The Khumbu Glacier Solokhumbu, Nepal

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@EverestRSSSE

Vanishing Glaciers of Everest

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Quick facts:

- Nepali name for Everest: Sagamartha
- Tibetan name for Everest: Qomolangma
- First successful ascent: 29th May 1953, by Edmund Hillary (New Zealand) and Tenzing Norgay (Nepal)

Names and altitudes of mountains near Everest:

Nuptse, 7861 m	Lhotse, 8516 m
Pumori, 7161 m	Ama Dablam, 6812 m

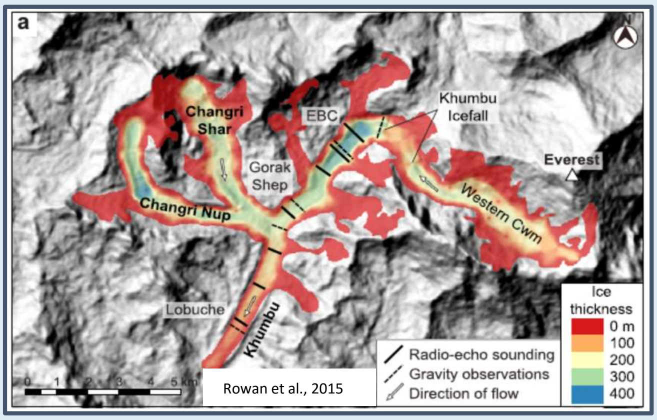
The Khumbu Glacier in 2016:

- **Length:** 15 km
- **Area:** 27 km^2
- **Volume:** 2.3 x 10^9 m^3 (about 812,000 Olympic swimming pools of water)
- **Velocity** at the base of the icefall: 67 m per year (derived from satellite imagery)
- **Velocity across the debris-covered tongue**: about 9 m per year (the lower 3 - 4 km of the glacier is stagnant)
- **Ice loss**: 1970–2007 there was between 25–50 m of total elevation (ice thickness) loss across the Khumbu Glacier, or about 0.67–1.35 m per year (Bolch et al., 2011).
- The Khumbu has the highest source area in the world

Debris cover:

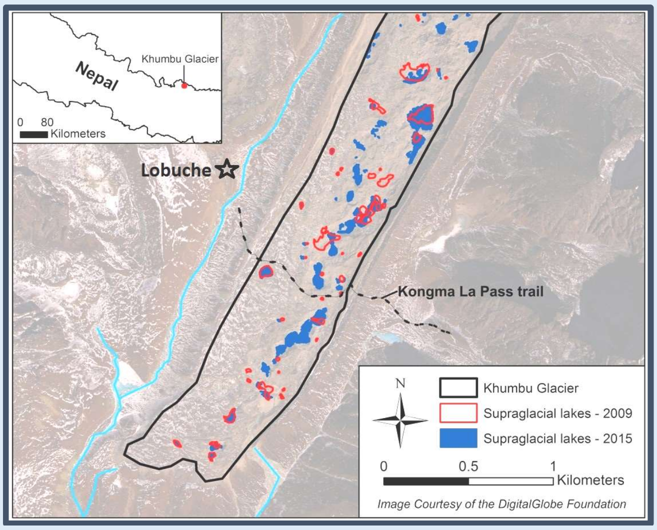
- The thickness of the debris layer (sediment, rocks and boulders) on the Khumbu Glacier varies from a few centimetres near EBC, to around three metres near the terminus
- Thin debris increases glacier melt as it absorbs solar radiation and transmits this energy to the ice beneath, whereas thick debris acts like a blanket to insulate the glacier
- The proportion of glacier area that is debris-covered in the Everest region is approximately 36% (Thakuri et al., 2014)

Modelled ice thickness:



Supraglacial pond expansion:

In the lower area of the Khumbu Glacier, supraglacial pond area (i.e. surface ponds) has increased by 33,593m^2 (66%) (2009– 2015) (Watson et al., 2016).



Ice cliffs:

Ice cliffs are common features on debris-covered glaciers and are 'hot spots' of melt where the surrounding debris-cover is thick. Cliffs can be tens of metres high and retreat at tens of metres per year.

Water resources:

- One fifth of the World's population depend on snow and ice melt for water resources including irrigation, sanitation, and hydropower. Climate change will modify the seasonality and magnitude of these water flows.

Science from the sky and in the field:

What are we researching?

