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Book of Abstracts

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Program

The **5th DWB Student Conference 2020: Sharing Forest & Soil Science online** takes place on May 13th, 2020. Presentations are available ONLINE due to the restrictions during the COVID pandemic situation.

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Abstracts

Institute of Forest Engineering

Oral presentation

Life cycle assessment of round timber and pulpwood production - a comparison of Austria and New Zealand

Leona Woitsch [1]*, Karl Stampfer [1], Martin Kühmaier [1], Jorie Knook [2], Hugh Bigsby [2]

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Abstract

Wood and forests are often hailed as sustainable and “green”, which is not necessarily the case. In this study, the environmental impacts of spruce and pine cultivation and processing are calculated in an environmental life cycle assessment. The LCA is conducted as cradle-to-gate, which means that all impacts, from soil preparation through harvesting and transport up to processing, until the wood leaves the sawmill or pulpwood plant are considered. The functional unit is 1 m^3 of timber delivered to the saw mill. In the inventory analysis, a flow chart shows all inputs and outputs of the system. Based on that and combined with data from LCA databases as well as from interviews with experts and scientists, the base for calculations (life cycle inventory) is established. Then, all environmental impacts are calculated and put into impact categories (life cycle assessment). These demonstrate where in the process chain the highest emissions and impact take place, and a subsequent sensitivity analysis shows which process step and assumption has the highest influence on the results. Transport has the highest impact, especially considering CO_2 and SO_2 emissions. Therefore, New Zealand performs worse in this category because of their longer transport distances. On the other hand, in New Zealand, the rotation cycle is about two thirds shorter than in Austria, which means that the carbon sequestration rate is higher. Finally, all results are compared in a discussion in order to offer suggestions for improvements.

Institute of Forest Entomology, Forest Pathology and Forest Protection

Oral presentation

Biocontrol potential of parasitoids of the green oak leaf roller *Tortrix viridana* L. (Lep., Tortricidae) – a literature review

Belinda Brandstetter [1], Christa Schafellner [1]

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Abstract

The green oak leaf roller *Tortrix viridana* L. (Hym., Tortricidae) is a forest pest distributed throughout the western palearctic region. During outbreaks, the insect causes significant damage to all oak species (*Quercus* sp.). Excessive larval feeding in the tree canopy results in wood increment loss and mast crop failure. In contrast to spraying pesticides, which often have severe negative impacts on the environment, biological control programs are considered as environmentally safe and risk free, e.g., by promoting natural enemy abundance and diversity. The project *Oak Resilience* by the Landesbetrieb Wald und Holz NRW/Germany aims to explore if and how oak stands that are frequently defoliated during winter moth and oak leafroller outbreaks can be stabilized by releasing parasitoids.

The present thesis summarizes the most important parasitoids of the green oak leaf roller from Europe, Turkey and Iran from the scientific literature and evaluates their potential to keep pest populations low. These natural enemies are egg, larval or pupal parasitoids from different families within the order of the Hymenoptera, especially Ichneumonidae and Braconidae and they encompass parasitic flies (Tachinidae) that belong to the order of Diptera.

The aim of this work is to find suitable parasitic species with a significant impact on green oak leaf roller populations regarding their frequency and occurrence during different stages of the population dynamics of the insect pest. These parasitic insects must be reared on alternate hosts in the laboratory at numbers high enough to be released in the forest in order to become established. The final goal is that the natural enemy complex can stabilize field populations of the green oak leaf roller at levels that are low enough to have little or no negative impacts on tree growth and vitality. Some pupal parasitoids within the ichneumonids like *Itoplectis maculator*, *Apechthis rufatus* and *Phaeogenes invisor* are promising candidates.

Poster Presentation

Vermehrungspotential der Geschwisterbruten bei *Ips typographus*

Alexander Gasplmayr, Axel Schopf, Christian Stauffer, Martin Schebeck

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Abstract

Steigende Temperaturen und ungleichmäßige Verteilung von Niederschlägen führen zu immer häufigeren optimalen Vermehrungsbedingungen für den Buchdrucker, *Ips typographus* (L.), in europäischen Fichtenwäldern. Diese Bachelor-Arbeit befasste sich mit der Anlage und dem reproduktiven Potential von Geschwisterbruten dieses Borkenkäfers. Diese zusätzliche Anlage von Bruten eines einzelnen Individuums kann einen bedeutenden Einfluss auf das Populationswachstum haben. Dieses Wissen ist entscheidend, um Prognosen über Vermehrungshotspots zu erstellen. Günstige Umweltbedingungen, welche in den letzten Jahren häufig aufgetreten sind, sind für die Anlage und Ausprägung von Geschwisterbruten fördernd und erlauben es dem Buchdrucker, eine oder mehrere Geschwisterbruten anzulegen. Ziel dieser Arbeit war es, das Vermehrungspotential von Geschwisterbruten zu beurteilen.

Buchdrucker wurden im Labor (25 °C, L:D 16:8) an Fichten-Stammstücken paarweise angesetzt (= Parentalgeneration). Nach 14 Tagen wurden die Brutsysteme geöffnet, die Anzahl der Nachkommen evaluiert (= Filialgeneration) und Weibchen der Parentalgeneration für eine oder zwei weitere Geschwisterbruten (= 1. und 2. Geschwisterbrut) an neuen Stämmen angesetzt. Die Nachkommenschaft der Geschwisterbruten wurde ebenfalls nach 14 Tagen evaluiert.

Die mittleren Muttergang-Längen der Filialgeneration (10,97 ± 4,62 cm) unterschieden sich von der 1. (8,82 ± 2,57 cm) und 2. Geschwisterbrut (7,47 ± 1,69 cm) nicht signifikant. Die mittlere Anzahl angelegter Einischen war im Vergleich der Filialgeneration von jener der 1. Geschwisterbrut nicht signifikant verschieden (49,9 ± 24,3 vs. 36,4 ± 15,5). Die Gegenüberstellung der Filialgeneration mit der 2. Geschwisterbrut, und der 1. Geschwisterbrut mit der 2. Geschwisterbrut wies signifikante Unterschiede in der mittleren Anzahl der Einischen auf (2. Geschwisterbrut 16,7 ± 8,8 Einischen). Die mittlere Anzahl von Larvengängen wies bei allen Ansätzen signifikante Unterschiede auf (Filialgeneration 47,6 ± 22,9; 1. Geschwisterbrut 31,6 ± 13,4; 2. Geschwisterbrut 12,7 ± 5,1).

Die Ergebnisse bestätigen frühere Untersuchungen, dass die Anzahl der Nachkommen von der Filialgeneration zu den Geschwisterbruten hin abnimmt, jedoch kann deren Anlage einen wichtigen Beitrag zum Populationswachstum leisten.

Oral presentation

Bioassay zum Nachweis des entomopathogenen Pilzes *Entomophaga maimaiga* (Entomophtorales: Entomophtoraceae) im Boden in einem Eichenmischbestand in Ebergassing (NÖ)

Simon Gunz [1]*, Jakob Pendl [1]*, Christa Schafellner [1]

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Abstract

Entomopahaga maimaiga (Entomophtorales: Entomophtoraceae) ist ein aus Japan stammender, insektenpathogener Pilz mit einer hohen Wirtsspezifität für die Raupen des Schwammspinners, *Lymantria dispar* (Lepidoptera, Erebidae). Nachdem sich der Pilz in Nordamerika als wirksamer Regulator von Schwammspinner-Populationen erwiesen hatte, wurde er ab 1999 in Bulgarien ausgebracht. Von dort breitete sich der Pilz rasch über die Balkan-Halbinsel sowie Osteuropa aus. In Österreich wurden von 2014-2018 insgesamt 15 Eichenwaldbestände mit bekannten Schwammspinner-Vorkommen beprobt, jedoch ohne Nachweis von *E. maimaiga*. Im Sommer 2019 wurden in Raupen von zwei Schwammspinner-Populationen in Niederösterreich erstmals Pilzsporen gefunden. Am Standort Ebergassing waren alle untersuchten Raupen infiziert.

Der Pilz bildet zwei Sporentypen aus, infektiöse Konidiosporen und dauerhafte Umweltsporen, die der Überdauerung klimatisch ungünstiger Perioden dienen und im Boden 6-10 Jahre überleben. Welche Sporen gebildet werden, hängt u.a. vom Alter des Wirtstieres ab. Bei entsprechender Feuchtigkeit beginnen die Dauersporen im Mai und Juni zu keimen; sie bilden infektiöse Konidiosporen aus, die aktiv ausgeschleudert und durch Wind verteilt werden. Bei Kontakt mit der Wirtsraupe dringen die Konidosporen durch die Kutikula ein und durchwachsen das Insekt. Am Ende des Vermehrungszyklus bildet der Pilz Dauersporen aus.

In dieser Arbeit sollen *E. maimaiga* Dauersporen aus Bodenproben vom Eichenstandort Ebergassing mit einem Bioassay nachgewiesen werden. Mitte April wurden 10 Eichen mit zumindest einem Eigelege am Stamm ausgewählt. Die obersten 1-3 cm der Bodenschicht an vier Stellen rund um den Stamm (250-400 cm^2) wurden entnommen und zu einer Mischprobe vereint. Zum Keimen der Sporen werden die Proben regelmäßig befeuchtet. Ab Mitte Mai werden jeweils 10 Schwammspinner-Raupen in kleinen Behältern mit dem Bodenmaterial für 3-4 Tage in Kontakt gebracht. Hat der Pilz infektiöse Sporen gebildet, sollten sich die Tiere infizieren. Die Raupen werden nach der Inkubation einzeln gezüchtet, tote Tiere isoliert und in eine feuchte Kammer gegeben, wo der Pilz den Kadaver durchwachsen und am Ende wiederum Dauersporen bilden kann. Die Raupen werden seziert, Präparate zur Inspektion der Todesursache angefertigt und vorhandene Pathogene wie z. B. Sporen von *E. maimaiga* unter einem Durchlichtmikroskop bestimmt.

Sollte der Nachweis von *E. maimaiga* gelingen, ist davon auszugehen, dass der Pilz sich in Österreich etabliert hat und künftig eine bedeutende Rolle bei der Eindämmung von Schwammspinner Massenvermehrungen spielen wird.

Oral presentation

Linking tree-ring widths of spruce to climatic factors and insect outbreaks

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Abstract

This thesis investigates the relation between insect outbreaks and climatic factors (temperature, precipitation) and their relative importance on the basal radial growth increments of Norway spruce. Secondary spruce forests in the prealpine foothills of Austria frequently suffer from short, but severe outbreaks of spruce sawflies (*Pristiphora abietina*, *Pachynematus montanus*). Here, we link dendrochronological datasets of 200 individual spruce trees selected from 5 sites in Salzburg and Upper Austria with a known history of sawfly defoliation during the past 60 years with meteorological data from the nearest stations. The aim of the study is (1) to pinpoint weather conditions in the year(s) before, during and after insect outbreaks that promote/suppress sawfly gradations and (2) to separate variations in tree ring widths related to climate, insect defoliation, and other disturbances (e.g., thinning).

The statistical program R and different packages [e.g., dplR] will be used to create climate diagrams [climatol], boxplots for different periods of the year, and climatic sequences to compare the different sites. As a first result, we observed a general increase in the mean air temperatures during the observation period. We will also use a drought index [SPEI] to observe curve similarities among the sites. Finally, we will implement the radial increment data of every single tree and use a moving average function for smoothing the data and creating a multilevel analysis. This will allow us to create a model for the radial growth increments of the trees after biotic, abiotic or man-made disturbances.

Oral presentation

Resource exploitation of the koinobiont endoparasitic wasp *Glyptapanteles liparidis* (Hym., Braconidae) from its host *Lymantria dispar* (Lep., Erebidae)

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Abstract

Parasitic wasps depend on the resources from a single host and thus, are strongly selected to optimize the acquisition and utilization of nutrients. Koinobiont parasitoids exploit hosts that continue to feed and grow; hence, host quality is determined by its nutrition and growth potential after parasitization. Here, we used the parasitic wasp *Glyptapanteles liparidis* (Hym., Braconidae) and gypsy moth larvae, *Lymantria dispar* (Lep., Erebidae), to examine the effect of food quality on host and wasp fitness parameters. Female wasps deposit many eggs inside the host larva. The parasitoids develop through two instars and feed on the host blood. Third instar parasitoids emerge from the moribund host and pupate in cocoons.

