Working Papers of the Finnish Forest Research Institute 133

http://www.metla.fi/julkaisut/workingpapers/2009/mwp133.htm
ISBN 978-951-40-2186-2 (PDF)
iSBN 978-951-40-2187-9 (paperpack)
ISSN 1795-150X

Adapting Forest Management to Maintain the Environmental Services: Carbon Sequestration, Biodiversity and Water

Abstracts and Programme of an International Conference at Koli National Park, Finland in 21.–24.9.2009

Leena Finér, Ari Laurén and Markus Lier (eds.)

METLA www.metla.fi

Working Papers of the Finnish Forest Research Institute publishes preliminary research results and conference proceedings.

The papers published in the series are not peer-reviewed.

The papers are published in pdf format on the Internet only.

http://www.metla.fi/julkaisut/workingpapers/
ISSN 1795-150X

Office
P.O. Box 18
FI-01301 Vantaa, Finland
tel. +358 10 2111
fax +358 10 211 2101
e-mail julkaisutoimitus@metla.fi

Publisher
Finnish Forest Research Institute
P.O. Box 18
FI-01301 Vantaa, Finland
tel. +358 10 2111
fax +358 10 211 2101
e-mail info@metla.fi
http://www.metla.fi/

Authors

Finér, Leena, Laurén Ari & Lier Markus

Title

Adapting Forest Management to Maintain the Environmental Services: Carbon Sequestration, Biodiveristy and Water. Abstracts and Programme of an International Conference at Koli National Park, Finland in 21.–24.9.2009

Year	Pages	ISBN	ISSN
2009	94	978-951-40-2186-2 (PDF) 978-951-40-2187-9 (paperpack)	1795-150X

Unit / Research programme / Projects

Joensuu Research Unit / Nordic Forestry CAR-ES, 50107

Accepted by

Pasi Puttonen, Director of Research, 8 September 2009

Abstract

This paper compiles the programme and the abstracts of the international scientific conference "Adapting Forest Management to Maintain the Environmental Services: Carbon Sequestration, Biodiversity and Water" held in the Koli National Park from the 21st to 24th of September 2009. The focus of the conference is the impacts of forest management on the environmental services – carbon sequestration, biodiversity and water protection. More specific aims are: a) to present an overview of current research on environmental services in forest management, b) to quantify the environmental impact of different management strategies and practices in order to support decision-making, and c) to improve the awareness of the environmental services provided by forests.

The conference was arranged by the Nordic Centre of Advanced Research on Environmental Services (CAR-ES) funded by SNS during 2004-2009 (http://www.nordicforestry-cares.org). This international conference will broaden the discussion on the environmental services provided by forests and it will present the achievements of CAR-ES to a wide international scientific audience. The conference is attended by 50 scientists and several stakeholders. Some selected papers presented at the conference will be published in a special issue of the scientific international journal Silva Fennica.

Keywords

Biodiversity, carbon sequestration, ecosystem services, forest management, water

Available at

http://www.metla.fi/julkaisut/workingpapers/2009/mwp133.htm

Replaces

Is replaced by

Contact information

Leena Finér, Metla, Joensuu, Box 68, 80101 Joensuu, Finland, leena.finer@metla.fi

Other information

http://www.metla.fi/tapahtumat/2009/koli/index.htm

Contents

Welcome to the conference

The environmental research within forest ecosystems has had a major focus on the negative impacts of pressures, such as air pollution or large scale clear-cuts. The Helsinki process and the concept of sustainable forest management (SFM) have turned the focus towards research on the environmental benefits of forests, which society now recognises and demands from the forest sector. Forest ecosystems provide many deliverables or benefits to society. The most obvious is wood for the forest industry and private households. Other direct benefits to humans include berries and mushroom picking, hunting and other recreational activities. More recent recognized benefits of forests include various environmental services, such as carbon sequestration, water protection and biodiversity. Some of these benefits have an immediate market value while others, such as recreational values are more difficult to price.

Since the recognized benefits of forests are diverse, forest managers are facing more complex and difficult decisions when they make management plans. Not all benefits can be optimized simultaneously and in some cases there is a lack of knowledge on how management decisions will affect a certain benefit. Forest management has the potential to reduce external pressures (such as climate change, air pollution or exploitation) and to optimise environmental services. There is an urgent need to increase the knowledge on how forest management can be used to maintain and enhance different environmental services. Such knowledge will enable a change in traditional management, so it continues to provide valuable wood products while at the same time sustains or restores environmental services at reduced external pressures.

The focus of this three-day international scientific conference “Adapting Forest Management to Maintain the Environmental Services: Carbon sequestration, Biodiversity and Water” held in the Koli National Park from the 21st to 24th of September 2009 is the impacts of forest management on environmental services – carbon sequestration, biodiversity and water protection. More specific aims of the conference are to: 1) present an overview of current research on environmental services in sustainable forest management, 2) quantify the environmental impact of different management strategies and practices in order to support decision-making, and 3) to improve the awareness of the environmental services provided by forests.

This conference is organized by the Finnish Forest Research Institute (Metla), the Nordic Forestry CAR-ES funded by SNS (Nordic Forest Research Co-operation Committee) during 2004-2009 (http://www.nordicforestry-cares.org), the Agricultural University of Iceland, Forest & Landscape Denmark, Icelandic Forest Research, Latvia State Forest Research Institute Silava, Norwegian Forest and Landscape Institute and Skogforsk, Sweden. All the Nordic countries, i.e. Denmark, Sweden, Norway, Iceland and Finland, and Latvia and Lithuania from the Baltic countries have actively participated in the work of CAR-ES. Two workshops have been arranged annually within CAR-ES since 2004, where the environmental services have been discussed from different perspectives. Each of these workshops have been attended by 10-30 Nordic and Baltic scientists. This conference will broaden the scope of the discussion on environmental services and present the achievements of CAR-ES to a wide international scientific audience. The conference is sponsored by the following organisations: SNS, Metsämiesten Säätiö, Maj and Tor Nessling Foundation. Metsähallitus, Stora Enso Forest and North Karelia Forestry Centre have participated in organising the field excursion to show practical examples of forest ecosystem services. The conference is attended by 50 scientists and several stakeholders.

Scientific Committee of the Conference

Per Gundersen, Leena Finér, Dagnija Lazdina, Eva Ring, Magne Sætersdal,
Bjarni D. Sigurdsson and Jan Weslien

Technical committee

Dr Ari Laurén (chairperson) Metla, Dr Karin Hansen Forest & Landscape Denmark, M. Sc. Markus Lier Metla.

International Scientific Committee

Prof. Leena Finér, (chairperson) Metla, Prof. Per Gundersen Forest & Landscape Denmark, Dr, Senior Scientist Magne Sætersdal, Norwegian Forest & Landscape Institute, Prof. Bjarni D. Sigurdsson, Agricultural University of Iceland, Dr, Senior scientist Eva Ring and Prof. Jan Weslien Skogforsk, Sweden, Dr Dagnija Lazdina Latvia State Forest Research Institute Silava.

Scientific papers

All oral and poster presentation contributors are given an opportunity to publish their study in a special issue of the international journal of forest science Silva Fennica. Silva Fennica publishes research articles, review articles, research notes, discussion papers and book reviews. The journal covers all aspects of forest research, both basic and applied subjects. The articles are subject to peer review. Please refer to instructions to authors at the Web pages of Silva Fennica www.metla.fi/silvafennica/. The manuscript should be submitted to Silva Fennica by the 1st of November 2009. When submitting the paper please make a note "Ecosystem services" to get it included in the special issue.

Sponsors

PRO AERE AQUA TERRA
MAJ AND TOR NESSLING FOUNDATION

METSÄMIESTEN SÄÄTIÖ
Ihminen ja metsä

norden

Organizers

METLA
FINNISH FOREST RESEARCH INSTITUTE

SKOGFORSK

FOREST & LANDSCAPE

SILAVA

Landbúnaðarháskóli Íslands
Agricultural University of Iceland

SKÓGRÆKT RÍKISINS

skog+landskap
NORWEGIAN FOREST AND LANDSCAPE INSTITUTE

Practical information

The conference is organised in the premises of the Heritage Centre Ukko, Koli National Park, Ylä-Kolintie 39, 83960 Koli, Finland. The conference venue is located opposite Sokos Hotel Koli.

Monday 21th September
20:00–22:00 "Ice breaker" informal reception, at Sokos Hotel Koli. Registration and information desk in the lobby of the hotel is open 21:00–22:00. Due to practical reasons the conference participants are ask to handle their posters already on Sunday evening.

Tuesday 22th September
08:30–09:00 Registration, Heritage Centre Ukko
09:00–15:45 Conference day 1 *(see programme for more detailed information)*
16.30–18:00 Poster session, Heritage Centre Ukko
19:30–22:00 Evening programme, guided tour at Koli National Park, dinner & sauna

Coffee and lunch break
Coffee and lunch is included in the participation fee. Coffee will be served during breaks in the lobby of Heritage Centre Ukko and lunches at Sokos Hotel Koli.

Internet
A wireless Internet connection is available in the conference venue. Please ask for the password from the registration desk.

Wednesday 23th September
09:00–17:20 Conference day 2 *(see programme for more detailed information)*
19:30–22:00 Evening programme, conference dinner at Sokos Hotel Koli.

Thursday 24th September
07:30–17:00 Scientific excursion *(see scientific excursion for more detailed information)*
Plane connection from Joensuu to Helsinki at 17.40 (last connection)
Train connection from Joensuu to Helsinki at 18.02 (last connection)

Important phone numbers:

Sokos Hotel Koli reception	+358 20 1234 662
Markus Lier (Metla)	+358 50 391 3063
Ari Lauren (Metla)	+358 50 391 3066
Leena Finér (Metla)	+358 50 391 3067
Emergency number	112
Taxi Koli	+358 500 374 004

Information about Koli National Park
The Koli National Park is located in Eastern Finland, North Karelia. The National Park (3000 ha) was established in 1991 to preserve the unique landscape, geological formations and cultural heritage, to protect the diverse nature and to promote the use of the area for research and nature travel. The highest point Koli National Park is *Ukko Koli*, which rises to 347 m above sea-level and 253 m above Lake Pielinen. This hill chain is as well the highest point of Southern Finland.
For more information: http://www.luontoon.fi/page.asp?Section=6834

Programme

Monday 21 September 2009

20:00–22:00 "Ice breaker" at Sokos Hotel Koli
21:00–22:00 Registration

Tuesday 22 September 2009

08:30–09:00 Registration at venue lobby, Heritage Centre Ukko
09:00–09:05 Welcome address by Leena Finér, Metla

General session on environmental services provided by forests

Chair: Dan Aamlid, Norwegian Forest and Landscape Institute

Keynote

09:05–09:50 Per Gundersen, Forest & Landscape Denmark, leader of CAR-ES. What do we mean by environmental services?
09:50–10:30 Herbert W. Schroeder, USDA Forest Service. How people value environments and their services.

10:30–10:45 Coffee break

Keynote

10:45–11:25 Bart Muys K.U. Leuven, Belgium. What environmental services can forests provide?
11:25–12:05 Kjersti Bakkebø Fjellstad, Ministerial Conference on the Protection of Forests in Europe (MCPFE). What do politicians need to know about environmental services for policy making?

Volunteer presentation

12:05–12:25 Jan Weslien, Skogforsk, the Forestry Research Institute of Sweden. How are environmental services affected by increased forest productivity and warmer climate?

12:30 Lunch, Hotel Koli

Session on forest management tools to sequestrate carbon

Chair: Bart Muys K.U. Leuven, Belgium

Keynote

13:15–13:55 Seppo Kellomäki, University of Joensuu, Finland. Forest management tools to sequestrate carbon.

Volunteer presentation

13:55–14:15 Bjarni Sigurdsson, Icelandic Forest Research. Effects of afforestation on carbon stocks and fluxes of previously grazed heathlands in Iceland.

14:15–14:45 Coffee break

Volunteer presentations

14:45–15:05 Christopher Dean, Dept of Environmental and Aquatic Sciences, Curtin University of Technology, Perth, Western Australia. Effective carbon management of forests requires recognition of major pools and timelines.

15:05–15:25 Anne le Mellec, LOEWE - Center for Biodiversity and Climate Research, Frankfurt/Main, Germany. From carbon sinks to carbon sources - insect outbreaks and altering forest function.

15:25–15:45 Marjo Palviainen, University of Helsinki, Finland. Decomposing tree stumps are long-term carbon pools and nitrogen sinks after harvesting.

16.30–18:00 Poster session at Heritage Centre Ukko

19:30–22:00 Evening program

Guided tour at Koli National Park, dinner & sauna

Wednesday 23 September 2009

Session on the forest management tools to maintain biodiversity

Chair: Magne Sætersdal, Norwegian Forest and Landscape Institute

Keynote

09:00–09:40 Kris Verheyen, University of Ghent, Belgium. Forest management tools to maintain biodiversity.

Volunteer presentations

09:40–10:00 Edda Oddsdottir, Icelandic Institute of Natural History. Effects of afforestation on species richness of plants and animals in Iceland.

10:00–10:20 Margus Pensa, University of Tallinn, Estonia. The effect of planted tree species on the diversity of herbaceous vegetation in a reclaimed oil-shale opencast in Estonia.

10:20–10:45 Coffee break

Volunteer presentations

10:45–11:05 Mike Smith, Forest Research Northern Research Station Bush Estate Midlothian, UK. Functional forests: Delivering sustainable multifunctional forest management at the landscape scale.

11:05–11:25 Olof Widenfalk, Skogforsk, the Forestry Research Institute of Sweden. Plant and insect diversity in young forests – The role of thinning, browsing and productivity.

12:00 Lunch, Hotel Koli

Session on the combining the management of forests and waters

Chair: Eva Ring, Skogforsk Sweden

Keynote

13:00–13:40 Kevin Bishop, Swedish University of Agricultural Sciences. Combining the management of forests and waters.

Volunteer presentations

13:40–14:00 Špela Planinšek, Slovenian Forestry Institute. A model for valuing and allocating forest sites that provide hydrological services (roles).

14:00–14:20 Ivan Pilas, Department of Ecology and Silviculture, Forest Research Institute Jastrebarsko, Kroatia. Fighting water scarcity to maintain forest environmental services - perspective of lowland floodplain forests in south eastern Europe.

14:20–14:45 Coffee break

Volunteer presentations

14:45–15:05 Hannu Mannerkoski, University of Joensuu, Finland. Forests, forestry and water - and their relations - in Finland.

15:05–15:25 Karin Hansen, University of Copenhagen, Denmark. Afforestation of former arable land at Vestskoven, Denmark. Sequestration of carbon in soil and biomass, leaching of nitrate and ground flora composition.

Final session to conclude and give direction for the future

Chairs: Per Gundersen, Forest & Landscape Denmark and Lars Högbom, Skogforsk Sweden

Keynote

15:30–16:10 Jette Bredahl Jacobsen, Forest and Landscape Denmark. Economic considerations in forest management to provide environmental services in the future.

Panel discussion

16:20–17:30 Panel discussion with the keynote speakers and stake holders.

Closing of the seminar

19:00–22:00 Evening program incl. conference dinner, Sokos Hotel Koli

Thursday 24 September 2009

07:30–17:00 Scientific excursion: How forest management in Finland provides environmental services in practice.

List of participants

	Name	Organisation	E-Mail
1	Ahtiainen Marketta	North Karelia Regional Environment Centre (PKA), Joensuu, Finland	marketta.ahtiainen@ymparisto.fi
2	Aleinikoviené Juraté	Lithuanian Forest Research Institute, Girionys, Kaunas, Lithuania	j.aleinikoviene@mi.lt
3	Amlid Dan	The Norwegian Forest and Landscape Institute, Ås, Norway	dan.aamlid@skogoglandskap.no
4	Bishop Kevin	SLU, Department of Aquatic Sciences and Assessment, Uppsala, Sweden	kevin.bishop@vatten.slu.se
5	Cahyono Agus Dwi Koranto	UGM Yogyakarta ,Faculty of Forestry UGM, Bulaksumur, Yogyakarta, Indonesia	acahyono@ugm.ac.id
6	Danielewska Alina	Poznan university of life sciences, Agrometeorology department, Poznan, Poland	alinkadanie@gmail.com
7	Dean Christopher	Department of Environmental and Aquatic Sciences, Curtin University of Technology, WA 6845, Australia	christopher.dean@curtin.edu.au
8	Dymov Alexey	Institute of Biology Komi SC RAS, Syktuvkar, Komi Republic, Russia	dymov@ib.komisc.ru
9	Finér Leena	Finnish Forest Research Institute, Joensuu, Finland	leena.finer@metla.fi
10	Fjellstad Kjersti Bakkebø	MCPFE Liaison Unit Oslo, Aas, Norway	kjersti.fjellstad@mcpfe.org
11	Futter Martyn	SLU, Department of Aquatic Sciences and Assessment, Uppsala, Sweden	martyn.futter@gmail.com
12	Gundersen Per	Univ. of Copenhagen, Forest & Landscape Denmark, Hørsholm, Denmark	pgu@life.ku.dk
13	Haga Sune	SamNordisk Skogforskning - Nordic Forest Research Cooperation Committee, SNS, Vantaa, Finland	sune.haga@metla.fi
14	Hansen Karin	Univ. of Copenhagen, Forest & Landscape Denmark, Hørsholm, Denmark	kiha@life.ku.dk
15	Hellsten Sofie	IVL Swedish Environmental Institute, Göteborg, Sweden	sofie.hellsten@ivl.se
16	Hiltunen Timo	Metsähallitus, Environment Specialist, Jyväskylä, Finland	timo.hiltunen@metsa.fi
17	Högbom Lars	Skogforsk – the Forestry Research Institute of Sweden, Uppsala Science Park, Uppsala, Sweden	Lars.hogbom@skogforsk.se

18	Hökkä Hannu	Finnish Forest Research Institute, Rovaniemi Research Unit, Rovaniemi, Finland	hannu.hokka@metla.fi
19	Jacobson Jette Bredahl	Univ. of Copenhagen, Forest & Landscape Denmark, Hørsholm, Denmark	jbj@life.ku.dk
20	Kellomäki Seppo	University of Joensuu, Faculty of Forestry, Joensuu, Finland	seppo.kellomaki@joensuu.fi
21	Kettunen Marianne	Institute for European Environmental Policy (IEEP), London, UK / visiting researcher at the Finnish Environment Institute (SYKE) Helsinki, Finland	mkettunen@ieep.eu
22	Koivusalo Harri	Finnish Forest Research Institute, Joensuu Research Unit, Joensuu, Finland	harri.koivusalo@metla.fi
23	Kortelainen Pirkko	Finnish Environment Institute SYKE, Research Programme for Global Change, Helsinki, Finland	pirkko.kortelainen@ymparisto.fi
24	Laurén Ari	Finnish Forest Research Institute, Joensuu Research Unit, Joensuu, Finland	ari.lauren@metla.fi
25	Lazdiņa Dagnija	Latvia state forest research institute - Silava, Rigas str, Salaspils, LV 2169, Latvia	dagnija.lazdina@silava.lv
26	Lier Markus	Finnish Forest Research Institute, Joensuu Research Unit, Joensuu, Finland	markus.lier@metla.fi
27	Mannerkoski Hannu	University of Joensuu, Faculty of Forestry, Joensuu, Finland	hannu.mannerkoski@joensuu.fi
28	Mattsson Tuija	Finnish Environment Institute SYKE, Helsinki, Finland	tuija.mattsson@ymparisto.fi
29	Mjöfors Kristina	SLU - Swedish University of Agricultural Sciences, Uppsala, Sweden	kristina.mjofors@mark.slu.se
30	Muys Bart	Katholieke Universiteit Leuven, Belgium	bart.muys@biw.kuleuven.be
31	Niemi Tuomas	UPM-Kymmene Corporation, Helsinki, Finland	tuomas.niemi@upm-kymmene.com
32	Nordlund Sten	Skogforsk, Uppsala Science Park, Uppsala, Sweden	stno@skogforsk.se
33	Oddsdottir Edda	Icelandic Forest Research, Mogilsá, Reykjavik, Iceland	edda@skogur.is
34	Palviainen Marjo	University of Helsinki, Department of Forest Ecology, Helsinki, Finland	marjo.palviainen@helsinki.fi
35	Pensa Margus	NE-Estonian Department, Institute of Ecology, University of Tallinn, Jöhvi, Estonia	margus@ecoviro.johvi.ee
36	Piirainen Sirpa	Finnish Forest Research Institute, Joensuu Research Unit, Joensuu, Finland	sirpa.piirainen@metla.fi

37	Pilaš Ivan	Croatian Forest Research Institute, Jastrebarsko, Croatia	ivanp@sumins.hr
38	Planinšek Špela	Slovenian Forestry Institute, Ljubljana, Slovenia	spela.fajon@gozdis.si
39	Rantakari Miitta	Finnish Environment Institute SYKE, Helsinki, Finland	miitta.rantakari@ymparisto.fi
40	Ring Eva	Skogforsk, Uppsala Science Park, Uppsala, Sweden	eva.ring@skogforsk.se
41	Sætersdal Magne	The Norwegian Forest and Landscape Institute, Ås, Norway	magne.setersdal@skogoglandskap.no
42	Sarkkola Sakari	Finnish Forest Research Institute, Vantaa Research Centre, Vantaa, Finland	sakari.sarkkola@metla.fi
43	Schroeder Herbert	United States Forest Service, Northern Research Station, University Place, Evanston, USA	hschroeder@fs.fed.us
44	Sigurdsson Bjarni	Agricultural University of Iceland, Borgarnes, Iceland	bjarni@lbhi.is
45	Smith Mike	Northern Research Station, Bush Estate, Midlothian Scotland, UK	mike.smith@forestry.gsi.gov.uk
46	Strömgren Monika	SLU (Swedish University of Agricultural Sciences), Uppsala, Sweden	monika.stromgren@mark.slu.se
47	Verheyen Kris	Ghent University, Laboratory of Forestry, Melle-Gontrode, Belgium	kris.verheyen@UGent.be
48	Weslien Jan	Skogforsk, Uppsala Science Park, Uppsala, Sweden	jan.weslien@skogforsk.se
49	Widenfalk Olof	Skogforsk - The Forestry Research Institute of Sweden, Uppsala Science Park, Uppsala, Sweden	olof.widenfalk@skogforsk.se
50	Winsa Hans	Sveaskog, Research and Development, Kalix, Sweden	hans.winsa@sveaskog.se
51	Vogt-Altena Holger	University of Goettingen, Department of Geography, Inst. of Landscape Ecology / and : US Army Europe, USAG Baumholder, DPW Environmental Division, Göttingen, Germany,	holger.vogt-altena@gmx.de
52	von Stedingk Henrik	SLU, Swedish Biodiversity Centre, Department of forest ecology and management, Umeå, Sweden	henrik.von.stedingk@svek.slu.se

General session on environmental services provided by forests

Keynote

What do we mean by environmental services from forests?

