Evaluation of Uncertainties on Annual Nutrient Load Induced by Time Proportional Composite Sampling Strategies

François Birgand & George M. Chescheir

NC STATE UNIVERSITY — Bio&Ag ENGINEERING

1. Introduction

- Automatic samplers have revolutionize water quality monitoring techniques and abilities
- One feature of these samplers is to sample water *at regular intervals* into a composite bottle, technique herein referred to as Time Composite Sampling (TCS)
- Annual nutrient load are sometimes calculated using this monitoring technique

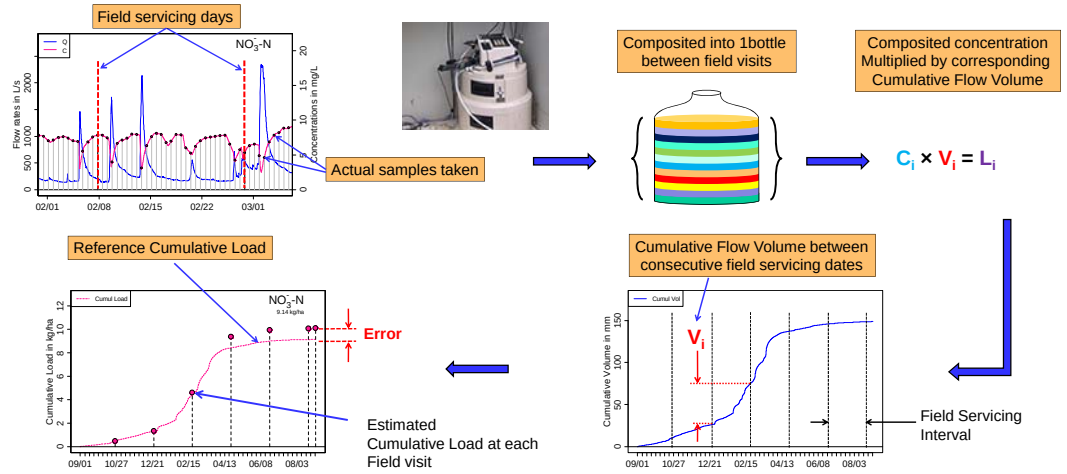
2. Objectives

- The objectives are to evaluate the potential error induced by TCS on the estimate of annual pollutant load at the outlet of small rural watersheds

3. Method

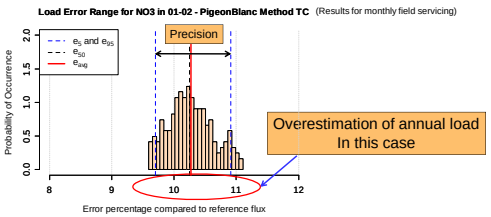
- Use *reference data* where available continuous data on flow rates and pollutant concentrations
- Numerically simulate sampling for different field servicing intervals and number of samples per bottle and *compare* the estimated load to the reference one

4. How are pollutant loads calculated using Time Composite Sampling?

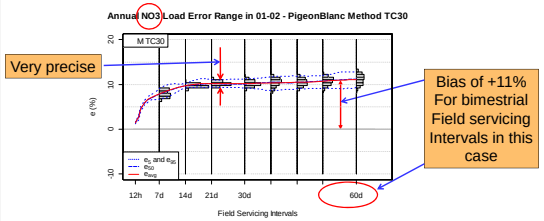


5. Results: TCS, biased method for estimating annual loads

- An infinite number of possible field servicing dates for a set servicing frequency induces a distribution of errors

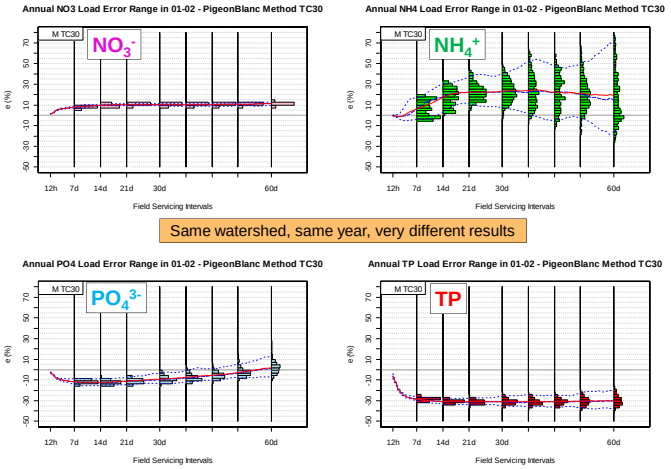


- Precise but potentially very biased method



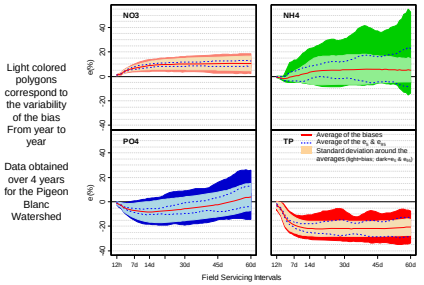
6. Results: bias and precision depend on the pollutants

- Number of samples (>30) per bottle has little impact in the results
- Bias and precision dramatically depend on pollutant
- Bias *negative* for pollutants which *conc. increase* during flow events (e.g. TSS)
- Bias *positive* for pollutants which *conc. decrease* during flow events (e.g. NO_3^-)



7. Results: interannual variability of bias and precision

- Although usually consistently precise, the TCS method induces bias that may change dramatically over the years



8. Conclusion

- The Time Composite Sampling method to evaluate annual nutrient loads is generally *not desirable*
- Although usually relatively precise, it induces large and unpredictable bias that may vary significantly over the years

Contact: francois_birgand@ncsu.edu

Abstract

Evaluation of uncertainties on annual nutrient flux and arithmetic average concentration induced by time proportional composite sampling strategies

François Birgand and George.M. Chescheir

The general use of automatic water samplers has revolutionized our ability to monitor nutrients, whether it be for long term monitoring at the outlet of a watershed or for a short term experimental project . One of the popular features offered by most samplers is time proportional composite sampling. Water is sampled at regular time intervals and the sampler is programmed to distribute a set number of samples into one or several containers. The result is that water in the one or several containers is a composite of several water samples. From these samples, nutrient flux corresponding to the time it takes to fill up each container can be calculated by multiplying the composite concentration by the cumulative flow volume during that time. Nutrient loads can then be computed by adding nutrient load corresponding to each container. This method should theoretically be robust because water is sampled often, comparatively a lot more so than for discrete sampling. However, the concentration values used to compute the fluxes for each container correspond to arithmetic average concentration while, theoretically, the flow weighted concentration should be used. For this reason, the results should be biased. This study proposes to evaluate the bias and uncertainties induced by this popular time proportional composite sampling strategy. High temporal resolution data on flow and concentration have been numerically sampled to simulate this strategy. The computed annual fluxes and average concentration obtained have been compared to the reference ones. This method shows that the method is usually precise but highly biased even when samples are composited in daily containers. Depending on the nutrient, annual fluxes tend to be biased towards overestimation or underestimation. Were the bias to be predicted, this sampling strategy would be one of the best available. However, prediction of the bias is still under investigation.