# FORESTS AND EXTREME WEATHER EVENTS: SOLUTIONS FOR RISK RESILIENT MANAGEMENT IN A CHANGING CLIMATE

FOREXCLIM

Project Meeting and a Workshop
Book of Abstracts

Ljubljana, 25 - 26 April 2018

Univerza v Ljubljani
Biotehniška fakulteta
Oddelek za gozdarstvo in obnovljive gozdne vire

University of Ljubljana

Biotechnical Faculty

Department of Forestry and Renewable Forest Resources

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C. Chreptun

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FOREXCLIM

# PROGRAMME

| DAY 1, WEDNESDAY, 25. 4. 2018 | | | |
|---|---|---|---|
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| 9:00-9:15 | | | Opening of the meeting |
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| 9:30-9:45 | Mats Lindeskog | Lund University (U-LUND) | Simulating forest management using LPJ-GUESS: current and future perspectives of the model |
| 9:45-10:00 | Ekaterina Sycheva | Technical University of Munich (TUM) | Simulating forest management in Europe applying the LPJ-GUESS management module: First results |
| 10:00-10:15 | Claudia Chreptun, Thomas Knoke | Technical University of Munich (TUM) | Deriving risk reducing management strategies with the forest economic optimization model YAFO 4.0 |
| 10:15-10:30 | | | Break |
| 10:30-10:45 | Janez Zafran | Ministry of Agriculture and Forestry (MKGP) | Strategy for Adaptation of Slovenian Forestry to Climate Change |
| 10:45-11:00 | Piotr Borkowski, Salvatore Martire | The European State Forest Association (EUSTAFOR) | Forest management in the face of Climate Change: the European State Forest perspective |
| 11:00-11:15 | Marion Karmann | The Forest Stewardship Council International (FSC) | How forest management standards contribute to mitigating climate change |
| 11:15-11:45 | | | Discussion |
| 11:45-12:15 | | | Break |
| 12:15-12:30 | Aleš Poljanec, Zoran Grecs | Slovenia Forest Service (ZGS) | Current activities and future challenges in preventing forest damage due to extreme weather events |

| | | | |
|---|---|---|---|
| 12:30-12:45 | Janez Polanc | Slovenian State Forests (SiDG) | Extreme weather events and SiDG |
| 12:45-13:00 | Veronika Valentar | Private Forest Owner Association (ZLG) | Mitigation and adaptation to climate changes from the forest owners point of view |
| 13:00-13:30 | | | Discussion |
| 13:30-14:15 | | | Lunch and networking |
| 14:15-14:45 | | | World cafe on the specific issues identified during the day: Discussion and conclusion |

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|---|---|
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| 13:00-17:00 | Project partners field trip |

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# European forest management in a more extreme climate: Modelling solutions for risk resilient management

[1]Anja Rammig

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Keywords: adaptation strategies; climate change; extreme weather events; forest management

Climate change and in particular extreme weather events require the development of risk-resilient forest management strategies across Europe. Here, we introduce the concept of our recently started EU-FP7 ERA-NET "Sumforest" project "FOREXCLIM" (FORests and EXtreme weather events: Solutions for risk resilient management in a changing CLIMate). In FOREXCLIM, we investigate the interactions between extreme weather (heat waves, drought, storm), subsequent forest susceptibility to fire and pathogens, market developments, forest management and related uncertainties to determine on how current forest management strategies should be adapted to sustain risk-resilient multifunctional forest landscapes in the future. In close collaboration with stakeholders, we develop a model-based strategy for identifying and operationalizing risk resilient forest management regimes. Our assessment will provide optimal silvicultural management regimes for integrated management of forests, i.e. fulfilling multiple ecosystem service provision goals. These results will serve as a basis for the development of guidelines for alternative, adapted management strategies at a local and regional scale.

References:

1. Griess VC., Knoke T. (2011). Growth performance, wind-throw, and insects: meta-analyses of parameters influencing performance of mixed-species stands in boreal and northern temperate biomes. Canadian Journal of Forest Research 41: 1141-1159.
2. IPCC. (2012). Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, and New York, NY, USA, 582 pp.
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4. Neuner S., Albrecht A., Cullmann D., Engels F., Griess VC., Hahn WA., Hanewinkel M., Härtl F., Kölling C., Staupendahl K., Knoke T. (2015). Survival of Norway spruce remains higher in mixed stands under a dryer and warmer climate. Global change biology 21: 935–946.

# Simulating forest management using LPJ-GUESS: current and future perspectives of the model

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Keywords: adaptation; climate change; forest management; LPJ-GUESS

The dynamic vegetation model LPJ-GUESS has been widely used in global model inter-comparison projects and the simulated gross primary production and net biome productivity lie in the middle of the ensemble range. The model compares well with inventory-based estimates of growth and stand structure from boreal, temperate and tropical forests, and regrowth timescales are comparable to observations. Equipped to simulate land use (including cropland and pasture), land-use change and forestry (LULUCF), the model has been used with global databases to study the effect of LULUCF on the global carbon balance and the share of primary vs. secondary forests in the land carbon sink. Detailed forest management and forest damage in the form of storm damage and spruce bark beetle attacks have been implemented in studies of Swedish forests. The current state of the forest management options in LPJ-GUESS will be presented and possible refinements and additions for central European forests in the light of adaptation strategies to climate change will be discussed.

References:

1. Lindeskog et al. (2013). Earth System Dynamics 4:385-407.
2. Smith et al. (2014). Biogeosciences 11: 2027–2054.
3. Lagergren, Jönsson (2017). Ecosystem Services 26:209–224.

# Simulating forest management in Europe applying the LPJ-GUESS management module: First results

[1]Ekaterina Sycheva

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Keywords: LPJ-GUESS; adaptation strategies; climate change; extreme weather events; forest management

We will present first simulation results of the newly developed modelling approach of forest management in the process-based ecosystem model (LPJ-GUESS). We implement a range of management schemes in the model including planting mixed forest, continous cover forestry, different intensities and types of thinning, and also the ability to apply two different management options during one simulation run. In a first step, we are concentrating on simulating the past and current state of the forest, and we model forest growth for the last 100 years in selected regions. Currently, we focus on forests in Germany, Slovenia and Sweden. We simulate forest stands at enterprise scale to estimate the effects of management on different stand types. We also run LPJ-GUESS on the country level to evaluate most common European forest management strategies, such as beech-spruce mixed stands, regular moderate and heavy thinning in comparison with no thinning, and their impact on standing biomass and productivity. Our results show that maximum of total yield is reached by moderate thining which matches the results of inventories.

