

Supplement of

High-resolution glacier mapping reveals inventory biases and terrain controls on debris cover in the Karakoram

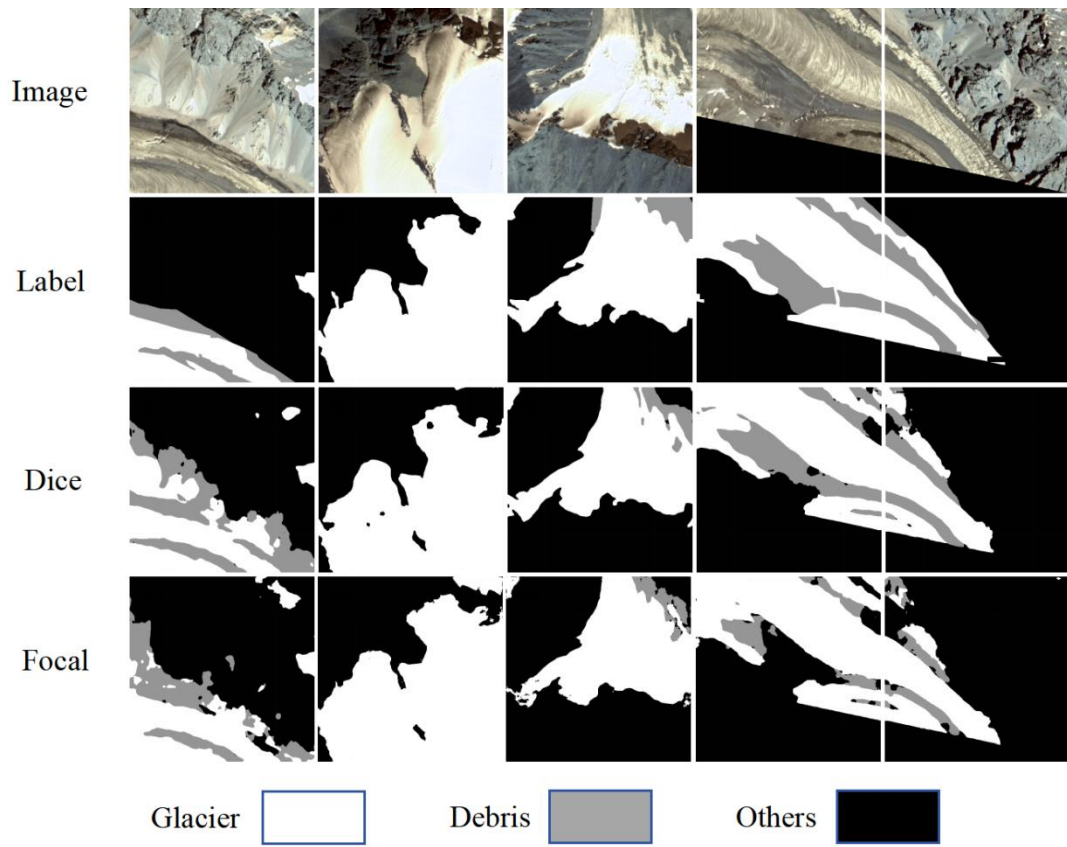


Figure S1. Comparison of extraction results in ZY-3 imagery for Dice loss function and Focal loss function.

