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Second Workshop of I.A.G./A.I.G. SEDIBUD - Sediment Budgets in Cold Environments:

Sediment Fluxes and Sediment Budgets in Changing High-Latitude & High-Altitude Cold Environments

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REPORT

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Second Workshop of I.A.G./A.I.G. SEDIBUD - Sediment Budgets in Cold Environments:
Sediment Fluxes and Sediment Budgets in Changing High-Latitude & High-Altitude Cold Environments

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Summary:

This **Second Workshop of the I.A.G./A.I.G. Working Group SEDIBUD** (Sediment Budgets in Cold Environments) builds on four previous ESF SEDIFLUX Science Meetings held in Saudarkrokur (Iceland) in June 2004, Clermont-Ferrand (France) in January 2005, Durham (UK) in December 2005 and Trondheim (Norway) in the end of October/beginning of November 2006.

A first kick-off Meeting of the new I.A.G./A.I.G. Working Group SEDIBUD took place during the third ESF SEDIFLUX Science Meeting in Durham, and the fourth ESF SEDIFLUX Science Meeting in Trondheim was organised in combination with the first I.A.G./A.I.G. SEDIBUD Workshop.

The theme of this Second I.A.G./A.I.G. SEDIBUD Workshop is *Sediment Fluxes and Sediment Budgets in Changing High-Latitude & High-Altitude Cold Environments*. The Workshop is split between scientific paper and poster presentations, presentation and discussion of SEDIBUD key test sites, discussions within defined work groups and a guided field trip to Kärkevagge.

This workshop will address the key aim of SEDIBUD to discuss Source-to-Sink-Fluxes and Sediment Budgets in Changing Cold Environments. Major emphasis will be given to consequences of climate change, scaling issues and source-to-sink correlations.

Central issues will be the presentation and discussion of the SEDIFLUX Manual (First Edition), the selection of SEDIBUD key test sites, the discussion and development of the SEDIBUD metadata database, the discussion of relevant SEDIBUD science questions and the development of further ideas to extend the scientific activities within SEDIBUD in a global framework.

Keywords: Sediment Fluxes	Sediment Budgets	Source-to-Sink Correlations
Scaling Issues	Climate Change	SEDIBUD Key Test Sites
SEDIFLUX Manual	Metadata Database	Working Group

Second Workshop of I.A.G./A.I.G. SEDIBUD

Sediment Budgets in Cold Environments

Sediment Fluxes and Sediment Budgets in Changing High-Latitude & High-Altitude Cold Environments

Abisko, Sweden,

September 15-19, 2007

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I.A.G./A.I.G. SEDIBUD
Sediment Budgets in Cold Environments

http://www.geomorph.org/wg/wgsb.html

Second I.A.G./A.I.G. SEDIBUD Workshop

Sediment Fluxes and Sediment Budgets in Changing High-Latitude & High-Altitude Cold Environments

September 15 – 19, 2007

Location

Abisko Mountain Station

Abisko, Sweden

Scientific Organisers

Assoc. Professor Achim A. Beylich (Norway)

Assoc. Professor Scott F. Lamoureux (Canada)

Dr. Armelle Decaulne (France)

Professor John C. Dixon (USA)

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Programme,

Preliminary List of SEDIBUD Key Test Sites &

Accepted Abstracts of Workshop Contributions

Editors:

Achim A. Beylich, Scott F. Lamoureux & Armelle Decaulne

September 15 - 19, 2007

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Content

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Preface

This Second Workshop of the I.A.G./A.I.G. Working Group SEDIBUD (Sediment Budgets in Cold Environments) builds on four previous ESF SEDIFLUX Science Meetings held in Saudarkrokur (Iceland) in June 2004, Clermont-Ferrand (France) in January 2005, Durham (UK) in December 2005 and Trondheim (Norway) in the end of October/beginning of November 2006.

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The organisers of the Second I.A.G./A.I.G. SEDIBUD Workshop are pleased to welcome all participants in Abisko!

Trondheim, September 2007

Achim A. Beylich (Norway)
Scott F. Lamoureux (Canada)
Armelle Decaulne (France)
John C. Dixon (USA)

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Science Meeting Programme & Schedule

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Saturday, September 15, 2007

Arrival at the Abisko Mountain Station and check-in

From 15:00 onwards
Registration of Workshop participants at the Workshop registration desk in the Abisko Mountain Station

16:00 – 18:00
Welcome and Reception for Workshop participants (Abisko Mountain Station)

18:00 – 19:00
Excursion "Abisko in 60 minutes"

19:30
Dinner in the Abisko Mountain Station

Sunday, September 16, 2007

09:00 – 09:30
Registration of Workshop participants at the Workshop registration desk in the Abisko Mountain Station

09:30 – 09:40
Opening of the Second I.A.G./A.I.G. SEDIBUD Workshop and Welcome to Abisko

09:40 – 10:00
Overview of SEDIBUD objectives and aims for this SEDIBUD Workshop

10:00 – 10:15
Coffee break

Paper Presentations

Paper Session 1

Chairs: Armelle Decaulne & John F. Orwin

10:15 – 10:35
Jukka Käyhkö: Reconstruction of the largest Holocene jökulhlaup within Jokulsá á Fjöllum, NE Iceland, based on hydraulic modelling and sedimentary field evidence

10:35 – 10:55
Þorsteinn Sæmundsson, Ólafur Arnalds, Christof Kneisel, Helgi Páll Jónsson & Armelle Decaulne: Monitoring of the Orravatnsrústir Palsa site, in the Hofsafrétt area in Central Iceland

10:55 – 11:15
Alexander Vasiliev & Irina Streletskaya: Coastal erosion sediment input to the Barents and Kara Seas (based on ACD classification)

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11:15 – 12:00: Poster Session

Achim A Beylich: Quantitative studies on sediment fluxes and sediment budgets in changing cold environments and the expected benefit from the unification of methods and measuring techniques

Achim A. Beylich, Scott F.Lamoureux & Armelle Decaulne: Sediment fluxes and sediment budgets in changing cold environments – examples from coordinated quantitative studies in three SEDIBUD key test areas in Canada, Iceland and Norway

Dorothea Gintz, Katja Laute, Karl-Heinz Schmidt & David Morche: Hydraulic geometry, grain size and grain shape characteristics of a high mountain river (Partnach River, Upper Bavaria)

Helgi Páll Jónsson, Armelle Decaulne & Þorsteinn Sæmundsson: Tephrochronology as a relevant dating tool in Icelandic geomorphology

Hugues Lantuit, Achim A. Beylich & Scott Lamoureux: Sediment budget in coastal settings: On the necessity to create a common framework for SEDIBUD and ACCO/Net activities during the International Polar Year

Timi Lopez, Achim A. Beylich, Winfried Schenk: Assessment and impact of cultural landscape in a U-shaped valley system in Western Norway (Erdalen/Nordfjord)

Grzegorz Rachlewicz, M. Burzyk, M. Samołyk, A.M. Szczucińska & W. Szczuciński: Particulate and dissolved matter transfer in small High-Arctic non-glaciated basins – Central Spitsbergen

Ola M.Saether, Achim A. Beylich & G. Åberg: Strontium isotope systematics in the Oppstryn drainage basin, western Norway

Irena Streletskaya & Alexander Vasiliev: Organic carbon in Quaternary sediments of Russian West Arctic coasts.

Jeff Warburton: Susceptibility of burnt upland soils to disturbance by cycles of wetting and frost: a laboratory simulation study

12:00 – 13:00
Lunch in Abisko Mountain Station

Paper Session 2

Chairs: Bernd Etzelmüller & Fiona S. Tweed

13:00 – 13:20
Hanna Ridefelt, Bernd Etzelmüller, Jan Boelhouwers & Christer Jonasson: Mountain permafrost distribution in the Abisko region, sub-Arctic northern Sweden

13:20 – 13:40
Nikita I. Tananaev: Effect of within-channel permafrost on sediment transport of rivers in polar environments

13:40 – 14:00
Jonathan L. Carrivick, Lee E. Brown & Katherine E. Arrell: Linking models of glacier meltwater production, hydrogeomorphology and ecological processes in Arctic and Alpine systems

14:00 – 14:20
John F. Orwin: The proglacial control on suspended sediment transfer from a deglacierizing basin, Small River, British Columbia, Canada

14:20 – 14:50
Coffee break

Paper session 3
Chairs: John C. Dixon & Jeff Warburton

14:50 – 15:10
Armelle Decaulne, Þorsteinn Sæmundsson & Helgi Páll Jónsson: Postglacial sediment budget records from colluvial cones in N and NW Iceland

15:10 – 15:30
Achim A. Beylich: Quantitative studies on mass transfers, sediment budget and relief development in a catchment in Arctic-oceanic northernmost Swedish Lapland

15:30 – 15:50
Ola Fredin, Eiliv Larsen, Astrid Lyså, Louise Hansen, Achim A. Beylich, Valentin Burki, Atle Nesje, Marc-Henri Derron, Raymond Eilertsen & Jan-Fredrik Tønnesen: SEDITRANS – a Norwegian fjord valley system; sediment budget, processes and landscape development

15:50 – 16:10
Grzegorz Rachlewicz: Seasonal changes of sediment fluxes in glacifluvial environment in Petunia Bay, Svalbard

16:10 – 16:30
Scott F. Lamoureux, Melissa Lafreniere, Dana McDonald, Kailey Stewart, Jaclyn Cockburn, Myrna Simpson & Andre Simpson: Climatic controls over watershed fluxes at the Cape Bounty integrated watershed observatory, High Arctic, Canada, 2003-7

16:30 – 16:50
Jeff Warburton: Sediment delivery in a large, steepland lake catchment

16:50 – 17:10
Discussion (Chaired by Achim A. Beylich & Scott F. Lamoureux)

17:10 – 17:30
John C. Dixon, Robert G Darmody & Colin E. Thorn: Long-term investigations of the chemical component of a sediment budget in a cold Arctic/Alpine Environment: A field excursion in Kärkevagge, Swedish Lapland

19:30
Dinner in the Abisko Mountain Station

Monday, 17.09.07

08:30 – 17:30
Excursion to Kärkevagge (guided by John C. Dixon)
Lunch packages from the Abisko Mountain Station

