2025
International
Year of Glaciers'
Preservation

Launch of IYGP 2025 – SIDE EVENT #35

Decades of Cryosphere Actions in ICIMOD: From a Geopolitically Sensitive Subject to a Flagship Initiative

21 January 2025
07:00 – 08:30 UTC, and local time
Online | Kathmandu, Nepal

https://www.un-glaciers.org/

WMO

unesco

2025 International Year of Glaciers' Preservation

WMO

unesco

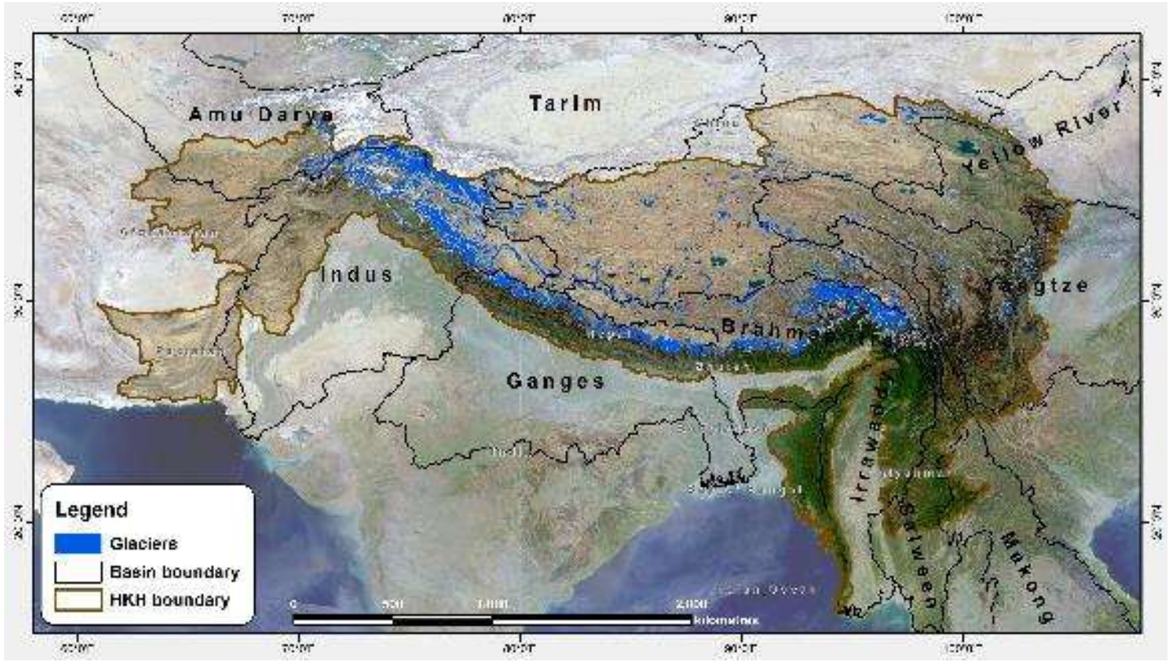
https://www.un-glaciers.org/

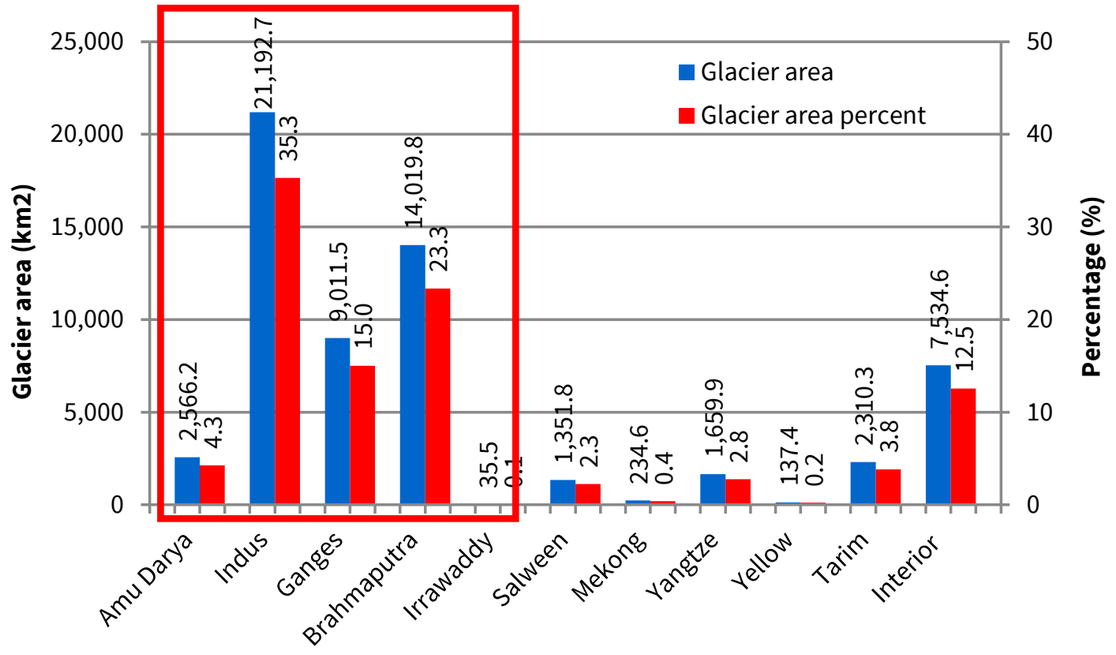
Decades of Study on Glaciers and Glacial Lakes in the HKH Region

Sudan Bikash Maharjan

ICIMOD

The Hindu Kush Himalaya Region (Water Tower of Asia)





HKH area: 4.19 million km^2

- **~9% of glaciers in globe**
- **240 million people** depend directly on HKH for their lives and livelihood
- **1.95 billion people depend** on the HKH for water, Food and Energy
- **>35% of world population** benefits indirectly from HKH resources and ecosystem

- It is the source of countless perennial rivers that originate from glaciers.
- It is also the source of various natural disasters such as snow/ice avalanche, glacial lake outburst floods (GLOF), Landslides/debris flows.

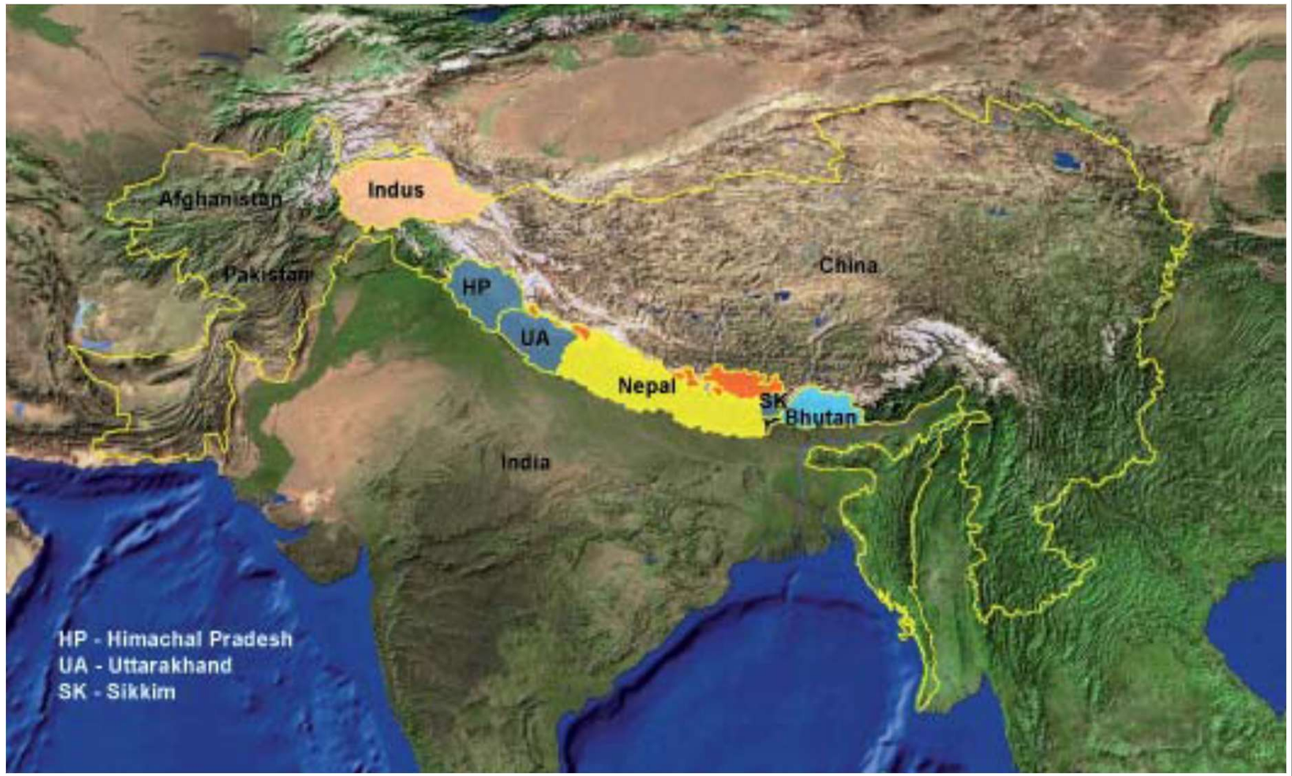
https://www.un-glaciers.org/

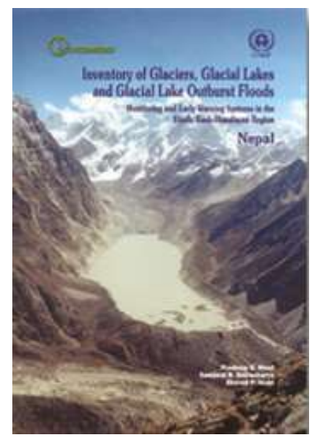
During 1999 – 2004: Inventorying of glaciers and glacial lakes