References:

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# Deriving risk reducing management strategies with the forest economic optimization model YAFO 4.0

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Keywords: ecosystem services; forest optimization; value-at-risk-approach; YAFO 4.0

After showing the research interests whithin the Project Forexclim a short example of the (linear) optimization prozess will be given as an introduction to the Value-at-Risk approach for deriving risk related optimization results with YAFO 4.0 (Härtl et al. 2013, Härtl et al. 2016).
The first results with LPJ-GUESS-Data and YAFO 4.0 illustrate the possibilities of the optimization model and clearify the need of information for a further developement of YAFO as a close-to-reality forest decision-support tool.

References:

1. Härtl F., Barka I., Hahn A., Hlasny T., Irauschek F., Knoke T., Lexer M., Griess VC. (2016). Multifunctionality in European muntain forests - An optimization under changing climatic conditions. Canadian Journal of Forest Research 46: 163-171.
2. Härtl F., Hahn A., Knoke T. (2013). Risk-sensitive planning support for forest enterprises: The YAFO model. Computers and Electronics in Agriculture 94: 58-70.

# Forest management in the face of Climate Change: the European State Forest perspective

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Keywords: climate change adaptation; forestry; SFM; state forests

Climate Change leads to new challegenes in forest management in relation to both mitigation and adaptation. On one hand growing forests absorb carbon dioxide, and Harvest Wood Products can substitute for non-reneweable materials and energy, on the other hand forest ecosystems need to be more resilient to climate change and extreme weather events, and the long term productivity mantained.

Climate change adaptation measures in European State Forest Management Organsations are very diverse, but generally based on active and sustainable forest management. Those include: planting mixed, climate-resilient and site-adapted tree species, promoting close-to-nature and continuous cover forest management, timely tending and thinning operations, with the aim of well-structured, stable, climate-fit and productive forests, minimizing risks and pest and diseases through pro-active risk management and timely pest control and salvage cuttings.

The main challenges in relation to climate change adapation in state forestry consist in the uncertainty about the real effects of climate change in the long run, as well as the real adaptation potential of trees species and provenances. Moreover, climate change adaptation measures may have some trade-offs with regards economic performances of forestry, and some challenges may arise when the need of sustainable forest management is not understood by a large public. Also, a growing number of EU policies have an impact on forest managament, and it is important that the approach to forests remain holistic and ackowledge existing legislations and tools.

In conclusion, while ackowledging the wide diversity of European forests, and the consequent adaptation needs, more emphasis is needed on the importance of forestering sustainable forest management in the face of climate change as well as in better assessing trade-offs and risks of certain climate change adaptation measures.

References:

# How forest management standards contribute to mitigating climate change

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Keywords: forest management certification standards; research needs

Responsible forest management plays a major role in mitigating climate change. Through specific rules that cover ecological aspects of management, FSC plays an important role in addressing some of the challenges that climate change poses. FSC standards provide specific guidance to maintain and enhance resilience of forest ecosystems and to reduce negative impacts of forest management interventions.

National FSC working groups consisting of scientists, forest practitioners, ecologists and other stakeholders agree on indicators for each of the criteria they deem appropriate for the forest management conditions in their countries. This results in standards which are adapted to different sizes of forest management operations and other national specific socio-economic criteria, as well as for specific ecological and geographical conditions.

Small-scale forest owners, larger operations and researchers can play a major role here through participating in the Standard Development Groups that design the National Forest Stewardship Standards. I will demonstrate how through their work, rules for responsible forest management that cover social and economic issues as well as ecological interventions can prove beneficial in support of climate change mitigation and adaptation strategies. My presentation will provide examples of how national indicators, by responding to the global Principles and Criteria, result in forest management requirements for the protection of High Conservation Value areas, promotion of species diversity, and minimal soil disturbance as a result of reduced impact logging practices.

I will also offer a pragmative perspective through FSC's development of the Bonn Initiative where experience and information gathered by the private sector can be a determining factor in finding solutions to the effects of global warming. The Bonn Initiative is a joint effort between certified companies, researchers and FSC to develop and share scientifically rigourous methodologies that will help quantify the benefits, such as improved carbon sequestration, that FSC certified forests contribute to mitigate global warming and fight climate change.

References:

1. FSC Forest Stewardship Standard FSC STD-01-001 Version 4 (2012) and Version 5 incl. International Generic Indictors (2015) www.fsc.org/document-center
2. Respective FSC National forest management and Ecosystem Services standards www.fsc.org/document-center
3. The Bonn Initiative launched at the COP (2018) www.fsc.org

# Current activities and future challenges in preventing forest damage due to extreme weather events

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Keywords: extremE weather events; climate change; risk management; prevention measures; Slovenia Forest Service

The magnitude, frequency and type of natural disturbances has changed over the last few decades. In the last four years alone, forests in Slovenia have been damaged by four major natural disturbances, causing about 18 million m3 of storm-felled timber that affected more then half of the forest area in Slovenia. In addition to disturbances, climate changes as well, are influencing changes in site conditions, structure and tree species composition of forest stands. Additionally forests are threatened by the rapid spread of invasive alien species and other harmful organisms. All of these present new challenges for forestry.

Quick sanitation measures in damaged forests and the timely detection and removal of weakened trees is a key direction to prevent the spread of harmful organisms and their gradation. Silviculture measures are aimed to increase stability and vitality of forest stands. The key actions are the small-scale regeneration, the regulation of tree species composition in line with changing site conditions, the gradual and early regeneration of potentially threatened forests (e.g. spruce monocultures), prevention and limitation of the spread of invasive alien species. Special attention is paid to spruce, as a tree species with an important economic value. The possibilities of its growth in changed site conditions and the prevention of management risks of spruce stands are being studied.

Among the more important challenges for practitioners and scientists in the future is to study changes of site condition and their natural tree species composition, monitoring the effects of silvicultural and protective measures, studying growing potential of some non-native species and genetically modified species. Increasing the use of modern remote sensing technologies to fast detection of weakened trees or stands is also an important task.