19:00
Dinner in the Abisko Mountain Station

Tuesday, 18.09.07

Work Group Sessions

08:30 – 12:00
Presentation of the SEDIFLUX Manual
Presentation and discussion of SEDIBUD Key Test Sites

12:00 – 13:00
Lunch in the Abisko Mountain Station

13:00 – 17:30
Discussion of the SEDIBUD Metadata Database
Discussion of key SEDIBUD Science Questions

19:00
Conference Dinner in the Top-Station of the Abisko Mountain Station

Wednesday, 19.09.07

09:00 – 11:00
Final discussion and conclusion, description of next steps and closing of the Second SEDIBUD Workshop

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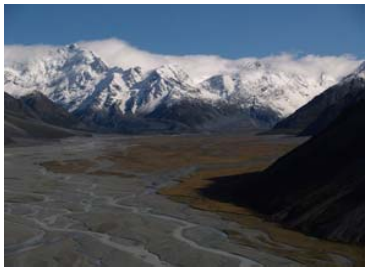
Preliminary List of SEDIBUD Key Test Sites (by September 2007)

Kärkevagge *field site, Sweden (Photo: John Dixon)*

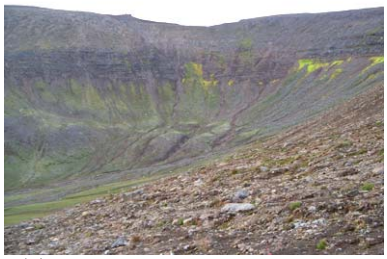
Moore House *field site, UK (Photo: Jeff Warburton)*



Godley Valley *field site, New Zealand (Photo: John Orwin)*

Musala *field site, Bulgaria (Photo: Emil Gachev)*

Kaffiøyra *field site, Svalbard (Photo: Michal Krol)*



Tindastöll *field site, Iceland (Photo: Helgi Páll Jónsson)*

Antarctica

Joyce and Garwood Glacier, Garwood Valley, proposed by John F. Orwin, New Zealand (jfo@geography.otago.ac.nz)

Argentina

Laguna Potrok Aike, proposed by Bernd Zolitschka, Germany (zoli@uni-bremen.de)

Austria

Pasterze, proposed by Andreas Kellerer- Pirklbauer, Austria (andreas.kellerer@uni-graz.at)

Bulgaria

Musala area, proposed by Emil M. Gachev, Bulgaria (e_gachev@yahoo.co.uk)

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Canada

Cape Bounty, proposed by Scott F. Lamoureux, Canada (Scott.Lamoureux@queensu.ca)

Finland

Kidisjoki, proposed by Achim A. Beylich, Norway (achim.beylich@ngu.no)

Germany

Reintal, proposed by Karl-Heinz Schmidt, Germany (karl-heinz.schmidt@geo.uni-halle.de)

Greenland

Kangerlussuaq-Strømfjord
Mittivakkat glacier catchment
Zackenberg, proposed by Bent Hasholt, Denmark (bh@geogr.ku.dk)

Iceland

Botn í Dýrafirði
Reykjarströnd
Tindastöll
Fnjóskadalur-Bleiksmýrardalur, proposed by Armelle Decaulne, France (armelle@nnv.is)
Hofsjøkull, northern forefield
Austdalur
Hrafndalur, proposed by Achim A. Beylich, Norway (achim.beylich@ngu.no)
Örravatnrústir, proposed by Þorsteinn Sæmundsson, Iceland (nnv@nnv.is)

New Zealand

Douglas Glacier
Godley Valley
Unnamed Valley, proposed by John F. Orwin, New Zealand (jfo@geography.otago.ac.nz)

Norway

Erdalen
Bødalen
Vinstradalen, proposed by Achim A. Beylich, Norway (achim.beylich@ngu.no)
Tana catchment, proposed by Jukka Käykhö, Finland (jukka.kayhko@utu.fi)

Russia

Mezen, proposed by Achim A. Beylich, Norway (achim.beylich@ngu.no)

Svalbard

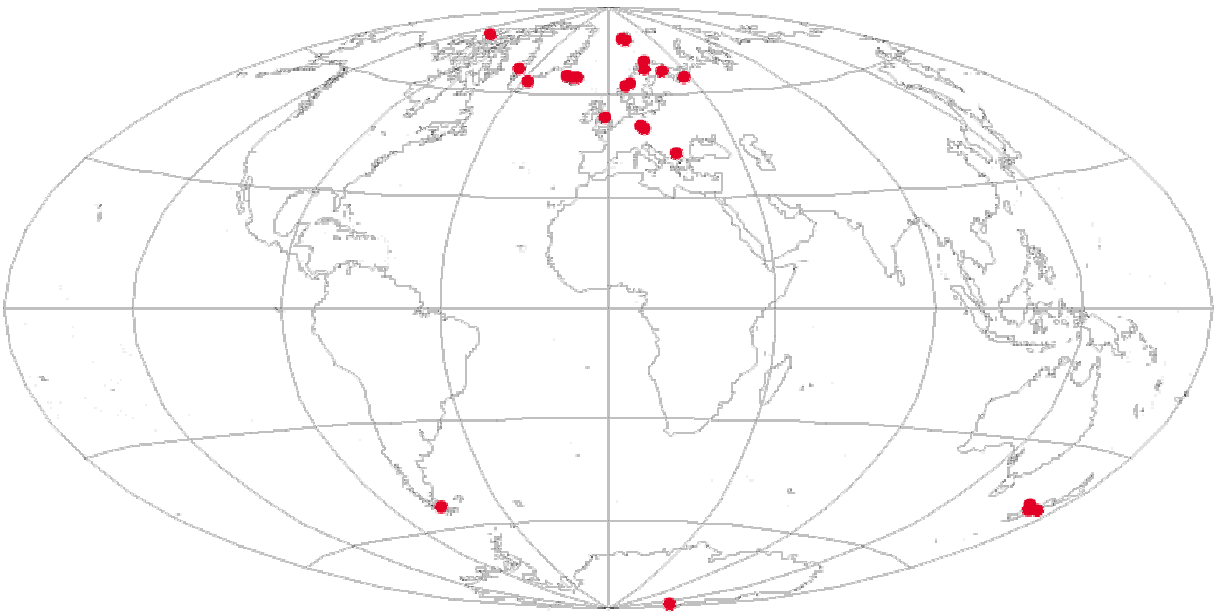
Catchment at Nordaustlandet, suggested by Achim A. Beylich, Norway (achim.beylich@ngu.no)
Dynamiskbekken
Ebbaelva
Hørbyeelva, proposed by Grzegorz Rachlewicz, Poland (grzera@amu.edu.pl)
Kaffiøyra, proposed by Michal Krol (supervised by Marek Grzes), Poland (gmark@geo.uni.torun.pl)
Scottelva, proposed by Josef Superson, Poland (superson@biotop.umcs.lubin.pl)

Sweden

Latnjavagge, proposed by Uf Molau, Sweden (ulf.molau@dpes.gu.se) and Achim A. Beylich, Norway (achim.beylich@ngu.no)
Kärkevagge
Kårsavagge
Låktavagge, suggested by Achim A. Beylich, Norway (achim.beylich@ngu.no)

United Kingdom

Moor House, proposed by Jeff Warburton, UK (jeff.warburton@durham.ac.uk)



Spatial distribution of proposed key test sites

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Science Meeting Presentations

Accepted Extended Abstracts

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Quantitative studies on mass transfers, sediment budget and relief development in a catchment in Arctic-oceanic northernmost Swedish Lapland

Achim A. Beylich [1, 2]

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This study on the Latnjavagge catchment (9 km2), located in the Abisko mountain area in northernmost Swedish Lapland, analyses recent gravitational and fluvial mass transfers in an Arctic-oceanic environment. By a combined recording of slope denudation and streamwork information on the absolute and relative importance of the different denudative processes for slope and valley formation, on the temporal and spatial variability of the geomorphic processes, on process intensities and frequencies, on the geomorphic role of a rare rainfall event and a mega slush flow event, on the sediment budget of the catchment and on recent trends of relief development is collected.

Regarding annual mass transfers, fluvial transport in the main channels dominates over slope processes. Fluvial solute transport is more important than fluvial sediment transport. Rock falls together with boulder falls are most important at the slope systems, followed by chemical denudation, mechanical fluvial denudation, ground avalanches, creep and solifluction, slush flows, debris flows, translation slides and deflation. The intensity of the present-day processes is altogether low.

Postglacial modification of the glacial relief is little. Due to the short time since the deglaciation (8000-10000 yr) and the low intensity of the active geomorphic processes, until today, there has been no adjustment of the Pleistocene glacial landforms to the surface processes which have been operating under Holocene morphoclimates until present.

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Quantitative studies on sediment fluxes and sediment budgets in changing cold environments and the expected benefit from the unification of methods and measuring techniques

Achim A. Beylich [1, 2]

[1] Geological Survey of Norway (NGU), Landscape & Climate group, N-7491 Trondheim, Norway
[2] Norwegian University of Science and Technology (NTNU), Department of Geography, Trondheim, Norway (achim.beylich@ngu.no)

Climate change affects Earth surface systems all over the world but with arguable the greatest impact in high-latitude and high-altitude cold environments. In these areas climate change shapes earth surface processes not just by altering vegetation and human activities but also through its impact on frost penetration and duration within the ground surface layers. It is a challenge to develop a better understanding of how these factors combine to affect sedimentary transfer processes and sediment budgets in cold environments. As a starting point our baseline knowledge of the sedimentary transfer processes operating within our current climate and under given vegetation cover, as a basis for predicting the consequences of future climate changes and related vegetation cover changes needs to be extended. It is therefore necessary to collect and compare data from different cold environments, and use this to assess a range of models and approaches for researching the relationships between climate change, vegetation cover and sediment fluxes.

Results from ongoing investigations on sediment fluxes and sediment budgets in selected SEDIBUD key test sites are presented.

