Permafrost in the Alps: the experience of PermaNET project

“Long-term permafrost monitoring network”

Umberto Morra di Cella - P. Pogliotti

Agenzia Regionale per la Protezione dell'Ambiente della Valle d'Aosta

(on behalf of permaNET team)

Project framework

Partnership:
14 partners from 5 countries
(Austria, France, Germany,Italy and Switzerland)

Duration: 35 months
(07/2008 – 07/2011)

Budget: 3,3 M euro

partners

Alpine SPACE
THIS PROJECT IS CO-FUNDED BY THE EUROPEAN REGIONAL DEVELOPMENT FUND
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EUROPEAN TERRITORIAL COOPERATION

Automous Province of Bolzano - South Tyrol, Office for Geology and Building Materials Testing
http://www.provinz.bz.it/hochbau/themen/geologie.asp

Bavarian Environment Agency, Department 10: Geological Survey, Economic Geology, Soil Protection
http://www.bayern.de/lfu

Regional Agency for Environmental Protection of Piemonte, Regional centre for geological researches
http://www.arpa.piemonte.it

Aosta Valley Autonomous Region, Regional administrations comittee for territory, the environment and public works, Department for the territory, environment and water resources, Section environment
http://www.regione.vda.it

Region of Veneto, Geological Survey
http://www.regione.veneto.it

Autonomous Province of Trento - Civil and Territory Protection Department, Geological Survey
http://www.protezionecivile.tn.it/frame.asp?Site=6

Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management, Forest Department
http://www.lebensministerium.at

University of Innsbruck, Institute of Geography
http://www.uibk.ac.at/geographie/

University of Graz, Institute of Geography and Regional Science
http://www.uni-graz.at/geowww

Central Institute for Meteorology and Geodynamics, Regional Office for Salzburg and Oberösterreich
http://www.zamg.ac.at

University Joseph Fourier - Grenoble I, Institute of Alpine Geography, Lab PACTE-Territoires UMR 5194 UJF-UPMF-CNRS-IEP
http://www.pacte.cnrs.fr

National Center for Scientific Research - EDYTEM Laboratory
http://edytem.univ-savoie.fr/

Grenoble Institute of Technology, GIPSA-lab UMR 5216 UJF-INPG-CNRS
http://www.gipsa-lab.inpg.fr

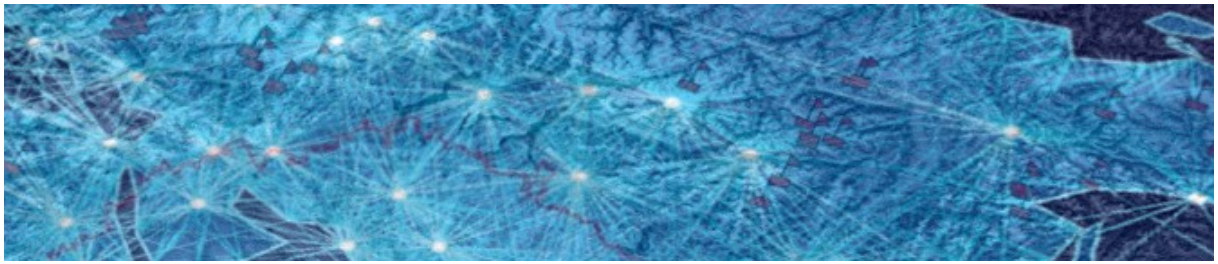
Federal Office for the Environment FOEN
http://www.umwelt-schweiz.ch

observers

International research Society INTERPRAEVENT
Ministero per la tutela dell'ambiente, del Territorio e del Mare, Direzione generale per la ricerca ambientale e lo sviluppo
University of Zurich
Swiss Federal Institute for Snow and Avalanche Research
Slovenian Torrent Erosion Control Service
Regione Piemonte, Direzione Ambiente, Settore Pianificazione Aree Protette
Seilbahnen Sulden
Dolomiti Superski
Skigebiet Ratschings-Jaufen
Confindustria Trento, Associazione Nazionale Esercenti Funiviari (A.N.E.F.), Sezione impianti a fune
Società degli Alpinisti Tridentini
Bayerische Zugspitzbahn Bergbahn AG
Südtiroler Alpenverein
Parco Naturale Adammello Brenta
Direction Régionale de l'Environnement Rhône Alpes
Pôle Grenoblois Risques Naturels
Office National des Forêts - Délégation Nationale Risques Naturels - RTM, Direction Technique Restauration des Terrains en Montagn
Parc National dècrins
Compagne des Guides de Chamonix
Amt der Tiroler Landesregierung, Abt. Geoinformation
Land Salzburg, Landesgeologischer Dienst
Amt der Steiermärkischen Landeregierung, Fachabteilung 17A/ Styrian Environment Information System Resort (LUIS), Department 1B
Land Vorarlberg, Landsvermessungsamt

Objectives

1. Creation of an alpine-wide **monitoring network** on permafrost



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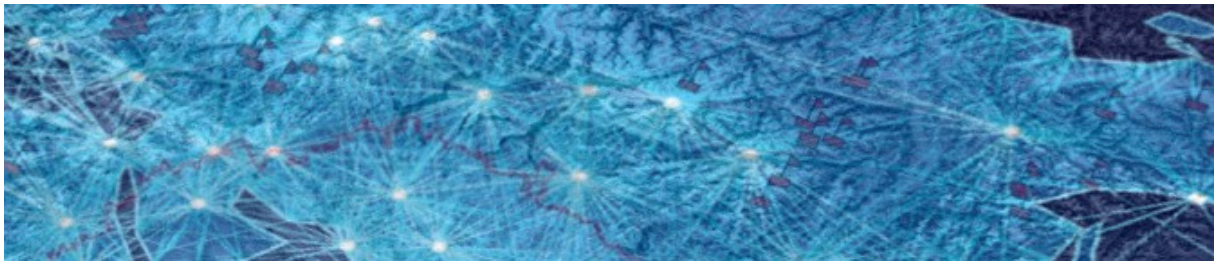

