Investigating steep bedrock Permafrost with Wireless Sensor Networks

Andreas Hasler (1), Igor Talzi (2), Stephan Gruber (1) and Christian Tschudin (2)

(1) Glaciology and Geomorphodynamics Group, Department of Geography, University of Zurich, Switzerland
(2) Computer Science Department, University of Basel, Switzerland
Contact: ahasler@geo.unizh.ch / +41 44 635 51 88

UNI BASEL
University of Zurich

NCCR MICS
Bundesamt für Umwelt BAFU

Background and motivation

Warming and thawing permafrost in steep alpine bedrock can affect slope stability, lead to natural hazards and complicate the operation of man-made infrastructure. Corresponding heat flux and phase change processes in porous fractured rock are currently poorly understood. To develop theoretical models for temperature simulation and for hazard assessment, continuous and reliable data of physical parameters in natural and diverse slope areas are required. At present, only limited measurement data exist for selected locations, but no large-scale measurement series are available. This is partly due to the lack of inexpensive, easy to deploy and reliable measurement systems. Furthermore, data collection in steep and inaccessible terrain is time consuming and dangerous with conventional data logging systems.

figure 1: deployment of sensor rods (n. mathys)

First deployment at Jungfraujoch (3500 m a. s. l.)

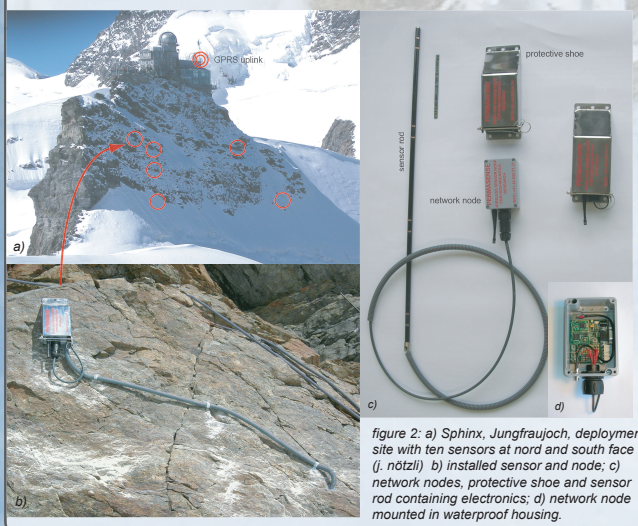

figure 2: a) Sphinx, Jungfraujoch, deployment site with ten sensors at nord and south face (j. nötzli) b) installed sensor and node; c) network nodes, protective shoe and sensor rod containing electronics; d) network node mounted in waterproof housing.

- The project PERMASENSE aims at developing and demonstrating a flexible, distributed wireless sensor network (WSN) adapted to geophysical sensors.
- The first sensor generation was deployed in autumn 2006 and measures temperature profiles and resistances in one meter deep boreholes.
- Currently, the network is beeing setup, which should permit a near real-time survey of the rock condition.

Sphinx, Jungfraujoch, deployment site, 3500 m a.s.l

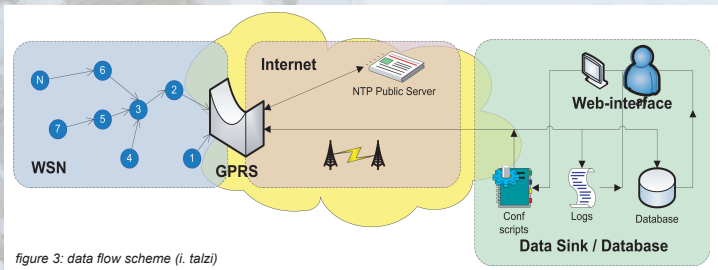

figure 3: data flow scheme (i. talzi)

Network and data transmission

The data chain consists of:

- wireless nodes and attached sensors,
- GPRS gateway node for data uplink,
- database server in the internet,
- web-based front-end for data. retrieval and network monitoring.

Acknowledgements

hardware: hanspeter brühlhart, ivan woodhatch, team shockfish

sensor electronics: peter soland, karoly szeker, peter robmann

mechanics: marcel schaffner, kurt bösiger, grischa martin

deployment: noldi mathys, lorenz böckli, jeannette nötzli, jan beutel

promot. comitee: wilfried haeberli

systemsX: daniel vonder mühll

Measured data and user-interface

- User-interface to display and export sensor data and system logs as well as to set network parameters.
- The data gained with this first sensor generation is expected to provide valuable insight into the advective component of the near-surface heat transfer as well as into freeze-thaw processes.

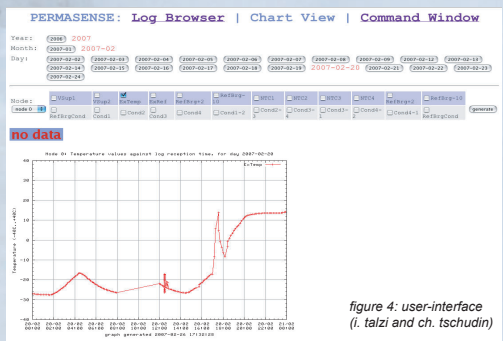

figure 4: user-interface (i. talzi and ch. tschudin)

Perspectives

We plan to build a second generation of sensors for summer 2007 that will also be able to measure crack dilatation and water pressure in pores or fractures as well as other geotechnical parameters. Beside its contribution to our understanding of permafrost and rock weathering in steep slopes this WSN is also a prototype for future real time monitoring systems for natural hazards.