Characterizing ice dynamics of the Quelccaya ice cap in Southern Perú

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Location

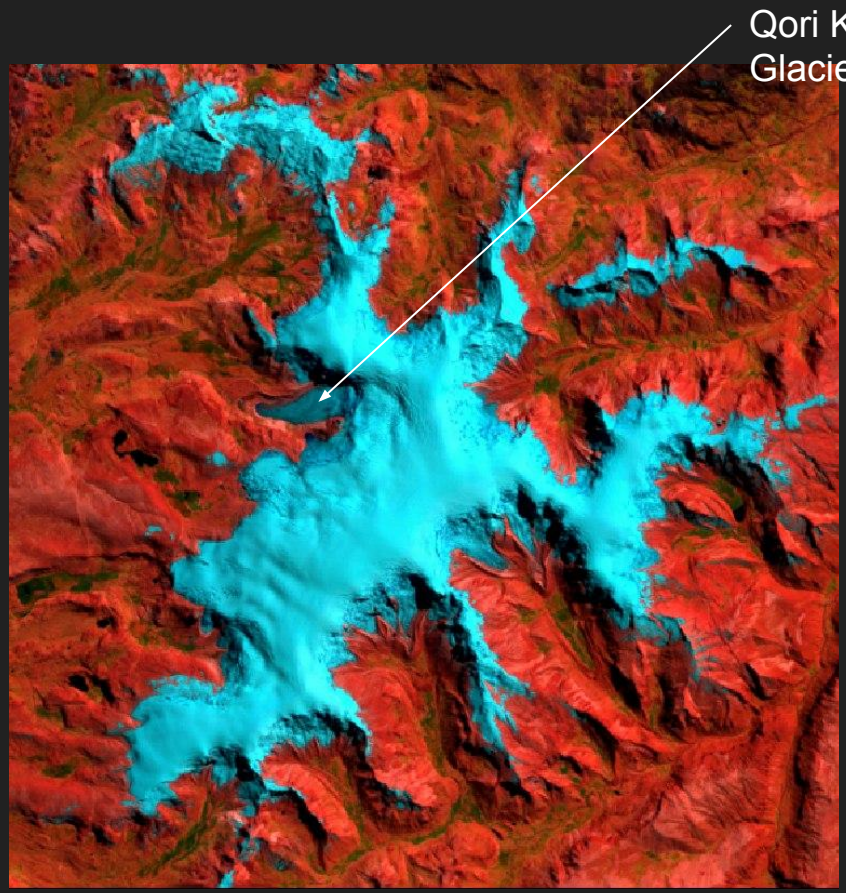
The Quelccaya Ice Cap is the second largest glaciated area in the tropics. It is located in the Cordillera Oriental section of the Andes mountains of Peru, the ice cap covers an area of **42.8 square kilometres** (16.5 sq mi) with ice up to **200 metres** (660 ft) thick.