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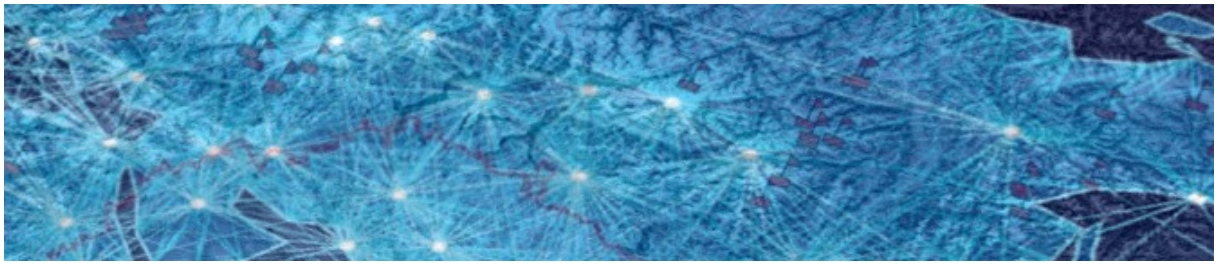
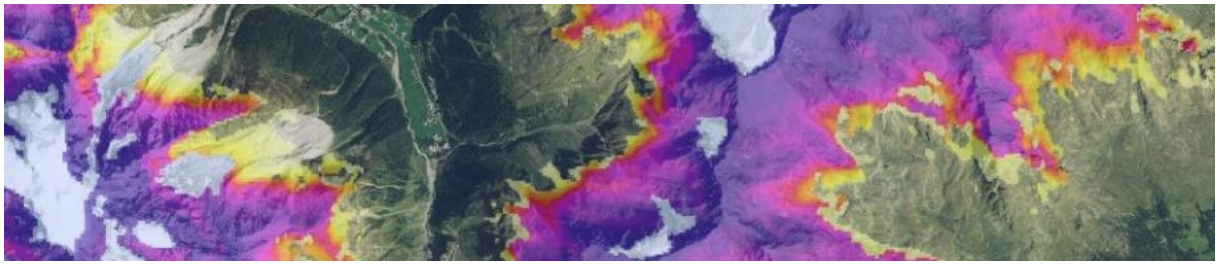


2. Creation of an alpine-wide **permafrost database**

3. Production of an alpine-wide **map of permafrost distribution**



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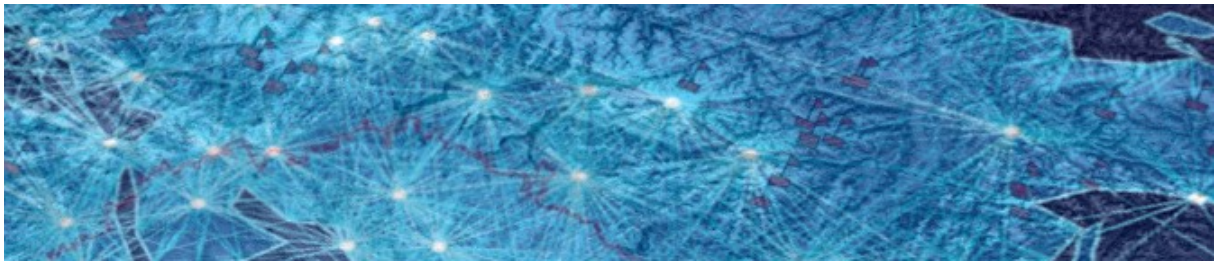

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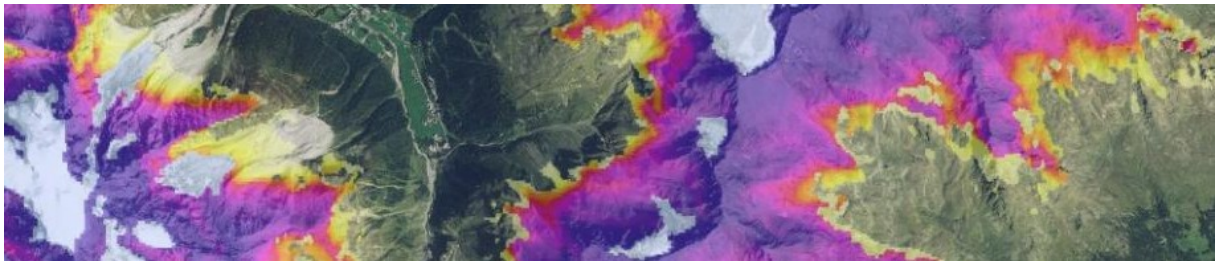

4. Development of **strategies for** dealing with permafrost-related **hazards and water pollution**

Objective 1

Creation of an alpine-wide **monitoring network** on permafrost

- Fill spatial-gaps of knowledge
- Homogenize data collection

11 new deep boreholes in the Alps

> 50 new GST sites – debris and rockwall

Standards for both drilling and data collection

Objective 2

Creation of an alpine-wide **permafrost database**

- Centralize data for sharing
- Create a wide\homogeneous dataset for analysis

2009-2011
Standardized collection of
permafrost evidence at alpine scale

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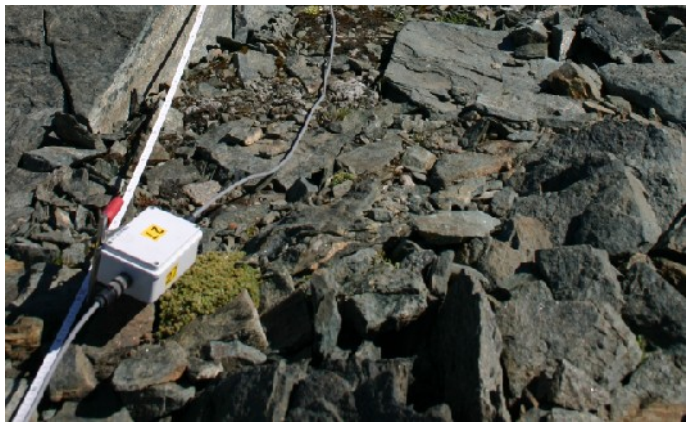

