Chapter 3 Fluvial geomorphology of Wales

Fluvial landforms and processes in Wales

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Introduction

Fluvial systems in Wales possess three noteworthy characteristics. Firstly, they have an extended evolutionary history of considerable interest, including, in particular, phases of rejuvenation and of glaciation; together, such phases have produced a well-known and attractive landscape mixture of waterfalls, gorges, plateau uplands and flat-bottomed valley troughs. Secondly, present-day fluvial processes acting in Wales create a considerable variety of river types, ranging from upland source area streams, active boulder-bed channels, meandering and braided reaches, through to highly sinuous channels and stable lowland rivers. Thirdly, over recent years a combination of academic interest in fluvial systems and pragmatic concern over river management (the latter arising because river erosion problems are costly, and remedial activities sometimes ineffective) has led to a considerable body of study and research such that many Welsh river reaches have become 'archetypes' that are now internationally well-known.

At the same time, the impacts of afforestation, land drainage and improvement, and river channelization, are modifying fluvial features in the landscape to an increasing extent. These activities are understandable in a country where the land has to serve so many purposes, and their effects on fluvial systems are not without scientific interest. However, in the context of a Welsh 'natural laboratory' it is important that these activities are undertaken wisely and with the greatest care, so that a fully representative range of geomorphologically important sites — where features evolve naturally — remains, and that irremediable modification to river systems does not eradicate or threaten important 'type' sites.

This presents something of a management problem for the conservation of dynamic fluvial systems within designated sites: one may wish natural processes such as erosion and deposition to continue, but decisions must be made about where lines must be drawn around sites so that changing river channel positions (by 2 m or more per year) can be accommodated without either the short-term need to shift site boundaries, or the protection of vast areas encompassing entire fluvial systems which might restrict necessary land use activities. It is essential that the conservation of fluvial systems, at least at a minimum number of sites, allows the ongoing action of fluvial processes and the evolution of river features. Inevitably, this will entail erosion of valley-bottom land in one place and the accumulation of river sediment in another.

The geomorphological development of the Welsh landscape

The long-term geomorphological development of the Welsh landscape has been subjected to many different interpretations. In particular, the various plateau levels have been viewed as the product of either fluvial or marine planation at time periods ranging from the Devonian to the Quaternary. Some may have been exhumed from beneath a Mesozoic cover. An extreme paucity of dated terrestrial sediments that can be linked to planation levels has in fact allowed ideas to range with extreme freedom. In recent years this situation has been somewhat modified both in the light of plate tectonic models (creating a better understanding of the effects of the widening of the North Atlantic and the development of the faulted Welsh massif in a trailing plate margin environment, for example) and also as a result of new and offshore evidence from boreholes such as that at Mochras, Gwynedd, and other land-based sites, and from exploration work in the Irish Sea. These, like the reinterpretation of weathering products fragmentarily preserved, tend to emphasize the Tertiary reduction of landscape features to low-relief surfaces, but also the importance of Neogene faulting and then relative uplift of the Welsh uplands (Battiau-Queney, 1984; Dobson and Whittington, 1987; Penn, 1987).

Quaternary glaciation added trough-like valleys and a widespread (if often thin) veneer of glacial sediments to the region. Again the sequence of events is not very well understood, although it is improving, particularly following examination of marine and coastal sites and the use of better dating techniques (Bowen, 1973; Bowen *et al.,* 1986). Details are not

appropriately discussed here, but it must be appreciated that fluvial processes are strongly conditioned by prior glacial activity.

During the most recent ice-sheet glaciation, valleys were partially mulled with sediments that present rivers are currently removing. In some places, valleys may also be largely filled with glacial sediment, such that newer gorge sections have been excavated in bedrock to bypass them.

In the Holocene, the landscape has been evolving under fluctuating climatic and human influences; involving, for example, the development of a forest cover followed by its removal, and the development of upland and lowland peat deposits over the past several thousand years. Such conditions have produced fluctuating environments and a range of features.

A simplified model of a Welsh valley, showing the context for present fluvial forms, is given in (Figure 3.1). More detailed discussion is available in Lewin (1981b). Streams may rise in high-relief mountains (e.g. Cadair Idris, northern Snowdonia) or on peat-covered moorlands. Waterfalls mark the passage of streams from moorland plateau to valley, although they may also occur in the valley-floor, as in the case of the limestone streams in South Wales (Hepste, Mellte). Slopes may be of cliff and scree type, with debris flows forming a distinctive feature on some steeper slopes.

Valley-bottom features tend to follow a down-valley sequence involving a change from boulder-bed channels, through active braided and meandering reaches, to stable but highly sinuous lowland rivers (Lewin, 1987). Such rivers may be bordered by terraces which generally appear to date from the last (Devensian) glaciation; some valley bench features are probably older, although these are rather poorly studied as yet. Several terrace levels have in fact developed in the past few thousand years, representing a response to varied river patterns (braided, meandering) and sediment supply (notably enhanced soil erosion following deforestation and the impact of mining).

Channel patterns in Wales provide important field evidence for the development of gravel-bed rivers. For example, there are some braided reaches, although these are not common and have probably been largely eliminated by river channelization over an extended time period. Actively meandering channels are common although much modified artificially in the middle reaches of Welsh rivers; in places these may be confined between terrace deposits or narrow valley walls. This gravel-bed meander type is now becoming better known worldwide. Finally, some reaches developed in finer sediments or even lowland peats are comparatively stable.

