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Cryosphere and related hazards in High Mountain Asia in a changing climate

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Glacial Lake Outburst Floods in High Mountain Asia

Overview

High Mountain Asia has the largest glacier cover beyond two poles

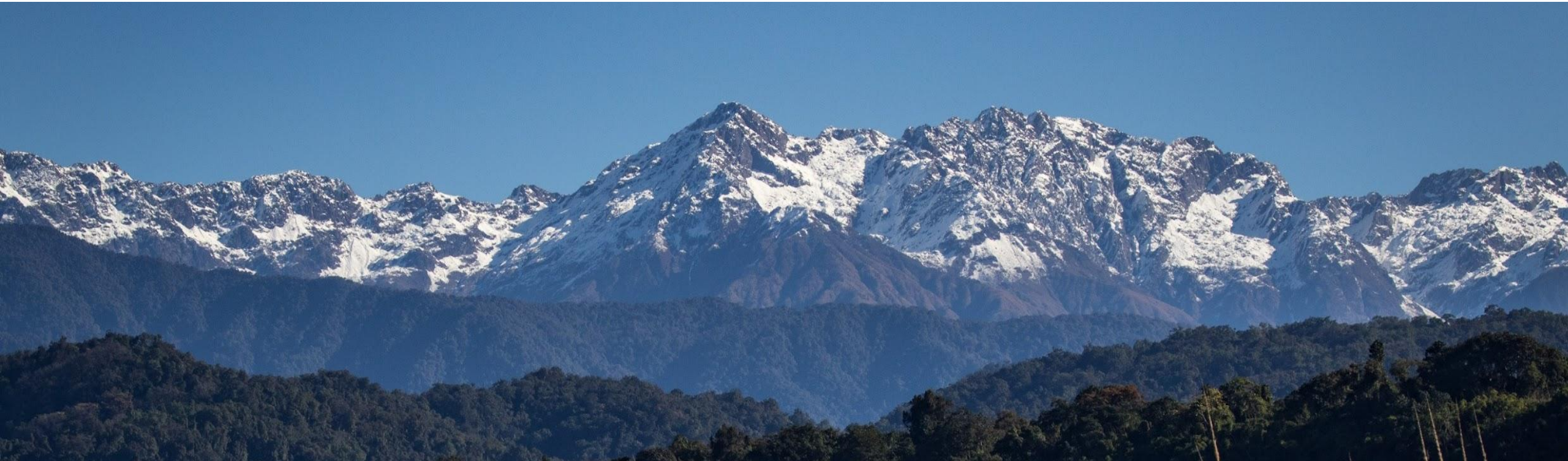
~ 30000 glacial lakes cover ~2000 km^2 in the region

Several studies exist that focus on the causes, mechanisms and trends of GLOFs over the past few decades

Dig Tsho, 2009, Sharad Joshi

Objectives

1. Comprehensive dataset of GLOFs in HMA, including their location, occurrence date, lake type, outburst mechanism, downstream impacts, etc.
2. Records of previously unrecorded events with local testaments
3. Dataset fully accessible and visualize using interactive tool



