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Frozen Ground

THE NEWS BULLETIN OF THE INTERNATIONAL PERMAFROST ASSOCIATION
WWW.IPA-PERMAFROST.ORG

Almost a quarter-century after the release of the first IPA Newsletter, that later became Frozen Ground, the News Bulletin of the International Permafrost Association gets a facelift

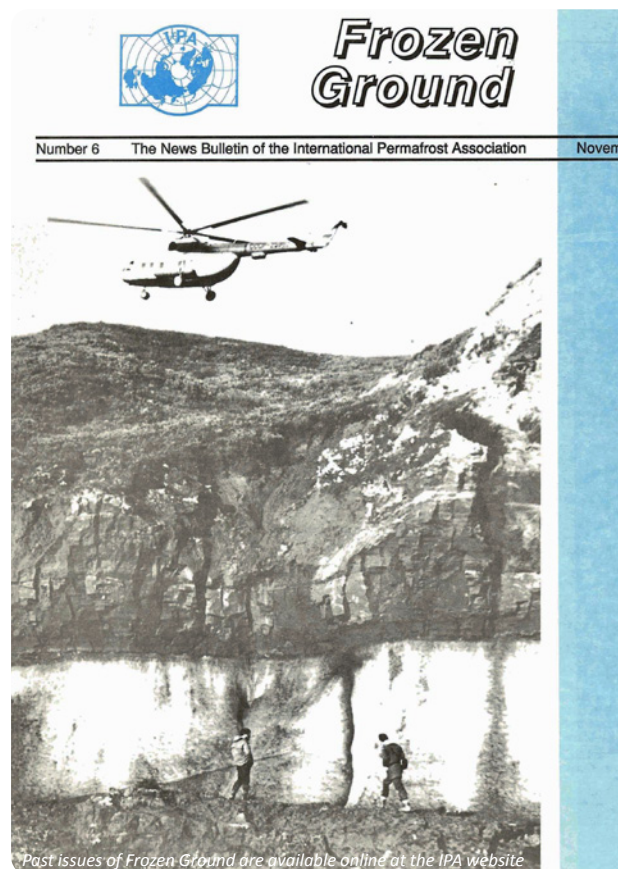
A NEW FROZEN GROUND

When the first newsletter of the International Permafrost Association came out in May 1986, it had little to do with the yearly bulletin that *Frozen Ground* has become. Made up of eleven pages carefully prepared on a typewriter by the then Secretary-General of the IPA, Dr. J. Ross Mackay, the newsletter was packed carefully in envelopes addressed to the friends of the IPA around the world and sent through regular postal mail. The newsletter evolved progressively to match the expectations of the community and became *Frozen Ground* in June 1989 with the first color issue and its immediately recognizable light blue stripe on the cover page (see right).

Now confronted with the emergence of the internet and email, *Frozen Ground* must find

a new place in the hearts of its readers, which are increasingly confronted with masses of communication from colleagues, professional organisations and the like. To address this irreversible trend and mobilize new resources for the support of research and outreach activities, the IPA Council decided in June 2010 to transform *Frozen Ground* into a shorter, sharper and more modern publication and to publish it online.

This first issue of a new bulletin demonstrates the commitment of the IPA to communicate in a forward-looking manner on its most recent activities in the field of permafrost research and its ambition to reach out to its members, but also to the general public and decision-makers. We hope that you will enjoy it as much as we did creating it.



Past issues of Frozen Ground are available online at the IPA website



A NEW STRATEGY FOR THE IPA

by Hans-Wolfgang Hubberten, President, International Permafrost Association

Dear fellow permafrost researchers and permafrost enthusiasts, some of you were not born when the International Permafrost Association was started by a few enthusiasts in 1983 in Fairbanks, USA. Since then, the IPA has come a long way and can be proud of its many achievements: The IPA map on permafrost is used in virtually every permafrost publication, the International Conferences on Permafrost attract more and more participants...



photo: B. Edmaier

A NEW STRATEGY FOR THE IPA

The IPA modernizes its structure and focuses its capacity on research coordination and science support.

(continued from page 1)

...and permafrost science and engineering are more lively than ever. Because of these successes, expectations have grown and the Executive Committee of the IPA decided to initiate a process to adapt the IPA structure to face the challenges of the 21st century. The overarching goal of the changes was to provide the IPA with the means to fund research initiatives, to create the institutional structure needed to sustain the level of activity of the International Polar Year, and to address some of the new issues and challenges emerging in permafrost science and engineering, including data management, and education and outreach.

