Catchments exports and monitoring


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Why estimating riverine exports?

Erosion
Riverine exports to oceans

Reservoir sedimentation

Nutrient and pollutant losses

Why is challenging?

Because a large proportion of annual load of most elements are exported during short time period

To better optimize sampling periods we need to better characterize load flashiness during these hot moments (high water periods)

\[ L = K \int_{t_0}^{T} Q(t) C(t) \, dt \]

How to characterize load and flow flashiness?

Duration curve of loads
% of cumulated loads starting with highest vs % of time

Duration curve of Flows
% of cumulated loads starting with highest vs % of time

\[ M_2 : \text{\% of cumulated loads in 2\% of time} \]
Good indicator to characterize load flashiness

\[ W2\% : \text{\% of cumulated flows in 2\% of time} \]
Good indicator to characterize flow flashiness

Load flashiness is linked to flow flashiness and type of elements

\[
C = aQ^b \\
\text{Load} = aQ^{b+1}
\]

Nitrate load variability is similar to flow variability (chemostatic behaviour)

TDS load variability is lower than flow variability (negative chemodynamic behaviour)

SPM and Total P load variabilities are higher than flow variability (positive chemodynamic behaviour)

Segmented C – Q relationships

- Non-linear relationship on 60 % of catchment – element combination

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Segmented C – Q relationships: 9 types

- 9 potential C – Q relationships and 2 or 3 dominant possibilities for each element
- \( b_{50\text{low}} \) - biogeochemical processes during low flow period
- \( b_{50\text{high}} \) - export pattern during high flow period


Moatar et al, 2017, WRR, Shapes and causes of C – Q relationships

For solute and sediment export regimes: importance of $b_{50\text{high}}$

- 9 potential C – Q relationships and 2 or 3 dominant possibilities for each element
- $b_{50\text{low}}$ - biogeochemical processes
- $b_{50\text{high}}$ - export pattern during high water (60 to 99% of annual load transported for $Q > Q_{50}$)
- Therefore we use $W_2$ and $b_{50\text{high}}$ to estimate $M_2$


EGU 2020 Session 2.3.2. Data-driven analysis of water quality time series
Load Flashiness (M2) Evaluation With Flow Flashiness (W2) and Export Pattern (b50high)

\[ \text{Probit}(M2) = \text{Probit}(W2) + 0.79 \times b50\text{high} \]
Using the nomograph published by Moatar et al, HyP, 2013, for discharge-weighted concentration method
And the relationship between $M_2$, $W_2$ and $b_{50\text{high}}$

The optimal temporal monitoring frequency of the studied constituents decreases in the following order:

TSS, TP, DOC, $\text{NO}_3^-$, and TDS.
Distribution of optimal sampling intervals required for 475 French stations for each parameter. The vertical dashed lines represent the current sampling frequency, i.e., monthly.
Catchment characteristics can be used in a first approach to set up water quality monitoring design.

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Conclusion

Solute and sediment export regimes are quantified by the load flashiness ($M_2$), which can be easily determined from flow flashiness ($W_2$) and $b_{50\text{high}}$ (from high frequency data or long-term low frequency).

The load flashiness diagram can be used to:

- classify elements, catchments,
- quantify human impacts and mitigations,
- optimize sampling strategies
- calculate uncertainties of long-term monitoring surveys

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