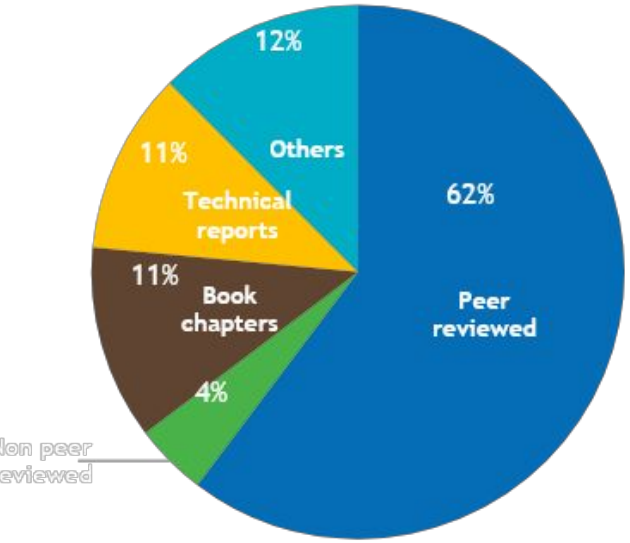
Methodology

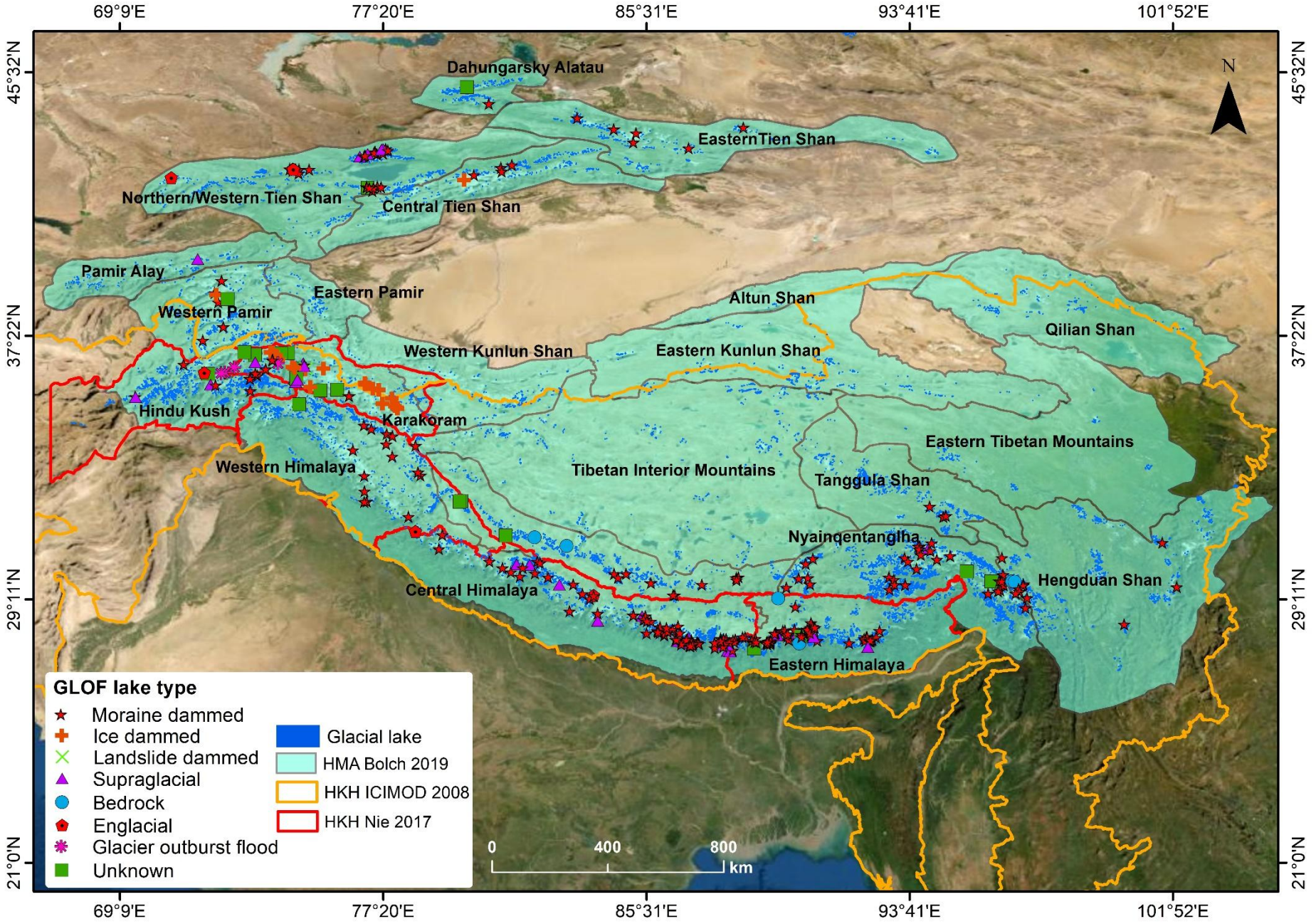
Compilation of GLOF database:

- peer-reviewed articles
- news articles
- book chapters
- technical reports
- others