Per Gundersen and the CAR-ES team

University of Copenhagen, Forest and Landscape Denmark, Hørsholm Kongevej 11, DK-2970 Hørsholm, Denmark, Phone: +45 35 33 16 78, fax: +45 35 33 15 17, E-mail: pgu@life.ku.dk

Ecosystem services has become the standard term when discussing the many products and diverse benefits that ecosystems provide to society. For a subset of these benefits - carbon sequestration, water protection and biodiversity - we use the term environmental services. In Europe, the Ministerial Conference on the Protection of Forests in Europe (MCPFE) has offered a general awareness of these services from forest ecosystems. The signature countries have agreed to a number of principles regarding sustainable forest management (SFM) where an important component is the maintenance and enhancement of environmental services. External pressures (e.g. climate change, air pollution, exploitation, and costs) on the ecosystem may, however, impede the capacity of forests to provide the desired services.

Forest management has the potential to reduce or avoid pressures and optimise environmental services provided that the mechanisms behind are known. Ideally, this knowledge will enable that management can be tuned to provide valuable wood products and at the same time sustain or restore environmental services at reduced external pressures. However, there are potential conflicts between sustained wood production and environmental services as well as among the environmental services. For instance, maximum C storage may compromise biodiversity, and conservation of biodiversity may restrict the extraction of products on part of the forest area. Conversely, it may be possible to solve several problems at the same time if forest management is optimised to reach multifunctional goals.

Over the last four years a network of Nordic environmental researchers have come together to analyze, discuss and integrate knowledge on environmental services. We have educated each other across specializations and disciplines, analyzed management options and discussed synergies and trade offs between water protection, biodiversity conservation and carbon sequestration.

In this paper, we argue for the holistic view on environmental issues in SFM and giver examples where studies of water quality, biodiversity and carbon sequestration have been combined in the same experiment, studied for a particular management option, or analyzed for a problem complex.

Keynote

How people value environments and their services

Herbert W. Schroeder[1]

Research Social Scientist
United States Department of Agriculture, Forest Service, Northern Research Station
Evanston, Illinois, USA
hschroeder@fs.fed.us

In this presentation I will first present a general scheme for understanding how people value environments, and then I will discuss how environmental services fit within that scheme. The concept of "value" is central to natural resource management, yet it is difficult to define and has different meanings in different fields. To an economist, the value of something is the amount that a person is willing to pay to get it. To a sociologist or social psychologist, a value is an enduring concept of what is good or desirable. Value can also mean the immediate experience of liking or attraction that a person feels toward something. Valuing is a human process that involves all of these behavioral, cognitive, and emotional aspects.

Value can arise from a natural environment in various ways. I will illustrate five different pathways starting within a natural system that lead to something being valued by somebody:

1. Natural environments are a source of physical materials that are either consumed directly or used to create products that people value, for example lumber for building houses.
2. Processes taking place within a natural environment may lead to biological and physical outcomes (changes in the state of the world) that people value, for example mitigation of global warming.
3. People can experience immediate enjoyment and appreciation when they are engaged in some form of direct interaction with the environment, for example when viewing a beautiful landscape.
4. A person's direct interaction with a natural environment may have beneficial psychological, social, and physiological outcomes that persist after the person has left that environment, for example stress reduction and recovery from mental fatigue.
5. Natural environments and places have important personal, social, historical, and cultural meanings for people, for example sense of place and spiritual traditions.

When we speak of "environmental services" we view the environment in terms of how it serves our desires and needs. What we value is not the environment itself, but the things that it does for us. This way of looking at environmental value is clearly appropriate when we consider value pathways 1, 2, and 4, and in some cases for pathways 3 and 5 as well. In other cases, however, the value of an environment to a person is based not on what the environment can do for the person, but on the environment as an entity to be appreciated for its own sake.

Initially, discussions of environmental services focused on beneficial biophysical functions of natural systems that often go unrecognized, such as pollination or the protection of coastal zones from storm damage. But as the notion of environmental services has gained in popularity, there has been a tendency to broaden the concept to include all forms of environmental value. Many people now see environmental services as including everything from production of tangible products like lumber to social, cultural, aesthetic, and even spiritual values. It may not be appropriate, however, to think of all of these environmental values as being environmental services. People can and do value and care about natural environments, places, and things for their own sake, rather than only valuing them as a source of goods and services.

Environmental services nevertheless are a very important part of the larger picture of how people value environments. Valuing nature for the services it provides is not mutually exclusive with valuing environments aesthetically, emotionally, or spiritually for what they are in and of themselves. In a person's experience of natural environments these two different ways of valuing may exist side-by-side, mutually reinforcing each other. As people become more aware of the services that natural environments provide to them, hopefully they will begin to develop a sense of appreciation toward these environments. In that case, the concept of "environmental service" might be expanded to include the services that people perform on behalf of natural environments that they value.

Keynote

What ecosystem services can forests provide?

Bart Muys

Division Forest, Nature and Landscape K.U.Leuven, Celestijnenlaan 200E box 2411, BE-3001 Leuven, bart.muys@ees.kuleuven.be

Ecosystems services refer to the benefits people obtain from ecosystems (WRI, 2003). Supporting services are crucial in the sense that they form the ecological basis for the sustained delivery of all other ecosystem services. Provisioning services are material resources produced by ecosystems. Regulating services are obtained from the buffering features of ecosystem processes. Cultural services include the non-material benefits from ecosystems. Environmental services refer to the supporting and regulating services together. Ecosystem services are greatly affected by humans and their activities, the scale of which ranges from the local to the global scale (Hermy et al., 2007).

It is often believed that forests as the natural vegetation in many places offer the best guarantee for supreme ecosystem service. But is this always the case or does it depend on management and other factors? And will optimizing management for one service not imply suboptimal provision of another service? And could maximal in situ provision also lead to decreased ex situ provision?
Some recent ecological theories might be helpful to understand relationships between ecosystem services. The diversity/productivity and diversity/stability hypotheses relate supporting services with provisioning and regulating services respectively, and predict higher production and/or stability in mixed systems. Successfully demonstrated in grasslands and other ecosystems (Balvanera et al., 2006), such relationships are not easily recognized in forests (Scherer-Lorenzen et al., 2005). Ecosystem exergy theory (also called maximum entropy theory , see Dewulf et al. 2008) allows relating supporting services with regulating services and predicts higher regulation (exergy dissipation) in climax forests as late successional systems (exergy storage). Also this relationship is under debate (e.g Wagendorp et al. 2006).

Despite these interesting patterns, ecosystem services remain dependent on scale and will be affected by management, which need to be taken into account when optimizing land use and forest management for improved and sustained delivery of ecosystem services. The scale issue refers to the fact that a given land use and forest management will deliver a certain local level of ecosystem service, but might have repercussions on the level of ecosystem service elsewhere in the landscape. We illustrate this with the green versus blue water paradigm in catchment management and propose a green-blue water approach for the coupled terrestrial-aquatic system as a way to optimize the water regulating function of the forest (Maes et al., 2009). The management issue refers to the challenge to find optimized management solutions from a range of management options leading to different outcomes in terms of ecosystem services. We illustrate this with the Afforest Decision Support System, which allowed formulating management guidelines based on simulation of carbon sequestration, groundwater recharge and nitrate leaching levels for a range of afforestation options in terms of previous land use, afforestation technique and tree species choice, followed by a multicriteria optimization of these levels (Heil et al., 2007).

References

Balvanera P., Pfisterer A.B., Buchmann N., He J-S., Nakashizuka T., Raffaelli D., Schmid B. 2006. Quantifying the evidence for biodiversity effects on ecosystem functioning and services. Ecology letters 9, 1146-1156.

Dewulf, J., Van Langenhove, H., Muys, B., Bruers, S., Bakshi, B.R., Grubb, G.F., Paulus, D.M., Sciubba, E. 2008. Exergy: Its potential and limitations in environmental science and technology. Environmental Science & Technology 42: 2221-2232.

Heil, G.W., Muys, B. & Hansen, K. (Eds.), 2007. Environmental Effects of Afforestation in North-Western Europe: From Field Observations to Decision Support. Springer Publ., Series Plant and Vegetation Vol. 1, 325p.

Hermy, M., Endels, P., Jacquemyn, H., Brys, R. 2007. Conservation of plants. In: Encyclopedia of Life Sciences. John Wiley & Sons Ltd., 8 p.

Maes, W., Heuvelmans, G., Muys, B. (2009) Assessment of land use impact on water-related ecosystem services capturing the integrated terrestrial-aquatic system. Environmental Science &Technology, in press.

Scherer-Lorenzen M, Körner C, Schulze E-D (eds). 2005. Forest diversity and function: temperate and boreal systems. Ecological studies, vol 176. Springer, Berlin.

Wagendorp, T., H. Gulinck, P. Coppin and B. Muys. 2006. Land use impact evaluation in life cycle assessment based on ecosystem thermodynamics. Energy 31: 112-125.

WRI. 2003. Millennium Ecosystem Assessment Ecosystems andHuman Well-Being. A Framework for Assessment. Island press, London.

Keynote

What do the politicians need to know about environmental services for policy making?

Kjersti Bakkebø Fjellstad

MCPFE Liaison Unit Oslo, T: +47 64 94 89 35, kjersti.fjellstad@mcpfe.org

The Ministerial Conference on the Protection of Forests in Europe (MCPFE) is a high-level policy process which involves 46 European countries and the European Community as signatories and around 40 organisations as well as countries from other regions as observers. It is a pan-European platform for dialogue and decision making on forest issues, with the aim to protect and sustainably manage forests. Throughout five ministerial conferences, the MCPFE has defined and further developed the concept of sustainable forest management in Europe.

Since its start in 1990, the MCPFE has always benefited from the involvement of the scientific community. The need for research activities in understanding the complex relationships within and among environmental services from forests is specifically expressed in policy documents. The continuous interaction between scientists and policy makers at all levels is elementary for informed and more effective decision making and for implementation of the political commitments.

Environmental services provided by forests are important issues for the MCPFE. There are several resolutions directly addressing the topic. Biodiversity, carbon sequestration and water are issues which have been specifically addressed by the MCPFE at several occasions.

The 5th MCPFE "Forests for Quality of Life" was held on 5–7 November 2007 in Warsaw, Poland. At the Conference, ministers and high-level representatives endorsed the Warsaw Declaration and two Warsaw Resolutions: "Forests, Wood and Energy" and "Forests and Water". Both of the resolutions and the declaration are addressing environmental services provided by forests. In November 2008, the MCPFE adopted the P*an-European Guidelines for Afforestation and Reforestation, with a special focus on the provisions of the UNFCCC*. The guidelines provide a set of recommendations for implementing economically viable, environmentally sound, socially equitable and culturally acceptable afforestation and reforestation programmes.

The MCPFE criteria and indicators, as well as terms and definitions, form the basis for monitoring sustainable forest management in the pan-European region. The environmental services are directly assessed by criterion 1, measuring carbon stock, criterion 4, measuring biological diversity and protected forests, and criterion 5, measuring protective functions of forests, notably soil and water. More than one-fifth of European forests are managed for securing their protective functions.

As a follow-up of the commitments from the latest ministerial conference in Warsaw, workshops and working groups have been conducted during 2008 and 2009. One of these groups, the *MCPFE open-ended ad-hoc working group on "sustainability criteria" for forest biomass production, including bioenergy,* has concluded that there is a need to further develop and/or update the MCPFE tools to serve as a basis for performance level and verification of sustainable forest management.

A workshop on Forests and Water was held in Antalya, Turkey in May 2009. The participating experts concluded that there is a need to gain more knowledge on how to manage forests for water, considering site-specific conditions. The participants also stressed a need for analyses on benefits and costs for the purposes of payments for ecosystem services.

In Warsaw resolution 1, the ministers recognise the need to increase knowledge on the role of forest ecosystems in long term carbon sequestration as a contribution to mitigate climate change in the context of the post-2012 climate regime.

The importance of environmental services is well appreciated within the MCPFE. But there is still some lack of knowledge on the complex interrelation between forests and the environment, and the interactions between different services. Further, there seems to be a need to enhance communication of research findings to policy makers. The research findings need to be communicated broadly and effectively targeted towards policy making.

How are environmental services affected by increased forest productivity and warmer climate? A modeling study

Jan Weslien[1], Leena Finér[2], Jon A. Jonsson[3,5], Harri Koivusalo[2] Ari Laurén[2], Thomas Ranius[5] and Bjarni D. Sigursson[3]

[1] The Forestry Research Institute of Sweden (Skogforsk), SE 751 83 Uppsala Sweden
[2] Finnish Forest Research Institute, Joensuu Research Unit, P.O. Box 68, FI 80101, Joensuu
[3] Agricultural University of Iceland, Keldnaholt, IS-112 Reykjavik, and Icelandic Forest Research, Mogilsa, IS-116 Reykjavik
[4] SLU, Dept of Ecology, P.O. Box 7077, SE 75007, Uppsala Sweden
[5] Present address: East Iceland Natural History Institute, Myrargotu 10, 740 Neskaupstadur Iceland

Forest productivity is expected to increase in the future due to the use of genetically improved plant material and climate warming. We explored the likely effects of increased forest production and a warmer climate in 15 scenarios (five productivity levels x three climate conditions) on three environmental services: carbon sequestration, water quality and amounts of coarse woody debris (CWD, important for biodiversity). The effects were simulated using a set of ecosystem models incorporating the same climate and management scenarios in a hypothetical managed Boreal forest landscape. We assumed that the age structure in the landscape was balanced and that increased productivity was coupled to a proportional decrease in rotation length, i.e. the interval between clearfellings. Under these assumptions the outputs at the landscape-level scale were briefly as follows. In each simulated climate scenario, increased productivity resulted in increases in amounts aboveground and belowground carbon sequestration, reduced CWD accumulation, but did not have significant effects on dissolved total nitrogen (DTN) loads in runoff water. Thus, increased productivity had both positive and negative effects on the environmental services. In contrast, warmer climate had only negative effects; At every simulated productivity level, a warmer climate led to reduced carbon sequestration belowground, reduced amounts of CWD, and increased DTN contents in runoff water. Reasons for these trends are identified and explained. Since it takes decades for stand structure to change significantly at a landscape level, we recommend further enhancement of management actions that are likely to mitigate the adverse effects of anticipated changes in climate and productivity on water quality and biodiversity.

Session on forest management tools to sequestrate carbon

Effects of afforestation on carbon stocks and fluxes of previously grazed heathlands in Iceland

Brynhildur Bjarnadottir[1] and Bjarni D. Sigurdsson[2]

[1] Icelandic Forest Research, Mogilsa, IS-116 Reykjavik
[2] Agricultural University of Iceland, IS-311 Borgarnes; Corresponding author: brynhildur@skogur.is

Anthropogenic emissions of carbon dioxide (CO_2) and other greenhouse gases and their possible impacts on Earth's climate are recognized as one of the main environmental problems of today. Therefore, the Nordic countries have been strong supporters of the Kyoto protocol and in their sustainable development plan the importance of forest management and afforestation for carbon sequestration was emphasized. Carbon sequestration is an important environmental service that can be affected by afforestation of treeless lands and management of already established forests.

Forests take up large amounts of CO_2 from the atmosphere through photosynthesis, which partly is stored as carbon in aboveground biomass (foliage, branches, stems and ground vegetation) and partly in soils as living and dead organic matter. The CO_2 is returned to the atmosphere through respiration by the living organisms that inhabit the forest or by decomposition of soil organic matter, combustion that takes place during forest fires and removal by harvest.

During the past 15 yr, Siberian larch has been the most planted tree species in Iceland. Currently, the rate of afforestation is ca. 2400 ha yr^{-1}, with Siberian larch (*Larix sibirica*), native mountain birch (*Betula pubescens*) and Sikta spruce (*Picea sitchensis*) being used in similar proportions, accounting for 67% of the total annual afforestation (Gunnarsson, 2006). The use of Siberian larch in forestry in the Nordic countries has been limited (Lyck and Bergstedt, 2004). The Siberian larch is, however, one of the economically and ecologically most important tree species in Russia. The area covered by Siberian larch amounts to nearly 14% of the total area of Russian forests (Lyck and Bergstedt, 2004). It is therefore a key species to study in terms of the global carbon balance.

The aim of present study was to estimate the annual carbon balance of the most common forest types created by afforestation in Iceland. The study was a part of the ICEWOODS project, which had the main aim to investigate biological and environmental changes following afforestation in Iceland. Stock-change methods were used to estimate the carbon balance of the main forest types mentioned above by establishing an age sequences (chronosequences) of 10-60 year old plantations for each type. Special emphasis was put on the most used forest type, Siberian larch, where the results of the stock-change measurements were compared with direct flux measurements made continuously over three years with the eddy covariance method.

The eddy covariance method is a micrometeorological method that allows direct measurements of net ecosystem CO_2 exchange. Prior to the present study, only one study using that method had been conducted in Iceland (Valentini et al. 2000).

References

Gunnarsson, E. 2007. Skógræktarárið 2006 [Annual planting in 2006]. Skógræktarritið (Icelandic Forestry) 2007(2): 104-107 (In Icelndic).

Lyck, C., and Bergstedt, A. 2004. Use and Availability of Larch wood in Northern Europe - a literature review. Unit of Forestry, The Royal Veterinary and Agricultural University, Denmark.

Valentini, R., Matteucci, G., Dolman, A.J., Schulze, E.-D., Rebmann, C., Moors, E.J., Granier, A., Gross, P., Jensen, N.O., Pilegaard, K., Lindroth, A., Grelle, A., Bernhofer, C., Grünwald, T., Aubinet, M., Ceulemans, R., Kowalski, A.S., Vesala, T., Rannik, Ü., Berbigier, P., Loustau, D., Guðmundsson, J., Thorgeirsson, H., Ibrom, A., Morgenstern, K., Clement, R., Moncrieff, J., Montagnani, L., Minerbi, S., and Jarvis, P.G. 2000. Respiration as the main determinant of carbon balance in European forests. Nature 404(20 April): 861-865.

Effective carbon management of forests requires recognition of major pools and timelines

Christopher Dean[1] and G.W. Wardell-Johnson[1]

[1] Dept of Environmental and Aquatic Sciences, Curtin University of Technology, Perth, Western Australia, christopher.dean@curtin.edu.au, g.wardell-johnson@curtin.edu.au

Wood products are commonly recognised as a major greenhouse-gas mitigation option achievable through forestry. However the wood products for some wet-temperate forests constitute only a minor pool, e.g. for *Eucalyptus regnans* dominated forests (a major wet sclerophyll species) (Dean and Roxburgh, 2006) and for an entire forest estate of 1.5 Mha (MBAC, 2007)—only ~4% of the total carbon stock. So where should we focus our management for forest carbon? We illustrate, through experiment, review and modelling, the significant options and hurdles in assessing, recognising and managing the larger carbon pools and fluxes.

Many recent measurements on mature stands in semi-arid, temperate and tropical regions have shown them to be an active carbon sink (e.g. Lewis et al., 2009; Luo et al., 2007). However, some of these measurements have not accounted for the hydrological flux of carbon. Furthermore some ongoing sequestration is due to CO_2 fertilization accompanying climate change. However, this latter effect is less influential in water-limited systems, which will become more widespread with increased water stress accompanying climate change.

Soil carbon is a neglected pool in forest and rangeland management—it is infrequently included in government assessments and policy. Soil carbon levels take ~2,000 yrs to stabilise following a major change in biomass. Such timelines are not included in current policies on carbon (although they are in models, such as Century, FullCAM and CAR4D). The trend in soil carbon with ongoing climate change in Australia (for the medium scenario, ECHAM5/MPI-OM) is that ~25% of the extant soil carbon will be emitted by 2100. Thus sequestration measurements, and forecasts, must be viewed against a background of increasing emissions, induced by climate change itself. Other likely influences (such as changed burning patterns, owing to prescribed burns, arson and population increase) must also be considered.

Reforestation of the previously forested rangelands represents the largest, most achievable offset of ongoing emissions in Australia (~7(±3) $Mt\text{-}C.yr^{-1}$). Harvesting effects must be assessed in production forests: for wet-temperate forests in southeast Australia the initial emission of carbon with the clearfell, burn and sow prescription is up to 30% of the total stock (before forest regeneration); and the longterm emission is between 30 and 60%, depending on a variety of factors including the fire history (acting through the soil carbon legacy) and harvesting cycle length. The optimum harvest cycle length is much lower for a maximum wood-products carbon pool than for the total carbon stock.