References:

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# Extreme weather events and SiDG

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Keywords: extreme weather events; SiDG, wind; insect damage; forest infrastructure

Climate change is happening and the overwhelming scientific consensus is that extreme weather events *will be* more *severe*, more changeable and more unpredictable. Locally or regionally adapted solutions will have to be developed to achieve the best results in fighting extreme weather events. Managed forests have more chances to survive extreme weather events than unmanaged. The intensity of forest management activities will rise. Forestry operations of SiDG are based on 10 years *FMPs, which are prepared by **SFS. Management activities of SiDG depend on FMPs. SiDG proposals/solutions to mitigate wind damage: 1.) Increase the stability (increase the increment, not the standing volume) and decrease the size of the stock at risk. 2.) Shorter rotations* (stands are harvested before they are exposed to wind risk). 3.) Carefully designed thinning regimes. 4.) Carefully planned fellings in order to minimize the length of exposed edges. Management activities connected to rotation age are driven by environmental and economic considerations, wood market requirements and by wishes of forest manager. 5.) Tree species choice plays a decisive role in stand stability. Especially Norway spruce (*Picea abies*) is known to be sensitive to wind throw on certain areas. One of very important consequence of wind storms is also insect damage (e.g. *Ips typographus* and *Pityogenes chalcographus*). In times of increasing environmental and capital pressures, we can and should implement only forest protection measures that are based on conservation of biodiversity. The forest infrastructure in Slovenia comprises forest roads, skid trails and other structural objects needed for access to the forests and forest exploitation. Due to the extreme weather conditions the construction of new forest infrastructure in Slovenian state forests will be designed and built stronger, with better materials and larger safety factors. The renovation of the existing infrastructure will follow the criteria for new construction and priorities set by SiDG managing board.

*FMP – Forest management plan, GGN

**SFS – Slovenian forest service, ZGS

References:

# Mitigation and adaptation to climate changes from the forest owners' point of view

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Keywords: climate changes; forestry economics; forest owners; forest resources; mitigation

After the catastrophic ice break in 2014, Slovenia focuses a new challenge due to the biggest wind break in last 50 years. Even more damange was caused by late frosts, stormy wather and water scarcity in agriculture. The incomes of Slovenian "family farms" consist from incomes from agricultural production and incomes from forest property. With exception of mountain farmers and specialised big scale forest owners, are forests for the majority of forest owners, mostly an additional source, which can temporary balance the incomes for bigger investments. The new situation in slovene private forests will demand bigger investments in afforestration and protection measures as well. The exploatation of forest resources is at the small scale less intensive, what can increase the risks (e.g. pests, forest fires etc.), but on the other hand they are a rich genetic resource basin and the asset of biodiversity. The mitigation to the climate changes started already in previous 50 years with step- by- step substitution of spruce with decidous trees as well as by promoting of sustainable managment, which enable sustainable incomes also for very small scale property. As the consequence of the promotion of multi- purpose objectives, slovenian forest owners are facing a big pressure caused by increasing socioecological importance as well as exploation of non- wood products from their forests. On the other hand, the investments for renovation as well as subventions for the care of younger forests are lower than expected and can not substitute the damage, caused by the herbivorous wild or by the socio economic services at the private properties. To reach many owners when promoting climate adaptation measures is more efficient through already existing groups or organizations. Forest owners associations can play the mayor role by awarness rising campaigns, sharing knowledge and by informing people. There is expected, that such organizations will support owners by practical management and organizational tasks.

References:

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# Risk attitudes and individual discount rates of forestry professionals and climate scientists: preliminary results from the experiment

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Keywords: risk attitude, discrete choice experiment, Holt and Laury task, policy scenarios, extreme weather

## 1. Introduction

Changes in climate and climate extremes call for an adaptation of forest management and the development of new resilient forest management strategies (for a review see Keenan 2015). Forest management strategies should not be considered one-time, single-level decisions, but rather a hierarchy of decisions made at various levels and time periods. Decisions on forest management are usually made by individuals, e.g. individual private forest owners, forest enterprise managers or policy decision makers. Decision makers are known to be diverse; their risk and time preferences influence greatly the decisions they make. Climate change and extreme weather events in particularly increase uncertainty and the risk of catastrophic financial and biological losses which must be accounted for in forest management planning. Risk attitudes of decision makers therefore play a crucial role in forest management planning and the selection of more or less robust measures to reduce losses in the standing timber and the projected revenues. Risk-seeking decision makers might decide for more risky tree species portfolio, not take the standing timber insurance, disagree with public support for compensating financial and biological loss in a forest at an incidence of an extreme weather event, and their individual discount rate might be relatively high. In contrast, risk-averse decision makers would try to minimize the risk of financial and ecological failure and decide for less risky tree species and mixtures and undertake different risk prevention measures such as silvicultural adjustments or forest protection measures against biotic damages. In case of bigger forest enterprises the prevention measures could include also business diversification, short term callable financial reserve assets or taking part in various insurance programs. Risk-averse managers are also expected to have lower discount rates than their risk-seeking counterparts and probably expect greater governmental support in case of forest damage.

Experimental studies on risk attitudes of forestry professionals and their time preferences are scarce, see for example Mußhoff and Maart-Noelck (2014), Brunnete et al. (2014), Sauter et al. (2016) and Sauter and Mußhoff (2018). A general conclusion of these experimental studies and more general literature on risk attitudes of decision makers in forestry has been that decision makers are typically risk-averse trying to reduce the probability of an unwanted event such as an extreme weather event-induced damage. However, risk attitude measurement instruments and the context of decision making situations are diverse and should be considered an important factor in eliciting risk attitude values. In this paper we want to test the well-established instruments for measuring risk attitudes and individual discount rates on a small mixed sample of forest professionals and climate scientists. In the paper we report the preliminary results of the experiment. The results could serve as an input to the parameters needed in the optimization of forest management under expected changes in climate and extreme weather events that is foreseen in the Forexclim project.