Quantitative longer-term studies on sediment transfers and sediment budgets are carried out within the NGU Project *Source-to-Sink Fluxes in Cold Environments* in five selected small cold environment catchments (<30 km^2) in Iceland, Swedish Lapland, Finnish Lapland and Norway. Investigations in East Iceland (Austdalur and Hrafndalur), Swedish Lapland (Latnjavagge) and Finnish Lapland (Kidisjoki) have been conducted for over six years whereas studies in Western Norway (Erdalen) have just been started three years ago. The five catchments are seen as clearly defined landscape units where detailed studies on sediment transfers and sediment budgets using unified techniques and approaches (including monitoring of present-day denudative processes as well as quantitative analysis of storage elements) - providing comparable data sets from the different cold environments - are possible. The five catchments are considered to be representative for the selected target areas in East Iceland, Swedish Lapland, Finnish Lapland and Western Norway.

Main focus of the research programme is on analysing the role of the factors morphoclimate, vegetation cover, ground frost, human impact, relief and lithology for present-day sediment fluxes, denudation rates, sediment budgets and relief development in the five different study sites. Direct comparison of the data collected in the different cold environment target areas provides information on variations in the absolute and relative importance of different denudative processes and helps to get more insight into the spatial differentiation of cold environments.

The two selected catchments in subarctic-oceanic East Iceland are characterized by very steep alpine relief and a partly destroyed vegetation cover (as caused by direct human impact). Mechanical denudation dominates over chemical denudation. Austdalur (basalt) is showing lower mechanical denudation rates than Hrafndalur (less resistant Rhyolites). The slightly less steep Latnjavagge in arctic-oceanic Swedish Lapland (mica schist) is

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characterized by clearly lower mechanical denudation rates, which is mainly due to a very stable and closed vegetation cover and stable step-pool systems developed in the creeks. In this valley chemical denudation appears to be slightly higher than mechanical denudation (see Beylich, this issue). Kidisjoki in subarctic Finnish Lapland (gneisses) is situated in the area of the Baltic Shield and shows very low chemical and mechanical denudation rates. Chemical denudation dominates over mechanical denudation. All four catchments are characterized by altogether low denudation rates. Chemical denudation ranges from 3.0 t $km^{-2}yr^{-1}$ in Kidisjoki to ca 8 t $km^{-2}yr^{-1}$ in East Iceland. All four valleys are characterized by restricted sediment availability. More than 90 % of the annual fluvial sediment transport occurs within a few days during snowmelt and/or rainfall generated peak-runoff. Only in the very steep catchments with partly destroyed vegetation cover in East Iceland mechanical denudation dominates over chemical denudation.

Erdalen is a characteristic and very steep U-shaped valley in the fjord landscape of western Norway (Nordfjord) (Beylich et al., this issue). The sub-Arctic Erdalen catchment is connected to the Jostedalsbreen ice cap and is in its uppermost areas glaciated. Current investigations in this key test site include the analysis of storage elements (see Fredin et al., this issue), the year-round monitoring of meteorological parameters, ground temperature, permafrost, runoff, fluvial solute and sediment transport as well as the analysis of slope processes like rockfalls, avalanches and debris flows by combining different monitoring, mapping and dating techniques.

The comparable data sets generated in these cold environment key test sites that follow guidelines and protocols provided in the SEDIFLUX Manual will be added to the SEDIBUD metadata database. The SEDIBUD metadata database will be used to model effects of projected climate change on solute fluxes, sediment fluxes and sediment budgets in sensitive cold environments worldwide (see Beylich et al., this issue).

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Sediment fluxes and sediment budgets in changing cold environments – examples from coordinated quantitative studies in three SEDIBUD key test areas in Canada, Iceland and Norway

Achim A. Beylich [1, 2], Scott F. Lamoureux [3] & Armelle Decaulne [4, 5]

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[2] Norwegian University of Science and Technology, Department of Geography, Trondheim, Norway
[3] Queen`s University, Department of Geography, Kingston Canada
[4] Laboratory of Physical and Environmental Geography GEOLAB, CNRS, Clermont-Ferrand France
[5] Natural Research Centre of North-western Iceland, Saudarkrokur, Iceland

The new I.A.G./A.I.G. Working Group SEDIBUD (Sediment Budgets in Cold Environments) (http://www.geomorph.org/wg/wgsb.html) builds on activities which were started within the European Science Foundation (ESF) Network SEDIFLUX (Sedimentary Source-to-Sink Fluxes in Cold Environments, 2004 - 2006) (see: http://www.ngu.no/sediflux, http://www.esf.org/sediflux).

Changes in climate have a major impact on Earth surface systems, especially in high-latitude and high-altitude cold environments. Such changes have a major impact on sediment transfer processes. The major aim of I.A.G./A.I.G. SEDIBUD is to provide an integrated quantitative analysis of sediment transfers, nutrient fluxes and sediment budgets across a range of key cold environments. Such a coordinated analysis has so far been lacking. The primary focus is on the impact on sediment transfer processes in response to a variety of climate change scenarios at a scale, which incorporates sediment flux processes from source to sink. In order to perform a fully integrated study of source to sink sediment fluxes and sediment budgets in cold environments, SEDIBUD analyses the key components of weathering, chemical denudation, erosion, aeolian processes, mass movements, fluvial transfers/transport, glacial sediment transfers, and sedimentation in lakes, fjords and coastal areas. SEDIBUD is also considering the impact of human activity on the environmental sites being studied and how this might relate to climate change.

Results from ongoing quantitative geomorphologic studies on sediment fluxes and sediment budgets in selected SEDIBUD key test sites in Arctic Canada, sub-Arctic Iceland and sub-Arctic Norway are presented and discussed in the context of possible effects of projected climate change on present-day process frequencies, intensities, process rates and sediment budgets in sensitive cold environments.

Cape Bounty is located in the Canadian High Arctic Archipelago and is representative of the low-relief, unglacierized landscape found in much of this region. Research is underway in paired watersheds with emphasis on suspended sediment delivery processes and fluxes, particulate and dissolved carbon and nutrient fluxes, and linkages between fluxes and periglacial slope processes, active layer disturbances, and hydrological routing. Additionally, each watershed drains into similar lakes that contain annually-laminated sediments that will provide long term measures of sediment and particulate organic material delivery.

Fnjóskadalur is a representative U-shaped valley in sub-Arctic Northern Iceland and is characterized by a wide range of different denudative surface processes. Current research in this key test area is focused on (i) the analysis and quantification of sediment fluxes from slope processes, especially snow avalanches and debris flows,

and (ii) the investigation of the magnitude-frequency relationship of snow avalanches and debris flows. Currently applied methods cover topographical and geomorphologic (underlining erosion and accumulation areas, extreme reach of slope dynamics as well as their lateral spreading) purposes. The used dating techniques (phytogeographical techniques: vegetal cover, lichenometry, dendrochronology; weathering; tephrochronology) reveal the rhythms of present-day slope activity as well as during the Upper Holocene period.

Erdalen is a very steep U-shaped valley in the fjord landscape of western Norway (Nordfjord). The sub-Arctic Erdalen catchment is connected to the Jostedalsbreen ice cap and is in its uppermost areas glaciated. Current investigations include the year-round monitoring of meteorological parameters, ground temperature, permafrost, runoff, fluvial solute and sediment transport as well as the analysis of slope processes like rock falls, avalanches and debris flows by combining different monitoring, mapping and dating techniques.

The potential and expected benefit generated by coordinated data exchange and the unification of methods and techniques applied to long-term process analysis/monitoring and the quantitative investigation of sediment budgets in cold environment catchment geosystems is presented.

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Linking models of glacier meltwater production, hydrogeomorphology and ecological processes in arctic and alpine systems

Jonathan L. Carrivick, Lee E. Brown & Katherine E. Arrell

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This paper reports on initial stages of a project with an overall aim to undertake an interdisciplinary study of parameterising and modelling glacial meltwater discharge, proglacial floodplain dynamics, and ecological response in a variety of proglacial river systems. Whilst these three components have been studied separately in detail, quantification of their interactions has so far been minimal. This research gap is important due to the requirement for accurate prediction of 1) Climate change effects on glacier meltwater and groundwater fluxes, 2) Proglacial channel hydrogeomorphological dynamics, and 3) the effect of each of the above on river biodiversity. These effects will be addressed by measuring and subsequently modelling spatial and temporal: (1) glacier meltwater production, (2) river discharge, sediment mobility and stream temperature in response to (1), and (3) stream macroinvertebrate community response to (1) and (2). To achieve these aims field measurements will be made of; (i) Glacier surface topography and the snow-ice interface, (ii) meteorological data (iii) Proglacial surface topography, (iv) River bed substrate character, hydraulics and physicochemical habitat properties, and (v) stream macroinvertebrate communities. Field measurements will inform development, validation and integration of linked models describing (a) glacier energy balance and runoff, (b) Fluvial landscape evolution/stability, and (c) ecological response to meltwater dynamics.

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Modern sediment burial processes in the western Barents Sea

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The continental shelf of the Barents Sea is composed of numerous deep submarine trenches (>300 m) interspersed with shallow banks (<200 m). The fate of sediments and organic matter reaching the seafloor is determined by the topographic steering of currents through this complex bottom topography and the activities of seafloor biological communities. To understand seafloor burial processes we assessed sediment accumulation and mixing rates along a north-south gradient (75° to 81° N) in the western Barents Sea; a region that encompasses open-water to ice-covered areas. Average sediment accumulation rates for the past 100 years were assessed using the radionuclide tracers, ^{210}Pb and ^{137}Cs. Short-term (seasonal) mixing rates were assessed using ^{234}Th. Shallow bank areas are characterized by little to no net accumulation and extensive physical and biological sediment reworking. Sediment focusing, indicative of down-slope transport along bathymetric gradients, is observed at some deep trench stations while at intermediate depths, sediment accumulation rates ranged from 0.5-0.7 cm/yr. Sediment reworking by benthic communities is also evident at some stations. Relatively low sediment accumulation rates on the shelf in combination with low orgC content (<1.5%) results in low organic carbon burial rates, e.g. 30-60 mgC/m^{2}yr. Low burial rates in this productive arctic marginal sea can be explained either by off-shelf export of carbon or efficient carbon utilization through strong coupling between pelagic and benthic ecosystems.

