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Interactive comment on "Reduced fine sediment flux in response to the managed diversion of an upland river channel" *by* M. T. Perks and J. Warburton

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This paper raises important issues relating to upland river management. The prevailing paradigm of river restoration / rehabilitation is one which has moved away from hard engineering solutions, in favour of 'softer' options, and one in which connecting the river with its sediment sources may be seen as favourable as part of a more naturally functioning integrated, cascading system. While this is by and large conducive towards river rehabilitation as advocated by, for example, Piegay et al.'s (2005) erodible river corridor approach and the generally recognised need to re-connect rivers with their floodplains (e.g. Fuller & Basher, 2013), there are clearly contexts where enhanced connectivity may in fact be detrimental to river health, due to over-supply of fine sediment, which is properly recognised as a pollutant degrading water quality and infilling gravel interstices. Clearly Glaisdale Beck is a case in point, and importantly in the British uplands, further caution is required where these floodplains are contaminated by heavy metal mining waste (Dennis et al., 2000; Foulds et al., 2014), because enhancing channel-floodplain / slope connectivity may re-mobilise large quantities of highly toxic material into the landscape.

This paper on Glaisdale Beck makes it clear that hard-engineering options, properly deployed, can be effective at mitigating fine sediment pollution where river health has been degraded, albeit by an arguably natural course of events in this context (landslide coupling). The authors also demonstrate that where advice and best-practice is not followed, in this case due to resource limitations, 'second-best' engineering may result in degradation of the environment and a prolonged period of instability and elevated sediment loads, as you acknowledge. Nevertheless, in the longer term, rivers will self-adjust and attain equilibrium and it is clear that this phase has been reached in the managed reach of Glaisdale Beck with a return to the pre-engineered grade of the river. The overall result is one of reduced SSC, which was the aim of the project. However, it is interesting to note that the SSC in the modified river still appears to remain stubbornly above the preferred threshold for that conducive to freshwater pearl mussel habitat. Does this mean the efforts to realign the channel in Glasidale Beck have not attained their goal? This would appear to demonstrate the significance of other fine-sediment sources in the catchment, such as the grips, presumably. While engineering of this channel could be construed as successful to some degree, and certainly in terms of disconnecting fine sediment supplied from a single mass movement complex, there is certainly a need to take a whole-catchment approach to mitigating sediment runoff in order to improve river health.

Assessing rainfall erosivity during the monitoring period I think makes a commendable effort to seek to rule out the affects on SSC caused by any systematic changes

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in storm/erosion intensity. There is always the possibility that changes in catchment erosion reflect natural variability in storm frequency, which can then be hard to isolate from changes attributable to the treatment in the channel. While the relationship between SSC and discharge is worked on rigorously using time series analyses and LOWESS modelling, I did wonder whether there may have been any change in flood regime during the monitoring period, since larger floods have the potential to destabilise upland channels as we well know (e.g. Warburton et al., 2002; Milan 2012). Critics might argue that initial failure of the hard engineering and rapid headward migration of the knickpoint was a result of an extreme flood, and subsequent geomorphic change attributable to further floods. In light of the recent (and ongoing) flood-rich period experienced in the UK, the fact that SSC has declined is probably testimony to the success of the approach adopted at this site. Nevertheless, some comment on flood regime during the monitoring period could be worthwhile, tabulating or graphing flood events over the period. From that, could you then comment on whether the adjusted managed diversion is in good shape to respond robustly to projected increased flood frequency and magnitude?

Some specific points to consider: The role of lateral erosion in channel development in the British uplands has also been demonstrated in the River Coquet, where extremely high rates of change were measured by Fuller et al. (2003) in response to bend cutoff (p1181, L14).

The location of the landslide complex contributing sediment to the pre-diverted channel could usefully be added to Figure 1.

I wondered whether the geomorphic changes identified in Figure 8 and discussed on p1193 had been mapped? If so, such a map would provide a useful addition to the paper.

I must confess to finding it hard to discern evidence for knickpoint migration from Figure 10. Perhaps a trend line is needed to highlight this? Also, is the over-deepening evident downstream of the lower drop structure (A) genuine degradation, or a return to the pre-engineered channel bed following flushing of sediment accumulated in the channel immediately following re-alignment? The 2009 survey is two years after the 2007 engineering, so it is quite possible that the elevated bed level here reflects an initial infilling response from sediment eroded from the bed upstream. It might be helpful to identify which part of the long profile relates to the realigned channel.

You comment on the arrest of the landslide within the old abandoned channel (p1196, L19) – is there any evidence / data on activity of this landslide you can refer to here? Is there the potential for landslide movement to resume, or even reach the new channel?

I found the manuscript very well written and virtually typo-free – a great job! Just note data = plural.

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