Carbon-trade accreditations require 95% confidence limits on baselines and projections. Consequently more data is needed for allometrics and dynamics of mature vegetation, and on soil carbon—to recognise large pool stocks and fluxes. Even within areas of similar site index, significant differences in carbon stocks arise from variables such as fire history, and the dynamics of self thinning and senescence. In addition belowground carbon is highly indeterminate (i.e. root:shoot ratios; and the legacy soil carbon from fires, land-use history and spatial heterogeneity biomass) but it can constitute half the standing stock. Apart from destructive sampling and LiDAR, taper equations are the most representative method for assessing and modelling aboveground woody biomass. For mature vegetation these require more detail on buttress shape, hollows, and the effect of ground slope on taper. Routine mapping is required to monitor carbon fluxes at the regional level.

Carbon management of forest lands, must: (1.) recognise the carbon content and history of zones of higher biomass, (2.) rehabilitate or reforest degraded land, (3.) categorise emissions from land-management effects as carbon pollution, (4.) centralise the organisation of land condition- and carbon-management, (5.) give incentives to land holders and managers to reduce carbon emissions and increase carbon sequestration, (6.) adjust policies to cater for long-term dynamics, and (7.) empower society to become more "carbon-literate".

References

C Dean & SH Roxburgh (2006) Improving Visualisation of Mature, High-Carbon-Sequestering Forests. Forest Biometry, Modelling and Information Sciences 2006(1): 48-69. [Online Journal] Available at: http://www.fbmis.info/ [Cited 25 Mar 2009]

Lewis, S.L., Lopez-Gonzalez, G., Sonké, B., Affum-Bafoe, K., Baker, T.R., Ojo, L.O. et al., (2009) Increasing carbon storage in intact African tropical forests. Nature 457: 1003-1006.

Luo, H., Oechel, W.C., Hastings, S.J., Zulueta, R., Qian, Y. and Kwon, H. (2007) Mature semiarid chaparral ecosystems can be a significant sink for atmospheric carbon dioxide. Global Change Biology 13: 386-396.

MBAC (2007) Forestry Tasmania's Carbon Sequestration Position. MBAC Consulting Group Pty Ltd., Victoria Australia. 43 p. Available at: www.forestrytas.com.au/assets/0000/0369/ CARBON_200712_MBAC_report_on_FT_carbon_stocks.pdf [Cited 25 Mar 2009]

From carbon sinks to carbon sources – insect outbreaks and altering forest functions

Anne le Mellec[1*], Timo Krummel[2], Ignacy Korczynski[3], Annett Reinhardt[2], Daniel Weber[1], Jerzey Karg[4], Jolanta Slowik[5], Holger Vogt- Altena[6], Stefan Erasmi[6], Carsten Thies[7] and Gerhard Gerold[2]

[1] LOEWE - Biodiversität und Klima Forschungszentrum (BiK-F, Center for Biodiversity and Climate Research), Georg-Voigt-Straße 16, Senckenberganlage 25, D-60325 Frankfurt/Main, Germany
[2] University of Göttingen, Landscape Ecology Section, Goldschmidtstr. 5 D-37077 Göttingen, Germany
[3] Poznan University of Life Sciences, Department of Forest Entomology, Ul. Wojska Polskiego 71c, PL-60-637 Poznan, Poland
[4] Research Centre for Agricultural and Forest Environment, Polish Academy of Sciences, Field Station *Turew,* Szkolna 4, Pl-4-000 Kocian, Poland
[5] University of Göttingen, Centre for Nature Conservation (CNC), von Sieboldstrasse 2, D-7075 Göttingen, Germany
[6] University of Göttingen , Section Cartography, GIS and Remote Sensing Goldschmidtstr. 5, D-37077 Göttingen, Germany
[7] Natural Resources Research Laboratory, Bremer Str. 15, D-29308 Winsen, Germany
* Contact: E-mail: amellec@gwdg.de

The eastern parts of Germany as well as Poland are dominated by a subcontinental/continental climate with annual precipitation rates ranging from 430 to 640 mm. For these areas summer temperatures are predicted to increase between 1.5 to 2 C° accompanied by a decline of summer precipitation of 10% to 20% over the next 50 years (Gerstengarbe et al, 2003). Forests in these areas are dominated by Scots Pine *Pinus sylvestris* (Brandenburg 83 %, Poland 63% of total of forested area), which is attributed to be one of the most adaptive specie in areas with low precipitation, soil water and nutrient availability. Scots Pine also shows high increment rates even under adverse environmental conditions, especially in the above mentioned regions, and thus presents itself as the backbone of the forestry industry. Consequently, vast areas of eastern parts of Germany (Brandenburg) and Poland were afforested with Scots Pine and are presently pure, single age class stands. However, such homogenous stands are characterised by unfavourable factors such as low diversity and an enhanced susceptibility for pest attacks. Pure stands reveal unfavourable conditions for pest antagonists and provide ample food for verminous insects. The assessment report of the IPPC predicts that forest perturbations such as mass outbreaks of insects will increase dramatically. In the course, changes in precipitation and temperature patterns are likely to occur. Limitations of water availability will not only affect the metabolism of plants by lowering the photosynthetic activity and thus biomass and ecosystem production (NEP, NPP), but will also increase the susceptibility of trees for diseases and insects attacks.

As yet few investigations were done to study the consequences of forest disturbances and their importance on biogeochemical functioning in forest ecosystems. We assume that phytophagous insect mediated organic matter inputs under outbreak conditions might enhance the soil decomposition activity resulting in an elevated production of CO_2. From this point of view, insect mass outbreaks might turn forests from carbon sinks into carbon sources due to a limited C storage in woody material and an enhanced soil induced respiration. In order to alleviate the consequences of outbreaks in forest stands and the associated monetary detriments it is indispensable to take preventive measures such as the transformation of existing species-poor forest stands into site-adapted, resilient management units which in turn will also be earmarked by a higher degree of biodiversity. In a collaborative research project, we are analysing these climate change-induced consequences of insect mass outbreaks in pine forests to develop tools for a sustainable forest management. In a collaborative research project, we will analyse these climate change-induced consequences of insect mass outbreaks in pine forests to develop tools for a sustainable forest management.

Keywords: climate change, mass outbreaks, phytophagous insects, biomass production, forest ecosystems

Decomposing tree stumps are long-term carbon pools and nitrogen sinks after harvesting

Marjo Palviainen[1], Leena Finér[2], Raija Laiho[1], Ekaterina Shorohova[3], Ekaterina Kapitsa[4] and Ilkka Vanha-Majamaa[3]

[1] University of Helsinki, Department of Forest Ecology P.O. Box 27, FI-00014 Helsinki, Finland
e-mail: Marjo.Palviainen@helsinki.fi, Raija.Laiho@helsinki.fi
[2] Finnish Forest Research Institute, Joensuu Research Unit, P.O. Box 68, FI-80101 Joensuu, Finland
e-mail: Leena.Finer@metla.fi
[3] Finnish Forest Research Institute, Vantaa Research Unit, P.O. Box 18, FI-01301 Vantaa, Finland
e-mail: shorohova@ES13334.spb.edu, Ilkka.Vanha-majamaa@metla.fi
[4] Saint-Petersburg State Forest Academy, 194018 Institutsky street 5, Saint-Petersburg, Russia
e-mail: kapitsa@list.ru

Stumps are the biggest coarse woody debris component, which is normally left to decompose in Fennoscandian forest stands after clear-cutting. Their role in nutrient cycling is, however, poorly known. Recently the request for such information has grown since the use of stumps as energy wood increases rapidly. We studied C and N dynamics in Scots pine (*Pinus sylvestris* L.), Norway spruce (*Picea abies* (L.) Karst.), and silver birch (*Betula pendula* Roth.) stumps, which had decomposed for 0, 5, 10, 20, 30 and 40 years after clear-cutting in southern Finland. We found that in 40 years conifer stumps lost 78 % and birch stumps 90 % of their initial C. In contrast, the amount of N in stumps increased during decomposition. After 40 years of decomposition, the amount of N was 1.7 and 2.7 times higher than the initial amount in pine and spruce stumps, respectively. From birch stumps N was released, but not until they had decomposed for 20 years or longer. The increase of N amount in stumps may be due to the translocation of N by fungi from the surrounding soil (Lindahl and Olsson 2004), the fixation of atmospheric N by bacteria living in stumps (Jurgensen et al. 1987), and the immobilization of N from rainwater (Downs et al. 1996). The results indicate that the stumps of the major tree species in Fennoscandian forests are long-term C and, especially, N pools, and they act as N sinks potentially diminishing N leaching into ground water and watercourses after clear-cutting. This suggests that stumps may markedly affect the nutrient status and nutrient cycling of boreal forests, and this should be considered when the ecological effects of removal of stumps for bioenergy production is evaluated .

References

Downs, M., Nadelhoffer, K., Melillo, J.M. & Aber, J.D. 1996. Immobilization of a ^{15}N labelled-nitrate addition by decomposing forest litter. Oecologia 105: 141-150.

Jurgensen, M. F., Larsen, M. J., Graham, R. T., & Harvey, A. E. 1987. Nitrogen fixation in woody residue of northern Rocky Mountain coniferous forests. Can. J. For. Res. 17: 1283-1288.

Lindahl, B. D. & Olsson, S. 2004. Fungal translocation - creating and responding to environmental heterogeneity. Mycologist 18: 79-88.

Session on forest management tools to maintain biodiversity

Keynote

Forest biodiversity, ecosystem services and the role of management

Kris Verheyen

Laboratory of Forestry, Ghent University, Belgium
kris.verheyen@ugent.be

More and more, forest ecosystems are managed according to sustainable development principles to provide a broad range of goods and services. During the last decade, it has been demonstrated that biodiversity is a key factor allowing or limiting the provision of these goods and services. Hence, the loss of biodiversity due to human and environmental factors is potentially threatening the ecosystem functioning and its capacity to provide goods and services. Until now, research on biodiversity-ecosystem functioning relationships was mainly confined to more tractable ecosystems, such as (experimental) grasslands. However, researchers recently started to focus on biodiversity – ecosystem relationships in forests as well using some well designed observational and experimental set-ups. Effects of differences in tree species diversity on ecosystem processes such as primary productivity, nutrient cycling, resistance against abiotic and biotic stress, etc was and still is the main focus of this line of research. In this talk I will, therefore, attempt to synthesize some of the main findings about the relationships between forest (tree) diversity and ecosystem functioning. Furthermore, I will give an outlook to future research on this topic and will end by saying something more about the way forest management can be used to maintain or enhance forest biodiversity and the ecosystem services provided by it.

Effects of afforestation on species richness of flora and fauna in Iceland

Edda S. Oddsdottir[1], Asrun Elmarsdottir[2], Bjarni D. Sigurdsson[3], Bjarni E. Gudleifsson[3], Erling Olafsson[2], Gudridur Gyda Eyjolfsdottir[2], Olafur K. Nielsen[2], Brynja Hrafnkelsdóttir[1], Arne Fjellberg[4], Borgthor Magnusson[2], Gudmundur A. Gudmundsson[2], Gudmundur Halldorsson[5], Kristinn H. Skarphéðinsson[2] and Maria Ingimarsdóttir[2].

[1] Icelandic Forest Research, Mogilsa, IS-116 Reykjavik
[2] Icelandic Institute of Natural History; IS-101 Reykjavik
[3] Agricultural University of Iceland, IS-311 Borgarnes
[4] Entomological Research, Tjöme, Norway
[5] Icelandic Soil Conservation Service, IS-851 Hella, Iceland
Corresponding author: bjarni.sigurdsson@lbhi.is

Recently, there has been increased emphasis on conserving species richness, biodiversity, threatened habitats and ecosystems in the Nordic countries and globally. Therefore it is important to identify what effects different forest management practices have on biodiversity and the functioning of ecosystems.

Establishment of forest cover in an area that has previously been treeless for at least 50 years is termed afforestation. Native trees have been redistributed and non-native trees have been introduced to the Nordic region for thousands of years, but during the past 100-200 years such activities became more common and widespread. Historically, afforestation has been most intensive in the southern (Denmark and South Sweden) and western (West Norway,the Faroes and Iceland) part of Nordic region (Eggertsson et al. 2008). The ecological consequences of such activities have not been fully understood and results are somewhat conflicting (Cannell 1999; Peterken 2001; Elmarsdottir et al. 2008). Furthermore, results also indicate it is the forest management practice that maybe leads to the most fundamental change in ecosystem structure and function.

The present study summarizes the findings of the research project ICEWOODS. The project was conducted in Iceland which has relatively limited native flora and fauna and therefore offers good opportunity to study how afforestation affects species richness of previously treeless areas. The main question answered is how species richness was affected during the first 50-100 years following afforestation. The focus was on a relatively high number of important functional groups in the ecosystem, i.e. all non-vascular and vascular plants, fungal fruitbodies and mycorrhizae, surface and soil invertebrates and birds. This broad approach gives opportunities to study if one or few functional groups can be used to predict the effect on the total species richness of an ecosystem, .This central ecological question is also of paramount importance when effects of other forest management practices are studied. The study included both native (*Betula pubescens*) and non-native tree species (*Larix sibirica, Picea sitchensis, Pinus contorta*) and was conducted in chronosequences for each forest type. Previously grazed heathlands were included for comparison.

References

Cannell, M.G.R. 1999. Environmental impacts of forest monocultures: water use, acidification, wildlife conservation, and carbon storage. New Forests 17: 239-262.

Eggertsson, O., Nygaard, P.M. & Skovsgaard, J.P. 2008. History of afforestation in the Nordic countries. In: Halldórsson, G., Oddsdóttir, E.S. & Sigurdsson, B.D. (eds.) AFFORNORD: Effects of afforestation on ecosystems, landscape and rural development. TemaNord 2008:562. Nordic Council of Ministers, Copenhagen. p. 15-28..

Elmarsdottir, A., Fjellberg, A., Halldorsson, G., Ingimarsdottir, M., Nielsen, O.K., Nygaard, P., Oddsdottir, E.S. & Sigurdsson, B.D. 2008. Effects of afforestation on biodiversity. In: Halldórsson, G., Oddsdóttir, E.S. & Sigurdsson, B.D. (eds.) AFFORNORD: Effects of afforestation on ecosystems, landscape and rural development. TemaNord 2008:562. Nordic Council of Ministers, Copenhagen. p. 37-47.

Peterken, G.F. 2001. Ecological effects of introduced tree species in Britain. Forest Ecology and Management 141: 31-42.

The effect of planted tree species on the diversity of herbaceous vegetation in a reclaimed oil-shale opencast in Estonia

Margus Pensa[1], Helen Karu[2], Aarne Luud[3], Elga Rull[1] and Riina Vaht[4]

[1] University of Tallinn, Institute of Ecology, Pargi 15, 41537 Jõhvi, Estonia;magnus@ecoviro.johvi.ee
[2] University of Tartu, Department of Botany, Lai 40, 51005 Tartu, Estonia; helen7@ut.ee
[3] Estonian University of Life Sciences, Department of Environmental Protection, Kreutzwaldi 64, 51014 Tartu, Estonia; aarne.luut@emu.ee
[4] University of Tartu, Department of Geography, Vanemuise 46, 51014 Tartu, Estonia; riina.vaht@ut.ee

Mining activities, especially mining in opencasts, degrade landscape to the heaps of a barren spoil where primary succession follows denudation. As the recovery of vegetation by means of primary succession is a slow process, reclamation projects are frequently started to establish monospecific plantations on mine spoil. Plantations may produce high quality timber products and may positively influence the economic status as well as the environment of degraded sites in the short period, but their long-term effects on biological diversity have only recently been studied. In this study we tested the hypothesis that planted tree species act as ecosystem engineers in reclaimed opencasts by creating different habitats, so that the herbaceous vegetation diverges at the later stages of succession according to the dominant tree species.

The research was conducted in the Narva oil shale opencast area, in the northeastern part of Estonia (59°18’N, 27°45’E). Narva mining field (62.2 km^2) was previously covered by moist mixed-forests in the northern part and by peatlands in the southern part. After the end of mining activities, the area is reclaimed for forestry purposes by planting Scots pine (Pinus sylvestris L.) seedlings on the spoil. As the result, Scots pine covers nearly 85–90% of the reclaimed area. The vegetation was sampled on 80 circular plots of 100 m^2 in July 2002–2005. The plots represented eight site types (10 plots per site type), which were distinguished according to the species composition and developmental stage of tree layer. Pioneer stage on recently (about five years ago) leveled mine spoil was characterized by the absence of tree layer (i). Three series of planted Scots pine stands that were 10, 20, and 30 years old, respectively (ii–iv). Nearly 30-year-old planted stands dominated by larch (Larix sibirica Ledeb. and Larix decidua Mill.) (v), silver birch (Betula pendula Roth) (vi), and alder (Alnus glutinosa (L.) Gaertn. and Alnus incana (L.) Moench.) (vii). Spontaneously developed stands in an area where the mine spoil had been left unplanted (natural stands) (viii). Because Scots pine was a dominating tree species in the area, all other 30-years-old sites occupied a relatively small area and were surrounded by Scots pine stands. Thus, the Scots pine chronosequence (i.e., site types i–iv) represents the successional trajectory that is typical to the study area. We assumed that the pioneer stage represented the initial sere for all sites whereas possible differences in herbaceous vegetation among older stages (i.e., the divergence from the Scots pine trajectory) were caused by the engineering effect of planted tree species.

Our results confirm that tree species create recruitment limitations on the development of herbaceous vegetation in the new forest sites. This is a significant addition to the studies that address the impact of dispersal and recruitment limitations on the vegetation of recent forests. The highest number of herbaceous species was recorded in naturally developed mixed stands. As compared with other site types, the herb layers of pioneer stage (the vegetation in recently reclaimed sites) and alder stands were the most different. In the terms of CSR strategy types, alder stands tended to enhance the growth of competitors, while stress-tolerant species were more abundant in pine stands.Although vegetation may be rather similar beneath different tree species, broadleaved trees tend to enhance the growth of herbaceous species, while conifers suppress it. As different herbaceous species are favoured by different tree species, the planting with various tree species ensures higher regional species richness than planting of just broadleaved or coniferous trees. Our results prove that the selection of tree species for land reclamation is a crucial decision that determines the diversity and successional trajectory of the vegetation in new forests.

Functional forests: Delivering sustainable multifunctional forest management at the landscape scale

M.A.Smith[1] and C. Edwards[1]

[1] Forest Research Northern Research Station Bush Estate Midlothian EH25 9SY
mike.smith@forestry.gsi.gov.uk

Glen Affric, a recently designated National Nature Reserve in the north-west highlands of Scotland is the largest area (224,000ha) of Caledonian forest owned by the Forestry Commission. In the period between 1945 and 1980's large areas of non-native tree species were planted in the forest. The current aims of management are to promote natural processes and foster the return to more natural woodland. The challenge is to convey a long-term vision of the desired forest structure for the next 150 – 200 years and to identify silvicultural options that achieve these aims while maintaining biodiversity and landscape values. This requires an evaluation of options and the creation of a plan for the next 20 - 30 years, informed by predictions of changes in key indicators of sustainability.

To meet this challenge the concept of the functional forest was adopted, which is concerned with the development of sustainable multifunctional woodlands at the landscape scale consisting of a functionally connected network of forest habitats that can contribute to the economic, environmental and social functions (ecosystem services) to society. This aspect of sustainable forest management, delivered through the development of forest design plans, is to attempt to organise the stages of woodland stands such that the forest ecosystem function is maintained, and that the functional connectivity of the components remains high at the landscape scale. This paper will show how a suite of GIS supported models coupled with forest stand dynamics has been applied to a forest planning process in Glen Affric.

Forest Habitat Networks (FHNs) are the building blocks of the functional forest and have been defined in GIS using the Biological and Environmental Evaluation Tools for Landscape Ecology (BEETLE Watts et al 2005). This undertakes a spatial analysis to determine if the permeability of the landcover will allow species to disperse from one preferred habitat patch to another. We used the Ecological Site Classification Decision Support System (ESC-DSS) (Pyatt et al 2001).to determine if within any given FHN all potential native woodland biotypes were proportionally represented in forest units or stands.

An understanding of the structural phases for a stand, and the balance of phases within a landscape, provides information on the current stage of development, and the likely direction of change. This provides the context to consider how the stand will develop over time as a result of various management operations. Circular sample plots were used to collect data from a sample of 'canopy structure polygons' on tree species composition, size and condition, and a sub-sample of trees aged from increment cores. These data were used to allocate plots to one of six stand structure phases (Non Wooded Habitat, Stand Initiation, Stem Exclusion, Understorey Reinitiation, Old Growth, and Delayed Reinitiation), based on an adaptation of the four stand phases used by Oliver and Larson (1996) to describe stand dynamics and succession in boreal forests. The proportion of each stand structural phase was compared with a theoretical distribution expected if the stand was subject to a 150-year stand replacing disturbance event. Management prescriptions were generated for each stand structure phase to develop stands at one of three successional rates (natural rate of change, increased rate of change, or enhanced change). Predictions on the adjustment in structural phases over a 50-year period were based on these successional changes.

We demonstrated that management prescriptions, i.e. silvicultural, can be provided that will help move the stand or woodland towards a specific goal, e.g. the creation of habitats, enhancement of biodiversity or provision of a commercial crop. This approach gives forest managers the ability to implement a landscape scale approach to habitat and forest management using ecologically suited species to sites. The lessons from this case study are now being used within the Northern Periphery 'Nortosia' project to develop a landscape approach to sustainability impact analysis of management alternatives in other forest types in Scotland.