First homogeneous compilation of Glaciers data of HKH region was carried out by ICIMOD

- ✓ Area coverage: Bhutan, Nepal, Pakistan, China (Koshi basin), Sikkim, Himachal Pradesh and Uttaranchal Pradesh, India
- ✓ Data Source : Topographic maps of 1963 to 1982 and Satellite images of 2000
- ✓ Methodology : Visual Interpretation and Manual digitization
- ✓ 15003 glaciers covering area of 33344 km^2
- ✓ 8,790 glacial lakes, of which 203 were identified as potentially dangerous

https://lib.icimod.org/record/7511
https://lib.icimod.org/record/21962

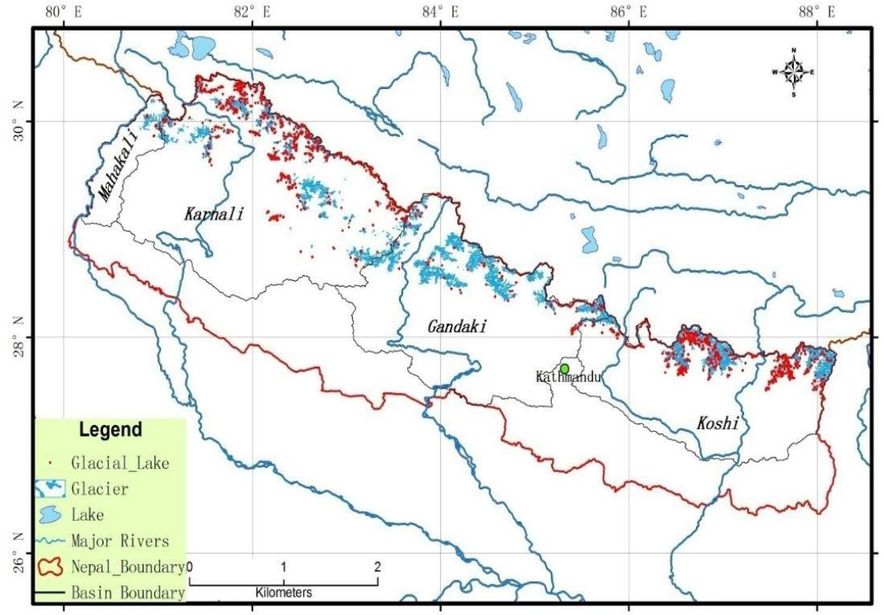


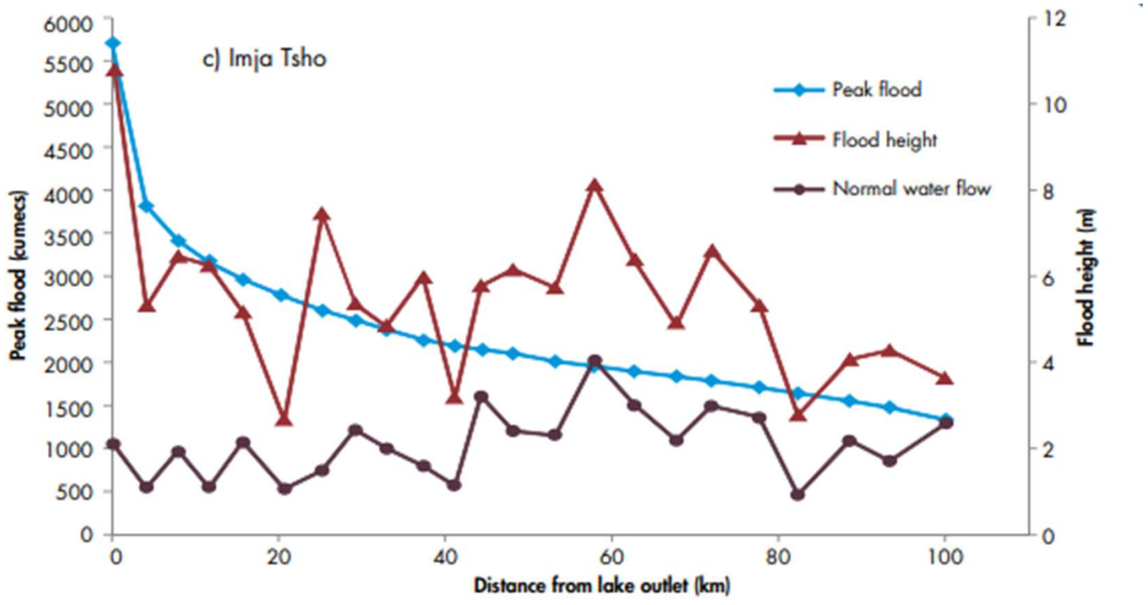


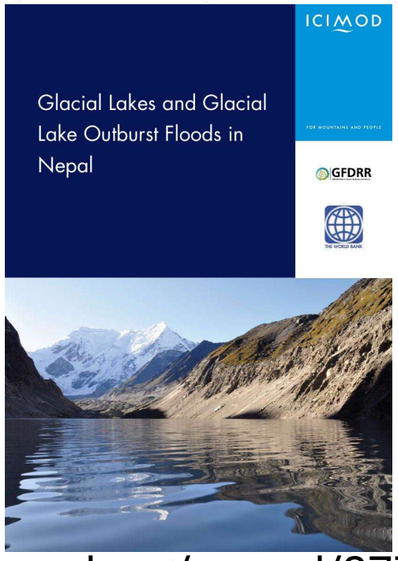
https://www.un-glaciers.org/

During 2009 – 2010: Glacial lakes hazard and risk assessment in Nepal

- ✓ Data Source: Landsat ETM+ images of 2005±1
- ✓ 1,466 glacial lakes covering an area of 64.75 km^2.
- ✓ **21 lakes were identified as critical (potentially dangerous)** ones with 6 lakes defined as high priority lakes





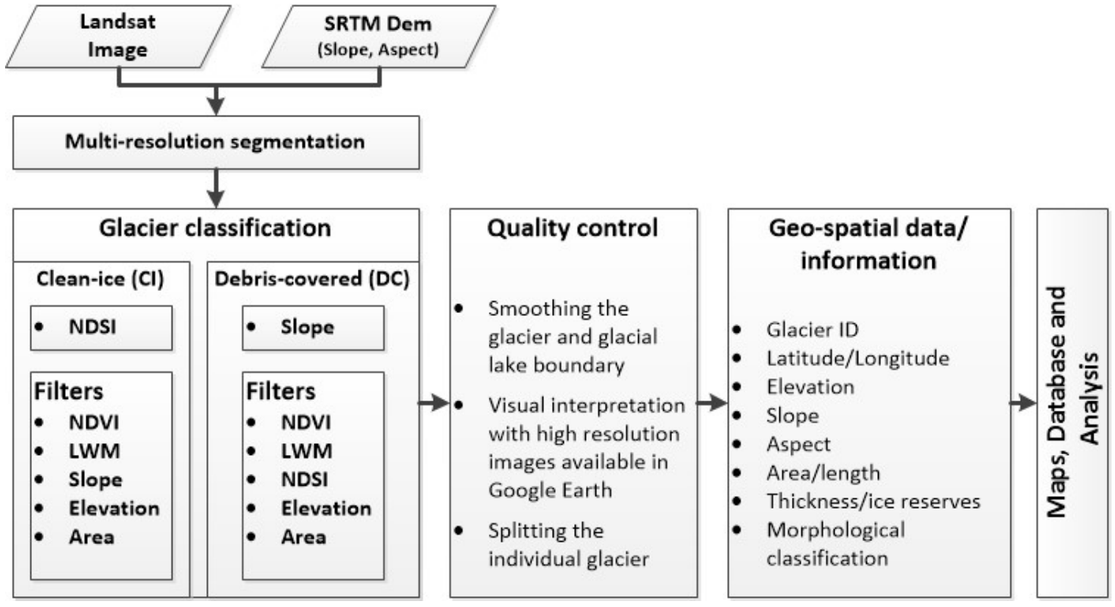


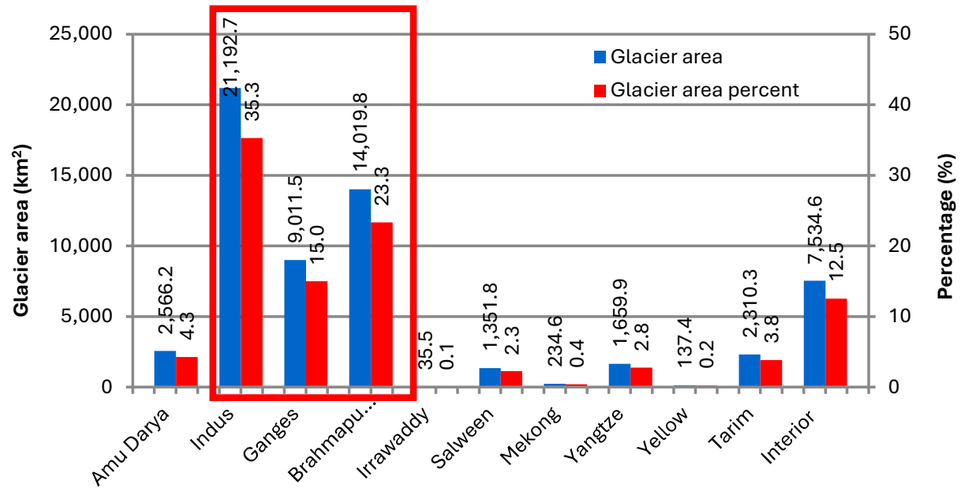
https://lib.icimod.org/record/27755

https://www.un-glaciers.org/

During 2010 – 2011: Status of glaciers in the HKH Region.