## 2. Methods

The experiment took place on April 25 during the Forexclim project meeting and international stakeholder workshop at the Biotechnical Faculty in Ljubljana. Before the experiment we pre-tested the survey internally at the Faculty with respect to question formulation and ambiguity, the appropriateness of the monetary values in the lottery tasks and the duration of the survey. Altogether 18 participants filled in the four-page questionnaire on risk attitudes and individual discount rates (Appendix 1). The questionnaire consisted of three questions on risk attitudes (the Holt and Laury task, Contextualized risk-attitude, Self-assessment), a lottery task according to Coller and Williams (1999) for measuring individual discount rates and several other questions on the possible policy scenarios for risk reduction. The questionnaire started with a lottery-choice measure validated by Holt and Laury (2002) in which the respondent found 10 different decision situations with two lottery pairs. In each situation, he or she could choose between lottery A or B. Lottery A and B consisted of two payout levels that remained constant for all 10 lottery pairs, but the probability of the two payout levels changed from p = 10% and 1-p = 90% at the first decision situation to p = 100% and 1-p = 0% at the last decision situation. The payout levels from Holt and Laury (2002) were multiplied by 90 as suggested by the authors themselves to provide sufficient incentives for participants coming from Germany, Slovenia, Sweden and Belgium (Sauter et al., 2016). The number of lottery A choices (the safe choice) was the Holt and Laury value that expresses the participant's risk attitude. One of the participants chose option A, switched to option B and later switched back to option A. According to Holt an Laury (2002) the participants with inconsistent choices can be included in the analysis by counting their number of safe choices.

The survey continued with the question in which the respondents were asked to self-asses their risk attitude by selecting on the scale from 0 to 10 to the value that corresponds best to their risk appetite. In the contextualized risk-attitude task the respondents were confronted with a decision situation to harvest a 120 years old Norway spruce stand next year without any sale contract but with varying probabilities of higher income from harvesting, or to harvest the stand next year for a fixed price of the harvested wood. Other questions related to risk reduction include the questions about what kind of risk prevention in forestry did respondents prefer and how much did they agree with the predetermined policy scenarios at an incidence of an extreme weather event in forests.

Individual discount rates were elicited by Coller and Willams (1999) task. Coller and Williams task presents subjects with 11 "payoff alternatives"; each payoff alternative pays 500 EUR in one month or 500 EUR + interests two months later (payment options A and B, respectively), where interest rate increases as one moves down the lottery task. Subjects were asked to indicate which payment option they preferred for each payoff alternative. The option at which the participant switched for the first time from option A to option B was depicted as the upper bound of his or her discount rate. One of the participants made an inconsistent choice and was excluded from the analysis of the discount rates. At the end of the questionnaire we recorded basic socio-demographic variables of respondents such as age, gender, education and institution.

## 3. Results and discussion

The observed risk attitude values show that the respondents were slightly to moderately risk-averse with the highest risk-averse value achieved in the forestry framed risk attitude task. The result is comparable with the results of similar studies in forestry (Sauter et al., 2016; Musshoff and Maart-Noelck, 2014; Brunette et al., 2014). However, the sample was too small to detect the correlation between Holt and Laury task, self-assessment and the forestry framed risk attitude task. We did not find statistically significant differences in risk attitudes measured by Holt and Laury task between forestry professionals working in public services and scientists working in higher education or science ($p = 0.636$), neither were there significant differences in risk attitudes between men and women ($p = 0.552$, independent samples t-test for equality of means corrected for non-equality of variances, the assumption of normality met (the Shapiro-Wilk test, $p > 0.05$)).

Table 1: Descriptive statistics of respondents (n = 18)

| | | Mean (Standard Deviation)/Count |
|---|---|---|
| Age | | 42 (9.3) |
| Institution | Not declared | 1 |
| | Public services | 8 |
| | Higher education/Science | 8 |
| | Other professionals | 1 |
| Gender | Male | 12 |
| | Female | 6 |
| Education | University degree | 10 |
| | Master of Science | 1 |
| | PhD | 7 |

Table 2: Descriptive statistics of risk attitude survey (n = 18)

| | Mean | Median | Standard Deviation |
|---|---|---|---|
| Holt and Laury task (0 to 10)[a] | 5.3 | 5.5 | 1.5 |
| Self assesment value (0 to 10)[b] | 4.8 | 6.0 | 1.7 |
| Contextualized risk attitude value (0 to 10)[c] | 3.1 | 1.5 | 3.8 |

[a]Values 0 to 3 indicate risk-seeking attitude, value of 4 indicate neutral attitude, values of 5 to 10 indicate risk-averse attitude.
[b]Self-assessment on a equidistant 10-point scale from 0 (extreme risk aversion) to 10 (extreme risk seeking).
[c]Values 0 to 5 indicate risk aversion, value of 6 indicates neutrality, values of 7 to 10 indicate risk seeking.

Table 3: Comparable risk attitude studies and obtained risk attitude values

| Study | Participants | N | Holt and Laury task | |
|---|---|---|---|---|
| | | | Mean | SD |
| Sauter et al., 2016 | German foresters | 137 | 5.7 | 2.4 |
| Musshoff and Maart-Noelck, 2014 | German foresters | 79 | 5.9 | 1.8 |

In risk prevention measures the respondents gave priority to ecological and biological measures. The respondents most agreed with the statements that silvicultural adjustments and forest protection measures are key risk prevention measures. Of 100 points available they on average allocated 33 and 25 points to these two options (Fig. 1). Insurance or building up short term callable financial reserve assets was considered less effective.

