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Annual Meeting of Working Group ConForest 2008

"The Concept for European Forests"

19. - 21. May 2008, Hotel Flora, Olomouc, Czech Republic

Conference Book

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Compiled by:
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Agenda

Annual Meeting of Working Group ConForest 2008

"The Concept for European Forests"

19. - 21. May 2008, Hotel Flora, Olomouc, Czech Republic

18. 05. 2008 Sunday

14:00 - 19:00 Arrival (transfer from Prague and Brno airport)
18:00 – 19:00 Check in and registration
19:00 Ice breaker

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19. 05. 2008 Monday

8:00 – 9:00 Registration

Plenary session

9:00 – 9:15 Opening the meeting, programme - Slodičák, Novák
9:15 – 9:30 Forests of the Czech Republic, state enterprise – Zavrtálek
9:30 – 10:00 Conforest info – Spiecker, Dedrick

10:00 – 10:30 Coffee break

1st working session (Moderator: Kulhavý)

10:30 – 10:45 The effect of manmade spruce stands conversion by beech and fir on the soil condition – **Klimo**, **Kulhavý**
10:45 – 11:00 Impact of tree species composition (spruce, mixed, beech) on througfall fluxes – **Berger**
11:00 – 11:15 The first reaction of soil fauna caused by conversion of Norway spruce (Picea abies (L.) H. KARST.) stand in the Karkonosze Mountains – **Skorupski et al.**
11:15 – 11:30 Carbon absorbing in the aspect of forest conversion – **Strzelinski et al.**
11:30 – 12:00 Conversion of matured Scots pine (Pinus sylvestris L.) stands by using group-clear cutting system in the Polish Lowland – **Raczka et al.**
Structure conversion of matured hornbeam-oak stand by using different cutting methods in the Polish Lowland - **Raczka et al.**
Forest conversion in industrial regions of Poland - **Raczka et al.**
12:00 – 12:30 Discussion

12:30 – 13:30 Lunch

2nd working session (Moderator: Raczka)

13:30 – 13:45 The assessment of 2-year spruce biogroups crops established after forest dieback at high mountain elevation in the Silesian Beskid Mts. – **Małek et al.**
13:45 – 14:00 Conversion by non-intervention: Using an individual tree simulator to assess the potential natural forest type – **Huber, Sterba**
14:00 – 14:15 Describing Growth of Natural Regeneration using a Mixed Model Approach – **Dedrick**
14:15 – 14:30 Bark beetle dynamics in declining spruce stands – **Hlásny, Turčáni**
14:30 – 14:50 Species composition in European beech (Fagus sylvatica L.) mountains stands in the aspect of global climate changes – **Wierzbicka et al.**

Economical aspects of Scots pine (Pinus sylvestris L.) stands conversion in the Polish Lowland – **Wierzbicka et al.**

14:50 – 15:10 Discussion

15:10 – 15:30 Coffee break

3rd working session (Moderator: Jankovič)

15:30 – 15:45 Analysis of conversion potential of pure stands in mixed stands as function of site – **Gonçalves et al.**

15:45 – 16:20 **Poster session 1** (5 min. per poster (Moderator: Jankovič)

- Interplantings into Birch (*Betula*) and Rowan (*Sorbus aucuparia*) young Stands – **Balcar, Kacálek**
- The impact indication in the target tree species composition planning – **Kulla**
- Humus conditions and stand characteristics of artificially established young stands in the process of the transformation of spruce monocultures - **Menšík et al.**
- The character of humus conditions at different ways of forest management – **Remeš et al.**
- Evaluation of the forest growth simulator SILVA on mature mixed Silver fir - Norway spruce stands in South-West Germany with special respect to the dbh growth response to release during conversion - **Mette**
- The impact of light condition during cultivation of European beech seedlings on morphological parameters and chlorophyll fluorescence – **Leugner et al.**
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16:20 - 17:00 **Poster session 2** (5 min. per poster (Moderator: Slodičák)**:**

- Comparison of the impact of Blue spruce, Norway spruce and reed Calamagrostis villosa on forest soil chemical properties – **Špulák, Dušek**
- Growth reaction of maturing spruce stand on different shelterwood cuttin – **Souček**
- Height growth of fir and beech underplantings in spruce stand – **Souček, Tesař**
- Evaluation of afforested soils' properties using multivariate analysis – **Kacálek et al.**
- Effect of hydromeliorative tratment, growth and development of forest stands on runoff from forest catchment – **Černohous, Šach**
- Evapotranspiration and soil surface evaporation in a young norway spruce stand after snowbreakage disaster in 2005/2006 – **Šach et al.**
- Thinning experiment in the spruce and beech mixed stands on the locality naturally dominated by beech – growth, litter-fall and humus – **Novák, Slodičák**
- Forestry on landscape level - introduction of a participatory planning support approach – **Fürst et al.**

18:00 – 20:00 Guided tour to Olomouc

20:00 - Dinner

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20. 05. 2008 Tuesday

8:30 – 18:00 Excursion to the Beskyd Mts.

- Experiment with the change species composition (spruce to beech and beech to spruce) with respect of ecological consequences, especially on water regime and soil properties)
- Norway spruce decline in the North Moravia region

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21. 05. 2008 Wednesday

ConForest session

8:30 – 10:00 Plenary session (Past and Future Conforest events, publication ...)