Semi-automatic – Object-based image classification

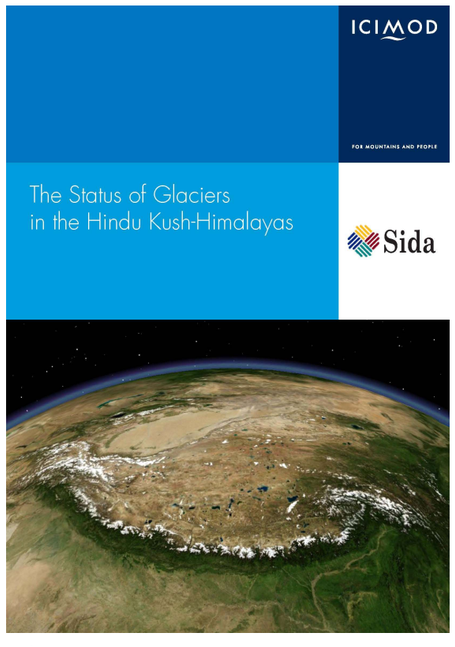




Data Source - Landsat ETM+ images of 2005±3 years

Mapping scale – 1:50,000

Area threshold : 0.02 km²



Glacier cover in HKH: 1.4%

Total glacier: 54,252

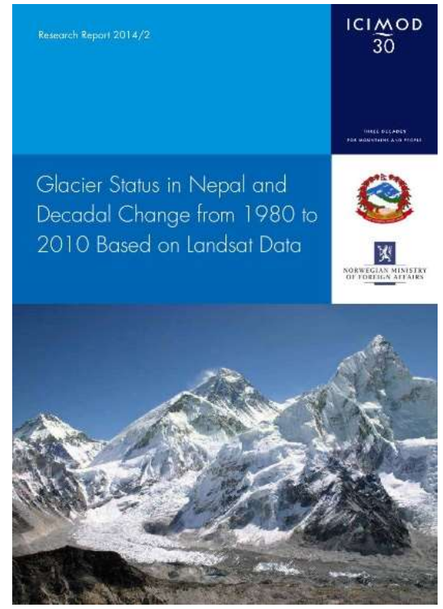
Total glacier area: 60,054 km²

https://lib.icimod.org/record/9419

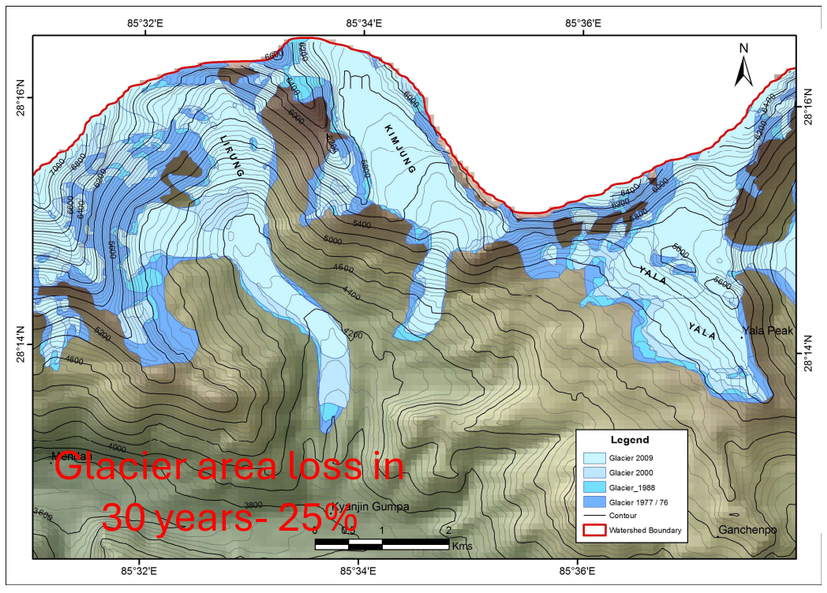
https://www.un-glaciers.org/

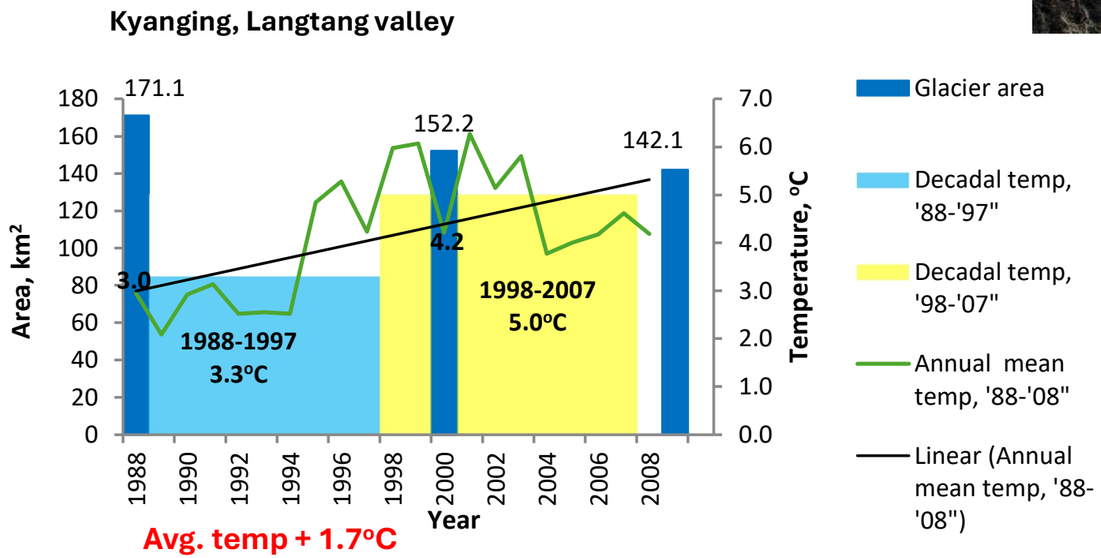
During 2012 – 2014: Decadal Change of Glaciers in Nepal (1980 – 2010)

Glacier attribute	Decade (Year)				Decadal change							
	~1980	1990	2000	2010	~1980–1990		1990–2000		2000–2010		~1980–2010	
Number	3,430	3,656	3,765	3,808	226	7%	109	3%	43	1%	378	11%
Area (km^2)	5,168	4,506	4,211	3,902	-662	-13%	-295	-7%	-308	-7%	-1266	**-24%**
Estimated ice-reserves (km^3)	441	370	343	312	-72	-16%	-27	-7%	-31	-9%	-129	-29%



