

Status of Glaciers in the Indus Basin

Hindu Kush Himalayan Glaciers

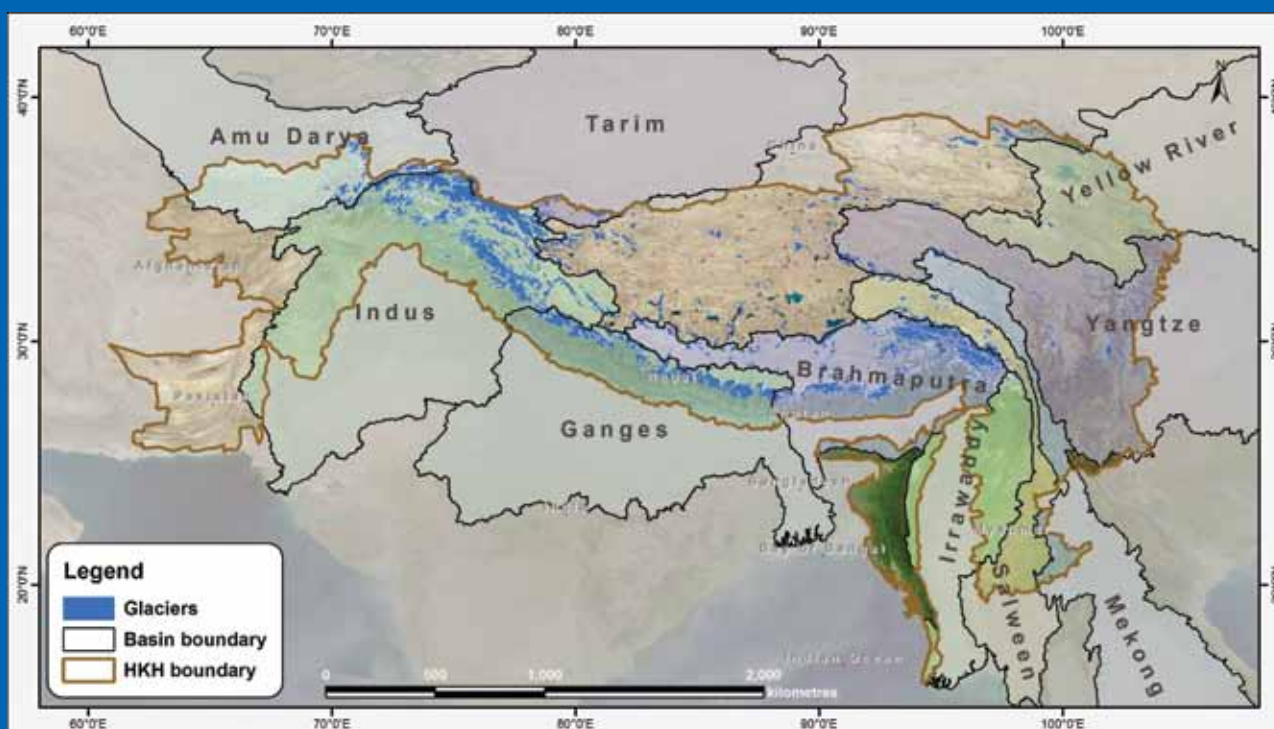
The Hindu Kush Himalayan (HKH) region encompasses an area of 4.2 million sq.km of hills and mountains in the eight countries of Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan. With its vast expanses of snow and ice, the region is known as the 'water tower of Asia'. The meltwater from Himalayan snow and ice feeds ten large river systems of South Asia: the Amu Darya, Brahmaputra, Ganges, Indus, Irrawaddy, Mekong, Salween, Tarim, Yangtze, and Yellow rivers.

A recently published inventory, *The Status of Glaciers in the Hindu Kush-Himalayas* (ICIMOD, 2011), identifies 54,252 glaciers with a total area of 60,054 km² and estimated ice reserves of 6,127 km³ in the HKH region. In total, 1.4% of the HKH region is glaciated. The largest individual glacier is the Siachen glacier with a total area of 926 km², whereas the average glacier size in the region is 1.1 km².