I would like to present to you some of the changes decided on in June 2010 in the next few paragraphs. The main changes introduced in 2010 relate to the structure of the association: the Secretariat of the IPA will be strengthened to take on more responsibilities in the management of the association and the secretariat leader will now have the title of **Executive Director**. The association will now dedicate a large part of its funds to the newly established **Action Groups**. These groups will be funded, have limited terms, and will need to focus on the

production of clearly defined research outputs. An application process will be publicized soon through the Permalist mailing list. An implicit consequence of the formation of Action Groups is the transformation of Working Groups into **Interest Groups**. These groups will retain the same mandate than the working groups and will be eligible to form action groups to fund targeted initiatives. They will now have to elect a PYRN co-chair.

A new category of membership entitled “**individual membership**” has been created. This category does not provide voting rights at the council, but entitles the members to several advantages listed on the IPA website. Individual members are now offered the possibility to donate a membership fee at their convenience (20 €, or 10 € for PYRN members).

The Standing Committee on Data, Information and Communication will now focus

on Data Management only and will have an oversight role in the Global Terrestrial Network for Permafrost (GTN-P). A separate standing committee on **Education and Outreach** will be progressively put into place to be operational in 2012.

An important outcome of the changes is the empowerment of **national committees**. Through the establishment of individual memberships, national representatives will be given the means to contact their members, establish mailing lists, organize and structure their community

(in countries where this was not already the case).

Frozen Ground production and printing made up around 80% of the expenses of the association in some years and the Council decided to shift these resources to targeted actions and to transform *Frozen Ground* into a shorter electronic product. **Country reports** will now be available online in a newly formatted interface, and easy to reference in online databases (more on page 7). For the first time in 22 years, the IPA also decided to increase the registration fees for its country members. These important decisions will allow funding of targeted activities (i.e. Action Groups) and the support of science and engineering with seed money.

These changes are tremendous for a relatively young organization (27 years), yet they were necessary to meet the level of expectation that has surged in the science community. Thanks to the involvement of past IPA presidents, executive committees, Council members, working party members, and all individuals that devoted their energy to the progress of permafrost research, permafrost is now widely acknowledged as a very important part of Earth system science. The IPA, through its activities and networks has been instrumental in supporting that process, yet, it needed to overhaul its structure to continue to support its ongoing activities and operationalize some of its well-regarded activities.

I trust that these changes will contribute to strengthen the visibility of the IPA and of



Permalist is the mailing list on permafrost science and engineering. It advertises meetings, conferences, job opportunities, topics of interest and is the platform for online collaboration in the field of permafrost research. Become a member of the IPA and get registered now on Permalist by visiting the membership page of the IPA on its website: www.ipa-permafrost.org



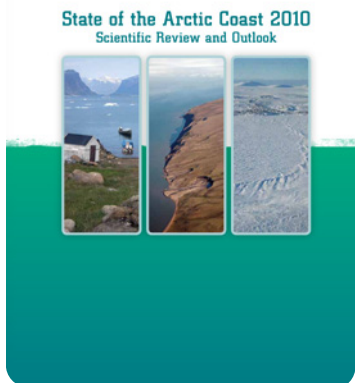
photo: H. Lamitt

permafrost science and engineering as a whole. I look forward to sharing the outcomes of these changes with you at the Tenth International Conference on Permafrost to be held in June 2012 in Tyumen, Russia.

State of Arctic Coasts 2010

by Don Forbes, Volker Rachold, Hartwig Kremer and Hugues Lantuit

The IPA teams up with IASC, LOICZ and AMAP to sponsor a new report on the arctic coastal zone, the first of its kind.



The Arctic coastal interface is a sensitive and important zone of interaction between land and sea, a region that provides essential ecosystem services and supports indigenous human lifestyles; a zone of expanding infrastructure investment and growing security concerns; and an area in which

climate warming is expected to trigger landscape instability, rapid responses to change, and increased hazard exposure.