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Postglacial sediment budget records from colluvial cones in N and NW Iceland

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Active denudative processes occurring on slopes, such as snow avalanches, debris flows and rockfall, have contributed to build large colluvial cones in N and NW Iceland since the ice sheet retreated, after the last deglaciation around 9000-10000 ^{14}C years BP. Moreover, these stratigraphical records provide indication on the kind of sedimentary transfer processes, their magnitude and frequency through time. Such processes have been recently considered as a relevant contributor to sediment budget in Iceland.

Vertical sections in the colluvial cones of N and NW Iceland exhibit a characteristic stratigraphy with successions of mass-movements material intercalated with soil horizons, all of various thicknesses through the Holocene period. These vertical profiles therefore exhibit the past phases of slope activity vs. phases of slope inactivity, in relation with climatic conditions.

The dating of most depositional processes is possible with known tephra layers and ^{14}C dated horizons. Such dating enables the calculation of aggradation rates of the cones for the whole Holocene or for the Upper Holocene, depending on findings. The quantitative analysis of sediment budgets on colluvial cones shows that changes in cone development are the result of changes in sediment storage, sediment discharge and sediment transfer. The interpretation of the sediment budgets on the cones provides evidence of changing response of the catchment system in accordance with paleoclimatic changes. Understanding the past development of colluvial cones is a key for the comprehension of present-day climate change implications in cold environments.

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Long-term investigations of the chemical component of a sediment budget in a cold Arctic/Alpine Environment: A field excursion in Kärkevagge, Swedish Lapland

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In 1960 Anders Rapp published his "classic" paper on the denudation of hill slopes in the Arctic/Alpine climate of Kärkevagge in Swedish Lapland and identified solution as the single most significant contributor to denudation in the valley. This determination however was based on an extremely small number of water samples emerging from particularly solute rich sources. Similarly, these early determinations largely ignored other components of the geochemical system. Over the past 15 years we have focused our research on defining the magnitude of contributions of chemical processes to the sediment budget in Kärkevagge.

Beginning in 1993, we have conducted a series of field investigations to examine natural and artificial rock weathering, chemical sediment formation and distribution, soil formation, and stream solute characteristics. Our research has specifically not been a monitoring study, but rather has focused on obtaining a comprehensive understanding of the geochemical system of the valley and to evaluate the conclusions of Rapp based on a more comprehensive sampling scheme.

Field Weathering Experiments

A ten-year long weathering study was conducted using vegetation communities to stratify the placement of rock disks and crushed rock samples to evaluate the controls on the rate of weathering of new rock surfaces. Discs of a soluble rock (dolomite) and a crystalline rock (granite) were used as surrogates for the local lithologies so the study was one of potential weathering, rather than actual weathering rates. Results of these experiments revealed that soluble rocks display measurable loss of mass within a decade of exposure to weathering solutions and that the principal controls on their dissolution are moisture and to a lesser extent pH. Overall rates of weathering of limestone disks range from 0.003-0.034mg/cm/day which significantly at the high (wet) end are greater than those in other climatic regimes. While granite disks reveal no significant mass loss in a decade, they do provide significant insights into the nature of the earliest stages of weathering of crystalline rocks.

Bedrock Weathering

Examination of weathering rinds on dislodged blocks, together with rock coatings on valley and rock surface walls, and surface waters together reveal the nature of bedrock weathering in the valley. Blocks of rock on the floor of Kärkevagge display the development of weathering rinds ranging from microscopically visible incipient form all the way to strongly developed iron-enriched, base depleted forms. Weathering rinds are characterized by the development of porosity within the outer portion of the rock. Rock porosity occurs in several forms including the development of both inter-granular and intra-granular porosity. The early development of porosity is critical in increasing mineral grain surface area and hence enhancing dissolution rates. Iron oxidation of ferromagnesian minerals, together with soluble mineral leaching, produces Fe-rich weathering rinds on many rock surfaces.

A hallmark of Kärkevagge is the presence of white streaks on the valley walls as well as the development of a variety of other rock coatings less conspicuously displayed. Anders Rapp stresses the significance of these streaks in supporting his conclusions about the importance of solutional processes in the valley. Our recent systematic and earlier cursory studies reveal a complex assemblage of rock coatings in the valley. The

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white streaks on the valley walls, identified initially as "lime" by Rapp have recently been determined to be dominated by aluminum rather that calcium. While some gypsum has been identified by XRD analyses, the bulk of the material in the white streaks is amorphous. Based on our chemical analyses we conclude that the aluminum oxyhydroxide sulphate that dominates these streaks is basaluminite. In more protected sites in the valley, other rock coatings are identified. The dominant coatings in these settings are gypsum (calcium sulphate) and jarosite (potassium/iron sulphate). The origin of all of these coatings is ascribed to the oxidation of pyrite by waters moving through the bedrock and associated acidification. In the case of springs above the white streaks the water is quickly neutralized by the presence of marble and so Al-dominated precipitates form. Where carbonate is absent and spring waters remain acidic Fe precipitates dominate. In short the rock coatings in Kärkevagge are linked to an acid sulphate weathering regime.

A year-long investigation of water chemistry in Kärkevagge coupled with earlier preliminary study reveal that waters of the valley are dominated by three water types: Ca, Mg sulphate and bicarbonate, Ca, Mg sulphate, and Ca, Mg bicarbonate. These water types display strong spatial variability that is strongly linked to lithology. Mixed carbonate/sulphate waters dominate the eastern and western sides of the valley where both carbonates (marble) and pyrite-rich rocks co-occur, sulphate waters dominate the head of the valley where marble is absent, and bicarbonate waters dominate in the north east corner of the valley where dolomite outcrops. Strong spatial contrasts in TDS are also observed with values exceeding 100mg/L dominating the eastern side of the valley where springs emerge from the valley side walls. TDS of streams on the western side and at the head of the valley are for the most part an order of magnitude lower. Mean chemical erosion rates for the valley are 46t/km^2/yr. which compares to mechanical erosion rates of between 1-20t/km^2/yr (Rapp 1960). Mean denudation of the valley is 8mm/1000yrs.

Soil Characterization

A substantial contribution to the solute load in the streams draining Karkevagge is made by pedogenesis associated with unconsolidated deposits on the valley floor and valley side slopes. While soil chemistry in the valley is highly variable depending on such factors as landscape age, stability, vegetation cover, microclimate and local geology, Soils are dominated by extractable Ca, followed by Mg, K, and Na, with extractable Fe and Al highest in the B horizons of Spodosols and in high elevation, stable landscape settings. Soils in Kärkevagge fall into three broad categories. Spodosols develop in association with acid weathering of glacio-fluvial deposits derived from micaceous schist accompanied by substantial snow accumulation and good drainage. Where similar parent materials occur and are influenced by Ca-rich leachates, Mollisols and Inceptisols occur. Finally where soils are developed on micaceous residuum and snow cover is sparse Inceptisols and Gelisols develop.

Over a decade of research in Kärkevagge has established that chemical processes are a significant component of the geomorphic process suite and that they contribute significant amounts of dissolved solids into the drainage channels of the valley. When averaged across the landscape, chemical erosion accounts for some 8mm/1000yrs, which is not substantially different from other climatic environments.

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SEDITRANS – a Norwegian fjord valley system; sediment budget, processes and landscape development

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Glacial fjords are perhaps the most spectacular glacial landforms; they are also important sediment sinks and conduits of sediments during both glacial- and interglacial periods. In order to characterize and quantify source-to-sink processes and volumes in a fjord system, we have within the SEDITRANS project examined a Norwegian fjord (Nordfjord) on different temporal- and spatial scales. We start by reconstructing the pre-Quaternary palaeo-geography in order to establish Quaternary glacial erosion. Furthermore, we have mapped and quantified sediment infill, stratigraphy and sediment volumes deposited since the last deglaciation.
SEDITRANS is integrated with an ongoing NGU project to analyse present day source-to-sink rates, climatic data and chemical denudation rates in a key tributary to the fjord (Beylich, this issue; Beylich et al., this issue).

In order to accomplish the above objectives we have utilized within SEDITRANS a wide array of investigations and tools, including mapping, dating techniques and stratigraphy both in the field and trough geophysical measurements, which has been done in the terrestrial, lacustrine and marine environments. All data, including basic data such as topography, was continuously assembled using Geographic Information Systems (GIS), greatly aiding interpretation, calculations and visualization.

Preliminary results include a conceptual model on sediment dynamics in the fjord environment where recycling of previously deposited sediments (eg. from the last deglaciation) plays a key role to the overall sediment budget. In addition, a quantitative, time dependent, sediment volume model is under development.
The project will provide first class knowledge on source-to-sink processes and rates in a Norwegian fjord and will serve as a baseline for ongoing and future studies of fjord environments.

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Revealing Landcape structure in two contrasting high mountain sites in Bulgaria as a basis to investigate sediment transfers

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This study presents the initial stage of a new research programme that has been started in the Bulgarian highest mountains Rila and Pirin. The programme's main goal is to investigate and evaluate contemporary geomorphic processes that occur in Bulgaria's subalpine and alpine environments and the relation of these processes to climate in order to model environmental reactions on possible climatic changes.

In this first stage a preliminary geomorphic and landscape mapping has been done for the two initially chosen key sites (Musala cirque in Rila and Kazanite cirque in Pirin) through analyzing aerial photographs and several field visits in summer 2006. Revealing the landscape structure of these representative areas will help to select study transects and to establish process measurements on a landscape basis as well as to evaluate the differences between the two main types of high mountain environments in Bulgaria.

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Hydraulic geometry, grain size and grain shape characteristics of a high mountain river (Partnach River, Upper Bavaria)

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Since 2000 our work within the framework of SEDAG (SEDiment cascades in Alpine Geosystems) has been focussed on hydrology, fluvial sediment transport dynamics and hydromorphological characteristics of the alpine river Partnach (Reintal Valley, Wetterstein Mountain Range, Bavarian Alps, Germany) (Morche 2005, 2006 and 2007, Morche et al. 2006, Morche et al. in press b, Morche & Schmidt 2005, Morche & Witzsche 2006, Schmidt & Morche 2006, Schrott et al. 2006). In August 2005 a dambreak flood occurred in the Reintal Valley. The hydrology and geomorphic effects of this high magnitude event were reported recently by Morche et al. (2006), Morche et al. (2007), Morche et al. (in press a) and Sass et al. (in press). Preliminary results show that the river system responds to the disturbance by higher bed load transport (Morche et al. in press a). Now, in the post-event state bed load is transported even during lower discharges than in the pre-event situation. Similar behaviour of river response was determined by Bathurst et al. (1990) for the Roaring River in Colorado, USA during the post-event field seasons. And even more than a decade after the flood the Roaring River carries more bed load than before (Bathurst & Ashiq 1998). Due to the geomorphic impact of the flood and the higher bed load transport hydraulic conditions of the Partnach River as well as the grain size and shape characteristics of its bed sediment (may) have been changed.

