LETTER

Are China's water bodies (lakes) underestimated?

Guoqing Zhang[a,b,1], Wenfeng Chen[a], Guoxiong Zheng[c], Hongjie Xie[d,e], and C. K. Shum[f]

In their study of surface water bodies (WBs) in China, Feng et al. (1) used the global surface water dataset (GSWD) by Pekel et al. (2) to report that the abundance of WBs (>1 km^2) and their total area were underestimated greatly by previous studies (3, 4). However, the incorrect definitions of WBs, data coverage, and the temporal windows in Feng et al. (1) could have resulted in large errors, and thus discrepancies for the number of WBs detected and their area changes.

As Earth's surface water is driven by changing climate and anthropogenic factors, it is important that an epoch date be defined at which the WB calculations are referenced. Feng et al. (1) used the GSWD (2), excluding rivers and streams, to calculate the WB occurrences in China during 1984 to 2015 and found there is a total of 6,821 WBs (>1 km^2). They argued that previous studies (e.g., refs. 3 and 4) have underestimated the number and sizes of WBs in China. Indeed, a smaller number (5,535) of lakes and reservoirs has been derived from Landsat images during 2005 to 2008 (3), and 2,693 lakes were mapped during 2005 to 2006 (4). Zhang et al. (5) demonstrated that China had 2,554 lakes (>1 km^2) in 2015 and that lake number and area in China including Tibetan Plateau (TP) have been increasing between the 1970s and 2015 (Fig. 1). When compiling a lake inventory, reservoirs and dams should be excluded, and a relatively stable season for WBs should be chosen to avoid seasonal, interannual, or longer variability (6). This is the reason why ±2-y or longer data intervals should be employed (5). These considerations are not addressed by Feng et al. (1), leading to the feasibility that the maximum WBs number and area were estimated. For the TP, Feng et al. (1) claim that WB number in their study is close to the value (1,291) determined by Mao et al. (7) from 2014, as lake number (>1 km^2) has been increasing in recent decades, and there are few reservoirs on the TP (Fig. 1). It is unsurprising that Feng et al. (1) mapped more WBs than previous studies (3, 4), as a longer period (1984 to 2015) was covered, the historical maximum water area was used, and more WB types were included. The differences in total area found between Feng et al. (1) and other studies (3, 8) are due to similar reasons.

In addition, Feng et al. (1) indicate that the WBs in China follow the size–abundance relationships. Although these relationships have been widely used, this hypothesis is reported to be inconsistent (e.g., refs. 9 and 10). Finally, a comparison of changes was presented in China's WBs between 1985–1999 and 2000–2015 (1). For the first of these time periods, there was a limited availability of Landsat images (2, 5), which could result in large uncertainties in the comparison of WB changes. We suggest that a rigid criteria of data selections and fully justified comparison and analysis are important for discovering surface water features and their variations.

Acknowledgments

This study was supported by grants from the Second Tibetan Plateau Scientific Expedition and Research Program (2019QZKK0201), the Strategic Priority Research Program (A) of the Chinese Academy of Sciences (XDA20060201 and XDA19070302), the National Key Research and Development Program of China (2018YFB0505005 and 2017YFA0603103-3), and the Natural Science Foundation of China (41871056). Funding support for H.X. was partially from the US NASA Award (80NSSC19M0194).

[a]Key Laboratory of Tibetan Environmental Changes and Land Surface Processes, Institute of Tibetan Plateau Research, Chinese Academy of Sciences, Beijing 100101, China; [b]Center for Excellence in Tibetan Plateau Earth Sciences, Chinese Academy of Sciences, Beijing 100101, China; [c]Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences, Urumqi 830011, China; [d]Center for Advanced Measurements in Extreme Environments, University of Texas at San Antonio, San Antonio, TX 78249; [e]Department of Geological Sciences, University of Texas at San Antonio, San Antonio, TX 78249; and [f]Division of Geodetic Science, School of Earth Sciences, The Ohio State University, Columbus, OH 43210

Author contributions: G. Zhang designed research; G. Zhang performed research; and G. Zhang, W.C., G. Zheng, H.X., and C.K.S. wrote the paper.

The authors declare no competing interest.

[1]To whom correspondence may be addressed. Email: guoqing.zhang@itpcas.ac.cn.

First published March 3, 2020.

