Quantification and characterization of sediment exports from small to medium catchments within the Loire river basin (France)

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ABSTRACT

Quantifying volumes of sediments produced on hillslope or in channel and transported within river systems is necessary to understand basin specific sediment yield and establish sediment budgets. Several research efforts have already investigated either global budgets at the river basin to continental scale or detailed budgets at the plot to field scale. However, very few studies have proposed estimation of sediment yields (SY) for small to medium catchments (10 to 10^5 km²) and tried to draw the link between sediment yields and basin properties.

In this context, the present study aims at bridging this gap and we focused on the Loire Brittany river basin (France) for which mean annual sediment loads at river outlets have recently been estimated (Delmas *et al.* 2012). 111 small to medium watersheds spread over this territory were chosen covering 78% of the total basin area. 61 watersheds are nested in at least one other watershed. We first present a large database of area-specific SY which were estimated from suspended sediment concentration and flow discharge data measured at gauging stations with survey length ranging from ten to forty years. Rating curves taken from the literature (Delmas *et al.* 2011) were chosen for the estimation of sediment fluxes. Secondly, sixteen variables recognised in the literature as controlling factors of basin hydrosedimentary response (drainage area, mean slope, mean and maximum altitude, percentage of vegetated areas, basin shape, drainage density, number of obstacles to flow, river mean slope, mean annual rainfall, precipitation variability, water flow discharge, infiltration, sediment load, mean annual erosion) were chosen for confrontation in a correlation matrix. Investigations on basin erosion and sediment export fluxes relied on the use of three indexes: SDR (Walling 1983), Fss_T (Ludwig and Probst, 1998), Fss (Delmas *et al.* 2009). Finally, a semi-distributed approach for the development of local sediment budgets is investigated.

The resulting estimated annual sediment loads at basin outlet range from 2.5 $x10^2$ to 8.6$x10^5$ $t.yr^{-1}$ and area-specific sediment yields (SSY) range from 2.9 to 32.4 $t.km^{-2}.yr^{-1}$ (Figure 1) with an associated mean uncertainty of 20%. Estimated values are identical to those found for catchments presented in the literature with similar global characteristics. Mean annual sediment loads from the three principal Loire tributaries (Allier, Cher, Vienne) contribute to 66.1% of the total load of the Loire river at its outlet while accounting for 40.6% of its surface. Strong variability in interannual and seasonal SSY values is observed.

Relation between SSY and basin area were investigated. Though it is common to expect a negative correlation between both variables due to an increase in deposition areas as catchment size increases, no clear relationship was found in the present study. Moreover, despite model uncertainties in the prediction of sediment loads, no clear relationship between specific sediment yields and chosen variables could be established. Calculated index were also confronted to SSY without clear correlation. These findings confirm those of previous researches and show that relationships between SSY and controlling factors are complex and non-linear.

Expected results from a semi-distributed model and from investigations on the contribution from nested to nesting catchments should provide a clearer insight into sediment transport and redistribution processes.

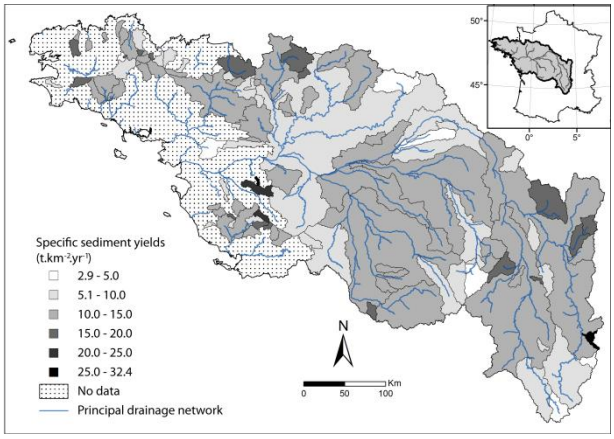

Figure 1 The 111 watersheds and associated specific sediment yields.

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