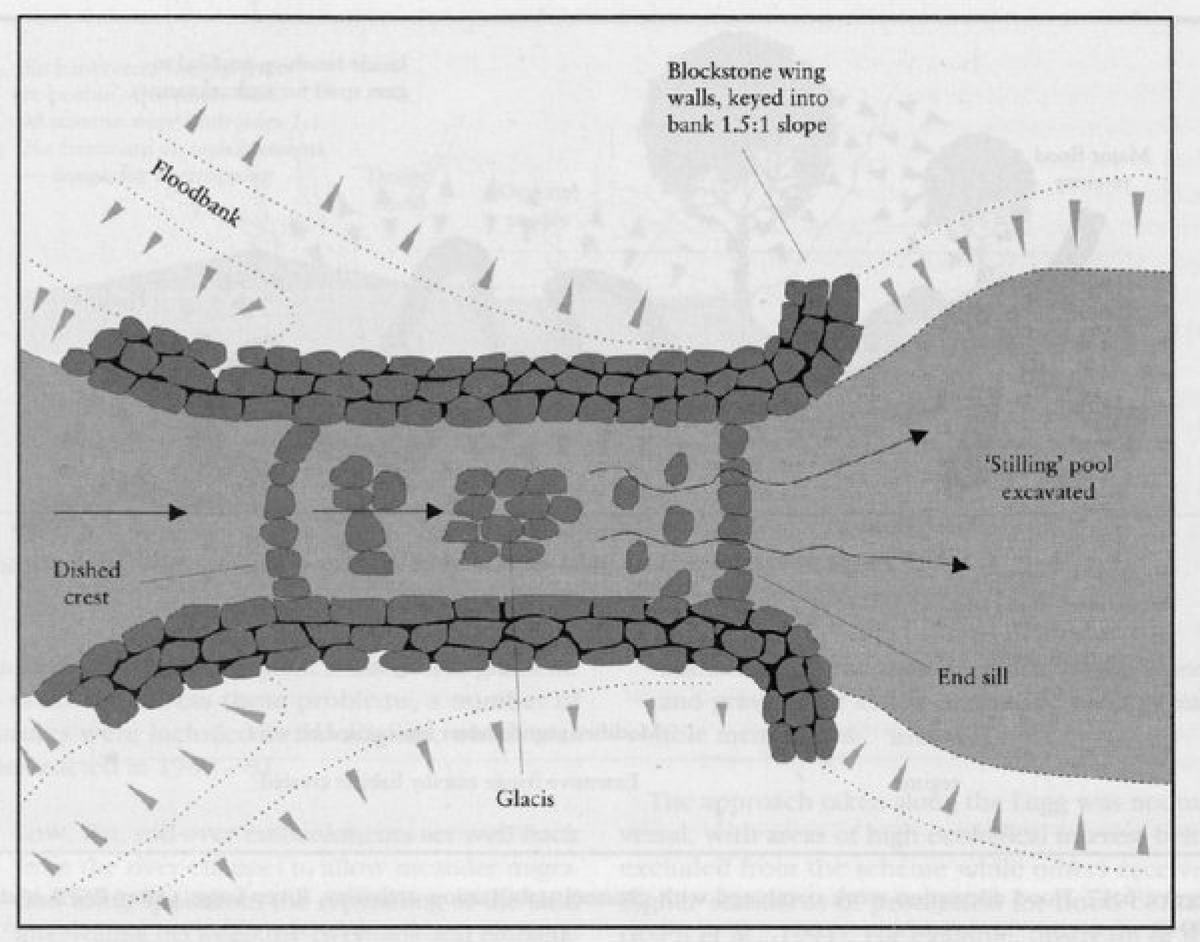
(Figure 6.46) The re-profiled floodplain section, River Lugg. (After RSPB et al., 1994.)



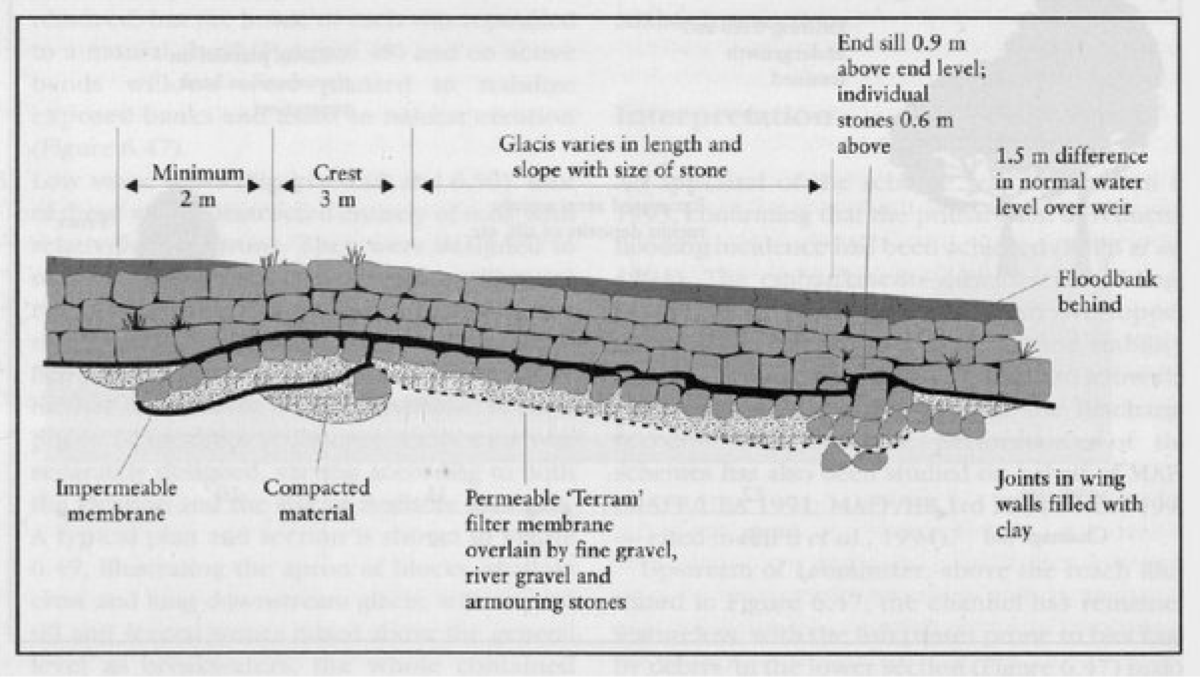
(Figure 6.48) River Lugg: a typical cross-section at a re-profiled meander. (After Lewis and Williams, 1984.)



(Figure 6.47) Flood alleviation work combined with channel stabilization activities, River Lugg. (After RSPB et al., 1994.)



(Figure 6.49) River Lugg: a plan view of a typical weir. (After Lewis and Williams, 1984.)



(Figure 6.50) River Lugg: a long sectional view of a typical weir. (After Lewis and Williams, 1984.)

(Figure 6.51) Upstream of the weirs on the River Lugg, slower-flowing water has allowed new habitats (reed and 'withy' beds, marginal wetlands and backwaters) to develop. (Photo: R.J. Davis.)