Starting with a collaborative workshop hosted by the Norwegian Institute for Air Research in October 2007, the International Arctic Science Committee (IASC), the Land-Ocean Interactions in the Coastal Zone (LOICZ) Project, the Arctic Monitoring and Assessment Programme (AMAP) and the IPA decided to jointly initiate an assessment of the state of the Arctic coast.

The goal of the report is to draw on initial findings regarding

climate change and human dimensions for the Arctic as a whole provided by the ACIA and AHDR reports to develop a comprehensive picture of the status and current and anticipated changes in the most sensitive Arctic coastal areas. The assessment takes a social-ecological approach

“The report is aimed to be a first step towards a continuously updated coastal assessment for the Arctic”

THE EDITORS

that explores the implications of change for the interaction of humans with nature. The report is aimed to be a first step towards a continuously updated coastal assessment and to identify key issues seeking future scientific concern in an international Earth system research agenda.

The draft report is the outcome of this collaborative effort and starts with a thematic review of the state of physical and ecological systems and human communities and activities on the Arctic coast as of 2010. It then moves on to a more holistic and coupled-system approach and a consideration of knowledge gaps and future research needs and concepts. Current knowledge is presented and synthesized, based on published literature and other sources.

The document was prepared by an international writing team, including 15 Lead Authors and 27 Contributing Authors. It is expected to be released in April 2011. For more information, visit: www.arcticcoasts.org

MicroPerm, a workshop on circumpolar integration of permafrost microbiological studies

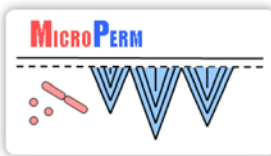
by Dirk Wagner

The IPA, with a grant from the International Council for Science (ICSU), applied for by the International Union of Geological Sciences (IUGS), organized the first integrative workshop on permafrost microbiology and microbial ecology.



The 1st Workshop on Microorganisms in Permafrost (MicroPerm) environments was held November 8-10, 2010 at the Alfred Wegener Institute for Polar and Marine Research in Potsdam, Germany. It attracted over 60 permafrost microbiologists from 14 countries. Permafrost microbiology is a relatively new field of science which attempts to understand the relation between permafrost

characteristics and microbial communities. The MicroPerm project seeks to establish a network of scientists working in the field of permafrost microbiology under the auspices of the IPA. The major objectives of MicroPerm are: (i) to establish a circum-arctic research network/study program, (ii) to



identify research priorities in the field of permafrost microbiology, (iii) to identify environment specific technologies and infrastructure and (iv) to develop methodological standard protocols. The workshop led to the establishment of two 'action groups' working on data base management of microbiological information and on a comparison

of different molecular tools for studying microbial community structure in permafrost. The 2nd MicroPerm Workshop will be held in spring 2012 in Canada. The workshop was funded by ICSU and supported by the following organizations: IUGS, IPA, DFG, IASC, SCAR, IACS, IUGG, INQUA and IUMS. For more information visit www.microperm.org



Permafrost in arctic and cryosphere observations

The IPA proposes its Global Terrestrial Network on Permafrost as a priority task for the Sustaining Arctic Observing networks (SAON) and the Global Cryosphere Watch (GCW)

The International Polar Year (2007-2009) contributed to greatly enhance the permafrost monitoring capacity in polar regions. In alpine areas, an increasing number of programs and initiatives (PERMOS, permalp, PermaNET) also helped to dramatically improve the monitoring of permafrost temperatures. To sustain these observing networks, a strong monitoring program for permafrost is needed. This program is the Global Terrestrial Network for

Permafrost (GTN-P, see below) on which the IPA has focused much of its attention over the past few months. Several initiatives at the Arctic and global levels, meant to coordinate observing, have paid great attention to GTN-P and the IPA expressed an interest in making its GTN-P a candidate for becoming part of both the Sustaining Arctic Observing Networks (SAON) and the Global Cryosphere Watch (GCW). The SAON initiative was prompted by the Salekhard declaration of the Arctic Council (2006) that called on

the Arctic and non-Arctic countries to establish an arctic observing system. The GCW is an initiative of the World Meteorological Organization (WMO) and is meant to be an international mechanism for supporting all key cryospheric in-situ and remote sensing observations. The SAON endorsed in January 2011 the initiative of the IPA to organize a data user requirements definition workshop for GTN-P. GCW recommended including the GTN-P sites as reference sites in its observing framework.



