Determining Archaeological Potential in the Pennine Alps using GIS tools

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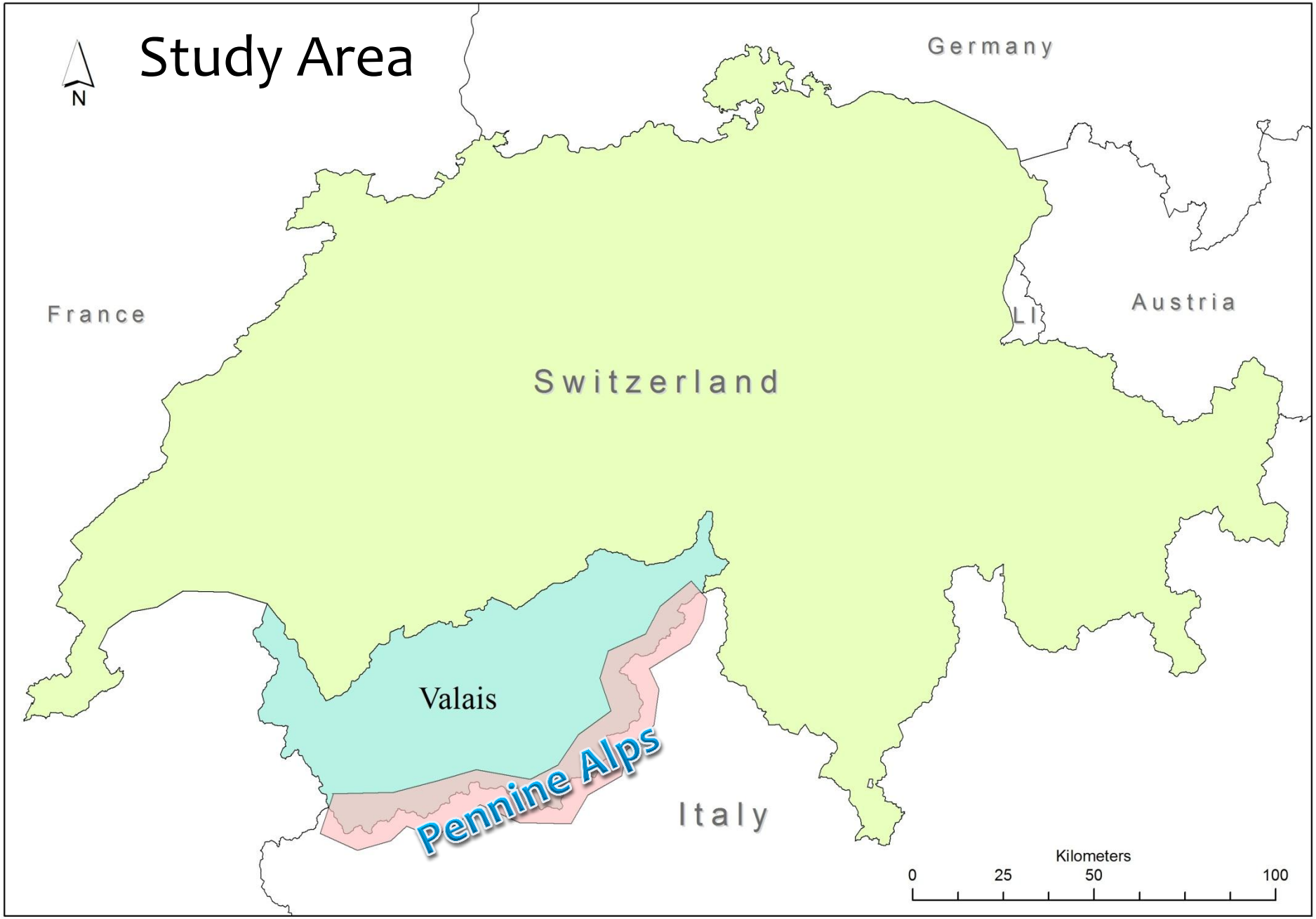
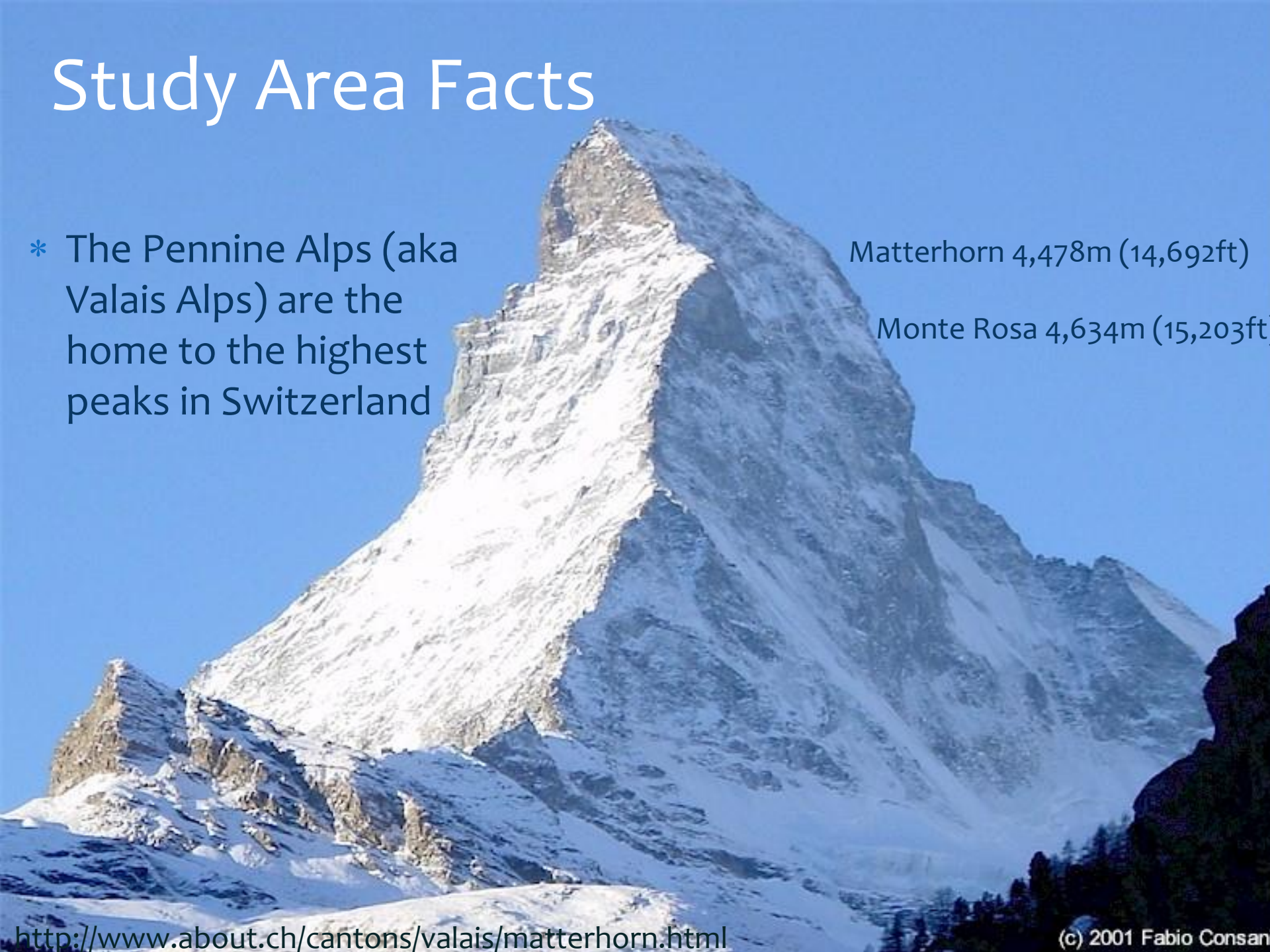
Introduction

* **This project uses a multidisciplinary approach to create an archaeological potential model in an area rich in cultural history with a rapid rate of glacier retreat**
  * Urgent need to collect and preserve findings once they have been uncovered from the ice
* **Partnership between the University of Fribourg and the Canton of Valais to protect and conserve cultural heritage**
* Project Partners:
  * Archaeology: Philippe Curdy, François Wiblé, **Canton of Valais**
  * History: Pierre Dubuis, Muriel Eschmann-Richon, **University of Lausanne**
  * Geosciences: Stephanie Rogers, Claude Collet, Ralph Lugon, Reynald Delaloye, Martin Hoezle, Matthias Huss, **University of Fribourg**