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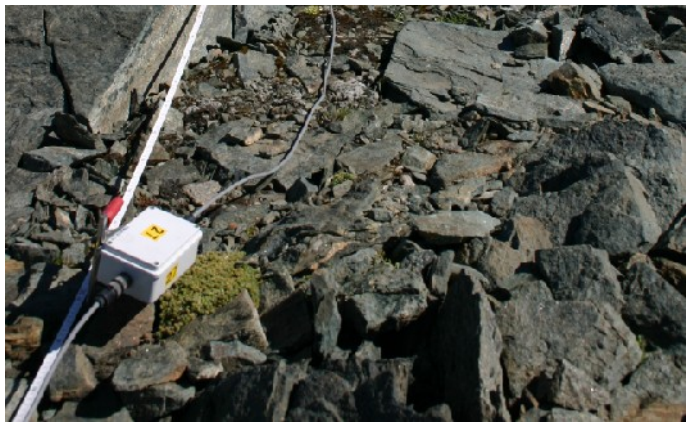


Objective 2

Creation of an alpine-wide **permafrost database**

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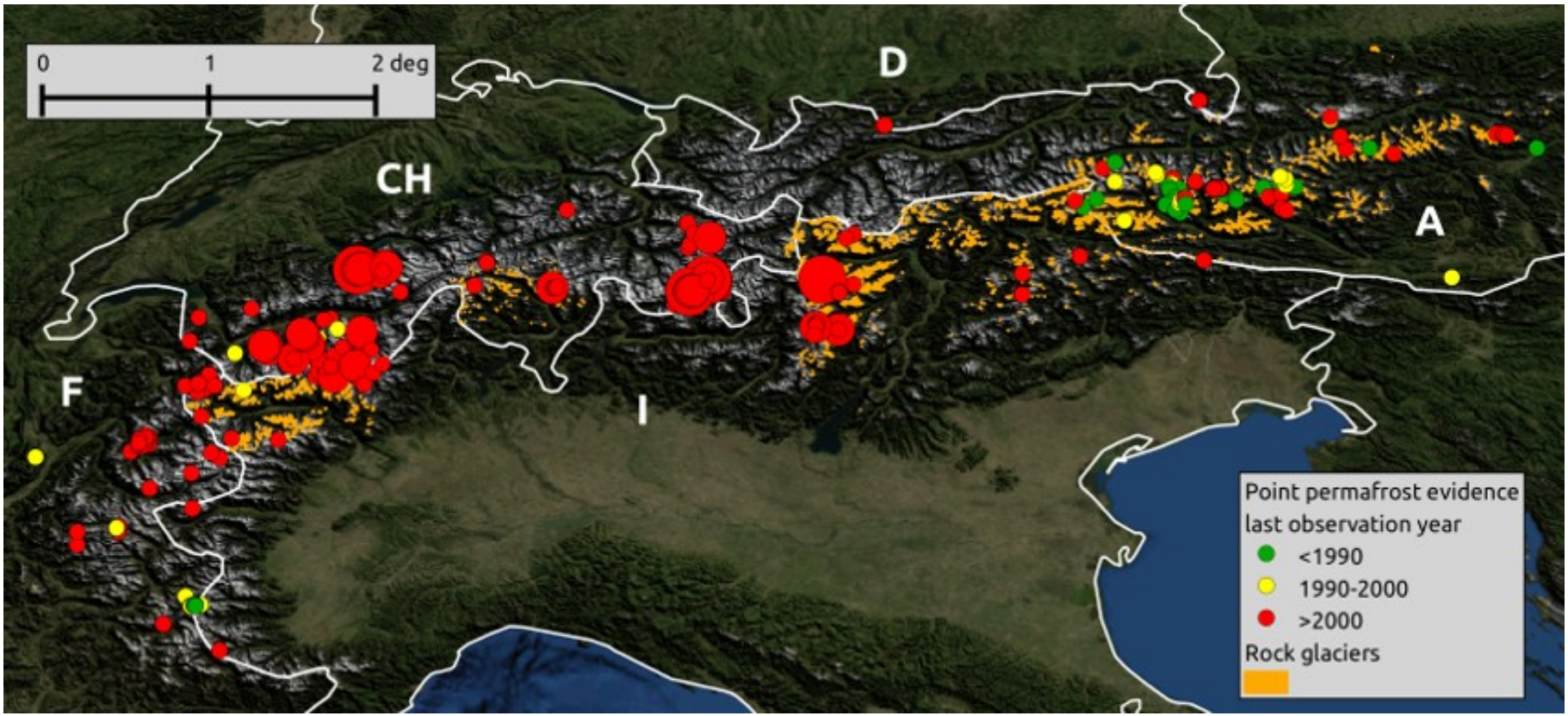
35 institutions provide data

> 400 point evidence

8 regional RG inventories (4795 RG)



The size of the dots indicates 3 classes (<3 yr, 3–8 yr, >8 yr) representing the length of observations associated

alpine permafrost data

Home | About | Evidence Map | Rock Glaciers Map | Download data | Contributors | Contacts | Profile | Logout

Welcome

The **Alpine Permafrost Data (APD)** is an on-line service for collecting and sharing permafrost data in the European Alps. The main goal of the database is to provide periodic, consistent and homogenized datasets on permafrost state and evolution. This website is addressed to all researchers, technicians and permafrost lovers working in the Alps. **Registration, data submission and updating of permafrost evidence is encouraged as well as the active participation in open discussions and database development.**

Background

The APD is based on an alpine-wide standardized collection of permafrost evidence, realized in the framework of the Alpine Space PermaNET project between 2008 and 2011. The APD was used for the development of the Alpine Permafrost Index Map. 35 contributors from Austria, Germany, France, Italy and Switzerland provided valuable data sharing permafrost knowledge and monitoring data. The development of the APD was a collaborative effort of ARPA Valle d'Aosta (IT), University of Zurich and SLF-WSL (CH).