In a first experiment, gypsy moth larvae were reared on either high nutrient diet (wheat germ) or low nutrient diet (70% indigestible cellulose). We recorded growth and development from hatching to moth eclosion at 15, 20 and 25°C. In a second experiment, the larvae were reared on the high nutrient diet until third instars. Eighty newly molted larvae were parasitized by *G. liparidis* wasps and evenly distributed to either high or low nutrient diets. The larvae were kept individually at room temperature until parasitoid emergence or host pupation. We documented the (i) host weight and instar at parasitoid emergence, (ii) duration of parasitoid development, (iii) number of parasitoids per host, and (iv) sex, weight and longevity of adult wasps.

In general, the time from hatching to pupation was up to one month longer at 15°C than at 25°C. Female pupae from both diets were significantly heavier than males, but females developed slower than males. Larvae on the high nutrient diet developed faster and achieved higher weights than on the low nutrient diet. Early instars reared on the low nutrient diet since hatching exhibited high mortality rates; no mortality was observed when first and second instars fed high nutrient diet and were transferred as third instars to the low nutrient diet. The development of the parasitoid larvae from oviposition to emergence was significantly delayed when the host received low nutrient diets. Depending on the host instar at parasitoid emergence, development time was 2-3 (fourth instars) and 6-11 days longer (fifth instars), respectively. Thus, the different parasitoid development times in the two host groups indicate a significant influence of the diet.

Oral presentation

Wolbachia Dynamics in European Cherry Fruit Flies

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Abstract

Wolbachia is a maternally inherited endosymbiont and the most prevalent bacterium found in arthropods and nematodes. It can manipulate host reproduction inducing e.g. cytoplasmatic incompatibility (CI) to enhance its vertical transmission. As a consequence, the spread of *Wolbachia* can also reduce the mitochondrial diversity of its host. The European cherry fruit fly *Rhagoletis cerasi* (Diptera, Tephritidae) is a severe pest of sweet and sour cherries. Crossing experiments in the 1970s revealed a unidirectional CI among northern and southern European populations and later the *Wolbachia* strain *w*Cer2 was defined as the causal agent, which is currently spreading within Central Europe. A hotspot of this ongoing spread was described in the Czech Republic where *R. cerasi* populations showed a smooth decrease of *w*Cer2 frequencies from south to north within a distance of less than 20 km. These transitional populations are optimal to study the *w*Cer2-dynamics and its associated *R. cerasi* mitochondrial haplotype.

In this thesis, an additional transect was defined and data from two years were compared. In 2017, screening of 162 individuals from seven different locations revealed no *w*Cer2-fixed populations in the South and one *w*Cer2-uninfected population in the North. In 2019, screening of 382 individuals from sixteen populations showed seven *w*Cer2-fixed populations in the South and nine transitional populations. However, no *w*Cer2-uninfected population in the North was observed. This fast *w*Cer2- spread to the North does not conform to estimations from previous studies and could be caused by different landscape structures as well as different climatic conditions.

The mitochondrial analyses performed only for the 2017 samples showed two haplotypes. All *w*Cer2-infected and two *w*Cer2-uninfected individuals were harboring HT2. The remaining 88 *w*Cer2-uninfected individuals harbored HT1. These data suggest the occurrence of imperfect maternal *w*Cer2-transmission in transitional populations.

Oral presentation

Bistable dynamics of *Wolbachia* spread in a Czech transect of *Rhagoletis cerasi*

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Abstract

Wolbachia are widespread bacterial endosymbionts, well known for their ability to manipulate insect reproduction. The most common reproductive manipulation phenotype is cytoplasmic incompatibility (CI). CI occurs when uninfected females mate with infected males, resulting in almost complete embryo mortality. The mechanisms of CI can be exploited to control agricultural pests and vectors of human diseases, representing a sustainable and promising alternative to conventional management methods. Monitoring *Wolbachia* spread under natural conditions is a key step to evaluate the risks related to the application of symbiont-based strategies.

A model organism for long-term *Wolbachia* studies is the European cherry fruit fly *Rhagoletis cerasi*. Univoltine life cycle and limited dispersal activity allow an in-depth characterization of *Wolbachia* infection dynamics in a natural host. Across Europe, *R. cerasi* populations are either infected or uninfected with the *Wolbachia* strain *w*Cer2. The *w*Cer2-infection pattern in Central Europe shows an ongoing invasion, generally from south to north, driven by strong CI. Especially transition zones, i.e. populations between complete *w*Cer2-infected and *w*Cer2-uninfected areas, where *w*Cer2 is currently spreading, are suitable to study the dynamics of *w*Cer2 on a fine scale in space and time.

In this project, *R. cerasi* populations of a transition zone in the Czech Republic described in 2015 were re-sampled in 2017 and screened for the presence of *w*Cer2. Results showed a gradual decrease in *w*Cer2 infection rates from south to north. Populations with *w*Cer2 infection frequencies above 50% in 2015 showed a significant increase of *w*Cer2-infected individuals in 2017, whereas populations with a frequency below 50% in 2015 showed more fluctuations. These results suggest a bistable model of spread, where a certain infection-threshold for *w*Cer2 is necessary to get established in host populations. Our work provides new insights into *Wolbachia* infection dynamics in natural populations and contributes to a better knowledge of this endosymbiont-host system.

Oral presentation

A temperature-dependent growth model for eggs and larvae of the spruce web-spinning sawfly *Cephalcia abietis* (Hym., Pamphiliidae)

Elisabeth Wedenig [1*], Christa Schafellner [1]

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Abstract

The spruce web-spinning sawfly *Cephalcia abietis* (Hym., Pamphiliidae) is a primary pest of spruce. The insects usually do not kill the tree; however, severe defoliation makes it susceptible for secondary pests (bark beetles). Depending on abiotic conditions, sawfly populations at different elevations and locations have different development times for the stages that occur in the crown (eggs, larvae) and the soil (prepupae, pupae) and the life cycle from oviposition until emergence of adult sawflies lasts 1-4 years. To establish a development model for the prognosis of sawfly eruptions it is necessary to know the thermal sums the insect stages need for completion. The present thesis calculates the thermal sums (degree-days, dd) for embryonic and larval development, i.e., from oviposition until dropping of the mature larvae. The data were derived from individuals of a sawfly population with a 3-year generation cycle collected in a mature spruce stand near Zwettl/Lower Austria.

In spring 2019, we trapped emerging wasps with soil-photoeclectors and nets. Females were kept individually or in small groups in cages with potted spruce saplings or spruce twigs cut from the field under controlled conditions in climate chambers, at room temperature, and under semi-field conditions (institute garden in Vienna), respectively. We monitored the period from oviposition to hatching (embryonic development) and from first to last instars (larval feeding) and recorded temperatures and the respective humidity levels.

Females at room temperature (24±2°C, June-August) laid eggs 1-2 days after release in the cages; larvae hatched 12 days post oviposition and developed within 3-6 weeks post hatching. Under semi-field conditions (21±4°C, June-September), eggs were observed 10 days post female release, the larvae needed 5-8 weeks post oviposition to complete development. At 20°C (climate chamber), eggs were laid 1-2 days post female release and larvae hatched 9 days post oviposition. The larvae completed development within 4-8 weeks post hatching.

Using these data and a development threshold temperature of 13°C, we calculated embryo and larval development from oviposition until first and last dropping of larvae from the crown (shortest and longest development). At room temperature, embryo development required 143 dd, larval development 248 dd (shortest) and 460 dd (longest), respectively. Under semi-field conditions, larval development was calculated as 335 dd (shortest) and 508 dd (longest). At constant 20°C, embryo development required 77 dd, shortest and longest larval development were 190 dd and 378 dd, respectively. All calculations were based on daily mean temperatures.

Oral presentation

Parasitoids and pathogens of a gypsy moth population during retrogradation at an outbreak site in Lower Austria

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Abstract

The gypsy moth, *Lymantria dispar* (Lep., Erebidae) is an important pest on deciduous trees, especially oaks (*Quercus* spp.), with a tendency to cyclic population outbreaks. In Central Europe, an extensive complex of natural enemies (predators, parasitoids, pathogens) is essentially involved in helping to control gypsy moth outbreaks and in keeping populations low in the years between outbreaks. Former studies in Austria identified the dipteran species *Parasetigena silvestris* and *Blepharipa* spp. (Dip., Tachinidae) and the hymenopteran species Glyptapanteles spp. (Hym., Braconidae) and *Phobocampe* spp. (Hym., Ichneumonidae) as the major parasitoids of gypsy moth larvae during low population densities. Among pathogens, the L. dispar-nuclear polyhedrosis virus (LdNPV) is considered as important factor in the collapse of gypsy moth outbreaks. In summer 2019, the entomopathogenic fungus *Entomophaga maimaiga* was detected for the first time in Austria in gypsy moth populations from two sites in Lower Austria (Eggenburg and Ebergassing). The fungus originates from East Asia; in 1999 it was deliberately introduced to Bulgaria for biological control, and since then has spread rapidly along the Balkan countries towards Central Europe. Accordingly, *E. maimaiga* will have considerable effects on the population dynamics of gypsy moth in Austria.

From spring to early summer 2020, we will collect gypsy moth egg masses, young and old larvae, and pupae from oak forests in Eggenburg. After two years of high population densities and defoliation of the trees, the population density is now decreasing. The collected immature stages will be reared in an outdoor insectarium until moth eclosion or parasitoid emergence. Gypsy moth larvae and pupae that die during rearing will be dissected and diagnosed for bacterial, viral or fungus pathogens. Additionally, we will sample cocoons of the braconid parasitoid *Glyptapanteles liparidis*, to determine the hyperparasitoids of this important natural enemy. Parasites and hyperparasites of the gypsy moth will be identified with keys for adults and immature stages. The present study will give insight into the occurrence and abundance of parasitoids and pathogens of the gypsy moth population in Eggenburg. The results will be compared with previous data from other gypsy moth populations in Austria. The role of *E. maimaiga* as new component of the natural enemy complex will be evaluated.

Institute of Forest Growth

Poster presentation

Vergleich verschiedener Baumfindungs- und Durchmesseranpassungs-algorithmen an mobilen Laserscandaten

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Abstract

Die Waldinventur stellt Informationen und Daten als Entscheidungsgrundlage für forstliche Planungen hinsichtlich der Umsetzung operativer Eingriffe und der Erreichung wirtschaftlicher Zielsetzungen zur Verfügung. Neben den traditionellen Aufnahmemethoden haben in letzter Zeit Waldinventuren mit Laserscannern immer mehr an Bedeutung gewonnen. Während terrestrische Laserscanner (TLS) schon länger im Einsatz sind, gibt es noch wenige Untersuchungen zur Waldinventur mit mobilen personengetragenen Laserscannern (PLS). Im Laufe der Jahre wurde eine Vielzahl an Algorithmen für die Auswertung von Laser 3D Daten entwickelt. Um nun die Leistung dieser Algorithmen fair miteinander vergleichen zu können sind einheitliche Testdaten nötig. Im Zuge dieser Arbeit wurden unterschiedlichen Algorithmen hinsichtlich Baumpositionsfindung und Durchmessermessung an denselben PLS - 3D Daten verglichen.