The Tenth International Conference on Permafrost will be held 25-29 June 2012 in Tyumen Russia. More info on www.ticop2012.org

THE GTN-P STRATEGY AND IMPLEMENTATION PLAN: A STEP FORWARD FOR MONITORING

by Hanne H. Christiansen

Permafrost monitoring, a core objective in the redefined IPA's mission, needed more capacity and coordination to sustain observations. The Global Terrestrial Network for Permafrost is the answer to this growing need.

The IPA is working on revising its strategy and developing an implementation plan for an upgrade of the Global Terrestrial Network on Permafrost, to be presented to the Global Climate Observing System (GCOS) and the Global Terrestrial Observing System (GTOS) in 2011. This work is being performed by the GTN-P Task Force established by the IPA Executive Committee in late spring 2010. It consists of Hanne H. Christiansen (Chair), Hugues Lantuit, Anatoly Brouchkov, Kjersti Gislén, Jeannette Noetzli, Alexander Kholodov, Nikolay Shiklomanov, Sharon Smith and Goncalo Vieira.

The Task Force met during EUCOP III in June 2010, and decided to develop a strategy and implementation plan to address the urgent need to sustain the level of observation of the IPY. The Task Force has been preparing its plan during the fall of 2010 and will be continuing to do so into the spring of 2011. The focus of the Task Force is largely on establishing professional management and periodic assessment services for GTN-P.

Another objective of the Task Force is to assess the potential for inclusion of permafrost relevant parameters in addition to the standard active layer thickness and permafrost temperature metadata, so that future permafrost modelling efforts can build on GTN-P outputs. Last but not least, the Task Force is also tasked with devising an entire permafrost observing system encompassing data collection (through the TSP boreholes and CALM sites),

archiving, management and distribution, with the objective of establishing a robust data portal for data dissemination. A first step in the implementation of the plan will be to host a workshop to define user requirements, involving representatives from the modelling community, from other cryospheric disciplines and of course permafrost scientists and engineers. The International Arctic Science Committee and the Scientific Committee for Antarctic Research have expressed interest in sponsoring the workshop, which should be organized shortly before or after summer 2011.



GTN-P
Global Terrestrial Network for Permafrost

THE THIRD EUROPEAN CONFERENCE ON PERMAFROST WAS A HUGE SUCCESS

by Hanne H. Christiansen and Bernd Eitzelmüller

More than 200 participants attended the northernmost permafrost conference ever in Longyearbyen, Svalbard.

The European Conference on Permafrost was held on permafrost terrain for the very first time, from 13 to 17 June 2010. Two hundred and forty one scientists and engineers travelled to the University Centre in Svalbard (UNIS) in Longyearbyen at 78°N to attend the Third European

Conference on Permafrost (EUCOP III). Participants represented 27 nations with the largest numbers from Germany (36), Norway (35), Switzerland (21),

the United States (20), Russia (18), Canada (17), Sweden (17), France (16), Denmark (7), Portugal (7), Austria (6), Finland (6), Italy (6), Spain (5), Korea (4) and China (3). Of the total participants, 171 were from Europe and 77 were students. Thirty-one per cent were women and 69 per cent were men. The high student participation rate was assisted by a low registration fee and the availability of inexpensive accommodation for this group.

Each day of the conference started with two plenary oral keynote presentations. The keynotes focused on results from the IPY in lectures entitled 'Thermal state of permafrost—an overview and status of the activities in the polar northern hemisphere' presented by V. Romanovsky, 'State of periglacial research at the end of the IPY' by N. Matsuoka, 'Remaining challenges in permafrost carbon research—a status at the end of the IPY' by

P. Kuhry and 'Where, how fast and why arctic permafrost coasts undergo coastal erosion' by H. Lantuit. In addition, keynotes on 'Permafrost research in Norway and Svalbard' by O. Humlum and 'The development of infrastructure on permafrost in Svalbard' by A. Instanes were presented to introduce local permafrost science and engineering research.

The main part of the conference programme consisted of four 2-hour blocks, each with three parallel sessions of 15-minute oral presentations, resulting in a total of 96 oral presentations. Almost twice as many presentations were given as posters, organised into two dedicated sessions, totalling 188 posters. Eleven different session themes were chosen to cover permafrost science and engineering. The largest number of presentations was in the geophysical monitoring in permafrost regions session, with eight oral presentations and 44 posters; the second largest was the periglacial processes and landforms session, with 16 oral presentations and 24 posters.