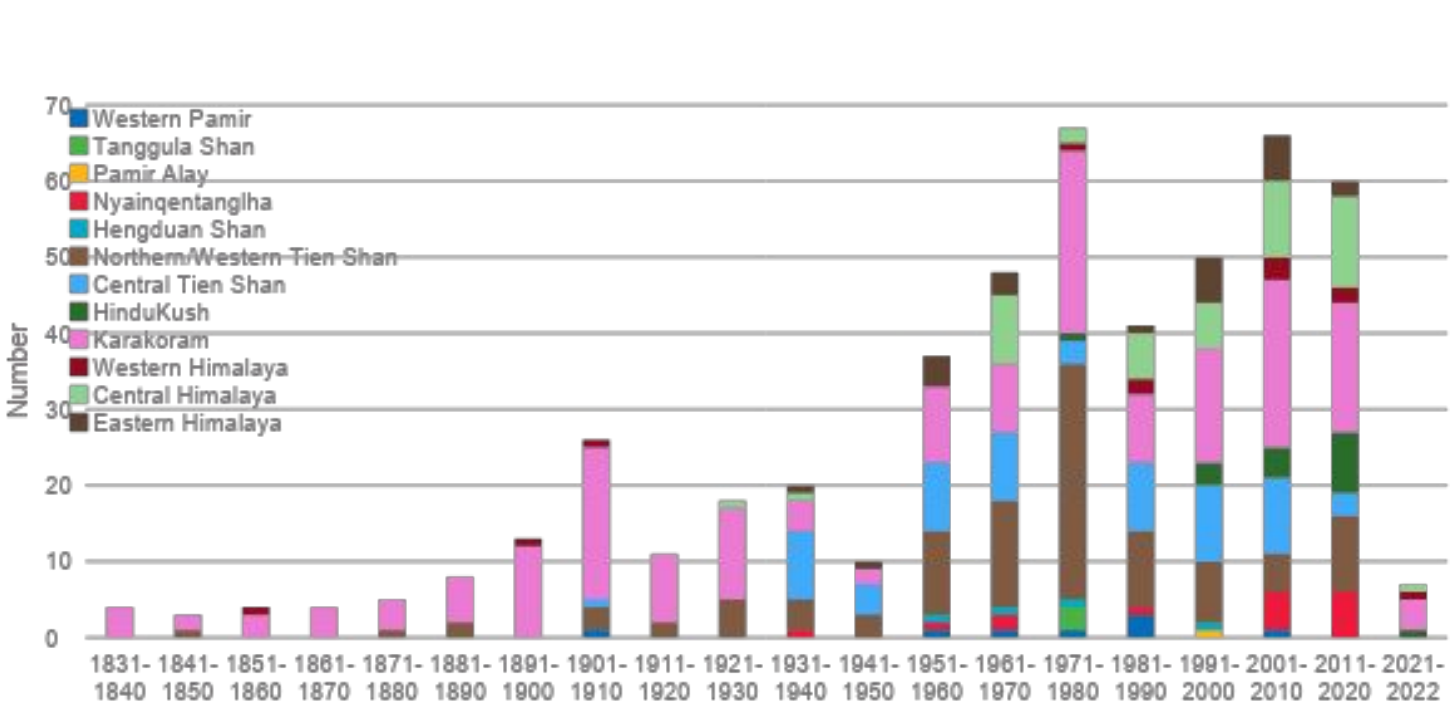
Lower Barun 2021, Sharad Joshi

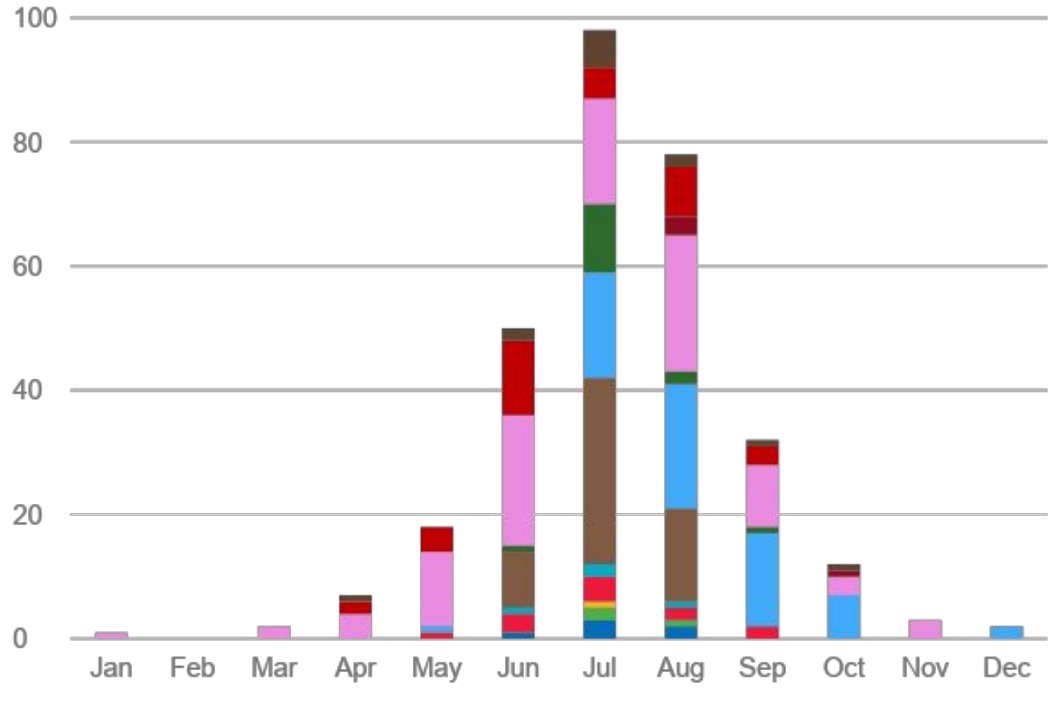
682 GLOFs recorded between 1833 (with 4 historic events before that date) and 2022 from 142 publications





