

Dynamics of the Taiga - Tundra Interface

Report of the Workshop held 13 - 15 April 2000, at the Abisko Scientific Research Station

Background

Apparent changes are occurring in the vegetation surrounding the taiga - tundra ecotone in northern Russia and Canada. In some areas to the North in Russia, e.g. the West Siberian Plain, forest is expanding, while in areas to the South bogs are expanding and forest is declining. In other, more oceanic, areas of northern Siberia, the tree line has been pushed southwards, and is now 200 km further South than would be predicted from the temperature regime and climate vegetation models. The mechanisms of change are unclear, but changes from a continental towards a more oceanic climate and waterlogging of trees are reported to be operative in some areas. This process is made worse by deforestation. Russia has the longest latitudinal tree line in the world: even small changes can be geographically significant in terms of feedbacks to the atmosphere and biodiversity. Also, the implications of even small changes in the location and nature of the tree line could be important locally and regionally for land use and the socio-economic structure of the North. Because of the importance of this topic, the International Arctic Science Committee (IASC) encouraged the initiation of an international research programme. To start this process, a workshop was held 13 - 15 April 2000 under the auspices of IASC, the Royal Swedish Academy of Sciences (KVA) and the Climate Impacts Research Centre (CIRC), at the Abisko Scientific Research Station. It brought together ecologists, physiologists, zoologists, soil scientists, dendrochronologists, remote sensing and GIS specialists, social scientists, as well as representatives from relevant large scientific programmes and networks.

Objectives

The aims of the workshop were threefold:

1. To understand past and present changes in the taiga - tundra boundary, including the mechanisms driving the changes, and to predict future changes at a range of geographical scales
2. To assess the implications of current and predicted future changes for:
 - a) ecosystem function and feedbacks to the climate system
 - b) biodiversity and conservation
 - c) land use
3. To facilitate interactions and to stimulate co-operation between different disciplines studying tree line processes, in Russia and elsewhere

Details of the meeting

35 scientists from 9 countries on 3 continents attended the workshop. Five institutions from Russia were represented. The participants had a wide range of backgrounds and disciplines. 31 papers were presented at the meeting within six programme sections (see Appendix 2). These sections covered a range of disciplines

and geographical locations of study sites. Following the formal presentations, group discussions focussed on

- a) how to record the substance of the output of the meeting in an international journal
- b) how to strengthen international collaboration
- c) how to formalise international collaboration within the IASC framework

These outputs are discussed below.

Output from the meeting

a) *publication*

The editor of *Ambio* has, subject to funding, agreed to publish papers summarising the sessions in the workshop, with input from, and co-authored by, the relevant participants. These papers are organised as follows:

1. Determining the location and dynamics of the tundra - taiga boundary and its implications; a concept paper. Lead Author: Terry Callaghan (CIRC, Sweden)
2. How and why has the taiga - tundra interface changed in the past? Lead Author: Tom Edwards (Waterloo, Canada)
3. Natural Causes of the current taiga - tundra interface. Lead Author: Bjartmar Sveinbjörnsson (Anchorage, USA)
4. Consequences of changes for the biological and physical systems. Lead Author: Richard Harding (Institute of Hydrology, UK)
5. Past, present and likely future socio-economic impacts of the taiga - tundra interface. Lead Author: Tatiana Vlassova (Russian Academy of Sciences)
6. Dynamic responses of the forest-tundra ecotone to environmental change. Lead Author: Bob Baxter (Durham, UK)
7. How can the dynamics of the arctic tree line be monitored remotely? Lead Author: Gareth Rees (Scott Polar Research Institute, UK)
8. Future research and management of the taiga - tundra interface. Lead Authors: Terry Callaghan (CIRC, Sweden), Robert Crawford (St Andrews, UK) and Ben Werkman (CIRC, Sweden)

b) *collaboration*

A number of new international contacts between individual researchers were created, and a number of existing contacts were reinforced. More importantly, the need for projects and collaboration involving the whole scientific community studying the taiga - tundra interface was recognised. Suggestions made at the meeting include:

- 1) combining ground-based measurements with remote sensing data, to allow scaling up
- 2) studying integrated catchment systems, to look at feedbacks, to study small and large scale areas, to use GIS techniques, to use past analogues, and to use modelling
- 3) creating monitoring networks, with standardised, simple measurements carried out around the circumpolar North, analogous to ITEX
- 4) setting up site transects, to study age classes (including dendrochronological techniques), tree line processes and health and vigour of individuals, both at a population and at an ecosystem level.

