ARE REGULAR SURVEYS ABLE TO PRODUCE ACCURATE AND PRECISE ESTIMATES OF RIVERINE FLUXES ? THE EUTROPHIC LOIRE RIVER, FRANCE.

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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. But on many major rivers, infrequent sampling of most pollutants makes flux estimates and their analysis difficult. The best way of using discrete concentration data sets and continuous discharge records for flux estimation is not clear, and several methods are usually proposed. This study explores the performance of different methods for estimating annual nutrient fluxes (nitrate-N, orthoposphate-P, total-P and particulate-P) and tried to answer three questions : (1) which method to use for estimating annual nutrient fluxes based on monthly sampling? ; (2) what levels of sampling frequency are required to achieve certain levels of precision ?; (3) Can past nutrient fluxes reconstituted from regular water quality survey be used for long-term trend analysis ?
The study is based on a data set of nutrient concentrations surveyed at high frequency during a 5-year pilot study (1981-1985) at the Orléans station in the middle reaches of the River Loire, France. The evaluations indicate that in the case 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. Good estimates (flux errors < +/- 10%) can be obtained from a sampling frequency of 10 to 15 days for nitrate, orthophosphates and total P. For particulate P, which is more variable, the frequency must be 5 days. The results indicate also that it is possible to identify temporal trends in a basin using the level of effort associated with a routine programme. However, it is highly recommended that the flux value be associated with the precision of the estimate.

Keywords : river flux, accuracy, precision, nutrients, phosphorus, nitrate, Loire

PREFACE

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1. INTRODUCTION

The demand for riverine flux estimates is growing for Earth Systems sciences and water quality management to: (i) evaluate mechanical and chemical denudation rates; (ii) estimate output from catchment ecosystems and source apportionment between point and diffuse sources (Kronvang et al,. 1996; Behrendt, 1993); (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 and Webb, 1981; Dolan et al., 1981; Ferguson, 1987; Littlewood, 1992; Phillips et al., 1999; Horowitz, 2003).

The total load over a given period T, such as a hydrological or calendar year, is given by integration of instantaneous flux, i.e. the product of concentration C and discharge Q. In practice, continuous and exact measurement of the streamflow and concentration required to calculate mass fluxes is not possible, principally due to lack of continuous concentration records. Regular water quality surveys are generally based on monthly sampling. The best way of using discrete concentration data sets and continuous discharge records for flux estimation is not clear, and several methods