This paper deals with investigations on the hydraulic geometry of the Partnach River and the grain size and grain shape characteristics of its bed material along a 2100 m channel reach.

Along this particular river course terrestrial surveys (longitudinal profile, cross sections) and Wolman pebble counts were carried out in the field season 2006. The post-event results will be compared with that from the pre-event observations (Morche et al in press b).

References:

Bathurst, J.C., Ashiq, M. (1998). Dambreak flood impact on mountain stream bedload transport after 13 years. *Earth Surf Proc Land* 23, 643-649. doi: 10.1002/(SICI)1096-9837(199807)23:7<643::AID-ESP889>3.0.CO;2-3

Bathurst, J.C., Hubbard, L., Leeks, G.J.L., Newson, M.D., Thorne, C. R. (1990). Sediment yield in the aftermath of a dambreak flood in a mountain stream. In: Sinniger, R.O. & M. Monbaron (eds.). *Hydrology in Mountainous Regions II – Artificial Reservoirs, Water and Slopes*. IAHS Publication 194, IAHS Press, Wallingford, 287–294.

Morche, D. (2005). Calculating the fluvial sediment output in high mountain catchments. RMZ– *Materials & Geoenvironmen*t 52, 99-102.

Morche, D. (2006). Aktuelle hydrologische Untersuchungen am Partnach-Ursprung (Wettersteingebirge). *Wasserwirtschaft* 96, 53-58.

Morche, D. (2007). Chemical denudation in an alpine geosystem - A 5 year record. In: Atalay, I., Efe, R. & A. Soykan (eds.). *Environment and Culture in the Mediterranean Region*. Abstract volume of the "International Symposium on Geography", 5th - 8th June 2007, Kemer/Antalya, Turkey, 83.

Morche, D., Katterfeld, C., Fuchs, S., Schmidt, K.-H. (2006). The life-span of a small high mountain lake, the Vordere Blaue Gumpe in Upper Bavaria, Germany. In: Rowan, J., Duck, R.W. & A. Werritty (eds.). *Sediment Dynamics and the Hydromorphology of Fluvial Systems*. IAHS Publication 306, IAHS Press, Wallingford, 72-81.

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Morche, D., Schmidt, K.-H. (2005). Particle size and particle shape analyses of unconsolidated material from sediment sources and sinks in a small alpine catchment (Reintal, Bavarian Alps, Germany). *Z Geomorph* N F Suppl.-Bd. 138, 67-80.

Morche, D., Schmidt, K.-H., Heckmann, T., Haas, F. (2007). Hydrology and geomorphic effects of a high magnitude flood in an alpine river. *Geogr Ann* 89A, 5-19. doi:10.1111/j.1468-0459.2007.00304.x

Morche, D., Witzsche, M. (2006). Spatial and temporal variation in grain size distributions of alluvial deposits in an alpine catchment. In: Rowan, J., Duck, R.W. & A. Werritty (eds.). *Sediment Dynamics and the Hydromorphology of Fluvial Systems*. Poster Report Booklet of the International Symposium of the IAHS and ICCE 3rd - 7th July 2006, Dundee, Scotland, 39-46.

Morche, D., Schmidt, K.-H., Sahling, I., Herkommer, M., Kutschera, J. (in press a). Volume changes of an Alpine talus cone in a state of post-event disequilibrium and the implications for downstream hydrology. *Norsk Geografisk Tidsskrift*.

Morche, D., Witzsche, M., Schmidt, K.-H. (in press b). Hydromorphological characteristics and fluvial sediment transport of a high mountain river (Partnach River, Reintal Valley, Bavarian Alps, Germany). *Z Geomorph* N F.

Sass, O., Krautblatter, M., Morche, D. (in press). Rapid lake infill following bergsturz events revealed by GPR measurements (Reintal, German Alps). The Holocene

Schmidt, K.-H., Morche, D. (2006). Sediment output and effective discharge in two small high mountain catchments in the Bavarian Alps, Germany. *Geomorphology* 80, 131-145. doi:10.1016/j.geomorph.2005.09.013

Schrott, L., Götz, J., Geilhausen, M., Morche, D. (2006). Spatial and temporal variability of sediment transfer and storage in an alpine basin (Bavarian Alps, Germany). *Geographica Helvetica* 61, 191-200.

Tephrochronology as a relevant dating tool in Icelandic geomorphology

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Tephra refers to ash and all other airborne material produced during a volcanic eruption. Tephra can be dated by using absolute (radiometric) or relative (stratigraphic observation) dating methods, while geochemical analyses trace the ashes to their volcanic origin. Thus a widely distributed tephra layer is an ideal time marker horizon in several disciplines, from earth sciences to archeology, when the tephrochronological record in the study area is known. Given the volcanic origin of the island, pioneer researches in tephrochronology have been carried out in Iceland (Thorarinsson 1944, 1967; Einarsson 1986). In particular, the Icelandic Holocene tephrochronological record is highly developed and includes several well known and radiometrically dated prehistoric marker tephras from identified volcanic systems. The historical record of eruptions is also well documented and has been linked to corresponding tephra layers. In central north Iceland the most prominent tephra layers come from the Hekla volcanic system, in south Iceland, and are easily recognized in soil sections. Thus, tephra layers have been recently applied as a relevant geomorphological dating tool in a preliminary quantitative study of Holocene colluvium (Decaulne *et. al.* 2007). The finding of undisturbed tephra layers between colluvial material in active path on slopes and cones enable estimation of the rate of post glacial sediment deposition, and more specifically during the Upper Holocene. At various locations in Central North Iceland tephra layers have been found at different depths within colluvial material. It therefore enables to estimate the spatial and temporal aggradation of sediments on slopes at least during the last 4000 ^{14}C years BP (Thorarinsson & Larsen 1977) which is the age of the oldest most widespread Hekla marker layer in the study area. By extension, such a dating tool provides significant information on the long-term sediment transfer related to different slope processes in connection with Holocene climatic changes.

References:

Decaulne A, Sæmundsson Þ., Jónsson H.P. & Sanberg O. 2007: Changes in deposition on a colluvial fan during the Upper Holocene in the Tindastóll Mountain, Skagafjörður District, North Iceland - Preliminary results. *Geografiska Annaler*, 89A (1), 51-53.

Einarsson T. 1986: Tephrochonology. In Berglund B. E.(ed.): *Handbook of Holocene Paleoecology and Paleohydrology*. Wiley & Sons, Chichester, 869 p, 329-342.

Larsen G. & Thorarinsson S. 1977: H4 and Other Acid Hekla Tephra Layers. *Jökull*, 27, 28-46.

Thorarinsson S. 1944: Tefrokronologiska studier på Island. *Geografiska Annaler*, 26, 1-217.

Thorarinsson S. 1967: The eruptions of Hekla in historical time. In *The Eruption of Hekla 1947-1948. Soc. Sci. Islandica*, 1, 1-170.

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Reconstruction of the largest Holocene jökulhlaup within Jokulsá á Fjöllum, NE Iceland, based on hydraulic modelling and sedimentary field evidence

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Glacial outburst floods (jökulhlaups) have a significant role for landscape evolution in NE Iceland. A number of jökulhlaups have routed from the northern margin of Vatnajökull during the Holocene. In this study, we present a reconstruction of the largest Holocene jökulhlaup in Möðrudalur along Jökulsá á Fjöllum, and evaluate the accuracy of the reconstruction based on field evidence of fine sediments deposited by backwater ponding onto areas where flow velocity was near to zero. The hydraulic modelling was undertaken using the HEC-RAS model and HEC-GeoRAS flood mapping techniques with a Digital Elevation Model (DEM) derived from ERS-InSAR data and field-based wash limit evidence. Based on the hydraulic model, the largest jökulhlaup produced extensive erosional and depositional landforms across an inundated area of ~1390 km^2 and is calculated to have had a peak discharge of 0.9 x 10^6 m^3s^{-1}. The distribution of fine backwater sediments indicates the actual minimum extent of flood water, whereas the stratigraphic position of the sediment beds can be utilised in dating of the flood events. The analysis results of the sedimentary field evidence are under construction and will be discussed in the presentation.

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Permafrost distribution and characteristics in a subarctic periglacial environment – Implications for permafrost and sediment dynamics

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In a subarctic periglacial environment in northern Sweden (Pallenvagge, south of Abisko) the spatial distribution of permafrost and its characteristics was investigated using different traditional and modern methods in order to assess the influence of permanently or seasonally frozen ground on local periglacial morphodynamics and sediment fluxes.
With geomorphological mapping as a traditional standard tool for geomorphic system analysis the geomorphic process regimes in the valley along altitudinal zones could be determined. An altitudinal sequence of permafrost-related landforms and processes could be found. In order to evaluate the permafrost distribution in the investigation area on a larger scale, measurements of the bottom temperature of the snow cover were carried out (so-called BTS-method). For the characterisation of the subsurface lithology 2D resistivity surveys were performed. Numerous gelifluction lobes indicate active permafrost in the slopes. Results of BTS-measurements in the proglacial area of two small mountain glaciers indicate a widespread occurrence of perennially frozen ground, which is expressed by patterned ground with sorted polygons in the flat parts of the investigation area. 2D resistivity tomographies carried out on typical periglacial landforms provide information of the permafrost characteristics within solifluction terraces, patterned ground with sorted polygons and an ice-cored moraine.
The extent to which periglacial morphodynamics and sediment fluxes are influenced by permafrost and/or seasonal frost is difficult to determine. Hence, long-term monitoring approaches for both permafrost and sediment dynamics are essential. Geomorphological mapping represents a traditional standard tool for geomorphic system analysis and serves as one basis for the development of sediment budget models. In conjunction with modern 2D geophysical surveys a more sophisticated data interpretation and the development of sediment budget models is enabled. The results indicate that future research should focus on the assessment and monitoring of the impact of changes in permafrost on surface sediment fluxes because these have a great potential to cause adverse environmental effects.