Datengrundlage bildeten 20 Stichprobenpunkte der Lehrforstinventur, die mit einem mobilen personengetragenen Laserscanner „GeoSLAM ZEB Horizon“ aufgenommen wurden. Als Referenzgrößen zur Beurteilung der automatisiert berechneten Baum- und Bestandesparameter dienten händische Messungen von Baumposition und BHD. Die verglichenen Algorithmen sind TreeLS, LiDAR360 und 3D Forest. Der Algorithmus TreeLS ist als kostenloses R-Package verfügbar. LiDAR360 und 3D Forest sind frei zugängliche interaktive Programme, wobei LiDAR360 nur als 30 Tage Demoversion nutzbar ist. Die Einstellparameter aller drei Algorithmen wurden optimiert, wobei bei LiDAR360 und 3D Forest dies manuell geschah und zusätzlich eine automatisierte Filterung der gefundenen Bäume hinsichtlich realistischer Baumhöhe und H/D – Verhältnis durchgeführt wurde. Bei TreeLS wurde die Optimierung der Parameter über eine Gittersuche automatisiert. Die automatische bzw. händische Optimierung der Algorithmen führte zu unterschiedlichen Kombinationen der Einstellparameter und so zu verschiedenen Baumfindungs- und Durchmessermessvarianten. Für jeden einzelnen der drei Algorithmen wurde die Variante mit den besten Einstellungen durch einen Vergleich von ausgewählten Gütemaßen zur Beurteilung der Baumfindung und Durchmessermessung ermittelt. Abschließend erfolgte eine Gegenüberstellung der Leistung hinsichtlich der besten Variante aller drei Algorithmen mit dem am Institut für Waldwachstum entwickelten WAFO – Algorithmus.

Alle Algorithmen lieferten brauchbare Ergebnisse und können für die Auswertung von mobilen Laserscandaten herangezogen werden. Die Entdeckungsraten bewegten sich durchwegs über 90% bei einer Kluppschwelle von 10 cm während der RMSE der BHD Messung je nach Algorithmus zwischen 2,4 und 5 cm schwankt. Hinsichtlich der Gütemaßzahlen schnitt der WAFO – Algorithmus am besten ab. Stammzahlreiche, dichte und astige Bestände mit viel Unterwuchs bereiten den Algorithmen noch Probleme. Hinsichtlich der Baumfindung konnte ein Kluppschwelleneffekt festgestellt werden. Je größer die Kluppschwelle gewählt wurde, desto vollständiger wurde die Baumfindung.

Poster presentation

Präzise Modellierung von Stammquerschnitten und Untersuchung des Einflusses der Querschnittsform auf die Durchmessermessung bei TLS-Daten

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Abstract

Zur Ermittlung des Einzelbaumvolumens wird der Brusthöhendurchmesser (BHD), die Baumhöhe und eine Formzahlfunktion herangezogen. Neue Methoden zur Durchmessermessung finden sich in automatischen Algorithmen zur Auswertung von 3D Punktwolkendaten, welche mit terrestrischen Laserscannern (TLS) aufgenommen werden. Aus diesen TLS generierten Punktwolken können die Stammquerschnitte in beliebigen Höhen dargestellt werden. Ziel der Bachelorarbeit war es zu untersuchen, inwieweit verschiedenformige Stammquerschnitte mit geeigneten geometrischen Formen oder flexiblen Funktionen aus 3D TLS Punktwolken nachgebildet werden können. Je nach modellierter Querschnittsform wurde auch der Einfluss unterschiedlicher Klupprichtungen auf die Durchmessermessung ermittelt.

Datengrundlage bildeteten 20 Eichen im starken Baumholz. Diese wurden mit einem terrestrischen Laserscanner (FARO Focus3D X330) auf einem engen Raster von Scannerstandorten gescannt. Über im Zuge des Scanvorgangs im Gelände positionierte Referenzkugeln konnten die Einzelscans am Computer zu einer 3D Punktwolke koregistriert werden, aus welcher dann die 20 Einzelbäume mit dem Programm „CloudCompare“ manuell ausgeschnitten wurden. Kreis- und Ellipsenanpassungsalgorithmen in den R-Paketen „conicfit“ und „edci“ modellierten die Stammquerschnitte in verschiedenen Höhen entweder als einfache Kreise oder als Ellipsen mit Halbachsen. Weiters wurden die Querschnitte auch als zyklische kubische Splines mithilfe des R-Paketes „mgcv“ dargestellt. Um Referenzdaten zur Beurteilung der Güte der modellierten Stammquerschnitte zu erhalten wurden die 20 Eichen gefällt und insgesamt 57 Stammscheiben geworben. Aus verzeichnungskorrigierten Fotos der Stammscheiben mit Refernzdistanzen darauf konnten die Umrisse der Stammquerschnitte ausgeschnitten und auf die wahre Größe skaliert werden. Die aus den Stammscheibenfotos generierten Umrisse dienten dann als Vergleichsgrößen für die modellierten TLS Querschnitte. Als Gütemaß wurde das Verhältnis aus Schnittmenge zur Vereinigungsmenge der Stammscheiben- und TLS Querschnittsflächen herangezogen.

Die Ergebnisse zeigten, dass die mit Splines modellierten TLS-Querschnitte das höchste Verhältnis und somit die beste Übereinstimmung mit den Stammscheiben haben. Die Ellipsen passen mittelmäßig gut und die Kreisanpassungen sind für die Modellierung von unförmigen Stammquerschnitten, wie sie insbesondere auch bei Eichen vorkommen, nicht geeignet. Dementsprechend ist auch der Einfluss der Klupprichtung bei unförmigen Querschnitten ein großer und nicht zu vernachlässigen.

Poster presentation

Modellierung von Schaftformen und Volumina aus mobilen Laserscandaten

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Abstract

In der traditionellen Waldinventur werden Baum- und Bestandesattribute durch zeitintensive, händische Messungen erhoben und Volumina nach bekannten Volumsschätzfunktionen berechnet. Moderne lasergestützte Sensoren können in Zusammenhang mit entsprechenden Auswerteroutinen Aufgaben der traditionellen Waldinventur übernehmen. Während stationäre terrestrische Laserscanningsysteme (TLS) nun schon einige Zeit auf dem Markt sind und in einigen Studien zur Waldinventur behandelt wurden, stellen mobile personengetragene Laserscanningsysteme (PLS) eine relativ neue Technologie dar. PLS-Systeme haben gegenüber TLS-Systemen das Potential vollständigere 3D Daten von Einzelbäumen oder auch Beständen in kürzerer Zeit zu sammeln. Traditionell werden exakte Schaftformen und -volumina über Schaftkurven aus am liegenden Stamm sektionsweise gemessenen Durchmessern modelliert. Laserscanningsysteme und insbesondere PLS-Systeme eröffnen nun die Möglichkeit obere Durchmesser am stehenden Stamm automatisch und zerstörungsfrei zu ermitteln. Im Rahmen dieser Arbeit wurde untersucht, ob Schaftkurven aus PLS-Daten erstellt werden können, wie gut die daraus abgeleiteten Volumina im Vergleich zu bekannten Volumsschätzfunktionen abschneiden und ob eine Filterung der PLS-Durchmesser vor der Schaftkurvenmodellierung vorteilhaft ist.

Datengrundlage bildeten 20 Stichprobenpunkte der Lehrforstinventur, die mit einem mobilen personengetragenen Laserscanner „GeoSLAM ZEB Horizon“ aufgenommen wurden. Als Referenzgrößen zur Beurteilung der automatisiert berechneten Baum- und Bestandesparameter dienten händische Messungen von Baumposition, BHD und Höhe. Aus den Punktwolken wurden 396 Einzelbäume mit dem Programm „CloudCompare“ ausgeschnitten. Für jeden dieser Einzelbäume wurden dann die Schaftdurchmesser entlang der Stammmachse in 0,5 m Abständen automatisch gemessen. Darauf aufbauend wurden mit dem R-Paket „TapeR“ gemischte, semiparametrische Regressionsmodelle angepasst und Schaftkurven modelliert. Die Entwicklung eines automatisierten Filters für die PLS Durchmesser erfolgte mithilfe eines logistischen Regressionsmodells auf Basis von händisch gefilterten Durchmessern an 60 Bäumen. Die sich aus den Schaftkurven ergebenden Volumina wurden mit Pollanschützvolumina als Referenz verglichen.

Es konnte ein funktionsfähiger, automatisch arbeitender Filter entwickelt werden, welcher mit nur einer Stellvariablen justiert wird. Durch die Verwendung dieses Filters, konnte der RMSE der PLS Volumsberechnung um 29,8% auf 0,302 m³ verbessert werden. Der bias von 0.148 m³ deutet auf eine kleine Überschätzung der Volumina im Vergleich zu Pollanschütz hin. Der sich aus den PLS Schaftkurven ergebende Brusthöhendurchmesser wurde mit den händisch ermittelten Referenzmessungen verglichen (RMSE: 2,66 cm; bias: 0,14 cm). Trotz der Filterung der Durchmesser, welche für eine möglichst genaue Modellierung und Volumsberechnung zwingend notwendig ist, werden große Volumina ab 2 m³ tendenziell überschätzt. Da bis zum jetzigen Zeitpunkt lasergestütze Schaftmodelle meist auf Basis terrestrischer Laserscanner erstellt wurden, fehlen für den direkten Vergleich geeignete PLS-Ergebnisse.

Poster presentation

Evaluierung des Einflusses der Scan-Parameter-Einstellung eines terrestrischen Laserscanners auf die automatisierte Auswertung von Waldinventuren

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Abstract

Terrestrisches Laserscanning (TLS) findet zunehmend Anwendung in der modernen Waldinventur und im Waldmonitoring. Dabei werden Baum- und Bestandesparameter über automatisch ablaufende Routinen aus 3D Punktdaten (Punktwolken) ermittelt. Die Güte dieser Baum- und Bestandesparameterschätzung hängt im Wesentlichen von der Genauigkeit der 3D Daten ab.

Ähnlich der traditionellen, ist auch die moderne sensorgestützte Waldinventur ständig nach weiterer Rationalisierung bestrebt. Das heißt, die Scan- und Prozessierungszeit sollte bei größtmöglicher Punktwolkenqualität klein gehalten werden. Ziel dieser Arbeit ist es, die Auswirkungen unterschiedlicher Parametereinstellungen bei einem terrestrischen Laserscanner (FARO Focus^{3D} X330) auf die Baumfindung und Durchmessermessung sowie auf digitale Gelände- und Baumhöhenmodelle zu untersuchen.

Datengrundlage bilden fünf Stichprobenpunkte der Lehrforstinventur, die im Multiscanmodus mit zehn verschiedenen Kombinationen der beiden zentralen Scanparameter Auflösung und Qualität erfasst wurden. Als Referenzwerte für die Güte der TLS Inventur wurden die Brusthöhendurchmesser händisch kluppiert und die Baumpositionen eingemessen. Nach der Ko-Registrierung der einzelnen Scans konnte jeweils eine 3D Punktwolke pro Einstellungsvariante und Stichprobenpunkt erstellt werden. Mit den am Institut für Waldwachstum entwickelten Algorithmen wurden aus den 3D Daten die Baumpositionen, Brusthöhendurchmesser, digitale Geländemodelle und Baumhöhenmodelle errechnet.

Hinsichtlich der Parametereinstellungen am Scanner erwies sich die Auflösung als gewichtigere Größe im Vergleich zur Qualität, je höher die Auflösung, desto höher die Entdeckungsraten und desto niedriger die Durchmesserfehler. Bei den Geländemodellen und Höhenmodellen steigen die Abweichungen mit niedriger werdender Auflösung. Einzig bei niedriger Auflösung ist ein höherer Qualitätsparameter vorteilhaft.

Oral presentation

Vermessung liegenden Holzes mithilfe terrestrischer Laserscans

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Abstract

Die Ermittlung des Bestandesvorrats wie auch des Einzelbaumvolumens stellt eine der zentralen Aufgaben der Waldinventur dar. In den letzten Jahren konnten zur automatisierten Entdeckung sowie Vermessung von stehenden Bäumen Algorithmen für die Auswertung von terrestrischen Laserscandaten erfolgreich entwickelt und angewandt werden.

Zunehmende Schadereignisse sowie Weiterentwicklungen in der Ernte- und Rücketechnologie benötigen automatisierte und präzise Informationen von liegenden Bäumen. Ziel dieser Arbeit ist es, Methoden zu entwickeln, um aus terrestrischen Laserscandaten automatisiert liegende Stämme entdecken und ihre Länge sowie Durchmesser an beliebigen Stellen vermessen zu können.

