Current climate change scenarios and risks of extreme events for Finland

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Abstract

A proper and timely adaptation to climate change and its impacts should be based on the best available knowledge on past, current and future climate, including information about average values, variations and extreme events. Future climate change cannot be predicted exactly. There are inaccuracies in observational estimates of the recurrence of extreme weather and climate events as well. Consequently, it is essential to give not only the best estimates of the magnitude of climate changes but also uncertainty ranges of the changes. When planning adaptation options, these ranges may be taken into account.

The greatest uncertainty in short-term climate forecasts arises from natural variations of climate. In the long run, the main uncertainties are related to deficiencies of climate models and greenhouse gas scenarios. The projections of changes in climate in Finland are mainly based on experiments performed with about 20 global climate models (Jylhä et al., 2009). Information derived from the output of global climate models has been complemented using simulations performed with regional climate models.

Based on the model simulations, climate in Finland will get clearly warmer – more so in winter than in summer. Accompanied with warming, many other climatic variables will change as well. The long-term trends in climate will be superimposed with natural climate variability, which will accelerate the climate changes during some periods and retard them during other periods, but these natural fluctuations cannot be predicted.

An important aspect in adaptation to climate change is the adaptation to the climate extremes. The warming experienced this far has been relatively small compared to the large natural temperature variability in Finland, but even so, it has apparently been sufficient to cause a marked increase in the probability of extremely high temperatures, and a decrease in the recurrence of very low temperatures.
References


ACKNOWLEDGMENTS

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The Mountain Pine Beetle epidemic in British Columbia: trees, beetles, fungi and climate change

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Abstract

The Mountain Pine Beetle (MPB; *Dendroctonus ponderosa*) and its fungal associates (e.g. *Ophiostoma clavigerum* and *Leptographium longiclavatum*) have caused an unprecedented epidemic in British Columbia over the past decade. Nearly 15 million hectares of forests has been attacked since 1993. The Mountain Pine Beetle carries fungal associates that are instrumental in tree colonization, infection and mortality, making the host a suitable environment for the beetles to lay their eggs and for the brood to develop. Although pine beetle epidemics are recurrent in Canadian forest ecosystems, this epidemic is one order of magnitude larger than previous ones. Among the factors believed to be contributing to the scale of the current epidemics are the increased area of susceptible host (pine stands > 80 yr-old) and increasingly favorable climate conditions, including reduced minimum winter temperatures (allowing brood survival) and increased summer temperature and reduced precipitations (increasing tree stress). These conditions have allowed the beetle to expand its range northward, at higher elevation, and across the Rocky Mountains into the zone of hybridization between logepole pine (*Pinus contorta*) and jack pine (*Pinus banksiana*). This recent movement could open the way for beetle attacks across the continent. High elevation pines, which are keystone alpine species, are also threatened by MPB as well as the White Pine Blister Rust. Our current research addresses the interactions between the trees, the beetles and its fungal associates from a genomics perspective. We are planning to generate genomics landscape maps of all three interacting organisms in order to better understand the migration, adaptations and potential interactions and to improve our predictive abilities.

ACKNOWLEDGMENTS

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Does restoration increase spruce bark beetle (*Ips typographus*) risk? – Experiences from Koli National Park, Eastern Finland

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Abstract

Restoration treatments of mature spruce forests mimicking natural hazards may result in an increased risk of bark beetle infestations. Commonly applied techniques for the production of decaying wood in boreal forests with management history are ring-barking and felling of individual trees or trees in groups. We applied the aforementioned techniques to the production of decaying and burned round wood in the restoration of even-aged Norway spruce stands with management history within the Natura 2000 area of the Koli National Park, Eastern Finland. In order to assess restoration-originated biotic risks to health of mature spruce forests, we implemented in 2005–2009 pheromone trapping for monitoring the changes in spruce bark beetle (*Ips typographus*) population in the restoration areas of Koli National Park and fresh logging areas as reference sites. After three years results, burning seemed to increase the spruce bark beetle population at the site considerably.
Effects of climate change on the interaction between *Ips typographus* and Norway spruce