Langtang Valley





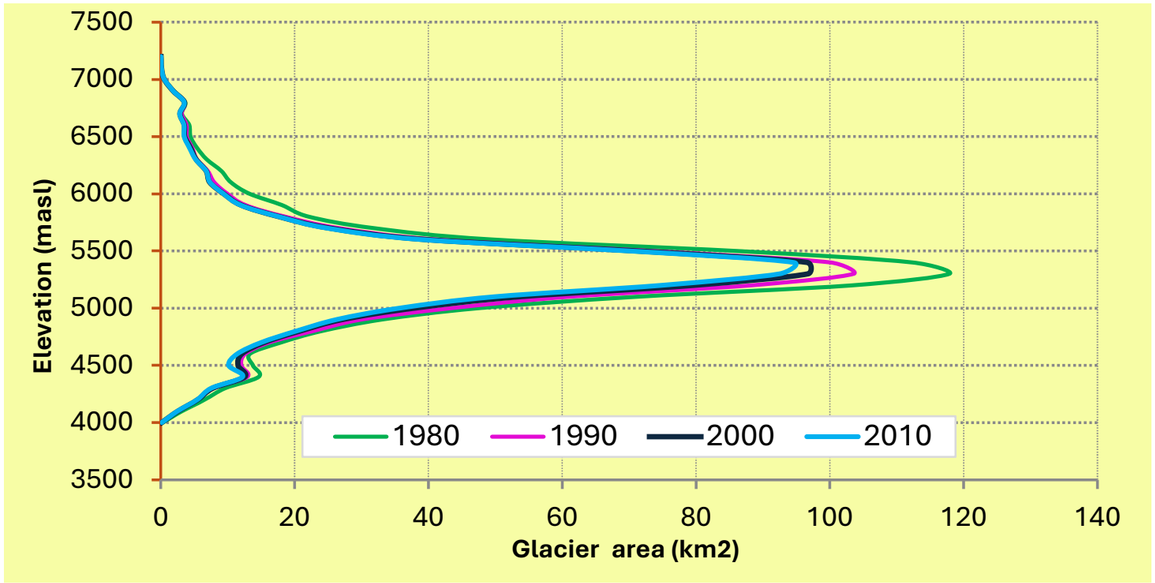
Avg. temp + 1.7°C
Area Loss -17%

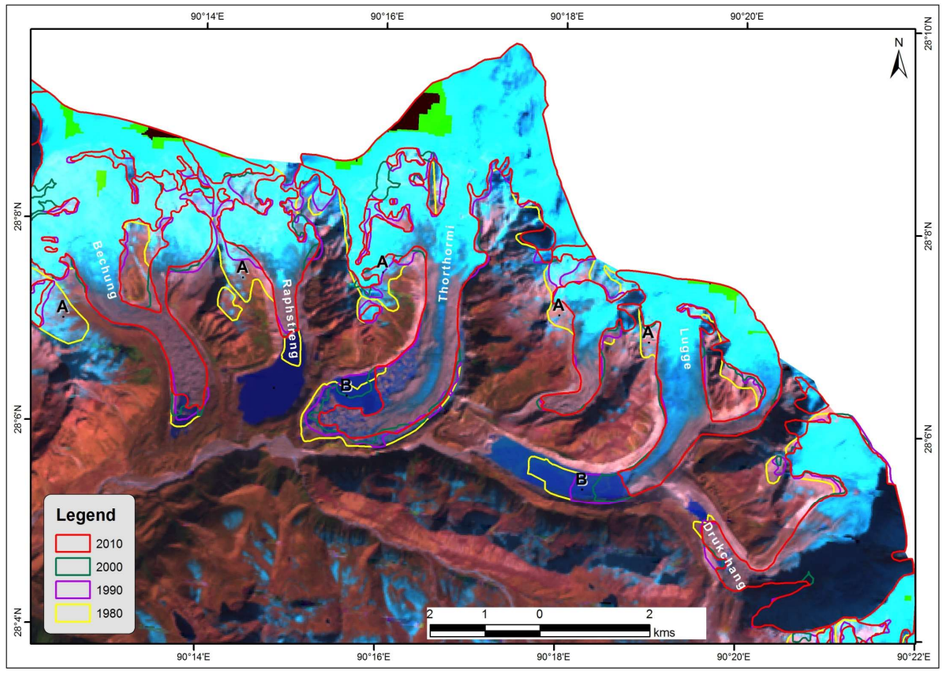
https://www.un-glaciers.org/

https://lib.icimod.org/record/29591

During 2012 – 2014: Decadal Change of Glaciers in Bhutan (1980 – 2010)

Years	Glacier Area (km^2)			Change in Glacier Area (%)		
	Clean-ice	Debris-covered	Total	Clean-ice	Debris-covered	Total
1980	757.4 ± 26.05	80.2 ± 1.61	837.6 ± 28.81			
1990	654.6 ± 14.74	86.2 ± 0.96	740.7 ± 16.67	-13.6 ± 1.2	7.5 ± 0.9	-11.6 ± 1.2
2000	598.2 ± 14.3	90 ± 0.79	688.2 ± 16.45	-8.6 ± 0.1	4.4 ± 0.2	-7.1 ± 0.1
2010	550.7 ± 13.83	91.4 ± 0.71	642.1 ± 16.12	-7.9 ± 0.1	1.6 ± 0.1	-6.7 ± 0.1
1980-2010				**-27.3 ± 0.9**	**14 ± 1.2**	**-23.3 ± 0.9**





https://lib.icimod.org/record/29316

Annals of Glaciology 55(66) 2014 doi: 10.3189/2014AoG66A125 159

The status and decadal change of glaciers in Bhutan from the 1980s to 2010 based on satellite data

Samjwal Ratna BAJRACHARYA, Sudan Bikash MAHARJAN, Finu SHRESTHA

International Centre for Integrated Mountain Development (ICIMOD), Kathmandu, Nepal
E-mail: sabajracharya@icimod.org

ABSTRACT. In order to monitor changes in the glaciers in the Bhutan Himalaya, a repeat decadal glacier inventory was carried out from Landsat images of 1977/78 (~1980), 1990, 2000 and 2010. The base map of glaciers was obtained by the object-based image classification method using the multispectral Landsat images of 2010. This method is used separately to delineate clean-ice and debris-covered glaciers with some manual editing. Glacier polygons of 2000, 1990 and ~1980 were obtained by manual editing on 2010 by separately overlaying respective years. The 2010 inventory shows 885 glaciers with a total area of ~642 ± 16.1 km^2. The glacier area is 1.6% of the total land cover in Bhutan. The result of a repeat inventory shows 23.3 ± 0.9% glacial area loss between ~1980 and 2010, with the highest loss (11.6 ± 1.2%) between ~1980 and 1990 and the lowest (6.7 ± 0.1%) between 2000 and 2010. The trend of glacier area change from the 1980s to 2010 is –6.4 ± 1.6%. Loss of glacier area was mostly observed below 5600 m a.s.l. and was greater for clean-ice glaciers. The equilibrium-line altitude has shifted upward from 5170 ± 110 m a.s.l. to 5350 ± 150 m a.s.l. in the years ~1980–2010.

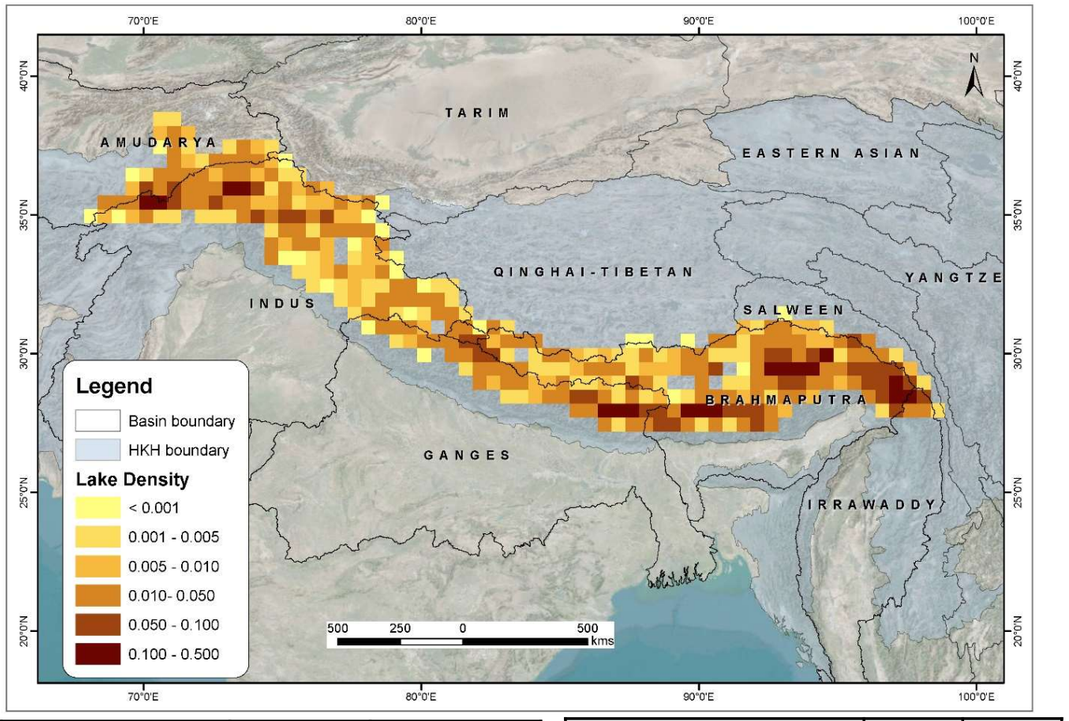
KEYWORDS: glacier mapping, mountain glaciers, remote sensing

Annals of Glaciology , Volume 55 , Issue 66 , 2014 , pp. 159 - 166
DOI: https://doi.org/10.3189/2014AoG66A125

https://www.un-glaciers.org/

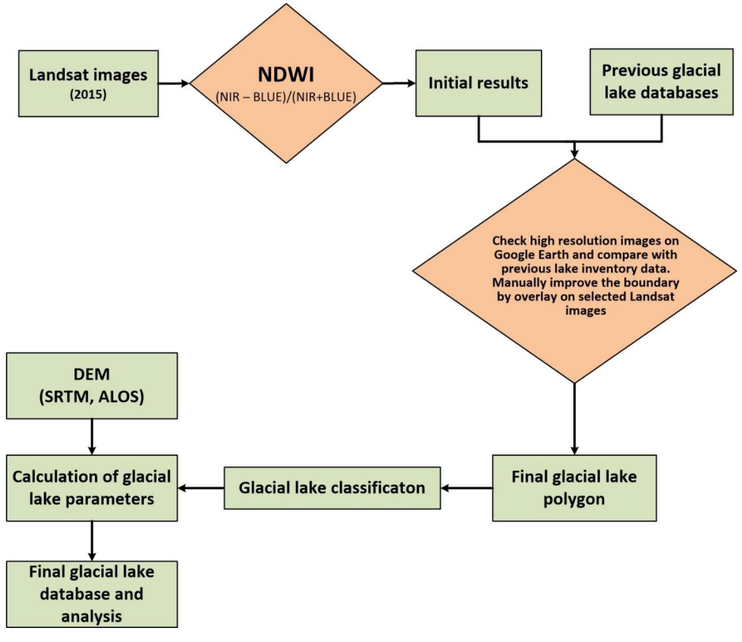
During 2016 – 2018: Status of Glacier Lakes in the HKH Region

