LETTER

Are nitrogen-to-phosphorus ratios of Chinese lakes actually increasing?

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Tong et al. (1) demonstrate an increased mass ratio of total nitrogen to total phosphorus (TN:TP) and decreased TP concentration in many Chinese lakes in association with widespread construction of sewage collection and treatment plants during 2008 to 2017. We argue this conclusion is not true and likely leads to reduced pressure for nutrient loading reduction.

We examined the difference of TP and TN:TP between 2008 and 2018 in 30 lakes (15 lakes were included in ref. 1) and found that TP increased in 47% of lakes and decreased in 23% of lakes, and TN:TP increased in 13% of lakes and decreased in 20% of lakes ($P < 0.05$).

We collected monthly monitored TP and TN:TP of 12 representative large lakes (nine lakes were included in ref. 1) during 2007 to 2018. TP increased in seven lakes and decreased in five lakes (Fig. 1*A*), and TN:TP mass ratios increased in two lakes and decreased in nine lakes (Fig. 1*B*). We also compared the slopes of regressions of nutrients with time for nine lakes. TP decreased in eight lakes and TN:TP increased in seven lakes in the Tong et al. (1) dataset, but TP decreased in two lakes and TN:TP increased in three lakes in our dataset.

We further investigated Lake Taihu in detail, as it is located in the densely populated Yangtze River Delta (>1,000 ca/km^2). Since the highly publicized drinking water crisis in 2007 (5), a variety of restoration measures were implemented, including construction of 24,500 km of sewage pipelines and 103 new wastewater treatment plants (6). To date, TN has declined significantly and TP has slightly increased, but TN:TP mass ratio has declined significantly (Fig. 2). The reason is associated with increased water consumption and wastewater discharge that resulted in an external loading undebated, and an enhanced mobilization of phosphorus resulted from an interaction between sediments and intense algal blooms (6).

The primary reason that our results differ from those of Tong et al. (1) is the field sample pretreatment. The dataset used by Tong et al. is from the China National Environmental Monitoring Center, and field sample filtration and settling are required to remove large algal colonies and suspended solids (denoted the EMC method) (7). However, samples pretreated by other institutions are often analyzed directly without filtering and settling (denoted the NEMC method). This different sample processing caused TP by EMC to be lower than that by NEMC. In addition, TP concentrations and TN:TP of these lakes tend to be modified by a series of distinctive biogeochemical processes during nutrient delivery in rivers (8) and lakes (9), such as sedimentation, denitrification, regeneration, remobilization, and resuspension.

Many lakes in China continue to suffer from eutrophication and algal blooms, as evidenced in the China Water Resource Bulletin (published by the Ministry of Water Resources of China, http://www.mwr.gov.cn/sj/#tjgb), which evaluated the trophic status of a wide range of lakes over 2008 to 2018. China needs more aggressive nutrient management, especially reduction of phosphorus loading.

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The authors declare no competing interest.

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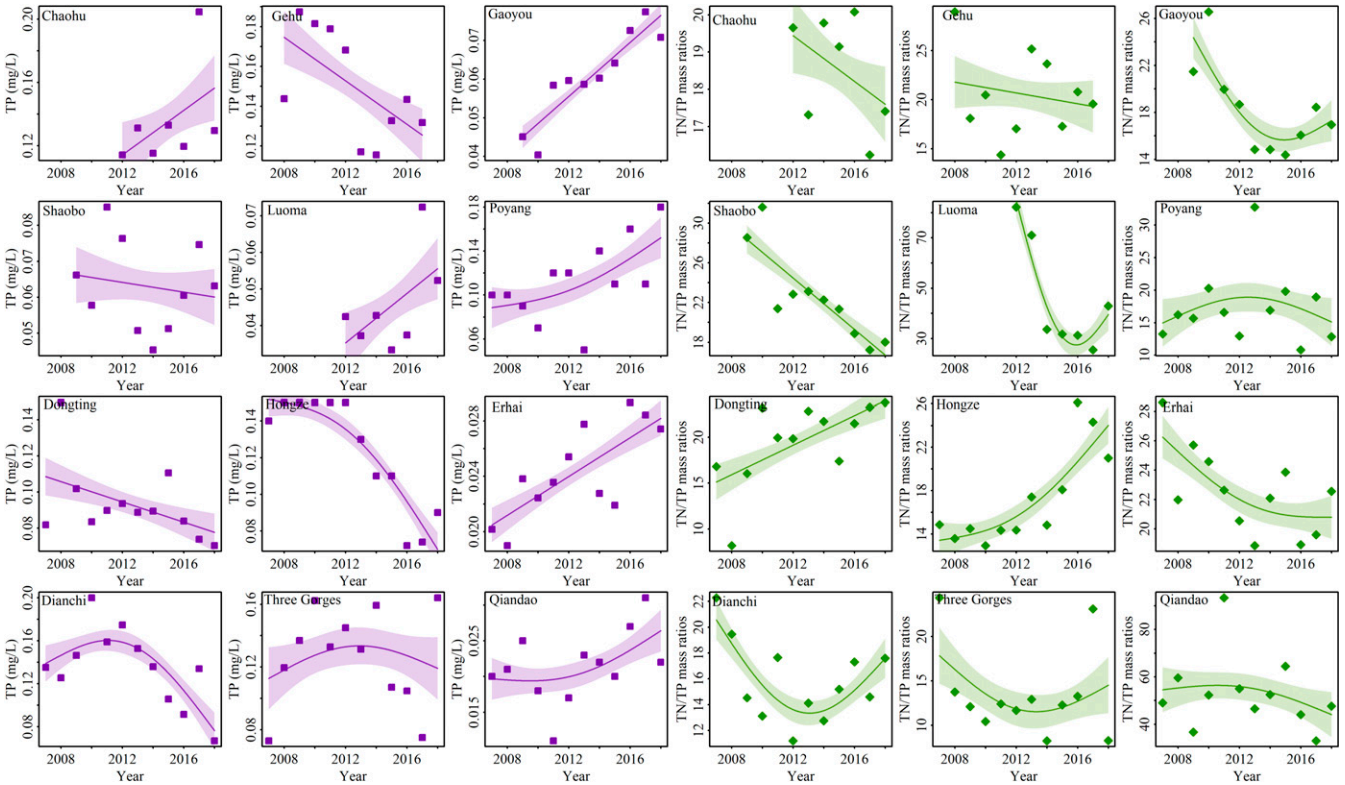