Die Optimierung von Algorithmen zur Bestimmung von Boden- und Vegetationspunkten soll dazu dienen, die liegenden Stämme vom Untergrund zu unterscheiden, ohne dabei 3D-Punkte von den Stämmen zu verwerfen. Die Bodenpunkte werden weggefiltert und die verbleibenden Punkte über dichtebasiertes Clustern zusammengefügt. Mithilfe einer Hauptkomponentenanalyse werden dann jene Cluster, die einen liegenden Baumstamm darstellen, herausgefiltert und um jene Cluster, die fälschlicherweise anfangs nicht dem jeweiligen Cluster zugeordnet wurden, erweitert. Es sollen dann Methoden entwickelt werden, um aus diesen Clustern Stammlängen und verschiedene Durchmesser zu messen. Darauf aufbauend wird das Volumen des liegenden Stammes berechnet. Als Vergleichsgrößen dienen manuelle sektionsweise Durchmesser- und Längenmessungen von 43 Fichten und Tannen.

Die automatisierte Erkennung und Vermessung von liegenden Bäumen eröffnet vielfältige Potentiale. So bieten sich durch exakte 3D-Modelle neue Möglichkeiten, beispielsweise Stämme wirtschaftlich optimiert auszuformen. Auch hinsichtlich der Entwicklung von autonomen Holzerntesystemen können automatisiert ausgewertete 3D-Laserdaten von liegenden Bäumen einen wichtigen Beitrag liefern.

Poster presentation

Impact of climate parameters and waters dynamic on radial growth of *Quercus robur* and *Fraxinus excelsior* in floodplain forests

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Abstract

Riparian forests represent an essential part of river ecosystems. Its forest vegetation is periodically influenced by flooding. Floodplain forest ecosystems are discriminated between softwood riparian forests, both differing in the intensity of ground water influences. Whereas softwoods grow in close distance to the stream, hardwood riparian forests are less influenced by groundwater. However, growth dynamics in both forest types are sensitive to the flood dynamics.

The Interreg project REFOCuS was initiated to examine the resilience of riparian forests in the arising Biosphere Reserve Mura-Drawa-Danube. Major goal of this transnational program is to develop integral silvicultural and conservation concepts for retaining and protecting floodplain forests. Among others, empirical analysis is based on wood core samples collected from pedunculate oak (*Quercus robur*) and common ash (*Fraxinus excelsior*) trees. Furthermore, the vitality of the sample trees was visually assessed in terms of of crown transparency classes.

Major focus of this master thesis is on the analysis of the inter-relationships between productivity, climate and ground water dynamics for the two tree species pedunculated oak and common ash. Climate is represented by monthly averages of precipitation and atmospheric temperature derived from meteorological grid data for every sample transect. Water dynamics are described by monthly measures for the water level. Productivity is measured by annual tree-ring widths.

Oral presentation

Stündlicher Zuwachs im Rein- und Mischbestand

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Abstract

The annual growth of Forest trees on warm and dry stand sites in middle Europe starts from middle of April and ends at the end of September. During the growth period the growth can be decreased or even be interrupted by drought. The sensitiveness of trees to decreased growth during drought is depending on the tree species. E.g. Spruce (*Picea abies*) is more sensitive than Beech (*Fagus sylvatica*). Reasons are the different root system and the ability open and close stomata during drought. In mixed stands different tree species can interact positively under dry conditions or the compete stronger. Automatic dendrometers are able to measure intra-annual growth in high time resolution. This study includes data of more than 100 trees out of 6 species measured on five different stand sites with a measuring range from 2 to 7 years. The tree growth can be modelled for different species by using a hierarchical nonlinear mixed effects model represented by logistic growth curves.

There are three main aspects in this publication:
(i) Verifying that depending on the climate the annual growth of tree species can vary between different years. (ii) Investigating if growth of mixed stands vs. monospecific stands varies between different years depending on climate. (iii) proving the effect of climate on growth depending on the social tree position. Possibly the results of such models will be one tool for future forestry to propose tree mixtures depending on the predicted climate of a stand site.

Institute of Forest Ecology

Poster presentation

Investigation of changing water holding capacities of four different superabsorbent polymers and their effects on soil microbial respiration

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Abstract

Superabsorbent polymers (SAPs), also known as hydrogels, are networks of polymer chains that are held together by cross-links and which can store great amounts of water. They are used, amongst other things, in order to increase water holding capacities of soils in agriculture and forestry. Most SAPs are based on synthetic, hardly biodegradable materials, whose application results in increasing soil contamination. Therefore, biodegradable alternatives have been developed in recent years. The SAPs analyzed in this study are Stockosorb (fully synthetic SAP), Polyter (consisting of a combination of synthetic polymers and cellulose), a natural SAP based on lignin and one based on cellulose.

This thesis will investigate two aspects of the different SAPs. Firstly, how water holding capacity of the hydrogels changes over a six month period, when exposed to several wetting/drying cycles. The experiment will be performed in the lab by creating soil/hydrogel mixtures, which will be wetted and measured at maximum water holding capacity. Consequently, the samples will be air dried for three weeks before being rewetted and remeasured. In a second experiment the influence of the hydrogels on microbial activity will be assessed. It is known that microbial soil respiration changes with varying water contents. By measuring soil respiration over a complete wetting and drying cycle the behavior of the gel in soil can be estimated, allowing conclusions on to what extent water is retained by the gel or released to soil, and therefore influencing microbial activity. In this way the ability to support the environment with water is tested. The change in water holding capacity is expected to be linked mainly to the biodegradation of the different products. Therefore, synthetic and hybrid SAPs like Stockosorb and Polyter are expected to display smaller changes in water holding capacities than the natural SAPs based on lignin and cellulose.

Poster presentation

Influence of Glyphosate and Barrier-H on soil respiration, soil enzymatic activity and microbial community composition

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Abstract

In 2014, the use of Glyphosate has reached 747 million kg, due to the introduction of genetically modified crops. Companies sell easy-to-use packages, including herbicide and herbicide-tolerant crop, like soybean or corn, and make out of farmers competing on increasing yields driven by the intensification of agriculture. However, this occurs at the expense of the environment, especially the soil. Bioherbicides, such as Barrier-H, are categorized as sustainable alternatives, because their ingredients are extracted plant metabolites, like essential oils. Barrier-H is mainly derived from citronella oil and primary applied on common ragwort with little scientific data available. This study demonstrates the effects of Glyphosate on the soil microorganisms in comparison to Barrier-H. CO2 soil efflux rates, potential extracellular enzyme activity, microbial biomass and microbial community composition where chosen to be the measured values representing soil fertility.

In total, 36 soil samples from an agricultural field in Tullln were treated either with realistic concentrations of herbicide (12 Glyphosate; 12 Barrier-H), or 12 samples remained as control. All samples were incubated for 28 days at 20°C and rewetted bi-daily. The CO_2 respiration was determined after 24h, 36h, 48h, 60h, 72h, 84h, and then weekly until 28d. The evaluation of enzyme activity, microbial biomass and microbial community will be conducted on samples harvested after 28 days of incubation.

The samples treated with Glyphosate indicated a high peak after 84h of incubation, whereas the samples treated with Barrier-H reached a low peak after 60h. After the peaks, the respiration of both treatments decrease steadily until they meet similar values of the control after 28 days.

The CO_2 respiration has shown an enhancement of microbial activity in the soil. Whereas the effect of Glyphosate was measured as twice as high compared to Barrier-H. Further investigations will give details about an increase or decrease of microbial biomass and may present a shift in bacteria to fungal ratio.

Institute of Silviculture

Poster presentation

Effekte von Lärchwiesenfreistellung

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Abstract

Um ökologisch wertvolle Lärchwiesen zu erhalten und wiederherzustellen, wurden Waldumweltmaßnahmen vom Naturschutzreferat/Land Salzburg auf Grundlage des Programms Ländliche Entwicklung 2007-2013 gefördert. Im untersuchten Projektgebiet wurde vor ca. 10 Jahren eine Lärchwiesenfreistellung durchgeführt. Im Rahmen dieser Masterarbeit wird untersucht, welche Effekte die Lärchwiesenbegründung auf das Wachstum der Baumpopulation und ausgewählte Baum- bzw. Bestandesparameter, den Beweidungszustand, den Zustand der Bodenvegetation und Naturverjüngung haben. Um diese Effekte zu analysieren erfolgte ein Vergleich von behandelten und unbehandelten Flächenteilen. Insgesamt wurden auf fünf Untersuchungsflächen jeweils zwei Flächentransekte angelegt. Es gibt vier verschiedene Flächentypen: beweidete Lärchweide, beweidete Vergleichsfläche, teilweise beweidete Vergleichsfläche und nicht beweidete Vergleichsfläche. Auf den Flächen erfolgte eine Vollaufnahme der Bäume. Folgende Merkmale wurden erhoben: Baumart, BHD, Kronendurchmesser, teilweise Baumhöhe und Kronenansatz, Stockdurchmesser und Stockhöhen. Alle Bäume und Stöcke wurden auch als Polarkoordinaten lagemäßig aufgenommen. Um den Beweidungseinfluss festzustellen, erfolgten einerseits stichprobenartig Biomasseuntersuchungen und andererseits die Häufigkeit von Trittsiegeln auf den Flächen. Die Bodenvegetationsaufnahmen wurden ebenfalls nach dem Braun-Blanquet Verfahren erfasst. Verjüngung wurde in drei Höhenklassen und einer Durchmesserklasse (<5cm) erhoben. Die Erhebungen im Gelände wurden im Herbst 2019 abgeschlossen und erste vorläufige Ergebnisse liegen vor.

Poster presentation

Exploring drought stress relevant gene variants of *Abies alba* in the alpine region

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Abstract

As the frequency of drought periods is likely to increase during the 21st century, there emerges a need to evaluate the potential of adaptation of our forest tree species to the anticipated changes of the environmental conditions. This thesis aims to validate a set of 22 candidate genes of the European keystone conifer Silver fir (*Abies alba L.)*, for which information about the genetic architecture is lacking. The study makes use of an outlier-based approach by comparing frequencies of 33 putative non-neutral single nucleotide sequence variations (SNPs) from decidedly dry sites (South Tyrol, 2 populations, 97 individuals) with those observed on well water saturated sites (Tyrol, 2 populations, 100 individuals). For this purpose, we designed multiplexable single-base-extension primers using BatchPrimer3, providing a cost-efficient way for SNP genotyping. Furthermore, we analysed 9 highly informative neutral simple sequence repeat (SSR) loci, using Bayesian clustering implemented in STRUCTURE along with Excel package GenAlEx, in order to compare population structure, molecular diversity, genetic distance and departures from Hardy Weinberg equilibrium. We expect (1) low genetic structure between the populations, as they all derive from the same glacial refugia of Silver fir. Due to the relative spatial proximity to these refugia we assume (2) higher genetic diversity in the southern populations, along with (3) elevated frequencies of drought-stress relevant gen variants in populations from dry sites.

Oral presentation

Simulated effects of tree species diversity and species pattern on biomass production at stand level

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Abstract

Recent synthesis in functional biology suggests that across a variety of systems and for a number of ecological processes, diverse communities often outperform the ones which are species-poor. Tree species diversity therefore has important implications for forest management practices. However, experiments and observational studies revealed that there is no general overarching diversity – ecosystem functioning relationship, but that diversity effects may vary across sites, densities and species compositions, and may be due to true complementarity or species identity effects. Tree-based forest ecosystem models offer the opportunity to explore diversity–functioning relationships. In this contribution the 3D hybrid forest model PICUS v1.6 is employed to simulate the behaviour of various species mixtures to shed light on diversity and species identity effects on biomass productivity. In total, eight tree species (*Picea abies, Abies alba, Pinus sylvestris, Larix decidua, Fagus sylvatica, Quercus petraea, Acer pseudoplatanus, Betula pendula*) were considered along a mixture gradient (species number, species shares) where species are either randomly distributed in space or intermixed in patches of various size (100m^2, 400m^2 and 900m^2 patch size). Simulated output is analysed for diversity–functioning effects related to biomass production.