- Add a new permafrost evidence -

See some examples:

- Borehole
- Ground Surface Temperature
- Surface Movement

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Alpine Space

Login

Hi Paolo Pogliotti,

Log out

Open discussions

News

http://www.alpine-permafrostdata.eu/

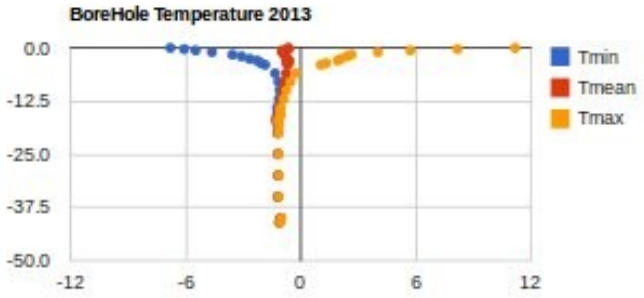
Home | About | Evidence Map | Rock Glaciers Map | Contributors | Contacts | Login

Metadata | Borehole Data | Ground Surface Temperature Data | Surface Movement

Borehole Depth (m) * 41

Choose the year to plot: 2013

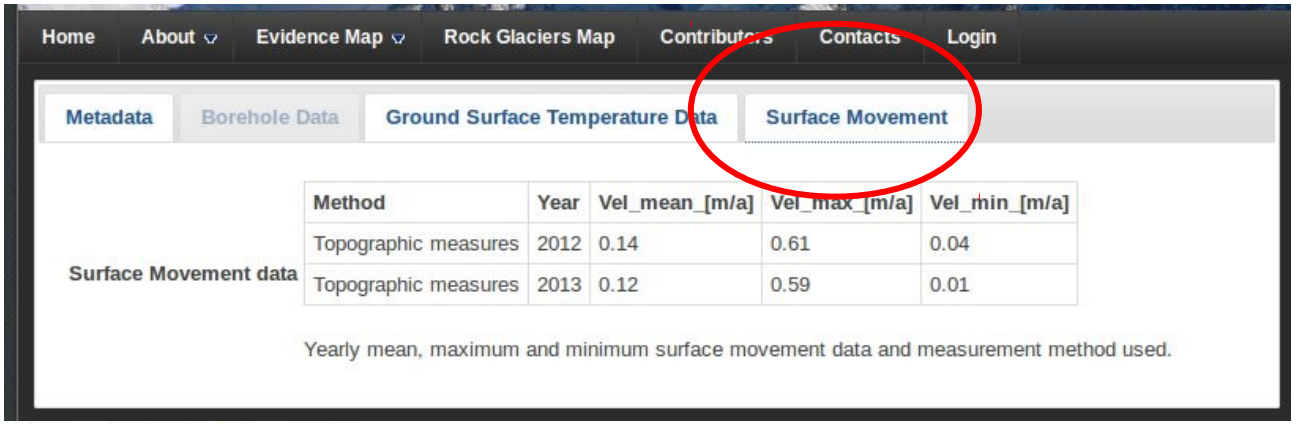
Temperature Data



Active Layer Data

Year	ALT (m)	Date
2008	3.94	2008-09-25
2009	4.93	2009-10-20
2010	3.86	2010-10-08
2011	5.13	2011-10-23
2012	5.42	2012-10-04
2013	4.6	2013-10-13

Yearly maximum active layer thickness (ALT) and date of maximum ALT occurrence.