10:00 – 10:20 Coffee break

10:20 – 10:50 – Final discussion

11:00 Lunch

11:45 End of the meeting and transfer to the airports

Extended Abstracts

The effect of the even-aged Norway spruce stands conversion by beech and fir on soil properties

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The extensive growing of Norway spruce (*Picea abies* Karst.) in Central Europe out of its natural range, where it was artificially regenerated particularly in recent 150 years, brought to forest management much benefit on the one hand particularly from the economic point of view but on the other hand, numerous problems. The orientation of forest management on increasing the production of wood was accompanied by the loss of biodiversity on many sites, increasing the risk of damage to forest both by abiotic and biotic factors. In the interest of decreasing the risk, possibilities are, therefore, considered of the conversion of these forests to close-to-nature forests adaptable to the forest environment. It refers most frequently to mixed forests. The conversion of these systems has to refer to ecologically based management, wood market, but also forest-policy and socio-economic consequences.

At present, the orientation of forest management in the Czech Republic is conditioned by catastrophic damages to spruce stands caused by biotic and abiotic factors and on the other hand, accepting the objectives of sustainable forest management conditioned by the preservation of the production function of forests, maintaining and increasing the biodiversity and using gene resources of autochthonous quality tree species in forest regeneration. The view of a reconstructed natural and recommended species composition of forests fully recommends this trend.

The aim of our work was to assess both trends in the change of soil properties and their ecological impacts. The research was carried out in two areas. In the paper presented, results are summarized from the area of "Novohradské hory". In 2003, soil conditions were assessed at Vyšné, Mlýnský vrch and Žofín localities. Studies were particularly aimed at the condition of a humus horizon and its response to the composition of forest stands. The Vyšné locality, which occurs on a slightly undulated terrain, is characterized by gley or gleyed soils of rather heavy soil texture. The Mlýnský vrch and Žofín localities on a steep slope on syenite are covered by Cambisol soils of various depths. The chemism of a typical Cambic gley and Cambisol differs. Considerable differences in the content of particular elements are partly affected by different parent substrates and partly by the different composition of present stands. Cambic gley is developed on clay Miocene sediments with a spruce stand and Cambiosol occurs in a beech stand (aged 100 years) on syenite. The comparison of both soil profiles shows that soil at the Žofín locality (Cambisol) is richer in nutrients due to the parent rock (syenite) and this condition is still more affected in upper horizons by the present beech stand. The organic matter accumulation in the surface humus shows a similar trend as at localities mentioned above, ie markedly higher values in spruce stands as compared with beech stands. Under certain conditions, however, the process of the surface humus transformation can proceed relatively slowly. It became evident at the Vyšné locality under a fully closed silver fir stand (age 50 years) where F and H layers of a spruce stand were evidently "conserved" being moreover increased by the silver fir litter.

The character of the soil surface also affects values of the surface humus. It showed itself at the Žofín locality where particularly in a spruce stand (age 80 years), the soil surface was created by boulders of syenite and in the space between boulders high heterogeneity of the organic matter accumulate occurred. For example, at the repeated sampling and determination of the H layer weight the weight ranged from 69 to 104 $t.ha^{-1}$. On flat terrain without boulders, eg at the Vyšné locality, the variability of the surface H layer ranged from about 40 to 50 $t.ha^{-1}$. The weight of nutrients excluded from the nutrient cycle and thus also from participation in the forest stand nutrition is consistent with the accumulated amount of organic matter in the surface humus. Most nutrients are accumulated in H layer (mull), which generally also shows the highest weight. Thus, we are particularly interested in nitrogen accumulation in organic form, which is to a great extent unavailable for plants. However, there is a hypothesis that particularly fine roots occurring in the boundary-line between H layer and

organomineral A horizon draw nutrients from the lower part of the layer in the course of the ammonization process. If we assess the total accumulation of nitrogen, calcium and magnesium in relation to the species composition of forests we can note marked differences in nitrogen. In mature spruce stands, about 1500 kg N. ha^{-1} is accumulated in surface humus while in beech stands, the accumulation decreases to about 600 kg N. ha^{-1}. Only in a fully stocked silver fir stand (age 50 years), there is more than 1000 kg ha^{-1} nitrogen accumulated in the surface humus.

Changes in A horizon

From the ecological point of view, A horizon where the organo-mineral complex is created shows great importance for the evaluation of the forest ecosystem condition. Changes in pH values occur there as well as accumulation of nutrients available for the nutrition of forest stands and, generally, the root system of herbs, shrubs and to a great extent also of trees develops there.

In recent 30 years, acidification processes are mostly related to the input of pollutants into soil (acid precipitation) but growing spruce monocultures for the period of more than 100 years shows also its share in the acidification of upper soil horizons. Such a phenomenon can be also observed at studied localities from the point of view of decreasing soil acidification during transformation processes in favour of beech stands. The same process was also noted at localities analysed earlier. The higher input of basic cations (particularly Ca) in beech litter and faster decomposition process is applied there. This condition became evident as compared

to spruce stands often by the higher concentration of Ca in A horizons. Particularly markedly the process was proved at the Vyšné locality where Ca concentration in A horizon was 142 $mg.kg^{-1}$ (according to Mehlich III), in the beech stand 623 $mg.kg^{-1}$. Effects of a silver fir stand did not become evident anyway markedly. Even in this case, an explanation presents itself on "preserving" the H layer from the previous spruce stand, which has affected the condition of H horizon.

