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

Valais

Pennine Alps

Switzerland

Germany

France

Austria

Italy
Study Area Facts

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

- Matterhorn 4,478m (14,692ft)
- Monte Rosa 4,634m (15,203ft)

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

Summer 2007

Photo by Philippe Curdy, Canton of Valais
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

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
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
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.
Least-cost Path Analysis Results

Least-cost Paths between Sion and Domodossola

Sion

Domodossola

Simplonpass

Lötschepass

Albrunpass

Griespass

Schnidejoch

Legend:
- Purple: Domodossola to Sion
- Orange: Sion to Domodossola

Kilometers:
- 0
- 2.5
- 5
- 10

Created: 25 May 2012
By: Stephanie Rogers, University of Fribourg
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Coordinate System: CH1903 LV03
Basemap: SwissTopo 1:200'000
Least-cost Path Analysis Results

Domodossola to Thun Path Simulation

Legend
- Purple: Domodossola to Thun
- Red: Domodossola, Griesspass, Ulrichen, Grimselpass, Thun
- Blue: Domodossola, Albrunpass, Sion, Schnidejoch, Thun
- Black: Domodossola, Albrunpass, Lötschepass, Thun
- Green: Domodossola, Simplonpass, Sion, Schnidejoch, Thun
- Brown: Domodossola, Simplonpass, Lötschepass, Thun

Created: 19 April 2012
By: Stephanie Rogers, University of Fribourg
Coordinate System: CH1903 LV03
Base map: Swiss Topo 1:500'000
Least-cost Path Analysis Results

Domodossola to Thun Path Simulation

Legend
- Domodossola to Thun
- Domodossola, Griesspass, Ulrichen, Grimselpass, Thun
- Domodossola, Albrunpass, Sion, Schnidejoch, Thun
- Domodossola, Albrunpass, Lötschepass, Thun
- Domodossola, Simplonpass, Sion, Schnidejoch, Thun
- Domodossola, Simplonpass, Lötschepass, Thun

Land Cover
- RECLASS
  - Forest, Bush, Shrub
  - Lake
  - Open Space
  - Swamp

Created: 19 April 2012
By: Stephanie Rogers, University of Fribourg
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Coordinate System: CH1903 LV03
Base Map: Land Cover reclassified from CORINE drapred over hillshade
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
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

Influences
- 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

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

Archaeological Potential
References

Thank You!
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