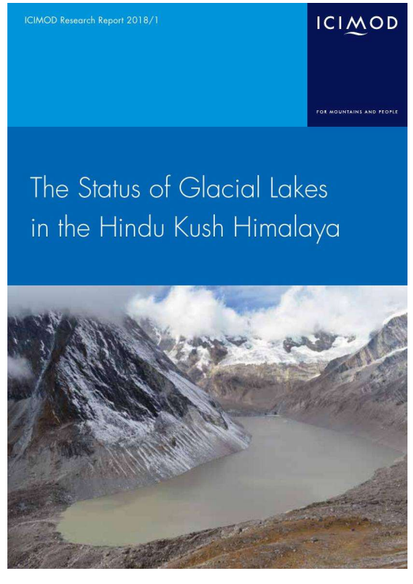
- Water bodies in front of and on or beside a glacier or in the lowland formed by paleo-glaciation are the object of glacial lake inventory.
- Fill gaps in HKH region
- Narrower temporal base (2005 ± 2)
- Single source of data (Landsat TM/ETM+)
- Good data quality for glacial lake change detection
- Lake size greater than 0.003 km^2 were mapped.
- Regional data integration
- Consistent classification schemes of glacial lakes



Basins	Number	Area (km²)
Amu Darya	1,474	66.10
Indus	5,689	260.54
Ganga	4,082	208.59
Brahmaputra	13,642	883.55
Irrawaddy	525	16.15
Mansarover	202	9.27
Total	**25,614**	**1,444.2**

Type		Number	Area
Moraine-dammed lake (M)	M(e)	2,636	314.47
	M(l)	290	21.85
	M(o)	5,378	134.06
Ice-dammed lake (I)	I(s)	1,253	12.75
	I(v)	27	0.8
Bedrock dammed lake (B)	B(c)	2,842	239.32
	B(o)	12,392	521.06
Others (O)	O	811	199.89
	Total	**25,614**	**1,444.2**





https://lib.icimod.org/record/33736

https://www.un-glaciers.org/

During 2018 – 2020: Potentially Dangerous Glacial lakes in Koshi, Gandaki and Karnali River Basins

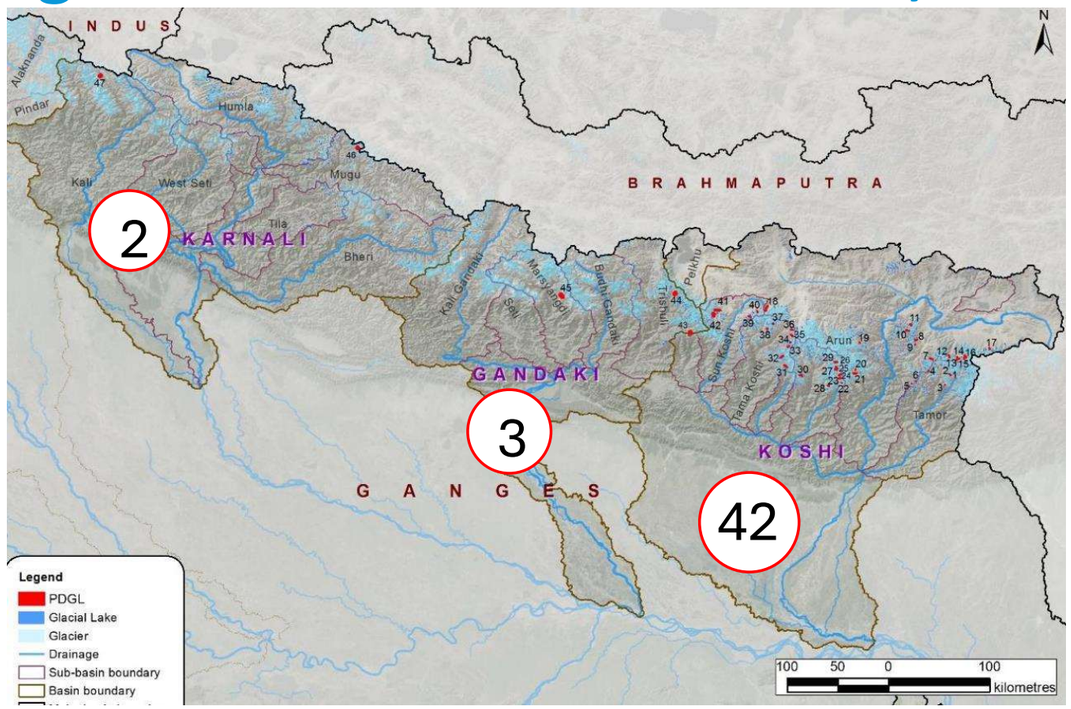
Step by step categorization using 22 various factors:

Level 1: Lake characteristics

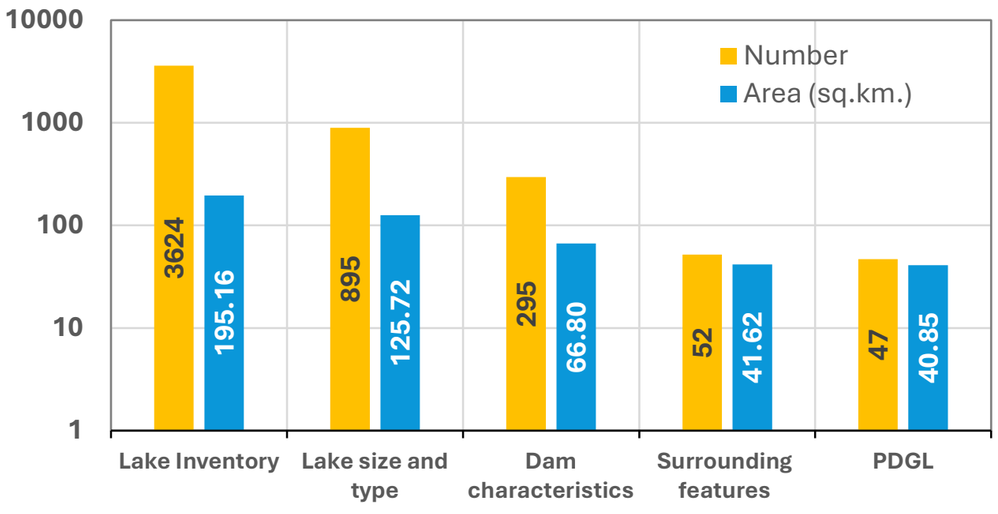
Level 2: Dam characteristics

Level 3: Characteristics of source glaciers

Level 4 : Physical condition of surroundings



https://lib.icimod.org/record/34905



Basin	Rank I	Rank II	Rank III	Total
Koshi	28	10	4	42
Gandaki	2	1	x	3
Karnali	1	1	x	2
Total	31	12	4	47

Country	Rank I	Rank II	Rank III	Total
Nepal	15	3	3	21
TAR, China	15	9	1	25
India	1	x	x	1
Total	31	12	4	47

RESEARCH REPORT

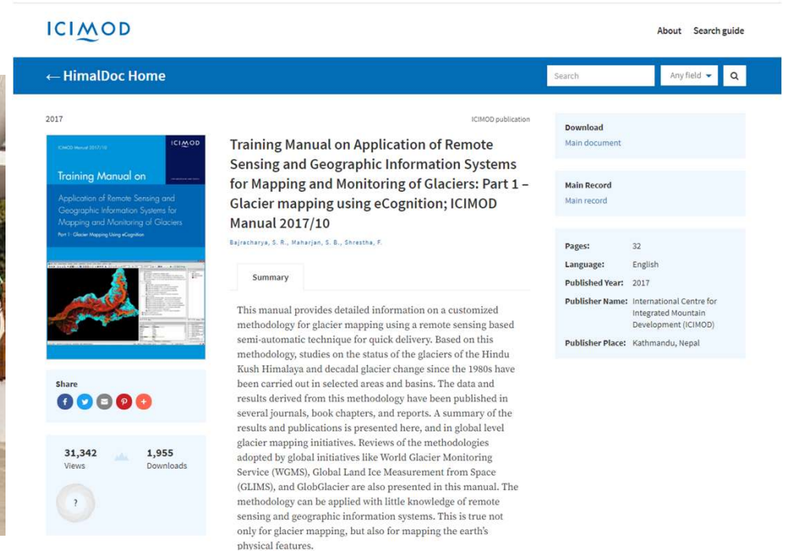
Inventory of glacial lakes and identification of potentially dangerous glacial lakes in the Koshi, Gandaki, and Karnali river basins of Nepal, the Tibet Autonomous Region of China, and India