GLOF distribution in HMA

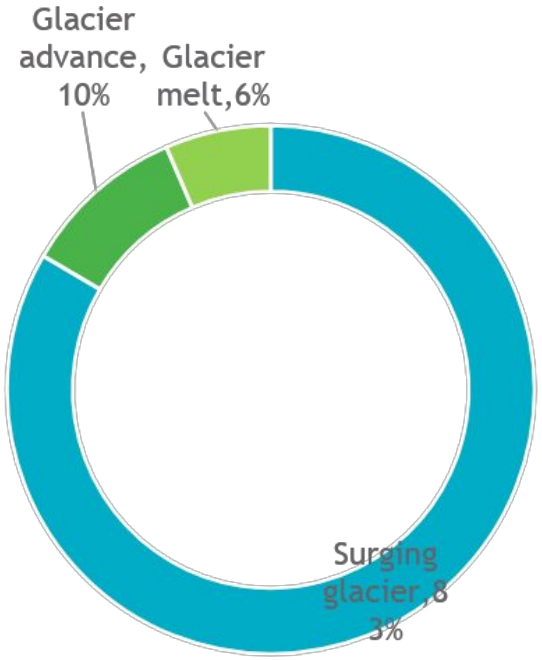




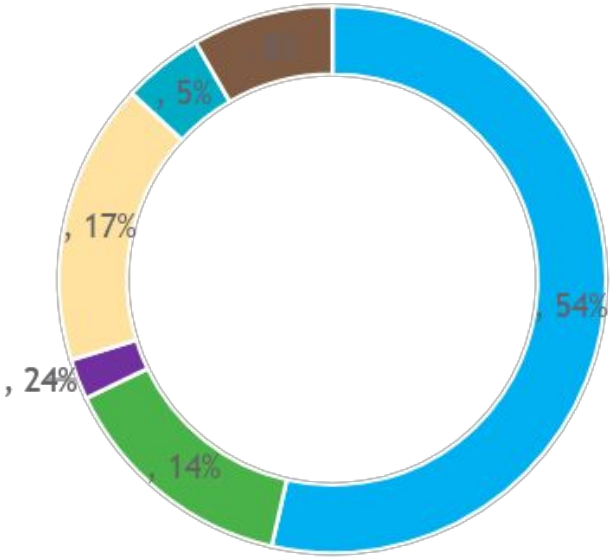
HMA lakes with five or more recurring GLOFs

