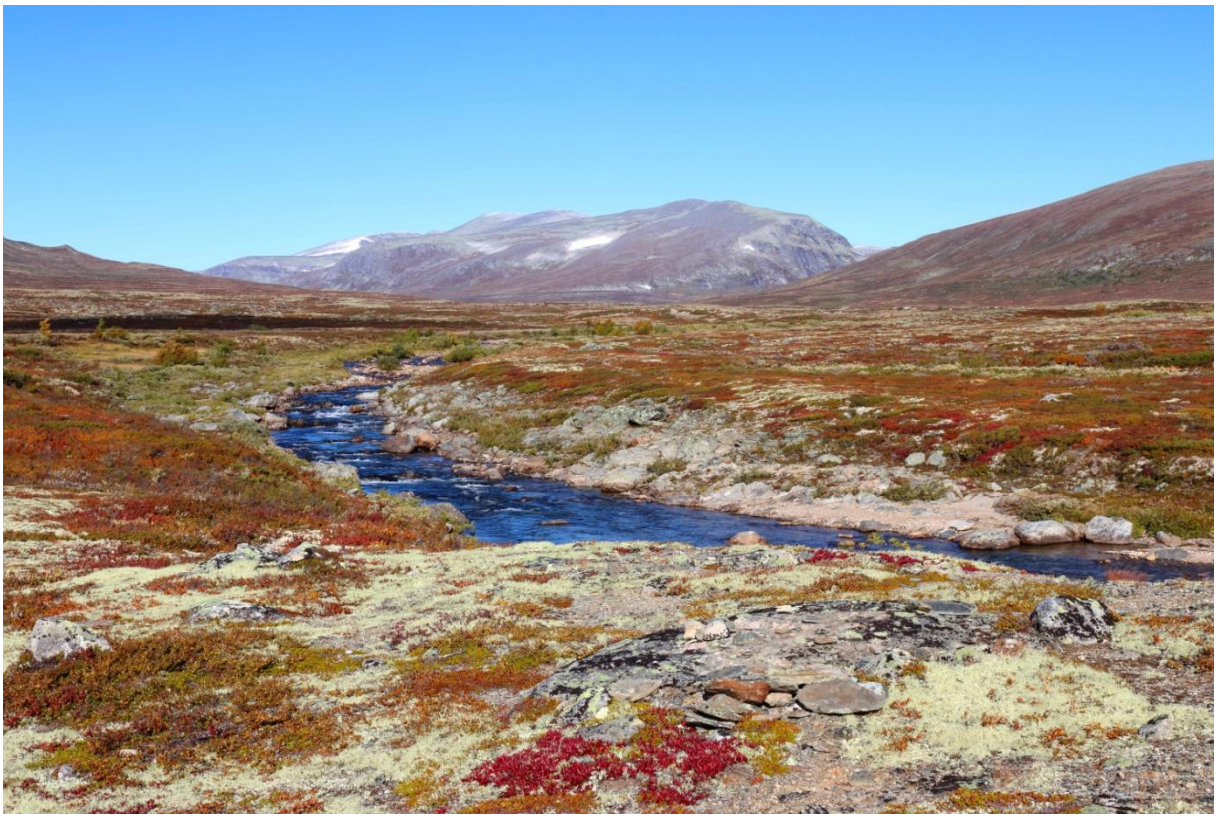
Geomorphological Field Laboratory
Publication Series

Number 2, October 2020

First IAG GeoNorth and IAG GeoNor Conference: *Geomorphology and Geomorphological Research in the Nordic Countries*

1-2 October 2020, Virtual Conference



Volume of Abstracts

Editors:

Achim A. Beylich and Katja Laute

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The stream Kaldvella in the Dovrefjell-Sunndalsfjella National Park in central Norway (Photo: K. Laute, 13.09.2020)

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First IAG GeoNorth and IAG GeoNor Conference:

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Preface

During the IAG Regional Conference on Geomorphology, 19-21 September 2019, Athens, Greece, the National Norwegian IAG Geomorphology Group (Geomorphological Research Group of Norway - Geomorfologisk Forsknings Gruppe i Norge) **IAG GeoNor** and the Nordic Network of National Geomorphology Groups from Denmark, Finland, Iceland, Norway and Sweden **IAG GeoNorth** (new Nordic Regional Group) were formally approved as **National Scientific Members** of the International Association of Geomorphologists (IAG) (http://www.geomorph.org/national-scientific-members).

IAG GeoNor is increasing the national and international visibility of Norwegian geomorphology and will stimulate the active communication, collaboration and exchange between senior and early career scientists from geomorphology and from other bio-geophysical and engineering disciplines working at different universities, research institutes and companies in Norway. In addition, GeoNor shall serve as a catalyst for the development of international scientific contacts and collaborations for Norwegian senior and early career scientists.

IAG GeoNorth is stimulating the active communication, collaboration and exchange between the national geomorphology groups/communities of Denmark, Finland, Iceland, Norway and Sweden in Northern Europe. By serving as an international IAG umbrella network, GeoNorth shall foster the initiation and/or further development of national geomorphology groups in the five Nordic countries. Being a formal and official organ of the International Association of Geomorphologists (IAG), GeoNorth is connected with the global IAG network of national senior and young geomorphologists' groups and communities.

Both IAG GeoNor and IAG GeoNorth have a key focus on the active support of young geomorphologists' activities and of the development of young geomorphologists' networks and national groups in the Nordic countries. In addition, GeoNor and GeoNorth reach out internationally by being closely linked with other geomorphology groups worldwide and by showing appreciation for the geomorphological research achievements and the scientific work of international colleagues that are carrying out relevant geomorphological research in the Nordic countries.

The First IAG GeoNorth and IAG GeoNor Conference on *Geomorphology and Geomorphological Research in the Nordic Countries* is held as Virtual Conference, 1-2 October 2020, and is organized under the auspices of the International Association of Geomorphologists (IAG).

We kindly welcome scientists and students from seventeen different countries to this event and we are looking forward to a fruitful scientific exchange of ideas and to valuable in-depth discussions and networking activities.

With kind regards and on behalf of the IAG GeoNorth and IAG GeoNor National Respresentatives and Core Members,

Achim A. Beylich and Katja Laute

Conference Organizers

Content

1. Conference programme

1 October 2020

09:00-09:10: Opening of the virtual conference and welcome of participants by *Achim A. Beylich* and *Katja Laute*

09:10-09:30: *Achim A. Beylich*: Information on the IAG National Scientific Members GeoNor (Norway) and GeoNorth (Regional Group Member including the five Nordic countries Denmark, Finland, Iceland, Norway, Sweden)

09:30-10:00: Introduction of the newly appointed Young Geomorphologists' National Representatives of

- Denmark: *Gregor Lützenburg* (Copenhagen)
- Norway: *Kamilla Skaalsveen* (Tromsø)
- Sweden: *Ramona Schneider* (Stockholm)

10:00-10:30: Invited key lecture by *Mauro Soldati, Mihai Micu, Marta Della Seta*: The International Association of Geomorphologists (IAG): Structure, organization and training programme

10:30-10:45: Invited key lecture by *Susan Conway*: The International Association of Geomorphologists (IAG): Outreach and communication

10:45-11:00: Questions and discussion

11:00-11:15: Break

11:15-11:45: Invited key lecture by *Irene M. Bollati, Mauro Bonasera, Ciro Cerrone, Anna Masseroli, Mariacristina Prampolini, G. Amato, L. Coco, F. Vergari*: The Italian Young Geomorphologists' Group: Tracing back the history of a young researchers' initiative in the framework of the Italian Association of Physical Geography and Geomorphology (AIGeo)

11:45-12:15: Questions and discussions

12:15-13:00: Lunch break

13:00-13:40: Invited lecture by *Benjamin Bellwald, Sverre Planke, Lukas W.M. Becker, Reidun Myklebust*: Meltwater sediment transport as the dominating process in mid-latitude trough mouth fan formation

13:40-14:00: *Mikkel S. Andersen, Verner B. Ernstsen, Lars Ø. Hansen, Zyad Al-Hamdani, Jørgen O. Leth*: Seabed geomorphology of the Danish waters – Preliminary results

14:00-14:20: *Katja Laute, Achim A. Beylich*: Recent glacier changes and formation of new proglacial lakes at the Jostedalsbreen ice cap in southwest Norway

14:20-14:40: Break

14:40- 15:00: *Rachel Oien, Matteo Spagnolo, Brice Rea, Iestyn D. Barr, Robert G. Bingham*: Analysing paleocirque glacier equilibrium line altitudes as indicators of paleoclimate across the southern Scandinavian Mountains

15:00-15:20: *Ramona A.A. Schneider, A.P. Stroeven, R. Blomdin, M.W. Caffee, N. Gribenski, C.L. Yi, X.K. Xu, X.Z. Zeng, M. Hättestrand, P. Fu, L.A. Owen*: Extending the paleoglaciological record of the southeastern Tibetan Plateau through quantification of temporal and spatial relationships between glacial and fluvial landforms