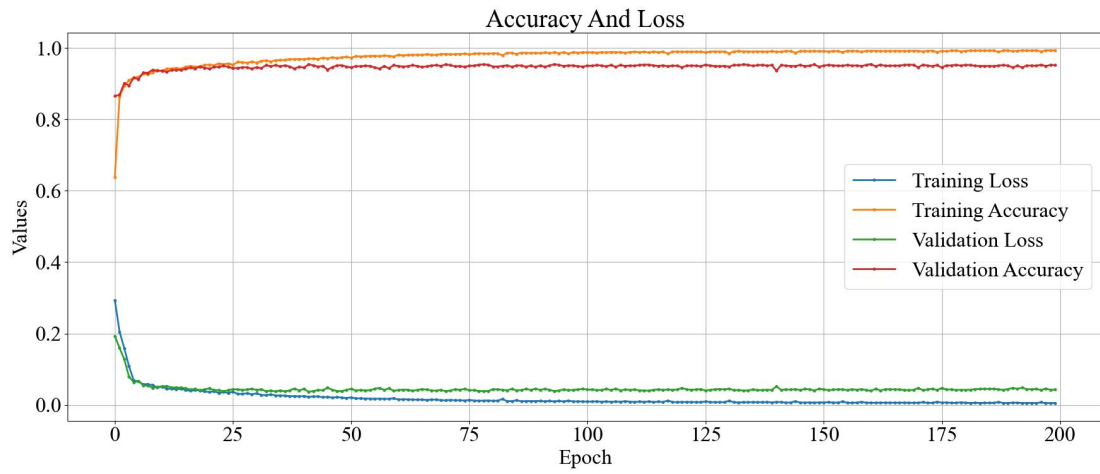


Figure S2. Variation of accuracy and loss values with epoch when training U-Net + CBAM using ZY-3 image data.

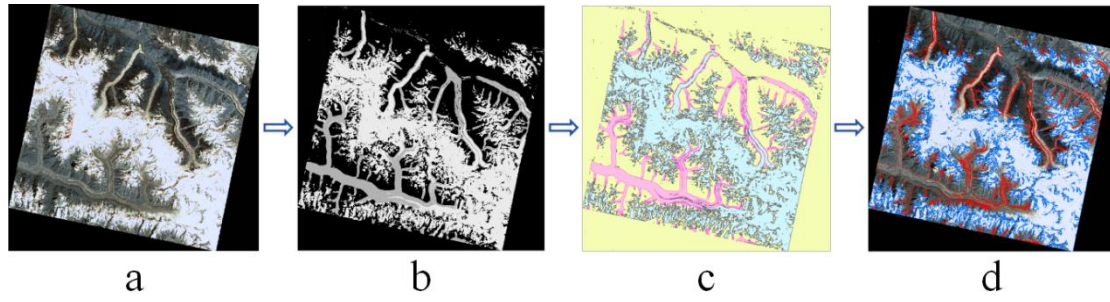


Figure S3. Processing flow for extracting glacier outlines using single-view ZY-3 imagery. **(a)** Single ZY-3 image. **(b)** Grayscale image of glacier boundaries extracted by the deep learning model. **(c)** Vectorised glacier extent. **(d)** Glacier boundaries after background removal.

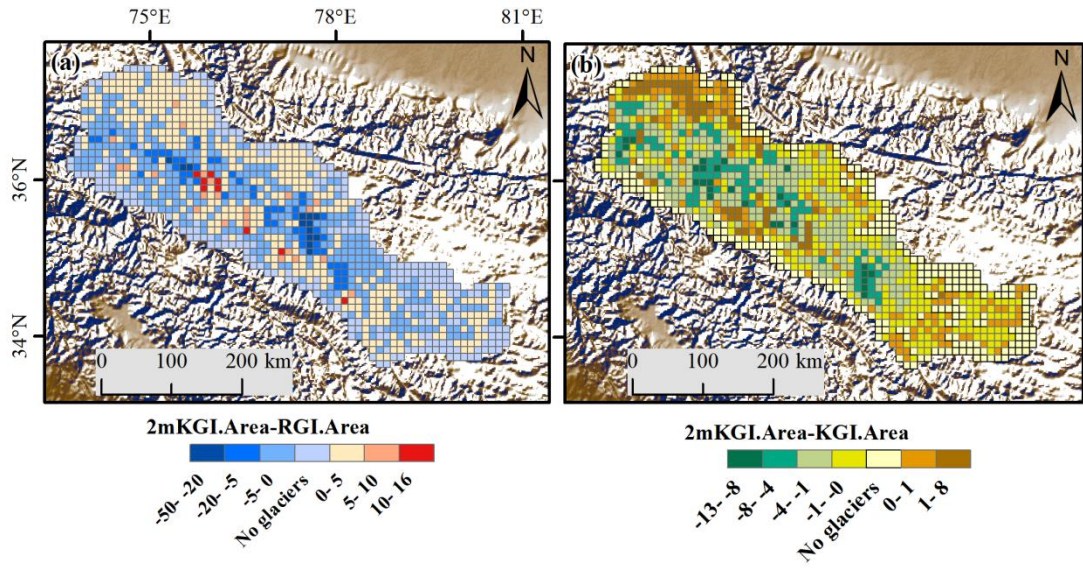


Figure S4. Grid-based (10 km × 10 km) comparison of glacier-area differences among inventories: **(a)** 2mKGI versus RGI in accumulation areas and **(b)** KGI-2020s versus 2mKGI.