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Abstract

Under current climatic conditions *Ips typographus* is always univoltine in Norway and completes a single generation between May and August. Further south in Europe, including Denmark and probably S-Sweden, development is bivoltine, with the completion of two generations in most years. By using a temperature-driven developmental model we have demonstrated that by 2070-2100 the voltinism of *I. typographus* in Norway will change dramatically (Lange et al. 2009). In a future climate where summers are only about 2.5°C warmer than today bivoltinism can be expected every single year in the most important spruce growing areas in S-Norway. This will probably have dramatic effects on forestry since two generations per year will give two, instead of one, attack periods each summer. In addition to increasing the number of attacked trees the effect of the attacks may also be more severe, as Norway spruce seems to be more susceptible to beetle attacks later in the summer. However, the susceptibility of Norway spruce to attack by *I. typographus* and its phytopathogenic fungal associates is also likely to change in response to climate change. Thus, we are currently modelling how tree resistance varies with temperature and tree phenology in order to provide more well-founded advice to forest managers on the interaction between bark beetles and tree in a future climate.

References

Heterobasidion parviporum - getting ready for the climatic change

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Abstract

Heterobasidion parviporum is the most important fungal cause of economic losses in boreal forests. In Finland the expected climatic change can be assumed to increase both spore production and mycelial growth of H. parviporum as well as the length of infection time. Despite the increased growth of conifers that will reduce damage caused by the fungus, the climatic change will undoubtedly increase Heterobasidion root and butt rot. In addition to temperature, also windiness and thus windfalls are estimated to increase. This effect will be accelerated by the weakening of conifer root systems and the lack of the ground frost. Therefore, a positive feedback between windiness and level of Heterobasidion root rot is expected.

In order to limit the destruction by Heterobasidion species, several new projects aiming ultimately to control it has been started. The work on mycoviruses has led to novel observations on their biogeography and also on their taxonomic dispersal capabilities among genus Heterobasidion. The possible usefulness of mycoviruses to control Heterobasidion root and butt rot are currently under evaluation.

ACKNOWLEDGMENTS

Ms. Marja-Leena Santanen is acknowledged for skillful technical assistance.
Testing different tree species for susceptibility to Heterobasidion annosum and Phlebiopsis gigantea – possible scenarios for climate changes in Latvia

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Abstract

Economical losses caused by root rot fungus Heterobasidion annosum s.l. in EU are about 500 million € per year. In Latvia, ca. 23% of Picea abies show presence of root rot. The damage will probably increase in warmer climate and hence the cultivation of more resistant conifers should be taken under consideration. The most commonly used biological control agent against Heterobasidion root rot in Europe is “Rotstop”, a preparation containing spores of Phlebiopsis gigantea. In Latvia „Rotstop” was registered in 2007. The goal of this investigation was to understand the development of H. annosum and P. gigantea in wood of Pinus, Picea, Larix and Pseudotsuga.

In period from July 2008 to March 2009, wood discs of Pinus sylvestris, P. contorta, P. strobus, Picea abies, P. sitchensis, Pseudotsuga menziesii and Larix sibirica were exposed to natural infection (basidiospores from a sporocarp) by H. annosum in different directions and distance from the spore source. Also the effect of artificial inoculation of the discs was investigated; the inoculation was carried out by conidiospores (representing both S type and P type of H. annosum). In total 798 wood discs were analysed by checking the occurrence of H. annosum on the discs. Pinus was the most susceptible genus to basidiospore infection and P. menziesii was least susceptible. Results with conidiospores were similar to basidiospores – the most susceptible tree species were P. sylvestris and P. strobus, least susceptible was P. menziesii.

