

POSTGLACIAL LANDFORM AND SEDIMENT ASSOCIATIONS IN A LANDSLIDE-FRAGMENTED RIVER SYSTEM: THE TRANSHIMALAYAN INDUS STREAMS, CENTRAL ASIA

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Abstract

The chapter concerns deposits and land form associations along high mountain rivers interrupted by landslides. The catastrophic landslides are largely due to failure of rock walls that were over steepened by glaciers and debutressed by deglaciation. Some 180 rock avalanche deposits have been identified that form(ed) cross-valley barriers on the Upper Indus streams. They provide a common explanation for widely discussed features in the fluvial zone. Aggradational sequences, built behind the landslide barriers, include mass movement, lacustrine, fluvial, and aeolian materials. Breaching has led to distinctive sets of erosional landforms, notably barrier-related and “defended” river terraces, trenched fans and fan terraces, rock gorges superimposed from valley fill, and mid-valley “isolated rocks.” Landslide interruptions have been major constraints on valley fill sedimentation and the phasing of late-, post- and para- glacial sediment transfers. Along with more frequent but smaller debris flow and avalanche barriers, and glacier interference with rivers, they have helped to produce a chronically fragmented drainage system. The interactions of a range of geomorphic and sedimentation processes in interrupted river reaches are decisive for the late Quaternary landscapes of the fluvial zone. The chapter focuses on the depositional and degradational landform associations involved. Climate change and tectonically driven stream incision, hitherto used to explain the features of interest, are shown to have been masked, suppressed or redistributed in response to interruptions of the river system. However, a further type of paraglacial transition is suggested involving postglacial responses of glacially destabilised rockwalls.

1. Introduction

For more than 140 years, earth scientists have given special attention to the great quantities of intermontane sediments along the transHimalayan Indus streams (Strachey 1853; Thomson 1852; Cunningham 1854; Schlagintweit 1857; Drew 1875; Oestreich 1906). Throughout the Upper Indus basin there are extensive river flats underlain by deep, valley-fill sediments (Figure 1). Trunk streams and tributaries have stepped profiles; relatively gentle, more open reaches, alternate with steep narrow ones. The former are flanked by stream terraces, alluvial remnants of large lakes and many, often coalescing, sediment fans. In some places, the rivers flow in bedrock, but most of the steep, canyon-like sections are cut into coarse valley-fill and flanked by stream terraces.

The valley-fill sediments include the “fans, alluvium and lacustrine deposits” of Drew (1873), and what Norin (1925) called “thick accumulations of river conglomerates” and “moraines”. They are the “diluvial” deposits of Paffen *et al.*, (1956, 13-15); the “alluvial/colluvial terraces and valley fills” of Goudie *et al.* (1984), and much of the “Quaternary and Recent [sediments]” of Searle (1991). Eolian deposits are also widespread, including loess, sand sheets and occasional dune fields.

It would be difficult to over-estimate the role of these sediments and related features in past reconstructions of the Quaternary and regional geomorphology. Giotto Dainelli, in the most influential synthesis, referred to them as “characteristic morphological elements” of the Upper Indus, “within the ancient valley floor” (1922, 13 and Plates V and XXVII). Owen and Derbyshire (1993, 123-4) identify them with the “main types” of processes, landforms and sediments in the Karakoram. Hitherto, the valley-fill materials have been attributed mainly to climate change, especially deglaciation, dessication and paraglacial sedimentation (Schneider 1959; Hewitt 1968; Kalvoda 1992; ed. Shroder 1993). The widespread trenching of the valley fill, and occasional rock gorges, are attributed to high but differential rates of tectonic uplift (Seeber and Gornitz 1983; Goudie *et al.* 1984, 400; Burbank *et al.* 1997). In effect, the valley floor features were seen to record the re-establishment, in the Holocene, of stream incision and high rates of sediment removal in response to tectonic uplift, following sedimentation “excesses” of late-glacial and paraglacial transitions.