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Impact of tree species composition (spruce, mixed, beech) on througfall fluxes

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Bulk precipitation, throughfall (TF) and stemflow (SF, for beech only) were monitored from May 02 to Oct. 03 in adjacent stands of pure spruce, pure beech and mixed spruce-beech in Lower Austria (Table 1). The study period was characterized by an extremely wet (02) and an extremely dry summer (03).

Table 1: *Element fluxes in precipitation (PD), throughfall (TF), stemflow in g m^{-2} (except H^+ which is expressed in mg m^{-2}) and precipitation amount (H_2O, mm) during summer 2002 (1 May to 31 October), winter 2002/2003 (1 November to 30 April) and summer 2003 (1 May to 31 October). Precipitation deposition (PD) was measured in the open field (OF), TF (+ SF) fluxes were monitored under the adjacent pure spruce (SP), mixed (MI) and pure beech (BE) stands.*

Period	Site	H_2O	H^+	K	Na	Ca	Mg	NH_4-N	NO_3-N	SO_4-S	Cl	PO_4-P
Precipitation (PD)												
summer 02	OF	792	8.4	0.06	0.13	0.12	0.02	0.13	0.28	0.41	0.17	0.04
winter 02/03	OF	354	2.7	0.14	0.05	0.04	0.01	0.24	0.17	0.20	0.10	0.02
summer 03	OF	357	5.4	0.30	0.08	0.24	0.02	0.22	0.27	0.26	0.19	0.03
Throughfall (TF)												
summer 02	SP	555	0.8	0.88	0.15	0.68	0.11	0.59	0.48	0.43	0.29	0.05
	MI	533	0.4	0.55	0.14	0.95	0.08	0.25	0.46	0.42	0.24	0.06
	BE	524	0.4	0.49	0.09	0.87	0.08	0.17	0.27	0.34	0.15	0.12
winter 02/03	SP	185	1.3	0.54	0.06	0.34	0.12	0.28	0.34	0.53	0.21	0.00
	MI	241	2.2	0.18	0.05	0.13	0.03	0.19	0.22	0.22	0.13	0.00
	BE	235	2.1	0.15	0.04	0.08	0.02	0.13	0.19	0.19	0.11	0.13
summer 03	SP	243	0.3	0.65	0.06	0.54	0.08	0.52	0.46	0.35	0.22	0.01
	MI	254	0.4	0.52	0.06	0.47	0.06	0.28	0.34	0.28	0.13	0.02
	BE	251	0.2	0.57	0.05	0.57	0.07	0.27	0.30	0.26	0.09	0.02
Stemflow (SF)												
summer 02	MI	39	0.0	0.13	0.01	0.05	0.00	0.03	0.02	0.03	0.01	0.00
	BE	47	0.0	0.17	0.01	0.06	0.00	0.04	0.03	0.04	0.01	0.00
winter 02/03	MI	10	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	BE	15	0.0	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
summer 03	MI	53	0.0	0.18	0.01	0.05	0.00	0.07	0.06	0.05	0.02	0.01
	BE	73	0.1	0.25	0.02	0.07	0.00	0.09	0.00	0.07	0.02	0.01

So far, a lot of research has been done comparing beech and spruce ecosystems but studies on the effects of mixed tree species are very rare. Hence, we were especially interested to address the impact of tree species composition on TF fluxes and asked the following three questions:

1. What are the regulating factors of throughfall flux? Two different methods were used to separate net throughfall (NTF) into the dry deposition (DD) and canopy exchange (CE) components. The regression analysis method on the event-to-event variation in NTF was useful for explaining the regulating factors for H^+ and K but failed for other substances, since we used multiple rain event collections, which mixed up both components. According to these results it is concluded that cation leaching was mainly driven by organic anions and bicarbonate but insignificantly by a cation exchange reaction with H^+, what may be considered a natural process in the absence of heavy acidic deposition. The filtering approach method, applying sulfate instead of widely used sodium as tracer for calculation of DD, yielded reasonable estimates. This model revealed that during the dry summer 03 DD rates were much higher than during the wet summer 02 for all studied elements. However, canopy leaching rates of K, Ca and Mg showed the opposite trend, since this process is mainly controlled by the amount of precipitation.

2. Do tree species affect atmospheric input? Calculated total deposition (TD) fluxes as estimates of true inputs to the system were different from measured TF fluxes and justify the conclusion that the mixed spruce-beech stand showed an approximately linear response for H^+, K, NH_4, NO_3, SO_4, Cl and PO_4, if compared to the TD fluxes of the single species stands, but an antagonist response for Ca and Mg, since TD fluxes of these cations were almost identical for the beech and the mixed stand.

3. Do the components of throughfall in the mixed stand indicate non-linear effects? For all ions DD fluxes of the mixed stand were in between the corresponding fluxes of the single species stands and revealed an approximately linear response, except for DD fluxes of NH_4, which were lower than expected for the mixed stand. Mean annual canopy leaching fluxes ($CE > 0$) of K, Ca and Mg were similar for the beech and the mixed stand but higher for the spruce stand (antagonistic response). Retention of H^+ ($CE < 0$) was caused by canopy exchange reactions (buffering) and decreased from the spruce over the mixed to the beech stand as expected (linear response).

Our overall conclusion is that tree species composition affects atmospheric input and consequently soil and soil solution chemistry. However, the question whether mixed species stands can be treated as a summation of the corresponding monocultures is site specific and dependent on the studied chemical element and process. Current knowledge about the complex processes and patterns in mixed species stands are still limited.