An open public lecture, 'The unintended research legacy of John Munro Longyear', was given by F. Nelson, University of Delaware, USA, to participants, Longyearbyen residents and visitors in the evening of the first day of the conference.

Hosting the conference in Svalbard

had the enormous advantage of enabling a significant field component. One half day of the conference was used to introduce participants to the science and engineering activities in and around Longyearbyen. During this half-day field excursion several EUCOP papers were presented orally and they were also given as poster presentations in the indoor part of the conference.

The field sites visited were 'Svalbard Airport and the seed vault' presented by I. Horvli, 'House infrastructure in Longyearbyen – UNIS on poles' presented by A. Instanes, 'Solifluction in Endalen' presented by A. Lewkowicz, 'UNISCALM and

The conference ended with seven different one-day excursions given over two days which were either free or available at low cost. The one-day field excursions were a huge success, so much so that there were not enough spaces on some, but all who wanted to participate were accommodated on at least one of them. On the first day, 154 conference participants walked, sailed and visited five different sites, while on the second day, 83 participants attended five excursions.

The conference produced many different kinds of results, but of course the scientific results are the most important. The circumpolar permafrost thermal snapshot



TSP boreholes in Adventdalen' presented by H. Juliussen and K. Isaksen, 'Longyearbyen slope processes' presented by O. Humlum and 'Ice-wedge process research in Adventdalen' presented by H. H. Christiansen, N. Matsuoka and T. Watanabe. Participants were transported between the six major field sites by bus and escorted by EUCOP guides.

presented during the conference, based on the many local, regional and international presentations, clearly showed that the warmest permafrost this far north in the northern hemisphere during the IPY 2007–09 is present on Svalbard. 'There has never been such a proud time in the history of permafrost research' said Prof. H. Hubberten, President of the IPA.



The DUE Permafrost project

by Annett Bartsch and Birgit Heim

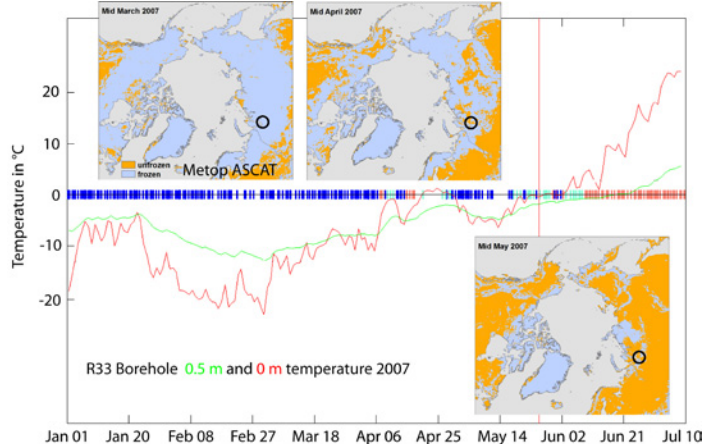
The European Space Agency (ESA) supports a large project on remote sensing of permafrost and builds up operational capacity for the permafrost community.

meeting. The observation strategy for all products and regions was presented by the project team and reviewed with the participants. Users presented their work, requirements and contact points for the project. The discussions ranged from permafrost modelling to process geomorphological applications

The second user workshop will take place on the 2nd to 4th of March 2011 in Fairbanks, Alaska. It is supported by L. Hinzman and will be hosted by the IARC. The workshop will feature a tutorial on remote sensing of permafrost and in-depth discussion sessions. The first version of the circumpolar dataset was completed in early 2011. Evaluation of the data sets using ground data from the

TSP and CALM data is ongoing. The first results for the Western Siberian permafrost region are promising.