During the meeting it became obvious that the taiga - tundra boundaries are often difficult to define and it was agreed to develop a rigorous statistical / mathematical treatment of the "tree line", recognising changes in density of trees along a latitudinal

gradient of a given distance. This concept will be developed and will lead to more meaningful comparisons of tree line dynamics at different geographical locations.

c) IASC framework

An expectation from IASC was that a Steering Committee would be set up to:

- 1) help integrate existing research and coordinate collaborative future research
- 2) stimulate further international collaboration
- 3) provide information from appropriate sources to IASC and other organisations on relevant issues
- 4) facilitate application to national and international funding agencies for collaborative international projects

Funds have been sought from IASC to start this process, with a meeting planned in St Andrews (UK) in November 2000. The steering committee would consist of representatives from the Arctic countries to ensure geographical representation. It is also important that this includes representation of various disciplines. The following nominations to IASC for a Steering Committee have been made:

Proposed member	Country	Main discipline
Serge Payette	Canada	Paleo Ecology
Bjartmar Sveinbjörnsson	USA	Arctic Plant Ecology
Tatiana Vlassova	Russia	Social Science
Oddvar Skre	Norway	Plant Physiology
Annika Hofgaard	Sweden	Terrestrial Ecology
Matti Eronen	Finland	Paleo Ecology
Gareth Rees	UK	Remote Sensing

The organisers for the meeting in Abisko will arrange this new meeting in St Andrews, but it is anticipated that the Steering Committee will elect its Chairman and Secretary, and develop detailed terms of reference with advice from IASC.

The expertise present at the workshop and represented in the new IASC Tundra Taiga Steering Committee, together with the summary of findings to be published in *Ambio*, should provide an authoritative and balanced input into the ACIA (Assessment of Climate Impacts in the Arctic) process *via* IASC.

Appendices

- Appendix 1. First Circular
- Appendix 2. Workshop Programme
- Appendix 3. Workshop Participants
- Appendix 4. Budget



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Workshop in Abisko 13 - 15 April 2000

Final Circular

Below is the latest version of the programme for the workshop. Due to the very good response, and the larger number of presentations than we anticipated, individual presentations are allocated 25 minutes. We suggest that this includes a talk of between 15 and 20 minutes (certainly not longer!), allowing the remainder of the 25 minute slot for discussions.

Some practical details:

- 1) Travel to Abisko. Abisko is located in northern Sweden, roughly halfway between Kiruna and Narvik (Norway). Kiruna has an airport, with two flights daily to and from Stockholm International Airport (Arlanda). Narvik has a small local airport, but probably more useful for international travellers is the airport at Evenes, a little North of Narvik, with several flights a day from Oslo. We will provide a minibus shuttle service from Kiruna and Evenes airports, Narvik has a direct railway connection to Abisko.
- 2) To aid planning: Could you please provide us with details of your travel arrangements, and any dietary requirements, so that we can make the necessary arrangements in Abisko.
- 3) Outing. Weather permitting, we hope to invite participants to take part in a short outdoor excursion to see the local tree line in winter conditions. Details will be provided at the meeting, but warm clothing and sturdy footwear will be required. We will almost certainly still have snow here in Abisko at the time of the meeting.

We look forward to welcoming you to Abisko and to the workshop.

Terry Callaghan
Robert Crawford
Ben Werkman

Tree Line Workshop Programme

12 April 2000

08.30h to 10.00h Breakfast

12.00h to 13.00h Lunch

19.00h to 20.00h Dinner

13 April 2000

08.00h Breakfast

Opening Session: Introductions

Chairman: Terry Callaghan

09.00h Terry Callaghan *Abisko Scientific Research Station, Sweden*

Welcome to Abisko Scientific Research Station

09.10h Robert Crawford *University of St Andrews, UK*

Opening address and objectives of the Workshop

09.20h Odd Rogne *International Arctic Science Committee*

Funding possibilities for international research cooperation and the role of IASC

Second Session: Historical Changes in the Tree Line

Chairman: Robert Crawford

09.40h Harvey Nichols *University of Colorado, USA*

Arctic tree-line: recent reproductive changes and a paleo perspective

10.05h Tom Edwards *University of Waterloo, Canada*

Holocene paleoclimate and paleoenvironments along the boreal circumpolar treeline: The view from stable isotopes in lake sediment and peat

10.30h Coffee

11.00h John Birks *University of Bergen, Norway*

Changes in forest composition and extent in northern Fennoscandia during the Holocene

11.25h Serge Payette *Université Laval, Quebec, Canada*

A history of forest growth related to climate in northern regions in the New World

11.50h Rashit Hantemirov *Inst of Plant and Animal Ecology, Ekaterinburg, Russia*

Holocene history of the northern tree line in the Yamal Peninsula

12.15h Lunch

Third Session: Recent Changes in the Tree Line

Chairman: Bjartmar Sveinbjörnsson

13.45h Peter Kuhry, M. Eronen, A. Nikula, K. Mikkola, T. Virtanen, S. Kultti and P. Oksanen *Arctic Centre, Rovaniemi, Finland*

Tree line dynamics in the East-European Russian Arctic at different temporal and spatial scales

14.10h Igor Lavrinenko *Laboratory of ecology and protection of the tundra, Syktyvkar, Russia*

Biological and ecological investigations in East-European tundra for the last 5-10 years

