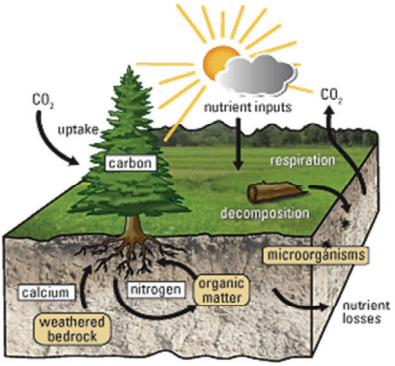
IUFRO Unit 4.04.07:

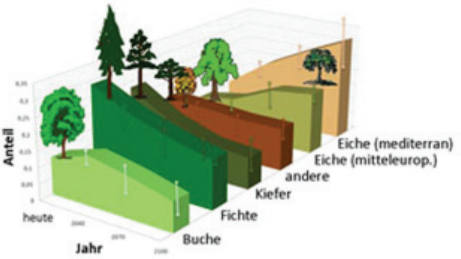
Risk Analysis: “Managing Risk in Uncertain Times”

21-23 April, 2016 in Freiburg

UNI FREIBURG



Source: U.S. Geological Survey created by Steven Prakis



Source: U.S. Forest Service

RISK ANALYSIS

IUFRO

Chair of Forestry Economics and Forest Planning

IUFRO Unit 4.04.07:

Risk Analysis: "Managing Risk in Uncertain Times"
21-23 April, 2016

Venue:
University of Freiburg
Chair of Forestry Economics and Forest Planning
room 200, on the 2nd floor
Tennenbacher Str. 4
79106 Freiburg, Germany

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Welcome to Freiburg!

Welcome to Freiburg and the 2016 Risk Analysis (IUFRO 4.04.07) Conference: "Managing Risk in Uncertain Times". IUFRO 4.04.07 was formed in 2012 with the intention of being a multi-disciplinary Working Party, devoted to exploring the application of a risk analysis framework (or methodology) to a diverse collection of forest resource issues. At our inaugural meeting in Chandigarh, India, 60 attendees from 5 countries heard 30 oral presentation to address the issue of risk from invasive, exotic forest species. Over the next 3 days we will devote ourselves to a more multi-faceted issue: how to manage risk during a time of rapidly changing climatic conditions.

Forest management planning and decision making have been able, in the past, to give only slight consideration to risk and uncertainty. Empirically-derived knowledge regarding the factors that are important in achieving desired ecosystem goods and services was plentiful, and uncertainty in this knowledge was generally not thought to be an important consideration. Today, our climate is changing at an unprecedented rate, and this rapidly changing climate is dramatically increasing our level of uncertainty regarding the biotic and abiotic processes that will determine the delivery of desired ecosystem goods and services. Under a changing climate the frequency and severity of natural disturbances are changing, post-disturbance (including post-harvesting) silvics are changing, and our models that attempt to capture these relationships are increasingly complex and uncertain. Overlaying all is a basic uncertainty in the details of our future climate and society's response to it. Forest resource management is developing novel approaches, such as adaptive management, to deal with the uncertainties. At the same time, risk perception by decision-makers and multiple stakeholders (with competing demands) will play a major role in determining management strategies.

We have 40 presenters from 18 countries to address this interesting and complex problem. We look forward to this opportunity to exchange ideas and form new collaborations.

David Gray and Rasoul Yousefpour

Schedule:
Managing Risk in Uncertain Times

Thursday, 21-April

Plenary

09:00-9:45 *Marc Hanewinkel, University of Freiburg, Germany*
Forest Decision-maker's perceptions of climate change, impacts and adaptation strategies

Section I: Risk Perception

09:45-10:10 *William F. Hyde, USA*
General Policy Uncertainty as an Overlooked Factor in Forest Management

10:10-10:35 *Christoph Hartebrodt, Forest Research Institute, Germany*
Objective-Related Risk Analysis with the Influence-Change-Exposure (ICE) Approach

10:35-11:00 *Torsten B. Möllmann, University Göttingen, Germany*
Impacts of standard risk-costs and risk attitude on investment decisions in forestry

11:00-11:30 **Coffee-Break**

11:30-11:55 *Daniel Mutenthaler, University of Natural Resources and Life Sciences, Austria*
Risk management in production planning and harvest scheduling

11:55-12:20 *Marielle Brunette, INRA, France*
A meta-analysis on farmer's risk aversion coefficient

12:20-12:45 *Stéphane Couture, INRA, France*
Is forest insurance a relevant support to induce adaptation efforts to climate change?

12:45-13:45 **Lunch Break**

13:45-14:10 *Philipp A. Sauter, Georg-August-University of Göttingen, Germany*
To insure forest assets or not - an analysis of foresters' behaviour

Section II: Modelling & Risk Prediction

14:10-14:35 *David R. Gray, Natural Resources Canada*
Quantifying the sources of uncertainty in model predictions of insect disturbances

14:35-15:00 *Mathieu Fortin, AgroParisTech, France*
Quantifying model- and sampling-related uncertainty in single-tree growth models

15:00-15:25 *Chris Kollas, PIK - Potsdam Institute for Climate Impact Research, Germany*
Biotic disturbances in the forest model 4C – from defoliators, root & stem rots, xylem cloggers to phloem feeders

15:25-15:50 *Matthias Albert, Nordwestdeutsche Forstliche Versuchsanstalt, Germany*
Forest Conversion in the Face of Drought Risk – Uncertainty in Forest Planning

15:50-16:20 **Coffee Break**

16:20-16:45 *Mathieu Fortin, AgroParisTech, France*
The impacts of windstorm and drought events in regional projections of sessile oak and European beech in Northeastern France

16:45-17:10 *Rami Saad, Swedish University of Agricultural Sciences, Sweden*
The potential for improvements in forest management planning by the application of data assimilation procedures

17:10-17:35 *George Z. Gertner, University of Illinois,Urbana-Champaign, USA*
Uncertainty Budget for a Lidar Driven Forest Growth Simulator

17:35-18:00 *Young-hwan Kim , National Institute of Forest Science, Republic of South Korea*
Estimation of Forest Carbon Stock Changes in Korea

18:30 **Conference Dinner at Schwarzwälderhof**

Friday, 22-April

Plenary

09:00-09:45 *Gerard B.M. Heuvelink, Wageningen University and ISRIC World Soil Information, The Netherlands*
Uncertainty propagation in spatial environmental modelling

Section III: Risk Assessment

09:45-10:10 *Kaja Mathilde Aamodt Heltorp, Norwegian University of Life Sciences, Norway*
Do Norwegian forest owners and decision makers adapt to climate change?

10:10-10:35 *Lidia Sukovata, Forest Research Institute, Poland*
Risk analysis of the nun moth outbreaks, possible counteractions and outcomes

10:35-11:00 *Oliver Jakoby, Swiss Federal Research Institute WSL, Switzerland*
Predicting phenology and infestation risk of the European spruce bark beetle (Ips typographus)

11:00-11:30 **Coffee Break**

11:30-11:55 *Radek Novotný, Forestry and Game Management Research Institute, Czech Republic*
Changes in wood anatomy features of mountain spruce (Picea abies (L.) KARST.) as a consequence of the combined effect of air-pollution load and climatic stress

11:55-12:20 *Samuli Junttila, University of Helsinki, Finnland*
Measuring leaf water content with dual-wavelength scanning LiDAR

12:20-12:45 *Radomir Balazy, Forest Research Institute, Poland*
The use of satellite data and growth models in the analysis of wind damages in Forest District Miedzylesie

12:45-13:45 Lunch Break

13:45-14:10 *Serban O. Davidescu, Forest Research and Management Institute, Romanie*
Expressing the physical condition of torrent control hydrotechnical structures using an equation assessing the cumulative impact of all damages occurred during exploitation

Section IV: Risk Management

14:10-14:35 *Rasoul Yousefpour, University of Freiburg, Germany*
Dealing with the risks and uncertainties of climate change in forestry

14:35-15:00 *Klaus Keller, Penn State University, USA*
How can we find robust climate risk management strategies under deep uncertainty and multiple objectives?