15:20-15:40: *Ola Fredin, J.L. Andersen, J.C. Newall, S.E. Sams, D. Fabel, A.J. Koester, F.M. Stuart, M.W. Caffee, B. Goehring, N.A. Lifton, K.N. Nichols, R. Blomdin, N.F. Glasser, Y. Suganuma, I. Rogozhina, J.M. Harbor, A.P. Stroeven*: Long-term glacial landscape evolution on the escarpment of western Dronning Maud Land, East Antarctica

15:40-16:00: *Mark D. Johnson*: End moraine construction in the Younger Dryas Middle Swedish end-moraine zone

16:00-16:20: Break

16:20-17:00: Invited lecture by *Lina E. Polvi*: The state of fluvial geomorphology in Sweden – previous research and unanswered questions

17:00-17:40: Invited key lecture by *Marwan A. Hassan*: Patterns of channel stability of mountain streams

17:40-18:00: Discussion and summary of the day

2 October 2020

09:00-09:40: Invited lecture by *Nils Rüther, Slaven Conevski, Kordula Schwarzwälder, Massimo Guerrero*: Sediment management for sustainable hydro power development and operation

09:40-10:00: *Katarzyna Wasak, Eliza Płaczkowska*: Links between catchment characteristics and headwater chemistry in a subarctic area (Finnish Lapland)

10:00-10:20: *Dongfeng Li, Xixi Lu, Irena Overeem, Albert J. Kettner, Yinjun Zhou*: Permafrost thaw expands erodible landscapes and increases fluvial water and sediment fluxes on the Tibetan Plateau

10:20-10:40: Break

10:40-11:00: *Costanza Morino, Susan Conway, Philip Deline, Kristian Svennevig, Antoine Lucas, Stuart Dunning*: Molards, a landform to track permafrost degradation in Iceland, Greenland and around the globe

11:00-11:20: *Jonathan Bussard*: Is tourism compatible with an adequate protection of the geomorphological heritage in southern Iceland?

11:20-12:00: Discussion, conference summary and outlook

12:00-13:00: Lunch break

13:00-14:30: IAG GeoNorth and IAG GeoNor Business Meeting

2. Information on IAG GeoNorth and IAG GeoNor

The National Norwegian IAG Geomorphology Group (IAG National Scientific Member GeoNor) and the Nordic IAG Network of National Geomorphology Groups from Denmark, Finland, Iceland, Norway and Sweden (IAG National Scientific Member GeoNorth, new Regional Group)

Achim A. Beylich

Geomorphological Field Laboratory (GFL), Selbustrand, Norway
E-mail: achim.beylich@geofieldlab.com

National Norwegian IAG Geomorphology Group (IAG GeoNor)

Name of the national group:
Geomorphological Research Group of Norway / Geomorfologisk Forsknings Gruppe i Norge (GeoNor)

Start of the national group:
September 2019

GeoNor core members and key responsibilities:

Dr. Achim A. Beylich, Geomorphological Field Laboratory (GFL), Selbustrand, Norway; E-mail: achim.beylich@geofieldlab.com

- Chair of GeoNor
- Coordinator / Chair of GeoNorth
- Head of strategy and activities development and coordination of core members/officers key responsibilities
- Initial coordinator of early-career scientists networking and activities within GeoNor and GeoNorth
- International networking and contacts
- Organisation and co-organisation of GeoNor and GeoNorth meetings
- Hosting and content of GeoNor and GeoNorth websites
- Financial matters (hosting of account and payments to IAG: Annual affiliation fee of 300,00 Euros)

Dr. Katja Laute, Geomorphological Field Laboratory (GFL), Selbustrand, Norway; E-mail: katja.laute@geofieldlab.com

- Secretary of GeoNor
- Co-organisation of GeoNor and GeoNorth meetings
- Website content and webmaster for GeoNor and GeoNorth websites
- Compilation and email distribution of GeoNor and GeoNorth newsletter

Professor Dieu Tien Bui, University of South-Eastern Norway (USN), GIS Group, Bø i Telemark, Norway; E-mail: dieu.t.bui@usn.no

- Representative for GeoNor members at Norwegian universities, and additional Norwegian representative within GeoNorth

Dr. Benjamin Bellwald, Volcanic Basin Petroleum Research (VBPR) AS, Oslo Science Park, Oslo, Norway; E-mail: benjamin@vbpr.no

- Representative for GeoNor members at Norwegian research institutes and companies (others than universities), and communication between the national geology/Quaternary geology, geography, and cryospheric sciences communities in Norway

Professor Nils Rüther, Department of Civil and Environmental Engineering, Faculty of Engineering, Norwegian University of Science and Technology (NTNU), Trondheim, Norway; E-mail: nils.ruther@ntnu.no

- Representative for GeoNor Members at Norwegian universities

Dr. Louise M. Vick, Department of Geosciences, UIT Arctic University of Norway in Tromsø, Norway; E-mail: louise.m.vick@uit.no

- Representative for GeoNor members at Norwegian universities

Professor Stefan Winkler, Institute for Geography and Geology, University of Würzburg, Germany; E-mail: stefan.winkler@uni-wuerzburg.de

- Representative for GeoNor members from outside Norway

Dr. Kamilla Skaalsveen, Department of Soil and Land Use, Division of Environment and Natural Resources, The Norwegian Institute of Bioeconomy Research (NIBIO), Tromsø, Norway; E-mail: kamilla.skaalsveen@nibio.no

- Young Geomorphologists' National Representative of Norway

National and international colleagues that are invited for being included in the GeoNor mailing list. These colleagues will receive the GeoNor newsletter and will be invited to GeoNor and GeoNorth meetings through the GeoNor mailing list

The mailing list includes senior and early career colleagues that work on geomorphology and/or closely related fields at Norwegian universities or/and Norwegian research institutes or companies. In addition, the mailing list includes the representatives of the four other Nordic geomorphology groups/communities and international colleagues that have carried out relevant geomorphological research in Norway and have contributed with published work on the geomorphology of Norway. The mailing list is just preliminary and will be extended. We have compiled the list based on our knowledge about existing colleagues. Invited colleagues of the mailing list are asked to forward messages sent through the mailing list to any colleagues that might be interested to join GeoNor, GeoNor activities and the GeoNor mailing list.

Purpose, organisation and key activities of GeoNor

The National Norwegian IAG Geomorphology Group (GeoNor) is increasing the national and international visibility of Norwegian geomorphology and will stimulate the active communication, collaboration and exchange between senior and early career scientists from geomorphology and from other bio-geophysical and engineering disciplines working at different universities, research institutes and companies in Norway. In addition, GeoNor shall serve as a catalyst for the development of international scientific contacts and collaborations for Norwegian senior and early career scientists. GeoNor shall significantly reach out internationally by being closely linked with the four other Nordic geomorphology groups/communities from Sweden, Finland, Denmark and Iceland, and by showing appreciation for the geomorphological research achievements and the published scientific work of international colleagues that have carried out relevant geomorphological research in Norway. As an active National Scientific Member of the International Association of Geomorphologists (IAG), GeoNor is part of a global network of senior and young geomorphologists' groups and communities. GeoNor is initiated and headed by Dr. Achim A. Beylich and is initially run by an efficient core group of eight scientists: Dr. Achim A. Beylich (Chair), Dr. Katja Laute (Secretary), Professor Dieu Tien Bui (Representative for GeoNor members at Norwegian universities and additional Norwegian representative within GeoNorth), Dr. Benjamin Bellwald (Representative for GeoNor members at Norwegian research institutes and companies (others than universities), and communication between the national geology/Quaternary geology, geography and cryospheric sciences communities in Norway), Professor Nils Rüther (Representative for GeoNor Members at Norwegian universities), Dr. Louise M. Vick (Representative for GeoNor members at Norwegian universities), Professor Stefan Winkler (Representative for GeoNor members from outside Norway) and Dr. Kamilla Skaalsveen (Young Geomorphologists' National Representative of Norway).

Concrete activities of GeoNor include

- An active and frequently updated GeoNor website which serves as relevant information and communication platform for senior and early career members of GeoNor. The website will provide information on relevant scientific projects, relevant meetings, training courses, opportunities for exchange visits, etc. in Norway and outside Norway. Early career/young geomorphologists will be given their own space within this website.
- The compilation and email distribution of a bi-annual GeoNor/GeoNorth newsletter. National and international GeoNor and GeoNorth members will be invited to submit contributions to the newsletter (e.g., information on research projects, training courses, workshops and seminars, exchange opportunities, etc.). Early career/young geomorphologists will be given their own section within this newsletter.
- The biennial organisation of national GeoNor meetings at varying field locations in Norway. At the varying meeting locations relevant ongoing research projects will be presented by GeoNor members and discussed within the group. The biennial GeoNor meetings will include scientific presentations from senior and early career scientists, extended scientific discussions, field excursions, and training courses for early career scientists. To each GeoNor meeting at least one senior and one early career representative of other Nordic geomorphology groups/communities and at least one international colleague (from outside the Nordic countries) with relevant published contributions on the geomorphology of Norway will be invited. The kick-off meeting of GeoNor is organised in combination with the

first GeoNorth conference (virtual conference) and the first national GeoNor biennial meeting will be held in 2021.