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The first reaction of soil fauna caused by conversion of Norway spruce (*Picea abies* (L.) H. KARST.) stand in the Izera Mountains

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The Izera Mts. are old, doom-shaped mountains with soils of little fertility. They are built mainly of acid rocks, including granite and sandstone, with low volume of calcium carbonate. The calcareous formations are to be found only as small lenses of limestone. Acid rock, such as granite and porphyry, form a basis for the poorest soils that mainly provide for mixed mountain forest and mountain forest sites (Zaręba 1986).

For the last 150 years, the species composition of Izera Mts. forest stands has undergone significant changes. Due to economic reasons, natural stands were converted into artificial, single-species spruce stands with minor share of fir, beech and great maple (Zaręba 1986). This contributed to numerous gradations of bark beetle (*Ips typhographus*) and damages caused by windfalls and snowbreaks (Konca et al. 1997). The creation of a large area of spruce monoculture, coupled with huge increase in air pollution caused by German, Czech and Polish power plants and industrial facilities, led to an ecological disaster throughout 1970s and 1980s.

Today the spruce stands in forest sites are being converted into beech and fir stands. The research was an attempt to observe first reactions to the conversion on the part of soil mesofauna that has been for many years developed under the influence of spruce stands.

Field research was carried out in May and November 2005. Twenty soil samples were taken from each of eight plots set across the Forest Management Area, with 10 samples taken in spring and 10 in autumn. Each sample covered an area of 40 sq. cm and was 5-cm deep. The following plots were set:

Plot no. 1 (a pure stand of 111-year-old spruce on a mixed mountain forest site),

Plot no. 2 (4-year-old beech in a thinned 111-year-old stand on a mixed mountain forest site),

Plot no. 3 (a pure stand of 38-year-old spruce on a mixed mountain forest site),

Plot no. 4 (a cluster of 8-year-old fir under a 112-year-old spruce stand on a mixed mountain forest site),

Plot no. 5 (a stand of 10-year-old beech on a mountain forest site),

Plot no. 6 (a stand of dominant 116-year-old spruce and a natural renewal of 8-year-old beech on a mountain forest site),

Plot no. 7 (a pure stand of 86-year-old spruce on a mixed mountain forest site), and

Plot no. 8 (a cluster of 8-year-old fir under a 97-year-old spruce stand on a mixed mountain forest site) (Plan Urządzenia 1994).

On the plots where new species had been introduced the samples were taken at a distance of ca. 50 cm from young trees; on the single-species plots the samples were taken under canopy.

From all the plots 2822 mites specimens of 57 species were taken. The eudominant species include *Veigaia nemorensis*, while the dominant species include *Trachytes montana T. aegrota*, *Leptogamasus obesus*, *Gamasellus montanus*, *Pachylaelaps bellicosus,* and *Polyaspinus cylindricus*. Also the zoocenologic analyses were carried out for calculating the index of occurrecnce stability and index of dominance. The percentage ratio of *Uropodina* suborder and *Parasitidae* family mites as well as of *Gamasellus montanu*s, typical for mountain spruce stands, was also analyzed; this selection was based on the specific relations between these groups in coniferous, deciduous and mixed forest stands (Skorupski et al. 2003, Kamczyc 2006).

The research results and the analyses lead to the following conclusions:

1. On the spruce stands that started to be converted into beech or fir stands in the course of just few years some significant composition and quantitative changes can be observed as regards Mesostigmata order mites.

2. *Gamasellus montanus* quickly decreased in number on the converted plots, which follows from its lower share in beech stands.

3. On the converted spruce stands more species were found and a share of Parasitidae family mites and *Gamasellus montanus* (counted in total) was decreased.

4. On the converted spruce stands the percentage share of Uropodina suborder mites was found to increase or remain high.

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Carbon absorbing in the aspect of forest conversion

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In 2007 the General Management Board of State Forests National Forest Holding recommended research works related to the absorption of carbon dioxide by forest ecosystems:

- carbon balance in forest biomass of the main tree species in Poland (coordinated by the Department of Forest Management, August Cieszkowski Agricultural University of Poznan),
- carbon dioxide absorption in connection with structural and functional changes of forests (coordinated by Forest Research Institute, Warsaw),
- assessment of carbon dioxide net streams (coordinated by the Department of Land Melioration, August Cieszkowski Agricultural University of Poznan).

The part of the work involving the carbon balance aims to identify (mainly on the basis of allometric equations) the volume of forest biomass in stands of main tree species. The results of the works should enable relevance between detailed management practices and the dynamics of carbon absorption (especially with respect to Scots pine monocultures' conversion).

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Conversion of mature Scots pine (*Pinus sylvestris* L.) stands by using group-clear cutting system in lowland Forest Division Olawa

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Characteristics of mature Scots pine stands at the age over 80 years in which the conversion process was initiated by using group-clear cutting system in the last 15 years were taken into consideration. Main goal of the conversion was to tailor stand species composition to soil and site conditions in connection with forest functions. Special attention of the analysis was focused on the practical conversion aspects:

(1) quantity and quality of lower stand layers (species composition, age, cover degree, provenance, type and degree of damage, silviculture suitability),

(2) site conditions (forest site type, humidity, soil subtype),

(3) technical elements of cutting system (protection of young generation),

(4) scale of forest conversion needs in Polish lowland forest division (large-scale results and tasks for future).