15:00-15:25 *Fabian Härtl, Technische Universität München, Germany*
A forest management planning approach considering risk aspects

15:25-15:55 **Coffee Break**

15:55-16:20 *Karlo Beljan, Faculty of Forestry, Croatia*
Historical forest management approaches and their influence on forest resistance to current natural hazards – a case study in Croatian beech–fir stands

16:20-16:45	*Michal Petr, Forest Research, UK* Diverse forest planners' climate change risk perceptions
16:45-17:10	*Rafal P. Chudy, Norwegian University of Life Sciences, Norway* Risk and uncertainty in forest sector modeling- the state of the art and future research directions
17:10-17:35	*Andrei Adorjani, National Institute for Research and Development in Forestry "Marin Dracea", Romania* Integrated GIS solution for monitoring torrent control structures
17:35-18:00	**Discussion**

Field Trip "Black Forest"

Saturday, 23-April

Time Schedule

08:00 Start from street „Tennenbacher Str. 4."

09:30 Arrival at the 1st Site "Lotharpfad"

12:00 Lunch Break at the 2nd Site mountain inn "Kernhof"

14:00 European Ash decline

15:30 Travel back to Freiburg

16:15 Optional stop at the train station „Offenburg" (Closer to Airport „Frankfurt am Main" ~2.15 Hours and ~2.15 to Basel Airport)

17:15 Arrival at Freiburg

Tour Guides:

Dr. Christoph Hartebrodt,
Head of Department of Forest Economics at the Forest Research Institute, Baden-Württemberg, Coordinator of the Federal Project "Competence Network Crisis Management, Climate Change and Transformation of Forest Ecosystems (KoNeKKTiW)"

Yvonne Chtioui,
Project Coordinator KoNeKKTiW

Site 1: 15 Years Later – Management of Large-Scale Storm Disasters and Regeneration of destroyed Forest Stands

Hurricane Lothar caught the people of Baden-Württemberg around noon on 26 Dec., 1999. The strongest squalls (up to 210 km/h) lifted roofs off, cut power lines and broke or uprooted trees. Roads and railway tracks were also impassable. Lothar hit, not only the south-west of Germany, but France and Switzerland were also affected. The hurricane felled 185 million m³ wood altogether in Western Europe.

The consequences for the forests of Baden-Württemberg amounted to about 40,000 hectares of windthrow and about 30 million m³ felled wood, which are more than 300% of the normal annual yield. The centres of the damage in Baden-Württemberg were located at the western slopes of the Black Forest along the Rhine Valley. The hurricane, making its way from central France, hit these areas with force. A second center was located in the North-eastern parts of Baden-Württemberg. Even so-called "stormproof" deciduous trees that had adapted to the soil were uprooted or broken. Nevertheless, more than 80% of the damages involved coniferous trees, especially spruce stands (64% of the damaged trees). The

livelihood of some forest farmers in the center of the Black Forest was threatened by these damages. For the region Lothar was the second severe hurricane within ten years after "Vivian and Wiebke" which hit in February/ March 1990.

	million m³	**in normal annual yields (%)**
Baden-Württemberg	**30**	**350**
Community forests	14.1	N/A
State forest	10.7	N/A
Private forests	5.1	N/A
Switzerland	**12**	**250**
France	**138**	**400**
Europe (sum)	**185**	**N/A**

Hurricane Lothar's path

The *Hurricane Lothar's path* (in German Lotharpfad) is a forest experience and educational trail, which is named after the storm itself. As

fallow through indoor livestock

r regions of the Northern Black

th spruce. As these regions were

greatly damaged.

After the storm, the nature conservation and forestry administration decided to designate the 10-hectare big area along the Hurricane Lothar's path as protected forest (in German Bannwald) in order to observe in the long term the natural regeneration of the area. The project is managed by the Ruhestein National Park Centre.

In June 2003, along the Black Forest High Road, B 500 (in German Schwarzwaldhochstraße) between Ruhestein and Kniebis-Alexanderschanze as part of the European Union funded project Grindenschwarzwald a 800 m long educational and forest trail was created, which passes through stairways, bridges and trails made of salvaged windfallen wood as well as above and below fallen trees– the Lothar path in a narrow sense. An observation deck offers a view over Braunberg,

Lierbach, Oppenau, Strasbourg and the Vosges; when visibility is good up to Feldberg, Kaiserstuhl and to the Alps.

Topics:

- Economic Consequences of Large-Scale Storm Events
- Climate Change and Extreme Events
- Challenges and Practical Management of Large Scale-Storm Events
- Regeneration of Stands – Planting versus Natural Regeneration

Site 2: Lunch Break

Typical Black Forest Meal in the mountain inn *Kernhof*, Anno 1638 with a brief lunch lecture on "Multi-pillar strategies as a key component of mixed farm forest enterprises in the Black Forest"

Site 3: Management of New Risks - Mountain Ash Dieback in the Southern Rhine Valley History, Present Challenges and Conclusions for Future Risk Management

Description of Mountain Ash Disease

After the discovery of this new fungal disease (Hymenoscyphus pseudoalbidus), damage to crops and natural regeneration were recorded. In southwestern Germany the disease increasingly affects thinned-out pole stands, timber and dieback crowns. It leads to an increase in the dying of larger ash trees.

The common ash tree (Fraxinus excelsior) and the narrow–leafed ash

hern and Central Europe through the spread of fungal of infected nursery materials.

In Germany, the disease could for the first time be described with direct proof in 2007 and in early 2009, it was also detected in Baden-Wurttemberg. Studies on infected branches showed, however, that isolated instances of the pathogen must have already been here already two to three years prior. Meanwhile, we can already talk about an extensive occurrence. While initially it was predominantly crops and natural regeneration that were affected, now it is increasingly pole stands and timber that are affected by the disease.

Forestry in the Lowland of the Rhine Valley

In the Rhine Valley there are quite a number of mostly communal forests, which are characterized by relevant shares of mountain ash. Due to the

disease described above these forest enterprises face severe silvicultural and economic consequences, such as loss of standing volume, future imbalances in the age class distributions and related consequences like discontinuity of outlay and income.

Presentation and Discussion of a Real Case

A greatly affected forest enterprise will be visited, where the consequences and potential options will be discussed together with representatives from the Forest Administration and the local community.

Topics

- Management of New Diseases
- Mountain Ash Disease
- Communal Forestry in Baden-Württemberg
- Consequences for Forest Management in Greatly Affected Forests
- Diversification of Forests as a Key strategy

Oral Presentations

Forest Decision-makers' perceptions of climate change, impacts and adaptation strategies

Marc Hanewinkel
University of Freiburg

Abstract

After a general introduction dealing with impacts of climate change on forests and adaptation strategies on the European level, the paper presents results of a questionnaire study that has been conducted within a large-scale integrated EU project on forest owners' perceptions of climate change and their readiness to take adaptive measures in different European countries, covering a North-South gradient. The paper highlights the importance of the decision makers' beliefs and personal experience of their readiness to take adaptive measures and it discusses how value profiles of different groups of forests owners and the background in terms of education may influence their behaviour. The paper closes with general conclusions on the importance of taking into account individual perceptions of decision makers to promote adaptation strategies to climate change within forest management.

Keywords: risk attitude, climate change adaptation, personal beliefs, climate change impacts

General Policy Uncertainty as an Overlooked Factor in Forest Management

William F. Hyde
retired, United States of America

Abstract

This paper is about uncertainty—a close relative of risk—as a determinant of forest management and forest sector development. Uncertainty in the macroeconomic policy environment, and even in the application of forest policy itself, has been largely outside the inquiry of most of us who are interested in forest policy. Yet evidence from several developing countries suggests that general policy uncertainty can overwhelm the impact of even well-designed forest policy. This paper reviews a few examples, including the effect of policy modifications, and even policy reversals, in China since its introduction of market reforms in 1978. Policy uncertainty, in these examples, has a universally negative effect on the local forest and on regional forest development. The paper continues with econometric evidence from a sample of 2490 forest manager households across eight provinces taken in three annual samples corresponding to China's second round of forest reforms beginning approximately in the year 2000. The results measure the effects of an improved bundle of land use rights, increased durability of those rights, their enforcement and the reliability of political leaders. Our evidence shows that each of these factors increases managerial confidence, reducing uncertainty, and is a measure of the decrease in uncertainty. Both labour and capital investment in the households' forests increase, while in addition forests improve, as well as the local human welfare.

