

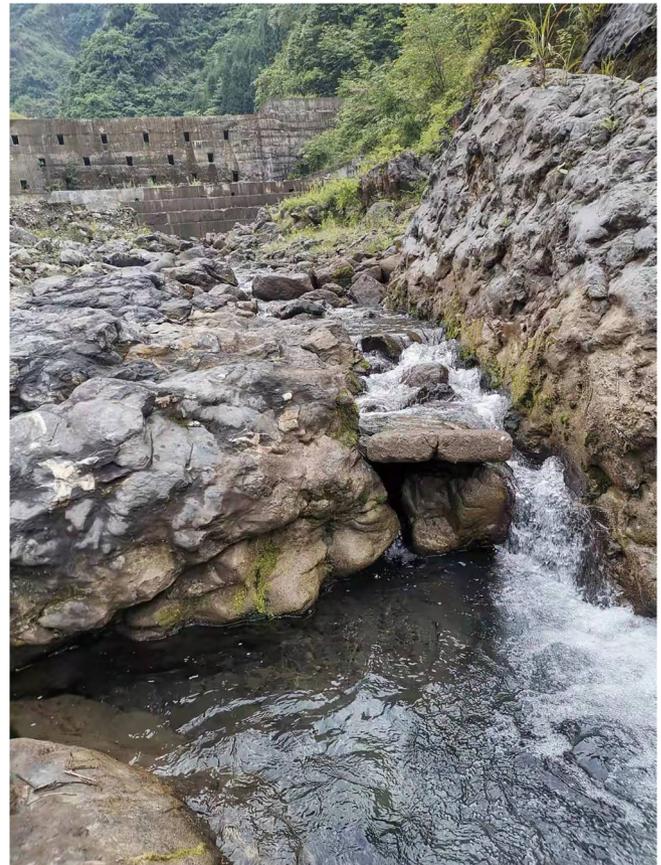
## LETTER

## Small-scale dams deplete frogs and toads

The Earth's biodiversity is in severe decline, and amphibians seem particularly vulnerable to environmental changes as they are among the worst affected animal groups (Barnosky et al., 2011; Dufresnes et al., 2021; Jetz & Pyron, 2018; Stuart et al., 2004). They are declining faster than birds and mammals and today almost 41% of amphibians are threatened with extinction (International Union for Conservation of Nature [IUCN]). This catastrophic decrease of amphibians is primarily due to habitat loss and excessive land use (Stuart et al., 2004) but also driven by other anthropogenic causes such as climate change, chemical pollution, invasive species, and especially spread of the notorious chytrid fungus (Scheele et al., 2019; Wake & Vredenburg, 2008). Here, we highlight that hydropower damming can also have dramatic influence on anuran species richness and abundance—even from considerable distance. The current increasing needs for “clean” energy led to expansion of hydropower and causes widespread severe and permanent alterations of nature (Kuriqi et al., 2019; Zarfl et al., 2015). The construction of hydropower plants is inevitably linked to dam construction, which means habitat fragmentation, habitat loss, and population isolation, thereby reducing animal abundance and species richness (Brandão & Araújo, 2008). While the ruinous loss of natural ecosystems via damming negatively affects diversity and abundance of several animal groups (Galbraith & Vaughn, 2011; Nieland et al., 2015; Stone, 2016), its effects on amphibians should be evident as the construction of dams has been connected to amphibian habitat loss and reduced egg survival (Brandão & Araújo, 2008; Kupferberg et al., 2012).