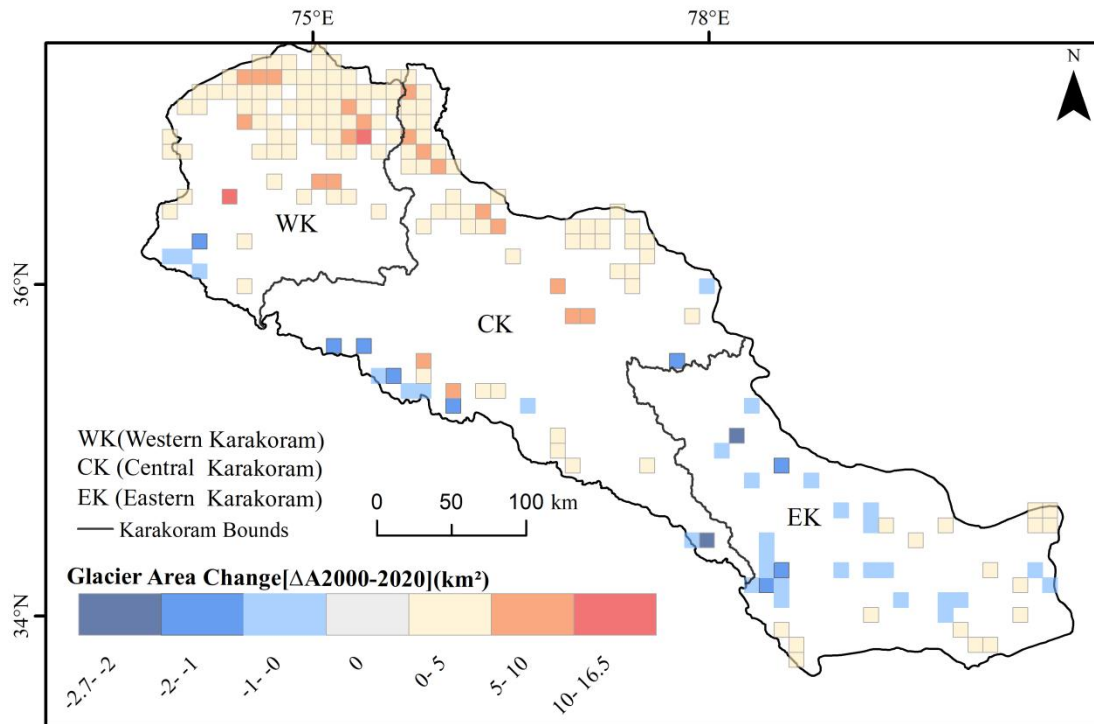


Figure S5. Inventory-based glacier-area differences between RGI v7.0 and 2mKGI after uncertainty filtering. Glacier area was aggregated to a 10 km × 10 km grid.

Table S1. Comparison of the recall for the various indicators in extracting glacier ice and supraglacial debris.

Characteristic	Ground Truth	Spectrum (%)	Spectrum + LST (%)	Spectrum + Slope (%)	Spectrum +LST + Slope (%)
Recall (glacier/debris)	100	94.5/61.6	70.5/71.8	95.0/72.2	97.1/84.6

Table S2. Summary of manual revision of the initially extracted glacier extents before glacier-unit subdivision.

Source	Initial area (km ²)	Final area (km ²)	Net area change (km ²)	Net change (%)
Clean-ice	19760.9	19021.9	-739	-3.7
Supraglacial debris	1953.1	2239.9	286.8	14.6

Table S3. Examples of glacier attribute information from the 2mKGI.

Glacier_ID	1	2	3
Area	0.011311	0.030646	0.108303
Longitude	74.492235	74.493569	74.502972
Latitude	36.04248	36.045467	36.04537
DEM_Min	3913	3708	4490
DEM_Max	5619	6016	4853
DEM_Range	1706	2308	363
DEM_Median	4747	4601	4602
DEM_Data	ZY-3 DEM	ZY-3 DEM	ZY-3 DEM
Slope_Min	6	0	0
Slope_Max	89	89	89
Slope_Range	83	89	89
Slope_Mean	56.933969	53.450026	33.277905
Aspect_Mean	178.011653	177.849817	176.217441
Debris_Area	0	0	0
Aspect	S	S	S
Source	ZY-3	ZY-3	ZY-3
Surge	NO	NO	NO