http://www.alpine-permafrostdata.eu/

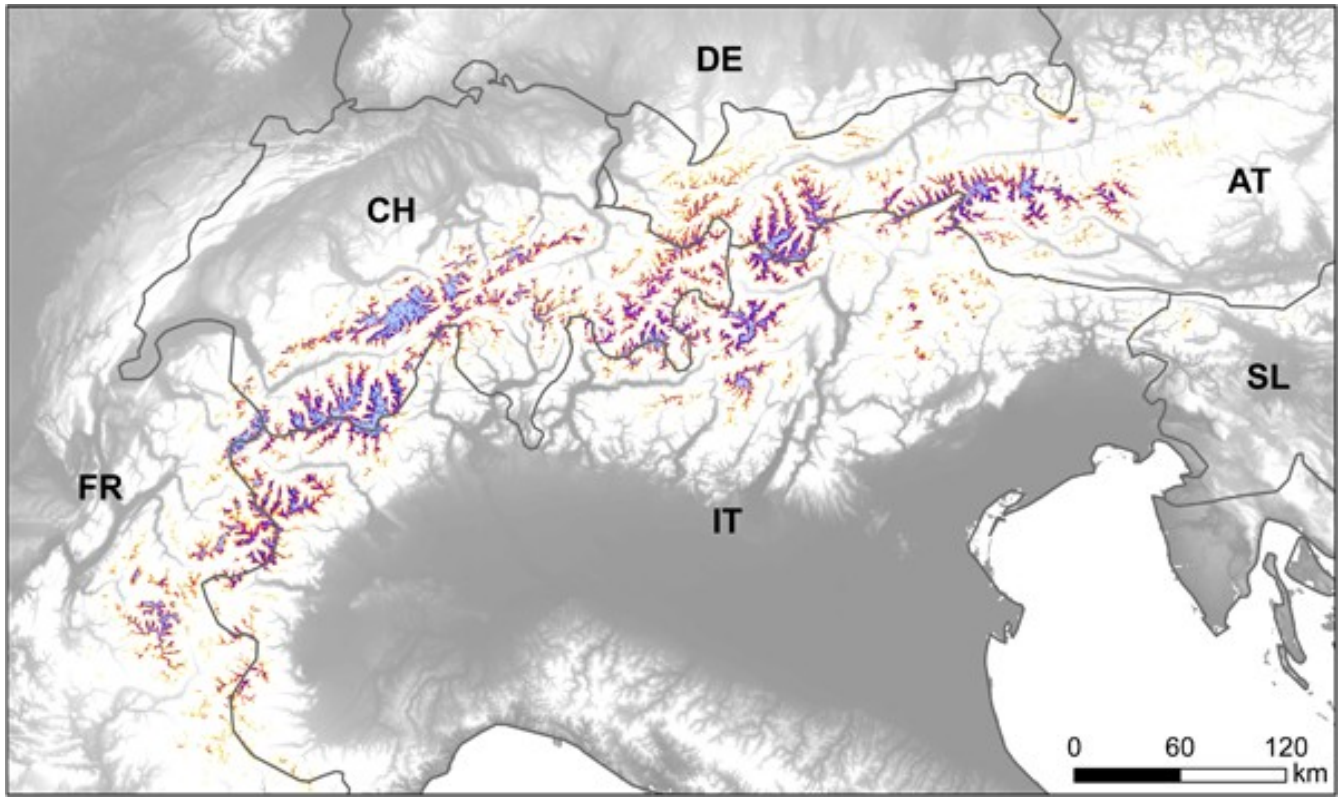
Objective 3

Creation of an alpine-wide **map of permafrost distribution**

- Provide stakeholders and researchers with a common operative tool

Index of the estimated likelihood of permafrost occurrence for the whole Alps

modelled and designed at the University of Zurich



http://www.geo.uzh.ch/microsite/cryodata/PF_map_explanation.html

Objective 3

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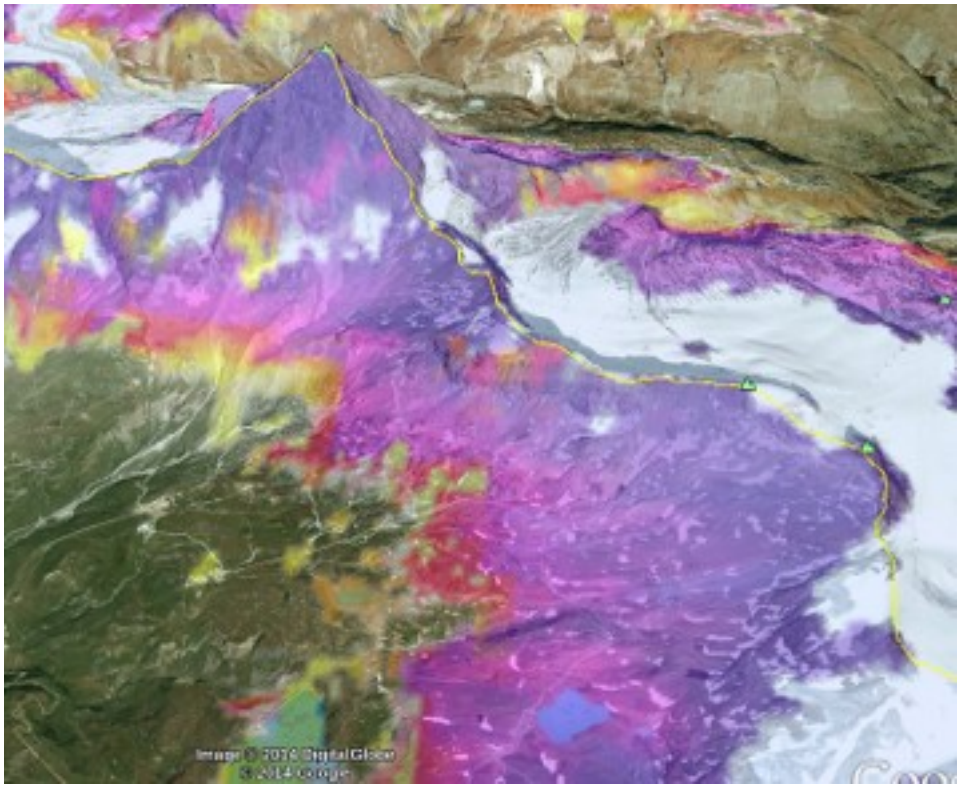
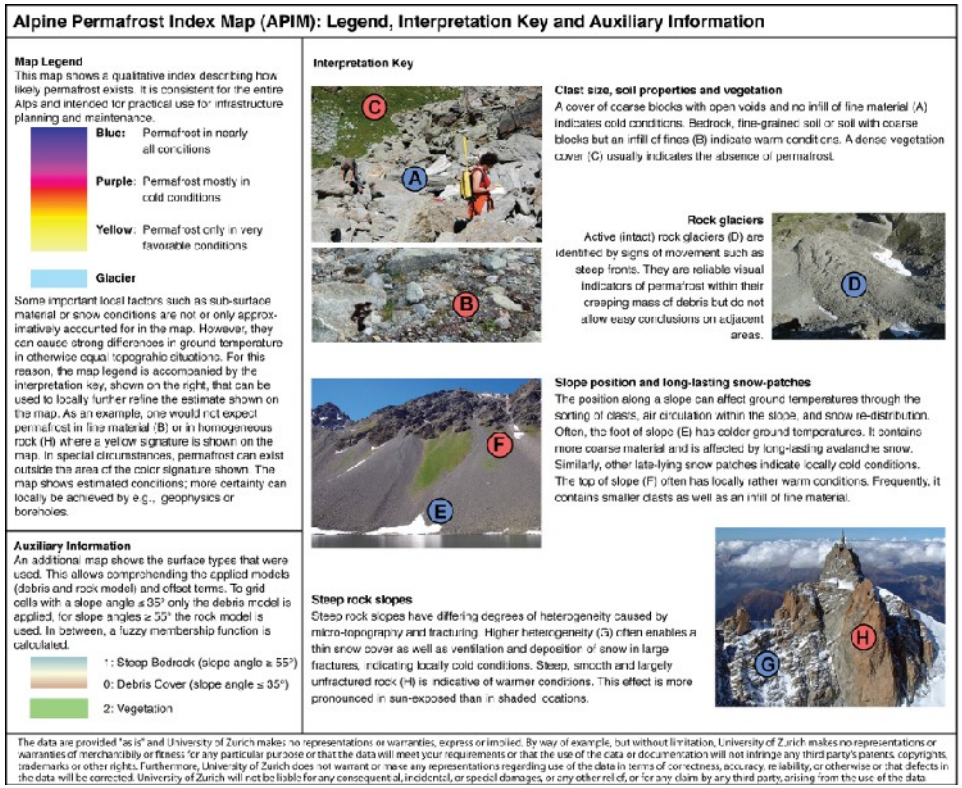
The legend and the **interpretation key** allow the map user to **refine the interpretation** of the color code considering the nature of terrain.





