



Measurement of fine sediment infiltration and deposition rates within a gravel bed: a pilot study in the Geul River, the Netherlands

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Transient storage of fine sediments in the river bed determines the fine sediment residence time in gravel bed streams at intermediate time scales between days and a few years. We measured the sediment infiltration into the gravel bed at two locations in the Geul River, the Netherlands (mean discharge = $2 \text{ m}^3 \text{ s}^{-1}$) using two methods: 1) a gravimetric method and 2) a metal concentration-based method. Both methods involved the placement of sediment traps, consisting of cylindrical mesh cages with a diameter of 15 cm and a height of 10 cm, in the gravel bed. In the first method, the cage was filled with clean gravel greater than 12.5 mm (the size of the mesh openings) collected from the local river bed ($D_{50} \approx 19 \text{ mm}$). In the second method, the sediment traps were filled with clean gravel and about 700 grams of fine sand. During the sampling period, this 'clean' sand was contaminated by deposition of metal-contaminated fine sediment from the Geul River. After four to eight days, the sediment traps were removed. A bag around the cage, which had been lowered during sampling, prevented the fine sediment to wash out from the sediment traps during removal. The fine sediment was washed from the sediment traps and subsequently dried and weighed. For the second method, the zinc concentrations of the fine sand and the fine sediment collected from the sediment traps were measured using a Thermo Fisher Scientific Niton® handheld XRF analyser. The sediment infiltration or deposition rates were then calculated from the differences between the zinc concentrations in the sediment samples and the 'clean' sand. The fine sediment deposition rates measured using the concentration-based method ($0.49 \pm 0.20 \text{ kg m}^{-2} \text{ d}^{-1}$ [mean \pm 1 st. dev.]) were consistent with those measured using the gravimetric method ($0.54 \pm 0.22 \text{ kg m}^{-2} \text{ d}^{-1}$). The mean and variation of the fine sediment deposition rates increased with stream discharge during the sampling period. The corresponding vertical mass fluxes in a 1 km long river reach are on the same order of magnitude as the longitudinal suspended sediment flux of the Geul River. This means that sediment infiltration into the gravel bed comprises a substantial portion of the sediment budget of the Geul River.