A web interface will be implemented for data download and will be used to deliver the final version of the data set at the end of the project. The last step of the project will consist of the implementation of the Permafrost Earth Observation Information System, PEO, with feeds to regional and global climate models, as a joint initiative of the ESA and the IPA in late 2011. The 3rd user workshop will be held at the Alfred Wegener Institute for Polar and Marine Research in Potsdam, Germany in early 2012. More info at www.ipf.tuwien.ac.at/permafrost



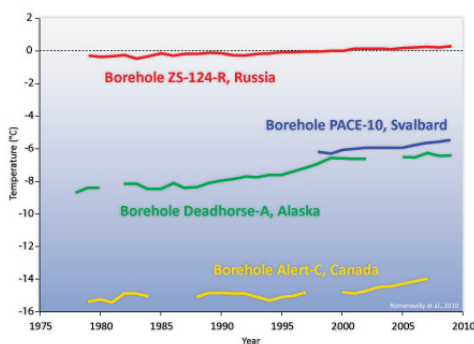
In 2008, the European Space Agency initiated a large project (called the ESA Data User Element DUE Permafrost project) to build up a mid to long term scenario for an Earth Observation (EO) service for permafrost. The project, from the beginning, actively involved scientific stakeholders in the elaboration of the science and implementation plan. The technical consortium is led by A. Bartsch, (TU Wien, Austria) and is supported by four partners (University of Waterloo (Canada), Jena University (Germany), AWI

(Germany), and Gamma Remote Sensing (Switzerland)). The satellite-observable products on regional to circum-polar scales are land surface temperature, surface soil moisture and surface frozen/thawed state, surface waters, terrain (elevation and subsidence) and land cover. Snow extent, and snow water equivalent will be provided by the DUE Globsnow project.

The first user workshop was held in Vienna as an official side event of the EGU 2010. 50 researchers participated in the one day

The IPY Thermal State of Permafrost outcomes

An unprecedented effort to assess permafrost temperature changes concludes with a series of publications in the journal Permafrost and Periglacial Processes



During the planning and implementation of the IPY, the IPA coordinated the acquisition of permafrost temperatures data under the Thermal State of Permafrost (TSP) Project #50. The TSP project goals were the acquisition of standardized temperature measurements (snapshot) from all permafrost

regions of Planet Earth, preparation of a global data set, and development of maps of contemporary permafrost temperatures. Networks of boreholes, equipped for long-term permafrost temperature observations, were established and consist of approximately 850 boreholes in both hemispheres with more than 25 participating countries. More than 350 of these boreholes were drilled and instrumented during the IPY period under various nationally funded projects.

Comparison of the current mean

annual ground temperature (MAGT) and historical data allows participating countries and other users to assess changes in the thermal state of permafrost over the last several decades. A summary of borehole metadata information is now available online at the National Snow and Ice Data Center. The TSP project also included active layer measurements, many of which are observed annually under the Circumpolar Active Layer Monitoring (CALM) project. In the future, these networks will ideally continue and expand as part of the Global Terrestrial Network for Permafrost in both polar and non-polar permafrost regions and will provide links to national and

international data resources. Permafrost temperature records show that permafrost warming which started two to three decades ago has generally continued into the IPY period. Warming rates are much smaller for permafrost already at temperatures close to 0°C compared to colder permafrost, especially for ice-rich permafrost where latent heat effects dominate the ground thermal regime. Colder sites are generally warming more rapidly. A special Issue of the journal Permafrost and Periglacial Processes presented the results from the project in June 2010 and is available at the site of the journal.



photo: B. Edmaier

IPA country reports available online

The IPA country reports are now available online starting from the year 1988 onwards

As part of the new IPA structure and reorganization, the Council of the IPA decided in June 2010 to shift the distribution mode of the country reports from the printed version of *Frozen Ground* to the internet. The reports will now be made available in a timely manner on a searchable internet interface and will be assigned an ISSN number to be tracked in bibliographical databases. In addition, the reports will be summarized in a RSS feed that will be linked to the IPA portals on social networks and fed to partner websites. All of the reports will be available as PDF files, with the advantage for the

country representatives to suggest potential edits that are easily changed in the pdf file.

In order to broaden the internet offer, the Executive Committee asked the Secretariat to think of ways to include all the past country reports and to make them available online.

The first reports from the archive are now available online for the years 1988 to 1992. The other reports will progressively be added to the database over the first months of 2011.

This unique database will allow the IPA to showcase unique moments of its history and to facilitate access to the country reports.

“All country reports starting in 1988 will progressively made available online on the IPA website”

Did you know that China and the USA had a joint temperature monitoring program in 1988? or that Japanese scientists studied permafrost in Antarctica, Canada, Svalbard, Greenland and of course Japan in 1990? All of this and much more information is now available online at the IPA website on the new country reports portal: <http://ipa.arcticportal.org/publications/country-reports.html>

KYRGYZSTAN MEMBER OF THE IPA

Kyrgyzstan was accepted as the 27th member of the IPA in December 2010 and will be enjoying the rights and duties of IPA membership starting in 2011.