References

Pyatt, D.G., Ray, D., Fletcher, J., (2001). An Ecological Site Classification for Forestry in Great Britain, Bulletin 124, Forestry Commission, Edinburgh.

Oliver, C. D., and Larson, B. C. (1996). Forest Stand Dynamics. McGraw-Hill, Inc., New York.

Watts, K., Humphrey, J.W., Griffiths, M., Quine, C.P. and Ray, D. 2005. Evaluating biodiversity in fragmented forest landscapes: principles. Forestry Commission Information Note. 73. Forestry Commission, Edinburgh.

Plant and insect diversity in young forests – The role of thinning, browsing and productivity

Olof Widenfalk

Skogforsk, Forestry research institute of Sweden, Uppsala Science Park, SE-751 83 Uppsala, Sweden
olof.widenfalk@skogforsk.se

Young forests are common in the landscape of production forests. Therefore, along with set-asides and reserves, much of the effort to preserve diversity will be undertaken in young forests. However, apart from the wood living fauna, in for example snags, we know little about the diversity of young forests. The most important type of management shaping the structures of young boreal forests is thinning. Browsing by moose is another important source of disturbance, known to interact with productivity to shape vegetation structure and species composition. Because of the effects on vegetation, indirect effects on herbivorous insects are likely, but still rather poorly known. This study investigates the effects of thinning and productivity on plant diversity in young forests by using survey data from the northern parts of Sweden. The study also investigates the effect of browsing on flower density as well as diversity and abundance of flower visiting insects, by experimentally simulating different moose densities along a productivity gradient. The results show that there is a higher species richness of plants in thinned young forests as well as forests with more gaps. It is also shown that both flower densities as well insect abundance is affected by both productivity and browsing. The two most common orders of insects - Diptera and Hymenoptera - however, show different responses. The results also show that interactions between productivity, thinning and browsing are important in affecting the abundance and diversity of both plants and flower visiting insects. It is concluded that management of young forests, in form of for example different thinning regimes, could be a further step to increase the diversity of young production forests.

Session on combining the management of forests and waters

Keynote

Combining the management of forests and waters

Kevin Bishop

Department of Aquatic Sciences and Assessment, Swedish University of Agricultural Sciences,
Box 7050, 750 07 Uppsala, Sweden
kevin.bishop@vatten.slu.se

Forest waters are related to a number of important ecosystem services such drinking water supply, ecological flows, and a quality that sustains aquatic biodiversity. Including these water-related services in forest management plans might seem self-evident, especially with the implementation of the European Water Framework Directive. But how well is this functioning in practice?

This talk will examine the challenges of first defining the aquatic ecosystem services, and then trying to balance these services against other values. These issues will be exemplified in a series of case studies.

1. A cost-benefit analysis of the value of liming forest soils in Sweden
2. The bioaccumulation of mercury in fish linked to harvest of nemo-boreal forests
3. The leaching of inorganic nitrogen after forest harvest in Scandinavia
4. Deforestation influence on flow extremes in the Blue Nile Basin, Africa
5. The acidifying influence of increased biomass harvest to reduce the use of fossil fuels
6. Definition of reference values for forest waters when assessing ecological status for the EU Water Framework Directive

The talk will include a presentation of the "Water and Soils" component of the eight-year, "Future Forests" programme (www.futureforests.se) that has just been launched in Sweden in order to search for better strategies to achieve 'more of everything' with regard to forest ecosystem services.

A model for valuing and allocating forest sites that provide hydrological services (roles)

Špela Planinšek, Andreja Ferreira and Anže Japelj

Address: Slovenian Forestry Institute, Vecna pot 2, SI-1000 Ljubljana, Slovenia
E-mail address: spela.planinsek@gozdis.si, andreja.ferreira@gozdis.si,anze.japelj@gozdis.si

Sustainable forest development, close-to-nature approach to forest management and multiple- use of forestlands are the three main maxims of Slovenia's forestry practice. While the first two have been implementing for several decades, the lastly mentioned is rather new and it has been operationally introduced through spatial forest planning. In concert with Forest Act (1993,2007), Slovenia's forest practice promotes 17 types of forest functions and roles (syn. functions, goods, services). One of them is also a hydrological role that is being understood in two ways: a) as a forestland directly protecting any kind of water source, and b) as a forestland, acting like a natural water filter, water reservoir, thus a factor, significantly affecting the water runoff.

The aim of this contribution is to present a model that was developed for valuing and allocating the both effects of the hydrological role and for determining the required silvicultural measures. The model was tested in the river Draga basin. That 1786 hectares large area belongs to the Alpine region and it is characterized by a high proportion of forestland (83%) and rather low proportions of other land uses such as mountain grasslands (7%), dwarf pines (4%) and barren rocks.

The development of the decision support GIS model (see: http://petelin.gozdis.si/prosti_dok/ forest_water_eng.pdf) required first to determine the demands for forest hydrological role and the capacity of forest sites for providing that role (Frehner et al., 2005, Wahl et al., 2005). While the demands were obtained by GIS cross-sectional analysis of external ecological factors such as terrain slope and soil types distinguished by their erodibility and water permeability, the capacity of forest sites was derived by cross-sectional analysis of internal forest stand factors such as stand structure, stand density and the degree of stand naturalness. The five mentioned layers were afterwards merged in specific order. The processed/joint map represented a good basis for determining most suitable silvicultural actions.

An advantage of the model is that it takes account of the natural conditions and it assists in shaping and directing silvicultural actions to such areas where they are most needed (16 % of forestlands). In turn, because the resulting model (joint map) is built-upon all the basic layers, it can be validated and changed by determining the key elements of internal forest stand factors after a particular action is taken. Moreover, for a side-result of the model is also the list of necessary silvicultural actions, they can be applied to every combination of external and internal factors. For instance: in the Draga valley, dense spruce monocultures, grown on fir-beech sites and steep slopes, are somehow questionable, although they also provide hydrological effects. By identifying such stands, hydrological effects can be significantly improved by regulating their tree-species compositions and by keeping the vegetation cover on erodable lands.

References

Forest Act = Zakon o gozdovih (Ur.l.RS 30/1993,110/2007)

Frehner, M., Wasser, B., Schwitter, R. 2005. Nachhaltigkeit und Erfolgskontrolle im Schutzwald. Wegleitung für Pflegemassnahmen in Wäldern mit Schutzfunktion. Bundesamt für Umwelt, Wald und Landschaft (BUWAL), Bern.

Wahl, N. A., Wöllecke, B., Bens, O., Hüttl, R. F. 2005. Can forest transformation help reducing floods in forested watersheds? Certain aspects on soil hydraulics and organic matter properties. Physics and Chemistry of the Earth, Parts A/B/C 30. p. 611–621.

Fighting water scarcity to maintain forest environmental services - perspective of lowland floodplain forests in south eastern Europe

Ivan Pilaš

Department of Ecology and Silviculture, Forest Research Institute Jastrebarsko
ivanp@sumins.hr

The development of various forest environmental services in Europe are closely related to water status of forests under the future progression of climate change across the regional gradient. Current scenarios (IPPC, SILVISTRAT) predict a shifting of climate variables towards more beneficiary conditions for forests in Northern Europe and increasing droughts and water scarcity in the South-East. The trends of the forest condition in Europe (ICP Forests 2008 report) confirm that the most damaged European tree species are common and sessile oaks with an average crown damage status of 35%. The strong increasing trend is evident in Mediterranean tree species as Holm oak and maritime pine and a decreasing trend can be recognized for Norwegian spruce and common pine which correspondends with current climate change scenarios. Climate trends in Croatia, situated on the junction of Mediterranean and south-east Europe, predict an increase of summer temperatures, a decrease of precipitation during spring-autumn seasons until 2070 (UNDP 2009) and a decrease of annual river discharge (PESETA study). Due to the spreading across three climate zones (Mediterranean, mountainous and continental), the development of various environmental conditions contributed to the presence of various forest types with extensive biodiversity. By far the most valuable forest resources present hardwood oak forests which cover an area of more than 200,000 ha and are situated in the continental lowland part of the country. During the past decade there was strong evidence of hydrologic changes in terms of runaway decline of groundwater tables followed by immense forest decline. The objective of this presentation is to evaluate the regional impact of climate change (warming, dry spells) on the hydrology of lowland forests in Croatia, predominantly trends and the seasonality of groundwater tables as a most disturbed hydrologic component. For the purpose of observations of the impacts, the regional long-term groundwater monitoring system of piezometric network (FORHIS) proves unavoidable. Alongside performing research activities nowadays, the possibilities of drought impact reduction through water table management needs to be evaluated. At the landscape level, these measures comprise temporal preservation of winter precipitation to secure more favourable soil water status during the first part of the growing season i.e. the amount of winter precipitation is not subject to changes according to the regional climate scenarios or even comprise growing trends opposite to the precipitation trends in other seasons. Consequently there are various possibilities of constraints on the surface runnoff during the winter season using the lowland microtopography; construction of forest roads to create depression storages, closing drainage ditches and the re-watering of old natural dry watercourses to stop exfiltration (flow out of the soil).

Forests, forestry and water - and their relations - in Finland

Hannu Mannerkoski

Faculty of Forest Sciences, University of Joensuu
hannu.mannerkoski@joensuu.fi

In continental Finland we have 304 100 km^2 land and 34 000 km^2 inland water surfaces. The land area can be divided into forestry land (263 100 km^2, 86,5 % of total land area) and other land areas (41 000 km^2) including agricultural lands, urban areas, roads and power lines. Forestry land includes all areas which at least could be used for forestry or are connected to forestry. It will usually be divided into productive forest land (mean annual increment > 1 m^3/ha, 201 500 km^2), poorly productive forest land (mean annual increment 0.1 m^3/ha - 1 m^3/ha, 27 700 km^2), waste land (mean annual increment < 0.1 m^3/ha, 32 100 km^2) and other forestry land (forest roads, landings, stock areas etc., 1 800 km^2). Forestry land covers mineral soil areas (171 700 km^2) and all peatlands (89 400 km^2). The area of true Histosols is about 66 300 km^2 (peat layer thickness > 40 cm). Originally the peatland area using the biological definition has been about 104 000 km^2 from which about 54 500 km^2 (includes also paludified forest soils) have been drained for forestry. The drainage of peatlands and paludified forest soils has been the most effective activity in forestry concerning the hydrology of forest areas and inland waters in Finland. Mainly it has been done during 40 years starting from 1954, although already during 1930's about 10 % of the total drained area. At the moment the drainage of natural peatlands for forestry has already stopped, but the maintenance of ditch systems on drained areas continues covering about. Normal forestry operations are directed mainly to the productive forest land excluding areas outside forestry like conservation areas (15 700 km^2, 42800 km^2 from total forestry land). Annually final cuttings cover about 1500 to 2000 km^2 which is about 1 % of productive forest land area. After final cutting reforestation will be made including almost always site preparation. Maintenance ditching has been done annually on about 700 to 800 km^2 areas and forest fertilization areas are only some tens of square kilometers. All these operations will have some hydrological effects, too.

First the research concentrated into the effects of forest drainage on water relations in forest and especially into the response of forest trees and other vegetation to more favourable soil moisture conditions. During 1960's public opinion started to worry about the water quality of rivers and lakes which were in connection of drained peatlands, and so the research of the effects of drainage on the amount and quality of discharge water started. At the same time also forest fertilization increased quite much and was thought to lead to eutrophication of water bodies. At the beginning forestry research found the amounts of nutrients leached so small that they did not have any remarkable effect on the sites studied but little by little researchers and also practical foresters understood that these small quantities were huge compared to natural leaching and were so very harmful for water quality. This led to the increasing use of water protective measures in forest drainage works, new ditching, maintenance ditching and site preparation ditching combined to reforestation, during 1980's. For forest fertilization shelterbelts against waters were specified and the use of slow-soluble fertilizers was recommended. All normal cutting operations also have some effects on discharge water quality. The effect has been stated with many studies but it has varied very much according to cutting type, site conditions and water protective measures used (Finér et al. 2005).

Nowadays the main load from forestry comes from final cuttings with site preparation and from maintenance ditching. In Finnish guides for forestry these effects have considered quite well and the planning of forest management tries to avoid harmful effects with many ways. The guidelines have been modified according to the research results. During the last 30 years the estimated annual load of forestry has decreased substantially, that of nitrogen into one half and that of phosphorus into one third. At the moment nitrogen load of forestry is about 5 % and that of phosphorus about 8 % of the total load caused by man.

References

Finér, L, Mannerkoski, H., Piirainen, S., Laurén, A., Koivusalo, H., Kokkonen, T. & Penttinen, S. 2005. Nutrient fluxes in managed boreal forests. In: Jalkanen, A. & Nygren, P. (eds.). Sustainable use of renewable natural resources — from principles to practices. University of Helsinki Departmentof Forest Ecology Publications 34: 123 – 133.

Afforestation of former arable land at Vestskoven, Denmark. Sequestration of carbon in soil and biomass, leaching of nitrate and ground flora composition

Karin Hansen, Lars Vesterdal, Per Gundersen and Torben Riis-Nielsen

University of Copenhagen, Forest and Landscape Denmark, Hørsholm Kongevej 11, DK-2970 Hørsholm, Denmark, Phone: +45 35 33 16 82, fax: +45 35 33 15 17, E-mail:kiha@life.ku.dk

Intensified management of farmland has caused modern arable soils to be N saturated and carry large pools of nitrogen. The risk of nitrate leaching may therefore be especially high on afforested arable land. Land-use changes from intensive agriculture to forestry will affect the ground flora composition. It is expected that the development towards a varied ground flora typical to forests will take long in afforested cropland. However, little is known about the dispersal and establishment of forest plants on former arable land. Little is also known about the carbon sequestration and in particular the relative contribution of soils to total ecosystem C sequestration following afforestation of former arable land. We here address the contribution of afforestation to the three environmental services C sequestration, groundwater protection and habitat for forest-related ground flora.

In this study changes in leaching of nitrate, in soil and biomass C stocks, and in vegetational characteristics and spread of species in the new forests were analysed after afforestation with oak (*Quercus robur* L.) and Norway spruce (*Picea abies* (L.) Karst.) on a nutrient-rich agricultural land at Vestskoven in Denmark. Afforestation effects were studied in each tree species using chronosequences of stands (1-30 years old). A ~200-year-old mixed deciduous plantation provided information on long-term changes.

Weeds were mechanically controlled during the first years after afforestation, which caused the nitrate concentration to be 15-20 mg/l. After ceased mechanical disturbance the concentrations of nitrate dropped to zero within a year. The nitrate concentrations were low or near zero in the young stands (3-20 years) while the concentrations increased to 25-50 mg/l in some stands of 20-30 years. In the older stands (>20 yrs) nitrate leaching below the root zone was up to 12 kgN/ha/yr and positively related to the N input from deposition.

Forest floors sequestered more C in spruce stands than in oak stands, but there were no differences between the two tree species in C concentration and storage of the mineral soil after 30 years. Carbon concentration and storage increased in the upper 5 cm of the mineral soil but decreased in the 5-15 cm and 15-25 cm soil layers with increasing stand age. The total soil C store remained unchanged over 30 years, but there was more soil C in the ~200-year-old plantation. The growing biomass of trees contributed most to C sequestration along the chronosequence.

The cover of light-demanding ground flora species decreased after canopy closure as a result of a darker environment and a suitable habitat for forest species was created. The percentage of coverage was smaller in the much darker Norway spruce stands. A Floristic Forest Index (FFI) based on the habitat descriptions in the Danish Flora was used to characterise the development in the floristic composition The FFI typically reach values of 2.5-3 in old natural forests (>200 years). At Vestskoven, the FFI was around 0.4 just after afforestation and approximately 1 after 30 years. There was no clear difference between the rate of dispersal of forest ground flora in the new oak and Norway spruce forests. The typical forest species found were well adapted to long distance dispersal. The cover of ground flora differed strongly between the dense spruce stands and the more open oak stands after 30 years.

Final session to conclude and give direction for the future

Keynote

Economic considerations in forest management to provide environmental services in the future

Jette Bredahl Jacobsen and Bo Jellesmark Thorsen

Forest & Landscape, University of Copenhagen, Rolighedsvej 23, 1958 Frederiksberg C., Denmark
E-mail: jbj@life.ku.dk, Phone, +45 3533 1746

Environmental valuation studies can be used to show the large socio-economic value that the provision of environmental services from forest has. The presentation reviews some of these studies from Denmark, with focus on biodiversity, water and carbon sequestration. On that basis it is seen that the socio-economic value often exceed the cost of provision several fold. Nevertheless, the provision is often minor. In order to be able to increase the provision of environmental services we need to understand the reasoning of the resource owners, and the possible conflicts between providers and users. This is done by a characterisation according to the degree of subtractability and excludability in the environmental service, i.e., whether the use of one individual limits the use for other people and whether it is possible to exclude some people from the use of the resource. The characterisation is used for an identification of what the (economically) limiting factors are for their provision and consequently possible paths for increasing the provision. The empirical basis is environmental services from forests in Denmark.

Poster session

The role of tropical and temperate forest on the global carbon-environmental services

Cahyono Agus

Faculty of Forestry, UGM, Yogyakarta, Indonesia
acahyono@ugm.ac.id, cahyonoagus@gadjahmada.edu

Introduction

Forest degradation is one of the main environmental issues in global ecosystems because it worsens environmental functions of forests; protection of soil and water resources, conservation of biological diversity, support of agricultural productivity and sustainability, carbon sequestration and mitigation of global warming, combating of resource degradation, provision of shade, amenity and recreation, and protection of coastal areas and fisheries. In 1980, the forest area decrease amounted to 7.5 million ha of closed forest and 3.9 million ha of open forest (Pancel, 1993). Rate of degradation is approximately 1.6 million ha yr^{-1}, while rate of rehabilitation is only approximately 500,000 ha yr^{-1} (Baplan, 2000). The demand for closed to nature-intensive silviculture (CtNIS) technology will increase with the increasing global interest in rehabilitating degraded forests in many countries, including Indonesia. Intensive silviculture will become a promising choice for creating productive and sustained forests (Freezailah, 1998).

Material and Method

Carbon budget in short rotation plantation tropical forest of Yemane in tropical region (Kalimantan, Indonesia) and temperate (Chiba, Japan) forest ecosystem were studied to clarify the role of carbon cycles and their dynamics in forestland ecosystem to the global environmental services through carbon change.

Results and Discussion

The growth of short rotation plantation of yemane was very rapid in tropical region. The MAI was significantly different and depended on site class. The average MAI of yemane reached its maximum at 6 years at approximately 15 m^3 ha^{-1} yr^{-1} on the poor site, 20 m^3 ha^{-1} yr^{-1} on the moderate site and 33 m^3 ha^{-1} yr^{-1} on the good site. These results were similar to those reported by Soerianegara and Lemmens (1992) that MAI of yemane was 20 to 25 m^3 ha^{-1} yr^{-1} under favorable conditions and even could reach over 30 to 38 m^3 ha^{-1} yr^{-1} on very good sites with intensive forest management. In general, MAI of at least 10 m^3 ha^{-1} yr^{-1} is the criterion for fast growth. The MAI in tropical regions was higher than that of temperate regions. Agus (1995) reported that MAI of evergreen broad-leaf forest on good sites in temperate regions varied from 5 to 9 m^3 ha^{-1} yr^{-1}.

The litterfall of yemane plantations was distributed almost evenly throughout all months during the year, although yemane was categorized as a non-evergreen tree. These phenomenon was caused by the evenly high rainfall and temperature throughout the year in wet tropical rain forest regions. Annual litterfall was 8 to 9 Mg ha^{-1} yr^{-1} in the moderate site and 12 Mg ha^{-1} yr^{-1} in the good site regardless of stand age. The rate of nutrient cycling in yemane tree biomass in tropical regions were greater than their availability in soil and if compare to that in temperate regions. Therefore, the contribution to nutrient loss of harvesting is higher than in temperate regions.

Net primary productivity of Tropical forest ecosystem was 2-5 times compared to those of in temperate region. Carbon sequestration in aboveground and belowground biomass in tropical forestland was about 100-200 Mg/ha, about twice compare to temperate ecosystem. Annual C-sequestrations in tropical forestland were 10-20 Mg/ha/yr, although about 40% were returned to soil ecosystem through litterfall. Carbon sink in tropical mineral soil were 100-130 Mg/ha (Agus et al. 2003). Forest harvesting will remained 40% of dead-biomass as a substrate for decomposition, whereas net primary production during natural succession was 600-750 $gC/m^2/yr$.

Conclusion

Short rotation plantation forest of Yemane could absorb 76 Mg ha^{-1} of C that equivalent to 279 Mg ha^{-1} of CO_2 from atmosphere during the first rotation (6 year-old), but all of them will be lost again through the litterfall (38%) and harvesting (62%). The gross carbon absorption in yemane was about 228-509 Mg ha^{-1} of C that equivalent to 836-1866 Mg ha^{-1} of CO_2 from atmosphere during the first rotation. Tropical forest ecosystems were cycled carbon faster and more dynamic than those of in temperate land, and potentially affected global carbon environmental services.

Keywords: environmental services, global carbon change, productivity, tropical forest

References

Agus, C., Karyanto, O., Kita, S., Haibara, K., Toda, H., Hardiwinoto, S., Supriyo, H., Na'iem, M., Wardana, W., Sipayung, M., Khomsatun and Wijoyo, S. 2004. Sustainable site productivity and nutrient management in a short rotation Gmelina arborea plantation in East Kalimantan, Indonesia. New Forest J. 28: 277-285 (http://www.kluweronline/issn/0169-4286).

