Hydrol. Earth Syst. Sci. Discuss., 10, C6847–C6852, 2013
www.hydrol-earth-syst-sci-discuss.net/10/C6847/2013/

Hydrology and Earth System Sciences
Open Access
Discussions

Interactive comment on "Re-suspension of bed sediment in a small stream – results from two flushing experiments" *by* A. Eder et al.

A. Eder et al.

alexander.eder@baw.at

Received and published: 23 December 2013

Final Author Comments

First we would like to thank the three referees for their inputs and comments on our paper. In the following lines we will answer and comment the questions and statements of the referees.

@referee1

Loss in flow – calibration – pressure transducers:

We have calibrated our H-Flumes in the laboratory with the same pressure transducers that were used during the experiments. A defined flow was sent through the weirs

and the water level was measured manually and with the pressure transducers. The accuracy of the pressure transducers is 0.1 mm and they are compensated for both, temperature and atmospheric pressure. Flow at the sites with V-notches was calculated from data of identically pressure transducers. The V-notch weir coefficient was obtained by hand measurements for different flow rates. Therefore we can assume that accuracy is very high for both types of measurement and will not influence our results and findings.

The diurnal fluctuations are indeed very interesting but we observe this phenomenon since we did the first measurements in the HOAL catchment. Even the use of other equipment (ultra sonic devices) has shown the same fluctuations. At present my colleague Martine Broer is working on the diurnal fluctuations in our catchment. The main outcome of her work is that the diurnal fluctuations are caused be transpiration from trees in the riparian zone along the stream. The diurnal fluctuations can be related to radiation and the stadium of the vegetation. We don't see any fluctuations in wintertime, when vegetation is without leafs.

Turbidity - sampled sediment concentration - relationship: During the flooding these relationships (calibrated for each site separately) were consistent and did not change dramatically. We did not put the corresponding graphic into the paper, since it does not really address our research questions. However it is an interesting topic and was already discussed by other authors including myself (Gippel, 1995; Gurnell, 1987; Eder et al., 2010).

Land use: We will include a description of the land use in the HOAL catchment in section '2 Study site' with the shares of arable land (87 Perc.), pasture (5 Perc.) forest (6 Perc.) and pavement (2 Perc).

Technical corrections: . . .will be incorporated in the text.

We can merge Figure 1 (left and right) to one single graphic, if necessary for editor's reasons.

We definitely will modify Figure 4

@referee 2:

Pg. 2, row 27: we will support this statement with the citation of ourselves (Eder et al., 2010)

Figure 1: In general a shift in time between turbidity peak and flow peak causes hysteresis effects in the flow – turbidity relationship. The direction of the hysteresis can be addressed to the sources of sediment. If turbidity starts to rise earlier than flow a clockwise hysteresis will appear when plotting turbidity against flow. Whenever this happens easily available, fast reacting sediment source(s) must be available, causing high sediment concentrations due to low flow rates. Therefore deposited sediment within the flume itself might cause faster rise in turbidity compared to flow. But I don't think the source H-flume will influence event based sediment load calculations dramatically.

Soil characteristics: We have analysed the first centimetre of the streambed sediments at several places before the artificial flooding. It mainly consists of silt (mean of 67.5

Size of channel: We will modify Figure 4 to display width of stream more clearly. Capacity of Channel: We can make a guess with assumed roughness and geometry values to calculate channel capacity for at least the two very different sections of the stream. But probably it is better to mention in the text, that the geometry, the slope and roughness is very heterogeneous at our stream. Especially for the lower section of the stream it is hard to find a representative profil and slope, because it is meandering, it has some steeper sections followed by ponds and some crossing branches and leafs influence roughness.

Artificial floods – recorded natural floods of same size: Although we compared the relationship between sediment concentration and discharge of the flooding experiment and natural events (Fig. 10), we are sceptical to compare our artificial floods with natural floods of similar size. During a natural event flow increases with flow length due

to tributaries and drainages whereas a decrease of flow was observed at the artificial flooding. Therefore hydraulic conditions and thus sediment transport are very different. Furthermore the preliminary conditions (stream bed as sediment source) of natural events might be very diverse.