Nordic IAG Network of National Geomorphology Groups from Norway, Sweden, Finland, Denmark and Iceland (IAG GeoNorth)

Start of GeoNorth:

September 2019

Chair of GeoNorth:

Dr. Achim A. Beylich, Geomorphological Field Laboratory (GFL), Selbustrand, Norway; E-mail: achim.beylich@geofieldlab.com

Confirmed network members and representatives:

Five national geomorphology groups/communities of

- ***Norway***; Representatives: **Dr. Achim A. Beylich** (Geomorphological Field Laboratory (GFL), Selbustrand, Norway; E-mail: achim.beylich@geofieldlab.com), **Dr. Katja Laute** (Geomorphological Field Laboratory (GFL), Selbustrand, Norway; E-mail: katja.laute@geofieldlab.com), **Professor Dieu Tien Bui** (University of South-Eastern Norway (USN), GIS Group, Bø i Telemark, Norway; E-mail: dieu.t.bui@usn.no); Young Geomorphologists' National Representative: **Dr. Kamilla Skaalsveen** (Department of Soil and Land Use, Division of Environment and Natural Resources, The Norwegian Institute of Bioeconomy Research (NIBIO), Tromsø, Norway; E-mail: kamilla.skaalsveen@nibio.no)
- ***Denmark*;** Representatives: **Dr. Mikkel Fruergaard** (Department of Geosciences and Natural Resource Management, University of Copenhagen, Copenhagen, Denmark; E-mail: mif@ign.ku.dk), **Dr. Verner Brandbyge Ernstsen** (Geological Survey of Denmark and Greenland (GEUS); E-mail: vbe@geus.dk); Young Geomorphologists' National Representative: **Gregor Lützenburg** (Department of Geosciences and Natural Resource Management, University of Copenhagen, Copenhagen, Denmark; E-mail: gl@ign.ku.dk)
- ***Finland*;** Representatives: **Professor Jukka Käyhkö**(Department of Geography and Geology, University of Turku, Finland; E-mail: jukka.kayhko@utu.fi), **Dr. Eliisa Lotsari** (Department of Geographical and Historical Studies, University of Eastern Finland, Joensuu, Finland; E-mail: eliisa.lotsari@uef.fi); Young Geomorphologists' National Representative: **N.N.**
- ***Iceland*;** Representatives: **Dr. Thorsteinn Sæmundsson** (Department of Geography and Tourism, University of Iceland, Reykjavik, Iceland; E-mail: steinis@hi.is), **N.N**.; Young Geomorphologists' National Representative: **N.N.**
- ***Sweden*;** Representatives: **Dr. Lina Polvi Sjöberg** (Department of Ecology and Environmental Science, Umeå University, Umeå, Sweden; E-mail: lina.polvi@umu.se), **Professor Arjen P. Stroeven** (Department of Physical Geography, Stockholm University, Stockholm, Sweden; E-mail: arjen.stroeven@natgeo.su.se); Young Geomorphologists' National Representative: **Ramona Schneider** (Department of Physical Geography, Stockholm University, Stockholm, Sweden; E-mail: ramona.schneider93@web.de)

Annual IAG affiliation fee (from 2020 onwards): 600 Euros

Purpose, organisation and key activities of GeoNorth

The new Nordic IAG Network of National Geomorphology Groups/Communities (IAG GeoNorth) is stimulating the active communication, collaboration and exchange between the national geomorphology groups/communities of Norway, Denmark, Finland, Iceland and Sweden in Northern Europe. By serving as an international IAG umbrella network, GeoNorth shall foster the initiation and/or further development of national geomorphology groups in the five Nordic countries. Being a formal and official organ of the International Association of Geomorphologists (IAG) (IAG National Scientific Member GeoNorth, Regional Group), GeoNorth is connected with the global IAG network of national senior and young geomorphologists' groups and communities. The new IAG National Scientific Member and umbrella network GeoNorth is initiated, coordinated and chaired by Dr. Achim A. Beylich (Norway) and is run by the GeoNorth representatives of the five Nordic national geomorphology groups/communities: Dr. Achim A. Beylich, Dr. Katja Laute and Professor Dieu Tien Bui (Norway), Dr. Mikkel Fruergaard and Dr. Verner Brandbyge Ernstsen (Denmark), Professor Jukka Käyhkö and Dr. Eliisa Lotsari (Finland), Dr. Thorsteinn Sæmundsson and N.N. (Iceland), and Dr. Lina Polvi Sjöberg and Professor Arjen P. Stroeven (Sweden). In addition, each of the five national geomorphology groups/communities has (or will have) an own Young Geomorphologists' National Representative.

Concrete GeoNorth network activities include

- An active and frequently updated GeoNorth website (including web-links to national websites of the national members of the umbrella network and connected groups and societies) which serves as information and communication platform for senior and early-career members of the five national geomorphology groups/communities (information on scientific projects, relevant meetings, training courses, opportunities for exchange visits, etc. in the five Nordic countries and outside the five Nordic countries). Early career/young geomorphologists will be given their own space on this website.
- The biennial organisation of joint meetings of the five national geomorphology groups/communities. These meetings are organised in varying Nordic countries at field locations where relevant ongoing research projects will be presented and discussed, and will include scientific presentations from senior and early-career scientists, extended scientific discussions, excursions, as well as well-selected high-quality training courses for early-career scientists.
- In addition to regular business meetings held during the biennial GeoNorth meetings, the senior representatives and the early-career/young geomorphologists representatives of the five Nordic countries will meet and hold additional planning/strategy meetings during international conferences (e.g., EGU, AGU, Nordic Geological Winter Meetings, IAG International and Regional Conferences).

3. Introduction of newly appointed Young Geomorphologists' National Representatives

Denmark

Gregor Lützenburg

Department of Geosciences and Natural Resource Management, Section for Geography, University of Copenhagen, Copenhagen, Denmark; E-mail: gl@ign.ku.dk

I am a PhD fellow at the Department of Geosciences and Natural Resource Management at the University of Copenhagen. My research background is in Geography with a focus on Geomorphology. I obtained a MSc degree in Physical Geography from the University of Vienna. In my previous research I worked with soil erosion in agricultural catchments and landslides in the Alps. My current research focuses on the drivers of coastal cliff erosion in Denmark and Greenland. By applying remote sensing data to investigate rates of coastal change along sedimentary cliffs over time I am gaining insights into different processes of cliff failure. Ultimately, the goal is to apply the obtained knowledge about coastal cliff erosion processes to predict future developments under a changing climate, shedding some light on the challenges to come.

As a national early career scientists (ECS) representative of Denmark within the IAG GeoNorth Network I am enthusiastic about building a network between young Geomorphologists in the Nordic countries, as well as representing us within the IAG organization. I would like to further increase the outreach and science communication activities in the network. My vision is to build a platform for early career scientists, to share knowledge and stimulate new research ideas. In the future I would like to organize physical as well as virtual networking events. I am looking forward to my new position as ECS representative and working together with you and promoting an inclusive science community. For questions or getting involved please reach out!

Norway

Kamilla Skaalsveen

Department of Soil and Land Use, Division of Environment and Natural Resources, The Norwegian Institute of Bioeconomy Research (NIBIO), Tromsø, Norway; E-mail: kamilla.skaalsveen@nibio.no

Kamilla works as a researcher at the Norwegian Institute of Bioeconomy Research (NIBIO), in the department of soil and land use, currently at the NIBIO office in Tromsø. Her background is a master's degree in Management of Natural Resources, mainly focusing on freshwater management, from the Norwegian University of Life Sciences. She recently returned to NIBIO after a three-year PhD studentship at the University of Gloucestershire (UK). The PhD, titled: "Assessing the Impact of No-till on Water Related Soil Functions and the Role of Farmer Networks in Knowledge Exchange and Implementation", was an interdisciplinary project assessing the effect of different soil management of soil physical and chemical variables, and the implications for water purification and retention in a UK case study. She also conducted a social science study of the characteristics of learning networks and knowledge exchange amongst UK farmers, combining qualitative in-depth interviews with a quantitative Social Network Analysis.

Through her work at NIBIO and PhD project, Kamilla is used to working across disciplines, including limnology, hydrology, soil and social sciences. She is particularly interested in the interactions between soil and water, and catchment scale measures that can improve the quality of these important resources.

