



ANALYSIS OF GLACIER CHANGE IN THE SIERRA NEVADA

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Study area:



Sierra Nevada (Glaciers, 2015)



Closer look (Glaciers, 2015)

Research questions:

Primary goal:

- Identify how many *perennial snow and ice features* still exist compared to the last mapping in 1987 and before.
 - >Perennial snow and ice features include - glaciers, rock glaciers, and snow/ice patches.

Secondary goals:

- Identify Glaciers (perennial snow or ice that moves).
- Look for evidence of past (moraines) or current (crevasses) movement.
- Have any glaciers become rock glaciers?

Basic anatomy of a glacier:

- Accumulation Zone - an area of gain
- Ablation Zone - an area of loss
- The equilibrium line is the dividing line between zones. During late summer, after the winter snow has melted, the boundary between zones becomes visible.
- Crevasse - deep open crack
- Moraine - accumulation of glacial debris
- Old moraines indicate the former extent of a glacier.

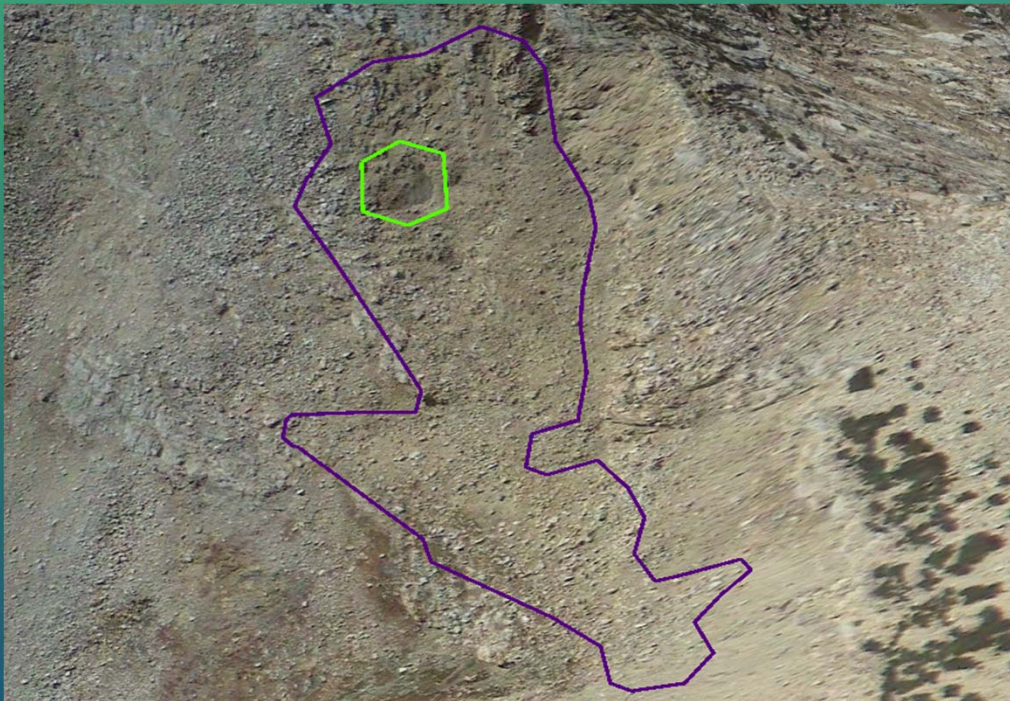


Equilibrium line on a glacier (Glaciers, 2015)

Anatomy continued:

Snow/Ice Patch

Rock Glacier



Unnamed Glacier, Sierra Nevada
Google Earth Image (RECNO 8668)

Galena Rock Glacier, Wyoming
(Glaciers, 2015)

Relevance:

- Helps to quantify the effect of climate warming on the landscape.
- Defines the changing hydrology (and ecosystems) of high alpine areas (less snow and ice).
- Important to help define the contribution to sea level rise.



Personification of Climate Change and its Effect on Glaciers

by Thomas Jones

Methods:

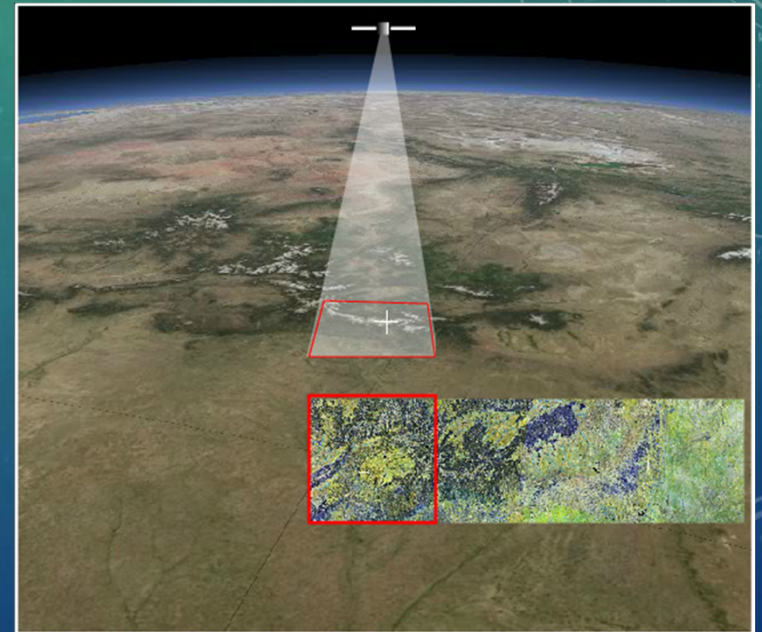
- With remote sensing, it is possible to analyze a large number of glacier, without the effort of field-based techniques.
- The remote sensing data is input into a Geographic Information System (GIS), and each snow or ice feature can be outlined using a vector map.
- The best time to collect data is late in the summer, so the terminus will be in its most retracted position and least seasonal snow cover.