ICIMOD

Trainings and on-the-job trainings

- Afghanistan
- Nepal
- Bhutan
- Pakistan
- Myanmar

https://lib.icimod.org/record/33680

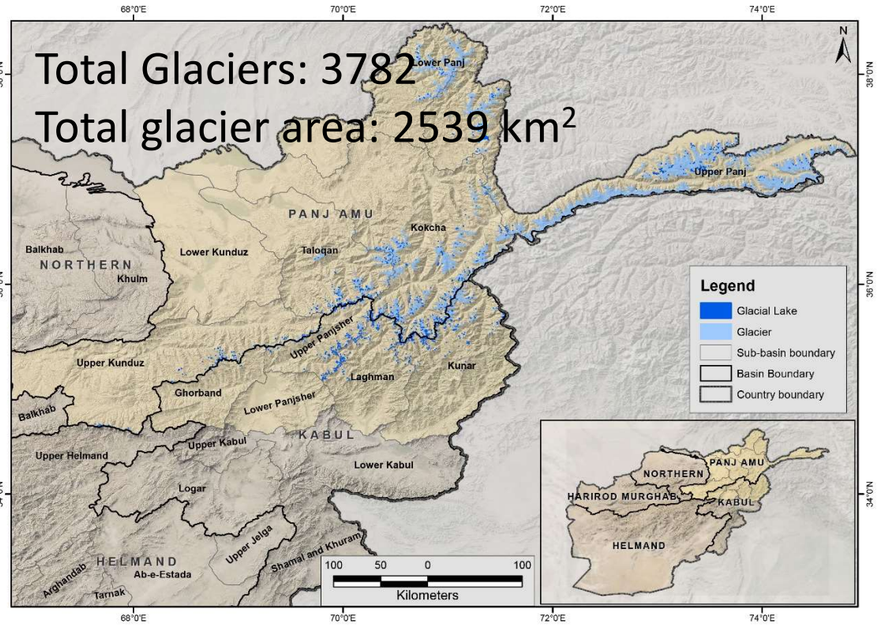


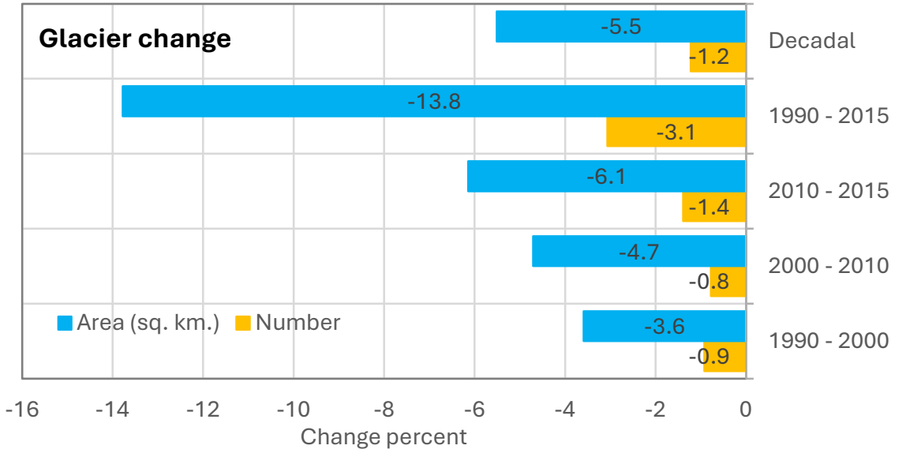
https://lib.icimod.org/record/33681

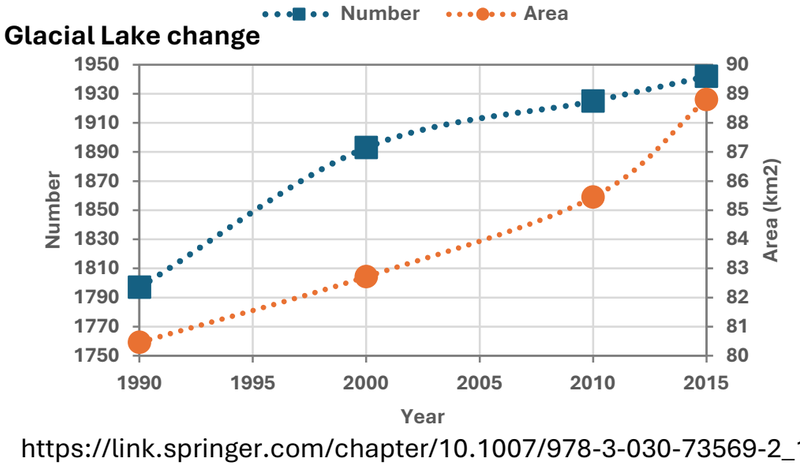
https://www.un-glaciers.org/

During 2018 – 2020: Decadal Change of glaciers in Glaciers and Glacial Lakes in Afghanistan (1990 – 2015)

https://lib.icimod.org/record/35341







https://link.springer.com/chapter/10.1007/978-3-030-73569-2_11

https://www.un-glaciers.org/

RESEARCH REPORT

Glaciers in Afghanistan

Status and changes from 1990 to 2015

ICIMOD

Chapter 11

Monitoring of Glaciers and Glacial Lakes in Afghanistan

Sudan Bikash Maharjan, Finu Shrestha, Fayezurahman Azizi, Esmatullah Joya, Birendra Bajracharya, Mohammad Tayib Bromand, and Mohammad Murtaza Rahimi

11.1 Introduction

During the needs assessment in Afghanistan, the General Directorate of Water Resources (GDWR) of the National Water Affairs Regulation Authority (NWARA) (previously Water Resource Department (WRD) of the Ministry of Energy and Water (MEW)) emphasized that the compilation of comprehensive data on the glaciers in the country is a national priority.

Glaciers are of paramount importance in arid and semi-arid places like Afghanistan and serve as sources of freshwater for a large proportion of its population. Globally, the considerable evidence on retreat and shrinkage of glaciers, and the formation and expansion of glacial lakes have become a hot topic for researchers, scientists, and policymakers. The clear evidence of glacial retreat in Afghanistan, as found by ICIMOD's studies, poses a serious threat to the country's water security.

Worldwide, most glaciers have undergone major retreat since the end of the Little Ice Age (Marshall 2014; Zemp et al. 2014). This retreat was first noticed in the 1960s (Grotzbach 1964; Gilbert et al. 1969; Braslau 1972), and it accelerated in the last three decades (Gardent et al. 2014; Bajracharya et al. 2014a, b; Mernild et al. 2013). The HKH region has the highest concentration of snow and glaciers outside the polar regions and they play a pivotal role in supplying water to 10 major river basins (Bajracharya and Shrestha 2011). Glacial changes are also a valuable indicator of climate change (Wester et al. 2019; Nie et al. 2017; Song et al. 2017; Bajracharya et al. 2014a). By the end of the twenty-first century, the global surface

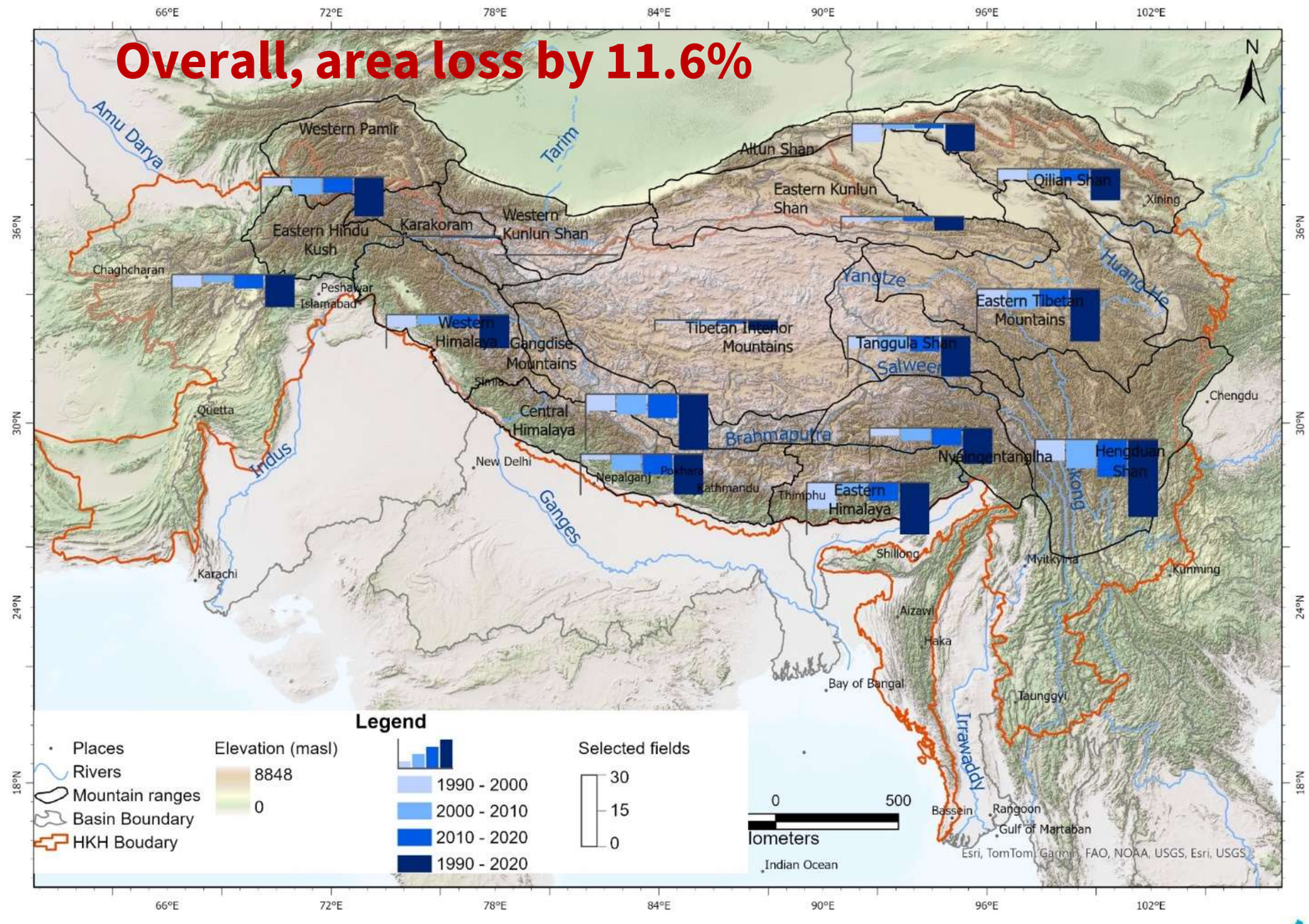
S. B. Maharjan (✉) · F. Shrestha · E. Joya · B. Bajracharya · M. M. Rahimi
International Centre for Integrated Mountain Development, Kathmandu, Nepal
e-mail: sudan.maharjan@icimod.org; bika@sudan@gmail.com