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Climatic and geomorphic controls over watershed fluxes at the Cape Bounty integrated watershed observatory, High Arctic, Canada, 2003-7

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We established coordinated field studies at the Cape Bounty integrated watershed observatory in 2003 to investigate the linkages between watershed elements in paired watersheds and lakes on south-central Melville Island, Nunavut, in the Canadian High Arctic. Our goal has been to identify the processes and sensitivities that control fluxes of water, sediment, particulate and dissolved carbon and nitrogen, and solutes from the watersheds towards the goal of incorporating these processes into a comprehensive watershed model to identify the impact of projected climate changes.

Results from the first five years of the project indicate a critical control over most processes by snowcover characteristics and pre-melt snow water equivalence (SWE). Sediment delivery is linked to contact with the bed and years with minimal snow cover substantially reduce discharge and contact with the channel bed during the peak runoff period in June. Nutrient delivery broadly follows sediment concentrations, and both demonstrate low concentrations and overall fluxes during the warmest period of the melt season in July after the spring nival maximum discharge.

Permafrost erosion is locally intense and results in substantial delivery of sediment from slopes to the channel system. An exceptionally warm summer and late season rainfall contributed to a large number of active layer detachments in 2007 that resulted in significant disruption to the west watershed while the east watershed remained relatively unaffected. Prominent active layer detachments that occurred at least 55 years ago continue to contribute substantially to watershed fluxes as well. Increased snowmelt and runoff provides the means to transport this material to the main channel and downstream. To evaluate these long term sediment yield perturbations, we will analyse annually laminated sedimentary records from both lakes.

Future work will continue to focus on sedimentary and biogeochemical sources and sinks. The Cape Bounty site is the longest watershed record of its kind in the Canadian High Arctic and will contribute new data and collaborative opportunities to SEDIBUD.

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Sediment budgets in coastal settings: On the necessity to create a common framework for SEDIBUD and ACCO/Net activities during the International Polar Year (IPY)

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The IPY has brought considerable attention to the Polar Regions and in particular has highlighted the need to re-evaluate global sediment and nutrient budgets. Several projects intend to revisit previous estimations and undertake measurement campaigns. However, these large efforts are principally geared towards the land or the sea. The coast, through which land and sea interact is a major interface of sediment budgets and needs to receive the attention it deserves within IPY. Human habitation, migration and resource use in the north occurs mostly along the Arctic coastline. This environment is sensitive to changing sea level, sea ice and air and ground temperature changes. Resource access and availability are directly impacted by these changes as well.

The ACCO/Net and SEDIBUD projects can provide value-added products to this endeavour by combining their approaches of sediment budgets in the coastal zone.

The Arctic Circum-polar Coastal Observatory Network (ACCO/Net) aims at creating a baseline for future coastal monitoring. Researchers from 7 countries are working along the entire circumpolar Arctic coastline to establish a network of observatories to monitor changes in the Arctic coastal zone. This includes monitoring changes in coastal erosion, sea ice cover, wave action and the temperature and response of the permafrost.

The primary aim of SEDIBUD is to provide an integrated quantitative analysis of sediment transfers, nutrient fluxes and sediment budgets across a range of key cold environments. The major focus is on the impact on sediment transfer processes in response to a variety of climate change scenarios at a scale, which incorporates sediment flux processes from source to sink. In order to perform a fully integrated study of source to sink sediment fluxes and sediment budgets in cold environments.

This paper highlights potential links between the two projects and a rationale for collaboration in the field of data management and data exchange.

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Assessment and Impact of Cultural Landscape in a U-shaped Valley System in Western Norway (Erdalen/Nordfjord)

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The Erdalen Valley in Western Norway (Nordfjord) has been used since several centuries for grazing (cows, sheeps, goats and pigs). The natural preconditions have been controlling the type and intensity of this land use. Land use has significant impact on the natural landscape and on erosion and accumulation processes. The Upper Erdalen system is today part of the Jostedalsbreen national park comprising a combination of natural and cultural landscape.

The main goal of this study is to evaluate the development of land use in Erdalen throughout time by applying a combination of different methods from physical and historical geography. Investigations are performed in the entire valley system reaching from the Jostedalsbreen ice cap to the valley outlet draining into the Strynevatnet. Focus is on the assessment of the cultural landscape as it is presented today and on the examination of the impact of current land use on the natural system and sediment fluxes.

Dominant land use is grazing by cows and goats. Cultural landscape is analysed by studying archives, performing qualitative expert interviews and evaluation of maps. The level of impact on the natural system and sediment fluxes is assessed by mapping effects of cow trampling, analysis of water chemistry and suspended sediment concentrations as well as soil chemistry.

The current landscape is a result of the interaction between natural and cultural processes and given land use appears to be a significant impact on the natural system including increased erosion.

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The proglacial control on suspended sediment transfer from a deglacierizing basin, Small River, British Columbia, Canada

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The extent of the proglacial control on spatial and temporal patterns of suspended sediment transfer was examined at Small River Glacier, British Columbia, Canada a small alpine basin experiencing ice recession from Little Ice Age (LIA) maximum (ca. 1910). The proglacial channel control on suspended sediment transfer patterns was characterized using a spatially distributed network of 9 gauging stations that provided high frequency (5 min) records of suspended sediment concentration from the entire proglacial area. Results showed that each gauging station was dominated ca. 80% of days by diurnal sediment transfer patterns and low suspended sediment concentrations. Irregular transfer patterns were generally associated with high sediment concentrations during snowmelt and rainfall events, resulting in the transfer of up to 70% of the total seasonal suspended sediment load at some gauging stations. Suspended sediment enrichment of up to 600% from channel storage release and extra-channel inputs occurred between the glacial front and distal proglacial boundary. Spatially sampled suspended sediment response data from extra-channel surfaces of different maturity during rainfall events was used to infer the relative inputs of sediment from extra-channel surfaces. The analysis showed that the intensity and duration of rainfall events had to increase in magnitude to mobilize surfaces of increasing maturity. This rapid temporal decline in surface response indicated that surfaces were stabilizing within decades of exposure from the LIA maximum. Overall, the proglacial area was the source for up to 80% of the total suspended sediment yield transferred from the Small River Glacier basin. This control suggests that short-term sediment storage and release of proglacial sediment may significantly modify suspended sediment yield patterns from glacierized basins.

Keywords: proglacial, suspended sediment, suspended sediment yield

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Particulate and dissolved matter transfer in small High-Arctic non-glaciated basins – Central Spitsbergen

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Seasonal variation in outflow, sediment transport and morphological changes have been monitored in five basins drained by periodic streams on the eastern coast of Petuniabukta in Billefjorden, Central Spitsbergen (78°43'N, 16°37'E) between 2001 and 2003. The areas of the particular basins are: Gizehbekken - 5.74, Sphinxenbekken - 2.25, Løvehovdenbekken -1.18, Dynamiskbekken - 1.26 and Fortetbekken - 0.93 [km^2]. Their drainages were built of carbonate rocks, gypsum, anhydrite and sandstones. The basins were located on mountain slopes (up to 900 m a.s.l.) and ended with alluvial cones at sea level or slightly above it. The outflow was active during positive air temperature days - when snowmelting starts, initially on snow cover, then on mineral surface (rocks or weathering/sediment cover) and while the permafrost active layer is thickening down to 1 m below the surface, also in form of groundwater flow. In case of Løvehovdenbekken a deeper groundwater circulation was probably also active. Except of flooding events caused by rapid snow melting stream water was not a significant agent in transporting particulate matter, even in steep parts of their course. Sediment transport rates during short (up to 1 day) flooding events may exceed up to five times the total of the remaining of the positive air temperature period (about 100 days). The most remarkable example of differences in particulate matter transport was observed in Dynamiskbekken in 2003 when 81.26 T100d^{-1}km^{-2} was transferred in conditions of average summer thermal and supply condition, in contrast to 397.44 Td^{-1}km^{-2} during one-day flood. Floods caused distinct geomorphic changes in area of alluvial fans, river mouths and fjord coastline. During floods the maximum transported sediment fraction are cobbles and gravels. Among the studied basins, Gizehbekken, which flowed partly through area of fresh glacial sediments, transported in "normal" conditions the largest amount of particulate matter - 496.55 T100d^{-1}km^{-2}.

Transport of dissolved matter was related to catchment size, rock types and tectonic setting. Dynamiskbekken and Sphinxenbekken represented HCO_3^--Ca^{2+}-SO_4^{2-}-Mg^{2+} water type in contrary to Gizehbekken and Løvehovdenbekken that carried SO_4^{2-}- Ca^{2+}- HCO_3^--Mg^2. Average concentration of dissolved matter within discussed streams varied between 149 and 902 mgl$^{-1,}$ which along with average water discharge between 0.017 and 0.186 m^{3}s^{-1}km^{-2} resulted in total annual chemical denudation rate in the range from 79.8 to 709.03 Tkm^{-2}. Biogeochemical processes were of minor importance. Only in areas of vegetation next to bird colonies the concentration of bio-components reached 0.5% of total ion amount.

The seasonality of water mineralization in streams was well visible. Since the early snowmelt steady increase of ion concentration was observed, reaching the highest values at the end of the positive air temperatures period. In the studied non-glaciated basins transport of matter is dominated by dissolved form (in ratio about 100:1 for two basins and 2:1, 1:1 for the remaining) when "normal" conditions are taken into account. Most of particulate matter is transported during short floods due to enhanced snow melting at the beginning of summer.

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Seasonal changes of sediment fluxes in glacifluvial environment in Petunia Bay, Svalbard

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The maximum quantities of drainage and sediments delivery to depositional basins in High Arctic environment are associated with glacifluvial outflow, due to accelerated ablation and intensive water circulation in edge and marginal zones of glaciers. Three proglacial rivers in Central Spitsbergen (Petunia Bay, Billefjorden) were studied during four summer periods to identify the variability of the discharge and suspended/dissolved matter transportation, outflowing from catchments glaciated in ca. 30%. Studied glaciers (Ebbabreen, Ragnarbreen and Hörbyebreen) reveal various types of nourishment (partly in valleys and partly from the neighboring ice-plateau Lomonosovfonna), marginal zones and outflow systems.