Alpine Permafrost Index Map (APIM): Legend, Interpretation Key and Auxiliary Information

Map Legend

This map shows a qualitative index describing how likely permafrost exists. It is consistent for the entire Alps and intended for practical use for infrastructure planning and maintenance.

Blue: Permafrost in nearly all conditions

Purple: Permafrost mostly in cold conditions

Yellow: Permafrost only in very favorable conditions

Glacier

Some important local factors such as sub-surface material or snow conditions are not or only approximatively accounted for in the map. However, they can cause strong differences in ground temperature in otherwise equal topographic situations. For this reason, the map legend is accompanied by the interpretation key, shown on the right, that can be used to locally further refine the estimate shown on the map. As an example, one would not expect permafrost in fine material (B) or in homogeneous rock (H) where a yellow signature is shown on the map. In special circumstances, permafrost can exist outside the area of the color signature shown. The map shows estimated conditions; more certainty can locally be achieved by e.g., geophysics or boreholes.

Auxiliary Information

An additional map shows the surface types that were used. This allows comprehending the applied models (debris and rock models) and offset terms. To grid cells with a slope angle ≤ 35° only the debris model is applied, for slope angles ≥ 55° the rock model is used. In between, a fuzzy membership function is calculated.

1: Steep Bedrock (slope angle ≥ 55°)

0: Debris Cover (slope angle ≤ 35°)

2: Vegetation

Interpretation Key

Clast size, soil properties and vegetation

A cover of coarse blocks with open voids and no infill of fine material (A) indicates cold conditions. Bedrock, fine-grained soil or soil with coarse blocks but an infill of fines (B) indicate warm conditions. A dense vegetation cover (C) usually indicates the absence of permafrost.

Rock glaciers

Active (intact) rock glaciers (D) are identified by signs of movement such as steep fronts. They are reliable visual indicators of permafrost within their creeping mass of debris but do not allow easy conclusions on adjacent areas.

Slope position and long-lasting snow-patches

The position along a slope can affect ground temperatures through the sorting of clasts, air circulation within the slope, and snow re-distribution. Often, the foot of slope (E) has colder ground temperatures. It contains more coarse material and is affected by long-lasting avalanche snow. Similarly, other late-lying snow patches indicate locally cold conditions. The top of slope (F) often has locally rather warm conditions. Frequently, it contains smaller clasts as well as an infill of fine material.

Steep rock slopes

Steep rock slopes have differing degrees of heterogeneity caused by micro-topography and fracturing. Higher heterogeneity (G) often enables a thin snow cover as well as ventilation and deposition of snow in large fractures, indicating locally cold conditions. Steep, smooth and largely unfractured rock (H) is indicative of warmer conditions. This effect is more pronounced in sun-exposed than in shaded locations.

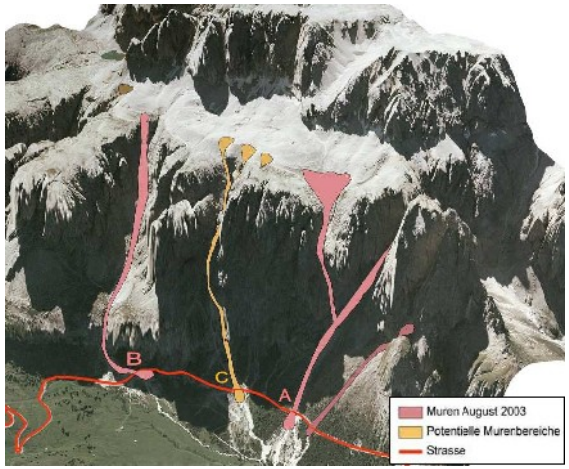
Objective 4

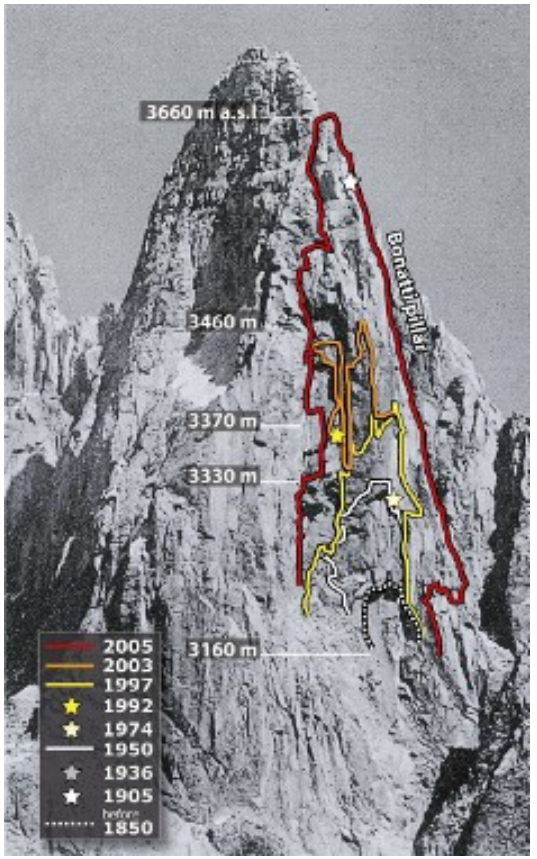
Development of **strategies for** dealing with **permafrost-related natural hazards**

