Maesnant, Pumlumon (Plynlimon), Ceredigion

[SN 785 872]

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Highlights

Maesnant contains a particularly good example of extensive natural soil pipe networks. Work on these pipes has made important contributions to hydrological theory, with implications for geomorphology, water quality and land management in the British uplands.

Introduction

The Maesnant Valley [SN 78 87] contains an important example of well-developed natural soil pipe networks in an undisturbed upland rough grazing environment. The networks are both extensive and comprehensive, including examples of all the major genetic and generic forms of piping known in the UK, ranging in regime from ephemeral to seasonal and perennial flowing, and in genetic origin from desiccation cracking and mass movement to hydraulic pressure beneath a phreatic surface (Jones, 1982).

Initial work on the piping began here in the early 1970s (Lewin *et al.,* 1974; Jones, 1975, 1978; Cryer, 1978, 1980). An intensive hydrological instrumentation of the catchment upstream of the Environment Agency weir at [SH 777 876] began in 1979. By the end of 1981 the basin contained 21 flow gauges, four rain gauges and four pipe sediment traps, providing a uniquely detailed study of hillslope hydrology (Jones and Crane, 1984; Jones, 1986, 1987a, b). The research indicates that *c.* 50% of storm flow and base flow is derived from pipe flow, a much larger proportion than hitherto considered possible (cf. Ward, 1975, p.255; Rodda *et al.,* 1976), supporting a major extension to the role of subsurface flow in generating storm response in the stream, suggested by Jones (1979) (cf. Ward, 1980, 1982).

Piping features are common in the Welsh uplands, and the site has an important and continuing role as a field laboratory for the investigation of runoff processes and sources of streamwater and their interaction with land management.

Description

The Maesnant catchment drains the western slope of Pumlumon (Plynlimon) in the Cambrian Mountains from the peak of Pumlumon Fawr at 752 m OD to the Nant-y-Moch Reservoir. The experimental basin comprises only the upper part of this catchment, covering an area of 0.54 km^2 upstream from the Environment Agency sharp-crested weir at 470 m OD. The pipe networks lie mainly on the southern side of the valley (left bank) and in the headwater area (Figure 3.36), although the longest single ephemeral pipe in the basin (indeed, the longest yet recorded in the literature) descends for 280 m down the side of Pumlumon Fach on the right bank. Both the headwater arms of the stream begin in pipe systems and are particularly good examples of this form of channel head and process of channel formation (Jones, 1971), with a series of unroofed pipe sections increasing in length downstream until a permanent open channel is formed (Jones, 1994, 1997b).

Piping is present in all the soils of the basin, ranging from peaty gleyed podzols of the Hiraethog Association to undifferentiated peaty soils (Rudeforth, 1970), with the exception of the ranker soils on the upper slopes approaching the crest of Pumlumon, which have an inherently high matrix permeability. The main zone of ephemeral pipes occupies the mid-slopes, where the pipes are typically small (50–150 mm diameter) and discontinuous, running at or near the base of the surface organic horizon (*c.* 150 mm thick) and above a shallow mineral soil (< 300 mm thick). The mineral soil here is developed from the *in situ* weathering of the Ordovician shales or greywacke. At the base of this slope on the southern side of the basin a terrace, said to be composed of soliflucted till (Watson, 1970), creates a gentler gradient (*c.* 4° against 12–15° for the mid-slope). Perennial groundwater seepage at this inflexion point causes widespread areas of bog. Larger (*c.* 500 mm diameter) and deeper (*c.* 0.5 m) perennially flowing pipes issue from this point. These pipes also tend to flow near the peat/mineral interface and there is a tendency for pipe beds to rest on the parent material, which is clayey and boulder-strewn, with gley (G) or eluvial-gley (e.g.) horizons forming the walls. The stream itself is incised into this terrace 3–5 m, and it would appear that the stream rejuvenation that created the terrace was responsible for the initiation of the perennial piping by steepening the hydraulic gradient.

Interpretation

Analysis of the Maesnant data has established pipe flow as a potentially significant source of stream flow where piping is present, with a number of important hydrological and geomorphological corollaries:

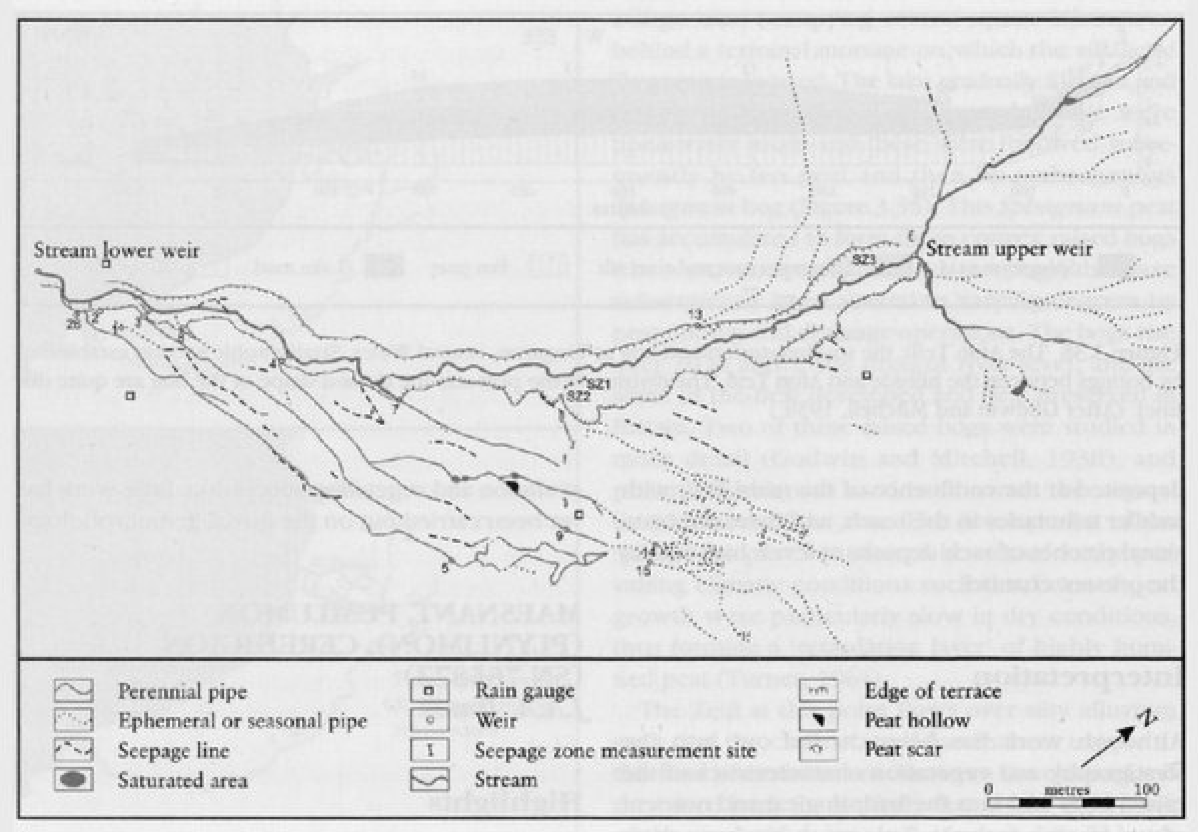
1. Piping offers a major extension to the theory of runoff or stream flow generation, because it dramatically increases the effective hydraulic conductivity of the soil, so that storm flow or flood flows in rivers can be generated by this in-soil drainage. It also extends the source of storm flow in streams well beyond the normally accepted bounds in humid areas, potentially to the very top of hillsides (Jones, 1988, 1997a; Connelly, 1993).
2. Piping has a number of geomorphological implications in terms of theories of hillslope development, channel initiation, sources of sediment and methods of monitoring erosion. It introduces a linear element in hillslope erosion similar to tilling and gullying on the surface, although less visible in the early stages. By concentrating flow and erosion it contributes to the selective erosion of certain parts of the hillside. Subsequently, piping may prepare the way for gullying and channel extension as it enlarges and collapses. Finally, piping can be a significant source of erosion and sediment transport on hillslopes (Jones, 1987a, 1990, 1994, 1997b).
3. There is also evidence that piping may have a significant effect on water quality in upland streams, and this is of particular interest in current debates on the effects of acid rain and afforestation policies. Pipes reduce the buffering capacity of a catchment (Hyett, 1990) and increase the contributing area that may need liming (Jones, 1997b). They also affect vegetation patterns (Jones *et al.,* 1991).

The Maesnant features are not unique. Piping is present in most catchments in the Pumlumon area and many others investigated in the southern Cambrian Mountains, the Brecon Beacons and the Black Mountains (Richardson, 1992; Jones *et al.,* in press). What is unique at Maesnant is the amount of research that has been concentrated in the catchment (Walling, 1984, 1991), and the implications from this for both theory and practical land management.

Conclusion

The Maesnant basin contains a particularly good example of natural soil pipe networks. At the present time these are the most extensive and longest yet surveyed worldwide. More importantly, they have been monitored hydrologically for a number of years, and the pipe-flow data collected at Maesnant are the most comprehensive in the world.

References



(Figure 3.36) Drainage networks in the Maesnant experimental basin.