For comparing the growth of H. annosum and P. gigantea in wood of different conifers, 98 billets from seven tree species were inoculated with several isolates of these fungi. We found, that P. gigantea grows faster in wood of Pinus strobus, P. sylvestris and P. contorta, than in Picea abies, Larix sibirica and Picea sitchensis, and there was no growth in Pseudotsuga menziesii. P. gigantea grows faster than H. annosum in Pinus contorta but in other tree species the situation was rather the opposite.
Ash decline in Lithuania: the current situation and research

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Abstract

The ash decline in Lithuania has started around 1996 and it still continues. Nearly all (95-99%) of our ash stands are damaged by the disease to a greater or lesser extent; many of the stands (nearly 30-40% of all ash stand area) have been already subjected to clear-cut (data provided by the Lithuanian Forest Sanitary Protection Service (FSPS)). In state-owned forests, there was an alarming rate of ash decline in 2001 (shift from 2320 ha of damaged ash stands recorded in 2000 up to 15200 ha in 2001). After the 2001, many of the stands were subjected to clear-cuts or sanitary fellings, however, due to new outbreaks of the disease the area of badly damaged stands is decreasing only slightly. Today, according to the observations by FSPS, only 25-30% (on average) of all ash trees in the observed remaining stands could be classed as externally healthy.

During investigations of ash decline in 2001-2003 in Northern and Central Lithuania, we concluded that a great majority of the investigated trees were colonised by Armillaria sp. Active root and stump decay caused by A. cepistipes was consistently recorded on a great number of the investigated trees, thus it likely contributed to and accelerated the decline of the investigated stands. Our results indicated that A. cepistipes was present on the investigated sites for at least 20 years without causing serious tree mortality. This confirmed the view of opportunistic behaviour of Armillaria in declining stands and pointed out to its secondary role in observed pathological process. Decay of stumps and roots negatively affects self-regeneration (sprouting potential) of ash, although health condition of the emerging sprouts does not correlate with the presence or absence of the decay. Disease symptoms on necrotic and dead sprouts are similar to those observed on wilting crowns of F. excelsior trees.

More recent studies had revealed likely primary cause of the ash decline – a hyphomycete Chalara fraxinea that attacks tree crowns. The pathogenicity of this fungus has been demonstrated by artificial inoculation tests. Early records of Hymenoscyphus albidus, the teleomorph of C. fraxinea, suggest that this fungus was present in Lithuania already before the massive ash decline and some environmental disturbance (or pathogen mutation, new hybrid?) could have induced its aggressiveness/reduced the resistance of ash. Among the
stress factors that could be involved in the ash decline, an increased frequency of dry years and a lowered level of ground water are usually mentioned.

**Keywords:** Armillaria, Chalara fraxinea, climate change, dieback, European (common) ash (*Fraxinus excelsior*), pathogenicity.
**Forest health decline after the climatic extremes in Estonia**

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**Abstract**

This time in our presentation the peculiarities of colonization of Estonia by the alien pine pathogens (together with the short characterization of the climatic excesses, the new alien species were already introduced by us at the meeting in Umeå in 2008) during some very first years of colonization of this country are analysed. A short characterization of the current situation in some other critical issues (ash dieback, wide scale stress and mortality of exotic species), attributed to or at least triggered by these climatic excesses is also given.

Followed by us growing number of the symptomatic records of these alien pine pathogens in Estonia, disseminating to north and, step by step, colonizing the habitats and host individuals, which were asymptomatic at the first inspections after the very first records of these alien pathogens in South-Estonia, allows us to conclude, that the large-scale occurrence of these species was actually new for Estonia and they obviously arrived from south.

Knowledge about these fungal pathogens already before their first records in Estonia was an important prerequisite for their early detection here.

After the lately climatic excesses an obvious and simultaneous worsening of the health status of several different tree species, especially of the exotics (e.g. several species of larches, spruces and also of deciduous trees) and of the native deciduous trees, growing here close to the northern borders of their ranges (e.g. common ash, pedunculate oak and white elm) has occurred in Estonia, accompanied by different, mostly fungal diseases.