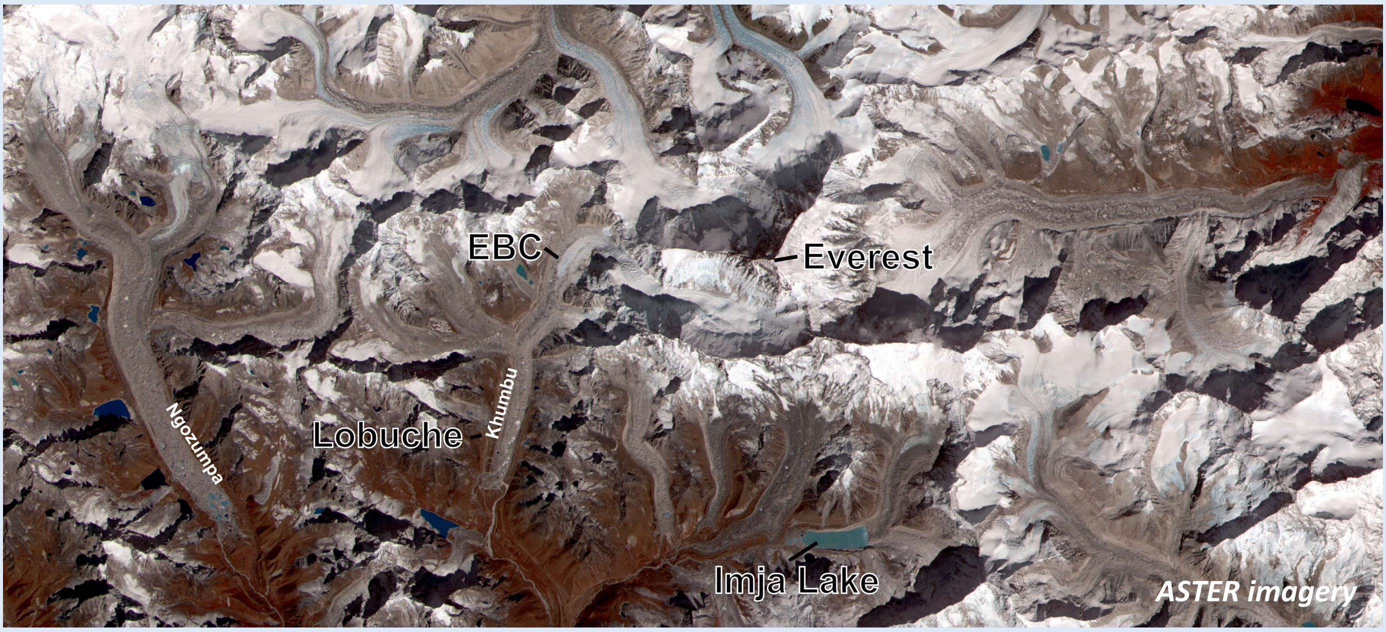
- **Glacier velocity,** because stagnant glaciers are no longer being replenished with new ice and are prone to large lake development
- **Glacier surface lowering,** which reveals how much ice is melting every year
- **Debris thickness and sub-debris melt rates,** which are used when modelling future glacier evolution
- **Ice cliff melt,** which is thought to be a significant source of ice loss on heavily debris-covered glaciers
- **Climatic warming and precipitation change,** which determines long term glacier evolution
- **Supraglacial pond expansion,** because they act as a positive feedback mechanism by absorbing solar radiation and transmitting it to glacier ice, causing more melt. Coalescing ponds are also indicative of large lake development and potential glacial lake outburst flood hazard
- **Supraglacial pond bathymetry,** to quantify surface water storage and seasonal change
- **Glacier hydrology,** to measure meltwater generation and downstream flows

A differential GPS provides sub-centimetre accuracy for ice cliff surveys or to georeference satellite imagery

From satellite & aerial imagery we can measure:

- **Glacier velocity** by automatically tracking features on the surface of the glacier
- **Ice loss** from repeat digital elevation models
- **Pond and lake expansion** by quantifying area change

The Everest region from space:



This outreach leaflet was prepared by Scott Watson *(@CScottWatson)* who is completing a PhD at the University of Leeds, UK

Rowan et al. (2015). Modelling the feedbacks between mass balance, ice flow and debris transport to predict the response to climate change of debris-covered glaciers in the Himalaya. Earth and Planetary Science Letters. 430, 427-438.
Thakuri et al. (2014). Tracing glacier changes since the 1960s on the south slope of Mt. Everest (central Southern Himalaya) using optical satellite imagery. Cryosphere. 8(4), 1297-1315.
Watson et al. (2016). The dynamics of supraglacial ponds in the Everest region, central Himalaya. Global and Planetary Change. 142. 14-27.