Glaciers in the major basins of the HKH region

Basins	Number	Glaciated area (km ²)	Estimated ice reserves (km ³)	Average area per glacier (km ²)
Amu Darya	3,277	2566	162.6	0.8
Indus	18,495	21,193	2,696.1	1.2
Ganges	7,963	9012	793.5	1.1
Brahmaputra	11,497	14,020	1,302.6	1.2
Irrawaddy	133	35	1.3	0.3
Salween	2,113	1,352	87.7	0.6
Mekong	482	235	10.7	0.5
Yangtze	1,661	1,660	121.4	1.0
Yellow	189	137	9.2	0.7
Tarim	1,091	2,310	378.6	2.1
Qinghai-Tibetan Interior	7,351	7,535	563.1	1.0
Total, HKH	54,252	60,054	6,126.9	1.1

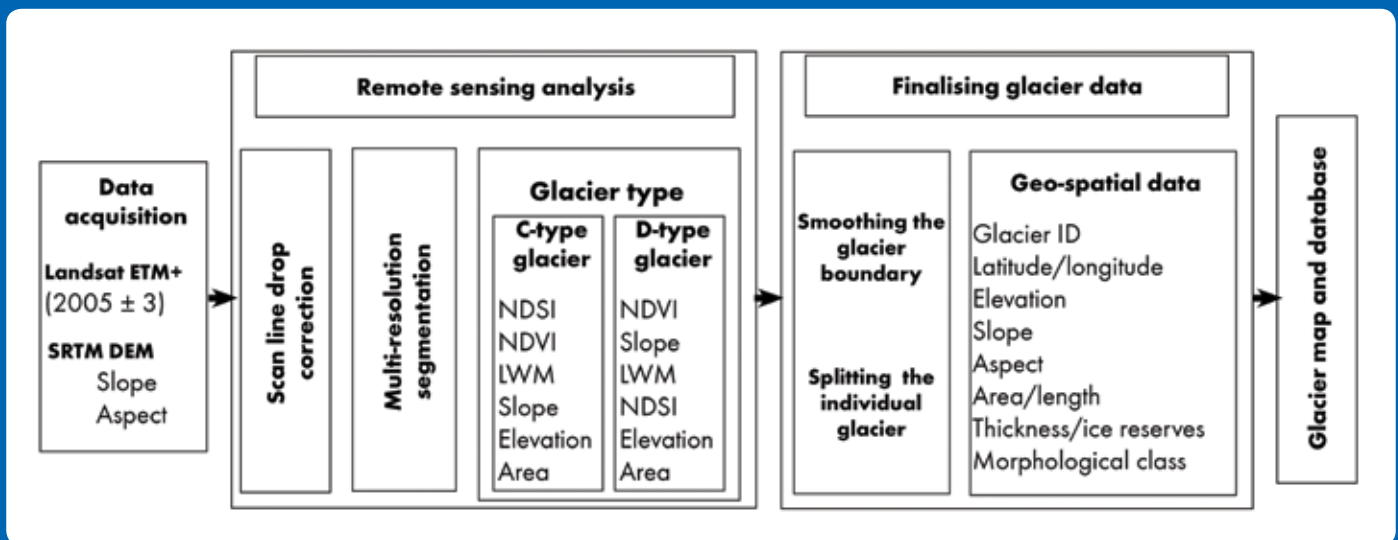
Distribution of glaciers in the Hindu Kush Himalayan region



Mapping methodology

To map the vast number and area of glaciers of the HKH region, ICIMOD developed a semi-automatic mapping methodology to delineate glacier boundaries on Landsat satellite images from the year 2005±3. The glacier area was derived from the glacier polygons in the GIS environment and thickness and glacier volume were estimated using an empirical formula. Other glacier attributes such as elevation, slope, and hypsometry were generated by draping the glacier polygons over Shuttle Radar Topography Mission (SRTM) digital elevation models. The morphology of each glacier was classified based on subjective judgement.

Semi-automatic mapping methodology using RS and GIS



Glaciers in the Indus basin

The Indus basin covers an area of about 1.1 million km². A large part of the upper basin lies within the Hindu Kush, Karakorum, and Himalayan mountains. Afghanistan, China, India, and Pakistan share the basin territory. Glaciers are a major landscape feature of the region, covering an area of 21,193 km²; ice reserves are estimated to be 2,696 km³. About 3.8% of the Indus basin area within the HKH region was found to be glaciated.