Keywords: uncertainty, forest policy, China

Objective-Related Risk Analysis with the Influence-Change-Exposure (ICE) Approach

Christoph Hartebrodt, Yvonne Chtioui
Forest Research Institute, Germany

Abstract

Only a few forest enterprises have adopted conceptual risk management thus far. Instead of showing a proactive, preparatory, and preventive behaviour, forestry, is used as a responsive crisis management practice mainly following large-scale natural disturbances. In the context of an ongoing global change this behaviour is coming more into question.

Derived from the impact – vulnerability – exposure concept of the Intergovernmental Panel on Climate Change and the ecological pressure – state – response (inter alia UN) approach, a more comprehensive model for risk analysis was developed. In contrast to traditional approaches, which focus mostly on individual reasons for disturbances (e.g. storm and bark beetles), risk is seen as the probability of non-performance of strategic (or operative) objectives.

Using systems thinking for these entrepreneurial objectives, a three-level analysis pattern was developed in which three aspects are assessed:

- Related INFLUENCING FACTORS (I)

- CHANGES when these factors enter into force (C)

- Structures and processes, which limit or increase the EXPOSURE of the individual objective (E)

The approach and its technical transformation are introduced and its strengths and shortcomings are discussed.

As the ICE method has been successfully introduced in a significant number of case studies on enterprises and institutions, insights into the practical application and possible outcomes are provided. Here, the focus is put on the objectives and average risk of non-performance, the most important influencing factors, the related changes, and the factors in the exposure level. An outlook on the future improvements completes the presentation.

Keywords: Three level (Influence-Change Exposure) Analysis, Description of Concepts, Case Study Results

Impacts of standard risk-costs and risk attitude on investment decisions in forestry

Torsten B. Möllmann (1); Philipp A. Sauter (2); Friederike Anastassiadis (2); Oliver Mußhoff (2); Bernhard Möhring (1)
1: Department of Forest Economics and Forest Management, Georg-August-University of Göttingen, Germany; 2: Department for Agricultural Economics and Rural Development, Georg-August-University of Göttingen, Germany

Abstract

When a forest manager makes a decision about an investment (e.g. choice of tree species or of rotation period) he basically uses yield tables, costs and prices to calculate his financial outcome. Due to natural and human incidents he will also have to consider risks. These risks affect him in two ways. Firstly, due to premature harvest, lower wood quality, higher costs for harvest, and other factors, his income will be lowered. This difference between a deterministic model, and one carrying risk, is also known as standard risk-costs. Secondly, the expected income varies, which also lowers the utility of a risk averse investor. Standard risk-costs can be calculated using hazard estimations such as survival functions and information about the financial consequences in the case of an calamity. To calculate the influence of risk one has to know the attitude towards risk.

Since little is known about the attitude towards risk of German forest owners and forest managers, the study conducted a lottery choice task during an online survey with 140 participants. The participants were also asked to estimate price and cost changes in the case of calamities. In the following, standard risk-costs will be calculated and then the influence of standard risk-costs and risk aversion on forest investment decisions will be evaluated.

Keywords: Risk management, risk-costs, attitude towards risk, forest investment

Risk management in production planning and harvest scheduling

Daniel Mutenthaler
University of Natural Resources and Life Sciences, Austria

Abstract

Climate change is increasingly recognized as an additional strategic challenge for commercial timber production. The associated hazards are most likely to further increase the risk of production, which is indicated by the share of sanitary fellings. In Austria for instance, sanitary fellings clearly already exceed a quarter of the total cut. In addition, market risks especially in terms of price fluctuations, are of great significance. So far however, risk management (RM) seems to rely mostly on self-insurance in terms of huge stocks of growing timber and an exceptionally high share of equity capital, at least in the Austrian private forest sector. The tools applied in strategic planning generally disregard any kind of risk or uncertainty.

Explicit RM in forest enterprises could increase the efficiency of production and the significance of planning exercises. For this purpose, a comprehensive framework for RM has been designed which encompasses all levels of decision making. A checklist helps to identify the specific requirements of any forest enterprise. Within this framework, several tools for production planning and harvest scheduling capable of handling risks are characterized according to an evaluation design. The significance for practical decision support is assessed in terms of a trans-disciplinary approach. The results indicate to what extent a respective tool is ready for practice and which amendments would be necessary in order to bridge the gap between theoretical concepts and their real world application.

Keywords: planning tools, evaluation, transdisciplinary research, forest management planning

A meta-analysis on farmer's risk aversion coefficient

Marielle Brunette (1); Johanna Choumert (2); Stéphane Couture (1);
Claire Montagné-Huck (1)
1: INRA, France; 2: CERDI, France

Abstract

Although widely studied, attitude towards risk of farmers remains a common research topic in experimental economics. The relationship between farmer's risk aversion coefficients and characteristics of the farmers and the studies is still in question. Using 63 studies, we shed light on why farmer's partial, absolute and relative estimated risk aversion coefficients differ. We investigate the incidence of choices made by authors (elicitation method, measure of risk aversion coefficient, payoff choice) and characteristics of the farmers (geographical location, type of activities) on the estimated risk aversion coefficients. Our results show that the model for the relative risk aversion coefficient has a stronger explanatory power than those for partial and absolute coefficients. We also show that some variables explained the three coefficients: published article, elicitation procedure, type of activities, while others variables like OECD and hypothetical/real payoff have no impact whatsoever on the estimated coefficient. Finally, we observe that the partial risk aversion coefficient is only estimated in developing countries with Ordered Lottery Selection as the elicitation method.

Keywords: risk aversion, risk preferences, meta-analysis, farmers

Is forest insurance a relevant support to induce adaptation efforts to climate change?

Marielle Brunette (1); Stéphane Couture (1)
1: INRA, France; 2: CES-Cachan, France

Abstract

One of the challenges of forest adaptation to climate change is to encourage private forest owners to implement adaptation strategies. In this paper, we analyse forest insurance contracts against natural hazards as a vector to promote the implementation of adaptation effort by private forest owners. For that purpose, we propose a theoretical model of insurance economics under risk and under uncertainty. Our results indicate that when climate change makes uncertain the probability of occurrence of the natural event, then it may be relevant to consider adaptation efforts into the insurance contract because it increases the adaptation effort of a risk averse and uncertainty averse forest owner. In addition, we show that the relevance of insurance as a vector to promote adaptation efforts is higher when the forest owner's effort is unobservable by the insurer as compared to a situation of perfectly observable effort. Then, under some realistic assumptions, forest insurance contract seems to be a relevant tool to encourage forest owners to adapt to climate change.

Keywords: forest, insurance, risk, uncertainty, climate change, adaptation strategies

To insure forest assets or not - an analysis of foresters' behaviour

Philipp Sauter (1); Torsten Möllmann (2); Friederike Anastassiadis (1); Oliver Mußhoff, (1); Bernhard Möhring, (2)

1: Department for Agricultural Economics and Rural Development, Georg-August-University of Göttingen, Germany; 2: Department of Forest Economics and Forest Management, Georg-August-University of Göttingen, Germany

Abstract

Natural risks in forestry have become more frequent in recent years and are expected to further increase according to climate change scenarios. Current governmental measures often focus on financial support in case of disaster. However, this could lead to high financial burden in the future and thus, the current support system should be reconsidered with regards to privatizing respective risks. Insurance policies could play an important role in this issue; however, forest assets are rarely insured in many European countries. To promote the concept of insurance contracts, the question arises as to which factors influence the decision making process behind insuring forest assets. To analyse decisions to insure against fire and storm risks, we conducted an online discrete choice experiment with 135 German foresters, using various policy scenarios and hypothetical forest enterprises dominated either by beech, spruce or pine. As a preliminary result without any public aid, about 20% of participants reveal a WTP for the fire insurance and the combined fire and storm insurance is equivalent to an actual insurance premium, while the WTP for the storm insurance is about half of the other insurance solutions. Public compensation after a disaster, which is current practice in several European countries, leads to reduced willingness to pay (WTP). On the other hand, subsidised insurance premiums and public compensation on the condition that the stand is insured, leads to increased WTP.