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Structure conversion of mature hornbeam-oak stand by using different cutting methods in the Polish Lowland

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Results of long-term studies on stand sample plot situated in Experimental Forest Division in Siemianice are presented in the paper. In 1967 the conversion was started in the hornbeam-oak stand (species composition: 60% of oak at the age of 110 and 40% of hornbeam at the age of 80) growing on the site of mixed fresh forest. Three different methods of final cuttings were used in the experiment:

(1) clear cutting system,

(2) group-clear cutting system,

(3) shelterwood cutting system and two species were artificially planted: common oak (*Quercus robur* L.) and silver fir (*Abies alba* Mill.).

Growth of young generation was described on the ground of measurements from: 1967, 1973, 1986, 1991, 1996, 2005 and 2007.

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Forest conversion in industrial regions of Poland.

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The paper presents area and volume analysis of stands growing in industrial regions of Poland at the turn of the 20th and 21st centuries. The structure of different methods of forest conversion was described in the aspect of: artificial regeneration, reforesting and underplanting. Main short- and middle-term rules of management planning connected with intermediate felling, final felling and species selection for silviculture practice are also presented. Zones of industrial pollution damages are estimated cyclically and together with annual volume increment are of great importance as a decision element for conversion starting.

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Assessment of spruce cultures (bio-groups) established after forest trees dicey in high elevated areas of the Skrzyczne and the Barania Mountain

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In 50's 60's of previous century in mountain spruce stands trees dicey intensification has been observed. Root rot and mass infestation by bark beetles were the main cause. That state was the consequence of unfavorable ecosystems changes witch means the nature broad leaved trees populations where replaced with spruce (often of unknown provenance). With the antropopression, forest soil degradation increase caused by spruce monocultures abiotic and biotic factors combined affection local disease phenomenon changed into multi areas forest trees dicey.

In response nowadays forestry search for effective ways to extinguish present and reduce the risk of future disasters in forest environment. Proctology forest management methods resulting sustain and a high productive forest ecosystem appears to be the solutions. The best way to achieve it seems to be usage of based on natural patterns semi natural silviculture, where people interferation limits to that guide and accelerate processes spontaneously occurring in forest environment. In high elevated mountain areas we might use natural trees biogroups model. Groups characterize higher resistance for difficult growth conditions than individual trees and fight, one-storeyed, even aged stand. Small trees collectives' observation allowed to prepare group reforestation method using increased resistance and individual cooperation.

Regarding great needs in this field for improvements we here taken efforts aimed to asses spruce cultures established with group reforestation method in high elevated areas in Beskid Śląski Mountains and their comparison with the asses of cultures established with typically used in Poland methods (regular pattern). Additional goal was determine the chosen factors influence (like surface coverage type and percentage or group shelter degree) for quantitive and qualitative features.

Research has been taken on 4 experimental and 3 comparative plots established on the area of Wisła and Bielsko Forest Inspectorates. These objects where chosen due to their localization in high elevated areas of Skrzyczne and Barania Mountain (1050-1180m a.s.l.) where trees growth is extremely difficult and previous stands.

Experimental plots were established in 2003, they are rectangular and about 1200m^2. Spruce sprouts were planted in 0,5m spacing from each other with Schönenberger (1986) group planting scheme. One year old planting stock with covered roots from well known and appropriate populations origin (both altitude and region similar)

Comparative plots were established in the same year in the vicinity of experimental plots. They were reforestated with the traditional method used for this species and type of area. 3 year old sprouts (1/2) with bare roots, were planted in regular spacing (1,0 x 1,0m) on whole area. Planting stock origin was the same. Assessment was taken in 2006, it embraced describing of basic parameters quality and location of groups established, those of natural origin and also groups of left dry wood; groups were assessment for quality of sprouts, type and percentage of herbs coverage, quantitative and qualitative features also the type and degree of sprouts damage and defect.

Collected data were transformed with statistical analyses. On the ground of received results and field measurements preliminary silvicultural assessment of established cultures has been taken.

The results of taken research showed the reforestation success on experimental plots is "good" (amongst 4 there was 1 "very good", 1 "good" and 2 "satisfying) whereas assessment of comparative plots appeared to be "satisfying". Sprouts growing in groups characterized themselves with higher vitality, survival and silvicultural utility, this means all the basic categories used for expectation of future reforestation development. In spite of age differences sprouts from both types of plots had similar growth parameters. Seedlings from the experimental plots received lower marks for quality

features, it was probably connected with their young age in the planting moment. Qualitative and quantitative features analyze showed existence of their significant variation connected with herbal coverage type and percentage of area covered with them. Seedlings growth and development appeared to be positively correlated with presence of blueberry and blueberry-grass coverage type. Higher surface coverage degree resulted in lower vitality and survival of sprouts, it was particularly visible with "grass" coverage type. The influence of group shelter was ambiguous. Total plots assessment proved the existence of their strong differentiation. Plots under influence of bordering stand were assessed as "best" for reforestation.

Observations taken suggest:

1. preliminary results suggested to use this type of forest regeneration in difficult areas where seedling can be exposed to the extremely inconvenient conditions due the positive effect of bio-group reforestation in comparisons to the traditional one (using regular spacing on whole area) while regenerating high elevated mountainous forests;
2. on reforestation success of forest culture significant influence have the factors connected with selection and preparation area for planting and the quality of preparatory work with stand establishment;
3. the most appropriate places for planting should be chosen with usage of "snow cover vanishing pattern".

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The present research was conducted as part of the project – "Evaluating of revitalization of degraded sites and forest mountain conversion in RDLP Katowice with emphasis to genetic selection - continuation of researches and adaptation of silviculture advices - asked by the Ministry of Environment and financed by NFOŚiGW in Warsaw within years 2007-2009.