However, in recent surveys I found these phenomena to be associated, in nearly every case, with post-glacial landslide barriers, especially those created by catastrophic rock slides (Hewitt 1998a; 1998b). Large landslides, and their potential for damming streams, have certainly been recognized by others in the region (Drew 1875; Oestreich 1906; Hewitt 1968; Hughes 1984; Goudie *et al.* 1984; Cronin 1989; Shroder 1989, 1993; Searle, 1991; Owen 1991; Owen and Derbyshire 1993, 125). But few catastrophic rock slides were actually identified, and their deposits were often misidentified as moraines (Hewitt 1999).

Of 182 catastrophic rock slides found to date, 174 were reconstructed from more or less ancient deposits in the present-day fluvial zone (Figure 2). Most descended from glacially over-steepened rock walls and were emplaced in ice-free areas. They left cross-valley deposits, the consequences of which are the main focus of this paper.

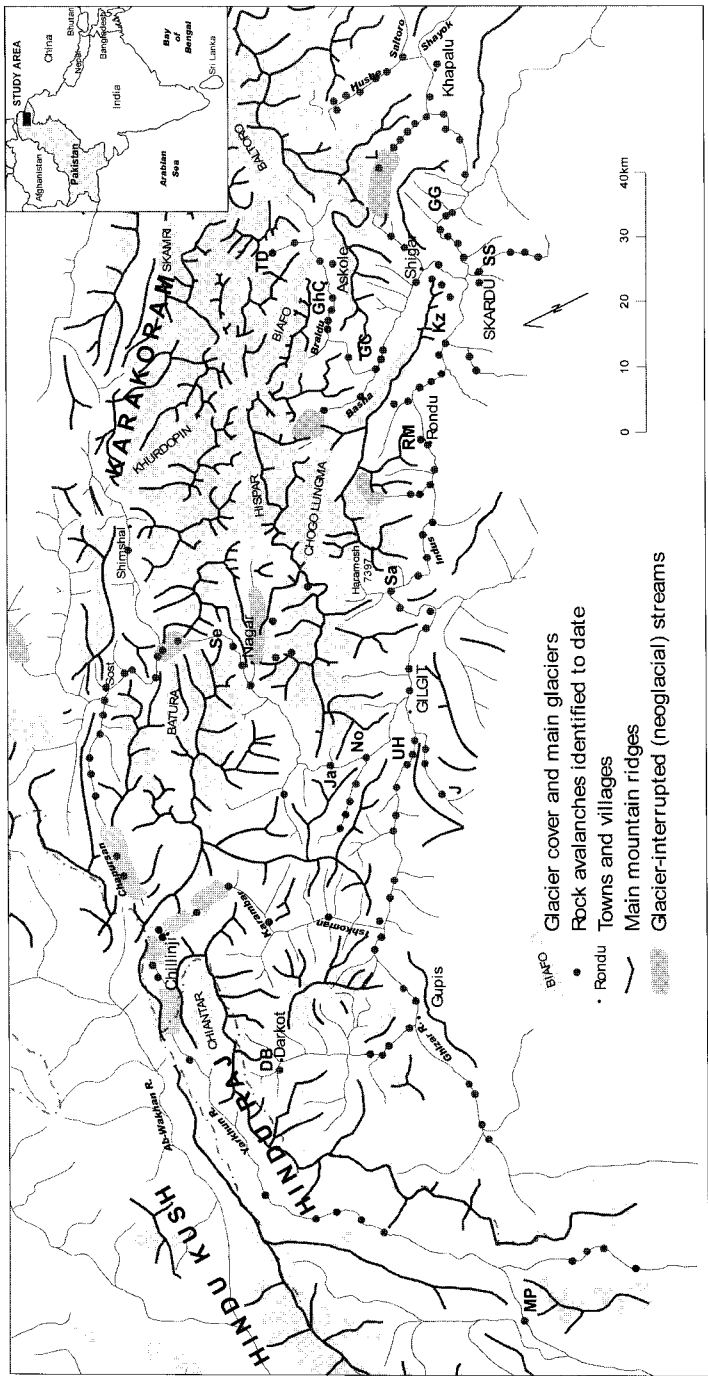


Figure 1. The trans-Himalayan Upper Indus Basin showing, schematically, the main mountain ranges; the extensive glacier cover; the Indus streams and locations of rockslide - rock avalanches identified to date. An inset map shows the location of the study area. Letters refer to rockslides discussed in the text and identified in Table 1.

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