Baplan. 2000. Indonesian Forest Statistics. Ministry of Forest & Estate Crop, Republic of Indonesian. 233 pp

Freezailah, B.C.Y. 1998. General lecture by executive director of International Tropical Timber Organization (ITTO) at the University of Gadjah Mada, Yogyakarta on 10 August 1998. 10 pp.

Pancel, L. 1993. Tropical forestry handbook. Springer-Verlag, Berlin. 810 pp.

Soerianegara, S.S. and Lemmens. R.H.M.J. 1993. Plant resources of South-East Asia No 5(1). Timber trees: Major commercial timbers. Prosea, Bogor. 620 pp.

Carbon sequestration and organic matter decomposing microflora in afforested and abandoned arable arenosols

Juraté Aleinikoviené[1], Kestutis Armolaitis[1], Aurelijus Burokas[2], Rolandas Meškys[2] and Rita Meškiené[2]

[1] Ecology Department, Lithuanian Forest Research Institute
Liepu str. 1, Girionys, LT-53101 Kaunas reg., Lithuania
[2] Department of Molecular Microbiology and Biotechnology, Institute of Biochemistry
Mokslininku str. 12, LT-08662 Vilnius, Lithuania
[*] Corresponding Author: Jūratė Aleinikovienė, Ecology Department, Lithuanian Forest Research Institute, Liepu str. 1, Girionys, LT-53101 Kaunas distr., Lithuania, Tel.: +370 37 547247, Fax: +370 37547446, e-mail: j.aleinikoviene@mi.lt

The pools of soil organic carbon (C) in the nutrient-poor Arenosols and soil microflora (bacteria, actinobacteria and micromycetes) were investigated in former arable agricultural land: (1) afforested (before 45 years) by Scots pine (Pinus sylvestris L.), and (2) abandoned over 12 years arable land. Before abandonment the arable land was fertilized and total addition of C with the farmyard manure comprised almost 30 MgC ha^{-1}. However our comparative study showed that the afforestation of Arenosols under not fertilized Scots pine plantations have leaded to a significant sequestration of C, mainly due to the accumulation and the decomposition of forest floor. Meanwhile the abundance (by 3-5 folds) of soil microflora (including lignin decomposer) as well as the taxonomic diversity (according to the cytochrome P450 clones) of prevailed bacteria were higher in more alkaline mineral former ploughing Ap horizon of the abandoned arable land. Along that the C pool in mineral topsoil of Arenosols in the studied biotopes did not differed or even was higher in the Scots pine plantations.

Keywords: Lithuania, arable Arenosols, afforestation and abandonment, organic carbon, microflora abundance and diversity.

Consequences of increased stand structural complexity for floral diversity and the prevalence of insect pests in Sitka spruce (*Picea sitchensis*) stands

N. Barsoum[1], D. Williams, N. Straw, M. Jukes, R. Johnson, A. Kiewitt and R. Ibrahim

[1] Forest Research, Alice Holt Lodge, Farnham, Surrey, GU10 4LH United Kingdom
nadia.barsoum@forestry.gsi.gov.uk

The UK government has made a commitment to promote sustainable forestry, including the maintenance and enhancement of biodiversity and the protection of trees against pests and diseases (MCPFE, 2007; Science & Innovation Strategy for British Forestry, 2005). In this context, silvicultural practices that increase stand structural complexity are increasingly advocated as a means of enhancing forest biodiversity and minimising susceptibility to insect pests. In the UK serious consideration is being given to the wide-spread conversion of even-aged, single-species conifer stands that currently dominate British forestry. However, while structurally 'diversified' (continuous cover) conifer stands are generally considered to be beneficial for biodiversity and to improve forest ecosystem resilience, there is limited published evidence to support these assumptions. The overarching aim of the study is to explore through field survey work the consequences of increased stand structural complexity on forest species diversity in a series of Sitka spruce stands. In 24 study stands located in four forests across Wales, traditionally managed, even-aged Sitka spruce stands are compared to Sitka spruce stands currently managed using continuous cover methods (uniform shelterwood and group selection systems). Specific objectives of this study are to identify relationships between the contrasting forest management practices and 1) the prevalence of insect pests and diversity of insect communities, 2) the abundance and diversity of ectomycorrhizae growing in association with Sitka spruce roots and 3) the diversity of ground vegetation, including bryophytes.

Carbon sequestration measurements of post cropland pine afforestation in Poland

Bogdan H. Chojnicki[1], Marek Urbaniak[1], Alina Danielewska[1], Janusz Olejnik[1] and Pawel Strzeliñski[2]

[1] Department of Agrometeorology; Poznan University of Live Sciences
[2] Department of Forest Management; Poznan University of Life Sciences

The rapid changes of global environmental conditions are mainly determined by human activities IPCC (2007). The processes caused by these acts strongly influence on the global biogeosphere. The terrestrial biosphere has been acted as a net carbon sink over decades. Its sequestrating capability is highly variable year-to-year ranging from 0.3 to 5.0 Pg C yr^{-1}. This amount is significant in comparison to the fossil fuel burning emission, about 7 Pg C yr^{-1}. Uncertainties of estimation of C emissions determined by land-use change are still relatively large. Both global warming effect and greenhouse gases (GHG) concentration in the atmosphere (specially CO_2) become so important nowadays since of those uncertainties. The investigation of trace gases exchange between ecosystem and atmosphere is a key issue.

European forests are generally carbon sink because of intensive biomass growth, therefore it is the largest European natural carbon pool (195 Tg C yr^{-1}). The scientific project where the main goals are estimation of net CO_2 and H_2O exchange between forest ecosystem and atmosphere is result of cooperation between State Forest National Holding and Agrometeorology Department, Poznan University of Life Sciences. The study site is located on post cropland afforestation in Tuczno. The 52-years old Scots pine (*Pinus sylvestris L.*) is main tree species around the measuring site.

There are several techniques used for the estimation of the GHG exchange processes between the ecosystems and the atmosphere. The eddy covariance technique became standard in carbon dioxide exchange measurements in forest conditions. Tuczno measuring tower is equipped with eddy covariance (EC) system and this is the first such a tower in Poland. The EC measurements of net ecosystem exchange (NEE) sensible (Q_S) and latent (Q_L) heat fluxes have been carried out permanently since January 2008. The initial results of measurements allows to consider Tuczno forest as effective carbon sink. The studied ecosystem sequestrated about 30 t·ha^{-1} of CO_2 during vegetation season 2008.

Both terrestrial and airborne laser scanning techniques are applied as supplement of EC measurements since 70% of forest carbon is allocated in above ground biomass. The terrestrial scanning laser technique is developed at Department of Forest Management, Poznan University of Life Sciences and as precise method of standing biomass amount estimation. The scanning measurements are carried out at this site since 2008.

The main goal of this paper is description of structure of Tuczno measuring site and applied techniques. The initial results of measurements will be presented additionally.

Key words: CO_2 fluxes, Scots pine forest, eddy covariance, terrestrial laser scanning

The role and importance of Mediterranean oaks as habitats for indigenous Central European insects

W.H.O.Dorow[1], Uwe Scheibler[2], W. Rohe[3] and A. le Mellec[2]

[1] Research Institute and Natural History Museum Senckenberg, Senckenberganlage 25, Ger-60325 Frankfurt am Main
[2] LOEWE – Biodiversity and Climate Research Centre, BiK-F, Georg-Voigt-Straße 16, Ger-60325 Frankfurt am Main
[3] HAWK FH Hildesheim-Holzminden-Goettingen, University of Applied Sciences and Arts, Fakulty management of Ressources, Buesgenweg 1a, Ger-37077 Goettingen

Between these taxa stable interactions evolved after their immigration to Europe after the last ice age. Passive drift and active dispersion still result in the introduction of new species, which – often unnoticed – disappear or take root – sometimes with dramatic influences on the native biocoenosis. In the course of climate change species will become extinct, others will immigrate and many will change their ranges of distribution.

The mediterranean oak species *Quercus frainetto*, *Quercus ilex* and *Quercus pubescens* probably belong to the set of tree species, which enlarge their range to Central Europe (Q. pubescens is already present in scattered areas in Germany). After planting these species in the project "forest of the future" new interactions with native animal species will be established and species from the original sites will immigrate to Germany. Of main importance for forestry are species which have a strong impact on their host tree. Therefore our research focus lies on Coleoptera and Lepidoptera. For backdated analyses of such taxa a sample base is established at BiK-F. Focal points of zoological research are:

- Which animal species live on oak species in their native habitats?
- Which animal species live on related tree species in Germany?
- Which animal species can establish themselves on the seedlings?

In a collaborative research project, we will investigate trophic interactions between the Mediterranean oak species as new habitat and nutrient source for indigenous insects.

Soil organic matter changes in cut spruce forest (middle taiga, Komi Republic)

A.A. Dymov[1], N.N. Bondarenko[1], E.M. Lapteva[1] and E.Yu. Milanovskii[2]

[1] Soil science department, Institute of Biology Komi SC RAS, Syktyvkar, Russia
[2] Soil science faculty, Moscow State University, Moscow, Russia
E-mail: dymov@ib.komisc.ru, phone: +78212245115

Tree cutting in the European North-East of Russia is a strong anthropogenic factor, responsible not only for altering vegetation cover but also local microclimate, physico-chemical soil properties, as well as soil organic matter composition and properties. Lately, a great deal of attention is paid to identification of soil organic matter change principles during vegetation cover succession. This trend appears because the question on how much tree logging triggers soil organic matter (SOM) change is still open.

In connection to the above said, the investigation aims are to study soil organic matter at different-aged cut areas and revealing SOM change principles during self-reforestation after final cuttings.

The investigation objects are located in middle taiga zone of the Ust-Kylomskii district (Komi Republic). We employed soils of chronosequence of clear-cuts: plot 1 (P1) – soils of control site (native spruce forest); plot 2 (P2) – soils under 6-year-old clear cutting; plot 3(P3) – soils under 38-year-old clear cutting. The investigated plots are formed on loamy soil-forming deposits with similar landscape position, forest type (before cutting) and harvesting method.

Humic substances were extracted from soils by 0.1 M $Na_4P_2O_7$ (pH 13) with following separation (acidation up to pH 1-2) to humic (HAs) and fulvic acids (FAs). FAs were purified on the absorbent carbon. Elemental composition of HAs & FAs was determined by gas chromatography methods on CNHS-O analyzer EA 1110 (Italy). Amino-acid composition of HAs & FAs was detected by the AAA 339 after acid hydrolysis (6 N HCl). Chromatographic separating of alkaline soil extracts (0.1 N NaOH) and HAs & FAs solutions was made using hydrophobic agarose gel (Octyl Segarosa CL -4B, Pharmacia) with using BioRad chromatograph.

Under middle taiga bioclimatic conditions, clear-cutting leads to a timely paludification and activation of gley process. This process takes place first 5-10 years after cutting. Hydromorfism intensification during first after-logging years results in spatial homogeneity both in morphological and chemical soil properties. Soils of “young” cutting area are observed for: the increasing acidity of upper soil part, intensification of iron mobilization and segregation, reduction of total nitrogen content in litter soil organic matter, increasing chemical “aggression” and migratory capability of humic compounds.

SOM fractionation by chromatography of hydrophobic interaction allows to separate 5-6 fractions with different ability to hydrophobic reaction. Intensities and peak areas on the chromatogram depend on cutting area age. SOM composition of the 6-year-old cutting area (P2) contains more hydrophilic compounds in litter and podzolic horizon in comparison with same horizons at the control. SOM composition of a 40-year-old birch forest (P3) has a hydrophilic/hydrophobic ratio in litter and podzolic horizon similar to that of control site, but SOM of illuvial horizon has same little hydrophilic fraction content as in the control. Hydrophobic properties of SOM are presented by humic acids, hidrofilic properties by both humic and fulvic acids. HAs contain 51.3-55.2 % C, 2.59-4.76 % N, 4.31-5.57 % H and 37.8-41.1 % O. FAs are characterized with lower carbon (44.9-50.7 %) and nitrogen content (0.81-1.81%) and higher oxygen one (43.4-51.6%). Such humic substances content is typical of podzolic soils. Reforestation on cutting area leads to increasing nitrogen content of HAs both in litter and podzolic horizon. Most of investigated HA & FA are of similar amino-acid composition, but total amino-acids content increases in HA from P2, especially in HAs from podzolic horizon in comparison with P1. Probably this data evidence simplification of HAs molecules from cutting area soils due to peripheral structures presented by polypeptide, polysaccharide and aliphatic fragments.

The study financially supported by the Russian Foundation for Basic Research (project-08-04-90718 mob_st) and International scientific project “OMRISK” (INCO-DC-013388).

Effects of afforestation by exotic conifers and native birch on ground vegetation composition in Iceland

Asrun Elmarsdottir[1], Borgthor Magnusson[1] and Bjarni D. Sigurdsson[2]

[1] Icelandic Institute of Natural History; IS-101 Reykjavik
[2] Agricultural University of Iceland, IS-311 Borgarnes

Afforestation has been increasing in Iceland for the past decades and it is foreseen that the same pattern will continue in the future. It has been documented in many studies that introduction of trees into a previously treeless ecosystems greatly changes both ecosystem structure and function, e.g. species richness and composition of the original vegetation. We believe it is important to recognize these effects in planning of afforestation and also study how forest management practices can be used to minimize negative effects.

The present study focuses on changes that occur in vegetation composition following afforestation in Iceland. The study was a part of the ICEWOODS project, which had the main aim to investigate biological and environmental changes following afforestation. The fieldwork was carried out in Iceland where vegetation were studied within stands of open heathland, coniferous plantations (*Larix sibirica, Picea sitchensis, Pinus contorta*) of different ages as well as native mountain birch forests (*Betula pubescens*). Within each stand, five plots (2 x 50 m) were randomly placed for sampling of vegetation, soil and gap fraction. Cover of vascular plant species and five key moss species was determined.

Comparison of forest stands of different age revealed a clear succession from open pasture toward older tree stands. The results of TWINSPAN classification showed that the greatest contrast in the vegetation was between open heathlands and young forest stands and the old forest stands. Species richness was highest in heathland/young forest stands but lowest in older stands where light at the forest floor was limited. Similarly, cover of vascular species, mosses and lichens decreased as the forest grew older and became denser. Plant species that were dominant in the heathland and the young forest stands are common heathland species and adapted to the open habitats. In denser forest stands these species retreated while shade tolerant species invaded the forest or became more common in the vegetation.

Twinspan classification also showed that birch stands were separated from conifer stands and species richness was found to be higher in the native birch forests. Dicot forbs were more common and moss cover was in general higher in the birch forests compared to the old coniferous forests where horsetails, sedges and grasses were more abundant. During the thicket stages the coniferous stands are relatively poor habitats for plants in comparison to the native birch forests. This is mainly due to the very limited light that reaches the forest floor in the dense coniferous stands, a condition that is not attained in the birch forests which can be explained by the fact that conifer trees are much higher than the native birch and less light reaches the ground in very dense coniferous plantations.

Our findings are coherent with other studies that have shown that light availability is the main factor that influences vegetation composition and species diversity. Thus relatively species rich communities of open heathland will not persist after afforestation. They will be replaced by species poorer communities of horsetails, monocots and forbs, which at the thicket stage may have extremely low plant cover and species richness. Similar to other studies, this shift in vegetation composition reflects changes in the relative proportions of many of the species.

Surrogate species indicating high species richness: true indicators or sampling effects?

Ivar Gjerde[1], Magne Sætersdal[1] and Ken O. Storaunet[2]

[1] Norwegian Forest and Landscape Institute, Fanaflaten 4, NO-5244 Fana, Norway
[2] P.O. Box 115, NO-1431 Ås, Norway.

Lists of indicator species are frequently used in practical conservation as surrogates for overall species richness. We investigated the indicator power of 892 species belonging to five different taxonomic groups (vascular plants, mosses, hepatics, lichens, and polypore fungi) and their cumulative ability to predict locations of the 10% overall most species-rich sites (local "hotspots") in three boreal forest areas in Norway. By using indicator species lists consisting of the 10% best indicator species in each area, we were able to locate 57-80% (mean: 67%) of the hotspots in the other areas (compared to the 10% found by randomly selecting sites). However, by selecting a similar number of random species, 55-72% (mean: 63%) of the hotspots were found. The proportion of hotspots found depended on the species distribution in the area they were used, and not that of the area where indicators were derived. We conclude that hotspots were localized mainly due to a sampling effect, whereas the true indicator effect was of marginal importance.

Are water and element cycles in larch (*Larix* sp.) intermediate between those in coniferous and deciduous tree species?

Per Gundersen, Laila L. Pedersen, Michael Rasmussen, Karin Hansen and Lars Vesterdal

University of Copenhagen, Forest and Landscape Denmark, Hørsholm Kongevej 11, DK-2970 Hørsholm, Denmark, Phone: +45 35 33 16 78, fax: +45 35 33 15 17, e-mail: pgu@life.ku.dk

Tree species modify the water and element cycles directly by creating different microclimates, through differences in water use and air filtering characteristics as well as indirectly thorough production of litter of variable quality. Major differences have been observed between broadleaves and coniferous evergreen tree species with broadleaf species generally having lower water use, lower atmospheric deposition of nutrient elements and more light penetrating to support a vigorous ground flora than in conifer species. Then again, conifer species tend to grow faster and accumulate substantial organic layers compared to the broadleaf species.

As a deciduous conifer, larch may have the growth and litter characteristics of conifer species but the water use and deposition characteristics of the broadleaf species. However, water and element cycles are not well studied under European conditions and comparisons with other tree species are lacking.

The use of larch in forestry may potentially increase in the future since it produces naturally impregnated durable wood. Furthermore it is a pioneer tree that is attractive for use in afforestation of arable land as a nurse species to quickly obtain a forest microclimate for other tree species and to create the perception of 'a real forest' for recreational use.

In this study we compared larch (*Larix sp*.) with Norway spruce (*Picea abies* (L.) Karst.) and oak (*Quercus robur* L.) or beech (*Fagus sylvestris* L.) with respect to hydrological parameters, throughfall composition, litterfall amount and composition, soil water nitrate concentrations, accumulation of organic layers and soil pools of C and N. Comparisons were done at two afforestation sites on loamy soils in stands of similar age 30-35 yrs. Flux measurements were performed by monthly sampling over one year (2000/1). For the comparison of organic layers, 4 additional sites were investigated.

The throughfall amount in larch was similar to that in oak/beech and lower in spruce. This difference was also reflected in soil water content in the top soil at one site but lost in variability at the other site. Nitrogen deposition decreased in the order spruce>larch>oak/beech. At one site the difference in N input was directly reflected in similar species differences in soil water nitrate concentrations at 90 cm depth (8, 4, and 1 mg N/l for spruce, larch and oak, respectively), whereas at the other very nutrient-rich site nitrate concentrations were 10 mg N/l under all tree species.

Differences in litterfall mass were small among the tree species, but the N content was low for larch. C/N ratios were consequently higher for larch (55-60) than for the other tree species (25-42). The accumulation of organic layers (6 sites) was similar in larch, spruce and beech and lower in oak. No tree species differences could be detected in the mineral soil C and N pools.

In conclusion, the water cycle in larch is most comparable to that of broadleaf species, whereas the soil carbon cycle is more comparable to that of coniferous species. Since larch had an N deposition close to that of the broadleaf species and at the same time had a high accumulation of N in the organic layer as in spruce, we expected N retention to be highest in larch. However, compared to coniferous evergreen and broadleaf tree species larch was intermediate in N leaching at the investigated N-rich former arable soils.

Stored carbon in biomass products-opportunities for sustainable forestry in India –a review study

H. S. Gupta

Indian Institute of Forest Management, Bhopal – 462 003 India

The products made from biomass, particularly wood- sequester carbon in them. Thus wood plays a major role in combating climate change. Studies indicate that the amount of carbon stored in forest products is increasing by about 150 million tons per year, equivalent to removing 540 million tons of CO2 from the atmosphere per year.In terms of employment the wood products industry generates 54 man-hours per tonne of dry wood, compared to only 2 man-hours in the bio-energy sector. With respect to the carbon cycle, the wood-based product industry thus provides far greater benefits in terms of employment and value added than direct burning of wood.

Carbon storage in large quantity can be achieved if better wood utilization and preservation techniques are practiced. From the perspective of CO2 storage, the most desirable situation for forest and forest products can be through extended rotation age and production of goods, which last long. This will lead to carbon being fixed in the woody form, which is durable. The paper reviews the social, ecological and economical dimension of this issue and also discusses the some activities by which , long-term carbon sequestration in wood production can be further achieved .

Also the related policy issues have been discussed in the Indian context, which may contribute to sustainable forestry in India.

Assessing the environmental effects of biomass scenarios in Sweden applying nutrient mass balances at a national scale

Sofie Hellsten[1] and Cecilia Akselsson[2]

[1] IVL, Swedish Environmental Research Institute Ltd, Box 5302, SE.400 14 Göteborg, Sweden
sofie.hellsten@ivl.se

[2] Lund University, Dept of Physical Geography and Ecosystems Analysis, SE-223 62,Lund, Sweden
cecilia.akselsson@nateko.lu.se

Increased biomass removal from Swedish forests has become important as the demand for renewable energy has increased. Biomass harvesting is associated with several environmental effects concerning carbon sequestration, biodiversity, nitrogen cycling, depletion of nutrients such as base cations and phosphorous and acidification of soil and water.