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Conversion by non-intervention: Using an individual tree simulator to assess the potential natural forest type.

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One method of converting forest stands into the potential natural forest type, could be refraining from any further interventions. In the forest management district Litschau in Lower Austria, sites formerly stands of the spruce (*Picea abies* L. Karst.) –fir (*Abies alba* Mill.)-beech (*Fagus silvatica* L.)-ecosystem have been changed by large clear cuts, planting of Norway spruce, invasion of Scots pine and litter raking. We use 22 plots in stands with different proportions of Norway spruce and Scots pine (*Pinus sivestris* L.) to forecast their development by the individual tree simulator PROGNAUS (LEDERMANN 2006) for 1000 years to see if this simulator is an appropriate tool for this question and to get an idea of the forest types developing in this way. Plot size is between 400 m² and 2000 m² in stands between the age of 10 and 110 years in 1977. The sites are located in the Austrian part of the Bohemian Massif, between 450 m and 550 m a.s.l.. Soil types are moist, substrate-induced Podzols, except for two sites with Mollic and Umbric Gleyosols, and slopes between 0 % and 20 %. Diameter at breast height (dbh) and tree height for every tree with a dbh ≥ 5 cm have been measured in the years 1977 and 1982.

First simulation runs over 1000 years with PROGNAUS and the data from 1982 showed no forest development phases, decreasingly volume per hectare and, in the year 2982, predominant Scots pine with dbh up to 200 cm. The reason is that the individual tree mortality model used in PROGNAUS is missing the classic U-shaped distribution of mortality rate over dbh for all species, except Norway spruce (MONSERUD AND STERBA 1999). Further simulations were performed by including the dbh- and dbh² - terms in the exponent of the logistic mortality rate function for Norway spruce also for the other tree species. Figure 1 shows the development of the volume per hectare over time. For all sample plots a maximum volume evolves after approximately 100 years, with an average of 840±93m³ha^{-1}over all 22 plots. At this time, for plots with Scots pine in 1982, the percentage of Scots pine is high or Scots pine is actually predominant. In the next 200 years, volume decreases to about 353±57 m³ha^{-1}. Afterwards all plots show three waves in the volume trend, with a wavelength of approximately 300 years. The amplitude seems to diminish with time and the average volume is 436±38 m³ha^{-1} for the last 100 years. For all sample plots Norway spruce is dominant (50 %) and Ash species (*Fraxinus spp*.) show a remarkable proportion of 13 %. Birch species (*Betula spp*.), oak species (*Quercus spp*.), Scots pine and larch (*Larix decidua* Mill.) show only small amounts of 4 % and 2 %, respectively. As shown in Figure 1 left, silver fir (*Abies alba*) is growing in, with an amount of 23 % in 2982, except for the two Gleyosol stands, where silver fir is missing and the amount of Ash and Scots pine is higher (Fig. 1 right), and for two site with a more moist Podzol soil type, where the amount of silver fir is smaller (10 %) or marginal.

The study area's potential natural forest type is the sub-hercynic spruce-fir-beech forest with a high proportion of Norway spruce (KILLIAN ET AL. 1994). Concerning the species composition, our results do not fit with expectation concerning beech, because it is completely missing due to absence of beech in the data, once used for parameterisation of the ingrowth model (LEDERMANN 2002) for this growing region in PROGNAUS. The maximum volume of the different sample plots (first wave of the curve) correlates highly significant with the site index of Norway spruce for the respective site (MARSCHALL 1975), but not with stand volume in the year 2982. The more or less constant volume over time is plausible, expected for unmanaged forests to be higher and the wavelength to be longer as for Plenter forests (THOMASIUS 1991). MAYER (1976) mentions a volume per hectare between 200 m³ha^{-1} and 600 m³ha^{-1} for Plenter forests in Switzerland, depending on site index, whereas stand volume in our simulation is 436±38 m³ha^{-1} for the last 100 years.

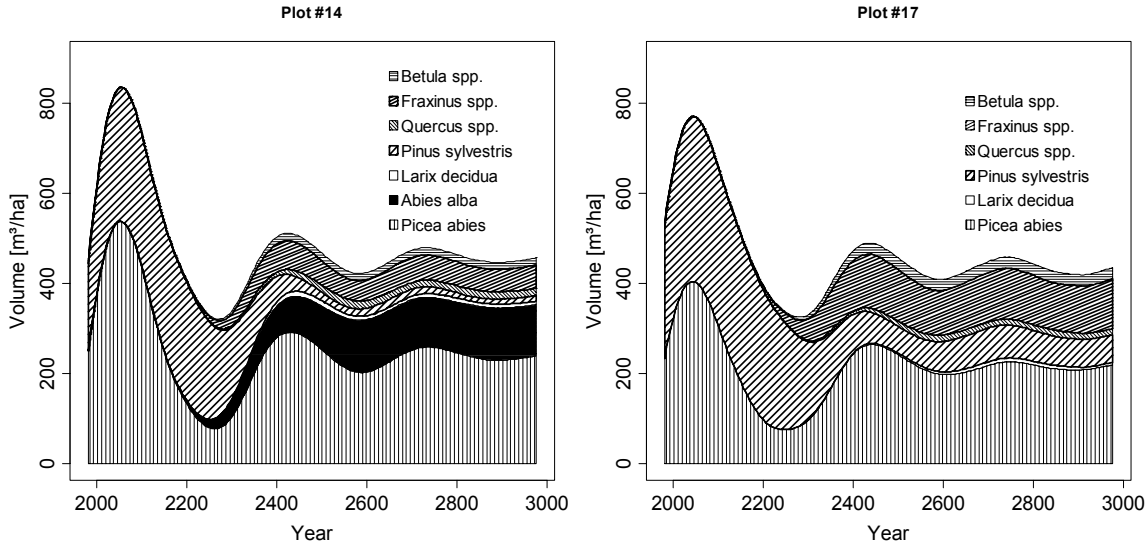

Fig. 1: Volume per hectare by species and year on substrate-induced Podzol (left) and on Mollic and Umbric Gleyosol (right)