Three main hydro-geomorphologic seasons in the operation of glacifluvial processes can be distinguished: Initial season, high-intensity season and ending season. Differences in dates delimiting these seasons reaches 5 days from year to year. The permanent melting period (except from some winter and early spring thawings) usually starts at the beginning of June, with positive temperatures occurring in the lowest parts of glaciers. Due to initial processes of snow-cover melting and its transformation the dynamics of outflow and sediment flux is limited. The maximum intensity of the outflow and related sediment transport is observed since the ablation area covers the whole zone below equilibrium line altitude and inglacial ice plugs melt-out. After snow cover disappearance a permanent degradation of the ice surface is supplying deep glacier circulation, mobilizing particulate matter flux. This season starts usually about the beginning of July and continues till about the mid of August, while sun operates at the highest level. After the period of intensive melting, the critical decrease of water discharge is observed. Within three days of continuous temperatures drop-down below 0°C the suspension transport decreases almost totally. According to domination of subglacial water circulation and cryochemical processes, a distinctive rise of solute transportation is observed. The course of intensity of the outflow and matter transportation in proglacial streams, dependent on heat exchange of the glaciers surface, is disturbed with randomly distributed precipitation events.

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Mountain permafrost distribution in the Abisko region, sub-Arctic northern Sweden

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The permafrost distribution in the Abisko region in northern Sweden has been assessed using the bottom temperature of snow (BTS) method, supported by continuous ground temperature measurements. In order to improve the statistical basis for the probability mapping, the study area was subdivided into three sub-regions, based on regional precipitation patterns. Spearman's non-parametric test was used to test the correlation between BTS-values and the topographic parameters elevation, curvature, slope gradient, wetness index and potential incoming short wave radiation. The results show that in two of the sub-regions the strongest significant correlation is between elevation and BTS-values, while curvature is strongest in the third sub-region. A binary logistic function was used to create permafrost maps showing probabilities of permafrost in two of the sub-regions (Fig. 1). This shows high probability for permafrost above 1300 m a.s.l. in the western part of the region and low probability below 1025 m a.s.l.. In the eastern part of the region the probabilities are also influenced by the potential incoming shortwave summer radiation. This leads to a higher probability of permafrost at a lower altitude, 850 m a.s.l., on northeast- to east-facing slopes compared to the other aspects. On the west-facing slopes the equally high probability of permafrost is at 1000 m a.s.l and at 1100 m a.s.l. on the S-facing slope. The general conclusion is that permafrost is widespread in the mountain areas of Abisko.

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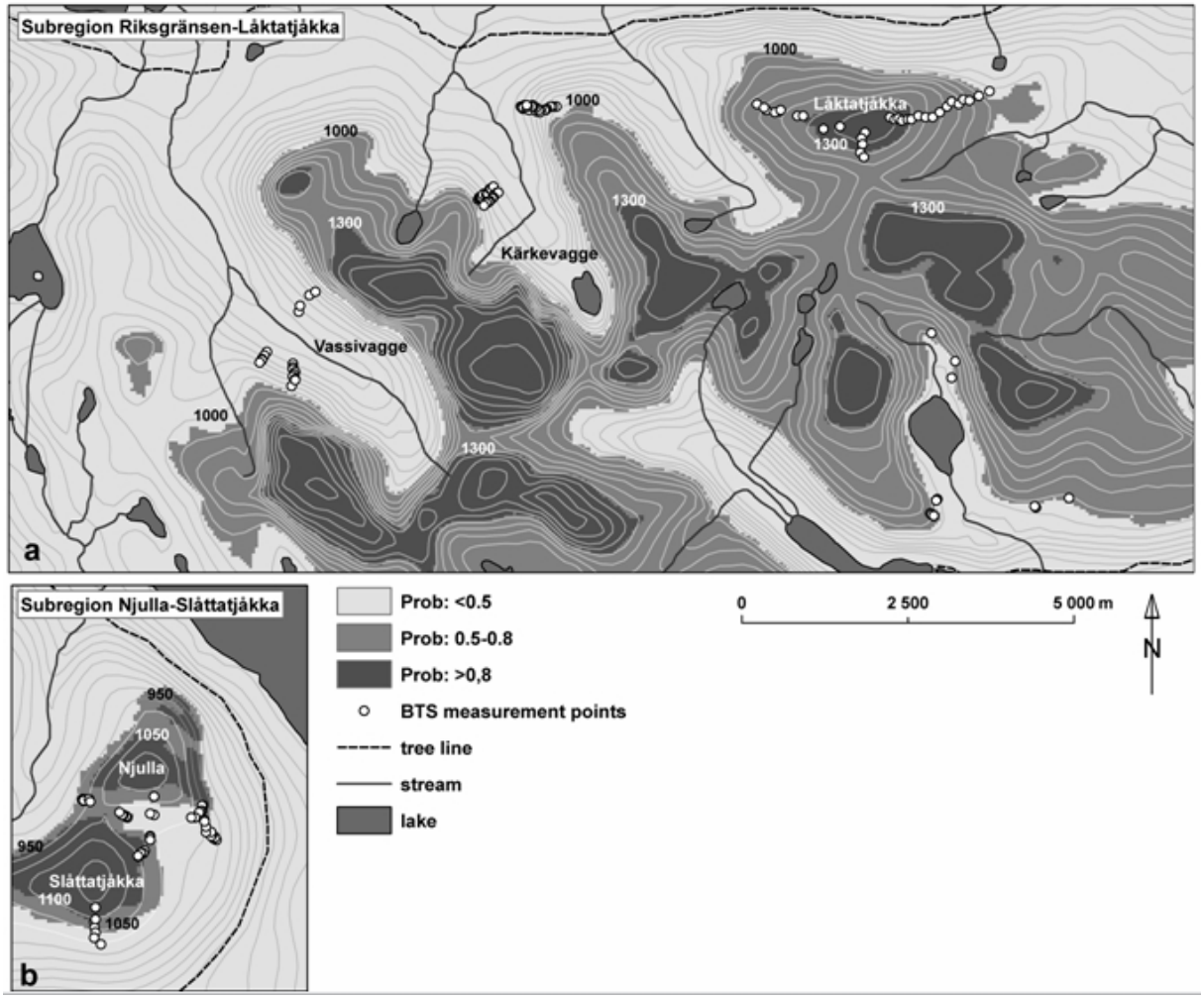

Fig. 1 Probabilities of permafrost based on the logistic regression models for the subregions Riksgränsen-Låktatjåkka (a) and Njulla-Slåttatjåkka (b). The subregion Björkliden is not represented in the figure since it was not possible to create a reliable model.

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Organic carbon in Quaternary sediments of Russian West Arctic coasts

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Sediments, organic carbon, dissolved salts, and, partially, released pore gases come into the sea at a destruction of coasts. At present, it is assumed that the income of a material of destroyed coasts into the Arctic seas is comparable to the amount of sediments carried by large northern rivers. The content of organic carbon in the coastal sediments of Barents and Kara Sea is still under poor investigation. Our results and published data allow us to make first approximations of organic carbon-content in coastal sediments of the Barents and Kara Sea. The mean values of the organic carbon content were calculated for the various types of sediments widespread at the coasts of Kara Sea. Organic carbon in clayey marine Middle and Late Pleistocene deposits presents mostly in adsorbed form. Its content corresponds in direct ratio with the content of clayey particles. Adsorbed form of organic carbon in clayey marine sediments is very resistant to the environmental changes: Organic carbon content does not change in the process of cryogenesis during the freezing-thawing cycles. Organic carbon content in thawed and consequently refrozen sediments shows no changes in comparison with original permafrost. In Late Pleistocene the condition of organic carbon accumulation in the western sector of Kara Sea were more favorable than in the eastern sector. Besides the adsorbed form, the organic carbon in the clayey sections of this sector accumulated also in the form of plant detritus and even peaty layers.

For thermoerosional coasts organic carbon content was found 0.1 – 0.6% in sands and 0.8 – 1.2% in clays and was found as independent from geological features (genesis, age and others). In the regions with accumulative forms such as places where low sandy islands form, the organic carbon-content is fairly low and usually is only 0.1%.

In the laidas, especially in the rivers estuaries, organic carbon content in sands increases to its usual level – 0.1 - 0.7% in the sand and to 1.2% in the clay sediments. The organic carbon accumulation in the contemporary littoral sediments is going in a different way. Organic carbon occurs here in the form of plant remains and pedogenesis products.

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Monitoring of the Orravatnsrústir Palsa site, in the Hofsafrétt area in Central Iceland

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The Orravatnsrústir Palsa site is located on the Hofsafrétt area, north of the Hofsjökull glacier in Central Iceland, at approximately 710-715 m a.s.l. Along with the well-studied Þjórsárver Palsa site, located south of the Hofsjökull glacier, the Orravatnsrústir site is one of the most well developed palsa site in Iceland.

The site is characterized by well developed palsas surrounded by small lakes and ponds located in a small valley like depression. Small rivers drain the area. In the northern part of the area the palsas are often 40-60 cm high and cover a surface up to 2000 m^2, but on the southern part the palsas are larger, up to 150-200 cm high and covering up to 2500 m^2. In general the palsa area is well vegetated, with grasses, sedges and lichen. Such a high vegetation cover is uncommon in Iceland at this high altitude and contrasts with the very poorly to non-vegetated surrounding areas, which characterizes the extensive upland plateau, covered by moraine and large sandur fields. The bedrock in the area mostly consists of basaltic lava and tuff.

Plans regarding the establishment of a large water reservoir have been made in the glacial river Jökulsá Austari, just east of the Orravatnsrústir site, linked to building of a power station, referred as the Skatastaðavirkjun. The planned reservoir, the Bugslón reservoir, would presumably raise the groundwater level in the area considerably, which might influence the groundwater level in the Orravatnsrústir area. Sediments transported by wind action from the lake banks, over the Orravatnsrústir area, could also seriously damage the vegetation in the area.