Study Area
N
Germany
France
Switzerland
LI
Austria
Valais
Pennine Alps
Italy
Kilometers
0
25
50
100

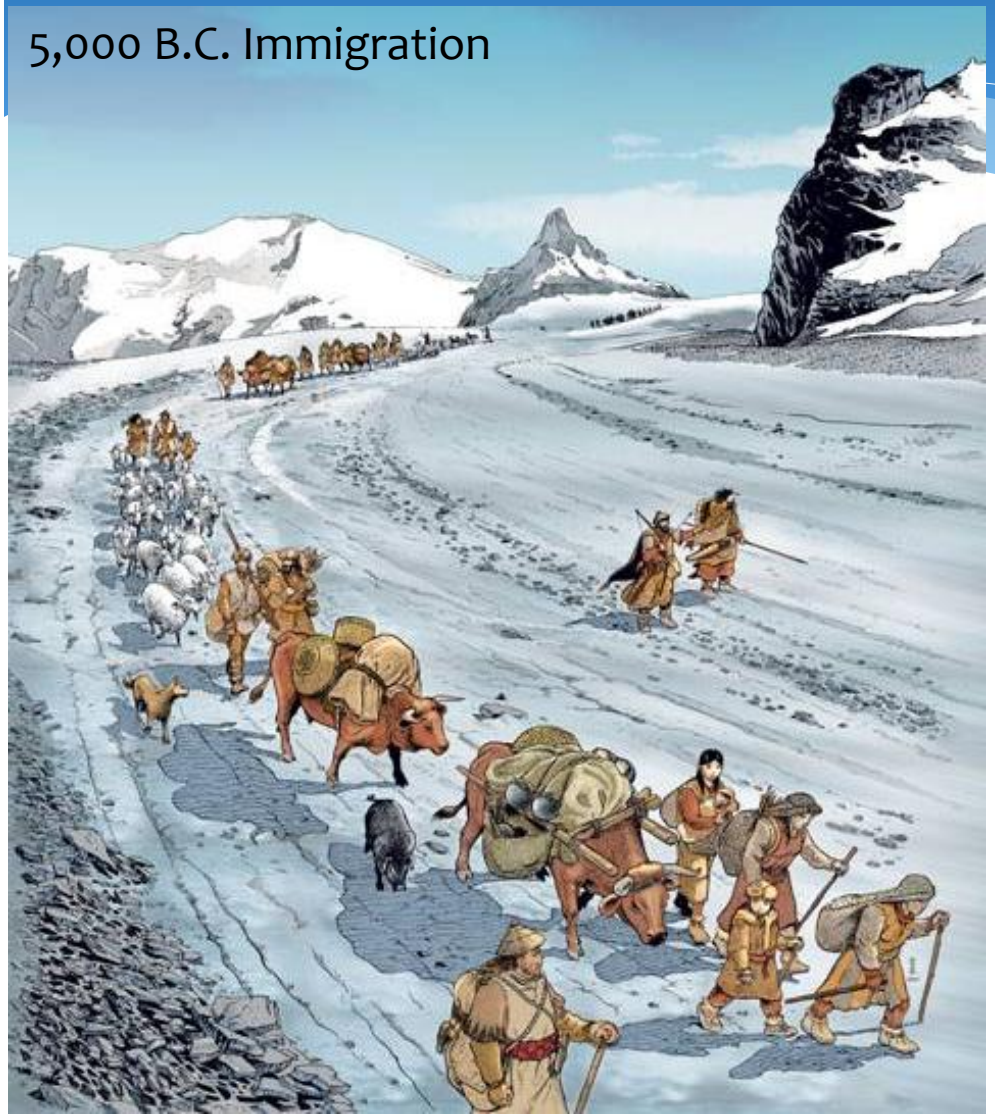
Study Area Facts

* The Pennine Alps (aka Valais Alps) are the home to the highest peaks in Switzerland



http://www.about.ch/cantons/valais/matterhorn.html

Historical Perspective



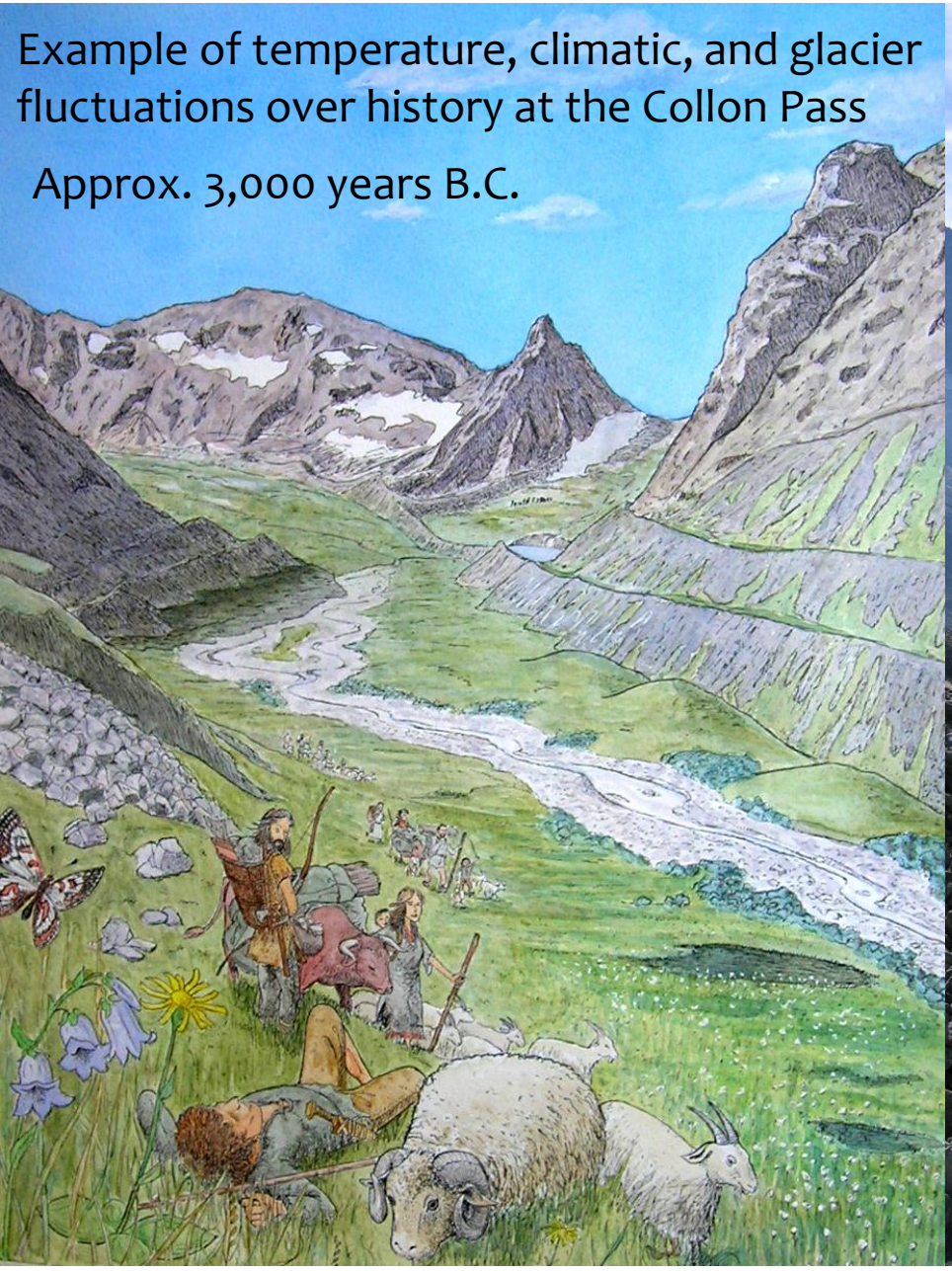
* High altitude passes between CH and IT used as communication and commerce routes for thousands of years

* Earliest indication of people in high altitudes in this region is from 7,000 B.C.

Reconstruction by: A. Houot, J. Charrance, 2002

Example of temperature, climatic, and glacier fluctuations over history at the Collon Pass

Approx. 3,000 years B.C.