- Provide handbooks and guidelines
- Define possible scenarios

Identification of risks deriving from permafrost degradation

Recommendations for policy makers





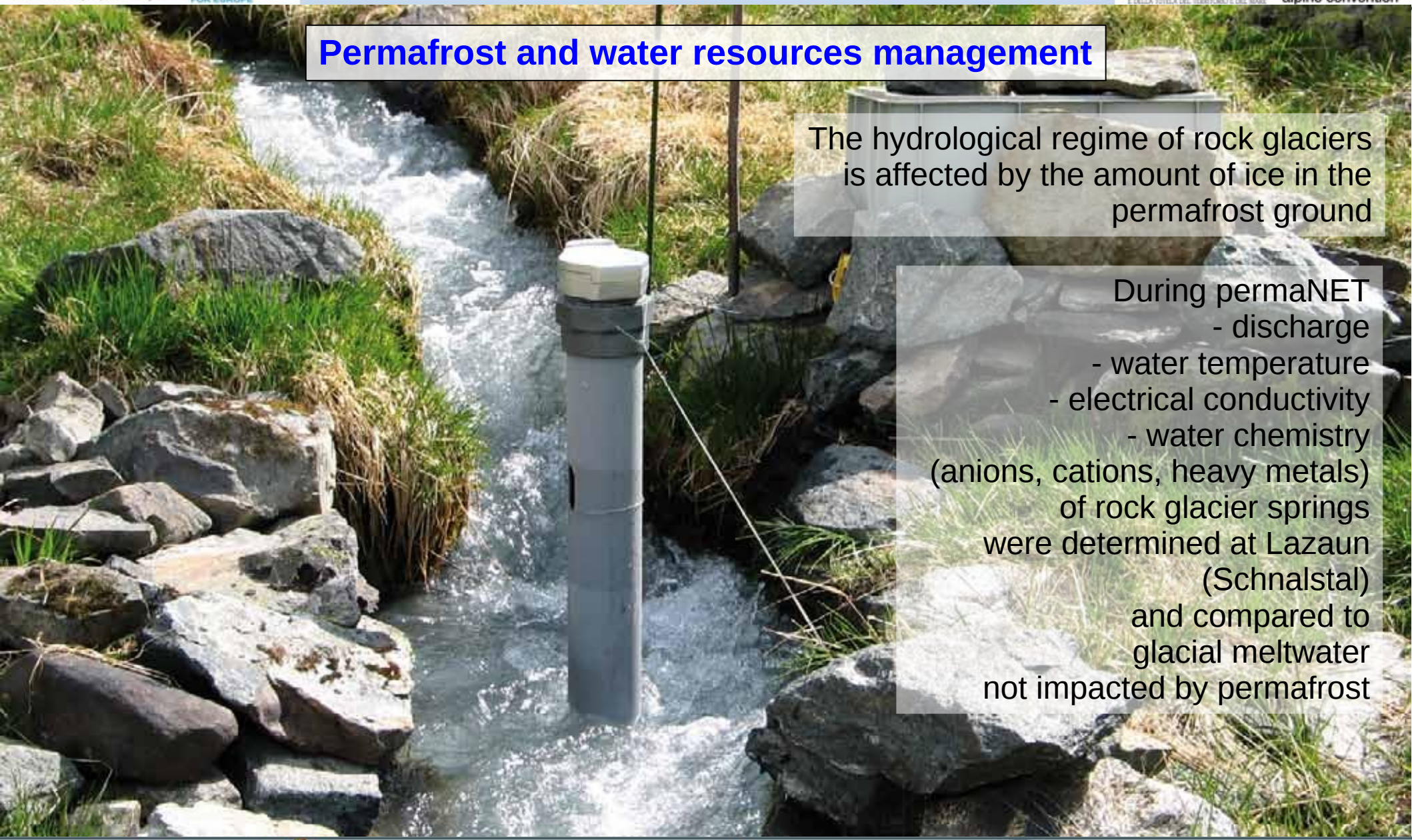
Permafrost and water resources management

Permafrost degradation will likely increase the melting of interstitial ice in rockglaciers.

Has been observed that melt water from rock glaciers are highly concentrated in heavy-metals and ions.

Surface waters (springs and creeks) in mountain may experience a strong change in chemical composition.

Permafrost and water resources management



The hydrological regime of rock glaciers is affected by the amount of ice in the permafrost ground

During permaNET
- discharge
- water temperature
- electrical conductivity
- water chemistry

(anions, cations, heavy metals) of rock glacier springs were determined at Lazaun (Schnalstal) and compared to glacial meltwater not impacted by permafrost

