

# Comment on “Multi-Scale Modeling of Nutrient Pollution in the Rivers of China”



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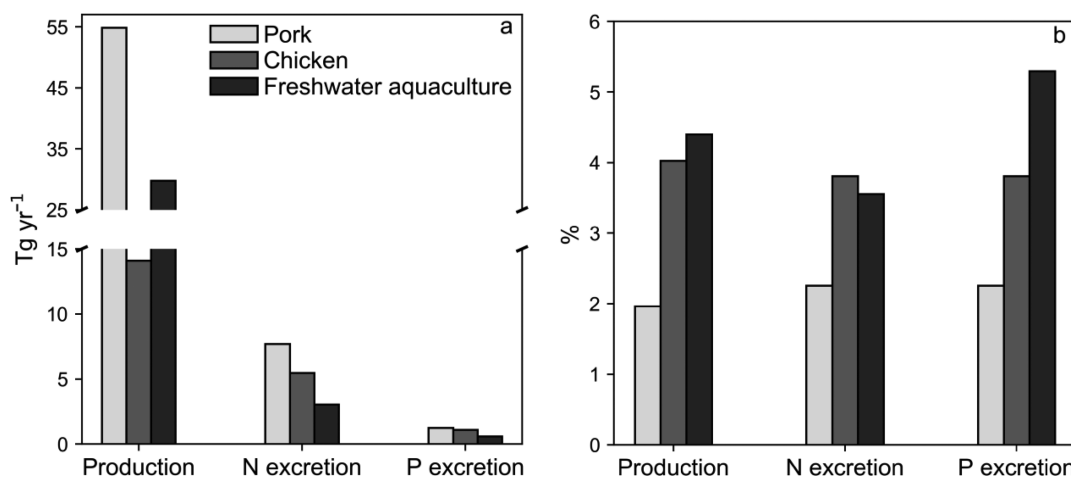
Article Recommendations

Recently, Chen et al.<sup>1</sup> presented a modeling study of the nutrient sources in Chinese inland waters. Wang et al. showed that freshwater aquaculture in China is a large, rapidly growing, and spatially concentrated nutrient source.<sup>2</sup> By ignoring the direct discharge of nutrients from freshwater aquaculture they (and several other recent nutrient inventory studies for China<sup>3–8</sup>) overestimated other nutrient sources (such as direct discharge of animal manure) and drew incorrect conclusions about possible nutrient management strategies to mitigate nutrient pollution.

More than half of the global aquaculture production is in China, and with a >60% increase since 2003,<sup>9</sup> there is growing concern about eutrophication caused by aquaculture. Freshwater aquaculture production in China is currently more than

bodies or agricultural areas that are most attractive for aquaculture production, such as lakes and reservoirs (Figures 2b,c).

While agriculture is the main source of nutrient pollution in China, which is partly routed through and processed in aquifers, nutrients from aquaculture are directly discharged to the water column, similar to wastewater and direct discharge of animal manure.<sup>2</sup> Neglecting this locally and regionally important direct source leads to a serious underestimation of the provincial excess nitrogen and phosphorus discharge. In addition, the average annual increase rate of freshwater aquaculture production was 1.1 and 2.2 times that of pork and chicken during 2003–2018, respectively, and the increase rate of nutrient excretion from freshwater aquaculture equaled or exceeded that from chicken