Keywords: forest insurances against fire and storm risks, foresters' behavior, discrete choice experiment, policy support

Quantifying the sources of uncertainty in model predictions of insect disturbances

David Richard Gray
Natural Resources Canada, Canada

Abstract

Insect outbreaks are the most important natural disturbance in the boreal forests of North America, and outbreaks of the spruce budworm (SBW; _Choristoneura fumiferana_ [Clem.]) are arguably the most severe of these. Outbreaks of this native defoliator occur somewhat regularly every 20–50 years over approx. 0.8 × 106 km2, predominantly in eastern Canada. Across this range, the outbreak erupts asynchronously, lasts for a variable number of years, and exhibits varying levels of severity. Defoliation during an outbreak reduces tree growth, and prolonged severe defoliation causes extensive tree mortality. There are enormous effects on timber supply, carbon flux, and wildfire occurrence. Forest policy must account for future outbreaks, but must also consider the uncertainty in the predictions of those outbreaks. Predictions have relied on correlative techniques where uncertainty exists in: 1) past outbreak data and the associated climate and forest conditions used to construct the predictive correlative model; and 2) estimates of model parameters. Additional uncertainty arises from 3) the future climate and forest conditions used in the projections; and 4) differences in the scale at which the model was constructed and projections are made. The contributions of these sources of uncertainty are examined and compared.

Keywords: initial conditions, pest outbreaks, multivariate predictions

Quantifying model- and sampling-related uncertainty in single-tree growth models

Lara Climaco de Melo (1,2); Robert Schneider (3); Mathieu Fortin (1,2)

1: AgroParisTech, France; 2: INRA, France; 3: Université du Québec à Rimouski, Canada

Abstract

Single-tree growth models aim at reproducing the three basic components of population dynamics: individual mortality, survivor growth and recruitment of new individuals. Each one of these components is represented by one or many statistical sub models. When fitted on field data, the sub models that compose the model have many sources of uncertainty that arise from the errors in the parameter estimates, the random effects and the residual error terms. Moreover, the model predicts the evolution of sample plots and not the population itself. We refer to this latter source of uncertainty as the sampling related uncertainty, as opposed to the previous sources that are model-related.

In this study, we simulated the evolution of a sample of plots using a single-tree simulator ARTEMIS-2009 (Fortin and Langevin 2012). Given the complex error propagation, the simulations based on Monte Carlo technique in which all sources of model-related uncertainty were taken into account. We tested which components of population dynamics brought the largest amount of uncertainty over a 50-year growth forecast. The stochastic features were successively disabled in each sub model to assess its contribution to the total uncertainty. Finally, we compared the model-related uncertainty to that induced by the sampling. The change in the relative contribution of the different growth components over time is discussed in this presentation as well as the importance of the sampling issue.

Fortin, M. and Langevin, L. 2012. Stochastic and deterministic single-tree models: is there any difference in growth predictions ? Annals of Forest Science 69 : 271-282.

Keywords: Growth modelling, Monte Carlo techniques, Stochastic simulations, Variance, Sampling

Biotic disturbances in the forest model 4C – from defoliators, root & stem rots, xylem cloggers to phloem feeders

Chris Kollas; Martin Gutsch; Petra Lasch; Felicitas Suckow; Christopher Reyer
PIK - Potsdam Institute for Climate Impact Research, Germany

Abstract

Process-based forest growth models are suitable tools to analyse impacts of climatic change on the dynamic of carbon and water fluxes in forest ecosystems. In the past, modelling studies of future forest growth were driven by climatic & edaphic factors and by silvicultural management only. However it is clear that also biotic (insects, pathogens) and abiotic disturbances (fire, wind) play a major role in future forest growth dynamics. Still, models representing these disturbances at the stand level are rare.

We introduce an approach (1) incorporating biotic disturbance in the process-based forest stand model 4C. In the framework applied, insects and pathogens are considered at the level of functional groups (e.g. defoliators, bark beetles, phloem feeders) or can be introduced by a species-specific parametrization (i.e. mistletoe, _Viscum album austriacum_). In a model experiment the impacts of disturbance by the five functional groups on forest growth and interactions with drought events are illustrated. As a further step, we present detailed analyses of a (observed and modelled) mistletoe outbreak on a mature pine stand in the southwest of Berlin, Germany.

Results are discussed with respect to (1) the basic assumptions (2) the sensitivity of disturbed forest growth and (3) the uncertainty introduced by biotic disturbances. Last, we will provide an outlook on ongoing model based applications on disturbance impacts at the national level (e.g. Germany).

(1) Dietze, M.C. and Matthes, J.H. 2014: Ecol. Lett. 17:1418-1426.

Keywords: process-based forest model, disturbance, biotic interactions, pathogens, ecophysiology

Forest Conversion in the Face of Drought Risk – Uncertainty in Forest Planning

Matthias Albert; Robert Nuske; Hermann Spellmann; Johannes Sutmöller
Nordwestdeutsche Forstliche Versuchsanstalt, Germany

Abstract

Forest management in central Europe faces a climate induced shift in forest growth potential as well as increasing current and emerging new abiotic and biotic risks. In forest planning, forest conversion may be an adequate measure to counter possible negative effects of climate change. Among many potential conversion measures, selecting tree species is a long-term commitment and therefore a careful evaluation of future risks and expected growth potential is inevitable.

Simulating possible forest developments helps to evaluate the impact of environmental changes. We apply a business as usual scenario reproducing today's silvicultural practices in Germany and project forest development under climate change in four regions in the lowlands of northern Germany. The regions follow a climatic gradient from west to east with increasing temperatures and decreasing precipitation. The simulations from 2011 until 2070 are driven by climate projections provided by the regional climate model STARS. We employed three climate runs (minimum, median, maximum) selected from 21 global climate model projections based on the emission scenario RCP 8.5.

We analyse how drought risk as one major restriction affects tree species selection. Firstly, we define drought risk using the critical limit approach for site water balance and derive species-specific thresholds. Secondly, we estimate drought stress induced potential height growth reductions. Based on these findings we show the consequences for forest conversion under climate change.

We incorporate uncertainty in the drought risk assessment using the minimum and maximum climate run to describe the lower and upper bounds of prospective climate change.

Keywords: forest conversion, tree species selection, drought risk, climate change, uncertainty

The impacts of windstorm and drought events in regional projections of sessile oak and European beech in Northeastern France

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Abstract

Windstorm and drought events are major disturbances for European forests and they may cause a great deal of damage at the regional level. Although they have been largely studied, the recurrence period of those events is still an open debate. Forest managers wonder what the impact of these major disturbances will be in the next decades if their recurrence period remains the same or if it eventually increases.

In this study, we used the single-tree model MATHILDE in which the damage caused by windstorm and drought events is explicitly taken into account (cf. Manso et al. 2015). Data from the national inventory for the Northeast region of France were gathered and used to simulate forest growth over the next 50 years. Monte Carlo techniques were used to simulate the occurrence of windstorms and droughts under different recurrence times while assuming a business-as-usual management regime in the simulations. The errors in the parameter estimates of the model, the random effects and the residual error terms were also simulated. The impacts of more frequent disturbances on forest growth are discussed in this presentation. We also present how the mean predicted values and the variance of the predictions are affected.

Manso, R., Morneau, F., Ningre, F. et Fortin, M. 2015. Incorporating stochasticity from extreme climatic events and multi-species competition relationships into single-tree mortality models. Forest Ecology and Management 354: 243-253.

Keywords: Windstorm damage, Drought, Monte Carlo techniques, Stochastic simulations, Forest growth

The potential for improvements in forest management planning by the application of data assimilation procedures

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Abstract

Uncertainty in forest information typically results in an economic loss as a consequence of inaccurate decisions. Several techniques were proposed to assess and handle uncertainties, in size and effect, in forest planning, e.g. sensitivity analysis, scenario analysis and probabilistic framework. Considering uncertainties in forest planning, using the proposed techniques, had been in many cases a difficult and complicated task to solve as a result of either large or unknown uncertainty in the forest information. Data assimilation (DA) as a method of improving the quality of existing information has been advocated recently for use in forest data acquisition. DA offers great opportunity to make use of new sources of information, e.g. remote sensing data, and combine them with the available data. DA procedure has shown a potential to provide (i) known uncertainty, (ii) smaller uncertainty in forest information, (iii) more frequent information updates, (iv) cost efficiency (v) allow optimized measurement decisions and (vi) increased utility and as a consequence a decrease in suboptimal loss. In this review, previous studies related to uncertainty in forest planning and decision making under uncertainty were employed to discuss the benefits of DA in forest planning and decision making.

Keywords: uncertainty; suboptimal loss; airborne laser scanning; combining data; Bayesian statistics.