F. Azizi · M. T. Bromand
General Directorate of Water Resources, National Water Affairs Regulation Authority, Kabul, Afghanistan

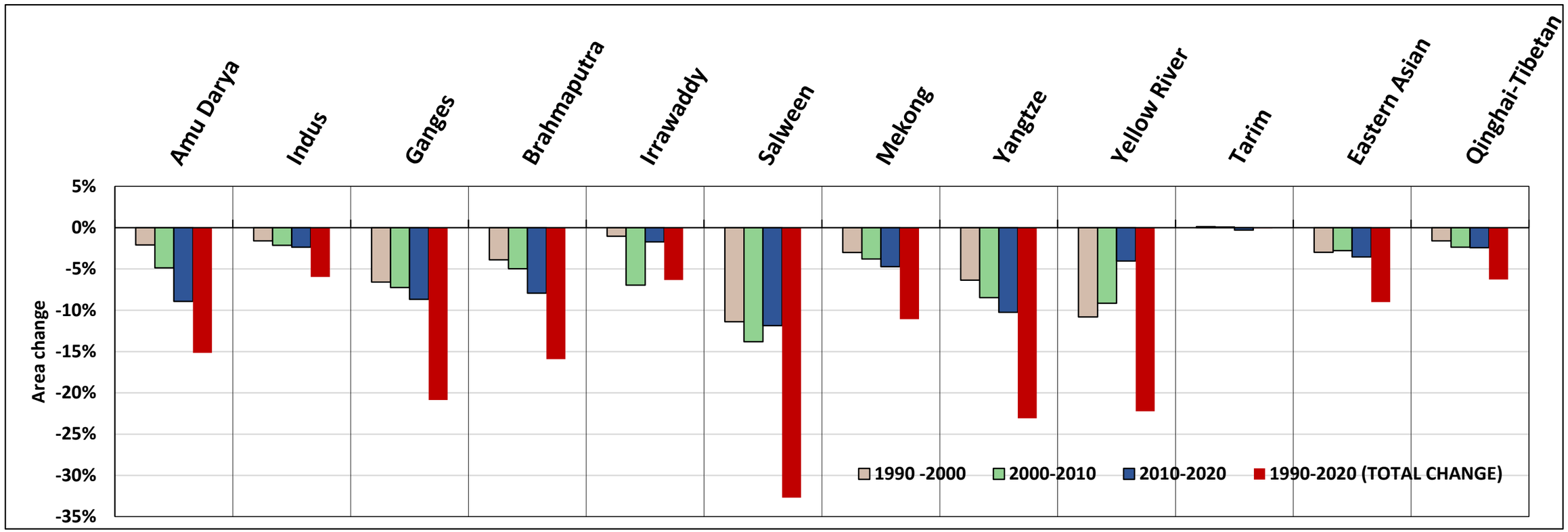
B. Bajracharya et al. (eds.), *Earth Observation Science and Applications for Risk Reduction and Enhanced Resilience in Hindu Kush Himalaya Region*,
https://doi.org/10.1007/978-3-030-73569-2_11

Decadal Changes of Glaciers in the HKH Region (1990 – 2020)

- Consistent data source – Landsat satellite images
- Spatial resolution – 30m
- Narrow Temporal resolution - ± one year
- Accuracy and Quality : checking with other inventories and high-resolution images
- Area Threshold: 0.02 km²
- Mapping Scale: 1:50000



Inter-Decadal Glacier Area Changes in Major River Basins (1990 – 2020)



The Ganges, Brahmaputra and Indus experienced the greatest loss of area.

Comparatively, recent decade has higher rate of shrinkage

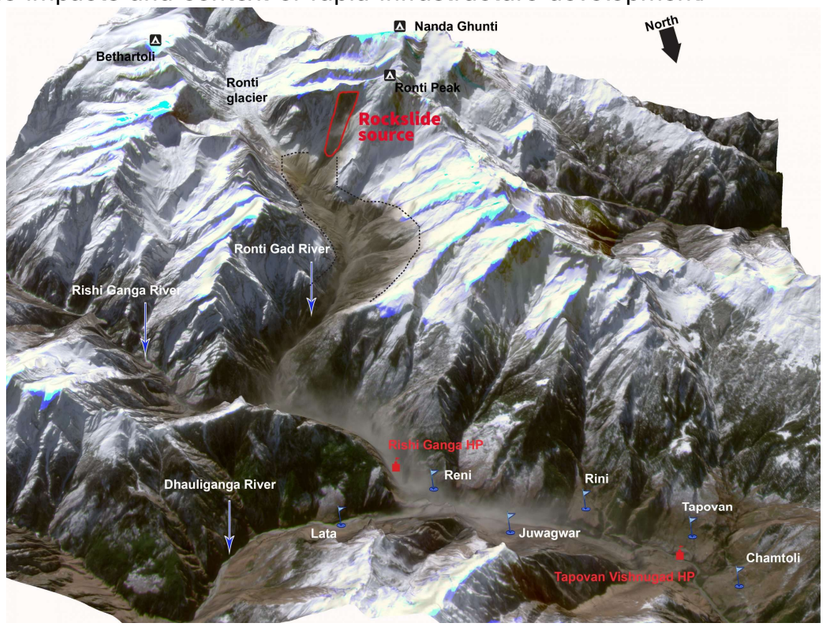
Consequences of Melting Glaciers

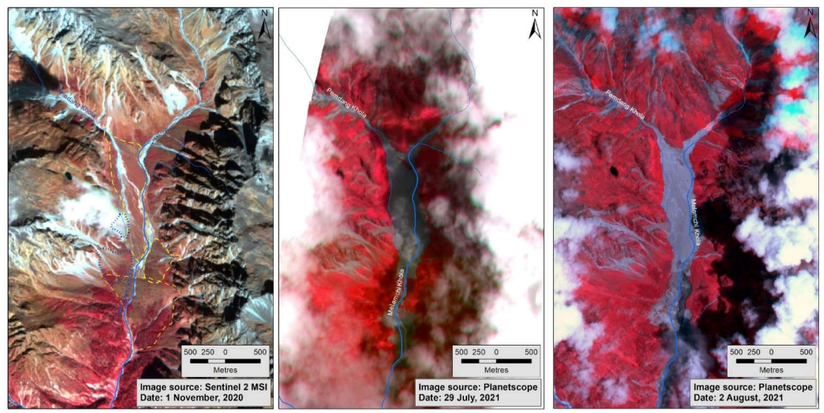
- Thame Flood, August 2024
- Ice Avalanche in Mustang, 2022
- Melamchi Flood Disaster, 2021 (10.53055/ICIMOD.981)
- Chamoli Flash Flood, Feb 2021
- GLOF in Panjshir Valley, Afghanistan, 2018
- Seti Flash Flood 2012

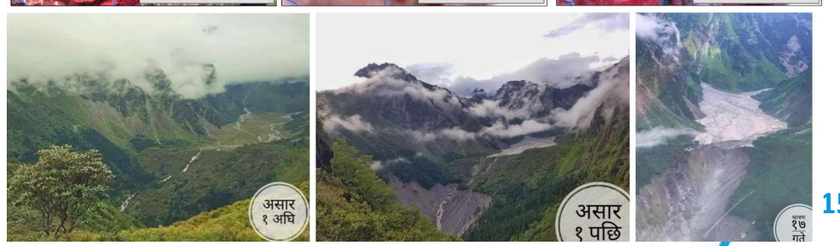
Disaster Responses

https://www.un-glaciers.org/

https://www.icimod.org/article/understanding-the-chamoli-flood-cause-process-impacts-and-context-of-rapid-infrastructure-development/