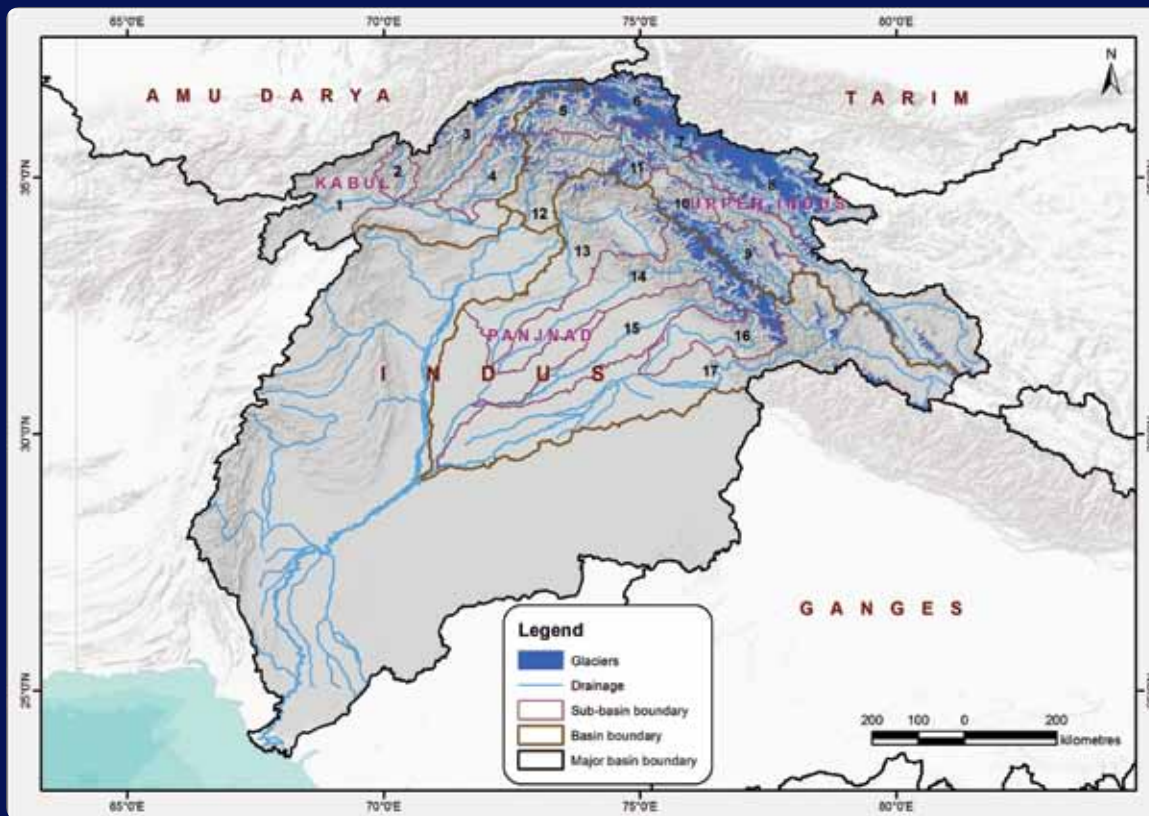
Snow and glacier melt is estimated to contribute more than 50% of the total flow to the Indus river system. During the dry season the flow from the mountains is particularly important for the water resources for irrigation, drinking water supply, hydropower, and other uses.

Debris cover plays an important role as it has an insulating effect and reduces melting rates. Based on a debris cover analysis of about 55% of the glaciers, overall 9.3% of the total glacier area in the Indus basin was debris covered. The debris-covered glaciers

were mostly valley glaciers with thick debris cover on the glacier tongue. They had an average slope of around 12°, whereas clean-ice glaciers were much steeper, with average slopes of around 25°.

Information on area, elevation range, aspect, slope, hypsometry, and debris cover of glaciers plays a significant role in the assessment and analysis of water availability in river basins