Uncertainty Budget for a Lidar Driven Forest Growth Simulator

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Abstract

The US Forest Service FVS (Forest Vegetation Simulator) is a very widely used growth model developed for projecting individual trees and forest development through time. FVS is now being used to evaluate a variety of global change scenarios as it relates to forest health, carbon life cycle analysis, sustainability, wildlife habitat, wildland fires, etc. In this paper, the total error in form of an uncertainty budget is developed for FVS projections, where initial models inputs are spatially explicit single-tree stem maps developed with small-footprint airborne lidar (Laser Imaging Detection and Ranging). An uncertainty budget shows the overall precision of estimates/predictions made with a system, partitioned according to different types of uncertainty sources within and outside of the system. In a comprehensive fashion, sources of uncertainties due to measurements, classification, sampling error, model parameter estimates, are accounted for in the lidar derived stem maps and within the FVS system. Spatially identifying the sources of uncertainties in time, modelling their propagation and accumulation, and finally, quantifying them locally on a tree basis and globally on a forest level are presented. Uncertainties in future forest responses, due to uncertainties in projected global climatic change predictions that will also drive this type of forest model, will also be discussed.

Keywords: Error budget, LIDAR, risk analysis, sensitivity analysis, uncertainty analysis

Estimation of Forest Carbon Stock Changes in Korea

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Abstract

Korean forests had been seriously degraded during the early 20th century, but reforested in the 1970s and 1980s. The National Reforestation Project in Korea successfully restored the forest cover and increased the carbon stock. However, as forests get mature and old, the annual net growth of carbon stock could decrease in the next few decades. This research was intended to estimate the forest carbon stock changes in Korea. For estimating the net growth of carbon stock, a forest carbon model was developed to consider various forest management options (e.g., afforestation, regeneration, use of wood products, use of woody biomass energy, etc.) and their mitigation potentials. Also, for estimating the change of forest stock, a forest growth model was developed based on the field survey data acquired from the National Forest Inventory in Korea. The result showed that the total carbon stocks of Korean forests would steadily increase from 429M tCO2 in 2010 to 670M tCO2 in 2050. However, the annual growth of carbon stock was projected to dramatically decrease, due to the heavily skewed age distribution. Since 81% of Korean forests ranged from 20 to 50 years old, the annual growth rate was rapidly decreasing by 2050 as forests became mature. Mitigation options for forest management help increase total carbon stocks but hardly change the pattern of decreased annual growth of forest carbon stock. To obtain more stable growth of carbon stock from Korean forests, it is necessary to increase age diversity in the forest landscape.

Keywords: Forest Carbon Stock, Forest Management, Age Distribution, Greenhouse Gas Mitigation Option

Uncertainty propagation in spatial environmental modelling

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Abstract

Input data for spatial environmental models may have been measured in the field or laboratory, derived from remotely sensed imagery or obtained from expert elicitation. Data are also often digitised, interpolated, classified or generalised prior to submission to a model. In all these cases errors are introduced. Although users may be aware that errors propagate through their models, they rarely pay attention to this problem. However, when the accuracy of the data is insufficient for the intended use then this may result in inaccurate model results, wrong conclusions and poor decisions.

In this presentation I review statistical methods for quantification of uncertainty in environmental data and for analysis of uncertainty propagation in spatial environmental modelling. The emphasis is on Monte Carlo simulation methods. We will also discuss geostatistical modelling of spatial interpolation error and address the effects of spatial auto- and cross-correlations on the results of an uncertainty propagation analysis. Quantification of model parameter uncertainty is covered using Bayesian calibration techniques.

The methodology is illustrated with real-world examples on pesticide leaching in soil, coastal inundation mapping and geometric correction of airborne imagery.

Keywords: Spatial environmental Modelling, Spatial Uncertainty, Bayesian Sampling, Geo-statistics, Decision-making

Do Norwegian forest owners and decision makers adapt to climate change?

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Abstract

The main objective of this project is to study whether and how Norwegian forest owners and decision makers adapt forest management decisions to knowledge about climate change (cc). The research-project is a part of the Ph.D.-project: "Forestry and forest management in an uncertain environment- adaption to climate change". Supervisors: Hans Fredrik Hoen and Terje Gobakken (NMBU) and Annika Kangaas (Luke).

A combination of in-depth semi structured interviews, combined with a survey to a larger sample of respondents.

The research questions were:

What knowledge and perceptions does forest owners and decision makers have of cc?

What knowledge and perceptions do forest owners and decision makers have of possibilities to adapt and mitigate forest management to knowledge about cc?

When making operative day-to-day decisions about regeneration, rotation ages (harvesting), and other silvicultural investments, does the owner or decision maker consider risk and uncertainty (R&U) related to cc?

Does R&U related to cc affect the strategic (long-term) management decisions?

Ongoing and future cc is likely to impact growth, mortality, stability and yield in Norwegian forests and forestry. There is uncertainty about the predicted climate scenarios, about how cc will influence the forest, the markets for forest commodities, frequency of extreme weather and so on.

Considering all this levels of risk and uncertainties, both in long-term planning and when taking operative management decisions, will become increasingly important for the forest owner or decision maker. Knowledge and perceptions about climate change is likely to influence will and ability to adapt to new conditions.

Keywords: Perception, climate change, adaption.

Risk analysis of the nun moth outbreaks, possible counteractions and outcomes

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Abstract

All types of human activity, including forestry, are based on making decisions. Changing climate poses different risks to environment, e.g., outbreaks of emerging insect pests, changes in location, duration, and frequency of known insect species.

Forests in Poland are dominated by Scots pine, mainly due to poor soil quality. They are affected by different insect pests, mostly defoliators. Their outbreaks lead to high tree defoliation, and consequently to such environmental effects as: a) lower vitality and higher susceptibility of trees to abiotic stress, pathogens, and secondary insect pests, b) reduced tree increment, c) higher tree mortality, etc. The outcomes for the forestry management are: a) the increasing amount and costs of silvilcultural measures required in the affected forests, b) lower income from wood production, c) unexpected changes in the forest management plan, etc.

The extent of the negative effects of insect outbreaks on forests and forestry depends on a wide variety of different factors, including site conditions, forest structure, outbreak scale and longevity, etc. Thus, the decision-support system would be a useful tool to help forest managers in analysing the risks and different counteraction-outcome scenarios. The system should include:

- models for medium-term probability prediction of the outbreak onset,
- models for classifying the forests in the groups of different outbreak risks,
- criteria to assess current outbreak potential of insect populations,
- possible silvicultural and protective counteractions and their cost-benefit ratio.

Some of these components developed for the nun moth, _Lymantria monacha_, management in Poland will be presented.

Keywords: Lymantria monacha outbreaks, decision support system, forest management, predicitve and classification models, cost-benefit ratio

Predicting phenology and infestation risk of the European spruce bark beetle (Ips typographus)

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Abstract

The European spruce bark beetle Ips typographus is the most significant insect pest in European spruce forests. The infestation risk of a forest stand depends on a multitude of different biotic and abiotic drivers, including stand characteristics, climate factors and disturbances, and may be altered due to management and climate change. For adequate risk management it is crucial to know which changes in the beetles' phenology and the forest predisposition are to be expected at different time scales. Therefore, we developed and combined static and dynamic modelling approaches to investigate the effect of these drivers and to predict the current and future risk of bark beetle infestations.

In this study, we illustrate the beetle phenology and the predisposition of forest stands for Switzerland under current environmental conditions and how this is likely to alter under climate change scenarios. This approach allows identifying regions with increased future infestation risk, e.g. due to faster beetle development or increased drought stress of host trees. Moreover, we demonstrate how the models are made available to the practice on our online platform www.borkenkaefer.ch. This webpage provides predictions of daily and forecasted bark beetle development and flight activity on different spatial scales.

The information provided by both the model and the online platform can be used by stakeholders and practitioners to evaluate short- and long-term management strategies. Altogether, this study demonstrates how models can be used to evaluate environmental risks and how scientific knowledge can be transferred into practice to support ecological risk assessment in forests.

Keywords: Bark beetle infestation risk, climate change, online information platform (www.borkenkaefer.ch), forest stand predisposition, dynamic simulation model.