Figures Courtesy: https://en.wikipedia.org/wiki/Quelccaya_Ice_Cap

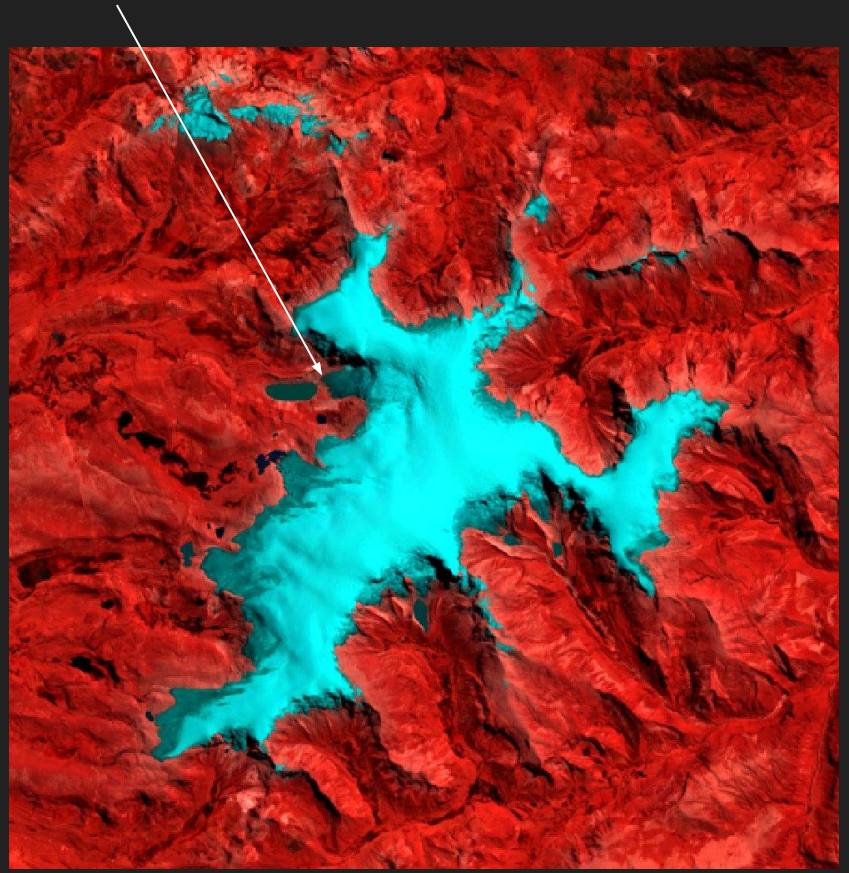
Problem Statement

- **If warming trends continue, Quelccaya, which until recently was the world's largest tropical ice cap, will have reached a state of irreversible retreat by the mid-2050s.**
- I want to track the ice cover of the Quelccaya to obtain a better understanding of the degree of ice loss over time.

Figure Courtesy: https://earthsky.org/earth/future-disappearance-quelccaya-melting-ice-cap-glacier-andes



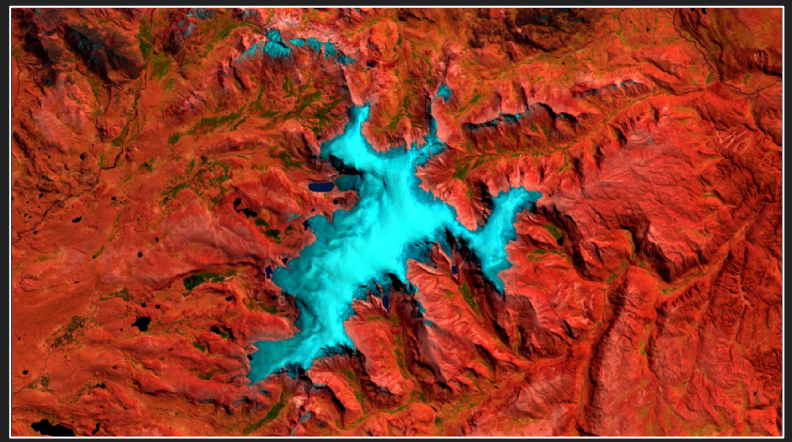
Landsat 5 TM Image from 25 July 1985
(FCC with bands 5, 4, and 3 as RGB)



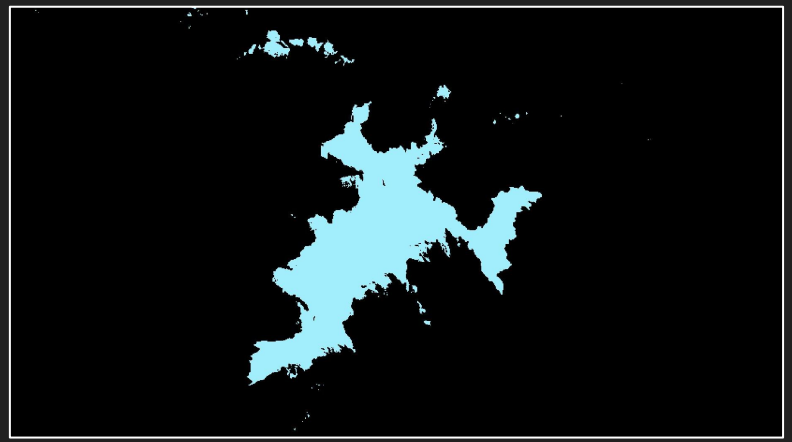
Landsat 8 OLI Image from 8 August 2019
(FCC with bands 6, 4, and 3 as RGB)

Methods

- I used Landsat 5, 7, and 8 images to track ice extent between 1985-Today. Intervals are be: 1985, 1990, 1995, 2000, 2005, 2010, 2015, 2016, 2017, 2018, and 2019.
- I used ERDAS Imagine to perform binary unsupervised classifications (K-means algorithm) of the Quelccaya Ice Cap.
- I did a change trajectory analysis between two images: 1985 and 2019.



Landsat 5 TM image from 30 July 2010 (FCC with bands 5, 4, and 3 as RGB)

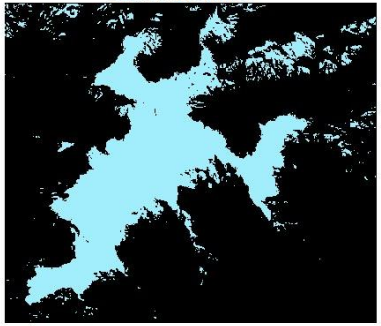


Binary unsupervised classification of Landsat 5 TM image from 30 July 2010. Blue = ice, Black = other.