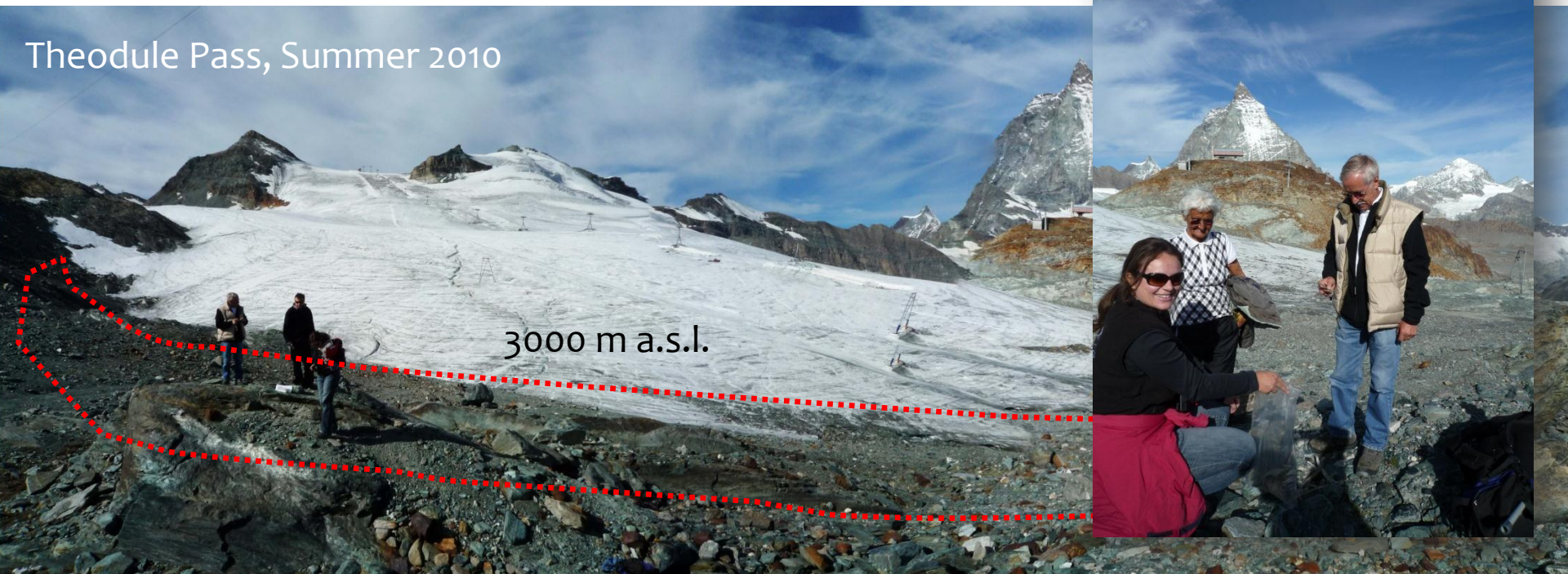
Reconstruction by: J. Fournier, 2007

Summer 2007

Photo by Philippe Curdy, Canton of Valais

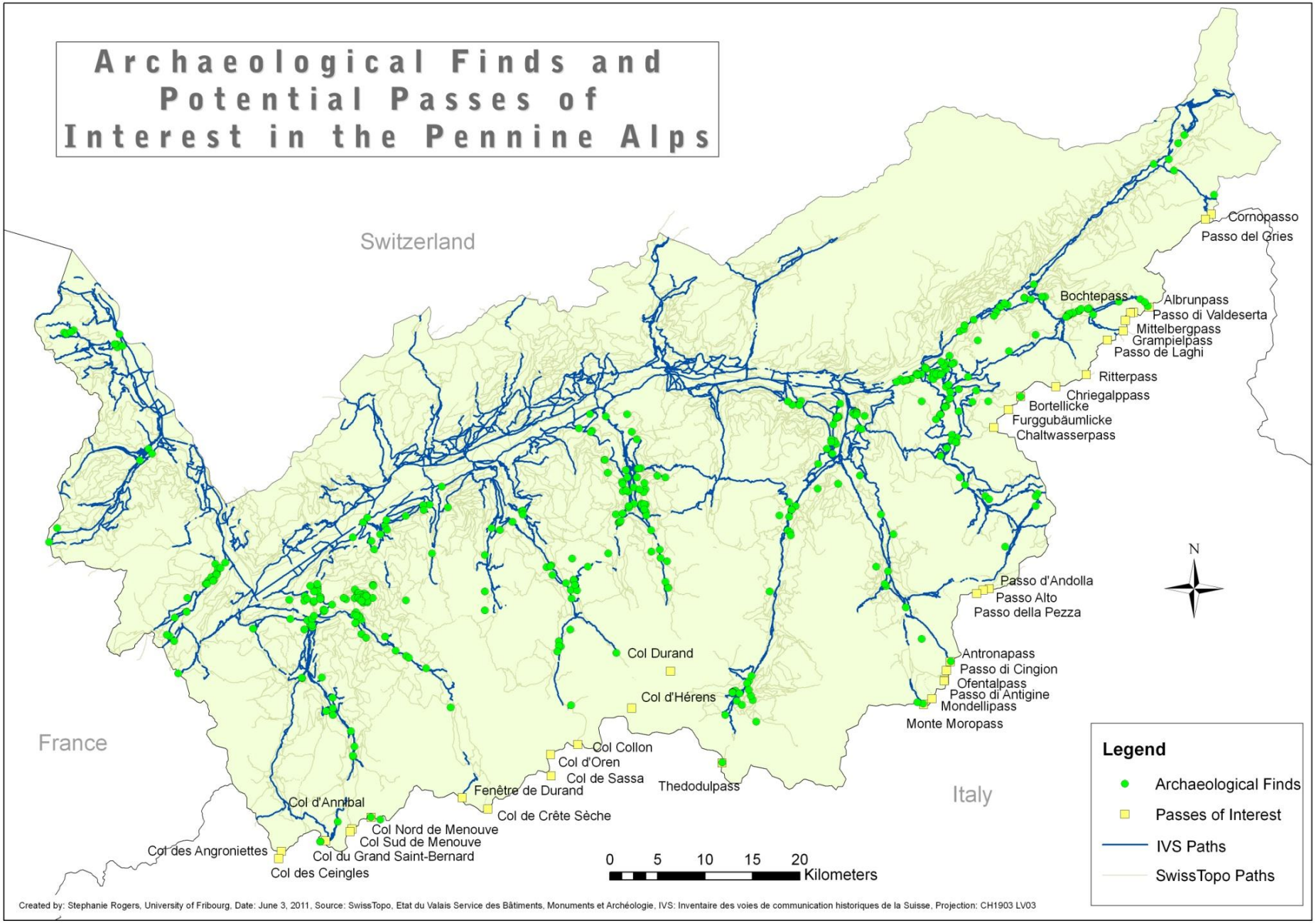
Archaeological Perspective

* Many archaeological remains have been uncovered in the Pennine Alps due to the rapid retreat of glaciers