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Describing Growth of Natural Regeneration using a Mixed Model Approach

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The establishment of regeneration is fundamental to the outcome of the conversion phase and the growth and recruitment of the next generation of trees (Malcolm *et al.*, 2001), as the occurrence of natural regeneration and its ability to thrive is linked to stand structure (Bagnaresi *et al.*, 2002). The ability to predict the response of regeneration will have a profound affect on the task of conversion, and with in excess of 4 million hectares of forest suitable for conversion in Europe alone, the understanding of the product of regeneration during conversion is of utmost importance. This study therefore assesses the links between the annual height growth increment of mixed spruce and fir natural regeneration against stand characteristics such as basal area per hectare, yield class, different intervention timings, competition indices and weather variables.

The five sites chosen for the study all come from a similar elevation of the Black Forest area of Germany. The trees selected were the five tallest of each species within each regeneration plot. The regeneration plots were 25m² in area and there were either 3 or 4 nested within subplots. Each subplot had a different intervention regime, and were approximately 1 hectare in area. There were 4 subplots nested within each plot. Two datasets were combined to produce the full data set. For dataset 1, the measurements began in 1986 and the annual height growth was measured at each intervention. Each intervention was approximately 5 years apart, and these measurements were used until 1995. The second dataset comprised of the selected trees having their annual height growth back-counted to 1995 from 2005/6 by using annual whirls. In total, 720 trees were included. The predictor variables comprised of the height of the regeneration trees, a competition index describing the ratio of the tree against the regeneration plot mean height for both species, site yield class, the basal area per hectare surrounding each regeneration plot, percentage canopy openness in a 10 metre radius above the regeneration plots, the time after the beginning of the experiment, the time after the last intervention, an intervention dummy variable from 1 to 4 which described the "speed" that the canopy was removed down to a basal area of zero, and temperature and precipitation for the previous 20 months for each plot on a monthly resolution.

A mixed model approach was used, the advantages of which are at least twofold. Not only can the experimental hierarchy be represented within the model and capture the nested effects of trees within regeneration plots, within subplots and so on, but also that a mixed model provides parameter estimates for the matrix of those nested observations. This hierarchy constitutes the random effects of the model, whilst the remaining independent variables form the fixed effects. It is this combination of random and fixed effects that comprises a mixed model. Additionally but not restricted to mixed models, is the process of using interaction variables. Instead of a model that provides a single parameter estimate for a main effect that must be added to the intercept, the interaction variables provide a range of estimates particular to the interaction stated. In other words, the effect of species in the first instance can only be described as a single coefficient which is applied as a singular value to the product of the model. The interactive variable effect provides a different species effect for each main effect to which it is paired. This then provides a more flexible and accurate model product.

The final model structure that describes the annual height growth increment of fir and spruce natural regeneration was:

lnai = est + r + h + tab + (species *ba) + (species*spddv*tai) + (species*pretapr) + (species*tapr) + (species*ci*yc) + (species*ci*spddv) + (species*yc*spddv) + e

where:

lnai	=	natural log (annual height increment (cm) + 2)
est	=	intercept estimate
r	=	random estimate
h	=	height (cm)
tab	=	Time after the beginning of the experiment
species*	=	species interaction variable

spddv	=	intervention speed dummy variable
tai	=	time after the last intervention
pretapr	=	mean temperature of the previous April (°C)
tapr	=	mean temperature of the current April (°C)
ci	=	competition index
yc	=	yield class
e	=	error

Many effects were contained and represented within the model. An example of this is the higher annual height growth increment of fir in relation to higher basal area values to that of spruce. The modelled parameter estimate of basal area for both species tends to zero for a basal area of zero, though spruce has a far greater slope. It may be that the experiment is at the point where spruce does not yet have a biological advantage over fir through the time the basal area has been removed. The model does however show the effect in the parameter estimates, especially through the competition index interactions with intervention speed and also with yield class. It is expected that in considering the parameter estimates, that spruce will become the dominant species within the regeneration plots within the next few years.

Fir tends to have a penalty in height growth increment in the second year after intervention, whilst spruce tends to be in the third year. This penalty in height increment is reduced for both species according to the speed of the intervention as seen in figure 1.

