Catchment exports and monitoring

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Solute and sediment catchment exports from drainage basins are difficult to quantify because they are exported during “hot moments”, generally during high water periods.

We present here a simple model for predicting load flashiness ($M_2$, proportion of load exported during the highest 2% of flows) from flow flashiness ($W_2$, proportion of flows exported during the highest 2% of flows) and export pattern ($b_{50\text{high}}$, linear slope of the log concentration-log discharge relationship based on data above the median flow only). The model is parameterised based on an extensive monthly-sample data set from France, and validated using an independent daily-sample long-term data set from US including several rivers near Lake Erie (altogether over 1.5 Million discharge-concentration).

Based on this model, we constructed a load-flashiness diagram to determine optimal monitoring frequency of dissolved or particulate constituents as a function of $b_{50\text{high}}$ and $W_2$. Based on $M_2$, optimal temporal monitoring frequency of the studied constituents decreases in the following order: TSS, TP, DOC, NO\textsubscript{3}, and TDS. Finally, we analyzed relationships between these metrics and catchments characteristics. Depending on the constituent, we explained between 30 to 40% of their $M_2$ variance with simple catchment characteristics, such as stream network density or percentage of intensive agriculture. Therefore, catchment characteristics can be used as a first approach to set up water quality monitoring design where no hydrological and/or water quality monitoring exist.

The load flashiness $M_2$ can also be used to optimize monitoring frequency to reach a certain level of annual load uncertainty (here 10%) for loads trend detection required for instance by international conventions such as OSPAR and HELCOM. Regulatory monitoring in Europe, recommended by the WFD, promotes the monthly sampling for any monitored constituents (dissolved and particulate) and for any basin size. Such standardized monitoring does not take into account the actual variability of the constituent concentration and loads, particularly for the small (100 – 1000 km\textsuperscript{2}) and very small (< 100 km\textsuperscript{2}) basins. For instance, our results show that a 30 days sampling frequency is not appropriate to calculate loads with a reasonable uncertainty (+/- 10%) in
more than 90% of cases.