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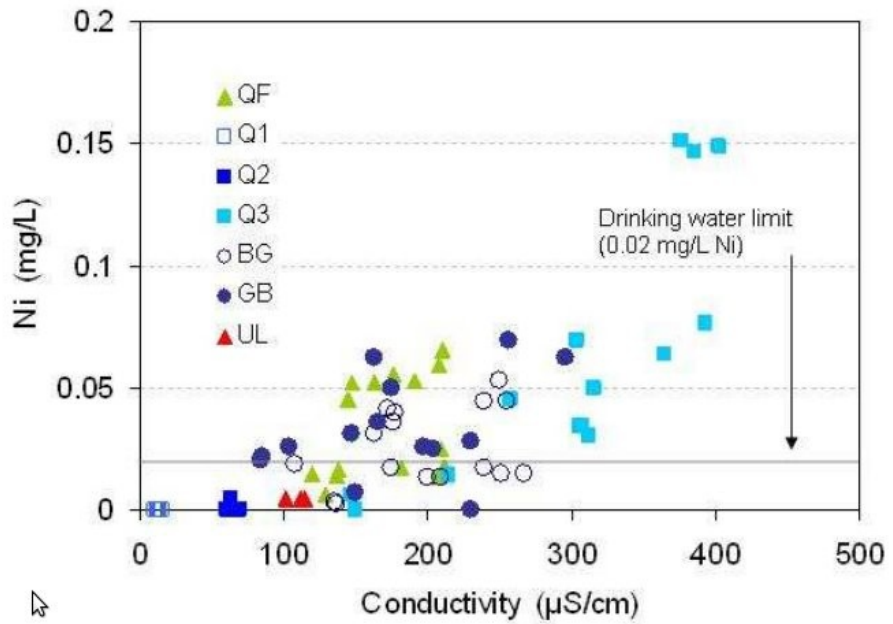

Fig. 4: Nickel concentration and conductivity of springs in the Lazaun cirque and at Ulten. Samples were taken in the years 2007, 2009 and 2010 (for abbreviations see above).

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Permafrost and water resources management

Core drillings were performed at two active rock glaciers (Lazaun – Schnalstal and Rossbänk – Ultental).

The cores were analyzed for
- ice-content
- ice-chemistry
- stable isotopes
- palynology

at Uni. Innsbruck

The total melting of rock glaciers is about 182,38 l/s (= 0,18 m^3/s), this is about **0,13%** of the total runoff of South Tyrol (142,76 m^3/s).

Permafrost and water resources management

Alpine Space
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WP7 Water resources

Action 7.4 – Handbook

Recommendations for the consideration of permafrost in drinking water resources management

Conclusions...

Monitoring network on permafrost

+

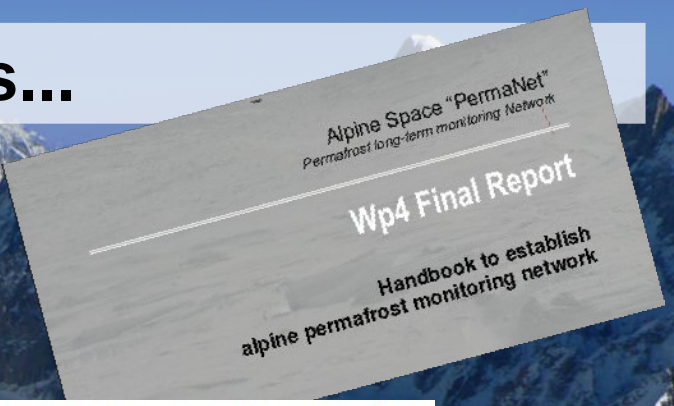
Permafrost database

+

Map of permafrost distribution

(+ case studies)

Conclusions...



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Thermal and geomorphic permafrost response to present and future climate change in the European Alps

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Spring temperature and water chemistry

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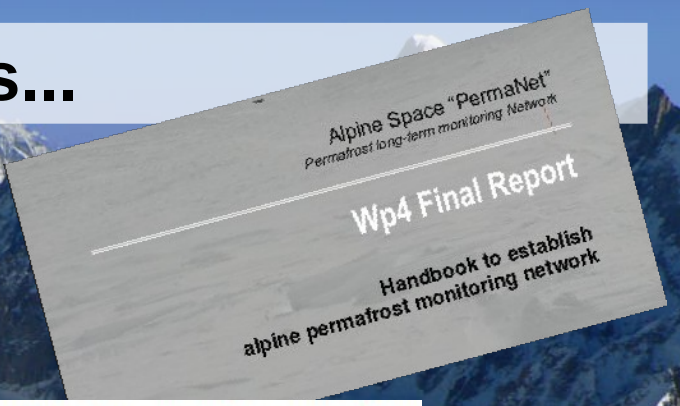

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The Cryosphere, 5, 651–657, 2011
www.the-cryosphere.net/5/651/2011/
doi:10.5194/tc-5-651-2011

The Cryosphere

Brief Communication:
"An inventory of permafrost evidence for the European Alps"

E. Cremonese[1], S. Gruber[2], M. Phillips[3], P. Pogliotti[1], L. Boeckli[2], J. Noetzli[2], C. Suter[3], X. Bodin[4], A. Crepaz[5], A. Kellerer-Pirklbauer[6,7], K. Lang[8], S. Letey[1], V. Mair[5], U. Morra di Cella[1], L. Ravanel[4], C. Scapozza[9], R. Seppi[10] and A. Zischg[11]

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[2]Glaciology. Geomorph
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[4]Laboratoire EDYTEM,
[5]Arabba Avalanche Cen
[6]Department of Geogra
[7]Institute of Remote Sen
[8]Autonomous Province
[9]Institute of Geography,
[10]Earth Science Depart
[11]Abenis Alpinexpert Sr

The Cryosphere, 6, 125–140, 2012
www.the-cryosphere.net/6/125/2012/
doi:10.5194/tc-6-125-2012

The

A statistical approach to modelling permafrost distribution in the European Alps or similar mountain ranges

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Revised: 6 December 2

The Cryosphere, 6, 807–820, 2012
www.the-cryosphere.net/6/807/2012/
doi:10.5194/tc-6-807-2012

The Cryosphere

Permafrost distribution in the European Alps: calculation and evaluation of an index map and summary statistics

L. Boeckli[1], A. Brenning[2], S. Gruber[1], and J. Noetzli[1]
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http://www.permanet-alpinespace.eu/

& thanks...