



## **Floods and other unsteady state conditions in suspended sediment transport in Austrian rivers and their relevance for monitoring concepts and sediment budgeting**

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The importance of high quality suspended sediment data is becoming more and more essential addressing issues like good water and ecological quality, reservoir management, damage prevention in floodprone areas, channel clogging, alteration of aquatic habitats, impacts on flora and fauna. Also the Water Framework Directive as well as the Austrian water law require an appropriate monitoring of the relevant parameters.

Suspended sediment sampling was carried out manually on selected Alpine rivers on a irregular basis in the past. In order to detect more detailed information on the spatial and temporal variabilities for the purpose of sediment budgeting, the Austrian Hydrological Survey decided to improve the monitoring program for suspended sediments. A study with the purpose of enhancing the monitoring concept by incorporating new sensor technology and adapting the evaluation procedures has been conducted.

In the year 2005 eleven gauging stations on Austrian rivers in alpine and nonalpine regions were selected as study sites for testing an optical backscatter sensor as a surrogate technology. Bottle sampling in the vicinity of the optical sensor, depth-integrated sampling and selected point sampling served as reference measurements (validation) and were additionally used as tools for the investigation of the spatial variability of the ongoing suspended sediment transport processes.

The Austrian rivers Inn, Salzach, Mur and Raab, equipped with the new sensor technology, faced a major flood event in August 2005. The observed discharge reached

a recurrence interval of around 200 years in the West (Inn) and around 10 years in the central and eastern part of Austria (Salzach, Mur, Raab). Bottle sampling revealed that the concentrations exceeded 20 g/l during peakflow at this 200 year flood event in Innsbruck/Inn. The measurements, based on turbidity recordings and bottle sampling, showed, that during this event the suspended sediment yield of the year 2004 has been transported two times. The results from the other rivers also indicate the importance of such flood events for sediment budgeting.

The suspended sediment yields have been calculated based on bottle samples, on turbidity recordings and on different combinations of both. The comparisons of the results revealed that low frequent bottle sampling is insufficient for an adequate monitoring of flood-waves. Optically sensed turbidity recordings provide information with a high temporal resolution at a fixed single point within the considered cross-sections. Unfortunately, these measurements are strongly biased by the grainsize distribution of the suspended material. In the post-processing of the data, a calibration procedure is used for converting the turbidity recordings into suspended sediment concentrations. Additional selected point sampling provides information about the spatial representativeness of the optically sensed suspended sediment concentrations.

Streams of glaciated catchments are subject to highly unsteady suspended sediment concentrations. Turbidity recordings at the gauging station Vent/Tyrol reveal peaks in concentration in the evenings during summer time. Yield calculations indicate again, that fixed date bottle sampling is an insufficient concept for appropriate monitoring suspended sediment in such catchments. A combination of turbidity measurements and bottle sampling delivers much better results.

It is proposed that the turbidity measurements could also be utilized for governing and optimising the automated pump sampling in order to concentrate the sampling within time periods with high flow and intensive suspended sediment transport, while in periods, which do not contribute much to the annual sediment yield, the frequency of the sampling can be substantially reduced.

Turbidity measurements in combination with suspended sediment sampling are a promising tool for successful longterm sediment budgeting.