

Loire River eutrophication mitigation (1981–2011) measured by seasonal nutrients and algal pigments

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Abstract The Loire River basin is very sensitive to eutrophication due to its multiple-channel morphology, summer low flows, high water temperatures, and high exposure to nutrient inputs from agriculture and urban sources. The seasonal variation of nutrients and chlorophyll-a from the river headwaters to the estuary (1012 km) was studied by harmonic analysis for three periods between 1981 and 2011. The Upper Loire does not present significant seasonal variations. The eutrophication level of the Middle and Lower Loire, favoured by hydroclimatic conditions, is responsible for significant seasonal amplitude of algal pigments, nutrients and physico-chemical variables. In the Middle Loire, the summer phosphate minimum ($15 \mu\text{g L}^{-1}$) is controlled by algal uptake, and the summer nitrate minimum (0.8 mg-N L^{-1}) is attributed to algal uptake and denitrification. The 1991 European Directives had an impact on phosphorus levels, but nitrate levels kept increasing slightly, showing a lack of appropriate agro-environmental measures in the Loire River basin.

Key words Loire River; eutrophication; nutrients; seasonality; phosphate; nitrate