Both scientific study and management do require that this valuable range of channel types remains available for field study.

GCR site selection

Sites chosen for the 'Fluvial Geomorphology of Wales' GCR Block aim to encompass and represent the broad range of fluvial 'archetypes' discussed above. Thus major features developed in bedrock, including both entrenched and ingrown valley meanders, waterfalls, gorges, and the distinctive features of limestone lithologies are represented. Rejuvenation features along river long profiles are also included in the suite of GCR sites. Alluvial sediments and terraces are represented at three sites at which features and developmental phases are known and have been studied.

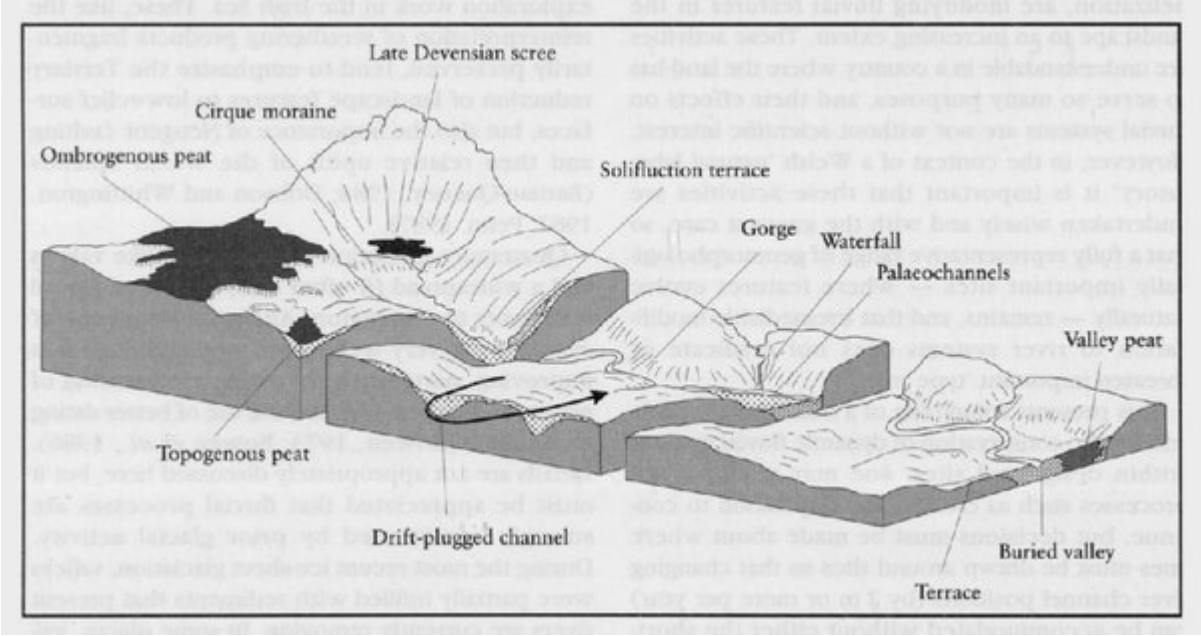
Finally, features resulting from contemporary processes, ranging from debris flows and pipes in headwater areas through to lowland channel types, are represented in the GCR. Several of these features are included within sites where a considerable amount of scientific work has been undertaken or is anticipated. For example, the behaviour of natural soil pipes on the Maesnant has been the subject of considerable research, and the site may be regarded as a 'benchmark' international site for hydrological work. Similarly, an extended 17.5 km reach of the upper Severn, one of the most unstable sections of natural channel remaining in England and Wales, has been the subject of intensive scientific investigations.

Overall, the GCR sites selected and described in this chapter vary considerably in size and sensitivity to possible modification by inadvertent or deliberate action. It is intended, however, that the conservation of this small number of sites will both allow natural development of their features and enhance the opportunities for future scientific work.

Although sites have been chosen to be prime representatives of the fluvial features of Wales, the landscape has clear affinities with other mid-latitude, humid climate plateau terrains in Europe (e.g. the Ardennes, Thuringia and Bohemia, Brittany and the Vosages) and North America (Appalachia). Therefore, while such landscapes contrast with tectonically active steepland landscapes (such as those in Japan or New Zealand), where fluvial processes may be much more dramatic in form and rate of operation, the Welsh sites do also form valuable comparisons and this adds to their conservation value. Thus the classic braided rivers of South Island, New Zealand, have closely similar sediments to those of the Welsh rivers developed on Palaeozoic shales, so that Welsh and New Zealand gravel-bed rivers do have very valuable points of comparison in process terms, although their tectonic settings are very different.

In summary, the selected GCR sites represent the range of fluvial environments in the Welsh landscape — source areas for water and sediments (including debris flows), bedrock channels and waterfalls, and a range of river types. Conservation of this representative range ensures the continuing existence of archetypal reaches, which in turn allows comparison with UK and worldwide fluvial environments.

References



(Figure 3.1) The Pleistocene legacy in upland geomorphology: block diagram showing typical slope and valley morphology and deposits. Fluvial activity is seen as superimposed on the morphology and deposits of glaciation and periglaciation. (After Lewin, 1981.)