Kamilla is now looking forward to her new role as the National Young Geomorphologists Representative of Norway and excited about the opportunity to developing new initiatives and activities along with the IAG representatives of the other Nordic countries.

Sweden

Ramona Schneider

Department of Physical Geography, Stockholm University, Stockholm; Sweden;
E-mail: ramona.schneider93@web.de

My name is Ramona Schneider, and I am excited to meet all members of IAG GeoNorth / IAG GeoNor at this first virtual conference!

I am an enthusiastic young geomorphologist who has recently graduated from the M.Sc. programme "Physical Geography and Quaternary Geology" at Stockholm University. I enjoy living in the North, because I am enthusiastic about polar and alpine environments and I love being outdoors. Therefore, I enjoy fieldwork and spend a lot of my free time hiking, camping, or cycling.

Fascinated by the geomorphological processes shaping the Earth's surface, and landscape evolution on different temporal and spatial scales, I started to focus on geomorphology early on in my education. I received my undergraduate degree in Geography from the University of Bonn in Germany with a B.Sc. thesis about physical modelling of sediment transport in a small-scale flume. I used Structure-from-Motion photogrammetry to quantify sediment budgets and conceptualised my findings in a geomorphological system framework.

My passion for polar environments made me move to Sweden, where I could focus on glacial and periglacial geomorphology and paleoglaciology. For my M.Sc. thesis at Stockholm University, I researched landscape evolution of the SE Tibetan Plateau by investigating the potential of fluvial terraces as climate proxies. Geomorphological mapping of fluvial and glacial landforms, and the dating of glaciofluvial terraces, indicate a dominance of climatic drivers on terrace deposition. Currently, I am finishing this project by integrating new and forthcoming dating results from ice-marginal moraines.

I am looking forward to establishing a network of young researchers in the Nordic countries with all of you! I am convinced that a strong community helps young scientists thrive, both professionally and personally. Together, we can share ideas, build on our diverse experience, and thus become responsible researchers who see their research objects and their roles as scientists in a holistic view.

4. Invited presentations on the International Association of Geomorphologists (IAG)

Invited key lecture

The International Association of Geomorphologists (IAG): Structure, Organization and Training Programme

Mauro Soldati [a], Mihai Micu [b], Marta Della Seta [c]

[a] IAG President – Dipartimento di Scienze Chimiche e Geologiche, University of Modena and Reggio Emilia, Modena, Italy; E-mail: soldati@unimore.it

[b] IAG Secretary General – Institute of Geography, Romanian Academy, Bucharest, Romania; E-mail: mikkutu@yahoo.com

[c] IAG Training Officer – Department of Earth Sciences, Sapienza University of Rome, Rome, Italy; E-mail: marta.dellaseta@uniroma1.it

The IAG is a non-governmental, non-political, non-profit scientific institution at all times free of racial, gender or national prejudice (www.geomorph.org). Its informal style is in keeping with the relaxed international and individual friendships established during the 1st International Conference on Geomorphology, in Manchester 1985.

The IAG was founded in 1989 to promote and develop collaboration in geomorphology between nations. The IAG aims to: (i) develop geomorphology through international co-operation; (ii) promote the dissemination of geomorphological knowledge between the scientific community and the general public; (iii) provide geomorphological advice to international institutions; (iv) encourage the membership of countries around the world; (v) promote geomorphological research and the establishment of Working Groups on specific geomorphological topics; (vi) support the training of geomorphologists at an early career stage from all around the world, with special attention to those from economically disadvantaged countries. The IAG organizes International Conferences every four years and Regional Conferences in between.

The IAG is served by an Executive Committee formed by elected, co-opted and special portfolio members, whose term of office is four years. The Executive Committee directs the scientific activities and handles the economic and administrative management of the Association. Affiliation to the IAG occurs through National Scientific Members (ca. 60 in 2020), i.e. associations or groups of geomorphologists from a country or a geographical region. National delegates appointed by each National Scientific Member form the IAG Council. The Council elects the members of the Executive Committee and approves its scientific and administrative management, examines and approves the finances (including annual accounts and membership fees), modifies the Constitution, disposes of or transfers the assets and approves the dissolution of the Association.

The IAG has always given high importance to the training of geomorphologists at early stages of their career. A specific Training Programme was established in occasion of the 5th International Conference on Geomorphology held in Tokyo in 2001. Since then, considerable financial resources have been invested to favour the participation of early career scientists in events organized by the

IAG or occurring under its auspices. So far almost 200 Young Geomorphologists from more than 50 countries have benefitted from this programme. The IAG itself has acted as either organiser or supporter of intensive courses and training schools in different countries of the World. Goals of the training activities are to help early career scientists to (i) increase their knowledge and experience in geomorphological research; (ii) discuss their learning and research experience with young colleagues from different countries; (iii) meet experienced scientists and young researchers in an informal setting, which favours scientific discussion. The IAG has recently set up the Network of Young Geomorphologists' groups, which is intended to favour scientific interaction and mobility for training and research worldwide.

Invited key lecture

The International Association of Geomorphologists (IAG): Outreach and communication

Susan Conway

IAG Vice President - Laboratoire de Planétologie et Géodynamique CNRS UMR6112, Université de Nantes, Nantes, France; Email: susan.conway@univ-nantes.fr

I talk about the upcoming IAG conferences and the process of proposing to host an IAG conference as well as how to seek the IAG's support for your own geomorphology events. I will outline the different tools that we have for communicating with the geomorphological community worldwide, including email, website and social media. The different memoranda of understanding with our sister organisations will be outlined. I will describe our plans for the upcoming International Geomorphology Week occurring during the first week of March 2021. Finally, I will describe the ways in which you could contribute to the IAG, as we will be seeking nominations for executive committee members in 2021.

Invited key lecture

The Italian Young Geomorphologists' Group: Tracing back the history of a young researchers' initiative in the framework of the Italian Association of Physical Geography and Geomorphology (AIGeo)

Irene M. Bollati [a], M. Bonasera [b], C. Cerrone [c], A. Masseroli [a], M. Prampolini [d], G. Amato [e], L. Coco. [f], F. Vergari. [g]

[a] Earth Science Department Ardito Desio, University of Milan, Milan, Italy; E-mail: irene.bollati@unimi.it
[b] University of Turin, Earth Sciences Department
[c] University of Naples Federico II, Earth Sciences, Environment and Resources Department
[d] ISMAR - Institute of Marine Science - National Research Council
[e] IFAC - Institute of Applied Physics "Nello Carrara" - National Research Council
[f] University of Chieti-Pescara, Engineering and Geology Department
[g] Sapienza University of Rome, Earth Sciences Department

The Italian Association of Physical Geography and Geomorphology (AIGeo), started organizing initiatives addressed to young researchers in 2005, when the first official event was held in Djerba, Tunisia. Since then, the Executive Committee of the AIGeo has continuously paid particular attention to the young geomorphologists through a series of initiatives planned on a regular basis. Besides a reduced rate to be paid for being an AIGeo member, in particular, three have been the categories of initiatives addressed to the youngs (see also the dedicated section on the AIGeo website: www.aigeo.it):

i) *Italian Young Geomorphologists' Days* - With a periodicity of 2 years, young geomorphologists are called to show the results of their researches during a dedicated congress, also open to foreign young geomorphologists, that contemplates also short courses and fieldtrips. Up to now, 8 editions have been organized since 2005 and the next one is in preparation for the Autumn, 2021;
ii) *Stage for Young Geomorphologists* - Young geomorphologists are involved in practical activities like geomorphological mapping and monitoring techniques experimentation on the field. Up to now, 5 editions of the stage have been completed and the next one is in preparation for June, 2021 in cooperation with EGU and IAG;
iii) *Grants for supporting the participation of young geomorphologists* to courses, workshops and congresses - These economic supports are provided following a selection according to the Curriculum Vitae and publications list of the candidates, and, where requested, the abstract to participate to the congress. Up to now several grants have been provided to youngs, more than 1 per year. In addition, during the 2015 and 2019 Young Geomorphologists' Days, specific grants to support the participation of foreign young researchers were delivered.

In 2013, during the *V Young Geomorphologists Day*, held in Rome, the first national representatives of the group (I. M. Bollati and F. Vergari) were selected by the Executive Committee. In 2015, the national representatives' group was widened inviting other 3 components (G. Amato, L. Coco and M. Prampolini) in order to assist in the organization of the growing number of initiatives. In the last years, the mutual participation to events organised by young researchers from other countries (e.g. Germany, Poland, France and Switzerland) have been strengthened. In 2019, the first formal election

of the new national representatives of the Italian Young Geomorphologists was held in Milan, during the *VIII Italian Young Geomorphologists' Days*. In this occasion, 4 new national representatives were elected: Mauro Bonasera (as coordinator and also invited member in the AIGeo Executive Committee), Ciro Cerrone (delegate for the international initiatives), Anna Masseroli and Mariacristina Prampolini. The great novelties introduced in the last years have been: i) the participation of the coordinator of the representatives to the Executive Committee meeting as spokesperson on behalf of the group; ii) the increase of the maximum age from 26 to 30 years for taking advantage of the AIGeo reduced rates, and iii) the preparation of a draft of an official Young Geomorphologists' Statute, to set all the above-mentioned activities of the Young geomorphologists' Group, as an implementation of the general AIGeo statute, to be proposed to the AIGeo Executive Committee. The last representatives are in charge until Autumn 2021 when new elections will be held during the IX *Italian Young Geomorphologists' Days* planned in Palermo.