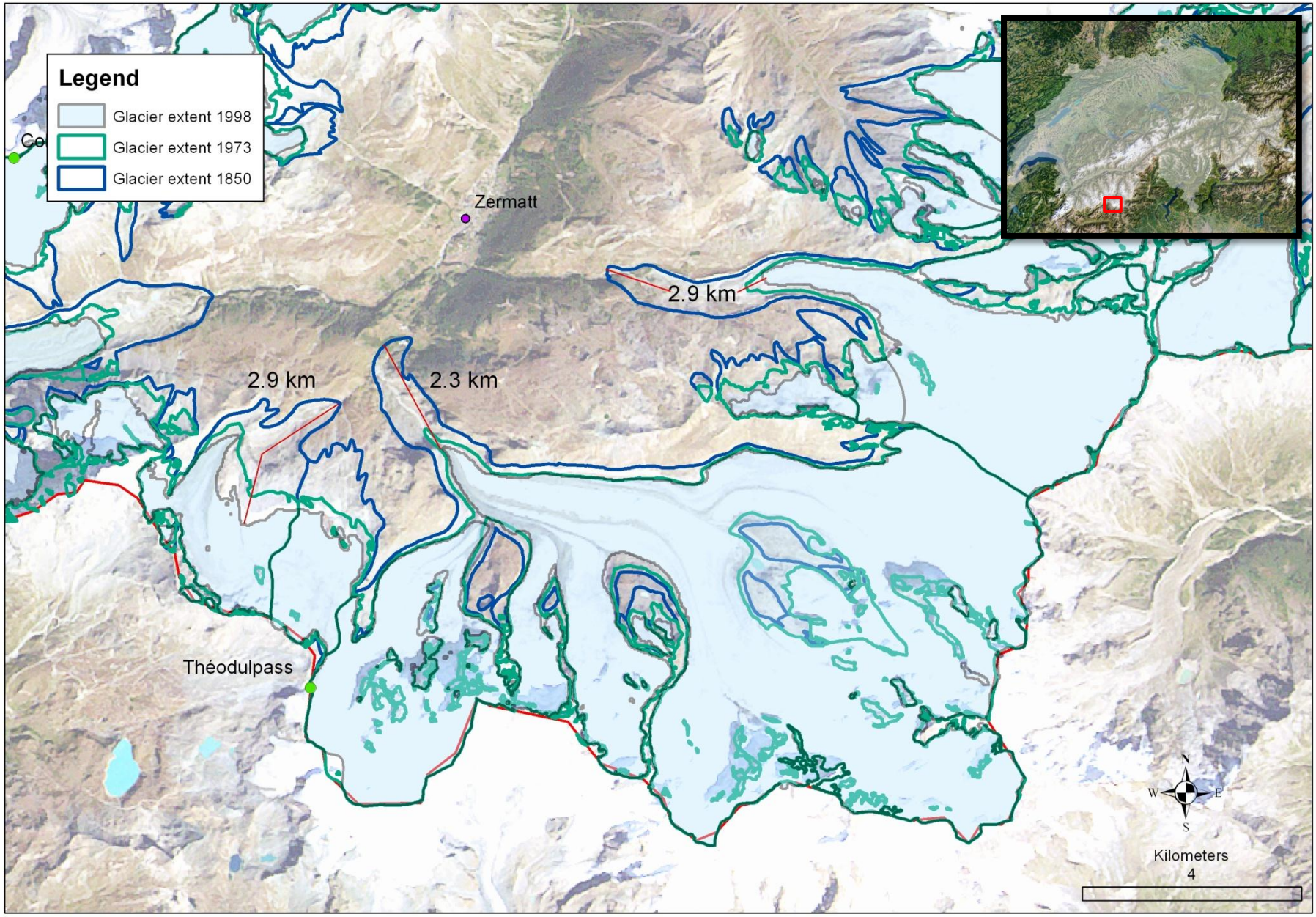
Archaeological Discoveries…

All images provided by the History Museum in Sion, Switzerland


Archaeological Finds and Potential Passes of Interest in the Pennine Alps
Switzerland
France
Italy
Cornopasso
Passo del Gries
Bochtepass
Albrunpass
Passo di Valdeserta
Mittelbergpass
Grampielpass
Passo de Laghi
Ritterpass
Chriegalppass
Bortellicke
Furggubäumlicke
Chaltwasserpass
Passo d'Andolla
Passo Alto
Passo della Pezza
Antronapass
Passo di Cingion
Ofentalpass
Passo di Antigine
Mondellipass
Monte Moropass
Col Durand
Col d'Hérens
Col Collon
Col d'Oren
Col de Sassa
Thedodulpass
Fenêtre de Durand
Col de Crête Sèche
Col d'Annibal
Col Nord de Menouve
Col Sud de Menouve
Col du Grand Saint-Bernard
Col des Angroniettes
Col des Ceingles
N
0 5 10 15 20
Kilometers
Legend
Archaeological Finds
Passes of Interest
IVS Paths
SwissTopo Paths
Created by: Stephanie Rogers, University of Fribourg, Date: June 3, 2011, Source: SwissTopo, Etat du Valais Service des Bâtiments, Monuments et Archéologie, IVS: Inventaire des voies de communication historiques de la Suisse, Projection: CH1903 LV03

Geographical Perspective

* Current warming period is causing glaciers to retreat
* Switzerland's glaciers have declined a third in volume since 1860 (Krajick, 2002)
* Frozen environments produce some of the most complete examples of archaeological remains
  * Increased interest and research in glacial and alpine regions to collect these valuable artifacts
  * Remains provide previously unavailable information about genetics, climate, biology and past human cultures

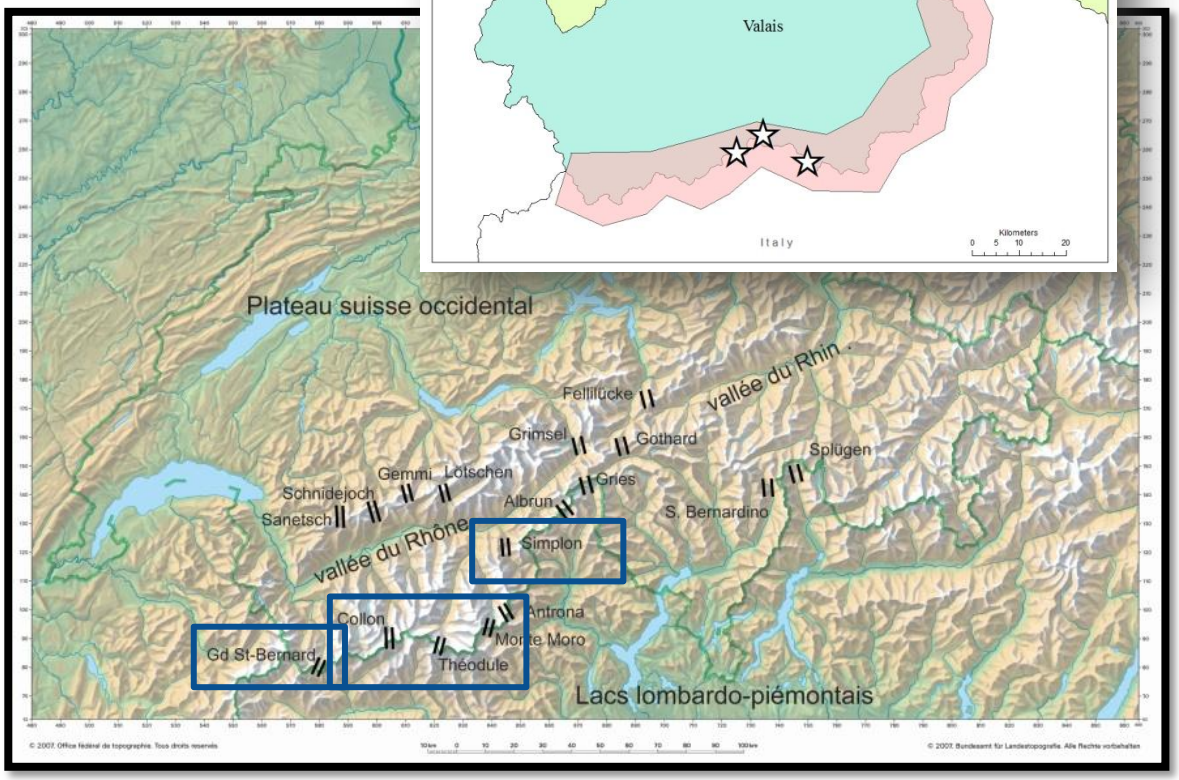

Legend
Glacier extent 1998
Glacier extent 1973
Glacier extent 1850
Zermatt
2.9 km
2.9 km
2.3 km
Théodulpass
N
W
E
S
Kilometers
4

Main Research Questions

* Which transalpine trails and passes have the highest discovery potential of artifacts?
* Which sites are most susceptible to rapid glacier retreat?
* Where are the most favourable places for the accumulation of archaeological relics?
  * Want to find the "best" locations for the conservation of archaeological material based on geographical, historical, and cultural inputs to a model

Methodologies

- **Archival Text Analysis**
  - Some major mountain passes are already well known and studied
  - Attempt to discover some "Lost" passes
  - Decided to focus on three less well known passes: Collon Pass, Theodule Pass, Pass of Herens