Distribution of glaciers in the Indus basin



Kabul basin

1. Panjsher-Ghorband
2. Alingar-Alishing Nuristan
3. Kunar
4. Swat

Upper Indus basin*

5. Gilgit
6. Hunza
7. Shigar
8. Shyok*
9. Zanskar
10. Shingo
11. Astor
12. Upper Indus*

Panjnad basin*

13. Jhelum
14. Chenab
15. Ravi
16. Beas
17. Sutlej*

* drainage catchment partly in China

Characteristics of glaciers in the Indus basin

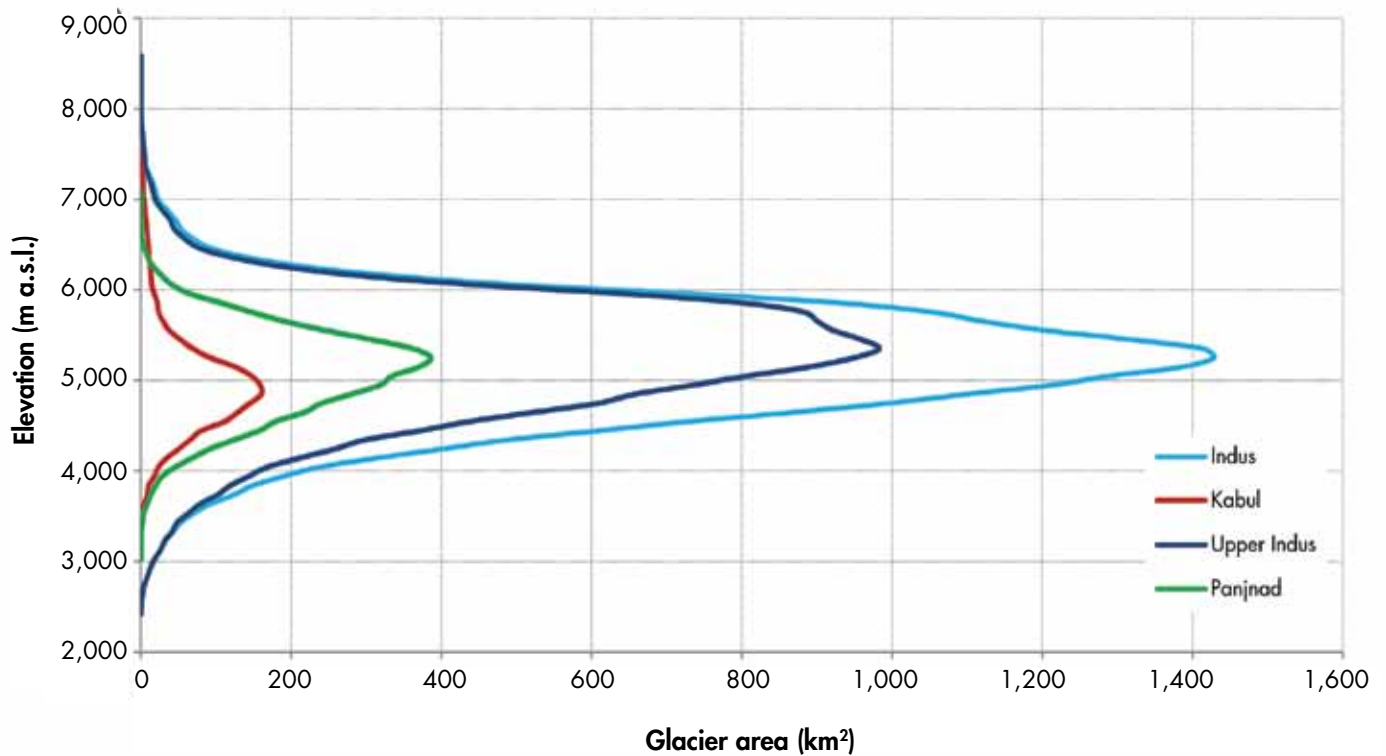
Basin	Sub-basin	Number of glaciers	Glacier area (km ²)	Estimated ice reserves (km ³)	Highest elevation (m a.s.l.)	Lowest elevation (m a.s.l.)	Largest glacier area (km ²)
Kabul	Panjsher-Ghorband	88	14.6	0.4	5,242	3,857	2.5
	Alingar-Alishing-Nuristan	37	5.8	0.2	5,284	4,162	1.5
	Kunar	1,149	1,573.9	176.8	7,578	3,114	189.5
	Swat	327	127.4	5.3	5,580	3,772	4.9
	Total	1,601	1,721.7	182.7	7,578	3,114	189.5
Upper Indus	Gilgit	968	938.3	71.3	7,730	2,703	61.8
	Hunza	1,384	2,753.9	310.6	7,749	2,409	345.7
	Shigar	439	2,374.1	601.9	8,566	2,774	631.5
	Shyok	3357	5,937.7	981.7	7,803	3,231	925.9
	Zanskar	1,197	975.5	82.1	6,368	3,997	62.6
	Shingo	882	612.7	42.9	7,027	3,656	46.3
	Astor	372	239.6	16.9	8,032	2,991	31.0
	Upper Indus	2814	1,230.0	66.1	7,820	2,760	51.9
	Total	11,413	15,061.7	2,173.5	8,566	2,409	925.9
	Panjnad	Jhelum	733	222.8	9.0	6,285	3,404
Chenab		2,039	2,341.2	210.7	7,103	3,001	109.3
Ravi		217	113.6	5.5	5,824	3,276	9.2
Beas		384	416.6	31.8	6,196	3,079	29.0
Sutlej		2,108	1,315.0	82.9	6,652	3,606	49.6
Total		5,481	4,409.2	339.9	7,103	3,001	109.3
Total	18,495	21,192.6	2,696.1	8,566	2,409	926.0	

Hypsograph of glacier distribution in the Indus basin

The glaciers in the Indus basin were mapped at elevations from 2,400 to 8,600 m a.s.l. Almost 96% of the glacier area of the Indus basin was found to lie between 3,700 to 6,400 m a.s.l. About 59% of the glacier area was distributed at 4,800 to 5,800 m a.s.l. The highest concentration of glaciers in the Indus basin was at 5,200 to 5,300 m a.s.l.



Area–altitude distribution of glaciers in the Indus basin



For further information contact

Samjwal Bajracharya sabajracharya@icimod.org

Photos: Birendra Bajracharya, Usman Ghani Dar

© ICIMOD 2012

International Centre for Integrated Mountain Development

GPO Box 3226, Kathmandu, Nepal

Tel +977-1-5003222 email info@icimod.org www.icimod.org

Prepared by ICIMOD Publications Unit, March 2012