Here, we compared species richness and abundance of frogs and toads from dams adjacent with 50 different Nature Reserves between 2007 and 2020 in China. While inside those Reserves no damming took place, close to some of them hydroelectric dams were constructed during that time. The assessment of species richness and abundance was conducted using a line transect method (length  $\times$  width: 500 m  $\times$  5 m). We recorded the number of species and individuals of each species

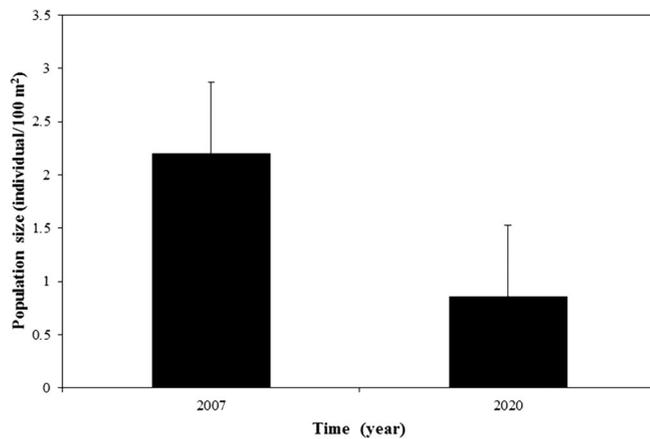
along each transect at the speed of 0.5–1 km/h. In June 2007, before any dam construction, we found 32 anuran species, consisting of 17 *Odorrana*, 12 *Paa*, and 3 *Amolops*. The year after, in all sites close to dams, a reduction of water flow, which caused habitat and spawning site loss, was apparent (Figure 1). Indeed, in June 2020 at sites where dams had been erected close by, eight of 32 species could not be found anymore. Moreover, the population size of species living in dams adjacent with 29 Nature Reserves decreased by  $\sim$ 60% (Figure 2). Although the potential confounding effects of other factors such as the chytrid fungus,



**FIGURE 1** A small dam adjacent with one Nature Reserve in Sichuan province

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**FIGURE 2** Difference in the population size of species living without dams (2007) and with dams (2020) adjacent with Nature Reserves

climate change and their interactions that may contribute to the amphibian decline (Scheele et al., 2019), there was no significant decline in the richness and abundance of frogs and toads inhabiting in sites adjacent with 21 Nature Reserves without dams. Hence, these dramatic decreases are likely a direct consequence of damming activities is evident as species richness and abundance of anurans in Nature Reserves without dams in close proximity did not change over the 13 years of this study.

Our data show that dam constructions, even from a distance, have detrimental effects on anurans, resulting in a sharp decline in their richness and abundance, and are likely to elevate their extinction risk. Considering the already widespread critical endangered status on the IUCN Red List (2020) for many anurans, it is vital that the Chinese government strengthens and enforces the Wildlife Protection Law of China. Measures protecting amphibians need to be implemented urgently. To ensure effective and enforceable protection, we strongly recommend that the establishment of small-scale hydropower plants near Natural Reserves should be avoided. We advocate that the government should further demolish some dams to ameliorate anthropogenic impact on anuran species. As a quick first aid, we advise that water should be released from dams during appropriate seasons to restore downstream amphibian breeding habitats.

### ACKNOWLEDGMENTS

The authors thank Mai, C.L., Liu, W., Cheng, S.N., and Chen Chuan to help collect samplings in fieldwork.

### CONFLICT OF INTEREST

The authors declare no conflict of interest.

### AUTHOR CONTRIBUTIONS

Wen Bo Liao conceptualized the research; Ying Jiang conducted the analysis and created figures; Alexander Kotrschal led the writing of the initial manuscript draft.

Ying Jiang<sup>1</sup>

Wen Bo Liao<sup>1</sup>

Alexander Kotrschal<sup>2</sup>

<sup>1</sup>Key Laboratory of Southwest China Wildlife Resources Conservation (Ministry of Education), China West Normal University, Nanchong, China

<sup>2</sup>Behavioural Ecology, Department of Animal Sciences, Wageningen University, Wageningen, The Netherlands

### Correspondence

Wen Bo Liao, Key Laboratory of Southwest China Wildlife Resources Conservation (Ministry of Education), China West Normal University, Nanchong, 637009 Sichuan, China.

Email: liaobo\_0\_0@126.com

### ORCID

Wen Bo Liao <https://orcid.org/0000-0001-5303-4114>

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