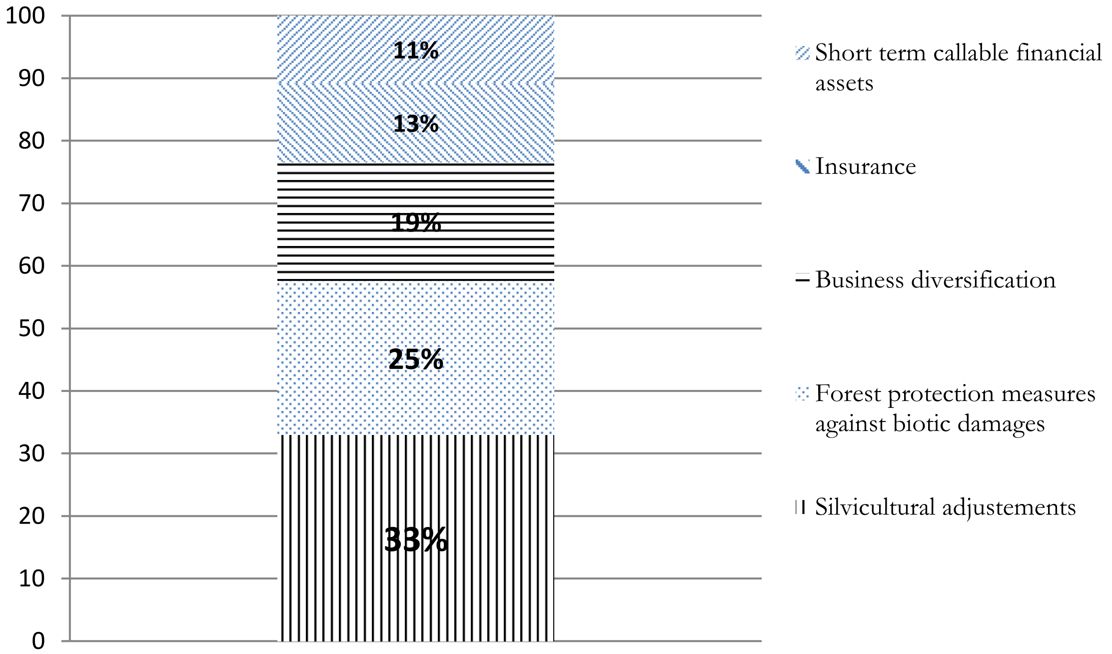


Fig. 1: The importance of risk prevention alternatives. The percentages represent mean value of points (of total 100 points available respondents could split to five alternatives.

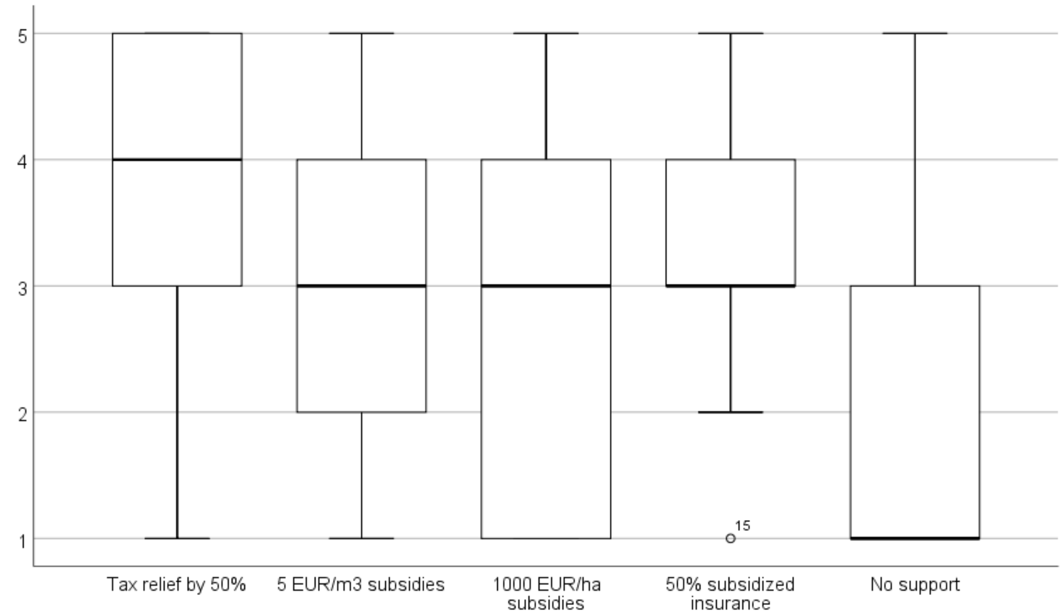


Fig. 2: Agreement with five policy scenarios at an incidence of an extreme weather event

The respondents' expectations from forest policy at an incidence of an extreme weather event were low. Most agreed scenarios after a storm or other extreme event was income tax relief from forestry by 50% and contingent public support for damaged wood in a form of 5 EUR/ $m^3$. However, except for tax relief (mean 3.7, median 4.0), the agreement with the mitigation scenarios was weak (Fig. 2).

Coller and Williams task (1999) showed that under the assumption of risk neutrality the individual's range of discount rates could be from 7.5% to 9.0%. Arithmetic mean value and the corresponding 95% confidence interval was 7.5% ± 2.69%. It should be noted that this estimate does not accounts for the discounted utility model with an exponential functional form neither estimates risk and time preferences jointly. Sauter and Mußhoff (2018) for instance estimated risk and time preferences of German foresters jointly and found the mean discount rate of 4.1% (95% confidence interval ± 1.1%) with a range between 0 and 7%. Although both experiments are not totally comparable, both show that time preferences of forest professionals are higher than reflected by typical interest rates used in forest economics in Central Europe. However, one should be aware that the range of discount rates found in our experiment should not be used for discounting future cash flows but as an alternative measure of risk. Moreover, since many decisions in forest management are already based on precautionary principle (e.g. specifying the allowable cut, tree species selection, growing stock accumulation) and since individual risk attitudes can be elicited separately from individual discount rates and included in the projections of harvesting schedules and regimes for each individual, the discount rate used for discounting future cash flows should be lower. Many economists advocate using low and declining discount rates for evaluating the future benefits and costs of projects that include climate-sensitive decisions (e.g. Stern 2007).

Table 4: Descriptive statistics of Coller and Williams task (n = 17)

| | Mean | Median | Standard Deviation |
|---|---|---|---|
| Coller and Williams task | 6.5 | 7.0 | 3.5 |
| Lower bound of discount rate | 7.5% | | |
| Upper bound of discount rate | 9.0% | | |

## 4. Conclusions

In this experiment we confirmed the results of many studies that the majority of decision makers are slightly risk-averse. We found no significant correlations between respondents' profiles and their risk attitudes. Due to small sample size and partly self-selection of the participants the study should be considered as a test and non-representative study. It should also be noted that the experiment design in this study deviated from more rigorous experiments conducted in other countries as it did not include financial incentives that randomly selected participants could earn depending on their lottery choices. It appears that the workshop participants considered that most of risk could be countered by silvicultural measures and not by other measures such as portfolio diversification, contingent public support in case of damage or standing timber insurance. Further investigations of combined measures for risk reduction and willingness of forest managers to implement these measures are needed.