Since 2013, a regular reportage of the activities, every 6 months, has been prepared by the national representatives and carried out within the AIGeo, during the meeting among the members of the association, in order to show the activities of the groups during each period. Each report is uploaded on the AIGeo website, in a dedicated section. Moreover, a shared file including the competences of each member of the group have been maintained as a sort of showcase to share own research experiences.

Since 2005 until 2020, a long and gradual path has characterized the growth of the *Italian Young Geomorphologists Group.* The contacts with foreign countries are progressively growing and the establishment of new collaborations with other national groups, who have been previously set or who have started to structure their own framework only recently, is welcome. Last but not least, the important support of the *International Association of Geomorphologists (IAG)* in pushing young researchers' activities revealed to be fundamental during the group growth.

The *Italian Young Geomorphologists Group* has the following contact e-mail address: italianyounggeomorphologists@gmail.com

5. Scientific abstracts

Invited lecture

Meltwater sediment transport as the dominating process in mid-latitude trough mouth fan formation

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Trough mouth fans comprise the largest sediment deposits along glaciated margins, and record Pleistocene climate changes on a multi-decadal time scale. Here we present a new model for the formation of turbidite sequences on the North Sea Fan derived from detailed horizon- and attribute-interpretations of high-resolution processed 3D seismic reflection data. The interpretation of the data shows that stacked channel-levee systems are building this up to 400 m thick last-glacial sediment sequence. The frequent channels at different stratigraphic levels and the lack of wedges and scars at the shelf edge show that glacial sediments were not temporarily stored at the uppermost slope. Instead, downslope sediment transport was a continuous process during shelf-edge glaciations of the Norwegian Channel Ice Stream, reaching accumulation rates of 100 m/kyr. The channels are elongated and can be traced from the shelf edge towards the deep basin for distances of >150 km, and document long-distance sediment transport in completely disintegrated water-rich turbidite flows. Our model highlights that exceptional large meltwater discharge to the slope led to erosive turbidite flows, and that freshwater supply is an underestimated factor for sedimentary processes active during glacial cycles.

Seabed geomorphology of the Danish waters - Preliminary results

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The European Marine Observation and Data Network (EMODnet), which is the online gateway to European marine data, is in the process of developing general as well as detailed geomorphological maps of the European waters. The Geological Survey of Denmark and Greenland (GEUS) is contributing to this work by developing a geomorphological classification of the Danish waters. This is the first attempt to create a large scale nationwide geomorphological classification of the Danish waters.

The classification analysis is based on bathymetric data publicly available in the EMODnet Bathymetry portal. The bathymetry is a Digital Terrain Model (DTM) with a resolution of 1/16 × 1/16 arc-minutes, which is generated from selected survey data sets, national/regional DTMs, satellite derived bathymetry and GEBCO 30 arc-second grid. The data preparation included 1) downloading data tiles, 2) mosaicking it into a single DTM, and 3) resampling the DTM to a resolution of 100 × 100 m.

The prepared DTM is then used as input into the Benthic Terrain Modeler (BTM) toolbox, which is an extension to ArcGIS, designed for spatial analysis of benthic landscapes. The principle of the BTM is based on the Bathymetric Positioning Index (BPI), which compares the elevation of each cell in the bathymetry raster to the elevation in its neighbouring cells. A large-scale BPI is used for classifying the area into large geomorphometric structures (crests, depressions, slopes, flats, etc.). Using a fine-scale BPI and other DTM derivatives, such as slope and rugosity, the large-scale structures are classified into smaller geomorphometric structures (crest top, crest slope, narrow depression, broad depression, etc.).

Subsequently, the geomorphometric structures are “translated” into classes of geomorphological features (e.g. channels, marine valleys, ridges and bedforms). The geomorphological translation is based on the classified geomorphometry combined with additional geometric and geographic parameters, such as depth, shape and distance to other features.

The geomorphological classification is validated against 1) specific sites within the Danish waters which were designated by expert judgement, and 2) geomorphological features outside the Danish borders from the EMODnet Geology portal.

Here, we present the preliminary classification results and discuss the challenges and limitations related to the spatial resolution of the data, the choice of analysis scale, and the classification key regarding the translation of geomorphometric structures into geomorphological feature classes.

Recent glacier changes and formation of new proglacial lakes at the Jostedalsbreen ice cap in southwest Norway

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At present, glaciated mountain environments are among the most dynamic geomorphic systems as they are exposed to various climatic and environmental changes. This study highlights the significant transformation of the Norwegian glacial landscape by illustrating recent glacier length changes and the formation of new proglacial lakes within the recently exposed glacier forefields at the Jostedalsbreen ice cap in southwest Norway.

Based on satellite imagery and digital orthophotos, we present a new glacier area outline for the entire Jostedalsbreen ice cap and the first detailed inventory of glacial lakes which were formed within the newly exposed ice-free area at the Jostedalsbreen ice cap. In detail, we explore (i) the glacial lake characteristics and types, (ii) analyse their spatial distribution and hazard potential, and (iii) discuss their geomorphic importance and future development.

For the period from 1952-1985 to 2017/2018 the entire glacier area of the Jostdalsbreen ice cap experienced a loss of 79 km^2. A glacier area reduction of 10 km^2 occurred since 1999-2006. Especially since the year 2000 the Jostedalsbreen ice cap has experienced a recognizable ice mass deficit and most of its outlet glaciers display a major frontal retreat, and in some cases the lowermost glacier tongues have in fact been completely separated. Two percent of the recently exposed surface area (since 1952-1985) is currently covered with newly developed glacial lakes corresponding to a total number of 57 lakes. In addition, eleven lakes that already existed have enlarged in size. Four types of glacial lakes are identified including bedrock-dammed, bedrock- and moraine-dammed, moraine-dammed and ice-dammed lakes. Especially ice- or moraine-dammed glacial lakes can be the source of potentially catastrophic glacier lake outburst floods (GLOFs). Proglacial lakes play a geomorphic key role with respect to sediment connectivity and the sedimentary budgets of proglacial areas. It is likely that a recognizable share of the future coarse- and partly suspended sediment loads from the retreating glaciers will probably be buffered by newly formed proglacial lakes.

Due to the predicted increase in summer temperatures for western Norway until the end of this century, it is very likely that the current trend of an accelerated mass loss of Norwegian glaciers will continue. As one consequence of this development, further new lakes will emerge within the newly exposed terrain. Because glaciers and glacier-fed streams in mainland Norway have a high importance for hydropower production, tourism and climate research, it is essential to gain an improved understanding of the possible environmental impacts of proglacial lakes in order to being prepared for advantages and challenges connected to these newly emerging landscape elements.

Analysing paleocirque glacier equilibrium line altitudes as indicators of paleoclimate across the southern Scandinavian Mountains

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The equilibrium line altitudes (ELAs) of paleocirque glaciers are used to obtain quantitative paleoclimatic information from alpine environments. The dimensions of these glaciers, and their ELAs, are reconstructed based on the topography of, now ice-free, cirques. Typically, this approach is used to derive paleoclimatic data for a particular time period, typically glossing over the fact that cirques are time-transgressive landforms, shaped over multiple glacial cycles. In this study, we test the validity of using paleocirque ELAs as indicators of paleoclimate by comparing them to modern cirques and their relationship to climate (Oien et al., 2020). To achieve this, we reconstruct ELAs from 800 paleocirques across the southern Scandinavian Mountains. The cirques are mapped in GIS, and their ELAs calculated using the cirque floor altitude and also via a more sophisticated approach, using the GlaRe and ELA GIS tools. The population of cirques is analysed to investigate whether sub-divisions can be made on the basis of floor altitude, aspect, and links to paleoclimatic patterns. This study will then be compared to 255 extant cirques.

Extending the paleoglaciological record of the southeastern Tibetan Plateau through quantification of temporal and spatial relationships between glacial and fluvial landforms

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In tectonically active regions, fluvial and glacial landscape systems interact in ways which are not yet fully understood. This is because endogenic or exogenic processes may be the main drivers of landscape evolution. For example, fluvial terraces may form in response to exogenic disturbances like climate change (and glaciation) or to endogenic forces like tectonic uplift. In this context, the Third Pole Environment is considered a key region to study the interplay between these two landscape systems. This is because it is a tectonically active region, as witnessed by numerous faults, tectonic basins, and landslides, that harbours many glaciers. Indeed, paleoglaciological data is a crucial source of information, not only towards landscape evolution studies, but also towards insightful paleoclimate reconstructions, by providing vital boundary conditions for regional and global climate models.