An adequate consideration of the effect of the climatic excesses in the arrival and nearly simultaneously following dissemination of several new pathogens on several different tree species should improve the building up of the control strategy, incl. the principal decision making, do we need at all in the current situation any special (chemical) control measures, and, if yes, then against which definite secondary infectious diseases.
Analysing future risks due to climate change – case study in Kemijoki Oy

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Abstract

According to recent studies, climate change will transform the environmental conditions connected to hydropower production in Finland. It has been assumed that in the future there will be warmer temperatures, more rainy days as well as major precipitation and longer dry periods. The weather changes are estimated to be more significant during the winter times. The climate change will impose new high uncertainty risks and challenges for hydropower companies, because there is no factual data of relationships between climate change and hydropower production. Hence, some changes may also create opportunities for power companies. Because of these future climate change-related risks (and opportunities) a new risk assessment framework was developed. The main idea of the procedure was to integrate climate scenarios and traditional technical risk assessment in order to achieve a practical method for identify and evaluate climate change risks for hydropower plants decision-makers. During the development work several tailored tools to aid risk assessment process were produced. The use of the risk assessment framework requires co-operation between natural scientists, for instance hydrologists, meteorologists, and risk analysers. The results are represented in the four-fold table. With the help of the visualisation power plants' decision makers will be able to decide what kind of future operations are required to adapt according to the circumstances.
Means of forest management to adapt to climate change

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Abstract

Forest ecosystems may adapt autonomously, but the importance of forests for human societies makes it important to influence the direction and timing of the adaptation processes and measures. Adaptation is not something only to be applied in the future, but actions are needed now in anticipation of the future conditions. Development of the necessary actions is still highly speculative and susceptible to uncertainties in the development of future climate. On the other hand, the future socio-economic context is unknown, with a need of an adaptive forest policy that is responsive to a wide variety of economic, social, political and environmental circumstances.

In the context of sustainable forest management, the adaptation refers mainly to the management in order to reduce risks of unacceptable losses and damages. Damage may affect the basic functioning and structures of the ecosystem, with a consequent imbalance between different functions of forests to humans. The damage should be considered in relation to the management objectives; i.e. what are the services aimed at in the management and how sensitive are the different services to the climate change or climate variability.

The concept of the adaptive management refers to the management, which aims at moderating or offsetting the potential damage but taking also advantage of opportunities created by a given climate change. This occurs through adjusting and modifying the management to meet the requirements “to moderate or offset the potential damage or to take advantage of opportunities created by a given climate change”. In this context, the adaptive management is a strategy to make the structure and the consequent functioning of the forest ecosystem to resist harmful impacts of climate change, and to utilise the opportunities created by climate change.
Future Forests – tasks and goals in a Swedish research program

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Abstract

Future Forests is a recently started research program in Sweden. The focus of the program is on developing sustainable strategies for managing our forests in the future, taking into account uncertainty and multiple goals. The program, with a total budget of about 4 Mill Euros per year for the next four years, is jointly financed by the Foundation for Strategic Environmental Research, the Forest sector in Sweden, and two universities in Sweden. I will present the rationale behind the program, the research being done, and especially our approach towards interdisciplinarity and integration in the program. Information on the program can be found on http://www.futureforests.se.
Remote sensing as a tool for a survey of defoliation and yield losses

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Abstract

We will experience increasing problems with insect outbreaks, caused by dry summers and mild winters in high latitudes. Although climate change may increase forest productivity, heavy and large-scaled defoliation and devastation will cause yield losses. Efficient and accurate methods are needed for monitoring and predicting changes in defoliation and pest status. Remote sensing (e.g. optical and microwave satellite imaging and laser scanning) will provide clear advantages over former methods and contribute to damage models, e.g. through mapping pest distributions or areas at risk of foliage damage. Development is still needed in order to produce cost efficient and accurate survey methods in the field of forest protection.

I present one of the first efforts to map spatial distribution and classify defoliation intensity by *Diprion pini* and *Neodiprion sertifer* (Hymenoptera, Diprionidae) with an airborne (ALS) and terrestrial (TLS) laser scanning, aerial photographs and a satellite imagery (e.g. Landsat TM). This interpretation is based on georeferenced field plots by permanent plot sampling and adaptive cluster sampling, and changes in image features and leaf area caused by sawfly defoliation in North Karelia, E Finland. The features of satellite images and 3D laser point data, as well as site variables are used to classify study plots according to defoliation intensity. Further, by knowing defoliation intensity, estimates for growth losses and tree mortality can be modelled. Predictive bioclimatic models for shifts in pest distribution and damage are based on remote sensing data, and operating at different levels of climatic change scenarios. The combination of promising new technology will improve disturbance detection, predictive spatial modelling, and estimating growth and economic losses.