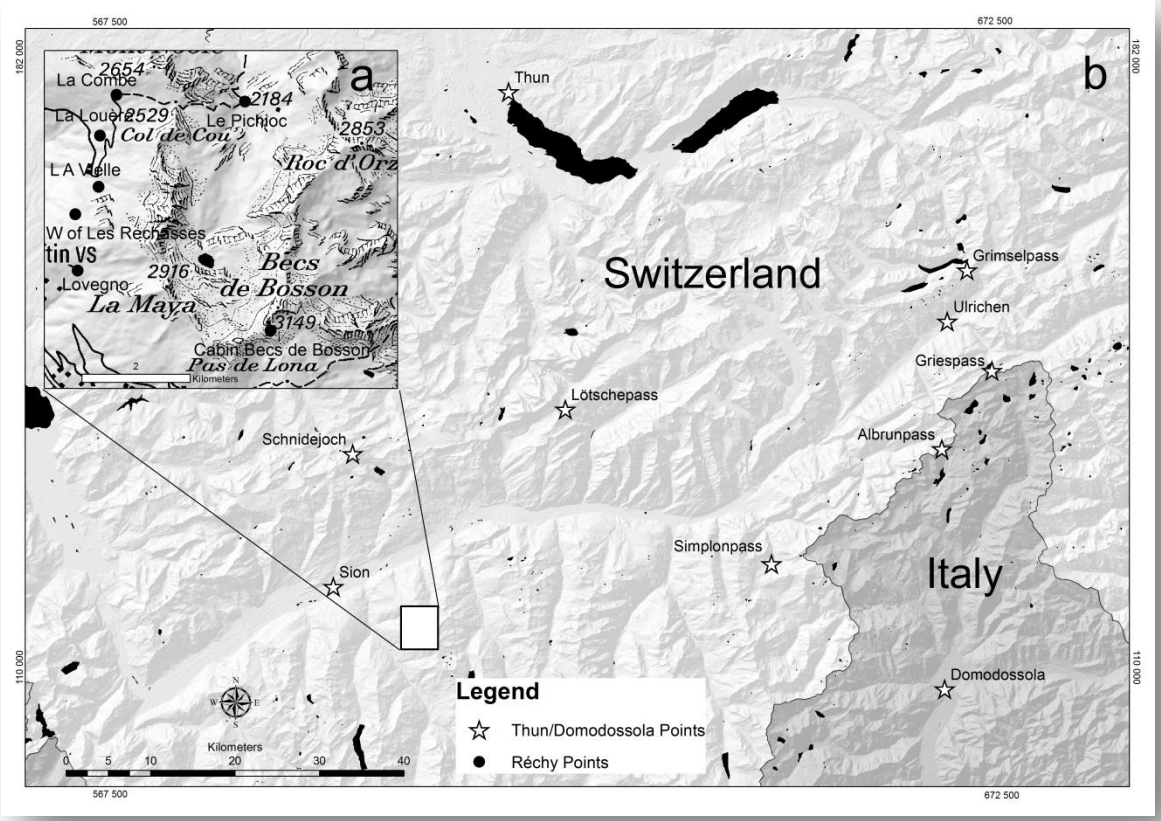
Cantonal Museum of Valais, Curdy

Methodologies

* **Least-cost Path Analysis**
  * Conducted to help narrow down possible corridors of travel between areas of the Pennine Alps
    * Sion to Aosta, Sion to Domodossola
    * Domodossola to Thun
  * Used ArcGIS 9.3 Distance toolset in Spatial Analyst extension
    * Cost Raster: Created by weighting Land cover (CORINE land cover database (250m resolution resampled to 50m resolution))
    * DEM: Downloaded for study area from ASTER GDEM (Global Digital Elevation Map). Originally 30m resolution resampled to 50m to match land cover
    * Anisotropic Algorithm for Slope: Tobler's walking speeds

