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Hydrology and Earth System Sciences
Discussions

Interactive comment on "A Process-Based Rating Curve to model suspended sediment concentration in Alpine environments" *by* Anna Costa et al.

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The authors in this manuscript obtain a well fitting sediment concentration rating curve by introducing four additional fitting parameters above the two that are required for the original simple power relationship. They use then some fancy fitting routines and find as expected a better fit to the observed sediment concentration data than the two parameter model. To make the method to work they need one of the most complete data sets that exist in the world. They conclude that in the future we should collect similar data sets to get better estimates of sediment concentrations.

Before this manuscript can be published in HESS, it will require several improvements.

A great number of abbreviations are introduced, making the article almost impossible to read. Abbreviations are not explained in the figures. Figures should stand alone and abbreviations should be mentioned. Headings of sections have abbreviations. Just too much jargon.

There should be some previous research done on Alpine sediment fluxes and processes. The authors do not mention any of these research studies in the following statement.

"In this paper, we propose a different approach, which we call the process–based rating curve (PBRC), and which takes into account different sediment supply conditions by differentiating among the main erosion and transport processes typical of Alpine catchments. We consider that the suspended sediment regime is determined by sediment fluxes driven by three main hydroclimatic forcings: (1) erosive rainfall (ER), defined as liquid precipitation over snow free surfaces, which is responsible for soil detachment and erosion along hillslopes, triggering of mass wasting events (e.g., debris flows and landslides), and enhancing channel erosion through increased discharge, (2) snowmelt (SM), which has a direct impact on hillslope erosion through overland flow, and affects channel erosion by contributing to streamflow, and (3) icemelt (IM), which transports high concentrations of fine sediment derived from the glacier bed and paraglacial areas. Due to the diversity of the erosion and transport processes (e.g. erosion driven by overland flow, soil detachment by raindrop impacts) and the variety of sediment sources involved (e.g. hillslopes, channels, glaciers), sediment fluxes generated by these three variables (hydroclimatic forcings) are expected to contribute to suspended sediment dynamics in a complementary way, both in terms of magnitude and timing. The expectation is that partitioning suspended sediment yield into these three distinct sediment fluxes will improve SSC predictions and provide a causal explanation of SSC concentrations based on data."

I doubt very much that the signal of raindrop impact is preserved somewhere hundreds of kilometers down. Pick up of sediment in rills of plowed soils and deposition afterwards could completely overwhelm the raindrop impact signal (Moges et al., 2016). Moreover in mountainous environment saturation excess rainfall dominates and total rainfall explains better the runoff amounts and sediment concentrations than the loads than the intensity (Tilahun et al., 2013, 2015). Unlike what the authors write in their manuscript it is the total rainfall in Guzman et al (2013) that is related to the sediment concentrations in the Ethiopia highlands and not the rainfall intensity (page 3 around line 10). I do not know how the Alpine environments are different from the Ethiopia highlands, but that it is the task of the authors to research the processes that are really occurring in the Alpine watersheds.

It is interesting that in the response to the reviewer 2 the authors write.

"Our empirical model partially accounts for the effect of hydropower operations on SSC magnitude and timing because we calibrated the parameters of the PBRC using the observed time series of SSC at the outlet of the basin, which are impacted by the hydropower operations. Therefore, the coefïňĄcients (a1, a2, a3), the exponents (b1, b2, b3) as well as the time lags speciïňĄc of each hydro-climatic variable (l1, l2, l3) include the impacts of reservoirs and hydropower operations (e.g. delays in sediment transfer are accounted for in the time lags chosen by the IIS algorithm). Even though our approach is relatively simple and cannot capture all the complexities of the sediment. . ..."

This contradicts the earlier explanation above about the processes in the watershed. In other words the authors present a model fitting routine that is inspired by some of kind reality but reality has ultimately very little to do with the explanation of the results. For example, what would happen to the sediment concentration when the reservoir operation changes? This cannot be simulated by the sediment rating curve model.

It is well known from the equifinality approach of (Beven and Freer, 2001) that many different combinations of parameters give a best fit for the signal at the outlet. The authors found this best fits using 6 parameters. There could be a range of parameter sets that give the same result. Moreover the model chosen might not be the best. It

should be addressed how optimum is the fitting parameter set.

This review is not to indicate that the manuscript cannot be published ultimately. However any fancy explanations about what happens in the watershed based on the fitting of the sediment concentrations seems out of place unless it can be shown based on experimental evidence that the parameters in the watershed affect the concentration at the outlet. Simply in my opinion, the manuscript is about a model with six parameters that is fitting the output of some kind of simple hydrological model to very detailed measurements of daily sediment concentration. The authors should be realistic what can be done with the model and where it can be used for. For example how is the management of the hydropower dams been changed over the years and can that be the reason that the sediment concentration are changing?

Reviewer: Tammo Steenhuis

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