Permafrost research has a long tradition in Kyrgyzstan and takes its roots in the vast permafrost extent in the country. Permafrost underlies approximately 30% of the country's territory and is contiguous to permafrost in Kazakhstan, China and Tajikistan



Permafrost in Kyrgyzstan

Arctic Systems Science Thermokarst Project

by William “Breck” Bowden and Antoni Lewkowicz

A major research project funded by the US National Science Foundation is examining thermokarst landforms and processes at the slope and landscape scales.

Rising temperatures and increased precipitation in Arctic regions are expected to have important impacts on arctic systems, including promoting permafrost degradation and thaw. Thermokarst failures are abundant and appear to have become more numerous around Toolik Lake on the eastern North Slope and in the western Noatak River basin in Alaska, USA. We expect that a widespread and long-term increase in the incidence of thermokarst failures will have important impacts on the structure and function of arctic headwater landscapes.

The US National Science Foundation's Office of Polar

Programs has funded a project entitled *The Spatial and Temporal Influences of Thermokarst Failures on Surface Processes in Arctic Landscapes* which takes a systems approach to address fundamental hypotheses about how thermokarst failures influence the structure and function of the arctic landscape. Collaborators on this project are quantifying the composition of vegetation, the distribution and processing of soil nutrients, and exports of sediments and nutrients to stream and lake ecosystems. In related objectives the researchers

“An increase in the incidence of thermokarst failures will have important impacts on the structure and function of arctic headwater landscapes”

are linking results obtained at this hillslope scale to patterns observed at the landscape scale to test hypotheses about the spatial distribution of thermokarst failures in the arctic foothills. The impacts of changes in land surface processes and formation of thermokarst failures may include feedbacks to the climate system through energy, albedo, water, and trace gas exchange.

This project involves 25 researchers from 12 institutions and is designed to quantify linkages among

climatology, hillslope hydrology, geomorphology, geocryology, community ecology of vegetation, soil nutrient dynamics, microbial ecology, trace gas dynamics, and aquatic ecology. Researchers are using a combination of field experimentation, remote sensing, and simulation modeling as a means to quantify these relationships and are also making comparisons with traditional knowledge from local communities. This project will begin a third and final year of fieldwork in 2011 followed by a year in which the collaborators will synthesize the results from experiments and sampling done between 2009 and 2011.

UPCOMING EVENTS

2011

Arctic Science Summit Week 2011

28-31 March 2011
Seoul, Korea

4th Russian Conference on Geocryology

7-9 June 2011
Moscow, Russia

11th Int. Symposium on Antarctic Earth Sciences

10-16 July 2011
Edinburgh, UK

XVIII INQUA Congress

20-27 July 2011
Bern, Switzerland

2nd Symposium on Mountain and Arid land Permafrost

22-26 August 2011
Ulaanbaatar, Mongolia

9th International Symposium on Permafrost Engineering

3-7 September 2011
Mirny, Russia

4th International Conference on Polar and Alpine Microbiology

4-8 September 2011
Ljubljana, Slovenia

2012

IPY 2012 Conference

22-27 April 2012
Montréal, Canada

Tenth International Conference on Permafrost (TICOP)

25-29 June 2012
Tyumen, Russia

XXXII SCAR and Open Science Conference

13-25 July 2012
Portland, USA

34th International Geological Congress

5-10 August 2012
Brisbane, Australia

32nd International Geographical Congress

26-30 August 2012
Cologne, Germany

INTERNATIONAL PERMAFROST ASSOCIATION

The mission of the International Permafrost Association is to promote research in permafrost and permafrost-related fields within the global scientific and engineering communities, to support the activities of researchers in these disciplines, and to disseminate findings concerning permafrost to the decision-makers, the general public and educators.

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Tom Krzewinski

Prof. Frederick Nelson

Address:

International Permafrost Association
c/o Hugues Lantuit
AWI Potsdam
Telegrafenberg A43
14473 Potsdam
Germany

Web:

contact@ipa-permafrost.org
www.ipa-permafrost.org

ISSN 1021-8610

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