Pg.4, row 31: We used three pumps. Unfortunately we had two smaller (P1, P2) and one big pump (P3). We started P1, followed by P2 one minute later. Another minute later we turned on P3. Due to the much higher nominal flow rate of P3 we had to switch it of first, five minutes after it was started. One minute later we turned off P1, followed by P2, again one minute later. Therefore we produced a stepwise initial wave. We can describe the procedure in the section '3 Experimental setup', but we thought it is not necessary for the results.

Pg. 5, row 4: The actual volume pumped into the stream was 16.9 m^3 (ev.1) and 17.1 m^3 (ev.2). This can be seen at Figure 6.

Pg. 5, row 26,27: The link to Fig. 5 will be moved to the next sentence.

Pg. 7, row 20-27: Unfortunately we did not analyse the bank material but from my personal experience I can describe the conditions. The bank material is more compacted and consists of cohesive material with some organic matter (roots), which functions as reinforcement. The stream bed material is very soft, settled during falling limb of previous events. Therefore it will be much faster eroded/resuspended than bank material. The stream is accompanied by a small forest. The flood plain itself was covered at some places by ground covering vegetation but also without vegetation at some other places.

Figure 10: You are right – for comparison experimental data from profile MW are relevant. The data of the other profiles are displayed to show that the relationship between sediment concentration and discharge is in the same order of magnitude. Technical corrections: . . .will be incorporated.

@ referee 3:

First peak in sedigraph of natural events: From my personal experience – I am out in the catchment during rainfall events as much as possible – I would say that in the HOAL Petzenkirchen catchment there is no immediate contribution of tributaries or of the lower parts close to the catchment outlet, which could explain the quick rise of sediment concentration. It takes some time until tributaries deliver water and sediments. Also the development of overland flow (from the lower parts) takes some time, depending on rainfall intensities, vegetation cover and antecedent soil moisture conditions. When different sediment sources (except the streambed) are activated the rise in sediment concentration occurs together with a rise of flow. Therefore, inputs from the fields should also show a significant change of flow or an additional peak in both hydrograph and sedigraph. In our catchment we address the very first, immediate peak in the sedigraph to resuspension from the streambed due to temporal aspects.

Sediment sources - 'cleaned channel' after big events: We totally agree - a large flood could clean the channel. But we think it is more important how the previous event end (like it is discussed on p 12088, lines 3-14). If sediment concentration in the channel is high and flow is decreasing rapidly, a lot of sediment will be deposited in channel. Contrary, if all the sediment sources were already exhausted and flow is decreasing slowly, transport capacity is high enough to export the remaining suspended sediments out of the catchment. Just a little amount of sediment will be deposited in this case. In future work the shape of the falling limb of previous events might be used as proxy for available sediments in the streambed.

Sediment sources - successive floods - exhaustion processes: Of course, it would be very interesting how the resuspension of sediments develops, if the artificial flooding is repeated five or ten times. Also the preservation of high flow conditions for two or three hours might give interesting information about the exhaustion of stream bed sediments. Actually we thought that the exhaustion of streambed sediments is more visible when we compared flood one and two. However, a slight decrease of exported

sediment load was observed and a movement of sediments demonstrated. But the source 'streambed' seems to be larger than we thought and sediment deposits were seen on the streambed before, between and after the artificial floods.

P12086, lines 17-19: it is hard to give numbers since event characteristics and thus velocity change from event to event. In general we meant storms that cause floods with duration smaller than the transport time of a particle (from a sediment source) to the catchment outlet.

P12087, line 18-21: You are right. It is more than simply the depletion of streambed sediments. We will also include your comment 'increase of total sediment load due to enlargement of contributing area.

P120087, line 28: the amount of resuspension is determined by the source itself and the flow rates (shear stress). Now it depends how the hydrological event looks like. Is there a long lasting increase in flow, when streambed sediments are resuspended according to their particle size? If so, resuspension occurs also later during the event.

Technical comments: . . .will be incorporated in the text.

We would like to keep Fig. 8, because the loss of water and decrease of exported sediment load is a crucial point in our discussion. Although according numbers are already given in Fig 6 and Fig 7 the loss and decrease is more clearly indicated in Fig 8.

Records at the catchment outlet are displayed at Fig. 5. We will include this reference in the caption of Fig. 5

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 12077, 2013.