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Earth Surface Dynamics Discussions

Interactive comment on "Hitting rock bottom: morphological responses of bedrock-confined streams to a catastrophic flood" *by* M. Baggs Sargood et al.

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We thank Paul Carling as a reviewer of this proposed manuscript and have addressed comments as specified below.

(1) Some consideration of how upland streams adjust to high-frequency low-magnitude floods would have provided better context to the stripping observed by the rare event,not least as the authors compare, without amplification, the channel morphology morphologies that do reflect frequent events (Montgomery & Buffington; Thompson).

Of the few studies of the bed load response and recovery time of such systems, Carling & Hurley (1987) found that over a seven year period with bedload flux events up

to 7 years return period, the flux of bedload in an upland UK stream demonstrated constancy of supply with no evident exhaustion effects due to variability in flood event magnitude and frequency thus such event frequencies served to maintain current morphology [Carling & Hurley, 1987, 'A time-varying stochastic model of the frequency and magnitude of bed load transport events in two small trout streams, pp 897- 920 in:Sediment Transport in Gravel-bed Rivers, (edited by CR Thorne et al), Wiley].

Floods with a lower-frequency than that reported by Baggs Sargood et al must have geomorphological change-effects other than total channel stripping and it would be useful to consider what is known in this respect. For example, upland stream beds deform into step-pools which reset for flows of a given return period. Setting the extreme event into context is especially important as the authors note the importance of stochasticity of bedload flux on page 16 in the Discussion but do not develop this notion adequately.

RESPONSE: This is a very relevant point raised by the reviewer and whilst we would like to draw on other possible examples there is a complete lack of research that has been conducted in the low sediment supply, hydrologically variable post-orogenic terrain such as eastern Australia. We have included the reference to these ideas presented in the Carling and Hurley (1987) paper within the discussion. Based on our experience it would appear that in such settings rare large magnitude events re-set the clock by stripping the alluvial cover. This was proposed by Nanson (1986) but for more alluvial settings. Our data in these more semi-alluvial settings would suggest that this is also the case in these headwater channels. We presume, but have little data to confirm, that smaller floods re-arrange the bed material until a more stable vegetated alluvial cover exists. This might take another half dozen or dozen events capable of transporting the bed material which for such settings could be in decades time.

(2) It was pleasing to see the concept of an 'alluvial overprint' noted in the Discussion (p 16). Carling (2009) introduced this concept in passing and did not elaborate fully. The concept does not merely refer to the presence of a coarse debris alluvial mantle in a bedrock channel, as suggested by the authors. Rather it alludes to the par-

tial development of an alluvial channel morphology within the constraints of a bedrock channel. In the case of the Mekong river, which Carling (2009) was describing, the river is trying to form a meandering to anastomosed alluvial morphology within partial sediment cover within the restrictions of a bedrock channel. The idea of 'alluvialoverprint' is developed a little further with the paper by Meshkova et al (2012) [Nomenclature, Complexity, Semi-alluvial Channels and Sediment-flux-driven Bedrock Erosion, in Gravel-bed Rivers: Processes, Tools, Environments, First Edition. Edited by MichaelChurch, Pascale M. Biron and Andre G. Roy, Wiley].

In Meshkova et al, the important concepts of 'bedrock', 'bedrock-confined' and 'bedrock-constrained' channels are also defined as the response of each of these kinds of systems likely can differ.

RESPONSE: We would refer to the upper Lockyer as a bedrock constrained, mixed bedrock-alluvial system or a semi-alluvial channel using the Meshkova et al., (2012) nomenclature and therefore have adopted the term semi-alluvial channel as a means of maintaining consistency within the literature. We have refined our use of alluvial overprint specifically to refer to the pre-flood condition where it would appear that the alluvial cover was configured in coarse-grained bedforms (step pools, cascades etc) that were subsequently removed in the 2011 flood. This organisation of the bed material we infer is equivalent to the alluvial overprint.

(3) In section 5.1 the authors note that empirical equations for initial motion did not apply well to their case study. However, they implicitly make the link to non-Newtonian flows as a possible explanation for the lack of predictability using clear-water flow equations.Although the presence of non-Newtonian flows is a possible explanation nowhere do the authors present data which might indicate that non-Newtonian flow had occurred in the study streams during the extreme event. It would have been useful to also consider why clear-water equations do not work in high-magnitude events. Such additional controls such as steep slopes, flow blocking, scour beneath boulders, over-passing, and macroturbulence should be accounted in such systems.

RESPONSE: Table 3 in the draft manuscript did not replicate well (grey shade did not reproduce) in the submitted draft. The Komar and Carling (1991) approach and the Bathurst (1987) equation both successfully predict the mobilisation of the entire sediment fraction during the 2011 flood with the Shields parameter not predicting the mobilisation of the D95. We have revisited this in the discussion and include comments about the largest of boulders being delivered to the channel network directly from the bedrock margins and the presence of hillslope failures and debris flows.

Minor points: Page 2 line 1 Earth should have initial capital letter as in line 2. Corrected

Line 5 delete '3' and insert 'three', delete '10' and insert 'ten'. It is a convention to use words for one to ten and numerals for 11 onwards in text unless units are involved. Thus ten samples but 10cm/s. Corrected

Line 11 where in the main text is the concept of a desktop reach introduced? P.9, Line 7

Line 15 Not clear how thalweg variance can decline as bedrock steps are exposed. This statement contradicts the main text.

RESPONSE: We have clarified this to emphasise that the 2011 flood resulted in the removal of coarse-grained mantle that presumably represented bedforms (e.g step-pools, bars, cascades) with the only major topographic steps now being the exposed bedrock steps.

Line 19 and elsewhere 'This' needs a subject word to follow otherwise it is a clause and not a sentence. If a clause is intended then a semi-colon should come before 'This'instead of a full stop. Corrected

Line 24. Upland channels are not usually referred to as bedrock channels. This would preclude any alluvial channel from existing in the uplands. Reworded

Page 3 line 13 delete semi-colon and insert colon - Corrected Page 4 line 18 'This' again needs a subject word - Corrected Line 26 (ditto line 3 page 5) I don't think 'vastly

is the correct word here – seems like unnecessary superlative Corrected Line 24 & 26 Page 5 ‘This’ again Corrected Page 6 line 7 delete ‘records pre-’ and insert ‘record pre-disturbance’ Corrected Line 8 delete ‘unique’ as it is not unique Corrected Line 15 missing bracket Corrected Line 25 insert ‘average’ after ‘above-‘ Corrected Page 7 line 1 insert subject word after ‘this’ Corrected Page 8 ‘This’ again Corrected Line 21 delete ‘is’ and insert ‘are’ Corrected Page 9 line 21 delete ‘was’ and insert ‘were’ Corrected Page 10 line 1 delete ‘were’ and insert ‘was’ Corrected Line 10 missing full stop Corrected Line 12 insert ‘based’ after ‘flume-‘ Corrected Line 13 delete ‘in’ and insert ‘to’ Corrected Page 11 line 22 ‘This’ again Corrected Page 12 line 8 insert ‘flood’ after ‘pre-‘ Corrected Line 10 ‘desktop reaches’ have not been defined – see Abstract comment – clarified and corrected Line 25 insert ‘an’ after ‘of’ Corrected Page 13 line 22 this statement re steps contradicts the Abstract clarified and corrected Page 15 line 22 insert ‘–LiDAR’ after ‘pre’ Corrected Line 23 delete ‘points’ and insert ‘point Corrected

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Interactive comment on Earth Surf. Dynam. Discuss., 2, 1093, 2014.