This study explores how temporal and spatial correlations between glacier advances due to climate change (as denoted by ice-marginal moraines) and fluvial terraces yield insights about exogenic-endogenic processes determining landscape evolution during the Quaternary. The Shaluli Shan plateau, located at the south-eastern margin of the Tibetan Plateau, is an ideal area for such studies because it has clear and abundant glacial and fluvial depositional landforms situated in a tectonically active region. As a first step, a high-resolution TanDEM-X Digital Elevation Model (12 m) was used to produce detailed geomorphological maps of glacial valleys, marginal moraines, glacial lineations, and fluvial terraces in unprecedented detail. Geomorphological and sedimentological field observations complemented the geomorphological mapping.

Six samples for Optically Stimulated Luminescence dating were taken from three different extensive and distinct terraces located in pull-apart basins along the Litang river bordering the plateau. Infrared

stimulated luminescence (IRSL) signals from feldspar multi-grain aliquots were used to determine depositional ages of terraces. We observe a robust MIS 2 signal in the depositional ages of two terraces. An older terrace level displays a larger spread in sample ages, but despite uncertainties related to a possible age-overestimation resulting from IRSL dating, it allows a correlation with MIS 4 glacier advances.

In addition, samples for cosmogenic nuclide exposure dating were collected from selected boulders on ice-marginal moraines formed by valley glaciers draining the Mt Genie massif on the Shaluli Shan plateau, which are located upstream of the sampled terraces. The exposure ages of these moraines will be resolved through ^{10}Be and ^{26}Al concentrations from quartz. Preliminary ^{10}Be-ages of two moraines inset in a large U-shaped valley, which are located upstream in the system and are therefore interpreted to be the youngest, also show an MIS 2 signal. Additional ^{10}Be-ages, including those for a stratigraphically older moraine, and ^{26}Al-ages for all 14 samples are forthcoming.

In combining both dating techniques, we compare the timing of glacial expansions with the depositional ages of the terraces. We pose that if there is a close correspondence in the depositional ages of moraines and downstream terraces that the driver is primarily exogenic. The observed correlation between the timing of regional maximum glacier extents and fluvial terrace deposition, although still incomplete (work in progress), indicates a dominance of exogenic drivers. We therefore formulate a conceptual model of landscape evolution which links terrace formation in the Shaluli Shan to regional glaciations. These results indicate that terraces of glaciofluvial origin have a potential to serve as proxies of former glaciations on the SE Tibetan Plateau. Even though this relationship needs to be investigated further, it can be particularly useful where the glacial record is sparse or ambiguous, which is a common challenge encountered in the Tibetan Plateau region.

Long-term glacial landscape evolution on the escarpment of western Dronning Maud Land, East Antarctica

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The East Antarctic Ice Sheet (EAIS) is generally assumed to have been relatively insensitive to Quaternary climate change. However, recent studies have shown potential instabilities in coastal, marine sectors of the EAIS. In addition, long-term climate reconstructions and modelling experiments indicate the potential for significant changes in ice volume and ice sheet configuration since the Pliocene. Hence, more empirical evidence for ice surface and ice volume changes is required to discriminate between contrasting inferences.

MAGIC-DML is an ongoing Swedish-US-Norwegian-German-UK collaboration focused on improving ice sheet models by filling critical data gaps that exist in our knowledge of the timing and pattern of ice surface changes along the western Dronning Maud Land (DML) margin and combining this with advances in numerical techniques. The ice-sheet margin in DML is characterized by a prominent escarpment about 200 km inland from the grounding line. The near-vertical cliffs of this escarpment constitute a major barrier between the polar plateau ice (Amundsenisen) and the downstream ice (Ritscherflya), resulting in abrupt differences of up to 800 m in ice surface elevations. This topographic barrier causes substantial challenges for both empirical ice sheet reconstructions and ice sheet models. As part of the project, field studies in the 2016/17 and 2017/18 austral summers targeted selected sites for in situ cosmogenic nuclide sampling. Comparing concentrations of nuclides with widely differing half-lives in bedrock and erratics from a range of altitudes above modern ice surfaces can test whether the ice-sheet margin in western Dronning Maud Land has thinned since the last glacial maximum or whether it perhaps thickened in places due to increased precipitation associated with warmer climates. Moreover, the cosmogenic nuclide inventories in bedrock provide information on ice sheet fluctuations and complex burial and exposure histories over even longer timescales, and thus, past ice sheet configurations. We report cosmogenic multi-nuclide (^{10}Be, ^{14}C, ^{26}Al, ^{21}Ne, ^{36}Cl) data from bedrock and erratics on nunataks of the Heimefrontfjella

and Vestfjella, and the Ahlmannryggen, Borgmassivet, and Kirwanveggen nunatak ranges along Jutulstraumen ice stream and the Penck Trough in western Dronning Maud Land, East Antarctica.

Results for 72 sample locations, of which 29 isotope pairs, 25 triplets, 3 quadruplets, and 2 quintuplets, yield a consistent glacial history pattern for the western DML margin. Spanning elevations between 741-2437 m above sea level, the samples record apparent exposure ages between <2 ka and >5 Ma. The highest bedrock samples, mostly from high on the escarpment, indicate (near-) continuous exposure since at least the Pliocene, with a very low apparent erosion rate of 15±3 cm Ma^{-1}. These results therefore indicate that the ice sheet has not extensively buried the escarpment since at least the Pliocene. In contrast, despite difficulties in retrieving suitable sample material from the often rugged and quartz-poor mountain summits, and the presence of inherited nuclides in many of our samples, and therefore our inability to present robust thinning estimates from elevation profiles, results from below the escarpment clearly indicate ice-surface fluctuations between the current grounding line and the edge of the polar plateau of several hundred meters within the last glacial cycle. The results highlight a decoupling of the ice sheet dynamics above and below the escarpment which has persisted throughout the Quaternary. This decoupling presents a significant challenge in the ice sheet reconstruction and highlights the need for the integration of cosmogenic nuclide results with ice sheet models in this region, and elsewhere along the Antarctic margin.

Finally, inverse modelling of the cosmogenic multi-nuclide inventories in bedrock yields estimates of total erosion and ice cover across multiple glacial cycles. Our results show that the EAIS in western Dronning Maud Land was thicker than present during most of the Quaternary, covering sample sites up to 200 m above the present-day ice sheet for ~80 % of this period. Thinning of the ice since the last glacial maximum, combined with a long-term record of thicker-than-present ice, indicates that the ice sheet below the polar plateau in western Dronning Maud Land generally expands and thickens during climate cooling, despite decreasing precipitation associated with a cooler Southern Ocean.

End moraine construction in the Younger Dryas Middle Swedish end-moraine zone

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New highway exposures and drilling reveal the stratigraphy and structure of the Middle Swedish end-moraine zone west of Billingen, Sweden. The material in the end moraines is primarily glaciomarine clay of Younger Dryas age that was deposited as varved clay in front of the retreating glacier and then pushed glaciotectonically to form push moraines during minor ice-margin oscillations during overall retreat during the Younger Dryas cold event. The moraines are composed of deformed and remobilized clay with some clayey diamicton and penecontemporaneously deposited and deformed sand. Between the moraines lie 'intermoraine flats,' composed of undeformed varved clay of Younger Dryas age and surface sands of Younger Dryas to early Holocene age. Based on estimations of moraine volume, sedimentation rate and ice-margin retreat rates, we calculate the overall ice-margin retreat and end-moraine construction to span 350-800 years within the Younger Dryas. Because the number of moraines in the Middle Swedish end-moraine zone varies across Sweden, we regard the individual oscillations west of Billingen to be driven by local physical and glaciologic factors rather than ice-sheet wide climate drivers. The study area is also the location of the early and final drainages of the Baltic Ice Lake. The final drainage of the Baltic Ice Lake took place several decades after the youngest moraine was formed. We consider it likely that the earlier, Allerød drainage of the Baltic Ice Lake (BIL) also took place at Billingen, despite the lack of clear local stratigraphic evidence. However, based on our model, a retreat driven solely by climate would not have exposed the outlet at Billingen, and we propose a dynamic break-up of the ice-margin likely centered on Valle Härad that was driven by the head difference between the BIL and the sea.