Changes in wood anatomy features of mountain spruce (Picea abies (L.) KARST.) as a consequence of the combined effect of air-pollution load and climatic stress

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Abstract

The changes in wood anatomy features of mountain spruce were studied in the Ore Mountains (Czech Republic, border region to Germany) where extreme stress event occurred during the winter 1995/96. The event was characterised by a sudden temperature break, that was followed by heavy frosts and by a long-term inversion situation associated with the accumulation of air pollutants (SO2, F) in the inversion layer and subsequently also in the extreme rime.

Nine spruce stands representing the gradient of forest damage after the winter 1995/96 were selected for the study. In 2014 increment cores were taken. Tree rings in the period 1991 – 2001 were examined to cover the years prior and after the stress event. The following anatomic parameters were measured separately for both earlywood and latewood: number of cells, lumen width, cell-wall thickness and radial cell diameter. Proportion of latewood was also taken into consideration.

Anatomical features of both early and latewood were affected by the stress, however, with the maximal effect occurring with a lag of 1 year from the time of event. The earlywood part was more responsive and showed a higher variability of parameters than did the latewood part. Analyses showed that the most responsive anatomical parameter is the number of tracheids. For earlywood the differences in lumen width, radial cell diameter and cell-wall thickness were also significant.

The study demonstrates the relevance of anatomic parameters as the stress indicators. The work has been carried out under the framework of the COST FP1106 network STReESS.

Keywords: Wood anatomy, Norway spruce, Air pollution, Climatic stress

Measuring leaf water content with dual-wavelength scanning LiDAR

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Abstract

Climate change is posing a serious threat to forest health. The amount and intensity of disturbances caused by biotic and abiotic factors, such as drought, pest insects and fire, are increasing globally. Change in vegetation moisture content is an important early indicator of biochemical changes caused by such disturbances.

It is a challenge to discriminate understorey and canopy biochemical parameters such as Equivalent Water Thickness (EWT) by using remote sensing. LiDAR measurements can provide range-resolved estimate of reflectance improving the mapping of forest canopy biochemical parameters with the ability to discriminate canopy and understory signal. Here, the potential of dual-wavelength scanning LiDAR in the detection of vegetation moisture content was investigated in a laboratory setting. Small-leaved Lime (_Tilia cordata_), Silver birch (_Betula pendula_) and Norway maple (_Acer platanoides_) leaves were sampled from the trees and measured with two terrestrial scanning LiDARs utilizing two different wavelengths (690 nm and 1550 nm). The leaves were measured 15 times and dried naturally during the 72 hour measurement campaign. The weight of the sample leaves were measured and leaf area determined before each LiDAR measurement in order to determine leaf moisture content. Preliminary results showed a strong relationship (R2=0.89) between the LiDAR intensity data (1550 nm) and the EWT of leaves. LiDAR intensity data at 690 nm showed also a strong relationship with EWT against modeling results of the effect of leaf water content on leaf optical properties. Further analysis of the data is still in progress and more results will be presented at the conference.

Keywords: lidar, multispectral sensors, terrestrial laser scanning, leaf water content, drought, forest health

The use of satellite data and growth models in the analysis of wind damages in Forest District Miedzylesie

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Abstract

The aim of the study was to evaluate the amount of damages caused in the Forest Stands by an atmospheric phenomenon called "the downburst", which affected Forest District Międzylesie (south-western Poland) on the 8th of July 2015. To evaluate the area of damages in particular forest stands, the Black-Bridge satellite imagery and the Normalized Difference Vegetation Index were used. The amount of damages was estimated by the local forest rangers (103 thousand m3) and compared to the results obtained by the Mathematical Model of Growth (168 thousand cubic m3) and these, calculated from the area of damages and the average volume of the particular forest stands, gathered in NFIS database (161 thousand cubic m3). The analysis showed that the forest service estimations were under-represented. The Mathematical Model of Risk proved that most of the forest stands in Międzylesie were highly and very highly endangered by strong winds. The fallen trees are very dangerous either for people and the ecosystem and they have to be quickly disposed. This is why the Forest Service needs reliable and quickly accessible data and software. The satellite imagery along with the mathematical tools and GIS technologies presented in the study enable to estimate the amount of damage on the areas which are hardly available for the foresters and their vehicles, and may accelerate the decision-making process and the disposal of fallen trees. Due to their high usefulness, growing availability and declining prices, these tools should be introduced to local forestry as quickly as possible.

Keywords: wind damages, remote sensing, GIS, growth models

Expressing the physical condition of torrent control hydrotechnical structures using an equation assessing the cumulative impact of all damages occurred during exploitation

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Abstract

Torrential watershed management is a traditional forestry activity in Romania lasting since the beginning of 20-th century. During that long period of time more than 18.000 hydrotechnical structures, especially check dams (less than 5 m height) and drain channels were built.

Those structures were placed in different environmental conditions and in the present day, their status varies depending on how they behave during their service. Thus, in order to have better funding for repairs, a hierarchy of damaged torrent control structures establishing the repair order is needed. The repair order needs a parameter which expresses the cumulative impact of all damages incurred during service.

Using data collected from almost 4000 hydrotechnical structures all around Romania from 2008-2011 a new parameter, called condition rate (Ys) was defined. The parameter takes account the most frequent damages, being defined as the square root of the sum of products between three terms: the weight given according a multi-criteria analysis to each damage; the damage intensity and a conversion factor in order to homogenize the different scales used to assess damage intensities.

This paper propose a new equation for the condition rate that includes all damages that occurred starting from the behavioral analysis of the same structures inventoried previously. The multi-criteria analysis establishing the weight of each damage is improved taking account the impact of each behavioural event on the structure's physical condition and the affected component of the structure. Also, the new approach takes into account the intensity of each damage at which the structure fails.

Keywords: condition rate, hydrotechnical torrent control structures, behavioral event, damage

Dealing with the risks and uncertainties of climate change in forestry

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Abstract

The main strategies to deal with climate change management in forestry are fourfold; i) adapt to its risks and impacts, ii) make robust decisions, iii) wait and improve the knowledge-base, and iv) do-nothing/continue with BAU. The level of complexity, amount of information, liberty in adjusting novel strategies and urgency for action defines which of these main strategies may be superior to others. The higher decisions' impacts, costs, irreversibility, and vulnerability of the ecosystem to climate change, the more crucial the timing and flexibility of decisions. Monitoring of actions outcomes and current merging consensus among politicians about climate target at the end of the century would decrease uncertainties and may approach decisions towards adaptation strategies.

Keywords: Climate target, deep uncertainty, adaptatipon, real options

How can we find robust climate risk management strategies under deep uncertainty and multiple objectives?

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Abstract

Anthropogenic greenhouse gas emissions cause climatic changes. The projected climatic changes drive risks. Identifying sound strategies to manage these risks poses non-trivial analytical challenges. For one, the projections are subject to deep (also referred to as Knightian) uncertainty that may be reduced in the future. In addition, stakeholders and decision makers often hold diverse values that result in complex multi-objective trade-offs. This presentation reviews the current state-of-the-art in characterizing the deep uncertainty surrounding climate projections and discusses methods (e.g., Hadka, D., J. Herman, P. Reed, and K. Keller: OpenMORDM: An Open Source Framework for Many-Objective Robust Decision Making. Environmental Modeling and Software 74, 114-120, DOI: 10.1016/j.envsoft.2015.07.014 (2015)) that can help to navigate the deeply uncertain trade-offs.

Keywords: Deep Uncertainty, Robust Decision Making, Trade-Offs

A forest management planning approach considering risk aspects

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Abstract

Forests provide many different benefits regarding ecological, economical, and social services. But traditional forest management planning and decision making is primarily based on timber production only. A second important point is that our knowledge about the future is always uncertain, even if we would not face climate change. So it is important to integrate risk as a measurement of expected uncertainties into decision tools for forest management.

YAFO is a decision support system that uses non-linear programming techniques to integrate risk aspects like timber price fluctuations and survival probabilities of trees into the planning process. Using data from forest growth simulators that has been evaluated with timber prices the tool derives economical optimized harvest schedules for forest enterprises by maximizing a predefined threshold of the net present value (value at risk).

Doing so, YAFO has the ability to consider different management scenarios (e.g. different price scenarios or different growth/management options due to climate scenarios). By using constraints it is possible to integrate other aspects into the optimized objective, like the provision of certain ecosystem services.

A first example of the application of YAFO is the derivation of timber supply scenarios using different price scenarios for Bavaria. Results show that it would be rational for forest owners to reduce their timber supply on the market if they expect rising prices.

