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Earth Surface Dynamics Discussions

Interactive comment on "Recalculation of bedload transport observations in Swiss mountain rivers using the model sedFlow" *by* F. U. M. Heimann et al.

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GENERAL COMMENT

The overall aim of this work is to develop a model (sedFlow) that will bridge the gap between the low resolution catchment models and high resolution channel hydraulic models but still maintain a good representation of fluvial bedload transport processes at intermediate spatial scales. The authors by developing a hybrid approach produce a modelling package that is designed to produce realistic simulations of the general morphodynamic of sediment transport events typical of major floods but at the same time achieve high calculation speeds. Inevitably such an approach requires some simplify-

ing assumptions that must be carefully selected and justified without over generalising channel hydraulics and sediment transport mechanisms. This paper is the second of a pair of papers which illustrates how this model, or more correctly modelling package, can be applied to medium-sized mountain catchments. The first paper describes the typology and structure of the model.

Overall the paper achieves its goal and provides two well-documented case-studies that provide a useful test of the model and illustrate some of the limitations and advantages of this approach. The authors do a good job in defining the need for a model of this type and demonstrate neatly the flexibility of their modelling approach. The two Swiss catchments are useful as they demonstrate contrasting catchment characteristics with many features in common with other mountain catchments. Although the paper is a companion paper it is written in such a manner that it could be read independently.

SPECIFIC COMMENTS AND QUESTIONS

1. Introduction and context (P774, L16-21) -This is a little too general and does not cover the range of potential bedload impacts. It would be useful to comment on the importance of bedload fluxes for causing damage to engineering structures, bedrock erosion etc. And provide some example references of case studies to illustrate these issues.

2. Case study catchments - It is stated that the results from this study will 'help to interpret simulation results produced with sedFlow in applied engineering projects'. However, the current format of the paper is slightly misleading because the initial description of the catchments does not emphasise that both sites are impacted and show a good range of examples of engineering intervention typical of many mountain catchments. It is important that this is mentioned earlier in the paper and highlighted in the description and discussion. There is also a need to emphasise the contrast in the two study catchments more. The two study sites are of similar size but have different man-

agement histories, different channel gradients and contrasting hillslope sediment supply systems. They also show extensive but different management interventions which represent a range of human modifications common to many mountain catchments.

3. Model structure and typology – The model structure and typology is not always transparent when discussed in the paper. For example, the paragraph on P787 (L13-23). It implies that the model runs all three methods as it is stated that 'the time step length used for the current time step is the minimum length obtained from three different methods of calculation for each simulated reach'? However it is not clear which method is used in the simulation. Or are the authors saying the step length is determined by the slowest of the three methods. I am struggling to visualise the order of the computations. More generally the sedFlow model clear has flexibility in terms of the computations undertaken but it is not always clear in this paper the computational steps that were included in the simulations for the two study catchments. This is inconsistent as on P788 it is stated that a modified version of the formula of Rickenmann (2001) is used to calculate fractional transport but other options used in the model simulations are not always clear, or well-justified. Details are later included in Table 2 but I think it is important to note earlier in the paper that sedFlow is really a package of modelling tools that can be adapted for use to suit particular catchments. This would remove some of the confusion which arises when it is not clear what modelling path is being selected. A summary diagram of the model would also help in this context.

4. Channel morphology and roughness - The assumption of the substitute rectangular channel (Section 2.3.1) needs to be evaluated particularly in the natural channel setting. Also because relative depth and macroroughness are considered to be significant factors in controlling bedload transport in these course mountain channels it is important that the depth determination and representative grain-size arguments are considered in terms of the sensitivity analysis. This is probably compounded by the fact that macroroughness elements are not adequately characterised by the pebble count method used to characterise bed grain-size. This is acknowledged as the coarse

component of the bed material is 'added' to try and correct for this (see P783, L6-9).

5. Reference bedload volume - The estimate of the reference bedload volume (Section 2.3.2) is fraught with uncertainty and the errors in the sediment budget are largely unquantified. Although values are reported as ranges (Min / Mean / Max) the span of the data is very large. Furthermore it is stated (P781, L23-26) that 'The sediment outflow at the mouth of the Brenno and thus the volume of the throughput load of the complete system is unknown. Therefore, we used the result of the sedFlow simulations as a best guess for this parameter.' However, if this data is to be used to validate the sedFlow model then its independence is compromised by this approach?

6. Description of the sedFlow model – The description of the sedFlow model is concise and contains much of the key information necessary to provide an overview of the model contents. Because of the companion paper which deals with this in more detail striking a balance between being concise and / inclusive is a little tricky. In this case I think this is about right but also think a diagram (typology chart) showing the structure and interlinkages of the model would be a really useful addition and a very effective means of communicating the nature of the model very efficiently. The five step calibration process makes good sense (Section 2.5) and Table 2 is particularly useful in providing the details of the simulation runs.

7. Sensitivity analysis (P790-791) – why are the results only reported qualitatively? The sensitivity analysis provides useful insights in to the performance of the model. It would be useful if there was some justification for varying the parameters by 30% (although Q is varied less in the Kliene Emme)? A simple figure or table showing the 'structure' of this calibration 'experiment' would be useful in visualising the analysis undertaken and the combinations of parameters which were varied in the exercise.

8. The conclusion at the end of Section 3.1 (P793) that ' the complete variation of input values caused considerable variation in the simulated ABT, but caused very little variability in the simulated erosion and deposition' is intriguing. This implies that erosion

and sedimentation in the channel have a relatively minor role to play in determining the sediment balance of steep mountain catchments and it is out of channel sediment supply coupled to efficient sediment routing that determines the ABT? However, in this modelling approach channel width is largely fixed so this may not reflect the true 3D morphodynamics of the situation.

TECHNICAL CORRECTIONS / MINOR ISSUES

P773, Title - This should not be a recalculation. An improved title would be 'Calculation of bedload transport in Swiss mountain rivers using the model sedFlow: proof-of-concept'.

P774, L2 – Should read 'Only a few . . .' or 'Relatively few . . .'

P774, L5 - Abstract – It would be useful to include a metric to demonstrate how successful sedFlow was in reproducing the historic bedload event?

P774, L6 – The term 'reasonable parameter set-ups' is rather vague – can this be stated more specifically.

General - Be consistent in use of stream and river terminology. Title says river but rest of paper talks about streams.

P775, L24-25 – Clearly identify this statement as the main aim of the study.

P775, L28 – Why alpine because elsewhere the emphasis is on steep mountain streams.

P776, L18-19 – Wilcock and Crowe (2003) work not based on Alpine streams?

P777, L4 – What is meant by 'reasonable parameter set-ups'?

P777, L8 – replace 'Further on' with 'In addition'.

P777, L17-18 – It would be useful to have a simple definition diagram showing this, as this is a fundamental definition for the paper

Figs 1 and 2 could be combined into a single Figure and a North arrow should be added.

P778, L2 – Do you really mean sill here (i.e. bottom sill or step sill) or is weir a more widely accepted term for these structures?

P779, L4 – By long lasting flood event do you mean it was an event of long duration or the impact has had a long legacy in the catchment?

P779, L16 – The 5% discharge reduction is based on the assumption that Q is proportional to A?

P782, L3 – When you say ABT diagrams identify these by Figure number (Figs 4 and 5).

P784, L14 – Saying something is state of the art does not make it so – it is important you indicate what this is?

Interactive comment on Earth Surf. Dynam. Discuss., 2, 773, 2014.