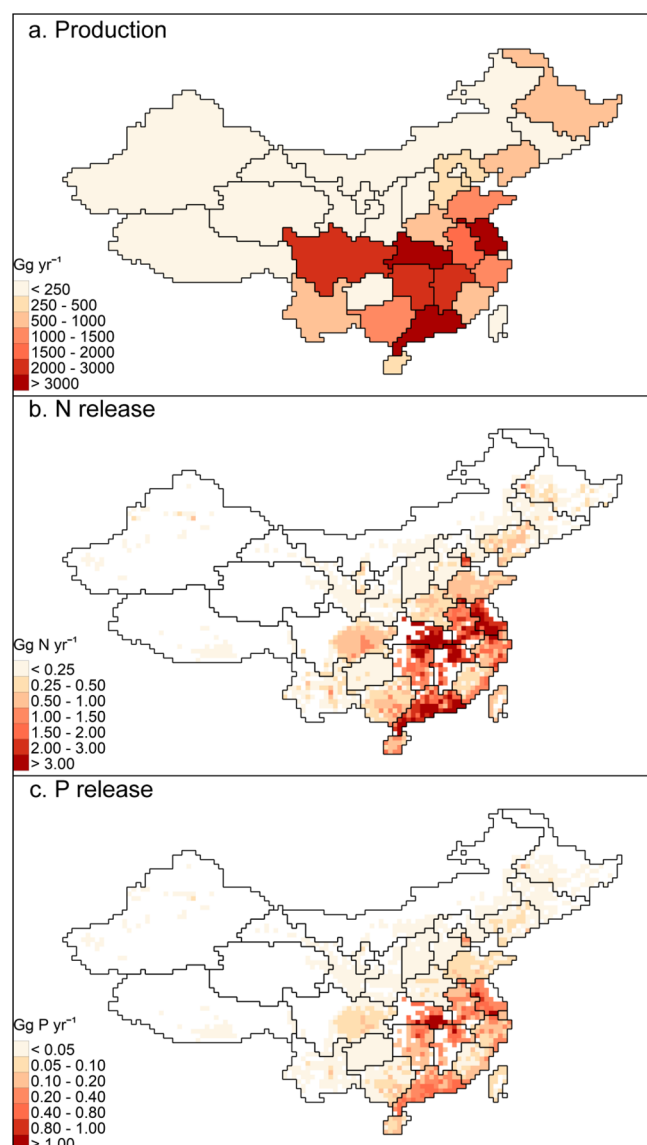
**Figure 1.** (a) Chinese pork, chicken and freshwater aquaculture (excluding aquatic plants) production (in Tg yr<sup>-1</sup> of fresh weight) and associated nutrient (i.e., nitrogen and phosphorus) excretions (in Tg N or P yr<sup>-1</sup>) for 2018 as well as (b) their average annual increase rates (in % yr<sup>-1</sup>) during 2003–2018. Production data for 2003 and 2018 were obtained from FAO,<sup>9,11</sup> China Fishery Yearbook,<sup>12</sup> Taiwan Fisheries Yearbook,<sup>13</sup> Statistical Communiqué of the People’s Republic of China on the 2018 National Economic and Social Development<sup>14</sup> and Taiwan Agriculture Yearbook;<sup>15</sup> N and P excretions were calculated according to Wang et al.<sup>2</sup> and Bouwman et al.<sup>16</sup> About 86% of China’s freshwater aquaculture production is finfish (78% of finfish is carp), 12% is crustaceans and 1% is mollusks.<sup>12,13</sup>

half of the country’s production of pork and exceeds that of chicken (Figure 1a). More than 60% of China’s freshwater aquaculture production comes from six provinces with an annual production >2 million tonnes in 2018 (Hubei, Guangdong, Jiangsu, Hunan, Jiangxi, and Sichuan, Figure 2a). The total nitrogen release from China’s freshwater aquaculture in 2018 is 1.26 Tg and that of phosphorus 0.15 Tg. Within each province, the nutrient pollution from freshwater aquaculture shows a further strong spatial concentration, particularly in the water-

and pork, respectively (Figure 1b). It is expected that this rapid increase in freshwater aquaculture will continue in the near future.<sup>10</sup>

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**Figure 2.** (a) Freshwater aquaculture fish production ( $\text{Gg yr}^{-1}$  per province), (b) associated nitrogen (N) release ( $\text{Gg N yr}^{-1}$  per 0.5-degree cell), and (c) phosphorus (P) release ( $\text{Gg P yr}^{-1}$  per 0.5-degree cell) in China for the year 2018. Provincial production data were obtained from China Fishery Statistical Yearbook<sup>12</sup> and Taiwan Fisheries Yearbook.<sup>13</sup> N and P release to surface water was calculated according to Wang et al.<sup>2</sup>

Chen et al.<sup>1</sup> conclude that on the basis of their approach “county mayors could choose effective solutions targeting dominant sources”. However, by ignoring aquaculture, the suggested societal transformation in the agriculture and waste management sectors toward nitrogen recycling will locally need to be much more ambitious and need to be expanded with pollution mitigation efforts in freshwater aquaculture.

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## Notes

The authors declare no competing financial interest.

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