Increased biomass removal results in more base cations (K^+, $Mg2^{2+}$, Ca^{2+} and Na^+) being removed at harvest, and therefore acidification increases with intensified forestry production. When base cations are removed, the soil buffering capacity decreases, which may eventually lead to negative effects on the quality of soil water and runoff water.

In this study base cation mass balance calculations and calculations of excess acidity have been applied at different forestry scenarios to assess the rate of depletion of base cations and the potential risk of acidification of soil and water. Base cation balances show the losses of base cations at differens forestry scenarios, while excess acidity provides an indication of the acidity balance.

The following forestry scenarios were considered: stem removal, whole tree harvesting and stump removal. Mass balances for base cations and excess acidity were calculated for 12 000 forest sites in Sweden showing that it may be necessary to compensate for the losses of base cations in order to maintain a sustainable forestry harvesting to prevent further acidification of soils and waters.

Balancing between peatland forest timber production and environmental effects of forest management practices in surface waters

Hannu Hökkä[1], Harri Koivusalo[2], Erkki Ahti[3], Ari Laurén[2], Sakari Sarkkola[3], Mika Nieminen[3], Eero Nikinmaa[4] and Jukka Laine[5]

[1] Finnish Forest Research Institute, Rovaniemi Research Unit, Box 16, FI-96301 Rovaniemi, Finland
email: hannu.hokka@metla.f
[2] Finnish Forest Research Institute, Joensuu Research Unit
[3] Finnish Forest Research Institute, Vantaa Research Unit
[4] University of Helsinki, Department of Forest Ecology
[5] Finnish Forest Research Institute, Parkano Research Unit

Drained peatland forests form one fifth of the total timber resource in Finland. In managing peatland forests for timber production, ditch network is commonly constructed to drain the peatland and regulate water table levels and soil moisture conditions. The drainage significantly improves tree growth, but at the same time causes loads of suspended solids and organic compounds to receiving water bodies. During a stand rotation, ditch cleaning is commonly required to maintain drainage capacity of the ditch network and to sustain high level of tree growth. Each cleaning occurrence will create a pulse of loads from peatland areas. To minimize the environmental consequences, we are studying management methods, where decisions are made on the basis of natural functioning of the forest ecosystem, and where the estimated role of the tree stand evapotranspiration in the water balance is one decision criterion. When tree stand water use capacity is considered, less intensive maintenance of the ditch network is necessary and the impact of the maintenance on water courses becomes minimized. In order to obtain a holistic view of hydrology in drained peatland forests, measurements on tree stand water balance including tree transpiration, canopy interception, and runoff are undertaken in experimental sites. This study exploits methods of field measurements and modelling, and aims to quantify the variation in transpiration of peatland stand as a function of climatic, soil, and stand conditions. Preliminary results show that even in northern Finland at latitudes above 65° N, evapotranspiration of vegetation cover is up to about 65% of total precipitation during the growing season. The results provide guidance in the development of management methods that support quantification of water balance in practical situations in the forests.

Spatial distribution of epiphytic lichens; consequence of dispersal patterns or habitat distribution?

Fride Høistad[1,2], Ivar Gjerde[2], Hans Blom[2] and Magne Sætersdal[2]

[1] Department of Biology, University of Bergen, Allégaten 41, N-5007 Bergen, Norway
E-mail fride.hoistad@skogoglandskap.no
[2] The Norwegian Forest and Landscape Institute, Fanaflaten 4, N-5244 Fana, Norway;
E-mail: ivar.gjerde@skogoglandskap.no, hans.blom@skogoglandskap.no, magne.setersdal@skogoglanskap.no

Epiphytic lichens are thought to be sensitive to gradients in environmental conditions, such as microclimate, stand structure, and substrate qualities. In addition, many lichen species seem to be dispersal limited and slow growing. The spatial distribution of lichens in forest stands may therefore be a result of dispersal and colonization dynamics, and spatial variations in habitat qualities. Which in turn will have implications for forest management.

We mapped and analysed the spatial distribution of epiphytic lichens and their host trees within 10 forest stands, all located in mature aspen-dominated (*Populus tremula*) forests in the coastal area of western Norway (60º N, 5º E) surveyed in 2007-08. The analysed area of each stand was either 1800 m^2 or 5000 m^2. In each stand every tree was plotted in a grid system with 1 m^2 resolution. In addition, tree species, diameter in breast height, bark structure, tree condition, vegetation types, and the abundance of 30 pre-selected lichen species were recorded for each tree. Totally 5930 trees with 37 684 lichen specimens (thalli) were recorded. The investigated lichen species belong to the “Lobarion community” (dominated by cyano-lichens), they have approximately the same habitat preferences, and are known to co-exist in aspen- dominated stands.

Out of the 30 investigated lichen species, 17 species had a sufficiently high number of individuals and was included in the analysis. We analyzed the spatial autocorrelation for each species and their habitats, and compared the spatial overlap between different species in different forest stands.

The abundance of the lichen species differed between the ten forest stands, and so did the spatial overlap between pairs of species occurring in several areas. The spatial pattern of the lichen species tracks the spatial distribution of the trees most suited as habitat, especially aspen. However, an aggregated spatial pattern of the lichens, not explained by host tree distribution, was found in several of the areas. We argue that this aggregated pattern results from dispersal and colonization dynamics.

Nitrogen load response to forest clear-cutting in areas of low and high atmospheric deposition

Harri Koivusalo[1], Ari Laurén[1], Tuija Mattsson[2], Sirkka Tattari[2], Sirpa Piirainen[1] and Leena Finér[1]

[1] Finnish Forest Research Institute, Joensuu Research Unit, P.O. Box 68, FI-80101 Joensuu, Finland, harri.koivusalo@metla.fi, ari.lauren@metla.fi, sirpa.piirainen@metla.fi, leena.finer@metla.fi
[2] Finnish Environment Institute, P.O. Box 140, FI-00251, Helsinki, Finland, sirkka.tattari@ymparisto.fi, tuija.mattsson@ymparisto.fi

Aquatic habitats in small streams and lakes of the boreal zone are sensitive to increased nutrient loads from surrounding catchments. Water protection in these areas calls for an understanding what the sources of nutrients exported to water courses are, and how different land use practices affect nutrient loads. Objectives for maintaining good status of aquatic habitats, such as the targets outlined in the European Water Framework Directive, set requirements to the planning and implementation of water protection policies. The policies raise a need to produce regional and national estimates of the excess nutrient loads caused by different land use practices. The estimates of nutrient loads generated by forestry practices are based on the specific load approach. A specific load is defined as the increase in the export of nutrients that results from a certain forestry treatment. These excess load estimates are based on paired catchment studies. When the field studies are regionalized, the specific load at the regional level is assumed to be independent of location and treatment time. However, results from catchment studies show different responses to the treatments, and thus the regional and national load estimates become uncertain especially in a local scale. The local scale becomes crucially important, when the question is about the planning and implementation of the water protection policy at a specific location. Although it is known that the specific loads show differences between the catchments, the mechanisms behind the differences are not fully known.

This study focuses on different nitrogen (N) load responses to clear cuttings in two catchments located in eastern (Kangasvaara) and southern (Rudbäck) Finland. The catchment areas are of the same order of magnitude, both catchments are covered with Norway spruce, and about one third of the catchment area was clear cut in both sites. Data from 1992 to 2003 reveal that the wet deposition of total N ranged from 3 to 6 kg ha^{-1} a^{-1} in Kangasvaara, and the export of dissolved total N was 0.4-0.6 kg ha^{-1} a^{-1} before the clear-cutting and 0.3-1 kg ha^{-1} a^{-1} after the clear-cutting. In Rudback the deposition varied from 6 to 10 kg ha^{-1} a^{-1} and the export was 0.8-2 kg ha^{-1} a^{-1} before the cutting and 2-4 kg ha^{-1} a^{-1} after the treatment.

A process-based hydrological and nitrogen transport model FEMMA was applied to quantify the catchment processes behind the observed N loads and to identify the causes for the different responses of the catchments. Preliminary modeling results suggest that the different levels of N deposition and different vegetation growth conditions have an impact on the catchment N pools. These differences are accordingly reflected in the relative importance of mechanisms controlling N release after the clear-cuttings. The understanding of these mechanisms provides the course for refining the estimation of nutrient loads at a regional level.

International programme “Forest Focus 2006” demonstration project biosoil in Latvia

A. Komorovska, A. Lazdins, E. Baders and K. Martinsone

Latvian State Forest Research Institute “SILAVA”
e-mail: arta.komorovska@silava.lv, address: Riga street 111, Salaspils, Latvia, LV2169

The international forest soil and biodiversity inventory project BioSoil was initiated in 2004 according to requirements of the Forest Focus regulation (directive No. 2152/2003). The Forest Focus is a Community scheme for harmonised, broad-based, comprehensive and long-term monitoring of European forest ecosystems. It concentrates in particular on protecting forests against air pollution and fire. To supplement the monitoring system, new instruments relating to soil monitoring, carbon sequestration, biodiversity, climate change and protective functions of forests were introduced within the scope of this initiative.

Under the scheme of the Forest Focus the monitoring of air pollution effects on forests is carried out on the basis of the systematic network of observation points (level I) and of the network of observation plots for intensive and continuous monitoring (level II). The monitoring activity continues from the network and plots established and implemented under Council Regulation (EEC) No 3528/86 and Regulations (EEC) No. 1696/87 and (EC) No. 1091/94.

The first evaluation of forest soil conditions in sample plots involved in the BioSoil project was implemented in early nineteenths. 31 European country participated in this project to obtain information about soil properties, which characterizes sensitivity of soil against air pollution. Latvia took part in this project as well, but due to incomparable methodologies applied in the study in different countries, obtained data were rather useless. Repeated inventory of the forest soil characteristics was implemented in 2005-2008 within the scope of the BioSoil project, this time providing much broader information about chemical and physical properties of forest soils, which are important in relation to acidification, eutrofication of soils, climate change and other environmental issues, as well as to try to detect and to explain short term fluctuations in environmental conditions.

The BioSoil project is the first attempt to implement full scale forest soil inventory in Latvia. Besides, results of this project will support Latvian forestry to identify those parameters of soil quality, which are important in evaluation of forest types and to elaborate forest soil maps.

Sampling of composite soil samples and the soil profile surveys for the inventory purposes were done between 2005 and 2007 in 16 x 16 km grid (95 the first level forest monitoring, ICP Forest, sample plots in total).

825 soil samples were collected within the scope of the soil survey and 450 composite samples were collected from certain depths of soil (from humus layer and from 0-20, 20-40, 40-60 and 60-80 cm depth). Standardized methods elaborated and approved by the ICP Forests (http://www.icp-forest.org/manual.htm) expert group were used to determine chemical and physical characteristics of soils. Laboratories involved in the project took part in several inter-calibration tests nd used reference soil sample to check integrity of results. Reporting of the project were done according to requirements of FSCC (Forest Soil Co-ordinating Centre). Standardized sampling and analytical methods utilized in the BioSoil project are now accepted as a standard for scientific research in forestry.

Keywords: soil survey, monitoring, chemical properties.

Impacts of stump removal and collecting of logging residue on nutrient cycle and forest biodiversity

E. Kubin, T. Murto and O. Tarvainen

The Finnish Forest Research Institute, Muhos Research Unit
Address: Kirkkosaarentie 7, FI-91500 Muhos, Finland
eero.kubin@metla.fi

In recent years the energy wood harvesting has increased rapidly. According to the national forest policy in Finland, even higher annual harvesting is set as a goal for coming years. The new forestry products need new types of technological solutions and production chains and the new markets need to be analyzed at local, national and global scales. Also, ecological constraints need to be taken into account in the energy wood production.

The impacts of logging residue and stumps are still inadequately understood in many respects. Thus, there is a great need for research based information on the principles and impacts of biomass production on the forest resources. The objective of this project is to produce information on the impacts of the utilization of forest-based energy, especially information on impacts of stump removal on habitat factors and on restocking. Responses and recovery of the nutrient cycle, microbiology, restocking, carbon balance and vegetation succession will be studied. The project is planned to be implemented in three geographical areas: Southern Finland, Central Finland, and Northern Finland.

The experimental layout and preliminary results are presented.

Estimating duration of treatment effect on nutrient export in the paired catchment experiment

Ari Laurén[1], Jaakko Heinonen[1], Harri Koivusalo[1] and Leena Finér[1]

[1] Finnish Forest Research Institute, Joensuu Research Unit, Yliopistokatu 6, P.O. Box 68, FI-80100 Joensuu, Finland, ari.lauren@metla.fi

Paired catchment experiment based on long-term monitoring of two adjacent catchments is the principal method for quantifying how forest management practices increase nutrient export to surface waters. In the experimental set-up, runoff and water quality from two adjacent catchments are monitored before and after a treatment (e.g. clear cutting) implemented on one while the other is left as a control catchment. Nutrient export is calculated from the measured runoff and nutrient concentration in the stream water. The basic assumption in the paired catchment experiment is that the two catchments response identically to any manipulation. To justify this assumption, the catchments should be similar in terms of area, topography, geology and vegetation cover before the treatment. In the analysis of the paired catchment data, the treatment effect is calculated using the pre-treatment dataset regression and the post-treatment records of nutrient exports. For the post-treatment period, the regression model and the load from the control catchment are used to predict the nutrient export from the treatment catchment under the assumption that the treatment has not occurred. The difference between the observed and predicted nutrient exports is a measure of the treatment effect. Typically the treatment effect is high shortly after the management practise and thereafter the effect gradually decreases with time and approaches zero. The total cumulative treatment effect is gained by summing up the annual treatment effects over the duration of the treatment effect.

From the point of view of the uncertainty involved in the treatment effect estimate, it is clear that there is no single method to determine the duration of the treatment effect from the paired catchment data. Estimation of the treatment effect duration has implications on the magnitude of the total cumulative treatment effect. In this study we compared three different approaches to quantify the duration of the treatment effect using simulated and real datasets. In the first approach, we assumed that the treatment effect is visible until the year when the annual effect is non-significant for the first time. This approximation is biased and tends to underestimate the real duration. The bias is the larger the more conservative is the test for the annual effects. Bias in the estimate of the treatment duration propagates to the estimated cumulative treatment effect. In the second approach, the treatment effect was assumed to continue until the estimate of the annual effect is zero or negative. When the treatment effect decreases gradually, this approximation is biased as well and the real duration of the treatment effect is underestimated due to random variation of the annual estimates. In the third approach, we approximated the annual treatment effects using a smooth nonparametric regression function, and we based the estimate of duration on the results of the regression function. If the treatment effect is clear and decreases rapidly, the choice of the method for determining the duration is not critical in the estimation of the cumulative treatment effect. However, if the treatment effect is small and decreases slowly, the estimate of the cumulative effect becomes sensitive to the choice of the method.

Preliminary results of cut away peat-land afforestation with using of waste water sludge fertilizers

D. Lazdina, A. Lazdins, J. Liepins, A. Bardulis and A. Komorovska

Latvia State Forest Research Institute "Silava"
dagnija.lazdina@silava.lv; Riga street 111, Salaspils, Latvia, LV 2169

In cut away peat lands are unbalanced content of plant nutrient elements. Soils usually are acid and dry. Wood ash could be good liming agent and resource of potassium. Waste water sludge (WWS) and compost is effective fertilizer and source of phosphorus. It is important to investigate such economic activity impact on environment and effect of WWS doses allowed using by current legislation on tree growth.

Aims of the research were to determinate impact of WWS and ash fertilization on soil properties and concentration changes of the main nutrient elements N, P, K, and Ca, Mg in different depth during 2005 -2007 on empted peat fields after peat output. Concentration of S and total C and heavy metals in soil top layer were determinate to clear up impact of fertilization on environment.

There were established experiment on field with WWS application 10 t_{dm} at 2005, where had been planted pine, birch, black alder and willows. Deep peat layer complicated use of heavy agricultural machinery. Soil analyses showed that pH_{KCl} of peat is 2.5...3. To evaluate effect of different fertilizers on soil the experimental area was divided into parts. In one part waste water sludge were used, in other – equal amount (by phosphorus) of physiologically alkaline mineral fertilizer containing significant amount of phosphorus and potassium. During a beginning of vegetation season (2005) spreading and ploughing of fertilizers weren't possible, therefore the decision was to use fertilizers later on surface of soil without ploughing. May, 2005 was rich with rain and as soon as soil was dry enough to use machinery on a peat-land waste water sludge was spread over already planted cuttings using horizontal manure spreader. The spreading took place in July, 2005, using maximal permissible dose of sludge (10 t_{dry} ha^{-1}).Mineral fertilizer was applied simultaneously with spreading of sludge. Mechanized spreading wasn't possible due to destroyed road infrastructure, therefore if was done manually in space between rows.

Effect of fertilization on trees growth and stock in field conditions were determinate by non-destructive method. Growth data were calculated by measuring data of height and root collar diameter of trees.

Fertilization by WWS significantly increased growth of trees and caused germination of seeds, after three years of sludge application there were 60-70 000 tree seedlings ha^{-1}. Naturally ingrown seedlings of pine during three years reached height of planted trees. After second year of WWSS application vegetation occurred. Willows were not suitable for abundant peat cut away areas with depth peat layer and high groundwater level.

Keywords: cut away peat-land, fertilization, waste water sludge

Short-term effects of logging on the water chemistry in two boreal streams in northern Sweden - 277 Balsjö; a paired catchment study

S. Löfgren[1], E. Ring[2], C. von Brömssen[1], R. Sørensen[1] and L. Högbom[2]

1 Swedish University of Agricultural Sciences
2 Skogforsk – the Forestry Research Institute of Sweden

The effects on water chemistry of logging in final fellings in northern Sweden remain largely unexplored. Here we report the results from the reference period and the first two years following logging in two partially harvested northern catchments, with and without a forest buffer along the stream. Two uncut reference catchments are included for comparison. The study site is typical for large areas of forest land in northern Sweden. Runoff was measured at the outlet of each catchment, and water samples were generally taken every second week. The logging increased runoff, Na, K, Cl, N-tot, P-tot and suspended matter leaching from both catchments. The NO3- leaching increased only from the catchment without a forest buffer. As yet, the effects of the forest buffer on the NO3- leaching cannot be evaluated due to low input of NO3- from the uphill clear-cut.

Keywords: clear-cut, forest buffer strip, stream water, potassium, nitrogen, phosphorous, suspended solids

Effects on soil-surface CO_2 flux the first year(s) after stump extraction

Kristina Mjöfors and Monika Strömgren

Department of Soil and Environment, Swedish University of Agricultural Sciences, Uppsala, Sweden
Contact: Kristina.Mjofors@mark.slu.se, Monika.Stromgren@mark.slu.se

One third of the woody biomass in a coniferous tree is located in the stump. One way to increase the supply of renewable energy sources, and thereby decreasing the oil dependency, is to extract the stumps after final harvest. However, a potential problem with stump extraction is soil disturbance, which can result in increasing decomposition of soil organic matter and decreasing soil carbon pools. More than twice of the amount of carbon in the standing biomass is stored in the Swedish forest soil. To assess to which extent the stumps can be considered as a carbon neutral fuel it is necessary to evaluate the indirect effects on soil carbon due to carbon dioxide emissions from the soil.

In this study, emissions of CO_2 from soil on plots with stump extraction (50x50 m) were compared with plots with patch scarification in a block designed experiment with 3 replicates. The experiment was situated in Stadra in mid Sweden (59º33'N 14º42'E). The former stand consisted of mature Picea abies, (L.) Karst and had a site index of H30 (30 meters at a stand age of 100 years). Clear-felling was carried out in the winter before the stump harvest took place. No further site preparation for establishment of the new stand was assumed to be needed at the plots with stump extraction. Measurement of soil-surface CO_2 flux, soil temperature and soil moisture were monthly performed in 20 points per plot during the growing season. Pre-measurements started June 2007 until stump harvest in September 2007 and continued in 2008 and 2009.

There was no difference between the plots before the stump extraction and patch scarification took place (Fig 1). The year after stump extraction, the soil-surface CO_2 flux was 20% lower on the plots with stump extraction than plots with patch scarification (Fig 1.). The decrease in the study in Stadra was probably due to soil compaction as a result of less buoyancy of the soil. Despite using the same machinery for extraction of stumps and for patch scarification wheel tracks occurred twice as much at the plots with stump harvest.

The results from the Stadra experiment imply that decomposition of soil organic matter do not have to increase after stump extraction, but that stump extraction could have other impacts on the soil such as compaction in some sites. Compaction could have negative effects on water percolation and plant growth. It can also result in soil conditions where emissions of N_2O and CH_4 may occur. The risk of compaction is likely to increase during wet soil conditions on sites with fine textured soil with poor drainage.