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# World Café on climate change adaptation and mitigation strategies

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Keywords: adaptation strategies, climate change, policy instruments

## 1. Introduction

Scientists have developed an increasingly sophisticated suite of computerized models for estimating possible impacts of climate change on ecosystems and society. Only recently the focus has turned also on mitigation and adaptation strategies to climate change. The approaches to strategies development are diverse depending on at which level of society the strategy is focusing and the complexity of the understanding of the adaptation and mitigation measures. Examples range from the global debate on the possible futures of social-ecological systems, human well-being and environmental sustainability including global change scenarios with forecasts of selected economic and environmental indicators to very concrete actions such as forest site-specific recommendations on suitable genotypes and provenances. Envisioning future alternative paths on the large scale often leads to rhetorical packaging in form of "the usual suspects": the good (Balanced Use of Ecosystem services), the bad (Global Markets), the ugly (Self-sufficient Economies) and the great unknown (Tyranny of Climate Governance) (Sarkki et al., 2017). On the other hand, mitigation and adaptation strategies developed for certain smaller areas with a bottom-up approach neglect the overall capacity of a social-ecological system to reorganize and establish new relations. Innovations could not be accounted for in the projections of the future trajectories of the system if the projections are entirely based on current relations. It should be noted that uncertainty may be either pernicious or propitious (Ben-Haim, 2006) and that every risk may also bring unexpected windfall. Risk analysis should therefore be wide enough and thoughtful to secure the highest robustness against unwanted uncertain variations and enable large windfall gain.

In a recent review, Brunette et al. (2018) summarized the risk type considered in 89 scientific papers on mitigation and adaptation strategies in forestry into economic profit, ecological sustainability and socio-political dimensions. They found relatively wide list of adaptation measures and approaches and conclude that relatively few papers explicitly took into account price risk in relation to climate change and the volatility of timber markets. Less attention has been given to the development of innovative solutions for climate change adaptation and mitigation. With respect to that it should also be noted that in the battle for the environment, intergovernmental organizations and civil society may excessively identify themselves with strict global climate policy, leaving all other local alternative developmental paths aside. Such pernicious pragmatism supports the adaptation scenarios that are based on the pragmatic experiences of current paradigms and situations rather than truly free deliberation on the future (Sarkki et al., 2017). Therefore, innovative solutions may emerge in the collaborative dialogue where the participants are engaged actively with each other and create constructive possibilities for action.

In this paper we want to present the results of a collaborative discussions of Forexclim workshop participants on climate change adaptation and mitigation measures.

## 2. Methods

Searching for solutions in climate change adaptation and mitigation was conducted by the help of the World Café method. A World Café is a structured conversational process for knowledge sharing in which groups of people discuss a topic at several tables with individuals switching tables periodically and getting introduced to the previous discussion at their new table by a "table host" (https://en.wikipedia.org/wiki/World_caf%C3%A9). The method consists of the following mains steps: 1) Setting the scene and the topics; 2) Group discussion; and 3) Presentation of the results.

At the beginning, the session was opened by introducing the method and presenting two questions to be discussed at the tables:

I. What silvicultural and management adjustments should be taken in a changing climate?
II. What science should do for risk resilient management in a changing climate and what policy and business adjustments should be taken?

In each Café the groups discussed the topic and wrote down the conclusions on the prepared poster. A „table host" stimulated the conversation. After 15 minutes each member of the group moved to a new table. The "table host" waited at the table and briefly filled them in on what happened in the previous round. After two moves the table hosts were invited to share insights with the rest of the participants and the plenary discussion followed.

## 3. Results

Table 1: Proposals for actions in science and policy at table 1

| What science should do for risk resilient management in a changing climate and what policy and business adjustments should be taken in a changing climate? |
|---|
| • We need rigorous science (do not let results follow money);<br>• In communicating the results find the balance between drama and ignorance;<br>• Science need to come up with findings that are reliable and replicable (e.g. about insecticides, pesticides or genetically modified organisms);<br>• We need to assign proper economic value to ecosystem services which leads to fair payments for good forest management practices;<br>• "Good science" should be communicated to media;<br>• More educational programs and trainings for trainers are needed such as teaching in the woods;<br>• Policy should provide more money for basic research;<br>• Uncertainty in the scenarios should be better communicated;<br>• Taxation for unsustainable production should be introduced. |

