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Measurement of High Sediment Concentration during Mountain Flood Events: Interpretation of the Results from Optical Fiber sensors in the Draix Experimental Catchments (France)

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The floods generated in small mountains basin are flash floods often devastating. Predicting runoff, erosion and sediment yield within mountainous catchments presents a strategic interest due to the consequences which arise from these phenomena and the need for natural hazard mitigation engineering. In order to study mountain erosion processes and corresponding protection devices, the experimental site of Draix was settled in the southern French Alps since 1983-1984. Now, six small watersheds, from 1 000 m^2 to 20 km^2 are monitored. The sediment production of a basin is measured at the outlet of the catchments for each storm event: the coarser part of the sediment yield is measured in a sediment trap, the finer part is measured in the gauging section both by sampling and continuous monitoring with an optical fiber sensor. As the substratum of the basins is black marls, a very erodible ground where erosion processes and sediment transport are particularly active, the sediment concentration are very high, often over 300 kg m-3, sometimes up to 800 kg m-3. Two prototypes of optical backscattering sensors were designed for these high concentrations in 1993 and have been since used in the field. Other commercial sensors have been used since 2006. The optical backscattering sensors are sensitive to the grain size distribution and the sensor calibration must be verified for each flood. The sediment concentration obtained from drying end weighting of samples automatically collected during the event are can be used to control and adjust the calibration curve. The relationship between the sensor response and the sediment concentration shows an hysteresis loop for 60% of the floods. This can be explained by the evolution of the grain size distribution during the flood event: the transported sediment may be coarser during the rising limb (unclockwise loop) or during the decay (clockwise loop). Grain size analysis of the samples was realized for several floods with a Malvern particle analyser. The analysis of different characteristics as grain size, concentration, discharge, rainfall intensity point out relationships which are in terms of erosion and sediment transport processes.