Since 2001 monitoring of the Orrvatnsrústir site has been carried out to understand the connection between climate variations and environmental changes of the palsa site. Size measurements of selected palsas both in the northern and southern sites of the area, and data of the thickness of the active have been collected along fixed transects across selected palsas.

In 2005 a 2D geoelectrical survey was carried out in the area indicating that the permafrost depth in the area varies from 6-8 m at this time.

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Strontium isotope systematics in the Oppstryn drainage basin, western Norway

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The strontium (Sr) isotope composition of runoff and particulate material can be used in catchments to determine the proportion of weathering products originating in areas with different bedrock as a supplement to major ion geochemistry. The Sr budget of a catchment is determined by the relative contributions of erosion and weathering of carbonate rocks versus silicate rocks, but also the preferential weathering of carbonate minerals versus silicate minerals and the contributions from different silicate minerals within the same rock unit. As an example it has been suggested that the importance of carbonate relative to plagioclase weathering could be exaggerated in cases where only the plagioclase-to-kaolinite dissolution reaction is considered (Pretti & Stewart 2002).

Samples of filtered river water and suspended particulate material collected on the filters are collected to estimate the particulate and dissolved loads of runoff from the northwest end of the Jostedalen glacier, western Norway. Strontium isotopic fingerprinting will be carried out by analysing the same samples for Sr-87 and Sr-86 isotopes in an attempt to delineate the relative contribution the two to three different major types of bedrock in the area under and adjacent to the glacier.

Strontium isotope systematics could enhance the precision of the more general mass balance which is performed with respect to major in geochemistry in the Oppstryn drainage basin and contribute to understanding the contribution of different types of minerals, rock types and sub-catchments when estimating the overall erosion and weathering in this part of Europe.

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Effect of within-channel permafrost on sediment transport of rivers in polar environments

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Permafrost conditions in polar territories control sediment supply originating not only from basin surface, but also from sources within the river channels. The effect of frozen bedforms on hydraulic parameters and channel morphology is directly influencing sediment availability and mobility. Channel relief and morphology and its transformations through different time scales affect observed sediment flux not less than watershed erosion does. At-a-station sediment discharge is due to this fact a result of both locally and generally acting forces. The aim of this study is to reveal how the permafrost affects river channels and sediment supply on different spatio-temporal scales.

The presence of seasonally frozen and permafrost layers within the bounds of river channels was discovered in early 1920-ies. Since then, a number of expeditions collected observation data, mostly descriptive, with rarely performed drilling. Only sandy alluvium beds (and thinner) are affected by freezing, and this is not an issue for gravel beds due to active heat exchange of stream with the channel itself (caused by high filtration factor of gravel alluvium). Formation of frozen grounds within sandy channels is possible with 1) freezing of channel surface during winter low-flow and 2) riverbank block failure and lateral channel movement. Thus freezing affects only limited riverbed areas – shallow waters, channel branches, large-scale bed forms.

These areas are mostly affected by seasonal freezing, which under certain climatic and geomorphic conditions can be transformed to permafrost layers. Seasonal freezing occurs only on dry channel surfaces and is controlled by hydrological and meteorological conditions throughout winter. Long-term existence of frozen layers and permafrost formation is determined by heat-transfer properties of alluvium and general climate severity. Within-channel permafrost layers and cores (found in large bedforms) result in increased channel stability, which influences both suspended sediment and bed load transport.

Suspended sediments transport on rivers in polar environments during springtime is much more supply-limited due to within-channel freezing. Snowmelt here occurs when the watershed surface is stabilized by permafrost. Wash-load is low, and the under-saturated river stream has excess transport capacity. Riverbed surface freezing strictly limits the within-channel sources of suspended sediments, which location is determined by local channel pattern morphology. On the latter stages of spring freshet, when the basin sources are active, riverbeds supply only a limited amount of sediments to the stream, defined by the within-channel active layer thawing depth. This leads to the prevalence of wash-load (basin-generated sediment) in total sediment flux.

Total bed load discharge, which can be formalized as a total volume of riffles, moving on the surface of larger bed forms, and the movement of the bed form itself. Limitations in mobility concern bed load as well, resulting in stability of large bedforms as well as individual smaller-scale riffles. First leads to forming of channel patterns, which are typical for polar rivers and include large central bars with smaller, "second-order" bars attached to them (in braided channels) and large bars in convex side of the bends in meandering rivers, while second defines decrease of bed load transport in small riffle form.

The analytical method of freezing-affected areas location is developed, based on bathymetry and stage data. Using GIS-analysis allows prediction of local scour and accumulation areas, channel pattern transformation forecasts.

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Coastal erosion sediment input to the Barents and Kara Seas (based on ACD classification)

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Coastal erosion sediment and organic carbon input within the transition zone between coast and shelf plays a major role in geomorphological and biochemical cycles. The estimation of the coastal erosion sediment and organic carbon input to the Barents and Kara Seas was fulfilled on the basis of the coastal mapping and the study of coastal sediments composition, content of ice, and soluble salts. The total length of the Barents and Kara Seas coasts evaluated on the ACD GIS reaches about 14 000 and 15 500 km, including thermal erosion coasts of 2760 and 2660 km length.

As a first step the coastline was divided into homogeneous geomorphological segments. For each homogeneous coastal segment the following values were determined: length, elevation, retreat rate, sediments, organic carbon-content, ice -content, and salinity. The main problem is to evaluate the content of organic carbon in the coastal sediments. On the basis of the published data and the results of our own fieldwork it was established that the average content of organic carbon in clays reaches 0.8-1.2%, and in sands – 0.1-0.6%. Calculation of the coastal retreat rate was based on coastal monitoring and published data. The total input of sediments, organic carbon, melted ice, and soluble salts was calculated as the sum of values determined for each homogeneous segment. Dynamics types of the coasts and results of the coastal erosion sediment input calculations are given at the table.

Table 1. Coastal erosion sediment input to the Barents and Kara Seas.

	Length of dynamic coastal types [km]			Sediment input [mil. ton/yr].				
	Stable	Accumulative	Thermal erosion	Total	Sediments	Melted ice	Organic carbon	Soluble salts
Barents Sea	9680	1560	2760	43.3	35.2	7.8	0.2	0.1
Kara Sea	6700	6240	2560	35.4	25.5	9.2	0.4	0.3

Comparison of these results with published data shows that the organic carbon input from the coasts subjected of thermal erosion, as determined by our calculations, is approximately 2-3 times less than was evaluated before.

The ACD Classification of the Barents and Kara Seas coasts and Maps of homogeneous segmentation are presented in this paper.

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Sediment delivery in a large, steepland lake catchment

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Upland and mountain environments are typically characterised by some of the highest global specific sediment yields. High rates of sediment production and transfer, particularly during extreme events, are cited as the principal cause of these yields. However, sediment budget studies reveal that in many steepland catchments, geomorphic processes are relatively inefficient at transporting sediment and high rates of erosion only manifest themselves at the local scale. Low sediment delivery ratios imply that much of the sediment mobilised during events enters storage relatively quickly due to inefficient coupling between slope-channel linkages and headwater-mainstream channels. The aim of this presentation is to illustrate these issues using sediment budget case studies from the upland Bassenthwaite lake catchment (355 km^2) in Northern England.

The talk considers three main topics:
Coupling of hillslope and channel processes (source-to-sink correlations)
Inefficient delivery of sediment from headwater catchment systems (linking sediment budgets at different scales)
Longer term context of changing climate and how ssource-to-sink sediment dynamics respond to global change

It is concluded that sediment transfer is an inefficient process in upland catchment systems but differs according to the dominant geomorphic process (debris flow, fine sediment flux, etc). High rates of erosion only manifest themselves at the local scale.
Low sediment delivery ratios are related to the inefficient coupling between slope-channel linkages and headwater-mainstream channels. This means sediment yield is episodic, with large outputs of sediment only following extreme rainstorms. However, these flash floods although devastating in the short-term may not be very significant at the large scale or over longer time periods. Future sediment yields, with respect to climate change, are hard to predict due to uncertainties in controlling variables (runoff versus vegetation). Upland sediment systems are complex systems which require detailed (multiple) sediment budgets, conducted at a variety of scales, to understand them fully. This last general conclusion is particularly important in the context of the work presented here because Bassenthwaite Lake currently faces problems from catchment erosion and pollution; and is the focus of a major lake restoration programme.

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Susceptibility of burnt upland soils to disturbance by cycles of wetting and frost: a laboratory simulation study

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Although the ecological effects of wildfires are becoming increasingly well understood, fires on steep mountainous terrain in the UK have not been investigated and little is known about the hydrological and geomorphological consequences of such events. A large wildfire, 16 – 23 April 2003, at Barrow Fell (455 m) in the northern Lake District (Northern England) devastated more than 100 hectares of open moorland resulting in total vegetation loss over 20 ha of the site. Concerns about potential accelerated erosion, by rainfall and frost action in the winter following the event prompted a field and laboratory programme designed to investigate potential soil loss following the fire. Monitoring at disturbed and undisturbed sites was carried out between November 2003 and May 2005. This was complimented by a laboratory experiment designed to investigate the effects of wetting / rewetting and frost heave on the characteristics of the soils. This paper describes the results of this experiment; the comparison of the local field conditions with the laboratory conditions; and considers the implications for the stability of the soil crust and potential sediment flux.

Wetting / rewetting and frost heave experiments were completed on 16 soil samples: burnt, crusted, and cracked (n = 8); burnt and crusted (n = 4) and unburnt (n = 4). Samples were subjected to either seven frost cycles or a nine rewetting simulations and the strength of the soil crust was monitored by a fall-cone test following each cycle. Simulations were designed to mimic local field conditions at the burn site. Results show that frost is more important in weakening the soil crust than wetting and rewetting. Differences exist between the three main soil types but local variations in crust strength are very evident in the large within sample variability of the measured data. Generally crusts where not fully destroyed. This is consistent with the field monitoring which shows rates of soil loss were generally low but spatial and temporal variability was very marked. It is concluded that although soil erosion rates following the burn are elevated, large scale severe soil loss did not occur. The relatively intact surface crust had low runoff rates (partly due to surface cracking) and was quickly revegetated in the aftermath of the fire.

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