A second example shows two case study areas in Montafon and Slovakia, where the consequences of providing an ecosystem service (protection against avalanches) were investigated under current and changing climate.

Keywords: economic optimization, risk integration, forest management planning, nonlinear programming

Historical forest management approaches and their influence on forest resistance to current natural hazards – a case study in Croatian beech–fir stands

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Abstract

Mixed beech–fir forests in Gorski kotar region, Croatia, were owned by several landowners during the 18th century. The interests and the organizational level of each owner appointed their approach to forest management. It is assumed that consequences of applied past management models are being manifested in the present stand structure, and also reflected in forest stability and resistance to natural hazards.

The research covered 109.000 ha that was governed by several ownership types during the last two centuries (state forests, landlords, estate and land communities). Historical archive sources were used to investigate former forest management and detect previous estate boundaries. Stratification of actual National forest inventory plot data enabled determination of present forest structure by (former and present) landowner types. In the year 2014 the whole area was affected by high intensity ice break. A sub-sample of NFI plots was remeasured after the ice break event to quantify the incurred tree damage and assess its spatial dynamics. The influence of past and present ownership type on present stand structure was analysed and its possible effect on stand resistance to ice break was assessed.

Results indicate differences in present forest stand structure according to the historical ownership types and also indirectly due to a different effect of ice break. Areas that were managed according to uneven-aged mixed forests approach are found to be more resistant to ice damage. In contrast, areas managed by owners who favoured pure conifer stands with significant share of pioneer tree species were more affected by ice break.

Keywords: beech – fir forests, history of forest management, ice break, damage, forest ownership, Gorski kotar

Diverse forest planners' climate change risk perceptions

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Abstract

All decisions forest managers or planners make involves risk. This risk describes, in the context of climate change, a lack of knowledge about its impacts on forests expressed either quantitatively or qualitatively. We understand quantitative risk as a calculated forest model output combining information about the probability of a hazard and its impact, such as drought probability and its impact on tree growth. We understand qualitative risk as people's perception related to intuitive judgements or feeling about a hazard (Slovic 1987), such as expectation of a pest outbreak. The perceptions will affect what risks foresters will address in their management, which will influence whether or not they will be willing to take adaptation measures and change their management. Hence, we need to better understand how forest planners perceive climate change risks over the next 30 years. To answer this question we conducted a survey with British forest planners managing the public forest estate (27% of woodlands in the Great Britain) using seven judgement scales. We investigated the major risks occurring in British forests, namely wind, drought, pests, fire, frost, and water-logging. Our findings show that forest planners, on the one hand, indicated high concern and increase in frequency of pests, drought, and wind risks but on the other hand, believed in high regulation and control for these risks by forest policy and planning (Petr et al. 2014). These findings might cause inertia for taking suitable climate change adaptation measures.

Keywords: risk perception, climate change, survey, forest planners

Risk and uncertainty in forest sector modelling- the state of the art and future research directions

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Abstract

Every investment is associated with risk. Forest belongs to the group of long-term investments, where the risk and uncertainty level associated with the management and planning are changing over time. Various approaches, theories and methods of how to incorporate risk and uncertainty into long-term forest management have been developed and implemented. Compared to general business economics and insurance mathematics, applications of entire risk and uncertainty decision processes are undeveloped in forestry.

Many studies deal with risk and uncertainty in forestry, but most of them apply to stand level and abiotic hazards (climate, wind, snow etc.). Very few studies have incorporated risk and uncertainty in forest sector models, i.e., economic models of forestry and forest industries.

The aims of this study are to: 1) present a comprehensive synthesis of studies that deal with risk in forestry and forest sector modelling, 2) study how risk and uncertainty factors are incorporated in models in sectors such as agriculture, fishery, energy and whole economy modelling, 3) analyse how insight from these studies from other sectors may be used for risk and uncertainty analyses in forest sector models, 4) identify the gaps and areas for future research.

Moreover, we propose principles of good practice to limit the risk and uncertainty in deterministic forest sector modelling.

Keywords: risk, uncertainty, forest sector modelling, meta-analysis

Integrated GIS solution for monitoring torrent control structures

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Abstract

Promoting a multifunctional, sustainable and competitive forestry, in order to prevent environment degradation through human activities, involves, beside many other actions, monitoring the forested areas prone to flash floods, including (where available) torrent control infrastructure.

The IT solution, designed to manage the database, gathers data regarding torrent control structures in Romania and allows their filtration using different selection criteria (type, location, used materials, damages etc.). The results can be view as tables, graphics or exported for further use.

The aim is to ease torrent control structure analysis for scientific research, identify and plan their repairs, especially for those having a low condition rate (Ys) and to be used by forester students for educational purpose.

The database may be freely queried, authorized users having access to add or modify data, based on their roles and capabilities in the system. The solution is built entirely using free software, (PHP, MySQL, Wordpress, Linux) keeping the cost low and ensuring the further modifications or extensions will be easy to make, transparent, independent of any software manufacturer or licenses. The database is available at www.abht.ro and it can be used as a blog, allowing the aggregation for scientific papers and comments. This database is integrated an a Web GIS platform, which provide spatial data and reports torrent control structures.

Keywords: torrent contro structures, monitorig, GIS, IT solution

Posters

Supporting integrated and systemic management of windthrow crises by public decision-makers

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Abstract

Nowadays, public authorities are facing manifold issues and challenges related to forest storm damage risks. Destructive winter storms are indeed one of the major abiotic threats for national or regional forest-based economies, potentially causing long-lasting impacts on stumpage prices and timber procurement. As environmental and societal goods and services provided by forests are also severely affected by such disturbances, public decision-makers have therefore a crucial role to play in reducing storm-related risks and alleviating potential impacts of windthrow crises.

However, despite a large body of empirical knowledge, more integrated risk management approaches are required today to support public authorities in this effort. Integrated management requires considering simultaneously every component of forest risks as well as interests and beliefs of every stakeholder during the risk management process in order to define efficient strategies at regional or national levels. It also implies that decision-makers should consider the problem from a holistic perspective, with the aim to improve the functioning of the forest system and thus the global welfare of the whole forest sector.

This contribution presents how to implement such original approaches at the strategic level and how decision support systems (DSS) developed by the forest community could help public authorities. As illustrations, the WIND-STORM software (Riguelle et al. 2015) that allows systemic analysis and a GIS-based DSS that supports tactical planning of timber storage after storm events (Riguelle et al., submitted) are presented. The authors also highlight how to strengthen risk awareness and governance within the public bodies.

Keywords: Windthrow, decision-making, public authorities

Combining provenance trials, functional wood anatomy and dual-isotope analyses to evaluate the risks associated with differing reforestation strategies for a warmer climate in North America

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Abstract

Regular reforestation activities offer the opportunity to adapt future forest structure, value and function to climate change. Under uncertain future climates, however, differing reforestation strategies each entail risks. The current reforestation paradigm that local seed sources are best may no longer be suitable as the climates to which trees have adapted over generations are shifting northward and higher in elevation. Assisted migration involves planting seeds from warmer, drier climates to maintain forest health under climate change, but these seedlings may also be more susceptible to cold damage and mortality. These risks can be evaluated in long-term transplant experiments, where seeds from across a species range are tested under a wide range of environmental conditions. We test population responses to climate over 35 years in arguably the largest provenance trial in existence: the IUFRO-Illingworth lodgepole pine (Pinus contorta var latifolia) provenance trial. We use growth analyses, functional wood anatomy, and a dual-isotope approach to assess 120 trees from 20 provenances at three experimental sites in southern British Columbia. Growth analyses show that the southern-most seed sources can increase drought tolerance, but at the expense of growth. Local seed sources are relatively drought tolerant and remain productive. Northern seed sources show less drought tolerance, implying that drought mal-adaptation may prevent boreal populations from taking full advantage of more favourable growing conditions under projected climate change. To identify the lowest-risk planting strategy, we are now examining the influence of xylem hydraulics and stomatal conductance, and cold response using recently discovered "blue rings".

Keywords: Assisted Migration, Risk Evaluation, Reforestation, Climate Change, Provenance Trials

The study of bark beetle gradation after storm damage in West Tatra mountains

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Abstract

The West Tatra mountains, in the Tatra national park, were were affected by gale disaster in may 2014. The wind blown trees were left with no management, in core zone of national park. Similar event happened in central part of the national park in 2004. The massive bark beetle outbreak occurred after gale disaster.