Oral presentation

Evaluation of Douglas fir stands at low elevation sites in Carinthia

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Abstract

The cultivation of productive native tree species becomes more and more challenging in the light of a changing climate. Norway spruce, the most common tree species in Austrian forests, is being threatened by natural disturbances such as wind throws and distinct bark beetle gradations. Douglas-fir (*Pseudotsuga menziesii)*, a non-native tree species with its origin in northwest America, could be one economically sound alternative, as it is better adapted to drought periods and not endangered by the bark beetle *Ips typographus.* Additionally, Douglas-fir stand productivity is high and it is known for its excellent wood quality. The aim of this thesis written in collaboration with the forestry authorities of the federal province of Carinthia was (a) to study the overall condition of Douglas-fir stands at low altitudes in Carinthia, (b) a silvicultural analysis of selected Douglas-fir stands, and (c) an evaluation of basal area increment and productivity models. The collected forest data showed that the 15 analysed Douglas-fir stands surpass the productivity predicted by the evaluated models. An evaluation of a basal area increment model developed for Douglas-fir stands in northern Austria using the RSME showed that the model cannot be applied to predict the basal area increment of stands in the federal province of Carinthia. Overall, Douglas-fir stands can show excellent growth perfomance in Carinthia.

Oral presentation

Nachhaltigkeitskennzahlen im Dauerwald

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Abstract

Plenterwald- bzw. Dauerwaldbewirtschaftung gilt als eine Alternative zu einer schlagweisen Altersklassenbewirtschaftung. In dieser Arbeit wird die Überführung von Altersklassen- in Dauerwälder am Beispiel eines Forstbetriebes und einem Zeitraum seit der Umstellung des Bewirtschaftungssystems von dreißig Jahren analysiert. Als Daten stehen vier permanente Inventuren zur Verfügung. Im Rahmen der Arbeit erden folgende Themen analysiert: (i) Analyse der bisherigen Bewirtschaftung, (ii) Abschätzung der zukünftigen Entwicklung unter Beibehaltung der betriebsüblichen Entnahmemethoden, (iii) Erarbeitung von Kennzahlen für die Dauerwaldbewirtschaftung. Ziel ist eine Darstellung und Beschreibung der Auswirkungen der Überführung auf verschiedene waldwachstumskundliche Parameter. Die Nutzungseingriffe erfolgen in gewisser Regelmäßigkeit, die Stärke der Eingriffe orientiert sich am Zuwachs. Die ersten Ergebnisse der Analysen zeigen Folgendes: Mit zunehmendem Überführungsgrad ein sich verengender Korridor in der Bestandesgrundfläche (Gleichgewichtsgrundflächen). Starke Nutzungseingriffe bzw. Kalamitäten bewirken eine gegenläufige Entwicklung. Die sich durch regelmäßige Nutzungseingriffe im Dauerwald einstellenden Gleichgewichtsgrundflächen sind bonitäts- und baumartenabhängig. Durch die zunehmende Ungleichaltrigkeit und Strukturiertheit der Bestände ist die Anwendung klassischer - im schlagweisen Altersklassenwald erprobter - Verfahren zur Nachhaltigkeitssteuerung auf Revier- bzw. Forstbetriebsebene durch Verlust der räumlichen Ordnung nicht mehr anwendbar. Modelle, die Nachhaltigkeit auf Revier- bzw. Betriebsebene in Überführungs- und Dauerwäldern zu steuern, sind notwendig und werden vorgestellt. Mit Hilfe von Clusteranalysen werden Wuchs- bzw. Betriebsklassen geschaffen, die als Basis für die Analyse wachstumskundlicher Parameter der verschiedenen Überführungsstadien dienen. Der Fortschritt in der Überführung sowie der Zeitbedarf für vollständige Überführung wird quantifiziert. Mit Hilfe des Waldwachstumssimulationsprogrammes MOSES kann die zukünftige Entwicklung der Bestände simuliert werden. Ein anhand der bisherigen Nutzungs-Eingriffe für MOSES entwickeltes Harvesting-Modul, welches die Plentereingriffe nachbildet, wird getestet und einerseits die vollständige Überführung in Dauerwaldbestände an vier Revieren verschiedener Bonitäten und Baumartenausstattung sowie andererseits an Dauerwaldbeständen das Erhalten der Dauerwaldstruktur simuliert.

Oral presentation

Entwicklungsdynamik von Lärchen- Zirbenwäldern in Salzburg und Kärnten

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Abstract

Die anhaltende Klimaveränderung und die damit verbundenen Einflüsse auf die Waldgesellschaften bedingen eine prognostizierte Veränderung der Baumartenzusammensetzung über die Seehöhe. Durch den relativ höheren Anstieg der Temperaturen in Hochlagen sind diese stärker von der Klimaveränderung beeinflusst. Dadurch verschiebt sich das Ökoton zwischen tiefsubalpinen Fichtenwäldern und hochsubalpinen Lärchen- Zirbenwäldern zukünftig voraussichtlich in höhere Lagen.

Das Ziel der Masterarbeit ist die Untersuchung einer möglichen klimabedingten Veränderung von hochsubalpinen Lärchen- Zirbenwäldern in fichtenreiche Bergwälder und der Einflussfaktoren auf den Verjüngungserfolg der vorkommenden Baumarten.

Die Erhebungen wurden in Lärchen- Zirbenbeständen im Forstbetrieb Kärnten- Lungau der Österreichischen Bundesforste durchgeführt. Die Aufnahme der Verjüngung erfolgte mittels 100 m² großer Transekte in elf verjüngungsfähigen Beständen. Die Erhebungsmethode ist angelehnt an das Erhebungsverfahren des österreichischen Wildeinflussmonitorings. Die Baumartenzusammensetzung der Altbestände wurde mittels Winkelzählproben erhoben. Im Zentrum der Untersuchung steht der Vergleich zwischen Altbeständen und der Verjüngung hinsichtlich der Baumartenverteilung. Als Maß der Konkurrenzkraft in der Jugendentwicklung wurde der dreijährige Höhenzuwachs der Verjüngung ausgewertet. Ebenso wird der Einfluss verschiedener Faktoren, wie Seehöhe, Exposition, Relief, Schlussgrad, Bodenbedeckung, Weide und Wildeinfluss auf den Verjüngungserfolg untersucht.

Erste Ergebnisse zeigen aktuell keine absehbare Veränderung der Baumartenverteilung im Untersuchungsgebiet. Der Vergleich der Baumartenzusammensetzung von Altbeständen und Verjüngung ergibt keine signifikanten Unterschiede. Der Höhenzuwachs von Lärche und Zirbe ist wesentlich größer als der Höhenzuwachs der erhobenen Fichten. Der Verjüngungszustand der untersuchten Bestände entspricht nicht den Erwartungen. Nur zwei der elf erhobenen Bestände weisen eine ausreichende Verjüngung nach den Kriterien des österreichischen Wildeinflussmonitorings auf.

Institute of Soil Research

Poster

Impacts of climate change on forest restoration in Australia

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Abstract

Australia has 134 million hectares of forest, covering 17% of the land area. Natural and anthropogenic fires have been influencing the Australian landscape and environment throughout an extensive time period. In the summer season 2019-20 the combination of hot and dry conditions has led to reportedly 10.65 million hectares burnt, ranking as one of the most destructive fire seasons to date. The objective of this thesis is a comparison of different regeneration approaches and different restoration programs to optimize the reforestation whilst taking into account the climatic changes due to anthropogenic impact. The causes of Australia's bushfire season 2019-20 need to be identified, in order to discuss the consequences, specifically regarding the forest state and regeneration, as well as restoration approaches. This task will be performed by comparing climate and fire data. The expected result of this thesis is to identify how restoration strategies need to be changed to more effectively combat the influence of climate change on Australia's forest. The aim is to reflect and suggest on what approaches need to be followed to restore ecosystems in a changing climate.

Oral presentation

Weathering and soil development along a soil chronosequence on the Galápagos Archipelago

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Abstract

The Galápagos Archipelago situated near the western South American Continent, has formed from hotspot volcanism on the eastward moving Nasca Plate resulting in age gradient island chain where the westernmost island is the youngest and the oldest one is the easternmost island. Due to its exclusive geological and tectonic setting, the study on soil chronosequence can be established. However, there is still limited information about this study and our work therefore aimed to explore soil evolution along soil chronosequence in Galápagos Islands. Soil samples were taken from four islands in Galápagos comprising six different sites representing age gradient and two sites as humid and dry / very dry comparison sites. Basic soil parameters (texture, bulk density, water retention, soil organic carbon, pH, phosphate retention, etc.) were analysed, and selective dissolution analyses as well as mineralogical analyses were carried out. Our results showed that soil parameters related to andic properties such as pH in NaF, phosphate retention, and water retention decreased and bulk density increased from youngest soil site to oldest site. Considering climate comparison, humid sites had higher pH in NaF, phosphate retention, and water retention and had lower bulk density than dry / very dry sites. From mineralogy analyses we found increasing stable clay formation with increasing age. Short – range order materials (allophane and ferrihydrite) were more prominent in youngest soil sites than in intermediate or oldest soil sites. In oldest soil site, more stable clay / clay size materials such as kaolinite, hematite and gibbsite were observed while smectite was found in dry soil site. Soil type according to WRB 2015 ranged from Andosol in youngest soil site to Ferralsol in oldest site.

Poster presentation

Determination of Nickel release from ground basalt rock in agricultural soils and the accumulation of Nickel by crop plants

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Abstract

Ground rock material are frequently used as rock flour in agriculture for improving soil quality. The use of basaltic rock flour from the Austrian quarry “Pauliberg” is, however, limited due to Ni contents ranging between 144-210 mg/kg DM, which is exceeding the Austrian limit value of 100 mg/kg DM for fertilizer use. The limit value does not apply to rock flour as they are counted as soil additives. Still, the use of Ni-rich basaltic rock flour may contribute to a significant input of heavy metals to agricultural soils and may affect the metal uptake by various crops. This master thesis analyses how much Ni is released into the soil and taken up by crops when using basaltic rock flour from Pauliberg. Therefore, a pot experiment was conducted with two different soils and three different crops. Basaltic rock flour was applied directly (1,79 g/kg soil) or in combination with compost (13,5 g compost + 1,89 g/kg soil). The first soil was a acidic sandy soil from “Gföhl” Waldviertel and the second soil was a carbonatic silt-clay soil from “Moosbierbaum” Tullnerfeld. These two soil types are representative for a large part of Austrian soils. The crops used in the experiment were wheat, soy, and spinach. The iron mobilizing root exudates of wheat and the N-fixation of soy could lead to a higher Ni release in the soil. Spinach was chosen because it is known for a high heavy metal accumulation in the biomass. Their individual impact on Ni release and plant uptake will be compared by analysing extractable Ni concentrations in soil and Ni uptake by plants. The pot experiment has been finished, but the sample analysis has not been completed yet. An important issue to resolve for future research is the long-term effect and accumulation of Ni in the soil over a few years, due to the annual application of basaltic rock flour from Pauliberg.

