Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2017-419-RC2, 2017

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

Anonymous Referee #2

Received and published: 18 August 2017

Comments to the Author Summary of the manuscript This manuscript (ms) presents a Process–Based Rating Curve (PBRC) to estimate suspended sediment transport in a Swiss Alpine River. PBRC estimates suspended sediment concentration by computing the sum of three rating curves (RC), using instant rain (ER), snow melt (SM) and ice melt (IM) instead of discharge. ER, SM and IM is estimated using gridded datasets and degree day factors. While temperature thresholds and ice melt factors are adopted from previous studies (Fatichi et al. 2015, Costa et al. 2017), respectively, melt factors are calibrated with MODIS maps. The PBRC equation is then calibrated using an iterative input selection algorithm. The results reveal that PBRC improves the estimation of daily SSC considerably, compared to RC based on discharge only (see Fig. 7). The

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study concludes that: i) ER, SM and IM contribute to SSC, ii) the time lag for the 5338 km2 large catchment is only 1day, 2 days and 5 days for ER, SM and IM, respectively, iii) IM contributes most per unit water, iv) PBRC reproduces daily SSC better than RC, and v) long term sediment loads are better estimated by PBRC than RC.

Evaluation In summary I think that a process based approach, as developed in this study, is needed to estimate SSC in Alpine catchments. Accordingly, I do think that the topic of the study is relevant. However, the authors fail to address a major issue in the Rhone valley: hydropower operations. Runoff of most glacier-fed tributaries of the Rhone are governed by hydropower operations leading to four major alterations of SSC: i) melt and runoff water is detained in reservoirs, ii) suspended sediment get trapped in reservoirs, iii) SSC in outflows of reservoir is almost constant, as it is mostly composed of glacial silt and iv) periodic flushing of reservoirs lead to exceptionally high SSC. All of the four impacts mentioned above are due to hydropower operations, and accordingly independent of ER, SM or IM. Nevertheless, I agree with the authors that PBRC provides a better estimation of SSC than RC. Accordingly, I recommend that the authors reflect on the impacts of hydropower operations on SSC and revise the methodology and manuscript accordingly. I leave it up to the editors and the readers of HESS to decide if this revision can be done in the frame of major revisions or should rather be done in the frame of a new ms.

Prior to publications I recommend: 1) Addressing the impacts of hydropower operations on SSC in the Rhone valley. This has been investigated by numerous authors, some of which are cited but not correctly put in context in the current ms. How much of the winter discharge comes from hydropower reservoirs? How much smaller is the discharge in summer due to storage in reservoirs? How does this affect SSC? 2) The estimation of ER, SM and IM is complex and in my opinion should be addressed using a hydrological model, taking into account the complexity of the Rhone valley. I find it inconsistent to adopt some model parameters (e.g. temperature threshold and ice melt parameters) from previous studies and calibrate other parameters to direct observations. Perhaps

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this can be addressed within a sensitivity analysis. 3) I recommend to compare total suspended load estimations with methods described in other studies and published by regional and federal agencies, e.g. FOEN. Furthermore, an uncertainty analysis would be very helpful. I also would like to see a plausibility check of all major conclusions: can rain be responsible for 75% of SSC, how does this compare to other studies? Is a time lag of 1, 2 and 5 days realistic, how does this compare to flood peaks after heavy precipitation events? How much is delayed in hydropower reservoirs? How does the IM contribution compare to other studies? 4) I recommend to avoid mass referencing (e.g. pg2, ln15, 6 references are listed) but to be more specific why references are relevant. Three relevant references are sufficient to fortify a statement. I recommend to select only directly relevant references and build on previous works. 5) Figure 4 and 9: why are there three panels for one heading (or letter, I would recommend adding a heading) on the left and only one heading for one panel on the right? I would present annual loads rather than SSC, this would make your study more relevant for future studies. 6) I recommend shortening the text. 7) Finally, I recommend to add a reflection why this study is needed and how it complements previous studies. I would also recommend to start the abstract and introduction by introducing the problematic of high sediment loads, rather than jumping directly to the methods.

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