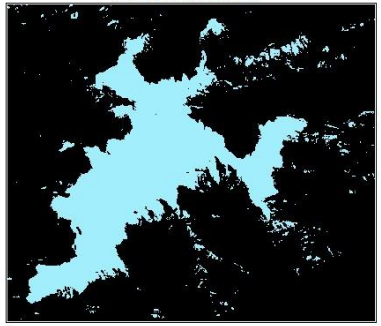
Results


1985
30.62% Ice Cover
1990
27.62% Ice Cover
1995
25.25% Ice Cover
2000
25.12% Ice Cover
2005
22.40% Ice Cover
2010
19.73% Ice Cover
N
5 0 5
Kilometers
5000 0 5000
Meters
Legend
Ice
Other
Binary unsupervised classification based on Landsat 5, 7, & 8.
Quelccaya Ice Cap
Andes Mountains, Peru
13°55'S 70°49'W
December 7, 2019
Map Creator: Alessandro Mauceri

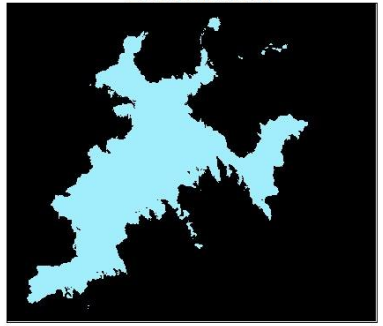
2015
22.95% Ice Cover



2016
22.01% Ice Cover

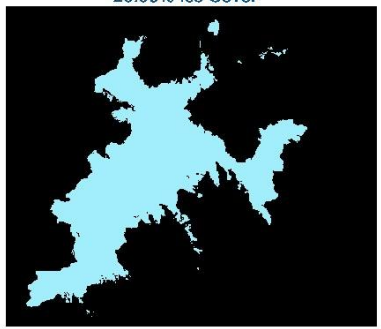


2017
20.13% Ice Cover

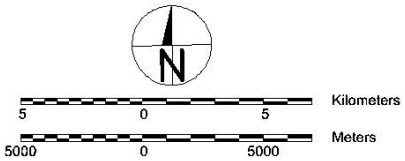


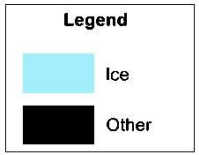
2018
23.23% Ice Cover

2019
20.06% Ice Cover



2050
0.00% Ice Cover

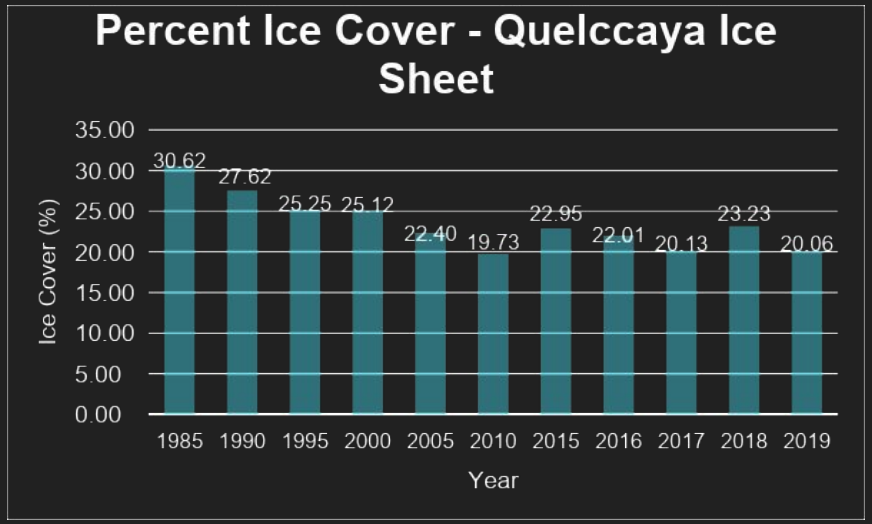




Binary unsupervised classification based on Landsat 5, 7, & 8.