Poster presentation

Impact of EDTA washing on heavy metal-contaminated soil: Comparing microbial community composition and carbon & nitrogen cycling. An isotopic labeling study

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Abstract

Soil washing and removal of toxic metals with chelants, particularly with ethylenediamine tetraacetate (EDTA), is viewed as a soil preserving remediation option. EDTA is a non-selective chelant; it removes soil micronutrients along toxic metals and promotes destabilization of soil minerals and dissolving of organic matter. This could lead to permanent disintegration of soil structures. Conditions during EDTA soil washing also reduces soil microbial diversity and activity, eliminates soil mezzo- and macro fauna and weakens soil food-webs. Influences on the soil's chemical, physical and biological properties might potentially limit the future use of remediated soil. The aim of this study is to investigate the impact of EDTA washing on heavy metal-contaminated (Pb, Zn, Cd) soil from Arnoldstein in Carinthia. Three different treatments in four replicates are compared:

Amended soil (washed, supplemented with compost and biochar (around 5% of each)), Washed soil, without further additives and original soil, unwashed/untreated. The experiment is conducted in 12 raised beds, cultivated with spinach and radish, outdoors under natural weather conditions. Isotopic labeled plant material was added to a 50 x 50 cm patch and soil and gas samples were taken at day 0 (before labeling), day 1, day 2, day 4, day 8, day 15, day 29, day 64 and at day 162 after the labeling. The degradation (and incorporation in microbial biomass) of the label will be measured via an Elemental Analyser coupled with Isotope Ratio Mass Spectrometer (EA-IRMS). A Gas Chromatography - Isotope Ratio Mass Spectrometer (GC-IRMS) will be used for gas samples (CO_2) and for Phospholipid Fatty Acids (PLFA) analysis. PLFAs can be assigned to specific, phylogenetically defined groups of microorganisms and used as biomarker in order to assess the community structure in soils (Zelles, 1999). To further gain insight into the nitrogen cycle and microbial biomass, extraction by microdiffusion (for available NH_4^+ and NO_3^-) also will be carried out.

First preliminary results of the microdiffusion extraction show the expected initial peak of the $\delta^{15}N$ value in NH_4^+ in all three compared soils, caused by the applied label at day 1. Starting at day 2 changes in in $\delta^{15}N$ value and NH_4^+ content are already visible, giving us a first small glimpse at the beginning of the degradation of the label and already showing possible differences regarding nitrification and mineralization between the soils. The complete results of this experiments will allow conclusions to be drawn regarding carbon and nitrogen cycling and microbial community composition within the soils impacted by EDTA washing.

This master thesis is part of the Garden Soil Project accomplished by the Institute of Soil Research, Department of Forest and Soil Sciences University of Natural Resources and Life Sciences Vienna and the Agronomy Department, Biotechnical Faculty, University of Ljubljana.

Poster presentation

Development of Nickel phytomining approaches on serpentine soils of Bulgaria

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Abstract

In some places in the world where ultramafic rock is the parent material for serpentine soil development, plants must deal with special conditions like high heavy metal content in the substrate. There are different strategies of the plants to tolerate or avoid heavy metals. One plant strategy to cope with heavy metal is the hyperaccumulation of elements to concentrations that are toxic to most other organisms. These hyperaccumulator plants show extreme behavior in metal uptake (above 1000 mg kg^{-1} for Ni) which makes them an excellent tool for remediation of heavy metal contaminated soils and phytomining. The technology of phytomining includes the use of hyperaccumulators to extract soil metals, especially nickel, on a commercial scale. Throughout the incineration of the harvested biomass it is possible to generate high-grade bio-ore for industrial use.

The main objective of this study, which takes place in cooperation with the Agriculture University of Plovdiv, is conducting a systematic research which will allow us to enhance the knowledge related to soil characterization and the development of nickel phytomining approaches on selected serpentine soils of Bulgaria. The extent of this work includes the characterization and identification of four Bulgarian soils from different sites and a pot experiment in the greenhouse with the nickel hyperaccumulator plant *Odontarrhena chalcidica* and different treatments for increasing the plant biomass and Nickel yields in plant tissue. The data from the greenhouse experiment should provide preliminary data on the phytomining potentials of the tested soils as basis for the further step in the project, a field experiment in Bulgaria. The setup of the greenhouse experiment included the cultivation of the nickel hyperaccumulator *Odontarrhena chalcidica* on the four different soils from Bulgaria and on an already researched soil from Bernstein/Austria as a reference. To demonstrate the fertilization effect fertilized and unfertilized replicates were included in the setup. Additionally, four different inoculations with microbial endophytes (Fungi1; Fungi2; Bacteria and Yeast) were applied to one of the Bulgarian soils. This treatment was also tested with and without fertilization. All the strains were isolated from roots of *Arabidopsis arenosa* from different metal-enriched sites in central Europe and they are known to be metal resistant and to increase plant biomass. The fact that the addition of the microorganisms only takes place on one soil is because the location of this soil in the field is most accessible and therefore a field trail is most likely to be carried out. The results available so far are the dried biomass data of the plants which already show significant differences among the soils and the treatments. As expected, a fertilization effect can be recognized and the biomass of the uninoculated replicates is in average 7 times higher with the NPK application compared to the control. The inoculation treatments only show a significant increased biomass with NPK fertilization and no differences to unfertilized and just inoculated. The strongest growth in biomass, with a 27-fold increase, was recorded in the fertilized Fungi2 treatment. At the end of this work, a recommendation should be made regarding which location and which treatments are advisable for a field experiment. The suitability depends on the Nickel content and the availability in soil, the total Nickel uptake by the plant, the biomass production and the accessibility of the location for setting up a whole field trial.

Poster presentation

Development of a novel method for measurement of heavy metal microbial bioavailability in soils

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Abstract

The inclusion of food production into an urban environment initiates several scientific research questions (socio economic and ecological impacts). One of the main concerns of city gardeners is the transfer of urban pollutants such as heavy metals into the consumer's food chain. Within the "Heavy Metal City-Zen" project, community gardens in the City Vienna have been recruited to conduct simple common collaborative experiments in their urban gardens. The collected soil samples are analysed at UFT Tulln an der Donau. It is researched which extraction method the most adequate is to measure the microbial bioavailability of heavy metals (Pb, Cd, Zn) in soils, that reflects the soluble and microbial biomass heavy metal concentrations most accurately. It is expected to obtain valid measurements of microbial available heavy metals along with N, C, SOM and pH with following procedures: extraction with water, $CaCl_2$, K_2SO_4, ammonium nitrate extractions (NH_4NO_3) or Mehlich 3 extractions.

Oral presentation

Investigating the effect of different growth conditions on maize root morphology and C root exudation

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Abstract

Root exudates released by living roots into the soil have important functional roles in rhizosphere processes (e.g. mediating interactions with soil organisms, nutrient mobilization, etc…). They comprise a large diversity of low molecular weight (organic acids, amino acids, phenolics and sugars) and high molecular weight organic compounds (mucilage and proteins). Both exudate quantity and composition are influenced by internal and external conditions. Commonly root exudates are studied in nutrient solution cultures, but the question remains whether results obtained from these artificial systems are representative for natural soil environments.

The aim of thesis is to evaluate the effects of different growth conditions (laboratory, field) and soil texture (sand, loam) on morphology and total C exudation of maize roots. We compared the soil-hydroponic hybrid exudation sampling approach, where maize plants are either grown in soil columns in the laboratory or grown in the experimental field site in Bad Lauchstädt (Germany). In addition, we studied the role of root hairs in plant growth performance and root C exudation by growing two maize lines (*Zea mays* wild type WT and root hair defective natural mutant rth3).

In the field, maize plants grown in the loam showed a better plant growth performance than in the sand due to differences in nutrient availability. Root hairs represented an improvement in the nutrient acquisition. Surprisingly, the portion of fine roots (≤0.2 mm) was higher in the maize wildtype than in the root hairless mutant rth3. Due to a more homogenised fertilisation in the laboratory experiment, availability of nutrients was greater in the sand than in the loam, which led to an enhanced shoot growth in the sand. In both experiments root C exudation rates tended to be higher in the root hairless mutant rth3, which could be a possible compensation mechanism for the lack of roots hairs to increase the nutrient availability.

Poster presentation

Selected soil parameters to characterise soil organic matter and its decomposition – impacts of land use and agricultural soil management

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Abstract

In light of the 4 per 1000 initiative an increase in soil organic matter (SOM) and its main component carbon (C) may contribute to food security and climate change adaption and mitigation. It is therefore important to characterise SOM and soil processes related to its stabilisation and decomposition using different parameters and methods. In this project special focus is put on two methods: permanganate oxidisable carbon (AC) characterising a labile soil carbon fraction and the nitrogen (N) mineralisation potential (NMP) indicating easily mineralisable compounds. We evaluate those methods in their usefulness to determine long-term changes in SOM in more detail and their sensitivity to changes in management practices. Subsequently, we want to draw conclusions how the parameters AC, AC/SOC, C/N and NMP that characterise SOM are affected by different agricultural management. Therefore, we analyse different long-term field trials considering soil tillage, mineral and organic fertilization and crop residue incorporation/removal. For the statistical analysis the R software is used. We expect that AC and NMP can offer further information regarding SOM pools and processes compared to total organic C and total N. Hence, AC and NMP should provide more details on how management practices affect SOM characteristics in the long run.

Oral presentation

The impact of a combination of management practices on soil organic matter accumulation and soil fungal communities in a Hungarian maize cropping system

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Abstract

Approaches to improve soil organic matter accumulation gain more and more importance in sustainable agriculture, e.g. to increase soil fertility or sequester carbon in soils. This master thesis aims to test the impact of a combination of management practices (reduced tillage, application of manure and commercial microbial products) on SOM accumulation and soil fungal communities in a maize cropping system by applying a three-fold strategy. First, the microbial composition of the products was tested. Cultivation of present microorganisms from the suspended products allowed for species identification and yielded data on viability (CFUs). Additionally, fungal communities were determined in a cultivation-independent approach using high-throughput sequencing. Second, we investigated soil from an arable field (Pusztaszabolcs, Hungary) that has been treated with the microbial products in conjunction with other soil management practices suggested to increase SOM accumulation. Samples were taken from two fields (reference, treated field) at 6 soil depths each (0-20cm,20-40cm,40-80cm,80-120cm,120-140cm,140-160cm) and analyzed for microbiological and physicochemical properties. Microbiological analyses included characterization of fungal communities by high-throughput sequencing (Illumina Miseq) and quantification of microbial groups by ddPCR. Physicochemical soil properties analyzed included pH, water holding capacity, texture, carbonates as well as soil organic carbon and total nitrogen pools. Thirdly, the short term effects of microbial products on SOM accumulation claimed by the manufacturer were examined in a lab experiment where crops were grown on different substrate mixtures (sand, compost, microbial product). The experiment was documented by a time lapse video. Pure cultures derived from the tested microbial products were dominated by the genera *Bacillus*, *Streptomyces* and *Aspergillus*, which are commonly found in soil. Quantification of fungal abundance by ddPCR showed a general decrease with soil depth. In the lab experiment we did not find an effect of product application on organic matter accumulation after ten weeks. The video is available at https://vimeo.com/384959161.

Oral presentation

Radionuclides in rocks and soils of the Galápagos Islands: geogenic and anthropogenic sources

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Abstract

The radioactivity of rock and soil samples of the Galapagos Islands was analysed in the course of this Master thesis. The samples were taken between 2017 and 2019 during soil scientific expeditions to the Galápagos Islands. Several soil and rock samples were taken on four different islands (San Cristóbal, Isabela, Santa Cruz and Floreana). The spectrum of samples ranges from different chronosequences and elevation sequences to rocks samples of lava, pumice and scoria. Due to that diversity the differences in radioactivity between humid and arid areas, topsoil and subsoil horizons, as well as soil and rock were investigated. The analyses of the gamma ray spectrometer pointed out that only the topsoils contain Cs-137, which is coming from anthropogenic sources. Moreover, while the observation of the chronosequences indicated that in dry climate the radioactivity decreases with the age of the parent material, no such relationship is implied in humid climate. Although in general the activity of Cs-137 increased with elevation, in scoria it increased more steeply than in lava. In comparison to available data of other countries of South America the deposition density of Cs-137 from Galapagos was similar to locations at the same latitude. Sampling sites of latitudes further south showed up to six times higher levels. As mentioned above, the data showed that with rising elevation Cs-137 activity predominantly increased. This might be attributed to the augmented precipitation rates and hence humid climate at higher altitude. Interestingly, the opposite was true for K-40. It is assumed that the precipitation leads to increased leaching and therefore a decline in K-40. The results of this thesis represent the first systematic evaluation of radioactivity on the Galápagos Islands.

Oral presentation

Effect of hedge rows on soil properties and functions

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Abstract

Hedge rows or so-called soil protection systems protect the soil from wind, decrease wind erosion and have positive effects on microclimate. These are the main reasons why the Agrarbezirksbehörde in Lower Austria plants hedge rows since 1958. Additional to these main aims nowadays ecosystem services like the provision of goods, cultural benefits and especially regulating effects get more and more important. Latter are carbon storage, regulation of greenhouse gases, erosion and flood protection, filtration of nutrients, organic plant protection and increase of biodiversity.