Keywords: Defoliation, laser scanning, pine sawflies, satellite imagery, spatial modelling, yield loss.
Annual variation in Scots pine diameter growth and its relation to weather variables in southwestern Finland in 1966-2007

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Abstract

Annual ring indices were estimated applying data from national forest inventories (NFI). Data from NFI6 (in 1971-1975) to NFI10 (in 2004-2008) were used. The estimated indices show annual differences between tree diameter growth levels (at 1.3 m height) as the most important stand and tree level factors affecting growth are fixed. Such concomitant variables are for example tree age and basal area of trees on the plot. The indices were estimated separately for different sites (5 site classes) and the co-variation with weather variables was studied. A database of smoothed (10 km*10 km grid) daily temperatures and precipitations produced by the Finnish Meteorological Institute was used in deriving values of weather variables: temperature sums (threshold 5 °C), precipitation sums, frost sums (threshold 0 °C), number of very warm summer days (max temp. > 25 °C), lengths of summertime heat waves (max temp. > 25 °C) and drought periods (daily precipitation sum < 2 mm).

Annual growth variations and the effect of weather variables seem to be site-dependent. On dry sites, rainfall between mid-May and the end of June is a decisive factor for Scots pine diameter growth. In addition, high number of very warm summer days has a decreasing effect on pine growth on dry sites. For intermediate and good sites it is not possible to find a single factor restricting growth as clearly as rainfall does on dry sites. It seems, however, that the temperature during early summer is of importance. Increase in the effective temperature sum in June increases growth, unless the number of very warm days during the early summer is high. High winter precipitation sums are also favourable to pine growth during the following summer, which is probably connected with sufficient soil moisture in the early part of the growing season. On sub-dry sites sufficient rainfall between mid-May and the end of June increases pine diameter growth.
Predicting the probability of severe droughts and changes in potential GPP under changing climate

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Abstract

Severe droughts during the growing period are currently rare in the boreal climate zone. The predictions of the future climate change do, however, suggest that rainfall events during the growing season may be more sparsely distributed but more intense. In addition, the predicted increase in temperature will lead to higher evapotranspiration. As a consequence, periods of drought may become more frequent. It has been suggested that this might reduce the biomass production of boreal forests. The soil water balance depends on soil properties, evaporation, plant transpiration, climatic conditions and micrometeorology, and their interactions. Therefore the probability of drought cannot be simply derived from scenarios of future climate, but a model taking into account the weather, soil and plant interactions is required.

In this study we estimated the potential Gross Primary Production (GPP) and the number of drought days with a model that couples a simple model of photosynthetic production based on meteorological parameters (air temperature, photosynthetically active radiation and water vapour pressure deficit) (Mäkelä et al. 2008), with a model for soil water conditions. We estimated the daily tree and understorey evapotranspiration (ET) during periods of no water stress using a semi-empirical model fitted to eddy-covariance measurements and calibrated it against measurements of soil water content at Hyytiälä research site in Central Finland. In the model, ET is also driven by meteorological conditions: temperature, irradiation and water vapour pressure deficit, modified by parameters reflecting stand properties (species, leaf area index, etc.). For periods of limited water availability, we reduced the GPP estimated for non-stressed conditions, according to the model of stomatal conductance during a drought by Duursma et al. (2008).

The soil water model was based on a model by Duursma et al. (2008). It utilises the open-bucket principle: soil water storage was described by the water holding capacity, i.e. the volumetric difference between water storage at the wilting point and at field capacity. The water storage is filled by precipitation and snow melt, while the water is depleted by evapotranspiration of both trees and ground vegetation, as well as drainage.
We used the combined model to calculate the potential GPP and probability of drought days under current climate conditions in a 10km*10km grid covering the whole of Finland. We then repeated this calculation with a simple simulation of climate change, increasing the temperature (by 3 or 5°C) and modifying the amount of precipitation (±10% from current). There are few drought days in current climatic conditions, and the drought risk concentrates on the coastal areas, where the precipitation due to sea effect is smaller than in inland areas. The results of the simulation indicate that the increase in drought risk under changing climate is rather modest, with the risk being greatest in soils with low water retention capacity. The benefit of increased temperature to the potential GPP is larger than the reduction due to drought; in all scenarios that we tested the potential GPP was increased. The increase was smaller on sites where the water retention capacity is low, and if decrease of precipitation was simulated. For sites with deeper soils, and with increase of mean temperature of 3°C and precipitation of 10% (as per the A2 scenario), the increase in potential GPP was up to 27%.