Since 2014, we have established a system of study areas and monitoring plots in core and management areas of West Tatra mountains in order to study the whole process of bark beetle gradation-. We study the process of bark beetle colonization of wind blown and wind broken trees on gale disaster areas. In 2016, we are going to study process of bark beetle attack on standing trees. A system of meteo stations has also been established. We also use terrestrial laser scanning of damaged areas. We will also use UAV with LIDAR, thermal, infrared and hyperspectral sensors. We will also make use of publicly publicly available data: Google EARTH, LANDSAT.

Keywords: bark beetle, spruce, outbreak, wind damage

Robust Decision Approaches for Forest Management under Climate Uncertainty

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Abstract

Climatic change has become increasingly evident and therefore its importance increases, considering the potential impacts of climate change when making decisions. This is especially an issue in forest management, as nature is impacted by changes in climate in the first place and as a consequence also human populations and economies. Effects of climate change in forests could include changes in growth, competition within and between species, for example, as well as catastrophic events. Due to the long rotation periods of trees, decisions on forest management are very long-term and therefore studded with severe uncertainty about future climate development, among other factors. As future climate is highly uncertain due to scarce evidence and plenty of competing viewpoints and values, and no clear probabilities within possible future climate scenarios, traditional decision support methods, such as Expected Utility Maximization, are not adequate for making good and robust decisions. Therefore, alternative decision support methods are used. Several so-called "robust" decision making frameworks have been developed and applied to decision problems, also in natural resources planning under climate change uncertainty. Yet, for forest management under climate uncertainty, robust decision approaches have only been applied in a very limited way. On this basis, the goal of this study is to develop a mathematical robust decision framework adapted to forest management decision problems that are prone to climate uncertainty. This framework will be based on already existing generic robust decision frameworks that are characterized by finding alternatives that satisfice over a set of plausible future scenarios.

Keywords: robust decision making, climate uncertainty, forest management

Physical condition of torrent control structures in two Natura 2000 sites (ROSCI 0207 Postăvaru and ROSCI 0195 Piatra Mare)

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Abstract

The establishment of protected natural areas is a recent initiative and constitutes a legal instrument for maintaining and protecting biological diversity. This is also the case of the two protected areas covered by the present research.

Before the legislative transformation, a torrential correction works was constructed in the two protected areas to protect the major objectives of national interest with a high degree of vulnerability to flash floods (the National Rood E60 and National Railway 500).

Therefore it is very important to know the physical condition of torrent control structures and to monitor this structure due to the importance of endangered objectives.

For this purpose we inventoried 96 hydraulic works of which 89 dams and 7 drainage channels, consisting of: identification of works, measurement of characteristic elements of constructions, the assessment of behavioural events (damages and failures) occurring during operation, photography, recording data and location (latitude, longitude).

Finally for each hydraulic work, according to its condition rate, ecological repairing interactions were established in order to restore the productive capacity of the hydraulic works.

Keywords: torrent-control structure, Natura 2000, monitoring

Afforestation of degraded lands in areas with high risk of aridity from Romania

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Abstract

Romanian steppe and forest steppe areas (Dobrogea Plateau, Low Danube Plains, Moldavian Plateau and parts of Pannonia Plain) are affected by extensive land degradation processes. At the same time these regions, having the lowest afforestation rate of the country, are exposed to high risk of droughts and aridity.

In the last 30 years 112 improving perimeters in the steppe and forest steppe region were constituted, covering a surface of 27,380 ha. From this area, 22,116 ha (81%) were afforested, the remaining 19% are unproductive lands or litigation terrains.

Most of the degraded lands (70%) are affected by sheet erosion of different degrees. A significant part (23%) is represented by lands affected by wind erosion - sand dunes. Other identified types of degradation, alluvial deposits, gulling, swamps, landslides, salty soils and land degraded by human activities, represents 17% of all inventoried perimeters.

The most widely used species was by far false acacia (Robinia pseudacacia), occupying 52.8% of afforested area in pure stands or mixtures. Other identified species were: oaks (Q. pubescens, Q. pedunculiflora, Q. cerris), honey locust (Gleditsia triacanthos L.), ash trees (F. pennsylvanica, F. ornus), pines (P. nigra, P. sylvestris). In smaller areas, various deciduous species, such as elms, poplars, mahaleb cherry etc., and shrubs (oleander, blackthorn, hawthorn etc.) were identified.

Established stands had low productivity performance and the state of vegetation was average or poor, according to site conditions. However, plantations have achieved a high degree of soil coverage and ensure a significant role in improving environmental conditions.

Keywords: steppe, forest steppe, afforestation, degraded lands, false acacia

Evaluating forest stands hydrological efficiency in Mâneciu Reservoir catchment (central Romania)

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Abstract

Forest functions are closely related to economic, ecological and social interests of the region. Wood production is, for more than half of Romanian forests, a secondary objective; mainly these forests, being managed in order to maximize their ecosystem services like water protection, land or soil protection, etc.

The main objective of forests in catchments of water reservoirs is to ensure a constant flow of high quality water. The analysed catchment, Mâneciu Reservoir placed in the Upper Teleajăn River, has 247 km2 area, covered on 73.6% by forests. All these forests have ecological functions, protecting the natural heritage (5%), infrastructure (5%), terrains against erosion and sliding (14%) and water (76%), especially the reservoir.

Forest management in this area must lead to a specific structure and an improvement of stands protective capacities. Since more than three quarters of the forests are water protecting, the hydrological efficiency of their actual structure will be evaluated using two different methods and the paper will present a comparison between them.

Using the "stand hydrological index", a new parameter proposed by one of the above mentioned methods, in order to evaluate forest services for water protection, will not only allow a comparative assessment of forests "hydrological creditworthiness" located in different environments, but also will allow estimation of its dynamics taking account future silvicultural measures. Moreover, simulations can be performed to compare different scenarios for establishing best forestry practices (logging type and intensity) in order to improve water protection.

Keywords: forest stand hydrological index, forest management, ecosystem services.

Estimation and Comparison of the Stem Volume on Cryptomeria japonica in Three Regions of Jeju Island using Kozak's Stem Taper Equation

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Abstract

The current standard volume tables might under or over estimate the volumes of individual trees in a specific region, because the tables were made based on the data collected from broader regions of South Korea. In order to solve this problem, this study was conducted to develop the local stem volume tables of Cryptomeria japonica in Jeju island in Korea. In the study, stem taper equations were examined and data samples were collected from 807 trees in 3 regions : Hannam(southern), Aewol(northwestern) and Gujwa(northeastern) in Jeju island. The Kozak model was applied to derive taper equations for estimating the stem volume of Cryptomeria japonica in each region, and fitness of the equations was statistically analyzed by using the Fitness Index, Bias and Standard Error of Bias. The stem taper curve derived from the Kozak model showed similar patterns among the regions. However, the Hannam region had a lower taper and thicker stem diameter than the others. In addition, local stem volume table was developed for each region and compared to the national standard stem volume table. The result of an ANOVA test showed that the local stem volume tables of Aewol, Gujwa and Hannam regions gave higher values than the national standard volume table with statistically significant difference($p<0.01$). Also the result of Duncan's test($=0.05$) showed that there was no difference in the stem volume among the three regions.

Keywords: stem volume table, stem taper equations, Cryptomeria japonica, Kozak model

The impact of an extreme drought episode in 2015 on the growth of the main forest species in Czech Republic

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Abstract

The purpose of our study is to evaluate the impact of this year's drought on the increment of selected forest tree species in the Czech Republic. The dendrometer's data were used to meet this objective. The radial growth has been continuously monitored by electronic band dendrometers at four monitoring plots of ICP Forest programme since 2009. At the same time, additional parameters such as climatic, soil and the phenological characteristics have been determined. The advantage of these data is the continuity of the measurements and the possibility of comparing the periods with and without drought stress.

However, the effects of the individual factors are not always clear and frequently they act in synergy. There are a large number of predictors and frequently the relationships between them are not linear. Classical statistical methods often fail to succeed in the evaluation of such data. Therefore the multivariate method, which enables the processing of large amounts of data with an unclear structure and relationships between the predictors was utilised for the evaluation.

The evaluation provided a detailed view of the relationships between the abiotic factors and the growth response of forest trees in the conditions of extreme drought stress.

Keywords: drought stress, dendrometer, diameter increment

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