This master thesis investigates the effects on sequestration of organic carbon, on pore space and soil structure. Furthermore, the resulting ecosystem services like the reduction of greenhouse gases, water retention and storage, water infiltration and the storage of nutrients and pollutants are recorded and assessed. The assessment occurs in terms the environmental goals of Lower Austria and Austria. In the end suggestions for the improvement of soil protection systems and hence the increase of regulative ecosystem services in the agricultural landscape of Lower Austria should be made.

With the help of data from the Lower Austrian Agrarbezirksbehörde 150 hedges in the districts Hollabrunn, Mistelbach, Gänserndorf, Bruck an der Leitha and Baden on Chernozem were selected. On every plot with the help of a drill one sample is taken in the hedge and one is taken in the acre. The sample is split in the upper 20 cm of the horizon and in the 20-40 cm depth of the horizon. These samples and the litter of an 20x20cm area in the hedge is brought to the lab. Furthermore, the structure of the soil is determined in the field. In the lab the nitrogen and the carbon contents and the texture are determined. Then the storage capacity for organic carbon is calculated. Values for water retention and for the soil water household are deviated and models for nutrient- and pollutant filtration are calculated.

Oral presentation

Nickel phytomining efficiency of different hyperaccumulator species

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Abstract

Nickel phytomining is a technology for extracting this metal from Ni-rich serpentine soils. It is based on the cropping of Ni hyperaccumulating plants and the recovery of the metal from these crops. The factors determining the efficiency of this agronomic method are shoot nickel concentration and harvestable biomass.

LIFE-Agromine is an EU funded project to demonstrate the phytomoning efficiency in four different locations of central and southern Europe and to investigate associated ecosystem services and carry out a full life-cycle assessment of cropping hyperaccumulators for nickel recovery.

The Austrian part of the project focuses at a field experiment on a serpentine site near Bernstein, Burgenland. In the third year in 2019 the phytomining efficiency of four hyperaccumulator species, *Odontarrhena chalcidica* (OC) (syn. Alyssum murale), *Bornmuellera tymphae* (BORN), *Leptoplax emarginata* (LEPT) and *Berkheya coddii* (BERK), was evaluated in four replicates on 10 m^2 plots established in spring 2019. Following the results of the years 2017 and 2018 shoot biomass is assumed to be the decisive factor for increasing the nickel yield. The experimental plots were fertilized with pig manure and planted at a density of 4 plants per m^2. In addition four2-year old plots where planted with OC to investigate the long term efficiency of agromining along 3 cropping cycles. On all plots the effect of phytomining on soil characteristics (e.g. Nickel availability) was investigated.

After harvesting the plants where dried and weighed to determine the shoot biomass. Representative samples were digested and the Ni shoot concentrations determined via ICP-OES.

Composite top soil (0-20cm) samples of 12 individual spots were taken from each plot. Before analyses the samples were air dried and 2 mm-sieved. pH, soil moisture and extractable Phosphorous and exchangeable cations were determined. Extracts with DTPA and $Sr(NO_3)_2$ were accomplished to assess labile Ni fractions.

Results on soil characterization are not available yet. Ni concentrations in plant shoots were highest in LEPT and BORN (17. 5 and 17.1 mg kg^{-1} respectively), but those species produced not even half the amount of biomass per hectare compared to OC (5.9 t ha^{-1}). Thus the highest Ni yield was achieved with *O. chalcidica*, reaching 94 kg Ni ha^{-1}. In contrast BERK had the lowest Ni concentrations and the lowest dry weights of shoots. Our results therefore show that *O. chalcidica* is the best-performing Nickel phytomining plant species on the Austrian site Bernstein.

Poster presentation

The potential of soil amendments to re-establish agricultural production on ex-tin mined area

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Abstract

Bangka Island is part of the South Eastern Asian tin belt extending from Myanmar to Malaysia where about 70% of this area is tin mining. The separation of tin via flotation of tin-containing soils results in acidic nutrient-poor soils with very low organic matter contents. Hence, ex-tin mined areas are highly unsuitable for plant growth due to their un-fertility. To improve soil fertility, soil amendments are importance. This research aims to evaluate the impact of different soil amendments on agricultural production and basic soil parameters on the ex-tin mined area.

The field trial was set up in July 2018 on ex-tin mined area which located in Bangka Regency, Indonesia by a randomized complete block design with five different soil amendments and control plots for comparison, with a size of 2 x 2 m in four replicates. The treatments consist of the: (1) Control, (2) Lime, (3) Compost; (4) Charcoal and combinations of (5) Charcoal and Compost, and (6) Charcoal and sawdust. The soil was amended with 10 t ha^{-1} for the single amendments (treatments 2-4), and with rate 20 t ha^{-1} for combined amendments (treatments 5 and 6). Cassava (*Manihot esculenta*) was planted and grown for 12 months as the main crop and *Centrocema pubescens* used as a cover crop to avoid soil erosion. Soil samples were taken before and after harvest to analyze soil properties. Soil samples were analyzed for the following parameters: pH, Dissolved Organic Carbon (DOC), and Electric Conductivity (EC). Crop yields were determined by weighing the total harvest of each crop per plot. Cassava yields were separated into belowground and aboveground yields.

Soil amendments showed positive effects on soil pH, DOC, and EC at harvest time. Lime treatment significantly improved soil pH and EC (7.40 and 72.30 µS.cm^{-1} respectively), while DOC was significantly increased by compost treatment. The combined treatment with charcoal (10 t ha^{-1}) + Compost (10 t ha^{-1}) has significantly highest yield of *Centrocema pubescens*. While another combined treatment, where, charcoal and sawdust were applied at 10 t ha^{-1} each, showed highest total cassava belowground yield (5.44 t ha^{-1}) as well as aboveground yield (3.06 t ha^{-1}). Cassava belowground yield on ex-tin mined area was lower than unmined area in Bangka (2.50 t ha^{-1} and 15 t ha^{-1}, respectively). Results of the present field experiment suggest that the application of soil amendments directly affected soil parameters. The effect on yields was positive but crop dependent, likely due to different nutrient requirements.

Oral presentation

Stem CH_4 and N_2O fluxes of *Fraxinus excelsior* and *Populus alba* in a temperate floodplain forest

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Abstract

Stem methane (CH_4) and nitrous oxide (N_2O) fluxes are still poorly quantified in temperate floodplain forests. Stem fluxes of *Fraxinus excelsior* (ash) and *Populus alba* (poplar) were monitored at stem heights of 30, 160 and 360cm at three sites across a gradient of temporarily flooded to upland conditions. Stems were overall sources of CH_4 and N_2O at all sites. The CH_4 source strength increased towards the wetter sites (upland 2.51±12.71, mid-elevation 5.2±17.26, and flooded 11.15±24.04µg CH_4-C $m^{-2}h^{-1}$). CH_4 fluxes sharply declined with increasing stem height for poplar but increased with stem height for ash. N_2O fluxes were small and did not show clear trends as a function of stem height. Neither radial chamber position nor the presence of mosses had significant effects on CH_4 and N_2O fluxes. Site specific stem CH_4 and N_2O fluxes were small and mostly insignificant when compared to the corresponding soil fluxes. Stem fluxes measured were in magnitude comparable to those of temperate upland sites – likely as a result of the short inundation times in the floodplain ecosystem. The distinctive CH_4 flux patterns of ash and poplar highlight potential pitfalls when stem specific up-scaling is solely based on single flux measurements at the trunk base.

Poster presentation

Characterisation of shooting ranges of the Austrian Armed Forces and determining the pollutant behaviour in selected hotspots

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Abstract

Shooting ranges may pose severe environmental threats (e.g. to groundwater bodies) due to the contamination with various pollutants, e.g. lead, antimony, etc. Remediating such sites often includes very expensive measures, as exemplified by the case “Schießplatz Glanegg”, near the city Salzburg. The remediation of this site was the most extensive in the history of the responsible Austrian ministry.

In order to facilitate the management of the shooting range and to reduce potential threats, the necessity was derived to subject all military shooting ranges in Austria to a classification according to their hazard potential and, if necessary, to carry out a detailed site and pollutant characterization.

In a starting approach, literature research was conducted considering historical, geological and hydrogeological information. Furthermore, the various types of ammunition used in the past are considered in the shooting range classification. The history, the ground conditions, the water balance, the location and the work-load of the shooting range are included in the categorization of the shooting range. After the assessment, it can be assumed that approx. 8% of all military shooting ranges in Austria have an increased risk potential.

Furthermore, other site-specific properties will be investigated by characterizing selected soil samples in the laboratory for their general and pollutant-related characteristics.

The behavior of most relevant pollutants will be investigated in detail in further field and laboratory work. In particular, adsorption/desorption isotherms as well as plant experiments will be conducted to study the potential risk of pollutant transfer to groundwater and to the food chain.

The results of this work, which is largely supported by the Federal Austrian Ministry of Defense, will provide a basis for the future management plans and risk mitigation in Austrian shooting ranges.

Poster presentation

Glyphosate adsorption onto clay minerals

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Abstract

Glyphosate (N-(phosphonomethyl)glycine) is a widely used herbicide which is currently discussed because of its side effects on health and environment. In soils, glyphosate may be strongly sorbed to certain clay types. The sorption is dependent on soil clay content and its specific surface area, content of aluminium and iron oxides, pH and organic carbon content. Many clay minerals have already been investigated regarding their sorption behaviour, but information on minerals commonly found in volcanic soils, such as allophane, halloysite and imogolite is still lacking. Recent studies showed that glyphosate can be found in relevant concentrations in some volcanic soils. The aim of this study is to analyse the adsorption behaviour of glyphosate on allophane, halloysite and imogolite. In order to make the results comparable, glyphosate-adsorption for kaolinite, which is already well-investigated will also be measured. Prior to the experiments, allophane and imogolite will be synthesised. Each mineral will be analysed at 3 different pH values (4, 5.5, 7). Adsorption will be measured with 5 different concentrations of glyphosate. The different minerals will be equilibrated in glyphosate solutions at a mineral : solution ratio of 1:100 for 24 h by shaking end-over-end. 0.01 M KCl will be used as a background electrolyte. After centrifugation, the filtered supernatants will be derivatised with ninhydrin and subsequently analysed colourimetrically at 560 nm. The results of this study will contribute to a better understanding of the behaviour of glyphosate in volcanic soils.

Oral presentation

Greenhouse gas fluxes from humid tropical forest and urban grassland soils

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Abstract

Global estimates of greenhouse gas (GHG) emissions from natural ecosystems are strongly related to climatological conditions and may vary significantly within ecosystems. Studies on soil GHG fluxes from humid tropical forest and grassland soils are limited compared to temperate climates. In order to accurately assess total global GHG fluxes, data from underrepresented ecosystems is needed. Therefore, this study evaluates emissions of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) from humid tropical forest and grassland soils in Singapore. The study was conducted during an one year period with monthly measurements. The experimental sites are located in a primary mixed broadleaf forest and an urban grassland. Soil GHG emissions were measured in closed static chambers from both ecosystems. Furthermore, soil GHG emissions of common management practices conducted in urban grasslands of Singapore were evaluated by comparing untreated grassland soil with compost amended soil (G-C) and soils covered with N_2 fixing plants (G-N).

Based on collected data, CO_2 fluxes in grassland were higher than forest soils. Compost application in G-C plots increased CO_2 fluxes until the end of the experimental period. Forest soils were a sink for CH_4 while grassland soils were generally a source of CH_4 but at low soil moisture also a sink. Soil respiration and CH_4 flux variations were explained best by soil moisture. All sites were net emitters for N_2O with forest soils emitting significantly higher N_2O rates than untreated grassland soils. This studies forest litter was characterized by a wide C:N ratio of 1:28 and neither of the dominant tree species were N_2 fixing plants. Nitrous oxide emissions were driven by nutrient availability and N_2O uptake occurred when soil moisture was low. Additional nutrient input in G-C triggered N_2O emissions for less than 48 hours until heavy precipitation presumably caused leaching or N_2 losses (not measured). The higher potential of nutrient leaching in G-C was assumed as dissolved organic nitrogen in soil solution was more than two-fold of untreated soil values. N_2-fixing plants did not alter N_2O fluxes in G-N compared to untreated grassland.