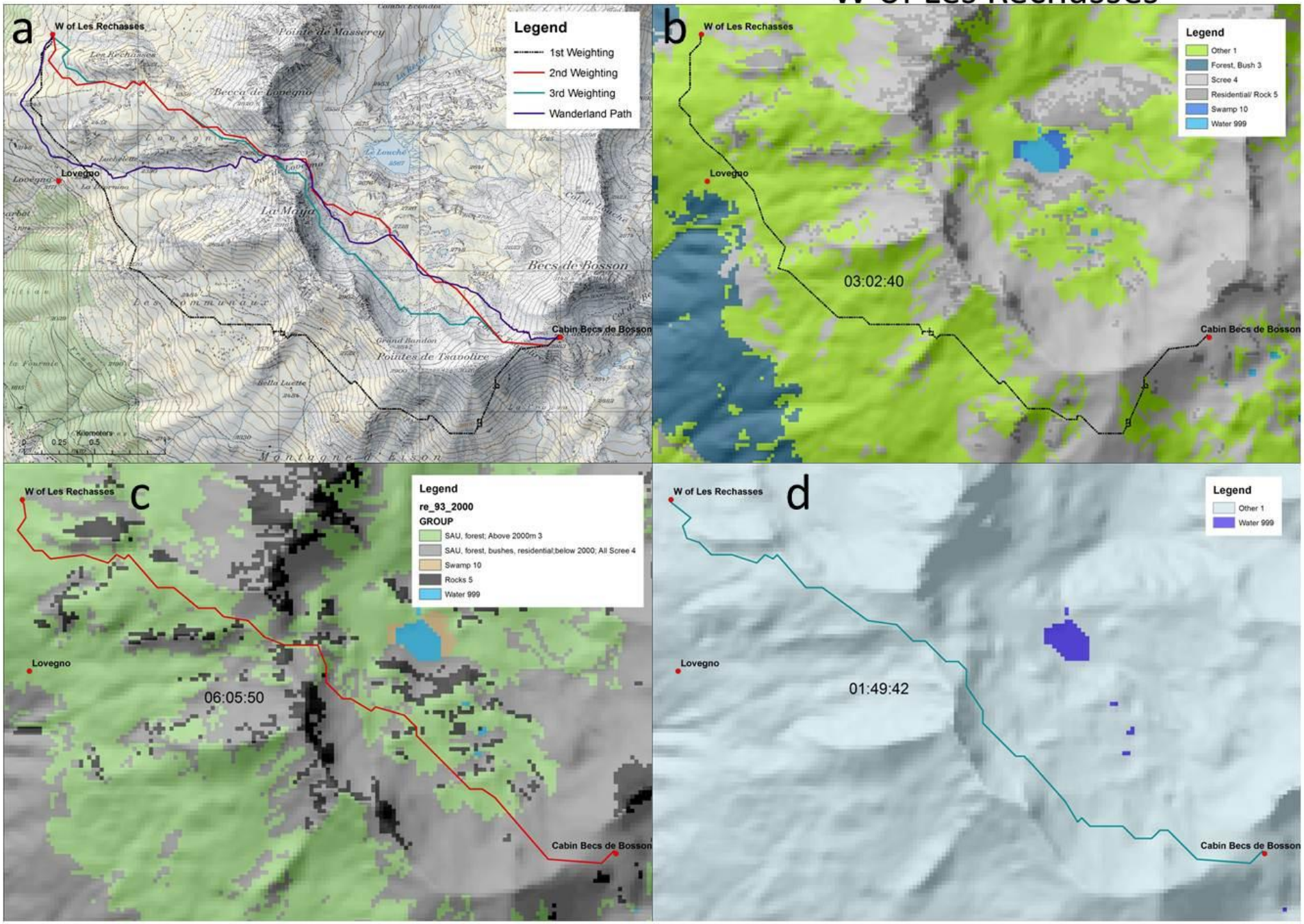
Methodologies

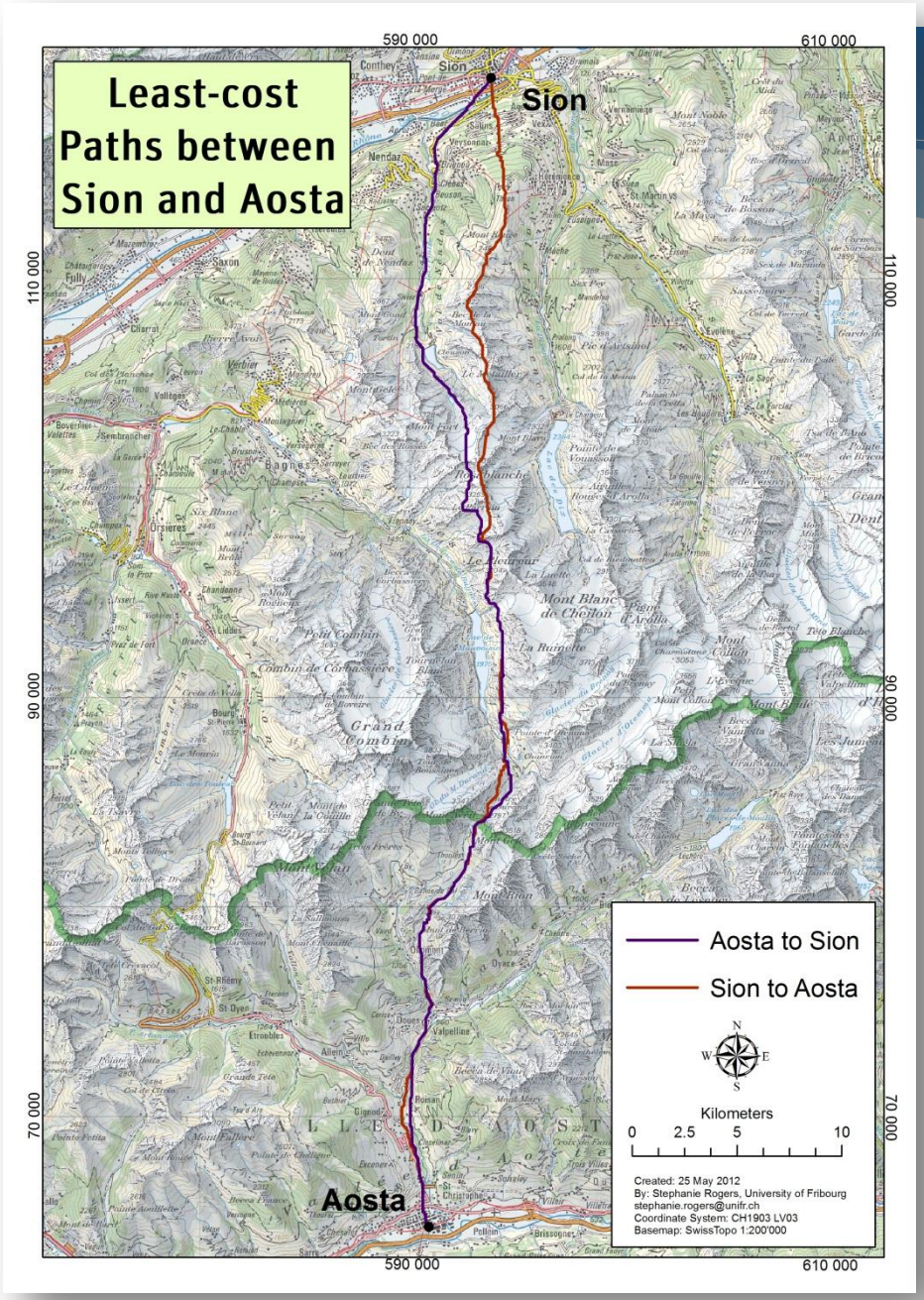
* Calibration site: Réchy

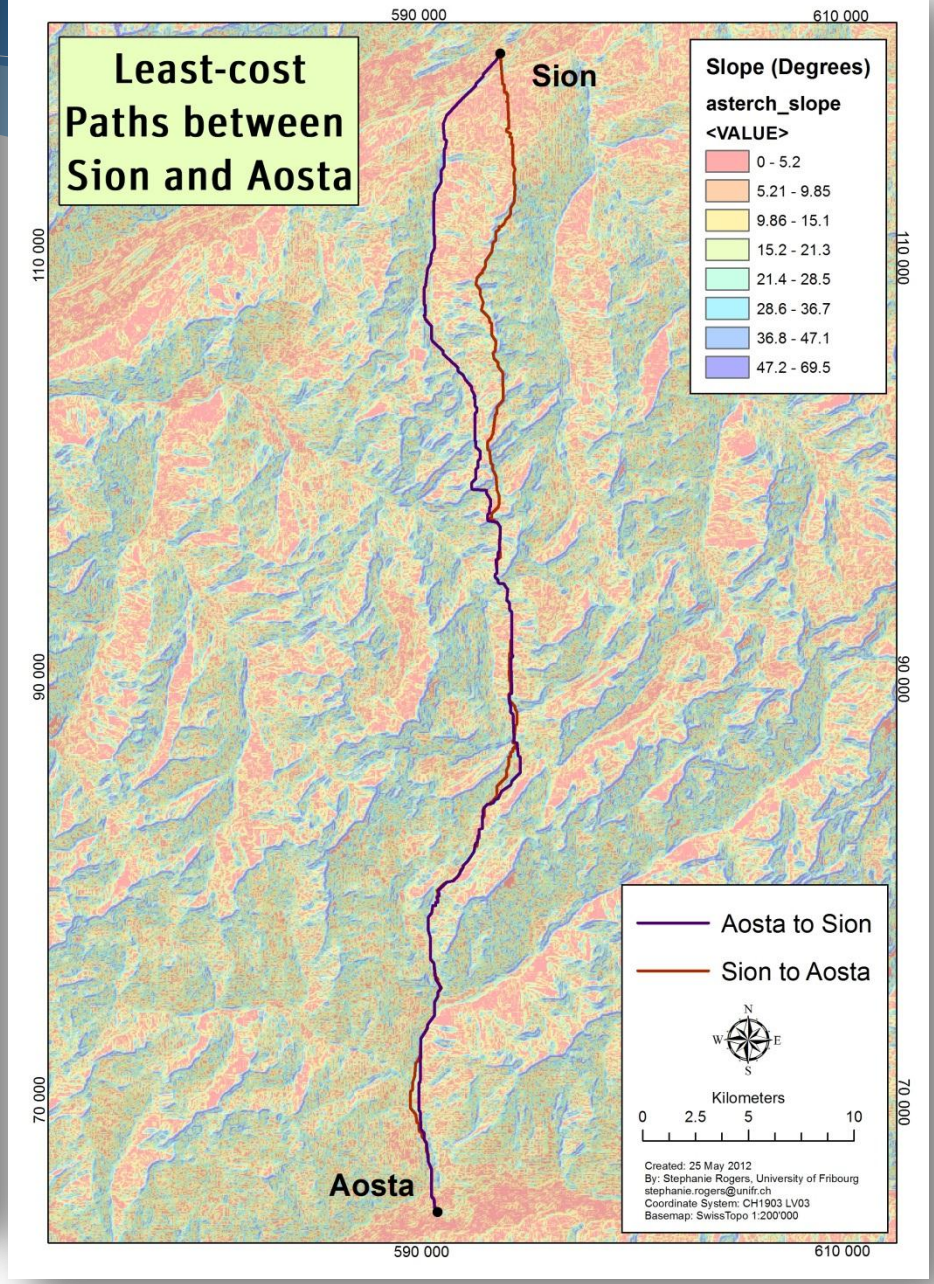


* Used a small study area to calibrate the land cover weighting and compare the results of the LCPs to actual trails that exist

