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EDITORIAL
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# Editorial: Lake Changes, Drivers and Consequences in High Mountain Asia

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**Editorial on the Research Topic**

**Lake Changes, Drivers and Consequences in High Mountain Asia**

Glaciers in High Mountain Asia (HMA) cover ~98,000 km$^2$ (RGI-Consortium, 2017) and have an estimated volume of ~7,000 km$^3$ (Farinotti et al., 2019), which is the largest ice reservoir on the Earth outside of the polar regions. Two types of lakes with different origins and evolutionary characteristics are widely distributed in HMA (**Figure 1**). Large inland lakes on the Tibetan Plateau are sensitive to climate changes, in particular to recent increases in precipitation (Zhang et al., 2020). Glacial lakes are smaller (Wang et al., 2020), and mainly dot the higher elevation bands of the Himalaya, Karakoram, Pamir, and Tien Shan. Glacial lakes can grow rapidly as a consequence of glacier retreat and can drain as potential catastrophic glacial lake outburst floods (GLOFs) (Veh et al., 2019). Under a warmer climate, both lake types have changed substantially given ongoing climate and cryosphere variations. In this Research Topic, we seek to understand better the interactions between atmosphere, cryosphere, and hydrosphere of lakes in high mountains and related implications for water resources and hazards.

We collected six research articles including four papers related to glacial lakes and hazards, and two papers about large inland lakes in regard to climate change (**Figure 1**). Furian et al. modelled the evolution of glacial lakes in the entire HMA until 2100 using the Coupled Model Intercomparison Project (CMIP6) models under four Shared Socioeconomic Pathway (SSP) scenarios. The authors find that glacial lake volume might increase to ~39.7 km$^3$ (~1,000%) for SSP585 relative to ~3.9 km$^3$ in 2018. Their projections have an unprecedented decadal resolution, and hence improve our understanding when and where lakes might form in the future. At regional scale, Sun et al. mapped glacial lake area changes between 1990 and 2020 in the Yarlung Zangbo River Basin using 30-m Landsat images from Google Earth Engine (GEE), and identified 23 lakes with very high hazard levels. Rinzin et al. mapped glacial lakes in the Bhutan Himalaya with high spatial resolution using Corona KH-4 data (1.82–7.62 m pixel size) in the 1960's and Sentinel-2 data (10 m) in 2016–2020. After the examination of glacial lake area variations, 31 lakes in the Bhutan Himalaya are deemed to pose a very high hazard level. Zhang et al. simulated the outburst of Jiweng Co. in southeastern Tibetan Plateau that happened on 26 June 2020. The authors used the Hydrological Engineering Center's River Analysis System (HEC-RAS) model, and showed a good performance of simulated peak flow relative to measurements (3.53% in difference). These four studies portrayed the historical and future changes in the size-distribution of glacial lakes, including associated changes in hazard and risk primarily driven by climate change. In addition, Pang et al. mapped interannual variations of 20 large inland lakes in the Tibetan Plateau using Landsat images from the GEE platform, and estimated lake volume changes using SRTM DEM. The authors identified that precipitation and

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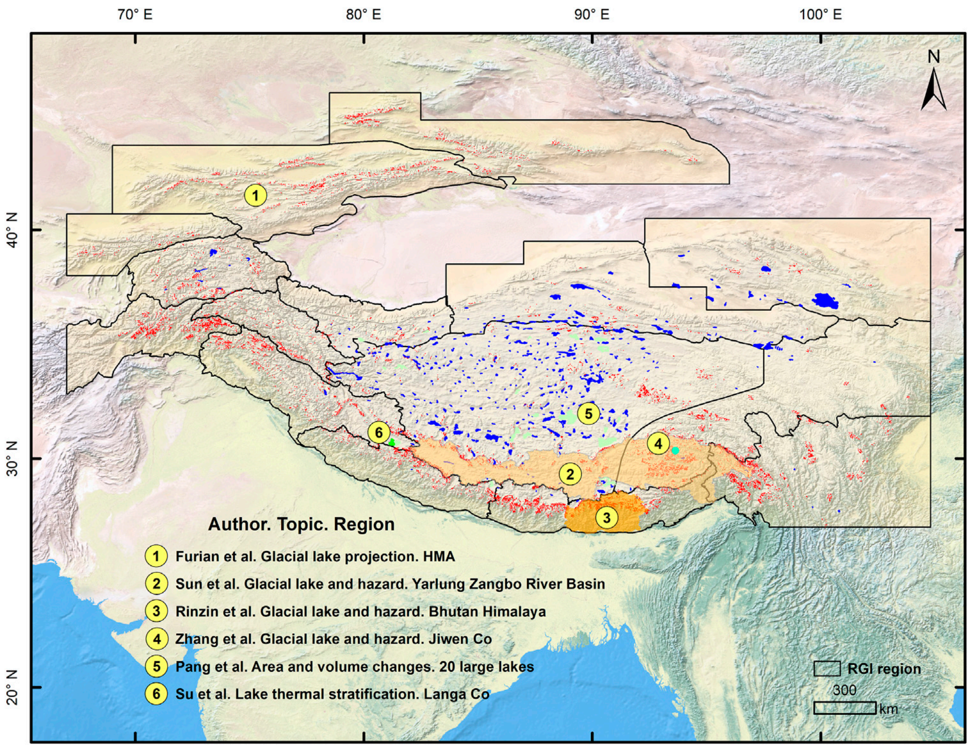


**FIGURE 1 |** Six contribution papers (1–6) published in Frontiers in Earth Science with Research Topic: Lake Changes, Drivers and Consequences in High Mountain Asia (HMA). Two types of lake including inland large lakes (blue) and small glacial lakes (red) are shown. Study regions for these papers are displayed with different background colors. The boundaries of Randolph Glacier Inventory (RGI 6.0) regions 13, 14, and 15 for HMA are shown. A list provides detailed information about the authors, study topic and regions.

temperature are the main factors that result in the rapid increase of the water volume in these lakes, although the influence of this phenomenon varies in different areas. Finally, Su et al. revealed a special summer destratification phenomenon (only lasting a few days) for Langa Co., a deep (~49 m) lake in the southern Tibetan Plateau based on *in-situ* observations of the lake water temperature.

Atmospheric warming in HMA is expected to accelerate ice loss and foster ongoing lake growth, accentuating the important role of research on high mountain lakes. The studies on glacial lakes in this Research Topic are valuable to assess the change in GLOF hazard, and call for detailed field surveys and potentially mitigation measures in locations associated with high risk. The studies on large inland lakes can help improve the understanding of lake evolution in response to climate change. Several studies involve the use of GEE platform and the Open Global Glacier Model (OGGM) to efficiently map and project lakes in the landscape. Such approaches are promising techniques, as they combine machine learning to implement large-scale assessment studies.

## AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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**Conflict of Interest:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.