References


Storm risks on forestry in Finland - occurrence and risk management

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Abstract

The accurate information for spatial variation of return levels of stormy winds is crucial for the wind risk management in forestry. In this work, we studied first how the extreme wind speeds that occur once in 50 years (V₅₀) at the height of 10 meters in Finland did vary spatially (1 km grid) based on the reanalyzed global meteorological dataset known as ERA-40 (Uppala et al., 2005, www.ecmwf.int/ research/era), covering years 1957-2002. It was created using all relevant meteorological observations like radio soundings, surface observations and also satellite measurements. We also compared V₅₀ values calculated using ERA-40 with return levels estimated using measurements made at a few meteorological stations through Finland. For this purpose, the return levels were calculated in two ways: i) by assuming a constant surface roughness, and ii) by taking into account the spatial variation of surface roughness, as calculated to 1 km grid using the CORINE land cover dataset (CEC, 1994). According to these analyses, the highest values of V₅₀ were found at south-western part of Finland (43.8 m/s, over the Baltic Sea). The lowest values (11.2 m/s) were found at the forest covered inland areas. Inland lakes and fjeld tops represented areas of local maximums. The mean value over the whole land including the sea areas was 17.7 m/s. The V₅₀ grid values correlated relatively well with corresponding values calculated at meteorological stations.

In this work, we also studied the impacts of climate change on the regional risks of wind-induced damage (i.e. critical wind speeds and their return levels) through Finland. This was done by employing: i) national level forest inventory data, ii) current baseline climate (1961-1990) and changing climate scenario (FinnAdapt A2, 2001-2100), iii) a forest ecosystem model (SIMA), and iv) a mechanistic wind damage model (HWIND) predicting the critical wind speeds for uprooting of trees, and v) currently applied management recommendations in private forests. As a result of this work, we found that the proportion of relatively low critical wind speeds (<17 m s⁻¹) needed for uprooting of trees will decrease through Finland in autumn time (birch without leaves, expecting also unfrozen soil conditions) under the changing climate (until 2100). The return levels of such winds is also about every two years in the most south. These changes are related to the decreasing dominance of Norway spruce (the most vulnerable tree species to wind damage) and especially in south, favoring especially the occurrence of birch, but also Scots pine. Compared to south, in the north on average clearly stronger winds are needed to damage trees (larger share of Scots pine, on average lower h/d-ratio of trees than in south). The return periods of such winds are also high in north. Thus, despite of the fact that under the changing climate, the growing stock and potential cutting drain will both increase
significantly in Finland (and most in the north), the risk considerations for wind damage will be the most crucial task in the south, despite of any changes in future wind climate (with increasing unfrozen soil period).

References


Whole tree harvesting – facts and visions in regard to bioenergy production and environmental issues

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Abstract

Possible climate change and its potential global impact together with security of supply have been two major drivers behind the development of bioenergy in Scandinavia. Apart from a stable use of solid wood fuel in individual houses, it all started after the two oil-crises during the 1970ts. Initially the forest industry started to use more of its residues as a process energy source, but soon another market emerged with combined heat and power plants connected to district heating grids. This marked grew over time together with the wood-pellet industry and soon forest industry residues could not feed the market. Next step in the development was to harvest more of the tree biomass available during harvest of stem wood for the forest industry – namely logging residues i.e. branches and tops. However, the market growth is still high with an average annual growth in Sweden during the last five years equivalent to 1.5 million cubic meters of wood. Therefore, also stumps and small diameter trees, as well as silvicultural means to allow increased biomass harvest in the future are on the agenda today. A breakthrough for the second generation biofuels will further increase the pressure on forest biomass.