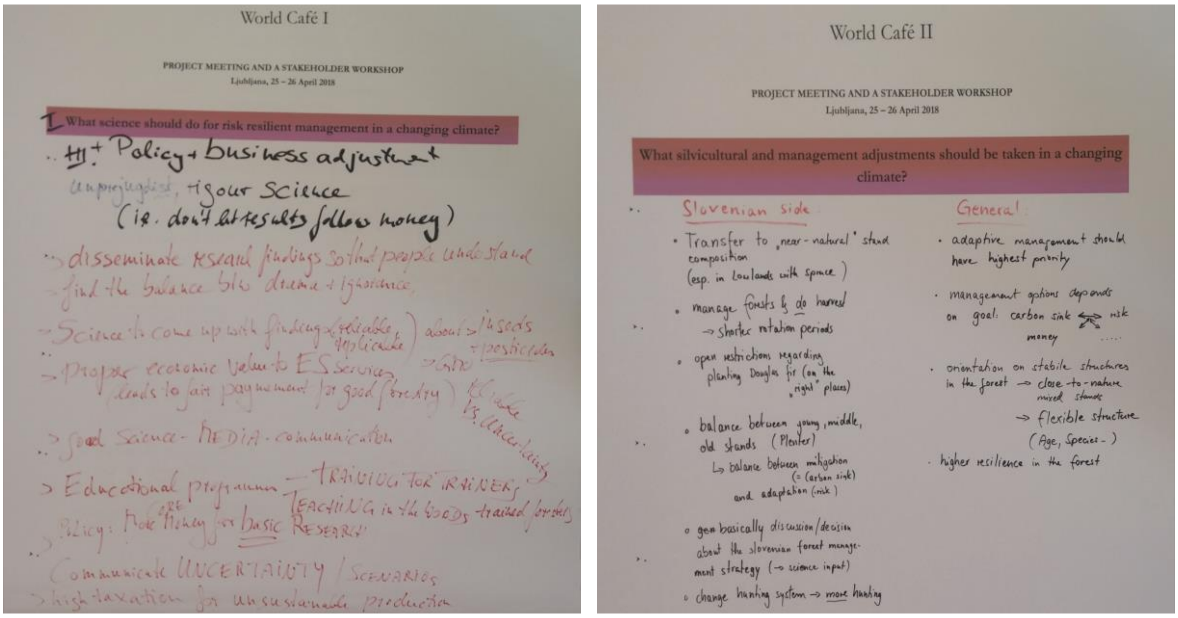


Fig. 1: Posters with proposals and comments

Table 2: Proposals for actions in silviculture and management at table 2

| Which silvicultural and management adjustments should be taken in a changing climate? | |
|---|---|
| **Slovenia** | **In general** |
| • Adapt tree species composition to "near-natural" particularly in lowlands with spruce;<br>• Manage forests and harvest with shorter rotation periods;<br>• Lift up restriction on planting Douglas fir (on suitable places);<br>• Balance between the young, middle and old stands (the Plenter structure);<br>• Find balance between mitigation (carbon sink) and adaptation (risk reduction);<br>• Open discussion and/or make decision on the Slovenian forest management strategy, where the input of science is needed;<br>• Change hunting system, increase hunting. | • Adaptive management should have highest priority;<br>• Management options should depend on goal (carbon sink, money);<br>• Orientation on stable forest stand structures with close-to-nature mixed stands and flexible structures with respect to age and species;<br>• All adjustments that support higher resilience in the forest. |

## 4. Conclusions

This structured conversation aimed to contribute to real-time policy analysis and development of actions at any level of decision making. It became evident that local actions do not necessarily coincide with the goals of global climate change policy and that less declarative and more vertically coherent measures are needed to give momentum to climate change adaptation and mitigation in practice. Science should carefully balance the tone of communicating the results between drama and ignorance. Climate change models may increase in their complexity but more attention should be paid to uncertainty communication in order that practitioners are able to understand the outcomes of the modelling exercises.

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# **Appendix 1:** List of participants

| | | |
|---|---|---|
| Claudia Chreptun | Institute of Forest Management Center of Life and Food Sciences Weihenstephan Technical University of Munich | Hans-Carl-von-Carlowitz-Platz 2, 85354 Freising, Germany |
| Doc. Dr. Andrej Ficko | University of Ljubljana<br>Biotechnical Faculty<br>Department of Forestry and Renewable Forest Resources | Večna pot 83, 1000 Ljubljana, Slovenija |
| Dr. Gal Fidej | University of Ljubljana<br>Biotechnical Faculty<br>Department of Forestry and Renewable Forest Resources | Večna pot 83, 1000 Ljubljana, Slovenija |
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| Doc. Dr. Matija Klopčič | University of Ljubljana<br>Biotechnical Faculty<br>Department of Forestry and Renewable Forest Resources | Večna pot 83, 1000 Ljubljana, Slovenija |
| Boštjan Košiček | Zavod za gozdove Slovenije, OE Sežana | Partizanska 49, 6210 Sežana, Slovenija |
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| Ekaterina Sycheva | Technical University of Munich, TUM School of Life Sciences Weihenstephan, Professorship for Land Surface-Atmosphere Interactions | Hans-Carl-von-Carlowitz-Platz 2, 85354 Freising, Germany |
| Vasilije Trifković | University of Ljubljana<br>Biotechnical Faculty<br>Department of Forestry and Renewable Forest Resources | Večna pot 83, 1000 Ljubljana, Slovenija |
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| Janez Zafran M. Phil. | Ministry of Agriculture and Forestry (MKGP) | Dunajska 22,<br>1000 Ljubljana, Slovenija |
| Alja Žunter | Zavod za gozdove Slovenije, OE Nazarje | Savinjska cesta 4, 3331 Nazarje, Slovenija |

# **Appendix 2:** Risk attitude survey and individual discount rates

1. **Below you will find 10 different decision situations. Please choose in each situation between lottery A or B!**

   **Please choose lottery A or B in each line by giving a tick ☑**

Table 1: Lottery task according to Holt and Laury (2002)

| | Option A | | Option B | |
|---|---|---|---|---|
| 1 | 10% chance to win EUR 180.00 or<br>90% chance to win EUR 144.00 | ☐ | 10% chance to win EUR 346.50 or<br>90% chance to win EUR 9.00 | ☐ |
| 2 | 20% chance to win EUR 180.00 or<br>80% chance to win EUR 144.00 | ☐ | 20% chance to win EUR 346.50 or<br>80% chance to win EUR 9.00 | ☐ |
| 3 | 30% chance to win EUR 180.00 or<br>70% chance to win EUR 144.00 | ☐ | 30% chance to win EUR 346.50 or<br>70% chance to win EUR 9.00 | ☐ |
| 4 | 40% chance to win EUR 180.00 or<br>60% chance to win EUR 144.00 | ☐ | 40% chance to win EUR 346.50 or<br>60% chance to win EUR 9.00 | ☐ |
| 5 | 50% chance to win EUR 180.00 or<br>50% chance to win EUR 144.0 | ☐ | 50% chance to win EUR 346.50 or<br>50% chance to win EUR 9.00 | ☐ |
| 6 | 60% chance to win EUR 180.00 or<br>40% chance to win EUR 144.00 | ☐ | 60% chance to win EUR 346.50 or<br>40% chance to win EUR 9.00 | ☐ |
| 7 | 70% chance to win EUR 180.00 or<br>30% chance to win EUR 144.00 | ☐ | 70% chance to win EUR 346.50 or<br>30% chance to win EUR 9.00 | ☐ |
| 8 | 80% chance to win EUR 180.00 or<br>20% chance to win EUR 144.00 | ☐ | 80% chance to win EUR 346.50 or<br>20% chance to win EUR 9.00 | ☐ |
| 9 | 90% chance to win EUR 180.00 or<br>10% chance to win EUR 144.00 | ☐ | 90% chance to win EUR 346.50 or<br>10% chance to win EUR 9.00 | ☐ |
| 10 | 100% chance to win EUR 180.00 or<br>0% chance to win EUR 144.00 | ☐ | 100% chance to win EUR 346.50 or<br>0% chance to win EUR 9.00 | ☐ |

2. **How do you perceive yourself: Are you generally a risk-averse person, meaning you try to avoid risks or are you a risk-seeking person, meaning you are willing to take risks? Please select on the scale to the value that corresponds best to your risk appetite best.**

Table 2: Self-assessment scale

| Trying to avoid risks | | | | | Risk neutral | | | | | Very willing to take risks |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