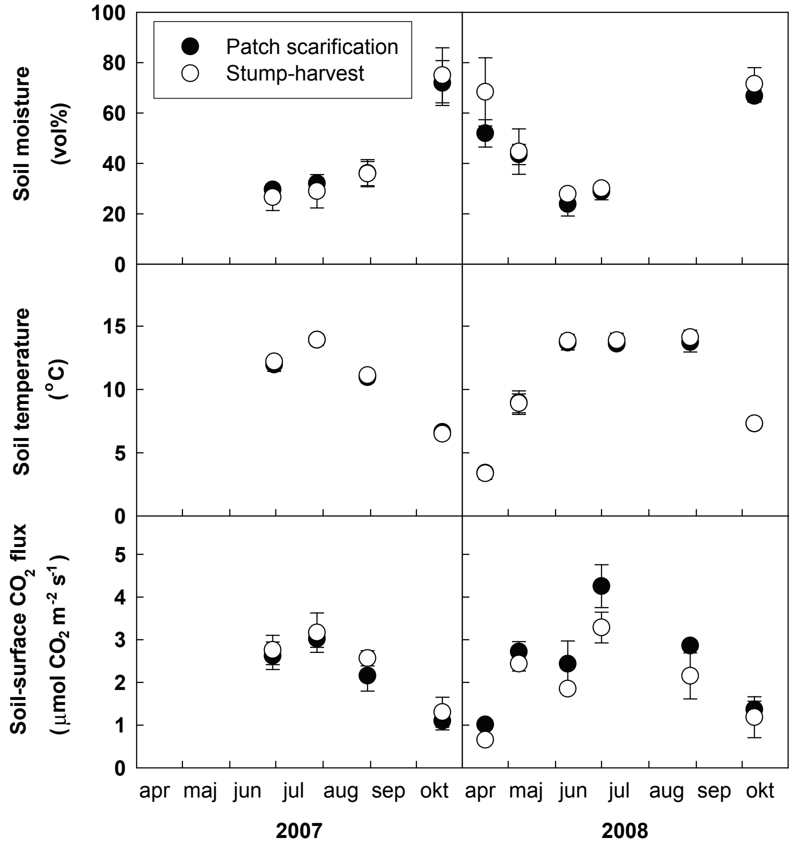


Figure 1. Soil-surface CO_2 flux, soil temperature and soil moisture before and after patch scarification (black dots) and stump extraction (white dots) in a forest stand in mid Sweden. The stump-harvest and patch scarification was performed in Sept 2008. One error bar denotes 1 standard error (n=3).

Effects of soil scarification on soil solution chemistry

Sten Nordlund, Eva Ring and Lars Högbom[1]

[1] Skogforsk – the Forestry Research Institute of Sweden, Uppsala Science Park,
751 83 Uppsala, Sweden
lars.hogbom@skogforsk.se

Soil scarification is a common feature in Swedish forestry, annually about 175,000 ha is treated annually with various methods. To what extent soil scarification affects soil nitrate leaching has been discussed during the years. Earlier studies have indicated that nitrate leaching was larger following soil scarification than on not scarified areas. However, later studies taking a more integrated approach have shown that the effects of soil scarification on soil solution concentrations is rather small, and could even be lower from scarified plots then from untreated plots. The later results were obtained from an experimental set-up where suction cups were placed in the centre of field simulated soil scarification. The simulation consists of undisturbed soil, bare mineral soil and a double humus layer, with portions normally achieved following practical operational soil scarification in a pie-chart fassion. The whole experimental set-up is thought to give an integrated measure of soil solution nitrate concentration following soil scarification. In 2006 we established a similar experimental design at 6 sites, with 5 simulated scarifications and 5 un-treated plots in central and northern Sweden. The main hypothesis behind why soil scarification reduces nitrate leaching is: i) the increased nitrification under the double humus layer is counteracted by decreased nitrification under the bare mineral soil; ii) soil scarification promotes tree growth and thus the nitrate uptake by the plants. In this poster we present the experimental set-up and the first year's results.

The effects of afforestation on Collembola density and species number

Edda S. Oddsdottir[1], Arne Fjellberg[2], Asrun Elmarsdottir[3] and Gudmundur Halldorsson[4]

[1] Icelandic Forest Research, Mógilsá, Reykjavík, Iceland
[2] Entomological Research, Tjöme, Norway
[3] The Icelandic Institute of Natural History, Reykjavík, Iceland
[4] Soil Conservation Service of Iceland, Gunnarsholti, Iceland

The effects of afforestation with different tree species on density and species number of Collembola in soil was studied. The study sites were unforested heathland (one site), three Sitka spruce forests (10, 44 and 45 year old), two pine forests (15 and 46 year old) and two old birch forests (grazed and ungrazed). All study sites were located at Skorradalur, West-Iceland. Five plots were selected at each site and 2 soil samples taken from each plot. Soil samples were immediately sealed, placed into plastic bags and transported to the laboratory for extracting soil arthropods. Animals were extracted from the soil samples by using the dry funnel method into 0.6% benzoic acid and Collembola were counted and identified to species.

The results show that species number of Collembola increases as forests (birch, Sitka spruce or pine) get older. Furthermore, afforestation increases the density of Collembola in soil in birch and Sitka spruce forests but no changes in density was detected in the pine forests. A Twinspan analysis showed that younger forests and unforested heathland differed in species composition from older forests. Furthermore, a DCA analysis showed that both density and number of species increased as light intensity on the forest floor decreased and ground vegetation cover declined.

There are several factors that influence the distribution of Collembola in soil, for example soil moisture, heat, pH and available nutrition. Fungal hyphae are important nutrition for Collembola and research have shown that fungal fruitbodies are more frequent in older forests, which may explain why density increases as forests grow older.

Forestry operations have a small impact on the groundwater quality in aquifers

Sirpa Piirainen[1], Leena Finér[2], Marja-Liisa Juntunen[1], Hannu Mannerkoski[3], Mirella Miettinen[4] and Michael Starr[2]

1 Finnish Forest Research Institute, sirpa.piirainen@metla.fi, marja-liisa.juntunen@metla.fi
2 University of Helsinki, Department of Forest Ecology, leena.finer@metla.fi, mike.starr@helsinki.fi
3 University of Joensuu, Faculty of Forest Sciences, hannu.mannerkoski@joensuu.fi
4 University of Kuopio, Department of Environmental Science, mirella.miettinen@uku.fi

Groundwater is the main source (60 %) of water distributed by waterworks to households and industry in Finland. Groundwater aquifers are mainly located on forest land, thus forest fertilization and intensive soil preparation are not allowed on groundwater aquifers to maintain the good quality of groundwater. High nitrate leaching to groundwater after clear-cuttings has been observed in studies done in N-rich soils in southern Sweden and central Europe (Wiklander et al. 1991, Weis et al. 2001). However, the effects of different forestry operations on groundwater quality are not systematically studied. A monitoring study on the effects of forest cutting on the quality of groundwater in large aquifers (5.2-15.4 km^2) showed that both thinning and clear-cutting (27-66 % of the recharge zone) increase nitrate concentrations for several years (Rusanen et al., 2004). However, even the maximum annual average concentrations remained very small < 2 mg L^{-1}, well below the upper level (50 mg L^{-1}) set for drinking water. The results from an other study (VALU) by Mannerkoski et al. (2005), on headwater catchments, where 10-30 % of the area were clear-cut and disc-plowed, showed also that influence of forestry to groundwater level and quality is small, although in some wells the maximum monthly concentration of nitrate increased to 6.3 mg L^{-1}. In the VALU study it was clearly shown that leaching of nitrate was delayed for some years after forestry operations and the effect seemed to be long-lasting.

In 2000 we started a new study to find out what is the effect of forest regeneration and soil harrowing on the quality of groundwater in the Class I groundwater recharge area. The area, called Silkunharju esker, locates in eastern Finland and the soil is glacial deposit with a texture of gravel. The main tree species was pine (Pinus sylvestris L.). 70 % of the area (2.47 km^2) was cut in 2001 and we have monitored the groundwater quality, groundwater table level and climatic variables in the area. We will show the results from the Silkunharju study, which indicate that the effects of forest operations are small on groundwater quality and short lasting. We will also introduce the latest measurements from the VALU study where the influences are longer.

References

Mannerkoski, H., Finér, L., Piirainen, S. & Starr, M. 2005. Effects of clear-cutting and site preparation on the level and quality of groundwater in some headwater catchments in eastern Finland. Forest Ecology and Management 220: 107-117.

Rusanen, K., Finér, L., Antikainen, M., Korkka-Niemi, K., Backman, B. & Britschgi, R. 2004. The effects of forest cutting on the quality of groundwater in large aquifers in Finland. Boreal Environment Research 9(3): 253-261.

Weis, W., Huber, C. & Göttlein, A. 2001. Regeneration of mature Norway spruce stands: early effects of selective cutting on seepage water quality and soil fertility. The Scientific World Journal 1(2): 493-499.

Wiklander, G., Nordlander, G. & Andersson, R. 1991. Leaching of nitrogen from a forest catchment at Söderåsen in southern Sweden. Water Air and Soil Pollution 55: 263-282.

Organic and inorganic carbon concentrations and fluxes from managed and unmanaged boreal first order catchments

Miitta Rantakari[1], Tuija Mattsson[1], Pirkko Kortelainen[1], Sirpa Piirainen[2], Leena Finér[2] and Marketta Ahtiainen[3]

[1] Finnish Environment Institute, P.O. Box 140, 00251 Helsinki, Finland
e-mail:forename.lastname@environment.fi
[2] Finnish Forest Research Institute, Joensuu Research Unit, P.O. Box 68, 80101 Joensuu, Finland
e-mail: forename.lastname@metla.fi
[3] North Karelia Regional Environment Centre, P.O. Box 69, 80101 Joensuu, Finland
e-mail: forename.lastname@environment.fi

Peatlands sequester significant amounts of carbon (C) globally and in the northern latitudes, streams provide a loss pathway for C via lateral transport downstream and degassing to the atmosphere. Recent studies have suggested that C loss via streams can make a significant contribution to the C budget of both peatland and upland areas dominated by organic soils (e.g. Dawson et al. 2001, Billett et al. 2004, Hope et al. 2004). However, the influence of the forest management is not known.

Seasonal and inter-catchment variation in losses of both organic and inorganic carbon via downstream transport and evasion were studied in 11 boreal first order catchments in eastern Finland dominated either by peatlands or upland soils. Out of these catchments 4 represent undrained peatlands, 4 drained peatlands, 2 unmanaged upland, and 1 managed (clear-cutting, ploughing) upland. Total organic carbon (TOC) and total inorganic carbon (TIC) concentrations of stream water were measured 7-11 times during year 2007 at the outlets of the catchments and the mean daily runoff was recorded by a V-notch weir and a water level recorder. CO_2 concentrations of the streams were calculated from measurements of TIC and pH with correction for water temperature.

Stream water TOC and TIC concentrations were highest in the undrained peatland dominated catchments, but the total range of concentrations between streams was much higher for TOC than for TIC. Annual downstream export of TIC was quite consistent between the catchments, but the export of TOC was highest in peatland dominated catchments. Consequently, highest lateral total carbon (TOC+TIC) exports were found from peatland catchments. TC exports were of the same magnitude from both drained and undrained peatlands, because in export calculations lower concentrations of TOC in drained peatlands were compensated by higher discharge rate.

Partial pressure of CO_2 in streams was the highest in undrained peatland dominated catchments, whereas the estimated total annual evasion of CO_2 was also high in the drained peatlands presumably due to higher discharge rate and long drainage network. The estimated total annual evasion of CO_2 varied widely depending on calculation method, but was mainly larger than the lateral TIC export at the catchments. In mineral soil dominated catchments both downstream export of total carbon and evasion of CO_2 into the atmosphere were low.

The drainage of the peatlands does not seem to increase TOC export over the long time span and has little effect on TIC loads. Instead, the streamwater evasion of CO_2 is potentially high from drained peatlands because the long ditch network and high discharge rates increase the turbulence of water and the contact time with air.

References

Billett, M.F., Palmer, S.M., Hope, D., Deacon, C.M., Storeton-West, R., Hargreaves, K.J., Flechard, C. & Fowler, D. 2004. Linking land-atmosphere carbon fluxes in a lowland peatland system. Global biogeochemical cycles 18, GB1024, DOI 10.1029/2003GB002058.

Dawson, J.J.C., Bakewell, C. & Billett, M.F. 2001. Is in-stream processing an important control on spatial changes in carbon fluxes in headwater catchments? The science of the total environment 265: 153–167.

Hope, D., Palmer, S.M., Billett, M.F. & Dawson, J.J.C. 2004. Variations in dissolved CO2 and CH4 in a first-order stream and catchment: an investigation of soil-stream linkages. Hydrological processes 18 (17): 3255–3275.

Trends in stream water concentration and export of phosphorus from boreal headwater catchments in Eastern Finland

Sakari Sarkkola[1*], Harri Koivusalo[2], Ari Laurén[2], Pirkko Kortelainen[3], Tuija Mattsson[3], Marjo Palviainen[4], Sirpa Piirainen [2], Mike Starr[4] and Leena Finér[4]

[1] Finnish Forest Research Institute, Vantaa Research Unit, P.O. Box 18, FI-01301 Vantaa, Finland
[2] Finnish Forest Research Institute, Joensuu Research Unit, P.O. Box 68, FI-80101 Joensuu, Finland
[3] Finnish Environment Institute, P.O. Box 140, FI-00251 Helsinki, Finland
[4] University of Helsinki, Department of Forest Ecology, P.O.Box 27, FI-00014 University of Helsinki, Finland, [*] Corresponding author: Tel: +358-10 211 2312, e-mail: sakari.sarkkola@metla.fi

Excess phosphorus (P) export from terrestrial ecosystems deteriorates surface water quality and aquatic habitats. Concern about aquatic habitats is relevant in boreal zone with a large number of lakes and streams, which are sensitive to eutrophication. Climate change is expected to increase P export, because warmer temperature accelerates the decomposition rate of organic material and at the same time increased precipitation and mild winters increase runoff. Former studies show increasing trends in e.g. dissolved organic matter concentrations in streams, rivers and lakes throughout Europe. However, trends of P are found to be controversial particularly in boreal forest areas. The mechanisms behind long-term annual and seasonal changes in P concentrations and export are not thoroughly understood.

We studied time-series of P concentration and export from 8 small forested headwater catchments (29-494 ha) in eastern Finland. The proportion of peatlands ranged from 8 to 70% and the mean tree stand volume varied between 26-186 m^3 ha^{-1}. Runoff, soluble phosphate (PO_4-P) and total phosphorus (TP) were monitored for 15-29 years (1979-2006) in the catchments. Three of the catchments were subject to forestry operations during the monitoring period, but the period of the treatment effects was removed from the data. Linear trends in annual and seasonal (spring, summer, autumn) time series were identified using Seasonal Kendall trend analysis. Mixed model regression analysis was applied to identify climatic variables and catchment characteristics explaining the variation in annual and seasonal concentration and export.

The results showed that phosphorus concentration was most often decreasing or remained unchanged during the monitoring period. The annual concentration of TP decreased in two catchments, whereas no significant changes were observed in annual PO_4-P concentrations. However, significant decreasing trends in PO_4-P were found in seasonal concentrations in three catchments. The proportion of PO_4-P from TP varied from 8 to 60%. Significant decrease in the TP export was found in five catchment and the decrease occurred in pace with decreasing runoff. Most of the temporal changes occurred during spring (March-May) and autumn (September-November). The magnitude of the trends was generally much smaller than the variation in concentration between years, seasons and catchments. The atmospheric deposition of TP (0.041 to 0.25 kg ha^{-1} $yr.^{-1}$) showed no trend, and it exceeded the amount of the annual TP export.

According to the mixed modeling results, the peatland percentage mostly explained the total variance (6-39%) of annual P concentration and export. Precipitation was the main hydrometeorological driver of P export during summer and autumn. Increased air temperature did not appear to a factor explaining increased P export from the catchments.

Dielectric time stability of glacial till ten years after forest management

Raimo Sutinen[1], Maarit Middleton[1], Pekka Hänninen[2], Sirkka Vartiainen[2], Ari Venäläinen[3] and Marja-Liisa Sutinen[4]

[1] Geological Survey of Finland, P.O. Box 77, FIN-96101 Rovaniemi
e-mail raimo.sutinen@gtk.fi, maarit.middleton@gtk.fi
[2] Geological Survey of Finland, Betonimiehenkuja 4, FIN-02150 Espoo
pekka.hanninen@gtk.fi, sirkka.vartiainen@gtk.fi
[3] Finnish Meteorological Institute, P.O. Box 503, FIN-00101 Helsinki, ari.venalainen@fmi.fi
[4] Finnish Forest Research Institute, Eteläräntä 55, FIN-96300 Rovaniemi, marja-liisa.sutinen@metla.fi

Temporal stability of spatial patterns (time stability) of field measured soil water content has been attributed to soil texture and topographic curvature in agricultural soils, but limited information is available on time stability of soil water content of forest soils composed on non-stratified glacial tills. We studied time stability of soil water regimes by measuring soil dielectric (ε) properties of fine-grained glacial till (0-15 cm) at 1-m-spacing along a 110-m-long transect with TDR twice a week through one growing season, from 31 May to 1 October 2001, in Finnish Lapland. The former Norway spruce (*Picea abies* L. Karst.) site had clear-cut, subsequently burnt over and treated with mechanical site preparation using disk drenching, and regenerated to Scots pine (*Pinus silvestris* L.). Ten years after silvicultural treatments the measurements of soil ε, analyzed with Spearman's rank correlation coefficients, showed significant time stability (r^s=0.82-0.93; P<0.01) of soil water content for the whole season. Precipitation on July (122 mm) was twice as high as the average (1982-1999), but persistent pattern of the soil ε accounted for both the drying phase until the end of June and the wetting phase until the end in September. Soil texture or topographic curvature was found secondary compared to coarse fragment content in contributing to spatial persistence of the soil ε. The minute recovery of vegetation after forestry practices also demonstrated that evapotranspiration and root water uptake played negligible role in the soil water dynamics. Our results imply that time stability of spatial pattern of soil water regimes in glacial tills greatly accounts for the composition of tree species in northern boreal forests and should be taken into consideration when artificial regeneration is contemplated in the harsh climate of Lapland.

Conservation values on drained peatlands

Henrik von Stedingk and Johnny de Jong

Swedish Biodiversity Centre, Swedish University of Agricultural Sciences
Henrik.von.Stedingk@svek.slu.se

During the 20th century a large proportion of the Swedish peatlands were drained to improve forest productivity. Today there are several options for the future of the drained peatlands: ditch cleaning; to increase forest productivity, ditch filling; to restore wetlands, and peat mining; for peat combustion for energy production. From biodiversity point of view drained peatlands have often been considered as destroyed natural biotopes with low conservation values. This assumption opens for exploitive interests. However, included in the concept drained peatlands are various mire types with different drainage severity and succession after drainage. Therefore it is not possible to generalize the conservation status for drained peatlands. Further, in the Swedish national swamp forest and wetland surveys drained peatlands were automatically given low conservation statues and was rarely visited in the field. Hence, the nature values of drained peatlands in Sweden have not been studied thoroughly. We have identified environments or conditions that can be found in drained peatlands that could harbour conservation values: 1) Areas with little drainage influence and preserved mire function. 2) Late forest successions after drainage with deciduous trees and dead wood. 3) Open pine forest or swamp forest that act as refugia for old growth lichens and wood fungi. 4) Pools and stream like older ditches with running water.

In order to describe conservation values and develop indicators for identification of key-areas for conservation eight areas of drained peatlands, located in central Sweden, will be investigated. We will make inventories of vascular plants, saproxylic fungi, bryophytes, birds and ground living beetles. Landscape characteristics are important factors when discussing the biodiversity value for a specific object. In this study we will also analyse landscape information such as other inventories, hydrology, topography, peatland density, mire types, drained mires, forest age and configuration of key-habitats in GIS. The goal is to produce tools for decisions on what action to take: for compensatory action or choice of after treatment in relation to ditch filling or peat mining , for choosing mires to restore, or for deciding to leave the drained peatland as it is.

Scientific excursion

Excursion programme, Thursday 24th September, 2009.

Scientific excursion: How forest management in Finland provides environmental services in practice

Ari Laurén[1]

[1] Finnish Forest Research Institute, Joensuu Research Unit, Yliopistokatu 6, P.O. Box 68, FI-80101 Joensuu, Finland, ari.lauren@metla.fi

The excursion aims at demonstrating the connections between forest management and production of environmental services in forested areas in Finland. In the excursion three aspects of environmental services are represented: carbon sequestration, biodiversity and water. Carbon sequestration will be discussed at a site, where forest bioenergy is harvested, and biodiversity at a site, where peatland restoration has been done. Water protection issues will be discussed in connection with ditch network maintenance site.

The hosts of our excursion sites represent the three main groups of forest owners in Finland. From the total area of forestry land, 52 % is owned by private forest owners, 35 % by state and 8 % by companies. In the excursion the private forest owners are represented by Metsäkeskus, i.e. Forestry centre of North Karelia, the state forests are represented by Metsähallitus, and the company forests by Stora Enso.