Combined effects of increased harvest and production intensity have raised concerns on environmental impacts in terms of long-term site productivity, biodiversity, soil damages, soil buffering capacity and green-house gas balance, together with effects on surrounding water ecosystems and ground water. But the acceptance for bioenergy is still high as it mitigates climate change and the forecasted impacts of a changed climate on the environment. It is likely that both biomass harvest and production intensity can increase further in Scandinavia, but there are most certainly limits even though the thresholds are unknown. Best management practice together with research and environmental monitoring combined with an adaptive forest management approach is suggested as a way to deliver more biomass to the energy market at the same time as environmental drawbacks are minimized and irreversible negative changes are avoided. Focus should be on effects at the landscape level rather than at site level and the time frame should be at least over one rotation period.
The pine weevil in a changing environment

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Abstract

Pine weevil damage in forest regenerations is a serious and costly problem. What are the prospects for the future? The environment affecting pine weevil populations is likely to change in many different ways. A changing climate with increasing temperatures will directly affect the development time and in long term perspective also the generation time of pine weevils in the north. The seedling damage will then probably increase in northern areas, which is a tendency that might already be discernable. In addition to increasing temperatures other abiotic and biotic factors are expected to change. Increased precipitation and new forest management methods are examples of such factors. The probable implications for future risk levels of pine weevil damage in regeneration areas will be discussed.
Increased damage by insect pests in Icelandic forests

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Abstract

Milder climate during recent years has resulted in the introduction of new insect pests and increased distribution of others in Iceland.

One of the new pests is a leaf miner on birch, the moth larva *Eriocrania unimaculella*. This insect was first noted in South Iceland in 2003 in the village Hveragerði, but its distribution seems slow and it has not yet spread to natural birch forests.

Another new pest, the leaf beetle, *Phratora vitellinae*, on willows, aspen and poplars, has been slowly spreading in the Reykjavík area. This insect causes severe damage on *Populus tremula*, *Salix myrsinifolia ssp. borealis* and some clones of *S. phylicifolia*. To a lesser extent it damages *Populus trichocarpa*, but has not yet been found in poplar forest plantations.

The lepidopteran species *Melanchra pisi* and *Operophtera brumata* have been increasing their distribution area. *M. pisi* is still restricted to the southern half of the country, but this summer it has been expanding in the western part of the country. It thrives well in lupine covered areas and from there attacks small forest plants.

The big news from this summer is the explosion like distribution of the larch tortrix, *Zeiraphera griseana*. Although named after larch, this species attacks many conifer species, and has been most severe on pines in the south and larch and fir in the eastern part of the country this summer. This species was first caught in light traps in the south in the nineties but has been very rare until now.
Response of wood decomposition by *Heterobasidion parviporum* to temperature changes and differentiation of subpopulations according to local climate

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Abstract

We determined the decomposition rate (DR) of spruce wood by isolates of *Heterobasidion parviporum* at various temperatures. Sixty three *H. parviporum* isolates originating from geographically distant and climatically varying environments (Finland, Denmark, Italy and Central Siberia) were cultivated at eleven temperatures ranging from -4°C to 33°C. Saw dust of Norway spruce (fresh sapwood and heart wood) was used as the only substrate and DR was determined as the production of carbon dioxide. Optimal temperature for decomposition varied considerably between the isolates and ranged from 20°C to 30°C. Average DR by all isolates was highest at 30°C and lowest at -4°C: 18 and 0.5 µmol CO₂/d/g of wood (d.w.), respectively. Based on these results, we calculated that a temperature increase of 2°C, for instance, would rise the DR by *H. parviporum* at winter temperatures (-4°C – 0°C) by 50%, at spring and autumn temperatures (0 – +6°C) by 30% and at summer temperatures (6°C – 20°C) by 20%.

The highest between-isolate variation in DR was observed at the extremes of the applied temperature scale, at 33°C and 0°C. At low temperatures (0 – +6°C) the DR by the isolates correlated negatively with the lowest monthly temperature of the location from were each isolate originated (e.g. at 6°C p = 0.000, n = 63), i.e. isolates from warmer regions were less active at low temperature. Hence, these data suggest that *H. parviporum* has differentiated according to local climate.