Allt Mor (River Druie), Highland

[NH 983 080]

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Highlights

The Allt Mor, within the Cairngorm massif, provides an excellent example of a steep, active, coarse-grained mountain torrent (Ferguson, 1981) with direct coupling of the slope and channel sediment systems. Within this site, major sediment transport and geomorphic activity occur only during episodic flash floods, but major changes take place in such events.

Introduction

The Allt Mor, a tributary to the River Druie, drains a small upland catchment (16.4 km^2) on the north-facing slopes of Cairngorm (1245 m) in the eastern Grampian Mountains. The river's regime is highly flashy, especially in response to localized summer convective storms. Recent research has demonstrated that it is only during such flash floods that major sediment transport and geomorphic activity takes place (McEwen and Werritty, 1988).

Description

The glacial history of the area (Sugden, 1970; Young, 1974; Gordon, 1993a) is extremely important in understanding the present controls on the fluvial system. The upstream end of the site is below the drift-bedrock boundary, the present Allt Mor being deeply entrenched within thick glacigenic deposits, with boulder-sized clasts embedded in a sandy matrix (entrenched channel; unit 1 in (Figure 2.42)). Downstream of Coronation Bridge, there is a large palaeofan (unit 2) dating from the meltout of the Devensian ice sheet, while inset within the lower part of this feature is the present-day active fan (unit 3; (Figure 2.42)). Below Coronation Bridge, from the palaeofan (unit 2) to the active fan (unit 3), there is a progressive increase in the area available for channel migration accompanied by a decrease in sediment size (gravel and sand) and lower slopes (reduced to 0.02). Sections excavated in the fan reveal organic horizons at depth, indicating former bar surfaces as the river has switched its channel across the fan surface (McEwen, 1981). The three units are highly interrelated in terms of their controls; further details can be found in McEwen and Werritty (1988). This site has a comparatively well-documented history of major channel adjustment to extreme flash floods.

Interpretation

Differing channel responses to flash floods have been identified within the entrenched reach, the upper palaeofan and the lower present-day active fan (McEwen and Werritty, 1988). The upper entrenched section (unit 1) is particularly interesting due to the close coupling of slope and channel activity over a distance of 2 km. The present channel is deeply incised within the glacigenic deposits so that it is highly confined in its upper reaches although this restriction is reduced downstream towards Coronation Bridge. This progressive change in controls is reflected in the channel plan-form. Upstream, with steeper slopes (0.04–0.07), greater confinement and coarser sediment size (largest clasts > 1 m), the channel meanders across a narrow valley floor within the glacigenic deposits, although in terms of its slope/discharge relationships it might be expected to braid. Channel confinement is locally highly important, with the river undercutting the steep faces at the base of the adjacent slopes. Downstream, above Coronation Bridge, the channel occupies a smaller proportion of the available floodplain area and is able to divide around bouldery bars. In the palaeo-fan, there is more room to migrate, although the steep slopes at the margins, composed of glacigenic sediments, still provide some local confinement. The lower fan displays the classic switching of channels expected of alluvial fan environments, but a clear sequence of former bar surfaces and abandoned channels of distinct ages is not readily evident due to frequent reworking.

The response of the system to flash flooding has been analysed by McEwen and Werritty (1988) with particular reference to a flash flood that occurred on 4 August 1978 (see also Ferguson, 1981). The recurrence interval for the hourly rainfall at Coire Cas was 50 years, while the estimated discharge recurrence interval was 50–100 years. Although flood flows within the Druie catchment are not gauged, the Allt Mor catchment has an exceptionally good rainfall record for an upland Scottish catchment and thus geomorphic activity can be related with reasonable accuracy to rainfall and flow events of differing magnitude and frequency (Figure 2.43).

Analysis of the varying response of these three channel reaches to a stress of 1978 flood magnitude allows several observations to be made. Firstly, because channel bed and floodplain material are relatively coarse, the sediment transport system (mainly bedload) behaves in a binary manner; that is it is either switched off or on. Thus, much of the flushing through of sediment in the upper entrenched section occurs during extensive bedload transport associated with high-competence flash floods. The installation of tracers on the Allt Mor to monitor spatial variation in channel competence during the next major flood would be of considerable value.

Secondly, the Allt Mor system responds in different ways depending on where the stress is applied and on the nature of planform controls determined by the glacial legacy. The entrenched section is an important zone of abundant sediment supply where undercutting and slope failure can contribute large amounts of sediment into the channel. The thresholds required for slope failure depend on the timing and magnitude of previous floods. There appears to be a cyclical build-up of sediment at the base of slopes between major floods and a periodic flushing of material downstream during flash floods (cf. Newson, 1989). The magnitude and frequency of events which trigger slope failure may differ from those competent in terms of bed-load transport and channel adjustment.