Fig. 1. Variability of TP concentrations (*Left*) and TN:TP mass ratios (*Right*) in 12 representative large lakes over the period of 2007 to 2018. Data sources: Poyang (Poyang Lake Ecosystem Research Station, Chinese Academy of Sciences [CAS]), Dongting (2), Erhai and Dianchi (School of Ecology and Environmental Science, Yunnan University), Three Gorges Reservoir (Institute of Three Gorges Reservoir, Chongqing Institute of Green and Intelligent Technology, CAS), Chaohu (Nanjing Institute of Geography & Limnology, CAS), and Gehu (3). Nonlinear trends for time-series data were fitted by generalized additive models according to Harding et al. (4). The solid lines represent the long-term trends estimated by additive models, and the shaded areas are the SE of the estimate.

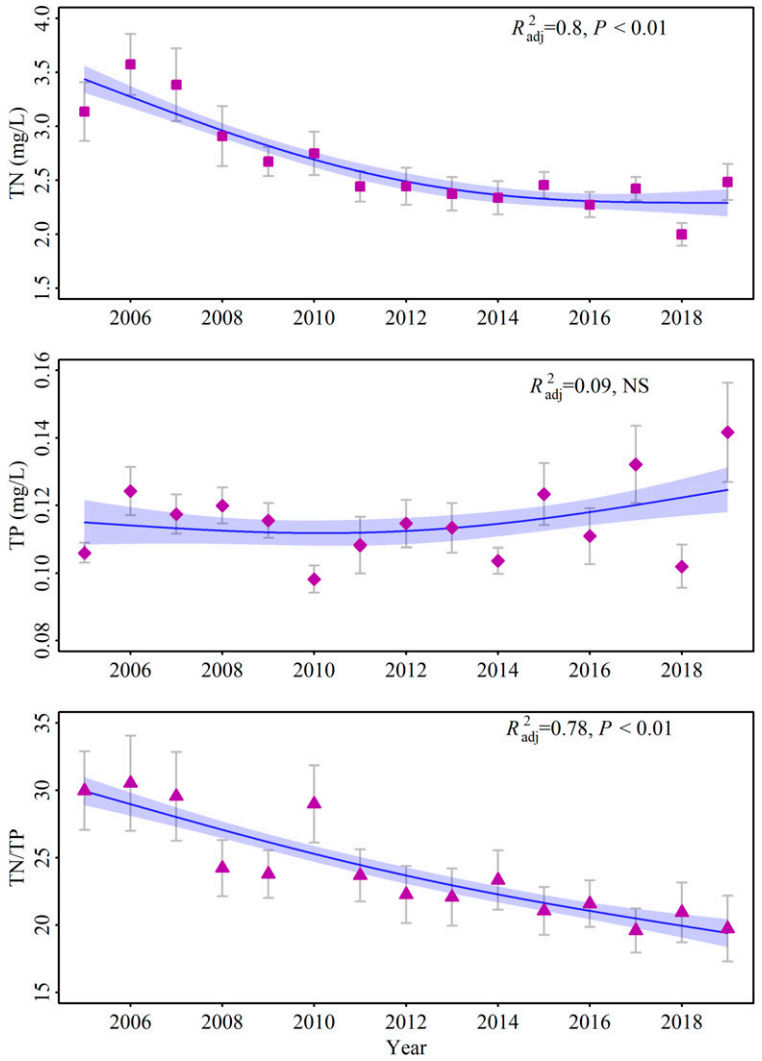

Fig. 2. Concentrations of TN and TP and TN:TP mass ratio of Lake Taihu during 2005 to 2019. Data are from Taihu Laboratory for Lake Ecosystem Research, Chinese Academy of Sciences. The solid lines represent the long-term trends estimated by additive models, and the shaded area is the SE of the estimate. R^2_{adj}: adjusted *R*-squared value of additive models. NS, not significant.

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