PROS:

- Easy way to count objects
- Cost effective, by contrast to most field work
- Repetitive coverage for inaccessible areas
- Images can be used in multiple applications

CONS:

- Interpretation uncertainty with multiple observers
- Relies on user experience
- Hard to determine debris-covered ice from surrounding terrain

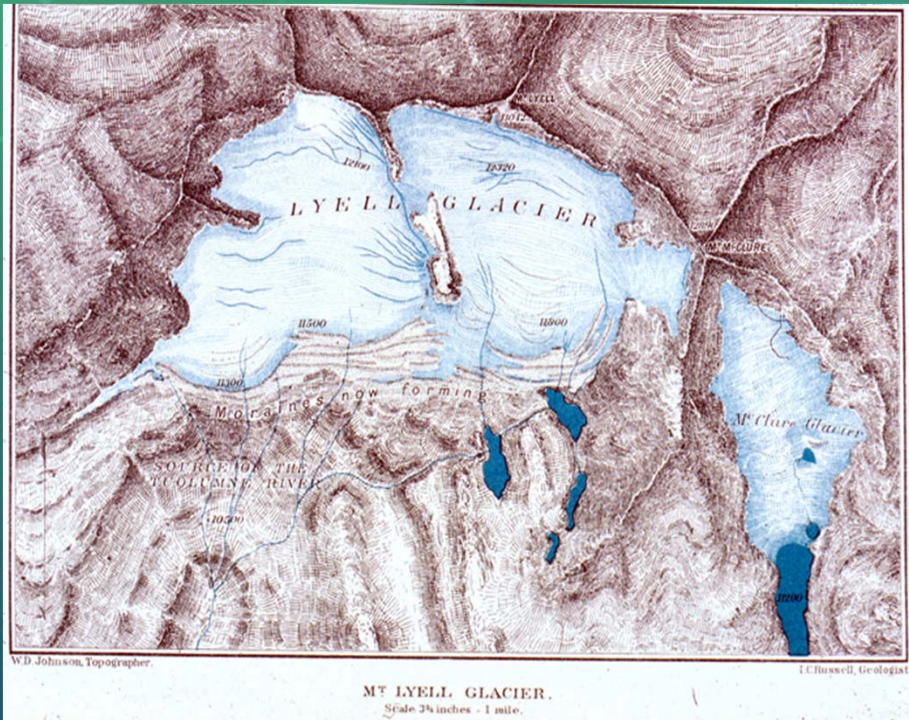


Remote Sensing - gathering information via satellite or aerial photography (Glaciers, 2015)

The 24K inventory:

- 24K-scale maps (1:24,000 US Geological Survey topographic maps) provide the most detailed mapping of perennial snow and ice features. Outlines were obtained from digital map versions.
- Aerial imagery from which the maps were based date from 1943 to 1987, but most occur during the 1960s, '70s, and '80s (Fountain, 2007).”
- Digitized (outlined) areas can be compared to measurements from subsequent years to quantify changes.

Lyell & Maclure glaciers:



Topographic Map of Lyell and Maclure glaciers

Photo date - 1883 (Glaciers, 2015)



Google Earth Image - 2013

24K outlines - 1984-85

West Lyell Glacier:



West Lyell: Photo date - 1883

Photographer - Israel C. Russell (Glaciers, 2015)



West Lyell: Photo date - 2013

Photograph from Google Earth

Data & analysis:

- The Sierra Nevada inventory contains 1719 data points.
- 635 had no perennial snow or ice features [*approximately 1/3 overall*].
- 1080 had perennial snow or ice features [*approximately 2/3 overall*].
- 373 classified as small patches of perennial snow or ice.
- 237 classified as rock glaciers.
 - >Further analysis is needed to identify other transitional features.
- 758 exhibited glacial characteristics (past or present movement)
 - >500 moraines & 258 crevasses.
- 4 data points had no usable imagery for 2012/2013/2014.
- 51 data points did not have 2013/2014 imagery, so 2012 imagery was utilized.

What's next?

- Re-digitizing the 24k inventory by creating new vector overlays.
- Compare area change in snow and ice features.
- Updated classifications for the entire American West inventory.

ACKNOWLEDGEMENTS:

- This analysis of glacier change in the Sierra Nevada mountain range would not have been possible without the efforts of the Glaciers of the American West project, which initially located and constructed the photographic inventory used.
- The initial work began with “students and staff from the Geology and Geography departments at Portland State University, with funding from the National Science Foundation, NASA, the US Geological Survey, and the National Park Service.”
- Special thanks to the National Science Foundation, Dr. Andrew Fountain, Hassan Basagic, Gunnar Johnson, Bryce Glenn, Jonathan Skloven, Eduardo Guzman, as well as the REU coordinator and organizers.

DR. ANDREW FOUNTAIN



QUESTIONS??



View downslope at the Palisade Glacier, Sierra Nevada
Photographer - Hassan Basagic (Glaciers, 2015)

Sources:

Basagic, Hassan J., "Quantifying Twentieth Century Glacier Change in the Sierra Nevada, California" (2008). Dissertations and Theses. Paper 2239. Web. 13 July 2015.

Fountain AG, Hoffman M, Jackson K, Basagic HJ, Nylén TH, Percy D. 2007. Digital outlines and topography of the glaciers of the American West. USGS Open-File Report. 2006-1340:23.

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