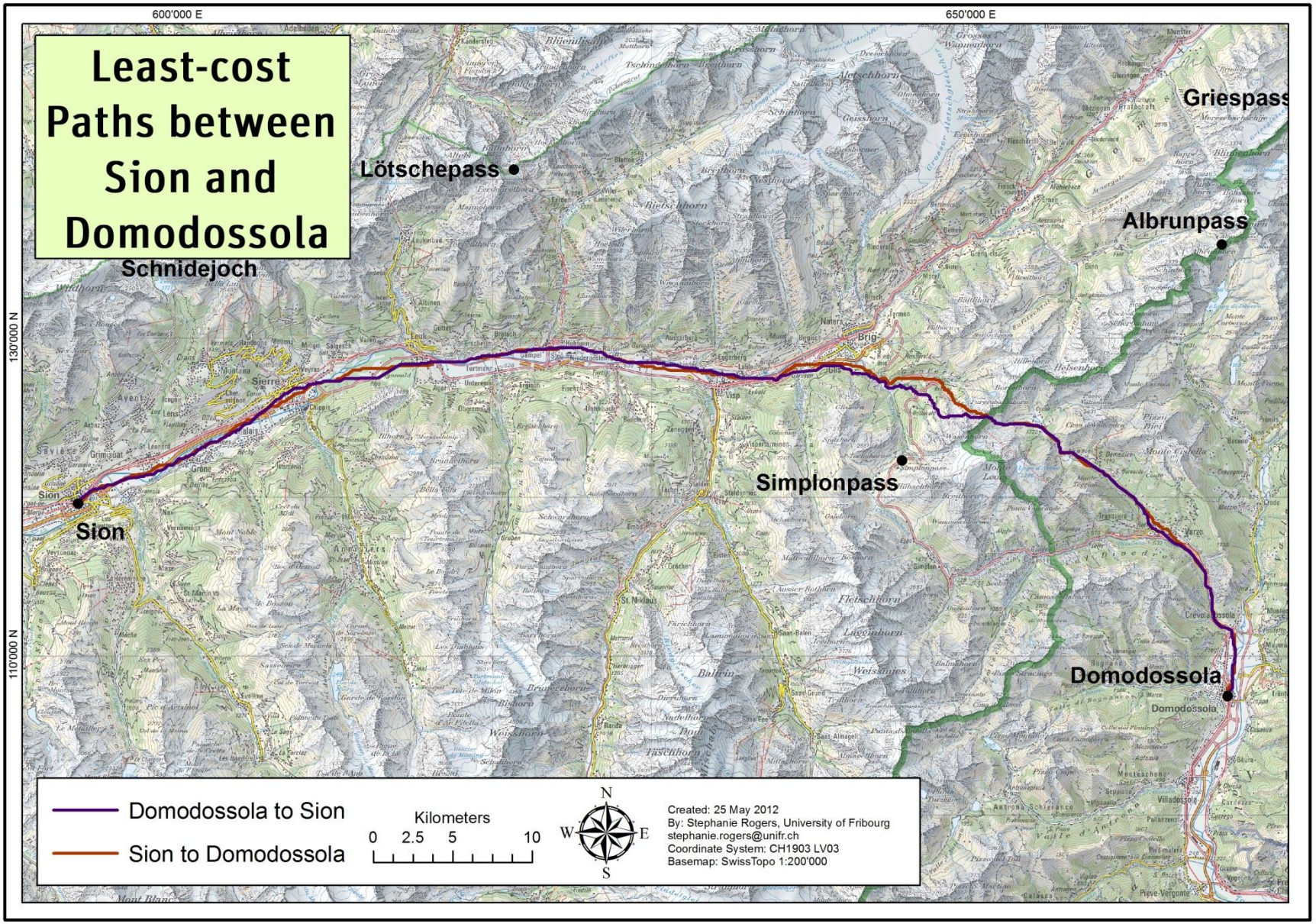
W of Les Rechasses



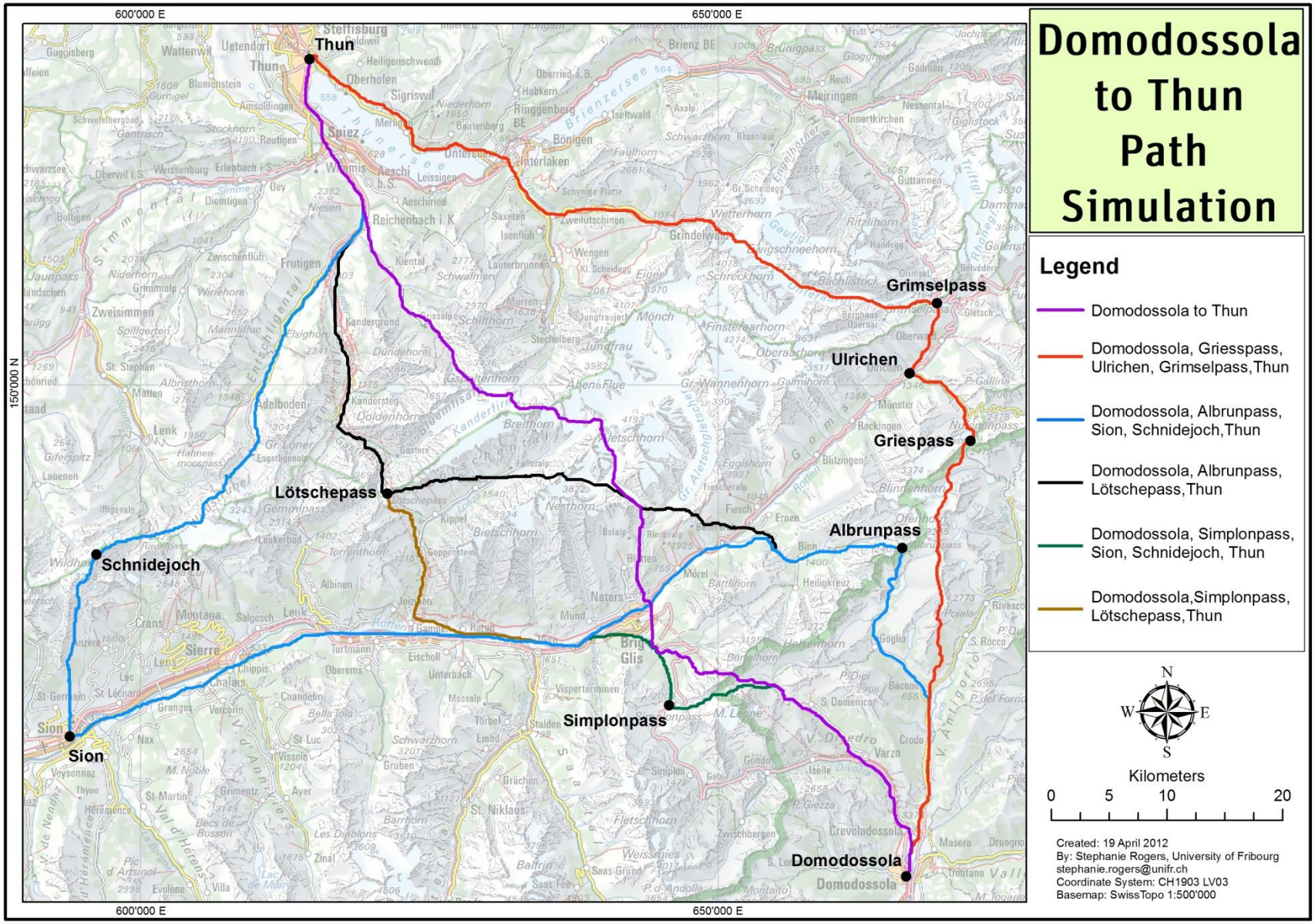

Least-cost Paths between Sion and Aosta
Sion
Aosta
590 000
610 000
110 000
90 000
70 000
Aosta to Sion
Sion to Aosta
N
W
E
S
Kilometers
0 2.5 5 10
Created: 25 May 2012
By: Stephanie Rogers, University of Fribourg
stephanie.rogers@unifr.ch
Coordinate System: CH1903 LV03
Basemap: SwissTopo 1:200'000


Least-cost Paths between Sion and Aosta
Sion
Aosta
590 000
610 000
110 000
90 000
70 000
Slope (Degrees)
asterch_slope
<VALUE>
0 - 5.2
5.21 - 9.85
9.86 - 15.1
15.2 - 21.3
21.4 - 28.5
28.6 - 36.7
36.8 - 47.1
47.2 - 69.5
Aosta to Sion
Sion to Aosta
N
W
E
S
Kilometers
0 2.5 5 10
Created: 25 May 2012
By: Stephanie Rogers, University of Fribourg
stephanie.rogers@unifr.ch
Coordinate System: CH1903 LV03
Basemap: SwissTopo 1:200'000