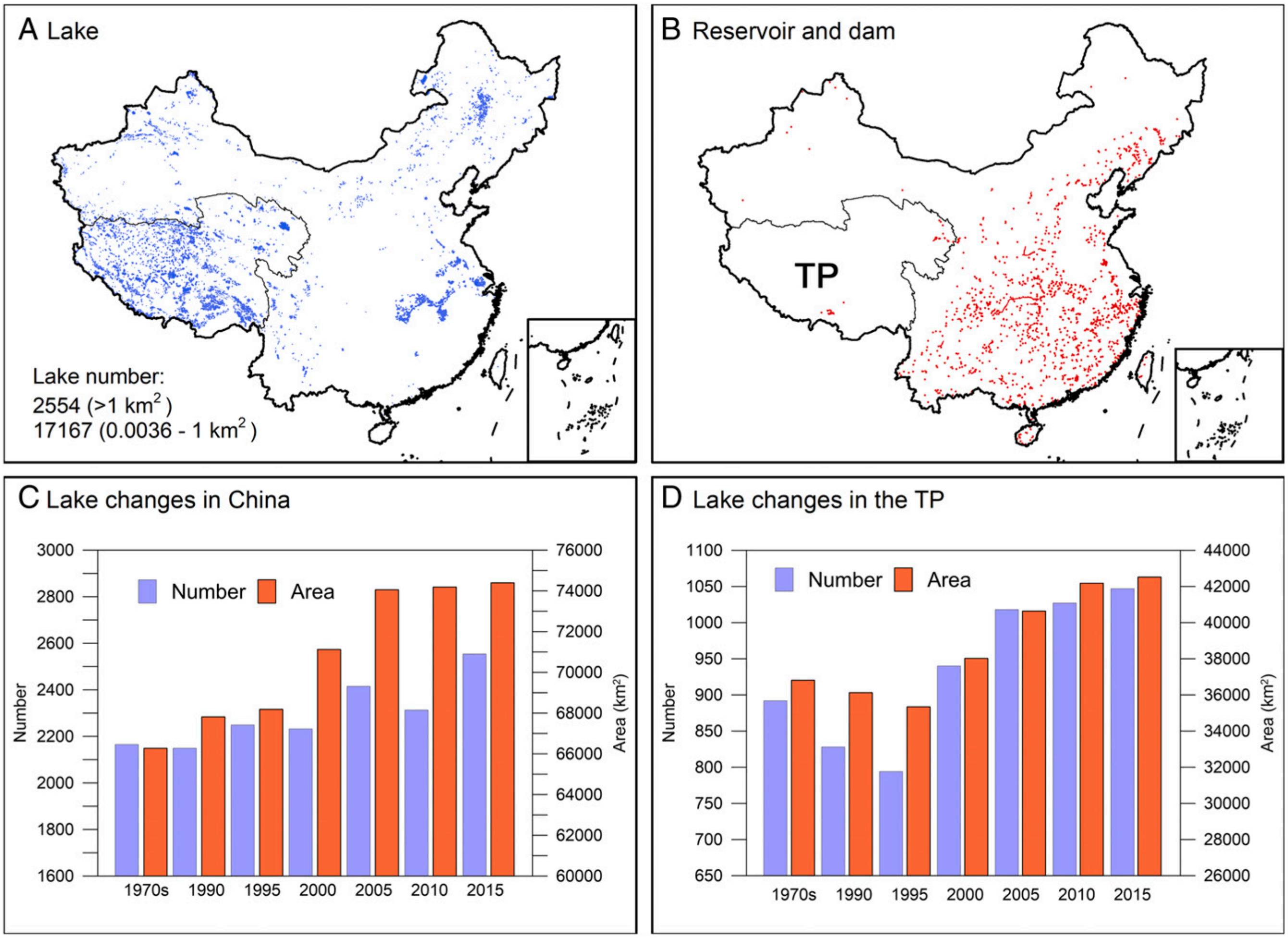

Fig. 1. **Lake number and area in China and their changes. (*A*) Lake distribution including 2,554 lakes (>1 km^2) in 2015 and 17,167 glacial lakes with size in the range 0.0036 to 1 km^2 in 2015. Glacial lakes are derived from http://data.tpdc.ac.cn/en/. (*B*) Reservoir and dam distributions in China. The boundary of the Tibetan Plateau (TP) is outlined. Reservoir and dam inventories are from a global dataset at http://globaldamwatch.org/data/. (*C*) Lake number and area changes in China between the 1970s and 2015. (*D*) Lake number and area changes in the TP between the 1970s and 2015. Lake number and area changes are from Zhang et al. (5).**

1 S. Feng *et al*., Inland water bodies in China: Features discovered in the long-term satellite data. *Proc. Natl. Acad. Sci. U.S.A.* **116**, 25491–25496 (2019).

2 J.-F. Pekel, A. Cottam, N. Gorelick, A. S. Belward, High-resolution mapping of global surface water and its long-term changes. *Nature* **540**, 418–422 (2016).

3 X. Yang, X. Lu, Drastic change in China's lakes and reservoirs over the past decades. *Sci. Rep.* **4**, 6041 (2014).

4 R. Ma *et al*., China's lakes at present: Number, area and spatial distribution. *Sci. China Earth Sci.* **54**, 283–289 (2011).

5 G. Zhang *et al*., Regional differences of lake evolution across China during 1960s–2015 and its natural and anthropogenic causes. *Remote Sens. Environ.* **221**, 386–404 (2019).

6 Y. Sheng *et al*., Representative lake water extent mapping at continental scales using multi-temporal Landsat-8 imagery. *Remote Sens. Environ.* **185**, 129–141 (2016).

7 D. Mao *et al*., Impacts of climate change on Tibetan lakes: Patterns and processes. *Remote Sens.* **10**, 358 (2018).

8 W. Wan *et al*., Monitoring lake changes of Qinghai-Tibetan Plateau over the past 30 years using satellite remote sensing data. *Chin. Sci. Bull.* **59**, 1021–1035 (2014).

9 B. B. Cael, D. A. Seekell, The size-distribution of Earth's lakes. *Sci. Rep.* **6**, 29633 (2016).

10 C. Verpoorter, T. Kutser, D. A. Seekell, L. J. Tranvik, A global inventory of lakes based on high-resolution satellite imagery. *Geophys. Res. Lett.* **41**, 6396–6402 (2014).