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TITLE: Variability of continental riverine freshwater and nutrient inputs into the North Sea for the years 1977-2000 and its consequences for the assessment of eutrophication

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ABSTRACT:

We determined the monthly and annual riverine freshwater, nitrogen (N) and phosphorus (P) loading into the North Sea from Belgium, The Netherlands, and Germany for the years 1977-2000. An average of 133 km³ yr⁻¹ of the 309 km³ yr⁻¹ precipitation into the watershed is carried by the rivers into the sea. Total freshwater discharge fluctuates with a strong 6-7 yr periodicity, is strongly correlated with precipitation, and exhibits a slight long-term decrease. The temporal changes of regional patterns of precipitation lead to changing ratios of annual discharge of the western rivers compared to the eastern rivers, varying between 2.2 and 3.5. The long-term oscillations in discharge were more pronounced as discharge increased. The annual means of total and dissolved inorganic N and P loads were estimated to be 722 and 582 kt N yr⁻¹ and 48 and 26 kt P yr⁻¹, respectively. The monthly N loads were much more strongly correlated with discharge, compared to the monthly P loads. Total N and P as well as dissolved inorganic N also demonstrated a 6-7 yr periodicity. The annual N loads decreased by about 17 kt N yr⁻¹ from 1977 to 2000. The total phosphorus and phosphate loads decreased from about 80 and 50 kt P yr⁻¹ in the 1980s to 25 and 12 kt P yr⁻¹, respectively, in the 1990s. The western rivers contributed the major part of the nutrient loads. The long-term oscillations in their nutrient loads were much more pronounced, compared to the eastern rivers. The area-specific loading rates estimated for all rivers are comparable to earlier estimates using shorter data records, smaller sample sizes, and a less complete watershed monitoring program. The monthly and annual average N:P ratios and their variability increased considerably for individual rivers during the study interval. These results confirm that the water quality of European continental rivers is strongly influenced by intense land use. They demonstrate the necessity for using long time series monitoring results to assess change and evaluate the effects of climate change on the North Sea coastal ecosystems, using ecosystem models on decadal time scales.

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