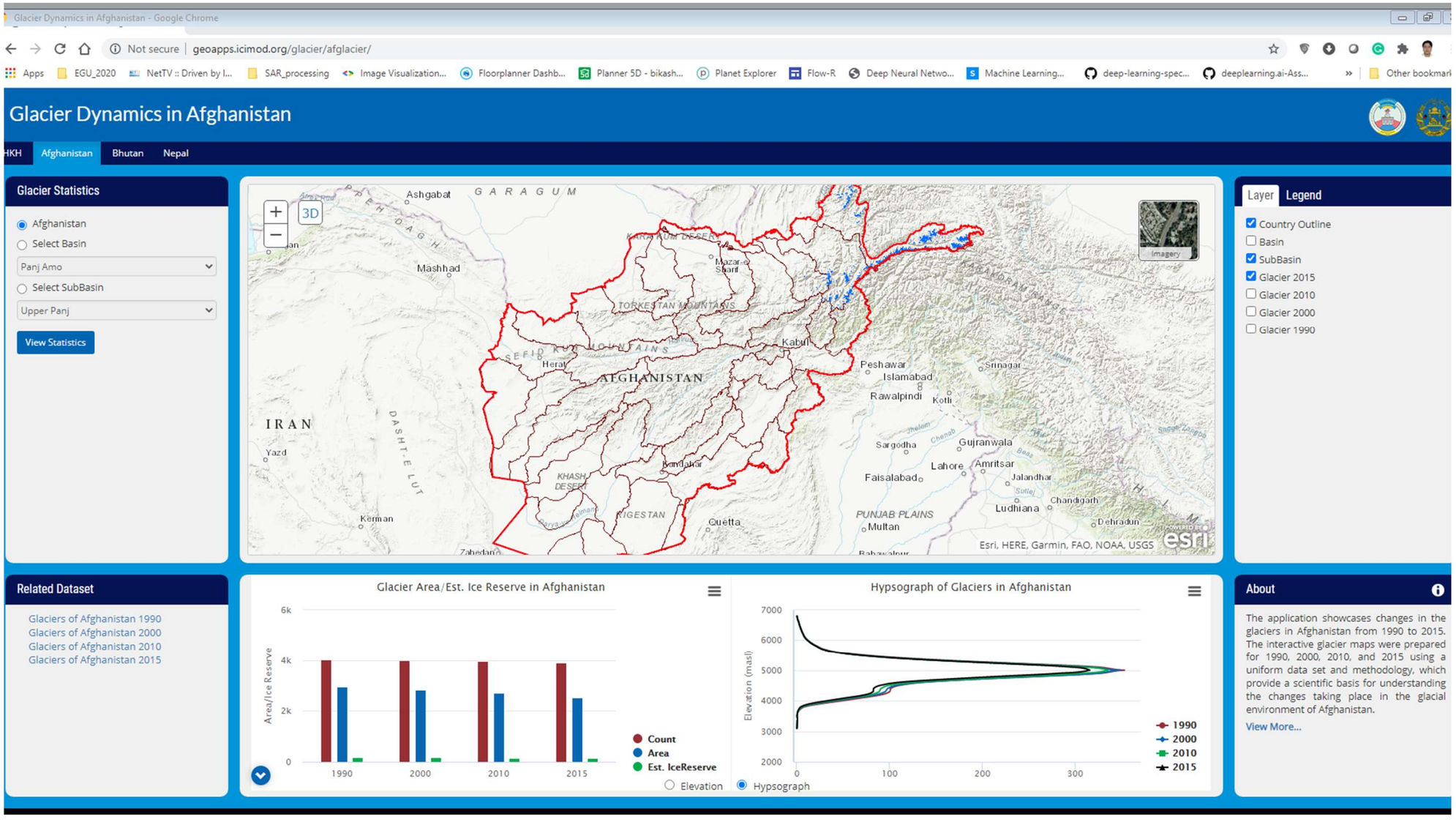




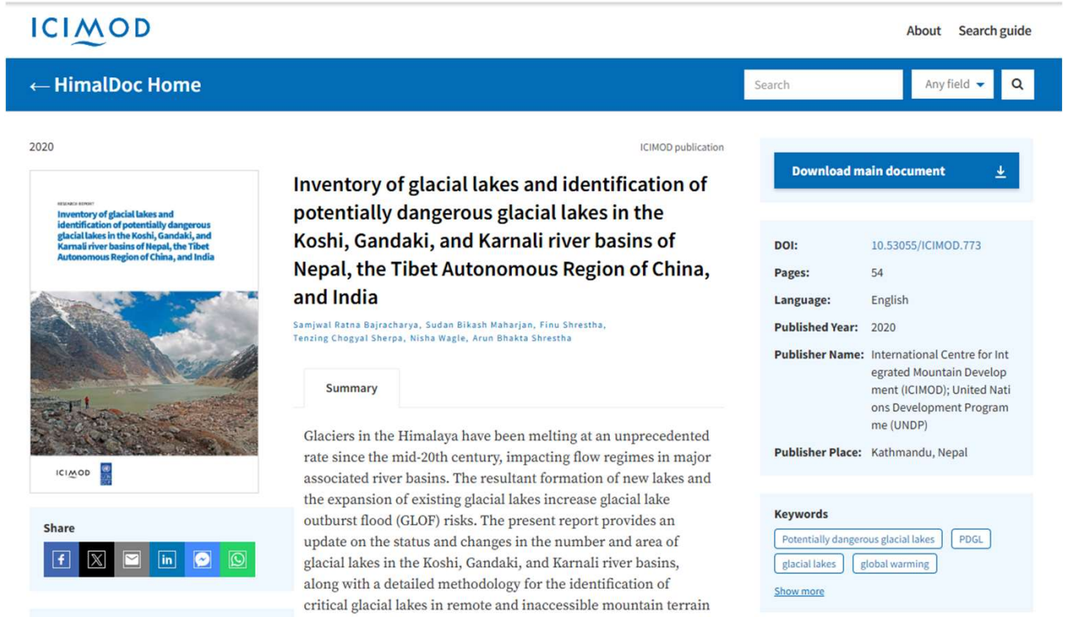


Data Visualizations

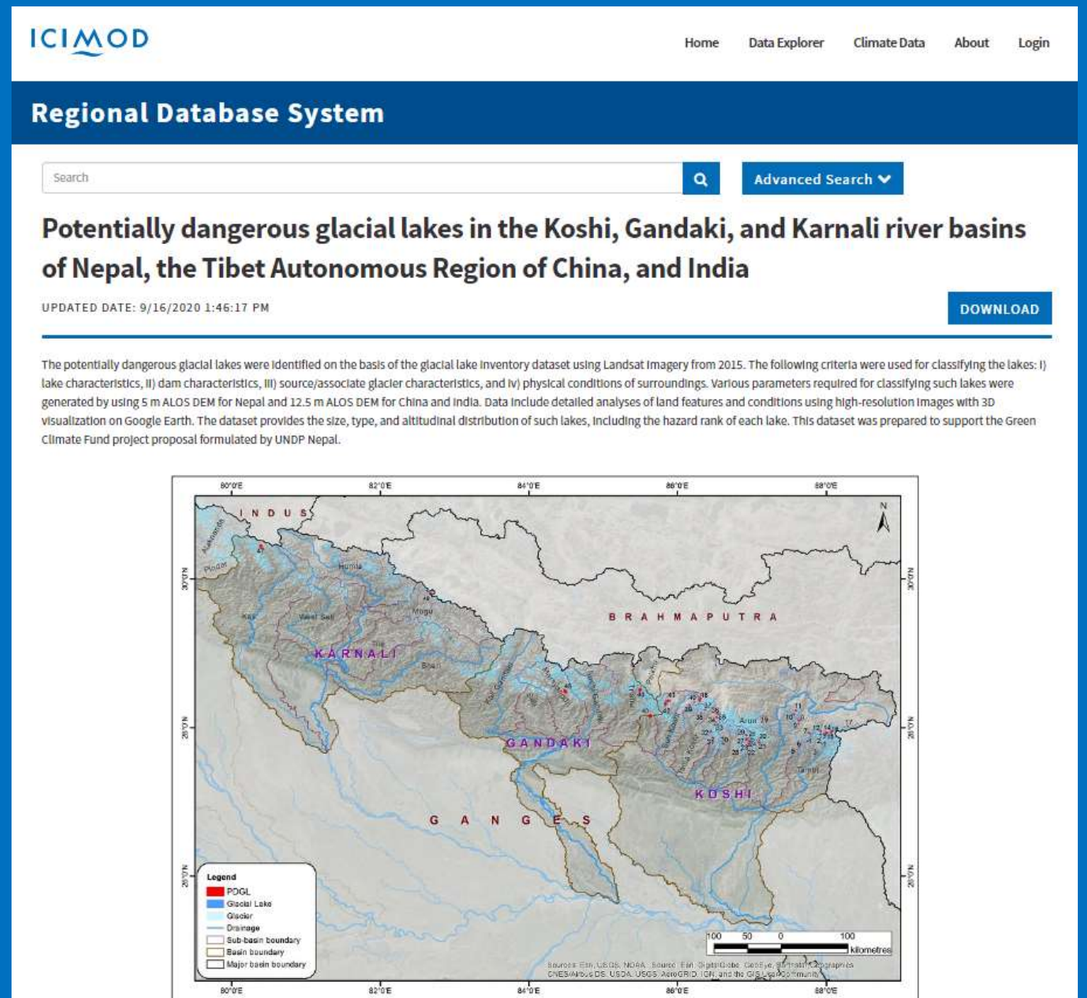
http://geoapps.icimod.org/glacier/



Himal Doc (*lib.icimod.org*)



Regional Database System (*rds.icimod.org*)



2025 International Year of Glaciers' Preservation

WMO

unesco

https://www.un-glaciers.org/

THANKS