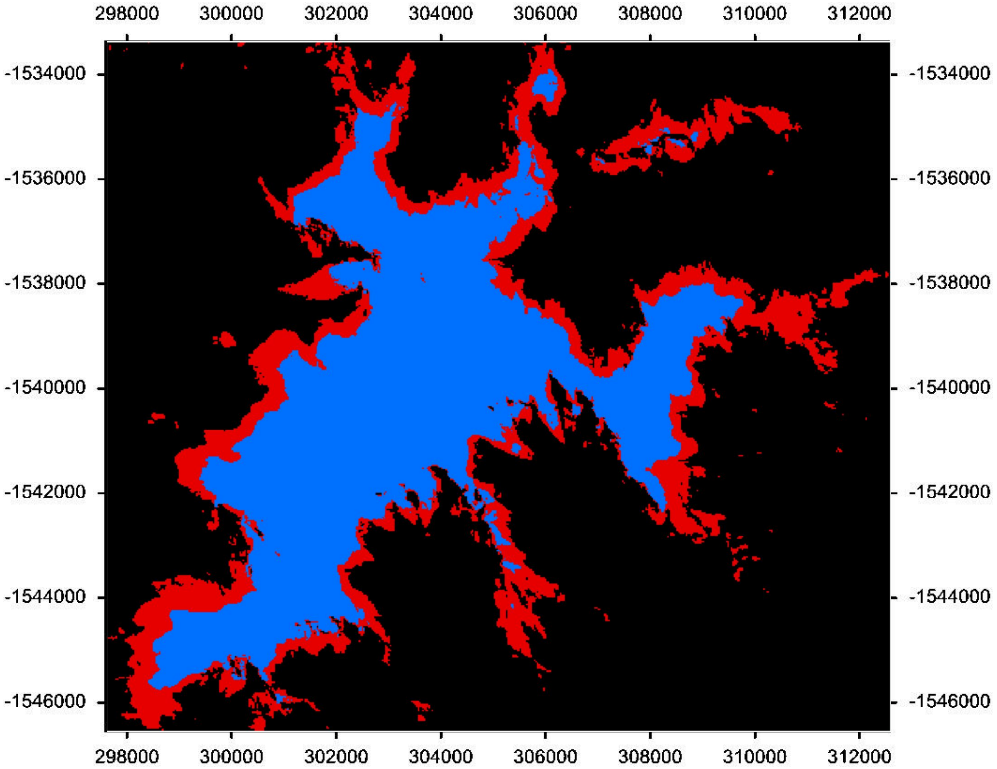
Quelccaya Ice Cap
Andes Mountains, Peru
13°55'S 70°49'W

December 7, 2019
Map Creator: Alessandro Mauceri



Date of Acquisition	Year	Landsat	Total # Pixels	# Ice Pixels	# Other Pixels	% Ice Cover	% Other
25-Jul	1985	5	220110	67398	152712	30.62	69.38
23-Jul	1990	5	220110	60795	159315	27.62	72.38
5-Jul	1995	5	220110	55577	164533	25.25	74.75
24-Jun	2000	7	878559	220657	657902	25.12	74.88
16-Jul	2005	5	220110	49296	170814	22.40	77.60
30-Jul	2010	5	220110	43434	176676	19.73	80.27
12-Jul	2015	8	878559	201590	676969	22.95	77.05
30-Jul	2016	8	878559	193404	685155	22.01	77.99
2-Aug	2017	8	878559	176877	701682	20.13	79.87
4-Jul	2018	8	878559	204068	674491	23.23	76.77
8-Aug	2019	8	878559	176211	702348	20.06	79.94

Change in Ice Cover between 1985 and 2019: Quelccaya Ice Cap



Change trajectory analysis based off Landsat 5 (1985) and 8 (2019)

December 7, 2019
Map Creator: Alessandro Mauceri

Implications

- Meltwater lakes and proglacial lakes have formed in front of Qori Kalis glacier and other Quelccaya glaciers and expanded in size. These lakes could be sources of future glacial lake outburst floods. Avalanches and floods from glaciers have killed over 35,000 people and glacial retreat will likely increase their incidence

- The freezing level regularly rises above the summit of Quelccaya, and in recent ice cores, meltwater infiltration has become apparent, to the point that oxygen isotope ratios are no longer preserved in the ice.

- Quelccaya is the largest glacierized area in the watershed of the San C[illegible] hydropower plant, which is used by the Cusco Region. The water is used for both irrigation and hydropower production. The population in the region is for the most part rural with low socioeconomic status, which makes it highly vulnerable to the effects of climate change. Additionally, glaciers have important religious [illegible]s.

Figure Courtesy: https://www.youtube.com/watch?time_continue=36&v=-6Uh7MzZ8hs&feature=emb_logo

Figure Courtesy: https://www.ayni-peru.com/new-quelccaya-treks-blog/

Questions?