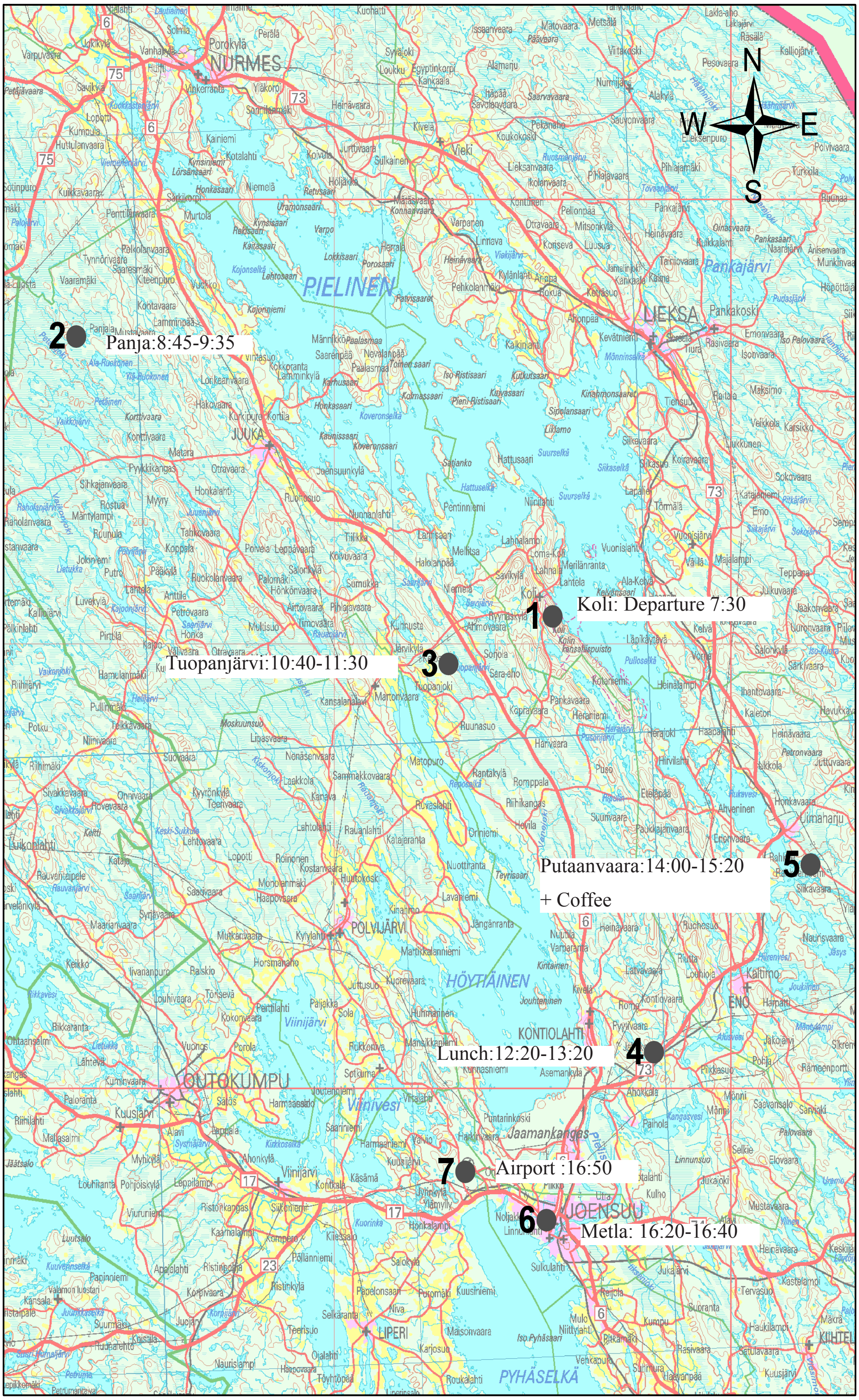
The first site at Panjanvaara near Juuka is hosted by Metsähallitus (Map point 2). Restoration of a ditched peatland has been conducted in the area in order to improve habitat quality for game, to restore peatland vegetation and to exploit the area in water protection.

The second site at Tuopanjoki is hosted by Metsäkeskus, representing the private forest owners in the North Karelia (Map point 3). In the Tuopanjoki area, ditch network maintenance has been done in a project involving 11 different private forest owners. The ditch network maintenance has been implemented taking into account water protection view points.

The third site at Putaanvaara is demonstrated by Stora Enso (Map point 5). The site consists of clear-cut areas altogether 11.9 ha, where forest bioenergy has been collected together with round wood. Methods and machinery for the bioenergy harvesting are demonstrated at the site.

Lunch is served at Kiertotien kievari -restaurant after the second site approximately at 12:20 (Map poin 4). After the discussion at the third site, Stora Enso sponsors us coffee in the field. Thereafter the bus continues to Metla Joensuu Research Unit, where some time is reserved for changing clothes and shoes before the transportation to the airport and railway station.

Map of the excursion



0 5 10 20 Kilometers

Excursion site

Restoration of Panja Riekkosuo mire

Arto Kammonen[1]

[1] Metsähallitus Eastern Finland, Hermannin aukio 3, P.O.Box 1058, FIN-70101 Kuopio, Finland
arto.kammonen@metsa.fi

Peatland restoration in Finland

About half of the peatland area in Finland, altogether ca. 5 millions of hectares, was ditch drained before the 1990s with an aim to enhance forest growth. Thereafter, an increasing concern about the environmental disadvantages of the drainage has ceased the drainage of pristine peatlands, and some of the drained areas have been managed to restore some of the original ecosystem functions and species structures of peatlands. Restoration has been conducted only in a small share of the drained peatlands; by the year 2007, ca. 15 000 ha of the drained peatlands was restored.

In the restoration, water fluxes in the catchment are changed by filling ditches, building dams and by cutting transpiring forest stands. Restoration enhances growth of peatland vegetation, creates suitable habitats for wildlife, but usually the restoration activities deteriorate quality of runoff water, at least for a period of a few years.

Restoration of Panja Riekkosuo mire

Before the drainage
The dominant peatland types in Riekkosuo area have been open mires and partly forested bogs. Present pine bogs in the area have apparently been open before the ditch drainage. Riekkosuo mire area is surrounded by a mosaic of mineral soil and peatlands. The surrounding forests are mainly composed of young stands. The nearest hills are Tynnörivaara in north east and Panjavaara in south. The surrounding forests are managed for commercial purposes forests, except of an old growth forest area that belongs to Natura 2000 network in Panjavaara. Riekkosuo is part of Luostanjoki watershed area and sub area watershed area is Kaitoo – Palojoki. Waters run northwest in this small sub watershed area. Later waters turn west and finally to the southern direction and lake Saimaa.

Drainage and its impacts
The primary ditching in Riekkosuo mire was conducted ditch in the 1970s. Ditching has changed structure of the forest stands and decreased biodiversity of the area. As a consequence, natural state of the area has diminished during the past three decades.

Restoration
Aim of the restoration in the Panja Riekkosuo mire was to improve habitats for willow grouse in area. Repaludification of the drained peatland was aimed to quicken the recovery of the typical flora in local peatlands. The restored area was aimed to be used in water protection as an overflow field cleaning the runoff from commercially managed forest areas at the upper catchment.

The land on the restored area is mainly non-productive or poorly productive forest land. Only two stands were classified as productive forest land. Riekkosuo mire was restored in 2008 by filling ditches and by cutting forest stands on Pine bogs. Whole tree harvesting was used, i.e. branches and foliage were removed from the area. The area of the restored peatland is 42 ha, and it is a part of larger mire having an area of 70 ha.

Planning of the restoration was done in co-operatation with Metsähallitus Natural Heritage Services (NHS) Wildlife and Forestry branches. In Metsähallitus conglomerate the game husbandry is in NHS. Forestry entrepreneurs and loggers conducted the restoration work according to the plans in Riekkosuo mire. The costs for whole operation were about 33000 euros. It was partly financed by EU and partly by Finnish government. With appropriate actions we hope to achieve positive effects on the area concerning game habitats, especially willow grouse and other fowls (Table 1).

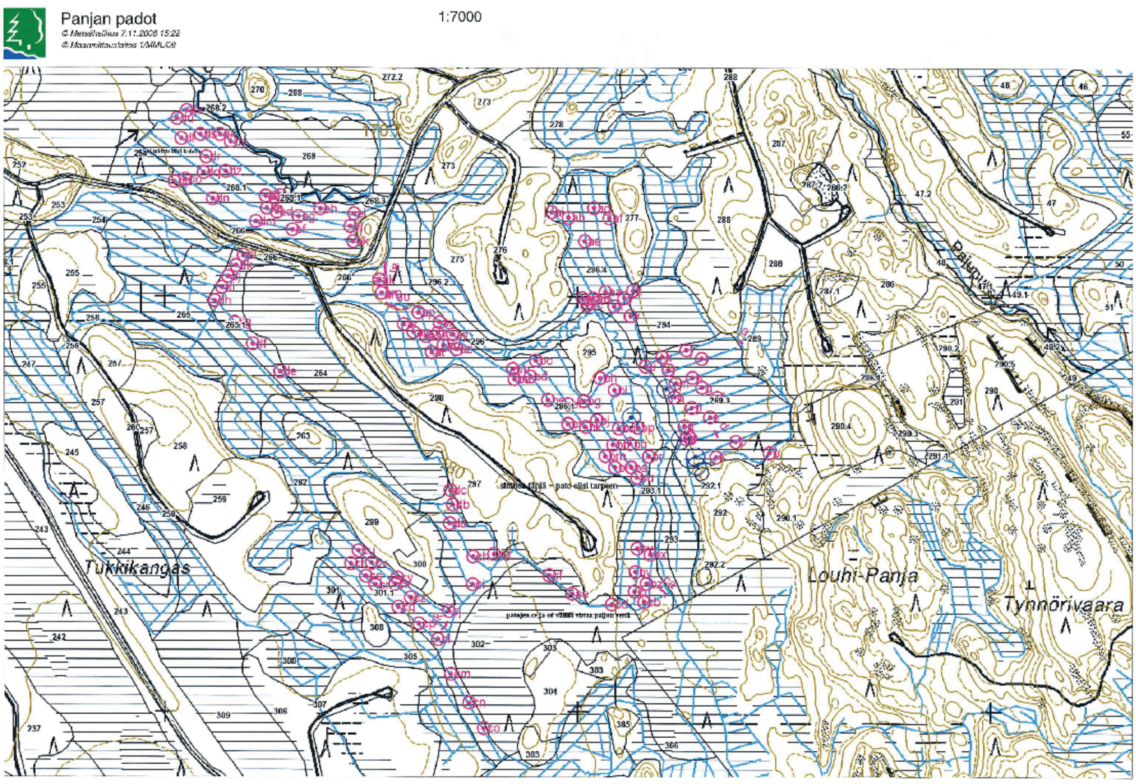
Table 1. Aims and actions in the restoration of Riekkosuo mire.

Aims	**Actions**
The willow grouse (Lagopus lagopus)	
Increase habitat openness	Standing volume and spacing of trees restored to a typical status of an unproductive bog
Improvement the habitat for willow grouse chickens to move and avoiding drowning in ditches	Filling the old ditches
Improving natural nutrition for game	Rehabilitation of natural vegetation by removing trees and damming ditches
Biodiversity	
Restoring the natural hydrology of the site to facilitate rehabilitation of peatland vegetation	Filling or damming the old ditches, direction of runoff evenly on the bog surface Tree stand volume was reduced to natural state
Improving habitat quality	A small pond was excavated for waterfowls
Water protection	
Take the benefit of the restored peatland in cleaning of the runoff waters from commercially managed forest upslope	Small dams and side ditches to are built to spread runoff evenly on bog surface. Peatland acts as a filter and vegetation uses some percentage of leaking nutrients.

In the future

Restoration activity is still going on in suitable areas, a few per year. To develop restoration methods, it is important to follow the results on the older restored areas. Do we get such results as planned? We do not intend to make any exact measurements, but we observe qualitatively, how paludification and natural water flow are restored. Also we compare how different methods of filling ditches or damming ditches work in long term.

Map: Dams built in connection to Riekkosuo restoration.



c Metsähallitus 27.8.2009
c Maanmittauslaitos 1/MML/09

Excursion site

Forestry on peatlands

Mika Nousiainen[1]

[1] Metsäkeskus Pohjois-Karjala, Siltakatu 20 B, 80100 Joensuu, Finland
mika.nousiainen@metsakeskus.fi

Ditched peatlands and forestry

About 5 million hectares of forest, that is ca. 25 % of the total forest area in Finland, is located on drained peatlands. Ditching of peatlands was most active during the 1960s and 1970s, and the target of the activity was to enhance forest growth. Before the large scale ditching, annual cuttings in North Karelia exceeded the increment of the growing stock. Ditching has received the targets; the annual increment in North Karelia has increased with ca. 50 % from the beginning of the 1960s and the increment has exceeded the cuttings. Ditching has ensured that forest management in North Karelia is sustainable from the wood production aspect.

Ditched peatlands play an important role in Finnish forestry now and increasingly in the future. During the ditching tree stands were rather small, but now the stands are coming to harvesting age. In North Karelia, it has been estimated that every fourth cut wood cubic metre comes from the ditched peatlands in the future.

Ditching of pristine peatlands has ceased and it is not allowed in present PEFC certification system. However, condition of the old ditch network deteriorates over time decreasing the forest growth. This problem is tackled with ditch network maintenance, where old ditches are cleaned and sometimes supplementary ditches are dug between the old ones.

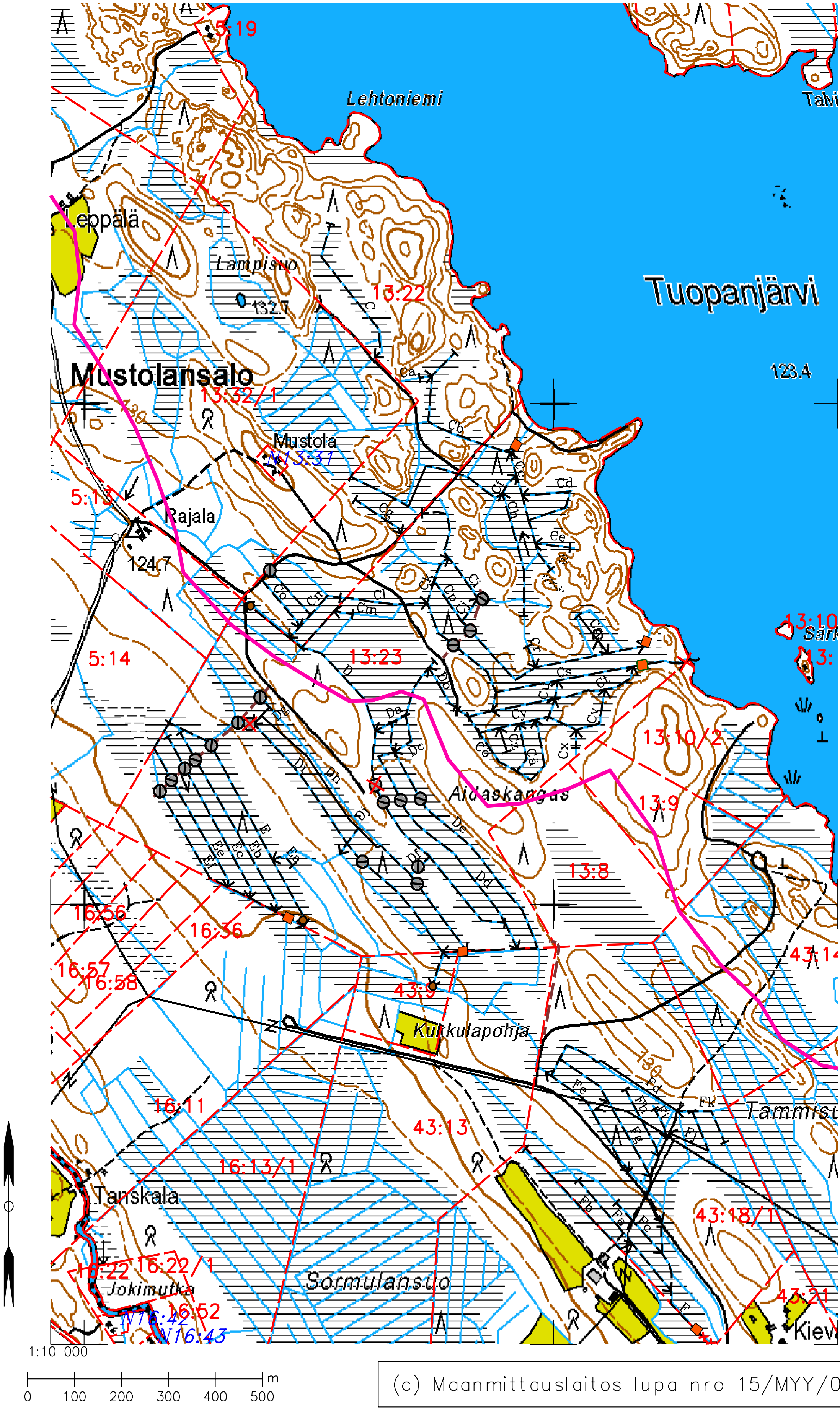
Water protection in ditch network maintenance

Water protection is an essential part of the ditch network maintenance. As obliged by the EU's water framework directive the ditch network maintenance is not allowed to deteriorate water quality in streams, rivers or lakes.

Different water protection methods are applied in ditch network maintenance. Water from the ditched area is directed first to sedimentation ponds to catch the coarse fraction of the suspended solids. From sedimentation ponds water flows to untreated buffer zones that are left between the stream and the ditched area to clean the runoff water.

Ditched pine stand in Juuka

- Operating area about 90 hectares
- 11 private forest owners in this project
- 9 sedimentation pools for catching the suspended solids
- State supports ditch network maintenance, for planning 100 % and for working 55 %.


Lehtoniemi
Tuopanjärvi
123.4
Leppälä
Lampisuo
132.7
Mustolansalo
Mustola
Rajala
124.7
5:19
13:22
13:32/1
5:13
5:14
13:23
13:10/2
13:9
13:8
Aidaskangas
16:56
16:36
16:57
16:58
43:9
Kukkulapohja
43:14
16:11
43:13
16:13/1
Tanskala
43:18/1
Tammist
16:22
16:22/1
Jokimutka
16:52
Sormulansuo
43:21
Kiev
1:10 000
0 100 200 300 400 500 m

Excursion site

Forest bioenergy

Jorma Kaukoaho[1] and Heikki Karvonen[1]

[1] Stora Enso Forest, jorma.kaukoaho@storaenso.com, heikki.karvonen@storaenso.com

Use of forest bioenergy in Finland

Substitution of fossil fuels with renewable energy sources increases the use of forest biomass for energy production. About one-fifth of Finland's energy is produced with wood, which is about five times more than the average in EU countries. This makes Finland the clear leader in the use of wood energy among the industrialised countries. EU's targets for the use of bioenergy are likely to increase the use of small diameter pulpwood in energy production.

The biggest share of the bioenergy used by Store Enso is composed of side products of pulping process, such as black liquor and bark. The use of forest residues including branches, canopies and stumps compose a smaller share, but their significance is increasing. In the future, production of new energy products, like biodiesel and ethanol, will challenge the traditional thinking of forest products.

Forest bioenergy harvesting

Site, machinery and yield of energy

The forest on the excursion site was dominated by Norway spruce with a Scots pine and Silver birch mixture. The harvesting area was 11.9 ha, from where the volume of the harvested wood was 3100 m^3. The harvested are is situated on mineral soil

In the clear cutting the logging residues are collected to loose piles, in which the residues are dried until the needles drop. Then the residues are collected to road side storages by using normal or modified forwarders. The residues are further dried in the road side storage. Drying can be enhanced by covering the piles with paper based wrappers. For the transportation residues are chipped with a mobile chipper. The use of mobile chippers is a low risk method for many kids of operational environments. The chips are transported by trucks for the further energy use.

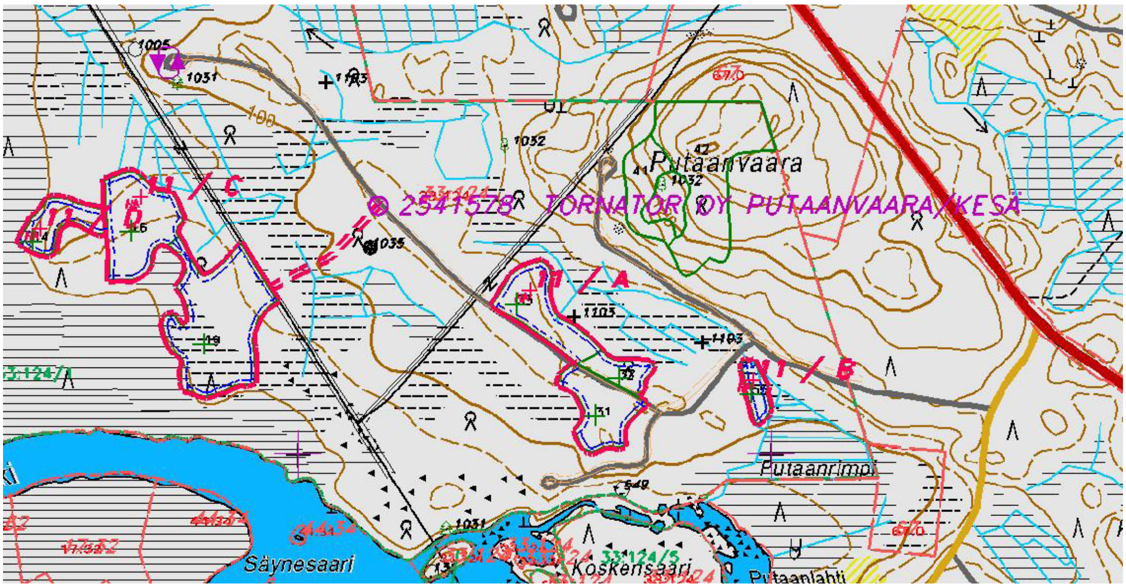
In this site the amount of forest residues used for the energy production is approximately 620 m^3, which yields to ca. 1100 MWh of energy. This corresponds to 124 000 litres of oil.

In the future

When the traditional pulp production in Finland is decreasing, the amount of energy from the side products, i.e. black liquor and bark, will decrease. Simultaneously the importance of forest residues in the bioenergy production will increase. The forest industry has good opportunities to develop the bioenergy business, because the organisation for the wood procurement and logistics already exists.

By far the same machinery can be applied for energy wood harvesting and transportation than for pulp wood harvesting and transportation. Stora Enso has a test biofuel plant in Varkaus, eastern Finland, which opens a front line place in the development of forest bioenegy use in the future.

Map of the site



MYY/029/09-V