Analysis of suspended sediment load calculations and transport processes in Austrian catchments

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ABSTRACT

In recent years the hydrological service in Austria implemented a new, continuous, long term suspended sediment monitoring system taking the spatial and temporal variability of the suspended sediment transport process into consideration.

To be able to determine the temporal and spatial variability of the suspended sediment transport a combination of direct and indirect methods is used. Optical sensors continuously record the turbidity at one point of the river bank and are calibrated by water samples taken close to the sensor. To calculate the hydrograph of near sensor concentrations two approaches are used whereby also a combination of the approaches is possible. Additional measurements are performed to detect the distribution of suspended sediments in a cross section (multi-point sampling or bottle samples combined with acoustic devices). To consider these measurements a direct correlation (regression) between near sensor concentration and mean concentration is established. Thus it is possible to estimate the suspended sediment load for certain time periods.

To determine the influence that these correction factors have on the results of the load calculations a sensitivity analysis was performed. The selected method to convert the turbidity data into near sensor suspended sediment concentration varies within the catchments but also with the season and has to be selected for each measurement site as it strongly affects the transport and load calculations. The results document that the consideration of the distribution of suspended sediments in a cross section is crucial to determine the suspended sediment load as the mean suspended sediment concentration in the cross section can reach more than the double of the suspended sediment concentration near the banks (e.g. Danube River). Although at many measurement sites a linear regression between near sensor suspended sediment concentration and mean suspended sediment concentration can be found, at some cases other approaches have to be applied (e.g. opening the weirs of hydropower plants). It is very important to exactly measure extreme events as they can contribute a high percentage to the total annual load but they can also strongly impact the correlation between those correction factors. The results of the sensitivity analysis are presented for annual and monthly load calculations of the years 2008, 2009 and 2010.

As the time series only exist for 2-5 years, analysis about long term developments or climate change are not possible, but processes on suspended sediment mobilisation and transport can be identified due to their impacts as thunderstorms (particularly heavy rainfall, debris flow), floods, snow melt, power plants or construction works.

The analysis of the data show, that in general the annual suspended sediment load increases with catchment area. However, at gauging stations downstream of natural river basins or hydro power plants the annual suspended sediment load is affected by suspended sediment deposition or flushing during flood waves. The annual suspended sediment yield increases with altitude of the catchment and/or with the percentage of glaciation. Additionally debris flow due to thunderstorms and heavy rainfall may lead to high suspended sediment yields and concentrations, whereas the maximum transport rates usually take place during flood or snowmelt waves. Flushing of storage basins as well as dredging can cause peaks of suspended sediment concentration but they used to be lower than the maximum concentrations caused by natural effects.

Keywords: suspended sediment transport, suspended sediment transport process, integrative monitoring method, sensitivity analysis, Austrian rivers