Lake/Glacier name	Lat (°)	Lon (°)	Elev (m a.s.l.)	Region	Outburst recurrence	Period of GLOFs	Lake type
Merzbacher/ Southern Invlshek	42.20	79.85	3271	Central Tien Shan	67	1902 - 2015	Ice dammed
Khurdopin/Khurdopin	36.34	75.47	3482	Karakoram	37	1882 - 2021	Ice dammed
Kyagar/Kyagar	35.68	77.19	4880	Karakoram	34	1880 -2019	Ice dammed
Unnamed/Aksay	42.53	74.54	3637	Northern/Western Tien Shan	30	1877 - 2015	Moraine dammed
Unnamed/Kuturgansuu	42.52	74.61	3470	Northern/Western Tien Shan	17	1846 - 2010	Moraine dammed
Unnamed/Chong Kumden	35.17	77.70	4691	Karakoram	14	1533 - 1934	Ice dammed
Unnamed/Hassanabad/Shisper	36.39	74.51	3370	Karakoram	13	1894 - 2022	Ice dammed
Unnamed/Karambar	36.62	74.08	2935	Karakoram	11	1844 - 1994	Ice dammed
Ghulkin/Ghulkin	36.42	74.88	2692	Karakoram	8	1980 - 2009	Supraglacial
Lake number 6/ Glacier No 182/Bezymyannyj/TEU-Severny	43.14	77.28	3380	Northern/Western Tien Shan	8	1973 - 2014	Supraglacial
Unknown/Teztor	42.54	74.43	3606	Northern/Western Tien Shan	11	1910 - 2012	Moraine dammed
Unnamed/Halji	30.27	81.48	5347	Central Himalaya	6	2004 - 2011	Supraglacial
Unnamed/Salyk	42.52	74.72	3390	Northern/Western Tien Shan	6	1938 - 1980	Moraine dammed
Unnamed/Topkaragay	42.49	74.52	3680	Northern/Western Tien Shan	6	1928 - 1993	Moraine dammed
Unnamed/Central Rimo	35.42	77.61	5100	Karakoram	5	1976 - 2014	Ice dammed
Unnamed/Batura	36.51	74.85	2713	Karakoram	5	1873 - 1974	Supraglacial
Unnamed/North Terong	35.25	77.31	4400	Karakoram	5	1975 - 2002	Ice dammed