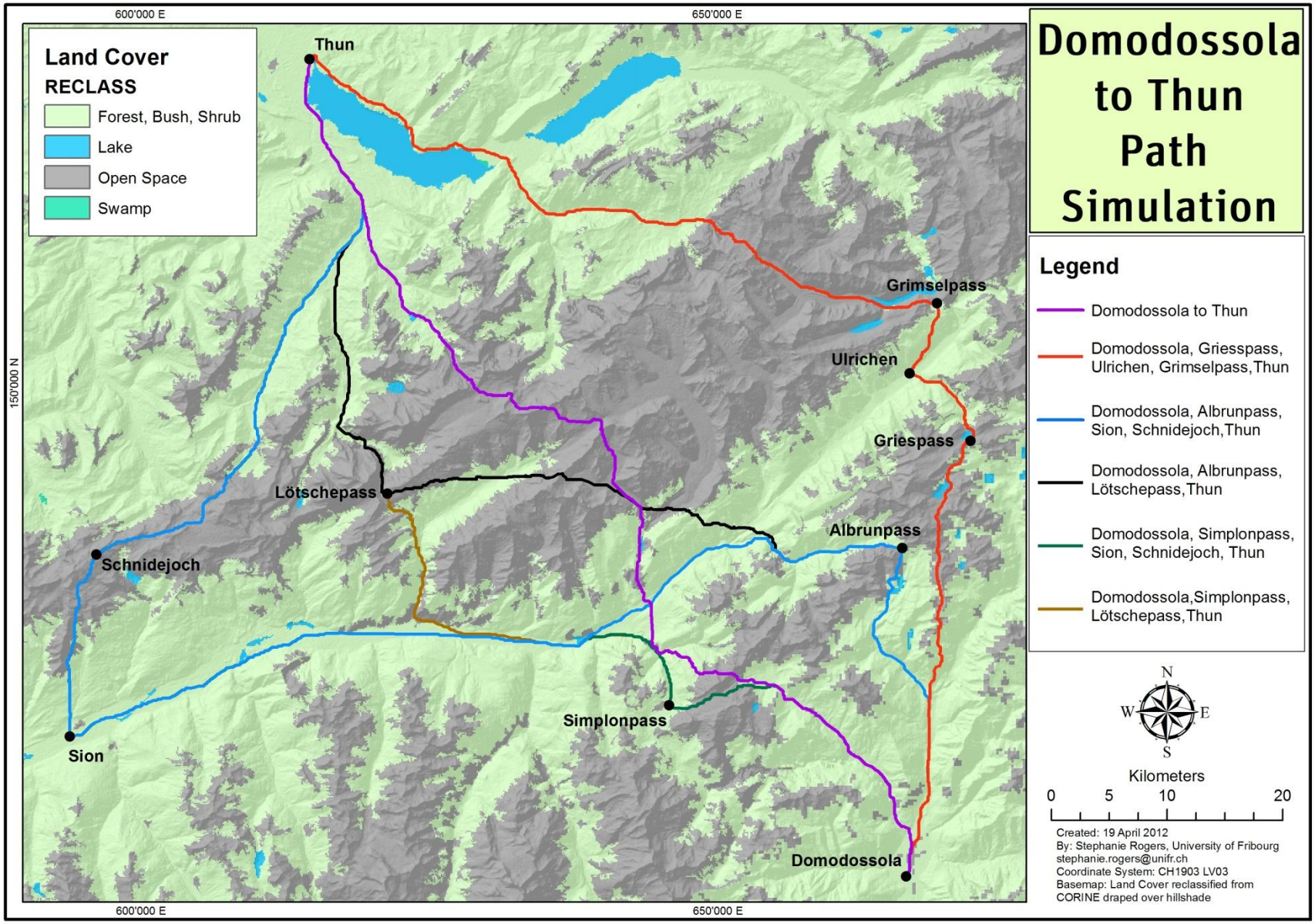
Least-cost Path Analysis Results



Least-cost Path Analysis Results

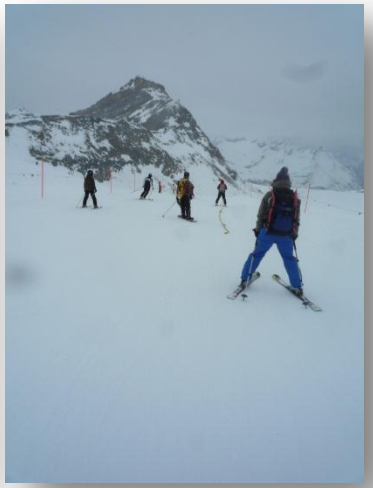


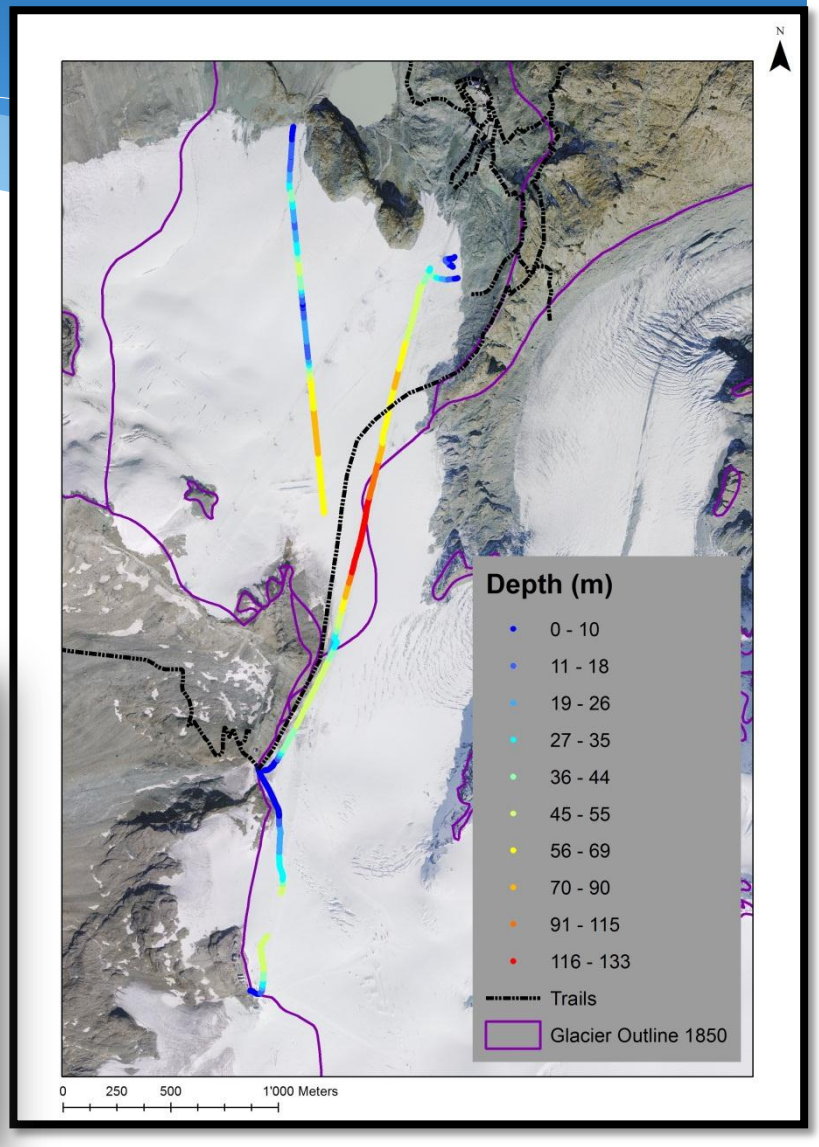
Least-cost Path Analysis Results



Methodologies

* Glaciological Modelling
  * Local scale: Ground Penetrating Radar (GPR) at Theodule Glacier to measure glacier thickness
  * Regional scale: Predictive model of glacier retreat for the entire Pennine Alps based on mass balance equations





Future Work and Expectations

* Another site for GPR measurements, perhaps Collon Pass
* Regional scale predictive glacier modelling
* Perform a Multicriteria Weighted Analysis (Dixon et al., 2005, Egeland et al., 2010)
  * Develop a method to predict sites with highest probability of archaeological remains....

Model creation

- Archaeological find locations
- Historical trails and passes
- Altitude of pass (higher than 2500m)
- Glaciated areas
- North facing slopes
- Buffered areas around Least-cost paths
- Bed topography, flat passes
- Colder than 0° for thousands of years

- Non-glaciated areas
- Steep slopes
- Rapidly moving ice
- South facing slopes
- Altitudes lower than 2500m

References

* **Dixon, E.J., W.F. Manley, and C. Lee, 2005.** The Emerging Archaeology of Glaciers and Ice Patches: Examples from Alaska's Wrangell-St. Elias National Park and Preserve . Archaeological Antiquity 70, pp. 129-143
* **Egeland, C.P., C.M. Nicholson, and B. Gasparian, 2010.** Using GIS and Ecological Variables to IdentifyHigh Potential Areas for Paleoanthropological Survey: An Example from Northern Armenia. Journal of Ecological Anthropology 14, pp. 89-98
* **Krajick, K. 2002**. Melting glaciers release ancient relics. Science 256, pp. 454-456
* **Tobler, W. 1993.** Three Presentations on Geographical Analysis and Modelling. Technical Report 93-1, National Center for Geographic Information and Analysis

Thank You!

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