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Compared performances of different algorithms for estimating annual nutrient loads discharged by the eutrophic River Loire

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Abstract:

Good estimates of pollutant fluxes are required for Earth systems sciences and water quality management. The gradual accumulation of water quality data records over the past few decades has increased the value of these data for examining long-term trends. On many major rivers, however, infrequent sampling of most pollutants makes flux estimates and their analysis difficult. This paper explores the performance of different methods for estimating nutrient fluxes. The objective is to assess the accuracy (bias) and precision (dispersion) of annual nutrient fluxes based on monthly sampling, which is the frequency with which 80% of French water quality surveys have been carried out since 1971. The study is based on a data set of nutrient concentrations surveyed at high frequency during a 5 year pilot study (1981–85) at the Orléans station in the middle reaches of the River Loire, France. The mean specific fluxes were 641 (nitrate-N), 96 (total-P) and 37 kg year^{-1} km^{-2} (orthophosphate-P). For each year, the data set was then 'resampled' by randomly simulating 12 sampling dates. 100 simulated monthly samplings were generated, upon which seven estimation methods were tested. The evaluations indicate that, when concentrations of specific substances in large rivers exhibit seasonal variation, a simple method based on linear interpolation between samples taken at approximately monthly intervals is advocated. With the monthly sampling interval, the precision (confidence level of 95%) of annual nutrient fluxes obtained by the appropriate methods was 13% for nitrates, 20% for total-P, 26% for orthophosphates, and 34% for particulate-P. The frequency of water quality surveys required to obtain an annual nutrient flux with 10% precision was around 15 days for nitrate, 10 days for orthophosphate-P and total-P, and about 5 days in the case of particulate-P. Copyright © 2004 John Wiley & Sons, Ltd.

KEY WORDS river flux; accuracy; precision; nutrients; phosphorus; nitrate; Loire

INTRODUCTION

The demand for riverine flux estimates is growing for Earth systems sciences and water quality management in order to: (i) evaluate mechanical and chemical denudation rates; (ii) estimate output from catchment ecosystems and source apportionment between point and diffuse sources (Behrendt, 1993; Kronvang *et al.*, 1996; Lidén *et al.*, 1999); (iii) evaluate nutrient and pollutant losses from land to sea for international commissions (e.g. OSPARCOM: Oslo–Paris Commission; HELCOM: Helsinki Commission) (Laznik *et al.*, 1999); (iv) carry out a long-term analysis of annual flux in response to changes in land use activities and atmospheric deposition (Heathwaite *et al.*, 1997; Littlewood *et al.*, 1998; Grimvall *et al.*, 2000); (v) evaluate riverine carbon fluxes to oceans (Meybeck, 1982). This demand has directed attention to the accuracy of flux calculation techniques and to the reliability of available information (Walling, 1977a; Walling and Webb,

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