Invited lecture

The state of fluvial geomorphology in Sweden— previous research and unanswered questions

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Fluvial geomorphic research in Sweden has a strong past, but many basic research questions remain unanswered after a decades-long lull in research activity. In the mid-20th century, Swedish researchers laid the groundwork for sediment transport research at Uppsala University. In his doctoral thesis Filip Hjulström (1935) presented what is now known as the Hjulström diagram showing the relationship between flow velocity and sediment size and whether particles are eroded, transported or deposited. Although the Shield's Diagram (1936), which is based on dimensionless shear stress, is more commonly used today to study sediment transport, Hjulström's contribution is notable as one of the first quantitative studies in fluvial geomorphology. The other notable contribution from the 20th century examined the geomorphic processes of a meandering river (Klarälven) by Hjulström's doctoral student Åke Sundborg (1956). Sundborg continued throughout his career to study erosional processes and refine Hjulström's sediment transport diagram.

Since the ground-breaking fluvial geomorphic studies in the mid-20th century, the research field laid fairly dormant in Sweden while the field matured in the United States (e.g., Schumm, Leopold, Wolman) and later in Europe. However, during this time, Swedish rivers were studied outside of the academic sphere for anthropogenic uses. From the mid-1800s to 1970s, virtually all streams and rivers in forested areas were channelized for timber-floating. Towards the end of the timber-floating era, hydropower development in the mid-20th century spurred mapping of Sweden's large rivers. Hydropower and timber-floating exploitation and their detrimental ecological effects have resulted in descriptive studies but few quantitative fluvial geomorphic studies. Some related research has been conducted by riparian and aquatic ecologists and limnologists that has shed light on fluvial processes. For example, riparian ecologists at Umeå University (Christer Nilsson and his research group) have furthered the understanding of channel types and floodplain dynamics in northern Sweden, taking into account the effects of river regulation, direct human disturbances and subsequent restoration.

Modern fluvial geomorphic research in Sweden has focused on 1) understanding past and present processes that have formed channels, in particular those affected by glaciation, and 2) applied research related to habitat restoration for key organisms. Most rivers in Sweden carry a clear legacy from glaciation; for example, the large rivers in Sweden draining into the Baltic Sea have alternating steep gorges and flat sections, and recent research has determined that the gorges were nearly exclusively carved sub-glacially. Tributary channels have a similar legacy with abundant coarse cobbles and boulders deposited as moraines, eskers or erratics, which the rivers are not competent enough to transport under current flow regimes. Due to their partial glacial origin, they can be referred to as semi-alluvial channels, which complicates our understanding of controls on channel geometry and sediment transport. Another factor that steers geomorphic processes of rivers in

Sweden, and at high latitudes in general, is winter ice and ice break-up. The role of ice on shaping subarctic and arctic rivers has gained increasing attention in several regions, including Canada and the Nordic countries during the past decade.

Applied fluvial geomorphic research has gained some traction, although much more is needed, with the large number of ongoing stream restoration projects and increased management and regulatory oversight due to the EU Water Framework Directive. For example, the a new stream classification from the Swedish Agency for Marine and Water Management will allow more detailed stream channel mapping and evaluation of the physical integrity of streams. Most stream restoration work has focused on timber-floated 'rapids' or semi-alluvial boulder-bed channels; the projects are commonly led by County Administrative Boards, mostly under the leadership of fish biologists that attempt to form habitat that will benefit trout and salmon. Some fluvial geomorphic research has shed light on how to quantify channel complexity of streams with different degrees of human disturbance, which has subsequently been used to relate to biodiversity metrics of various organism groups. Sediment transport around boulders in semi-alluvial channels has been the subject of recent research; such findings benefit restoration practitioners that add spawning gravel and substrate for salmonids or freshwater pearl mussels.

The gap in fluvial geomorphic research in Sweden in the late 20th and early 21st centuries, compared to time period when it has flourished in many other regions of the world, including Europe, the Americas, and Australia and New Zealand, has left many basic questions unanswered. For example, we are just now learning what are the main processes driving the formation and morphodynamics of Swedish rivers. While many fluvial geomorphic theories are based on assumptions of connectivity, many Swedish channels are punctuated by instream lakes decreasing connectivity of flows and sediment; and while the channel geometry and sediment transport of alluvial channels are fairly well understood, semi-alluvial channels are poorly studied. Furthermore, much of the fluvial geomorphic research literature is based on studies in temperate climates, and much less is known about the cumulative effects of winter ice cover and dynamic ice break-up periods. The reason why there has been so little fluvial geomorphic research Sweden is open to speculation; although, one reason the field may have flourished in other countries could be due to greater risks to people and property from flooding or dynamic streambank erosion. But with the rising appreciation of stream restoration and financing of large restoration projects, in addition to increased flooding risks with climate change, the need to understand fluvial geomorphic processes in Sweden is on the rise.

Invited key lecture

Patterns of channel stability of mountain streams

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In this lecture, we discuss the impact of bed surface structures on bed evolution, sediment mobility and channel stability in response to episodic sediment supply. We conducted seven runs of flume experiments under different sediment supply regimes, and we quantified grain size distribution of the bed surface, sediment storage, bed shear stress and thresholds for motion (using different methods) associated with bed surface structures, discussing the implications for bed stability and sediment transport. To identify and quantify bed surface structures we developed a semi-automated method based on mapping the potential anchor stones and their relative protrusion. Our results showed that the response of the bed to sediment pulses depends on the history of the bed surface roughness and structure, as these factors changed much more in response to supply perturbations earlier in the experiments. While surface armouring remained intact, bed surface structures developed during the experiment. The threshold of motion showed an overall increase during the experiments. Our results highlight the importance of sediment supply regime as a control of bed surface evolution and the stabilizing function played by surface structures, in relation to particle mobility and sediment transport. We interpret that the increase in the threshold of motion is associated with the development of bed surface structures in the absence of significant changes in the particle size distribution of the bed surface material.

Invited lecture

Sediment management for sustainable hydro power development and operation

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Due to the increasing demand of CO2 neutral energy not only in Europe but also in the World, a relatively large amount of new hydro power plants (HPP) are built. In addition, will existing ones refurbished and renewed in order to run them more cost effective. HPP are an essential source of renewable energy in the world. However, one of the major challenges with HPP are the negative consequences on the ecology. This goes along with the disturbance of the sediment balance in the river. Due to the dam, the free-flowing area of the river is disturbed and the river reach between the dam and the back water zone experiences an increasing depth and a decreasing flow velocity. Consequently, depositing sediments upstream of the power plant are collected in the dam area which leads to filling up of the reservoirs dead and life storage and finally to an increase of the riverbed in the area where the backwater zone starts. This might increase the flooding risk in the surrounding areas. Downstream of the dam, the sediment balance is negative. Especially the coarse material which has been trapped upstream in the dam is missing to keep the river bed elevation in equilibrium. The absence of that part of the grain size distribution leads to a decrease of the river bed elevation. In the same way will the diversity of the particle sizes decrease which leads to decrease of the sediment quality downstream of a dam. This is extremely important for the habitat quality for many fish species which need to have a wide particle size distribution in all their life stages. This is intensified by a phenomenon which is called armor layer formation. An armor layer forms when a constant flow discharge washes out the fine fraction of the grain size distribution and makes the courser particles to form a layer which protects the sub-surface layer from erosion. A fully developed armor layer has an up to 10x higher critical shear stress as the critical shear stress for the largest grain size in the mixture.

A sustainable sediment management at HPPs can mitigate some of the negative side effects in the river upstream and downstream as well as on the hydraulic structures. There are many different strategies available depending on the size and type of HPP as well as on the prevailing sediment yield and sediment characteristics. The problem lays in the fact that conducting management strategies are expensive. In addition, they are rather difficult to dimension due to the lack of sediment data.

This presentation will discuss in-depth the interference of the HPP on the river reach and how to mitigate these effects. In addition, a new measurement technique to quantify suspended and bed load material is presented in order to have a solid base for the dimensioning of sediment handing strategies at HPPs. In the end, some of the most successful sediment handling strategies to protect hydraulic structures and the habitat quality downstream are presented to illustrate its importance.

Links between catchment characteristics and headwater chemistry in a subarctic area (Finnish Lapland)

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Headwater areas are known to be a significant source of water as well as mineral and organic matter for the downstream parts of catchments. Water chemistry is the reflection of the chemical denudation in the catchments and play important role in elements cycling in the environment. The aim of the study is to determine the links between catchment characteristics, and the water chemistry of small headwater streams in Finnish Lapland. We hypothesize that a significant role in affecting headwater chemistry despite the bedrock chemistry play the geomorphological location, type of recharge (quick flow, slow flow), the vegetation cover of catchment and distance to the sea. Four study areas were chosen for water sampling: Malla Nature Reserve; Kevo Nature Reserve, Kaldoaivi Wilderness Area, and Oulanka National Park. Geology of these study areas is quite diversified, but four main groups of bedrock can be distinguished: 1) sedimentary calcarous rocks, rich in Ca and Mg – dolomite; 2) igneous mafic rocks and metamorphic rocks rich in Mg and Fe – biotite paraschist and mafic tuff; 3) igneous felsic rocks and metamorphic rocks rich in quartz and plagioclases – arkose quartzite, quartz feldspar paragneiss of Silisjoki Suite, quartz feldspar paragneiss of Kaamanen Complex, granodiorite and orthoquartzite; 4) sedimentary clastic rocks, rich in quartz– silicate claystone.Based on topographic maps and ortophotos, 76 small headwater catchments were chosen (up to 4 km^2). In order to determine the effect of vegetation cover on water chemistry, 42 catchment representing similar lithological conditions (similar bedrock and quick-flow regime) and four types of vegetation cover: alpine meadows, heath tundra, birch forest and boreal forest were chosen.