14.35h Peter Scott *Churchill Northern Studies Centre, Canada*

Dynamics of the taiga in central northern Canada

15.00h Sergei Kirpotin *Tomsk State University, Russia*

Development and dynamics of West-Siberian palsas as a climate indicator

15.25h Coffee

15.55h Sergei Vorobiev *Tomsk State University, Russia*

Sub-Arctic soils in West-Siberia

16.20h Vladimir Lukiantsev *Tomsk State University, Russia*

Water and soil fauna of the Nadym-Pur interfluvium in the West-Siberian Plains

Fourth Session: Processes determining Tree Lines

Chairman: Peter Kuhry

16.45h Bjartmar Sveinbjörnsson *University of Alaska Anchorage, USA*

White spruce treeline in Alaska - external factors, internal processes

17.10h Friedrich-Karl Holtmeier *Inst für Landschaftsökologie, Münster, Germany*

Microsites influencing structures and dynamics in the timberline ecotone - studies in northern Europe, in the Rocky Mountains and in the European Alps

17.35h Marja-Liisa Sutinen, E Hyvönen, P Hänninen, S Penttinen, M Siira & R Sutinen *Finnish Forest Research Institute, Finland*

Soil properties as determinants of tree species distribution in timberline area in Finnish Lapland

19.00h Dinner

20.00h Tundra Bar

14 April 2000

07.30h Breakfast

Fourth Session: Continued

Chairman: Peter Kuhry

08.30h Robert Crawford *University of St Andrews, UK*
Treelines, oceanicity and paludification

08.55h Bob Baxter *University of Durham, UK*
Dynamic response of the forest-tundra ecotone to environmental change

09.20h Oddvar Skre *Norwegian Forest Research Institute, Norway*
Effects of a predicted climate change on tree-line formation in Fennoscandia

09.45h Staffan Karlsson and Martin Weih *University of Uppsala, Sweden*
Soil temperatures near the altitudinal and latitudinal distribution limit of the mountain birch: implications for nitrogen economy

10.10h Coffee

10.40h Christian Körner *University of Basel, Switzerland*
Physiological determinants of the treeline

11.05h Annika Hofgaard *Climate Impacts Research Centre, Sweden*
Temporal growth response of trees across ecotones

11.30h Alexey Fedorkov *Inst of Plant and Animal Ecology, Ekaterinburg, Russia*
The reproductive system of conifers at the tree line under climate changes and air pollution.

12.00h Lunch Outing to the Abisko Tree Line

15.00 Working Groups Discussions

19.00 Workshop Dinner

21.00 Tundra Bar

15 April 2000

Fifth Session: Consequences of Tree Line Dynamics, including Plant-Atmosphere and Plant-Soil Interactions

Chairman: Christian Körner

07.30h Breakfast

08.30h Olga Lavrinenko *Inst of Plant and Animal Ecology, Ekaterinburg, Russia*
Dynamics of vascular plants and lichens biodiversity at the taiga-tundra ecotone under anthropogenic impacts and climatic change

08.55h Tatiana Vlassova *Russian Academy of Sciences, Russia*
Social and economic aspects of the taiga-tundra tree-line dynamics in Russia

09.20h Richard Harding *Inst of Hydrology, UK*
The impacts of vegetation cover on components of the surface energy balance

09.45h Nicolai Panikov *Stevens Institute of Technology, USA & Russian Academy of Sciences, Russia*
Implications of tundra - taiga boundary dynamics for the soil microbial community

10.10h Torben Christensen *University of Lund, Sweden*
Implications of tundra - taiga boundary dynamics for trace gas emissions

10.35h Coffee

Sixth Session: Remote Observations of Current and Future Changes in the Tree Line

Chairman: Richard Harding

11.05h Gareth Rees *Scott Polar Research Institute, UK*
Remote sensing tools for identifying changes in the treeline

11.30h Ben Werkman *Climate Impacts Research Centre, Sweden*
Landsat data analysis of the tree line in northern Siberia

11.55h Ian Brown *Climate Impacts Research Centre, Sweden*
Radar satellite data analyses of the tree line in northern Siberia

12.20h Lunch

Final Session:

13.30h Plenary Conclusions and Discussion

15.00h Workshop Close

19.00h to 20.00h Dinner

20.00h Tundra Bar

16 April 2000

08.30h to 10.00h Breakfast

12.00h to 13.00h Lunch

19.00h to 20.00h Dinner

Appendix 4. Budget

Financial balance for the Taiga Tundra Workshop (in SEK):

Expenses:

National/International travel	178 200:35
Local Transport	10 309:50
Catering	38 311:00
Administration	13 332:08
Total	240 152:93

Income:

International Arctic Science Committee (\$10 000)	90 770:00
Climate Impacts Research Centre	100 000:00
Royal Swedish Academy of Sciences	96 344:50
Total	287 114:50

The remaining balance of 46 961:57 will be used towards the costs of publication of the proceedings in *Ambio*.