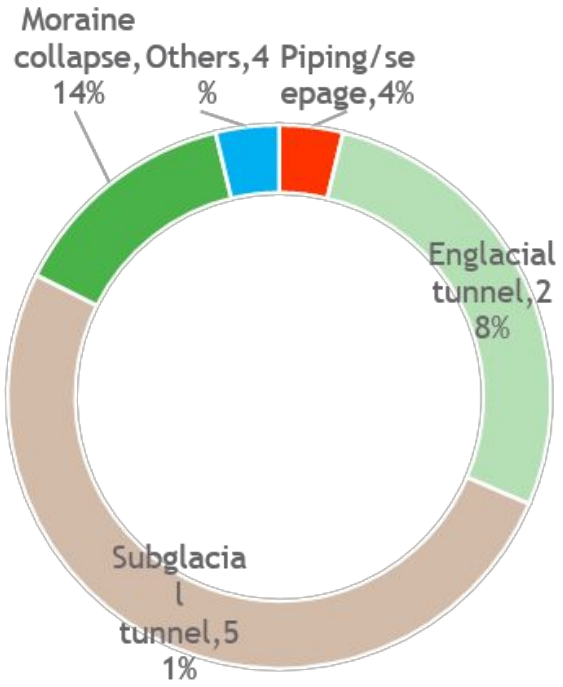
Drivers and mechanisms of GLOFs



Drivers for lake formation

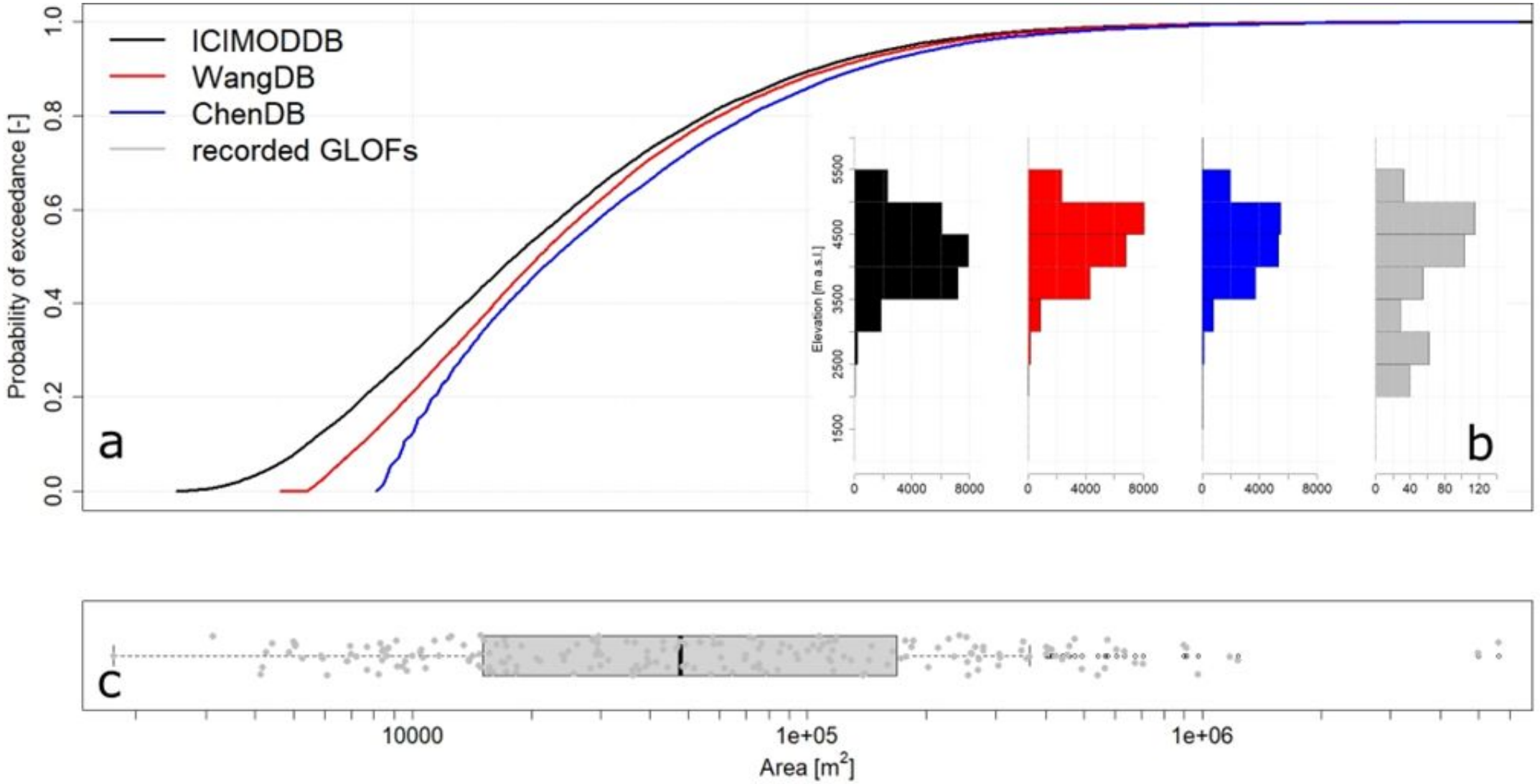


Drivers for the GLOF

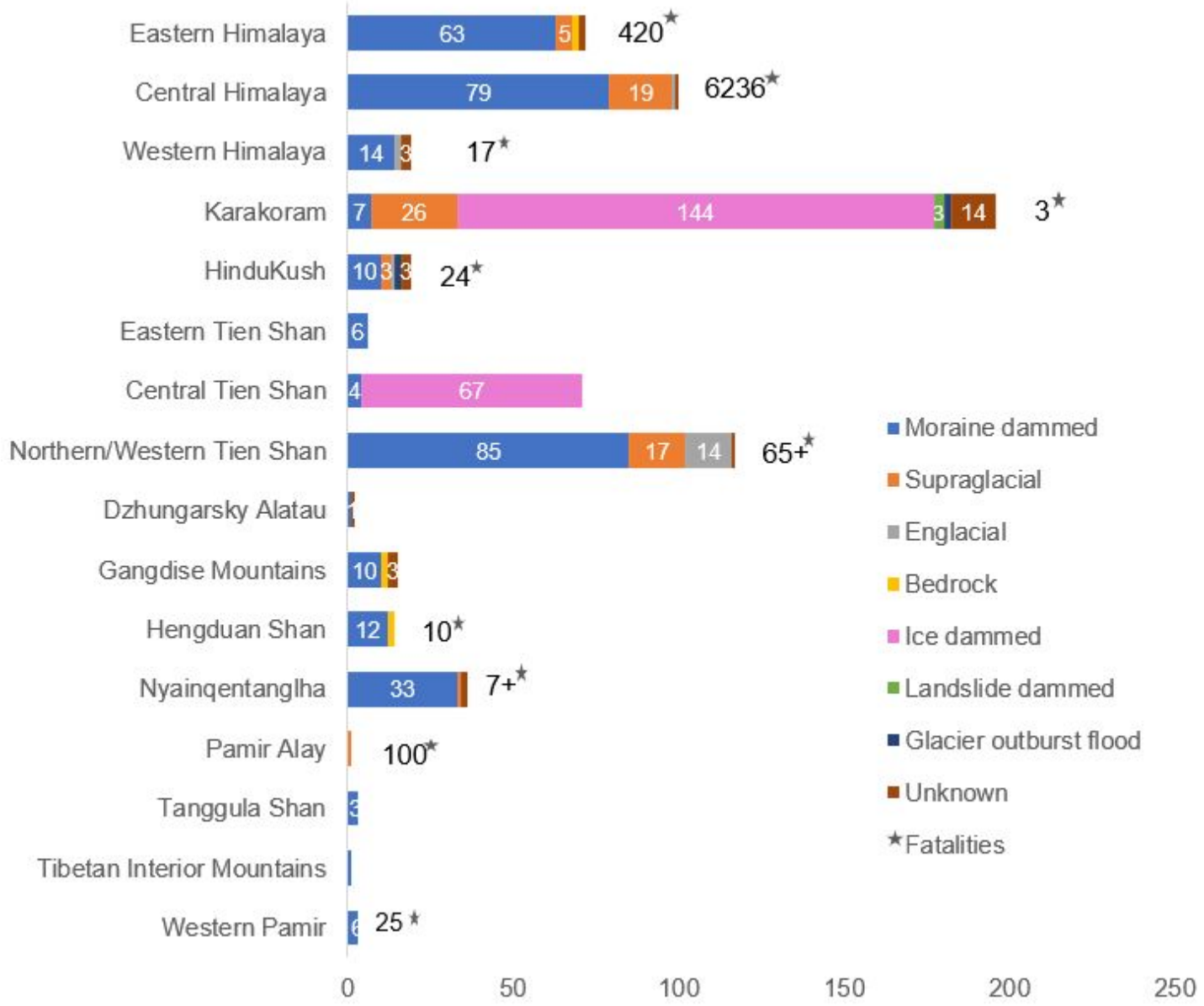


Mechanism for GLOF

Lake database comparison



GLOFs in the region



Socioeconomic impacts from GLOFs

- Settlements, agricultural lands, bridges, roads, trekking trails, hydropower, human lives
- A total of 6907+ fatalities were recorded in the HMA since 1954

Total recorded GLOFs in all affected countries of the HMA as well as recorded fatalities and economic damage

Country	Total GLOFs	Moraine dammed	Ice dammed	Total fatalities	Total economic damages [USD]
Afghanistan	4	3	0	15	NA
Bhutan	20	15	0	20	14,600
China	201	150	38	617+	89 million
India	59	25	30	6017	5100 million
Kazakhstan	34	15	0	62+	NA
Kyrgyzstan	153	71	0	103	0.1 million
Nepal	54	35	0	36	76.7 million
Pakistan	146	14	76	12	22.5 million
Tajikistan	11	6	0	25	NA
Total for HMA	**682**	**334**	**144**	**6907+**	**5.3 billion**