Sampling and measurements of phisico-chemical properties of the waters were done in August 2017. Spring and stream discharge was measured using bucket method. The electrical conductivity (SEC) related to a temperature of 25°C, the pH and the water temperature (T) were measured using an ELMETRON multifunction meter CX-461.Major ions (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, NH_4^{+}, HCO_3^{-}, SO_4^{2-}, NO_3^{-}, Cl^{-}, F^{-}) were determined using ion chromatography (DIONEX ICS 2000). Total dissolved solutes (TDS) were calculated as the sum of all determined ions.In order to examine statistical differences between chemical composition of waters representing catchments of different parent rocks, vegetation covers and study areas, one-way ANOVA and principal component analysis (PCA) were employed.

The obtained results verify, that the most important factor to control water chemistry is bedrock. However, in Oulanka there are no significant differences between chemistry of waters in dolomite catchments and biotite paraschist and mafic tuff catchments despite of different chemical composition of rocks. Most likely it is the result of fact, that surface waters in Oulanka are supplied mostly by quick flow waters percolating glacial till, which are thicker in this area than in the others, and which consists of mixed material derived from close and distant transport.

When the geological component is excluded, plant communities an important factor affecting stream water chemistry in small subpolar catchments representing quick flow. The concentrations of Ca^{2+}, $Mg^{2+}$and HCO_3^{-}in streamwaters in boreal forests catchments are significantly higher in comparison to

other plant communities, following birch forest, heath tundra and alpine meadow. Those differences can be explained by different potential of vegetation to accelerate weathering of minerals and leaching ions retained in soil exchange complex, however the processes of basic cations cycling comprise also plant uptake and biological cycling. The significant positive correlation between altitude and SEC, Ca^{2+}, Mg^{2+},HCO_3^-suggests that also favourable climatic conditions and biological activity in lower altitudes can promote weathering processes and ion leaching in forest zone.

The lowest basic cations concentrations are found in spring- and streamwaters in alpine meadow catchements in Malla. The lowest SEC and Ca, Mg and HCO3 ions in Malla can be the result of an array of factors: sparse vegetation cover, thin soil and regolith, large areas of bare rocks, without plant cover, which do not favour chemical weathering and the fact, that some streams in that area are recharged by the perennial snow patches, that are poor in basic cations, especially Ca^{2+} and Mg^{2+}.

The atmosphere-derived ions e.g. Na^+, Cl^-andSO_4^{2-} differentiate analysed waters between catchments covered with particular plant communities in less extend. However, some exceptions can be found. The lowest concentrations of sea-derived ions are noted in the spring- and streamwaters in the alpine meadow waters in Malla. Theconcentrations of these ions are similar to those noted in snowpack presented by other authors in Swedish Lappland. The significantly lower concentrations of Na^+, $Cl^-$and SO_4^{2-}in stream waters in catchments covered with alpine meadows than in other plant communities is therefore most likely the result of snow-derived ion supply. The exceptionally high concentrations of SO_4^{2-}can be found in catchments covered with birch forest. This can be the effect of the specific sulphur cycle, which is strongly bound with biological processes.

The analysis of Na^+,$Cl^-$and SO_4^{2-}, as well as Na:Cl ratio revealed, that chemical composition of water depends also on a distance of study area to the sea and potential transport patches. Strong positive correlation coefficient between Na^+ and Cl^-in studied waters irrespectively on geological factors suggests that they predominantly derive from the atmospheric deposition rather than from weathering. However, the Na:Cl ratio vary for different waters. All sampled waters lie on the right side of the sealine, which indicates enrichment in Na^+as a result of the Na-bearing minerals dissolution. It is typical for waters enriched in Na^+ as a result of weathering. The closest location to the sealine is for springwaters in Malla recharged by perennial snow patches. Stream waters in Kevo are enriched in both Na^+ and Cl^-ions in comparison to the waters in other areas. This is most likely the result of its geographical location: Kevo is located near the sea and, in contrast to Malla, is not shadowed by the Scandes. Waters in Kevo are also enriched in SO_4^{2-}. The sources of this ion are the most likely both sea aerosols and pollutants from Kola Penisula.

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Permafrost thaw expands erodible landscapes and increases fluvial water and sediment fluxes on the Tibetan Plateau

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Suspended sediment flux (SSF) in cold environments is a crucial proxy to link glacial, periglacial, and fluvial systems and highly relevant to hydropower operation and aquatic ecosystems. However, the response of SSF to climatic and cryospheric changes in cold environments remains poorly investigated due to the lack of long-term monitoring and the complexity of sediment cascade. Here we show that the water and sediment dynamics in the permafrost-dominated headwater of the Yangtze River on the Tibetan Plateau (TP) is driven by thermally-induced permafrost thaw, on a basis of 33-year daily in-situ observations (1985-2017). Air temperature dominates the seasonal pattern of discharge and SSF; it controls the expansion and contraction of the active contributing drainage area (ACDA) and respective contributions of permafrost terrain with an evolving active layer and glaciated headwaters. In contrast, rainstorms dominate the shorter-lasting fluvial extreme events. The different discharge-sediment regimes per season reveal reduced sediment availability in the autumn recession season and the clockwise hysteresis pattern suggests a sediment supply-limited system. The ACDA in spring and autumn increases significantly over the past three decades and implies expanding landscapes for active hydrogeomorphic processes. In a warmer and wetter future for the region, the SSF of similar permafrost rivers will probably continue to increase with expanding erodible landscapes and more extreme weather events. We conclude that incorporating these dynamics into models is necessary in order to accurately predict how SSF in cold environments responses to ice-snow-permafrost melting in the context of ongoing climate change.

Molards, a landform to track permafrost degradation in Iceland, Greenland and around the globe

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This study explores the possibility to use the landform called “molards” as a marker of permafrost degradation in Iceland, Greenland and around the globe. Molards in permafrost terrains are cones of loose debris that result from thawing of blocks of ice-rich sediments mobilised by a landslide. Molards cannot form without ground ice, which cements the source material, allowing it to behave like solid during transport. Once the ground ice has thawed, its cementing action is lost, inducing collapse of the material into molards (Morino et al., 2019). In this study, we show that molards can be a landform directly revealing permafrost degradation under different permafrost conditions, from continuous to discontinuous. We apply quantitative terrain analysis using high-resolution DEMs to describe and quantify the morphometric characteristics of examples of molards located in Iceland and Greenland. We also report on molards in landslides that we have identified and analysed from remote sensing around the globe. This study highlights the need for a better understanding of molard formation, evolution, morphology, longevity, and their environmental settings, and we emphasise that they can be used as a geomorphological tool to understand climate change and natural hazard in cold environments.

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Is tourism compatible with an adequate protection of the geomorphological heritage in southern Iceland?

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Geoheritage, as part of the natural heritage, is considered by scientists as a testimony of Earth's history that must be protected. However, when exposed to human activities such as tourism, geoheritage can also be considered as a natural resource. This is the case, for example, when geosites are part of the tourist offer for their scientific, educational or recreational interest or as part of an attractive landscape. This raises the question of the compatibility of the exploitation of the resource for tourism purposes with protection needs.

In southern Iceland, the number of tourists has increased very rapidly over the last 15 years and tourism practices have also changed. Some popular sites such as the glacial lagoon of Jökulsárlón, the glacial landscapes of Skaftafell or the colourful volcanic landscapes of Landmannalaugar have come under increasing pressure, raising questions about the protection of geoheritage. While nature remains the main reason for travellers to visit Iceland, the aesthetic dimension of the landscape probably tends to mask the scientific interest of some geosites, which are rare on a global scale.

At the same time, heritage recognition of the geomorphological features of the landscape has been improved, notably through the inclusion of the Vatnajökull National Park into the UNESCO World Heritage List and with the creation of the Katla Geopark. But do these recognitions have an impact on tourism practices? Does the development of certain forms of geotourism encourage sustainable protection of geoheritage in southern Iceland?

Within the framework of a PhD thesis, we are addressing these questions through a series a interviews with skakeholders in the tourism and nature protection sectors. The aim is to assess the positioning of the various stakeholders on the issue of geomorphological landscapes management and, more generally, to determine under what conditions tourism is compatible with the protection of geoheritage.

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