Oral presentation

Impact of EDTA washing on heavy metal contaminated soil - Bioavailability of Cd, Pb and Zn

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Abstract

Causes of anthropogenic pollution that burden our ecosystems including the degradation of soil are manifold. Among anthropogenic pollutants heavy metals are estimated as main contaminants of European soil. While some heavy metals are considered important plant nutrients in small doses (e.g. Zn, Cu), most of them are toxic for the human body. To achieve food security goals, it is therefore mandatory to develop solutions for a proper handling of contaminated soil. A possible strategy to deal with heavy metal contaminated soil includes a new washing technology, using a potent chelating agent (EDTA) to extract heavy metals.

To investigate the impact of EDTA washing, a raised bed trial was implemented in late Summer 2019. In detail three soil treatments (n = 4) were randomly distributed over in two blocks. The treatments consisted of contaminated soil from Arnoldstein, Carinthia and two washed variants, one amended with compost and biochar.

The aim of this thesis was to investigate the effect of each treatment on the bioavailability of Cd, Pb and Zn by analysing vegetable cultivars, grown on the soils as well as different metal fractions in the soil. Therefore, pedological characteristics affected by heavy metals like pH, cation exchange capacity and organic carbon content have been investigated. Metal fractions in the soil were extracted using different methods: Total metal content (soil digestion), potentially bioavailable fraction (Mehlich 3, ammonium nitrate), plant available fraction (plant digestion) and collection of the mobile fraction in soil leachates. Metal analysis was done using GF-AAS and ICP OES. First results indicated that EDTA treatment lowers both total content as well as potential bioavailability of heavy metals in soil and leads to a reduction of heavy metal plant uptake. No significant difference in metal uptake has been found between the two spinach cultivars.

The analysis of heavy metals in the soil leachate and the second culture (radish) as well as the soil fertility analysis is still in progress.

Poster presentation

Rehabilitation of formerly trace metal contaminated soil

Teresa Stockreiter [a], Christoph Noller [a], Wolfgang Friesl-Hanl [a,b], Rebecca Hood-Nowotny [a], Andrea Watzinger [a]

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Abstract

Trace metal contamination in soil is permanent and presents a risk to human health. Ore mining/smelting is one of the most important sources of soil Pb. The use of efficient flue gas cleaning systems led to a sustaining decrease of trace metals emissions in western Europe. However, industrial activities in other countries could significantly affect global emissions. Urban agriculture is booming, fulfilling diverse functions including food production. Developing solutions for a proper handling of contaminated soil helps to achieve food security.

This master thesis is part of the Garden Soil Project, whose target is to research the environmental, agronomic, social and economic potential of the soil remediation technology. EDTA soil washing technology was applied on heavy metal contaminated soils, for extracting Cd, Pb and Zn from a contaminated Cambisol located in Arnoldstein, a former lead mining and smelting region in Austria.

The aim of this thesis is to continue investigating the effect of the soil washing and amendments on soil and plant properties. We will also explore the additional impact of green manuring using *Phacelia tanacetifolia* and NPK fertilization later during this season. Since it's the second year of the Garden Soil Project, we focus on the medium-term stability and distribution of trace metals on different soil components.

The experimental set up includes twelve raised beds of 1 m^3, filled with three different soil treatments in four replicates: The contaminated, unwashed soil and two washed variants, one amended with compost and biochar. Different aromatic herb species will be planted on the raised beds to identify high and low accumulating plants. A separate lettuce cultivar experiment under greenhouse conditions will be conducted to evaluate the effect of cultivar selection on trace metal uptake.

The expected outcomes are: Improving soil physical properties by green manuring (e.g. bulk density and water holding capacity) and consequently increasing plant biomass production; Reducing trace metal plant uptake after fertilization due to antagonistic interaction; and a decrease in trace metal bioavailability compared to first growing season due to a continuous effect of the soil amendments.

Poster presentation

Biochar Technologies at the Energy-Food nexus in Africa: A unique window for climate smart agriculture

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Abstract

Traditional three stone fires are used for cooking in many countries around the globe as they are widely available and easy to use. This type of cooking uses solid biomass such as wood. In the year 2010, 77 % of the African population relied on such fuels, from which 95% of the users reside in sub-Saharan Africa.

High wood consumption and low energy use efficiency raise ecological and social-economical concerns such as deforestation and land degradation, besides the biomass is also competing to be used in other ways than fuel. Moreover, the level of air pollution in the kitchens is also a hazard to human health. Mostly affected by that are women and children. As they do the wood collection and cooking, which takes a lot of time, time that otherwise could be devoted to income generation or education.

Improved alternative cook-stove-gasifier systems, which produce biochar and heat for cooking could substantially reduce consumption of wood fuels, improve the energy use efficiency, mitigate harmful indoor emissions and counteract soil organic matter depletion while using the biochar as possible fertilizer or soil conditioner. They have the potential to decrease C- emissions while using less wood and increase in soil C-sequestration when the produced biochar is returned to the soil.

Unlocking biochar technologies in SSA may offer a unique window to low-carbon futures and climate-smart agriculture.

This thesis evaluates the differences in greenhouse gas emissions between a three stone fire and a cook-stove-gasifier system. The degree to which we can reduce emissions and wood consumption by using crop residues such as, rice husk, coconut shells and maize cobs, as a feedstock for biochar production. Ultimately by developing an improved cook stove compared to the currently most popular three stone fire.

Secondly, looking at the bigger picture we will scale up to a sub- Saharan African region production level, running per country analysis based on FAO statistics to investigate which proportion of wood use we could substitute with maize shafts as feedstock for biochar production and to determine whether there enough annual biomass production for biochar to cook two daily meals for a household of approx. six people. The last objective is to identifying positive effects of biochar production while using an improved cook stove on the environment and the rural community.

The aim is to compile and model this data to calculate carbon input-output scenarios and a regional analysis. Tools used for it are literature review, R-calculations such as ANOVA and Sankey diagrams.

Other BOKU Institutes

Oral presentation

Festlegung des Hiebsatzes für den Stand Montafon

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Abstract

Die naturnahen Gebirgswälder im Montafon bieten einerseits Schutz vor Naturgefahren, andererseits spielen sie eine große wirtschaftliche Rolle in der Talschaft. Im Rahmen dieser Arbeit wird ein Hiebsatz für den größten Forstbetrieb im Tal, dem Stand Montafon Forstfonds festgelegt. Dies passiert auf Basis der multifunktionalen Inventur von 2002 und 2011 mittels des Stärkeklassenverfahrens nach Waldherr. Beim Stärkeklassenverfahren wird aus Durchmesser-Stammzahl-Verteilungen der Inventuren eine Normalverteilung des Vorrats ermittelt und die Funktion der Umtriebszeit wird durch die Zielstärke übernommen. Die Dynamik der Vorratsveränderung wird nicht mehr über das Alter ermittelt, sondern durch den gemessenen Durchmesserzuwachs in den Stärkeklassen. Somit ist es möglich, in naturnahen Wäldern ohne bekanntes Alter, einen Hiebsatz ohne Umtriebszeit zu ermitteln. Die Ergebnisse zeigen, dass auf Basis des Stärkeklassenverfahrens eine Festlegung der Hiebsätze möglich ist.

Oral presentation

Erfassung und Analyse des forstlichen Rechnungswesens von 2001 bis 2019 im Spiegel der deutschsprachigen Fachliteratur

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Abstract

Die Entwicklung des forstlichen Rechnungswesens der vergangenen Jahrzehnte ist durch eine umfassende Auseinandersetzung mit unterschiedlichen Themenbereichen geprägt. Da diese wissenschaftliche Disziplin ihre Wurzeln maßgeblich im deutschsprachigen Raum hat, haben sich daraus Initiativen wie das „Forstökonomische Kolloquium“ gebildet, bei dem sich deutschsprachige Forschungseinrichtungen und Lehrstühle im Bereich der Forstökonomie zu einem jährlichen Austausch treffen und unter anderem regelmäßig auch aktuelle Entwicklungen im forstlichen Rechnungswesen vorgestellt und erörtert werden. Das forstökonomische Monitoring mit Hilfe von Testbetriebsnetzen ist ebenfalls charakteristisch für den deutschsprachigen Raum und fungiert als Schnittstelle zwischen Wissenschaft und forstlicher Praxis. Der deutschsprachige Raum, die sogenannte DACH-Region ist daher für diesen Bereich der Wissenschaft sowohl historisch als auch aktuell von besonderer Bedeutung.

Aufbauend auf zwei vorangegangenen Diplomarbeiten, die sich mit der Erfassung der deutschsprachigen Literatur des forstlichen Rechnungswesens beschäftigten, soll diese Reihe nun für den Zeitraum von 2001 bis 2019 fortgesetzt werden. Soucek (1998) befasste sich mit der Erfassung und Analyse der deutschsprachigen Literatur im Zeitraum von 1803 bis 1965 und legte somit den Grundstein für die Arbeit von Faltejsek (2001), der diese bis zum Jahr 2000 fortsetzte. Dabei wurde eine Datenbank erstellt, die Beiträge zum forstlichen Rechnungswesen seit dem Jahr 1803 archiviert und als Grundlage für diese Bachelorarbeit dient.

Um eine konsistente Suchstrategie zu gewährleisten wurde die Stoffabgrenzung mit den vorausgehenden Arbeiten abgeglichen, sowie Autoren und Schlagwörter - insofern diese noch aktuell sind -, übernommen. Durch die gefundenen Beiträge sollen aber auch neue Autoren, Themenbereiche und Schlagwörter die mittlerweile Relevanz für das forstliche Rechnungswesen erlangt haben identifiziert werden. Da die Internationalisierung der Forschung einen generellen Trend zu englischsprachigen Publikationen zur Folge hat ist es auch interessant, wie sich die Fachliteratur hinsichtlich Sprache und Anzahl der deutschsprachigen, insbesondere auch praxisorientierten Beiträge in den letzten Jahrzehnten entwickelt hat.

Ziel dieser Arbeit ist einerseits die quantitative Erfassung der Literatur im Zeitraum von 2001 bis 2019 in einem, dem Stand der Technik entsprechenden Literaturverwaltungsprogramm, sowie andererseits die qualitative Analyse der Beiträge hinsichtlich Themenbereichen Autorenschaft sowie Medien.

Poster presentation

Maschinenkostenkalkulation für Kleinwaldbesitzer

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Abstract

Over 50% of the total area of the Austrian forest is managed by small forest owners. The average size of these small forests is less than 50 hectares. In terms of machinery, the small forest owners usually have a tractor, a cable winch and somewhere between 1 and 4 chainsaws to aid their forestry operations. Machinery costs account for a large part the total cost of their overall operation. Accordingly, in order that such businesses can be run economically, it is essential to understand and successfully manage the cost structure of the machine costs and to allocate them to the operating and machine-hours worked.

Due to high costs, the ownership of many types of machine are beyond the economic reach of many small forest owners. However, these machines are essential for the management of the forest. There are various options for the calculation of machine costs. The central question of this work is whether small forest owners take the opportunity to calculate machine costs in the ongoing operation of their forest and also as a basis for intended investment decision making.

For the purpose of this work, various experts from the Chamber of Agriculture and other practitioners were interviewed. These interviews are a vital element of this work and the evidence gathered through the interview process provides essential information and numerous practical examples. They also provide a useful insight into the work and practices of small forest owners. Different models are used for the purposes of calculating the machine costs and these are compared against each other. Based on an investment decision, individual calculation models are used for a tractor and a winch and the different calculation approaches of the models are shown and analysed.

This body of work ends with a discussion and view of the increasingly difficult and unpredictable calculation conditions of machine costs, costs that are influenced by climate change.

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