ICIMOD RDS

Regional Database System

Search

Advanced Search

GLOF database of High Mountain Asia

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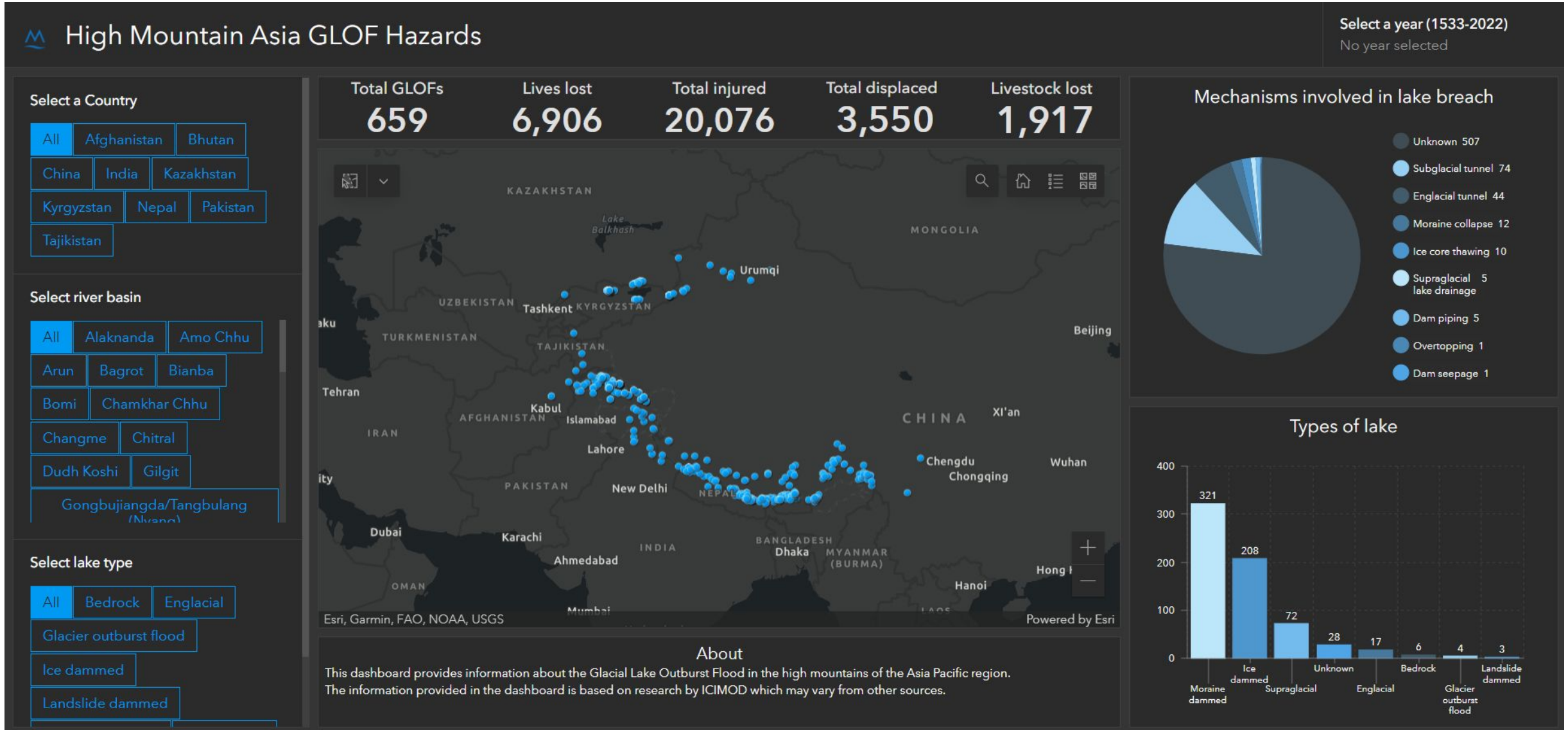
Glacier lake outburst floods (GLOFs) have been intensely investigated in high mountain Asia (HMA) in recent years and are often the first hazard related to the cryosphere mentioned in the region. As glaciers are receding and surrounding slopes become increasingly unstable such events are expected to increase, although so far, no evidence exists for the same. Many studies have investigated individual events and some regional inventories exist however they either do not cover all types of GLOF, do not cover the entirety of the region and none generally discuss downstream impacts. Previous inventories also do not rely on non-academic sources and are not combined with already existing inventories of glaciers and lakes. In this study we present a first comprehensive inventory of GLOFs in HMA, including the time of their occurrence, processes of lake formation and drainage involved as well as downstream impacts. We find 660 individual GLOFs that occurred between 1833 (with 4 historic events before that date) and 2022, 20% of which occurred from repeated events at just three ephemeral ice dammed lakes. All events resulted in 6907 fatalities, of which 6000 were caused by just one event that included a number of other drivers of the eventual flood. The combination of the database with previous inventories of glaciers and lakes allows future assessments of potential drivers of GLOFs, allowing more robust future projections of their evolution. The presented database and its future updated versions are traceable, version controlled and can be directly incorporated into further analysis.

http://rds.icimod.org/Home/DataDetail?metadataId=1973283

GLOF Hazard dashboard



Conclusion

- GLOFs are frequent, but regional variations are large

- 682 GLOFs were documented between 1833 and 2022
  29% Karakoram
  17% Northern/Western Tien Shan
  15% Central Himalaya
  11% Eastern Himalaya

- 88% of the events were documented from scientific sources, while remaining were other sources

- A total of 6907+ fatalities were recorded in the HMA since 1954, with observed economic damages of 5.3 billion USD

- Database will be freely accessible in the future through ICIMOD RDS as well as on GitHub as a version-controlled database

Acknowledgments

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Confederazione Svizzera
Confederaziun svizra

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Education Network

Thank you