Regionalization of Glacier Mass Balance Measurements

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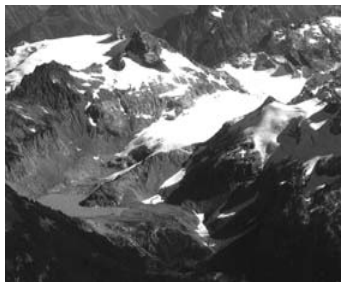
125 years of science for America 1879–2004

Retreat of South Cascade Glacier

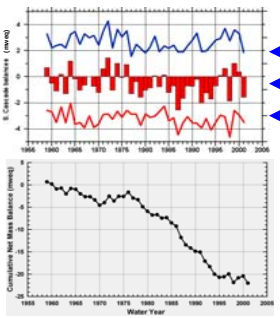
1928



2000

Calculated from: Glacier trim lines and moraines; Analysis of aerial photographs

Volume Estimates	
YEAR	km³
1650	0.49
1890	0.49
1928	0.32
1958	0.24
1970	0.22
1985	0.19
2001	0.16

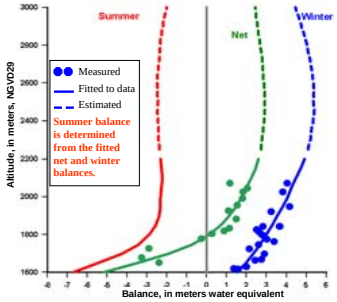


Data Record and History of South Cascade Glacier

Temperate glaciers of the North Cascades are indicators of climate change and an integral part of the regional hydrologic cycle. To understand the response of glacier mass balance to fluctuations in atmospheric circulation, the U.S. Geological Survey (USGS) has measured the winter, summer, and net mass balances of South Cascade Glacier in the northern part of the Cascade Range for the past 44 years. This record, one of the longest such records in the world, shows a dramatic reduction of glacier extent and volume as the mass balance responds to short-term climate fluctuations.

The contribution of glacial recession and melting of perennial snowfields to the annual discharge from glacierized basins in the North Cascades is an important factor in the regional hydrology. Inter-annually, glaciers store water during cool, wet periods and release water during warm, dry periods. The USGS has developed a technique that combines the South Cascade Glacier mass balance observations, as a function of altitude, with Landsat-7 satellite imagery and digital elevation models in a Geographic Information System (GIS) to determine the inter-annual loss or gain of water by glaciers in the region.

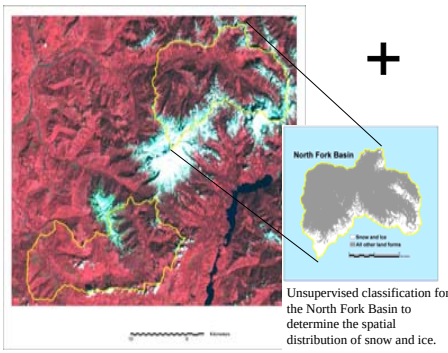
Field measurements provide seasonal mass balance information.



Variations of mass balance with altitude are described by balance-altitude curves.

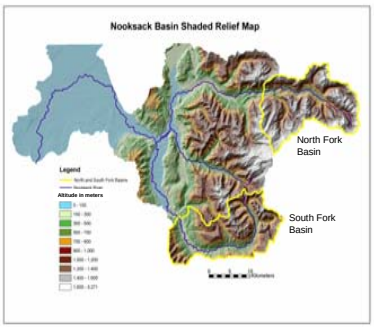
Using Imagery, GIS and South Cascade Glacier Mass Balance Data for the Nooksack River Basin Application

In the GIS system, the snow-and-ice-covered area is combined with the digital elevation model and the basin boundary to yield the snow-and-ice-covered area as a function of altitude within the basin .

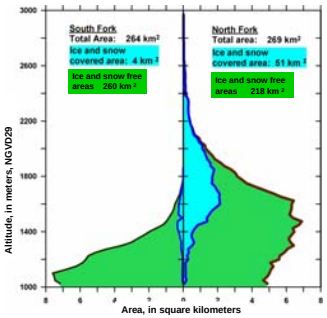


Unsupervised classification for the North Fork Basin to determine the spatial distribution of snow and ice.

Sample Landsat-7 image, in false color, September 1999, showing the North and South Forks of the Nooksack River Basin, their GIS boundaries, and their disparate snow and ice coverage.



Shaded relief of the Digital Elevation Model (DEM) data used to extract the altitude bands for the North Fork of the Nooksack River.



Graph showing the 1999 ice and snow cover as a function of altitude.

	1999	2000	2001
North Fork	51.4	20.7	12.9

Total ice and snow covered area (km²) for the North Fork basin.

1999 – 2001 Comparison for North Fork Basin

	1999 (positive balance year)	2000 (near normal year)	2001 (negative balance year)
Measured discharge (10^6 m³)	775	766	490
Accumulation	49	43	22
Ablation	33	46	44
"Glacier" Contribution (gain or loss)	-16 (gain)	3	22 (loss)
South Cascade Net Balance (*mweq*)	1.02	0.38	-1.57

Integration of the balance-altitude curves with the vertical distribution of snow and ice in the basin, yields the glacier contribution to runoff. The method used the balance-altitude curves for 1999, 2000, and 2001, which correspond to a positive balance year, a near normal year, and a negative year; and the snow and ice distribution for 2001.

2/17/04