**3. What kind of risk prevention in forestry do you prefer?**
**You have exactly 100 points available, which you should split between the following five statements. The more points you allocate a statement, the more you agree with it.**

Table 3: Risk prevention measures in forestry

| | |
|---|---|
| Silvicultural adjustments | |
| Business diversification | |
| Build up short term callable financial reserve assets | |
| Insurance | |
| Forest protection measures against biotic damages | |
| Total | 100 |

| Other measures: Please specify |
|---|
| |

**4. How much do you agree with the following policy scenarios at an incidence of an extreme weather event in forests?**

| | Strongly disagree | | Neutral | | Strongly agree |
|---|---|---|---|---|---|
| Public support (EUR 1000/ha damaged land) | 1 | 2 | 3 | 4 | 5 |
| Tax relief (income tax reduction from forestry by 50%) | 1 | 2 | 3 | 4 | 5 |
| Contingent public support (EUR 5/m³ damaged wood) | 1 | 2 | 3 | 4 | 5 |
| Subsidized insurance premium (50% of the insurance premium) | 1 | 2 | 3 | 4 | 5 |
| No public support | 1 | 2 | 3 | 4 | 5 |

5. **Imagine that you own a 120 years-old Norway spruce stand that you want to harvest next year. Now, you have the following two options for selling the timber:**
   - **Option A: You sell your timber next year at the prevailing price. You estimate to make a profit of EUR 25000 with a probability of 90%. At a probability of 10% you expect a downturn of timber prices, which would reduce your profit to EUR 15000.**
   - **Option B: You close a purchase agreement at an agreed price this year.**
   -

**Please select in each decision situation bellow, if you want to sign a contract at an agreed price or not.**

**Please choose option A or B in each line by giving a tick** ☑

Table 4: Forestry framed lottery task

| | Option A | | | Option B | |
|---|---|---|---|---|---|
| | Expected profit from timber sale **next year** | | | Contract | |
| | 10% probability | 90% probability | | 100% probability | |
| 1 | EUR 15000 | EUR 25000 | ☐ | EUR 23450 | ☐ |
| 2 | EUR 15000 | EUR 25000 | ☐ | EUR 23550 | ☐ |
| 3 | EUR 15000 | EUR 25000 | ☐ | EUR 23650 | ☐ |
| 4 | EUR 15000 | EUR 25000 | ☐ | EUR 23750 | ☐ |
| 5 | EUR 15000 | EUR 25000 | ☐ | EUR 23850 | ☐ |
| 6 | EUR 15000 | EUR 25000 | ☐ | EUR 23950 | ☐ |
| 7 | EUR 15000 | EUR 25000 | ☐ | EUR 24050 | ☐ |
| 8 | EUR 15000 | EUR 25000 | ☐ | EUR 24150 | ☐ |
| 9 | EUR 15000 | EUR 25000 | ☐ | EUR 24250 | ☐ |
| 10 | EUR 15000 | EUR 25000 | ☐ | EUR 24350 | ☐ |

6. **Your decision: money in one month or in seven months**
**We offer eleven choices between two guaranteed safe amounts of money: option A and option B. The money from option A is guaranteed to be paid out in one month's time, while the money from option B is guaranteed to be paid out in seven months' time. The amount of money in option B is varied systematically.**

**Please choose which option (A or B) you prefer in each line by giving a tick ☑**

Table 5: Lottery task according to Coller and Williams (1999)

| | Option A (Payment after 1 month) | | Option B (Payment after 7 months) | | Annual interest rate |
|---|---|---|---|---|---|
| | May 25 | | November 24 | | |
| 1 | EUR 500.00 | ☐ | EUR 500.00 | ☐ | 0.0% |
| 2 | EUR 500.00 | ☐ | EUR 504.36 | ☐ | 1.5% |
| 3 | EUR 500.00 | ☐ | EUR 508.70 | ☐ | 3.0% |
| 4 | EUR 500.00 | ☐ | EUR 513.00 | ☐ | 4.5% |
| 5 | EUR 500.00 | ☐ | EUR 517.29 | ☐ | 6.0% |
| 6 | EUR 500.00 | ☐ | EUR 521.54 | ☐ | 7.5% |
| 7 | EUR 500.00 | ☐ | EUR 525.78 | ☐ | 9.0% |
| 8 | EUR 500.00 | ☐ | EUR 529.99 | ☐ | 10.5% |
| 9 | EUR 500.00 | ☐ | EUR 534.17 | ☐ | 12.0% |
| 10 | EUR 500.00 | ☐ | EUR 538.33 | ☐ | 13.5% |
| 11 | EUR 500.00 | ☐ | EUR 542.47 | ☐ | 15.0% |

---

**We ask you to provide the following information. The data remains confidential and will only be analyzed group-wise and anonymously.**

**Type of Institution**
- **Public services** ☐
- **Higher education /science** ☐
- **Other professionals** ☐

**Gender**
- **Male** ☐
- **Female** ☐

**Year of birth** ______

**Education**
- **Secondary school** ☐
- **University degree** ☐
- **Master of Philosophy** ☐
- **Doctor of Philosophy** ☐

**Appendix 3:** Internal project partner meeting agenda

## Internal Meeting
## 26. 04. 2018
## Session room 50, 2nd floor

**9:00 – 10:00: Evaluation of the stakeholder meeting**

9:00 – 9:30: Evaluate the outcome from the stakeholder meeting
- ➔ how to integrate possible information, ideas, criticism...
- ➔ in which part of the project (LPJ, YAFO), by whom

9:30 – 10:00: Discuss research directions related to management scenarios
- ➔ Development of historic, current, future scenarios
- ➔ Management and scenarios at country/regional scale

**10:00 – 12:00 Data**

10:00 – 10:30: Validation data for LPJ-GUESS management runs
- ➔ Slovenia, Sweden, Germany
- ➔ Site-scale, regional scale

*Recreation break 30 min*

11:00 – 12:00: Climate data for LPJ-GUESS simulation runs
- ➔ Which data to use (historic/current/future)
- ➔ Climate scenarios: Global – regional
- ➔ Bias correction etc.

**12:00 – 12:30 Outlook**

1. Planned papers
2. Next meeting(s)
3. Coupling of LPJ and YAFO
4. Simulations on European scale – more countries?
5. Integration of extreme weather events