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Research papers

Effects of sampling strategies and estimation algorithms on total nitrogen load determination in a small agricultural headwater watershed

Ying Li[a], Haw Yen[b], R. Daren Harmel[c], Qiuliang Lei[a,*,1], Jiaogen Zhou[d], Wanli Hu[e], Wenchao Li[a], Huishu Lian[a], A-Xing Zhu[f,g], Limei Zhai[a], Hongyuan Wang[a], Weiwen Qiu[h], Jiafa Luo[i], Shuxia Wu[a], Hongbin Liu[a,*,1], Xiaohong Li[a]

[a] Key Laboratory of Nonpoint Source Pollution Control, Ministry of Agriculture and Rural Affairs of China, Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences (CAAS), Beijing 10081, China
[b] Blackland Research and Extension Center, Texas A&M AgriLife Research, Texas A&M University, TX 76502, USA
[c] Center for Agricultural Resources Research, USDA Agricultural Research Service, United States Department of Agriculture, Fort Collins, CO 80526, USA
[d] School of Urban and Environmental Sciences, Huaiyin Normal University, Jiangsu Province 223300, China
[e] Institute of Agricultural Resources & Environment, Yunnan Academy of Agricultural Sciences, Kunming 650205, China
[f] Key Laboratory of Virtual Geographic Environment (Nanjing Normal University), Ministry of Education, Nanjing 210023, China
[g] Department of Geography, University of Wisconsin-Madison, Madison, WI 53706, USA
[h] New Zealand Institute for Plant & Food Research Limited, Private Bag 4704, Christchurch 8140, New Zealand
[i] AgResearch, Ruakura Research Centre, 10 Bisley Road, Hamilton 3214, New Zealand

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ABSTRACT

Monitoring data collected from rivers are used to support assessments of the quality of the river environment and help decision makes formulate appropriate management plans. Therefore, accurate and precise estimates of constituent fluxes in streams and rivers are important. However, seasonal errors have not received enough attention and the published results have rarely been verified by other methods. In this study, the error associated with sampling frequencies (3 daily, weekly, 2 weekly, 4 weekly, 6 weekly, 8 weekly) and seven load estimation algorithms were examined. Seasonal and annual total N loads were estimated and wavelet coherence was used as a reference. In order to reduce the contingency of the results, three years data were used and total N (with 17.53% particulate N, 58.70% NO_3^--N and 23.77% other dissolved N fractions) was chosen to reflect water quality parameters. Results indicated that 2 weekly sampling frequency and algorithm F (linear interpolation) are sufficient for evaluating the characters of annual total N load in Fengyu River Watershed with 5% RMSE (root-mean-square error). There was a large RMSE (3.97–44.66%) in summer with a high CV (coefficient variation) (35.2%) for total N concentration. These results can serve as a useful reference for decision makes who need to establish monitoring programmes in watersheds with similar characteristics.

1. Introduction

In recent decades, numerous monitoring projects have been conducted to assess water quality degradation in riverine systems (Hudnell, 2010; Richards et al., 2008; Vörösmarty and Meybeck, 2004; Walling and Webb, 1996). Such monitoring programs have been conducted to: (i) assess current water quality conditions (Roygard et al., 2012); (ii) distinguish between point and non-point pollutant sources (Roygard et al., 2012); (iii) provide data for watershed modeling (Gassman et al., 2007; Ullrich and Volk, 2010); (iv) report field boundary conditions and monitoring time to evaluate long-term trends in river loads (Brauer et al., 2009; King and Harmel, 2003); and (v) evaluate the effectiveness of best management practices to guide policy and management decisions (Brauer et al., 2009; King and Harmel, 2003; Lennartz et al., 2010; Snelder et al., 2017). Ideally, the uncertainty of monitoring data (in terms of accuracy and precision) would be minimized by using appropriate collection and analysis methods, and estimates of the uncertainty would be reported alongside the data to guide data users (Birgand et al., 2010; Harmel et al., 2009; Moatar et al., 2013). However, the error in annual constituent load estimates relative to the "true" reference load may reach ± 100% in some cases, which limits the usefulness of the data (Walling and Webb, 1981; Yen et al., 2016).

* Corresponding authors.
E-mail addresses: leiqiuliang@caas.cn (Q. Lei), liuhongbin@caas.cn (H. Liu).
[1] USDA is an equal opportunity employer and provider.

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