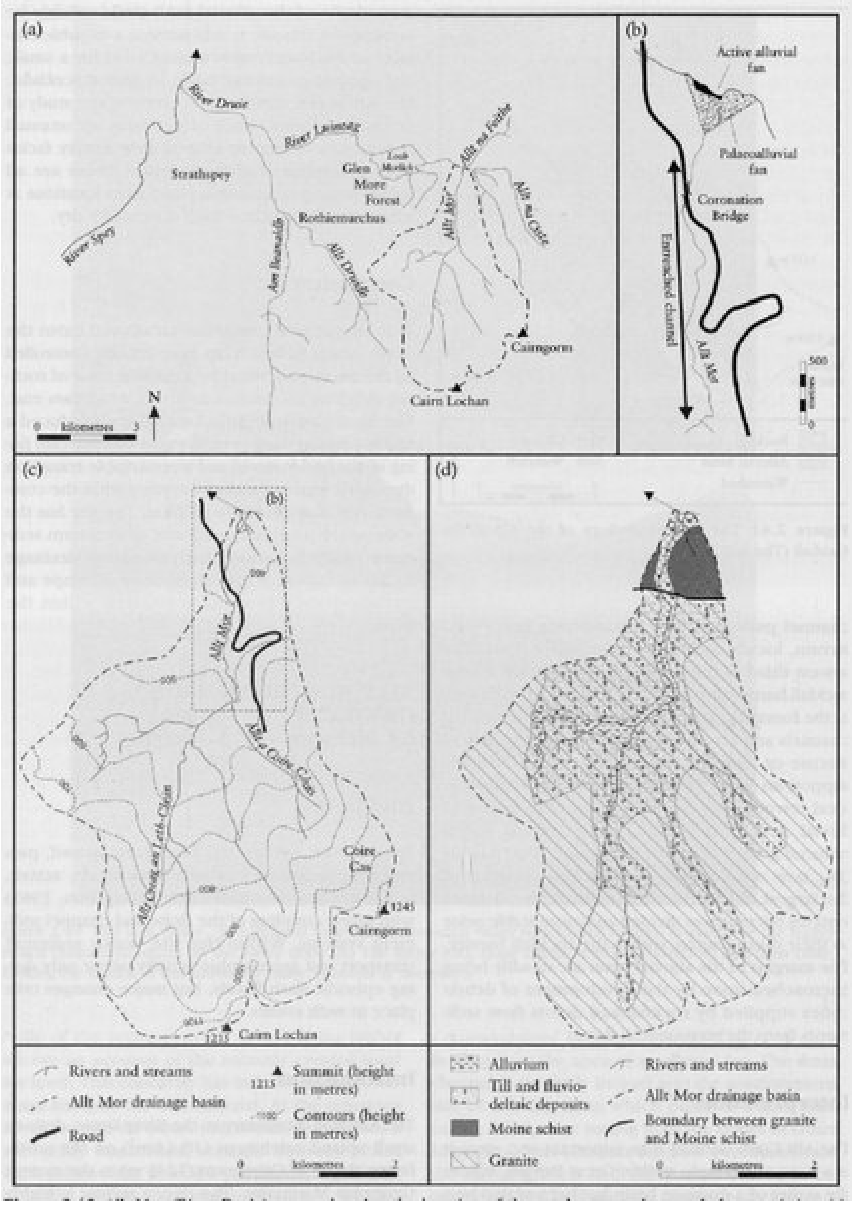
Thirdly, the importance of the inter-arrival times of floods in relation to their geomorphic significance has also been demonstrated. For example, within the palaeofan section, it is known that the 1978 flood had a lesser geomorphic impact due to the fact that major flood channels had already been excavated by a more extreme flash flood which occurred in August 1956 (McEwen and Werritty, 1988). The channel was therefore already partially adjusted to accommodate extreme discharges. Extensive sedimentation did, however, take place below Coronation Bridge during the 1978 event. Unfortunately, much of this was artificially removed from the channel after the flood and so subsequent natural channel adjustment cannot be monitored.

Downstream in the active fan area, flash floods are important in allowing channel switching and channel reworking of the fan surface; and are also important in determining the foci for subsequent change. Thresholds for sediment transport and reactivation of the fan surface are, however, lower than for the upper and middle reaches. More moderate floods, such as occurred in 1981, can also have an important impact.

Conclusion

This site is an exceptionally good example of an alluvial fan fed by a high-energy mountain torrent. It is noteworthy in that there is a substantial amount of information on the magnitude and frequency of past geomorphic activity, thereby enabling current processes to be placed in a longer-term perspective. The Allt Mor system can be subdivided into three distinct but interrelated units, namely a gullied or entrenched reach, a palaeofan and the present-day active alluvial fan. All vary in the nature of their response to extreme flooding depending on the extent of the glacial legacy (in terms of slope, channel constriction and sediment availability) and the inter-arrival times of earlier competent floods. It is during extreme flash floods that major geomorphic activity takes place and interactions between different reaches can be clearly observed.

References



(Figure 2.42) Allt Mor (River Druie) maps, showing the location of the catchment and general characteristics. (a) The location of the site; (b) the lower reaches of Allt Mor; (c) the topography; (d) the solid and drift geology. (After McEwen and Werritty, 1988.)

(Figure 2.43) The Allt Mor channel immediately upstream of the Coronation Bridge, 24 hours after the 3 August 1978 flash flood. (Photo: R.I. Ferguson.)