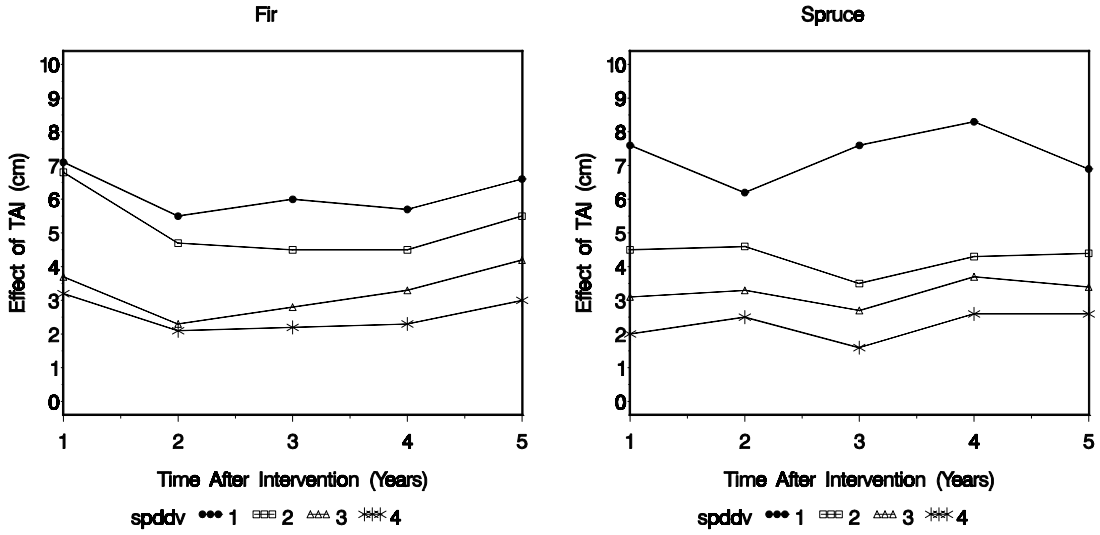

Figure 1: The effect of the time after the last intervention on the annual height increment of spruce and fir natural regeneration.

Spruce tended to have the larger penalty for intervention in the slower intervention speeds, but appeared to be a lower penalty than fir in the fast intervention. This is most likely to be due to the species' relative tolerance of basal area. However, spruce did not generally appear to have such a large overall reaction to interventions as compared to fir. Overall conclusions to the product of the model are that the model captures many of the growth characteristics displayed by the mixed species regeneration plots. Mixed modelling is an appropriate and useful tool in the provision of understanding the height growth dynamics of a hierarchical experimental design. The use of interactive variables to create the parameter estimates for each species/independent variable provides a greater degree of model accuracy than merely using main effect variables. The class function of the model also provides a key insight into the species effects within classes, such as yield class and intervention type. Further modelling of these data after 5 to 10 years using the mixed model process would further validate the model and confirm the model behaviour.

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Forestry on landscape level - introduction of a participatory planning approach

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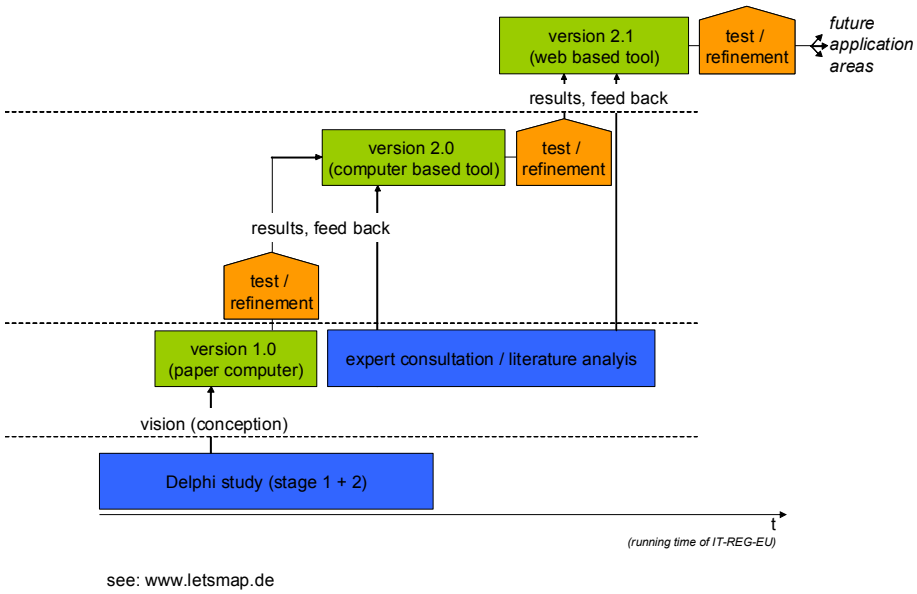
Forestry on landscape level must respond to manifold interests. In the consequence, management measures should integrate not only expert knowledge but also the needs of regional citizens. This raised the demand for solutions, which are able to integrate multiple perspectives and various temporal and spatial scales. Management support systems (MSS) and Spatial Decision Support Systems (SDSS) allowing for participatory approaches have proved to be most useful for complex, strategic problems that cannot be completely supported by algorithms and analytical solutions. The systems should give support by (a) providing an overview of the problem area, (b) assessing the impact of each possible management strategy, (c) comparing the management alternatives and (d) estimating the preferences of different stakeholders or stakeholder groups. Because MSS and SDSS are based on formalized knowledge, their application in management support has facilitated decisions that are reproducible and as rational as possible. The use of MSS and SDSS helps to better integrate knowledge on how different land-use management types and strategies affect the regional income, biological diversity and public services such as the provision of drinking water and recreation facilities. Beyond this background, a web-based planning support tool "Pimp your landscape (P.Y.L.)" was developed, which can be adapted to different scale levels - from stand level to regional scale. In the context of the Interreg-III a project IT-REG EU and the BMBF-project ENFORCHANGE, P.Y.L was designed as integrated trans-regional land use management support for the model regions Euro Region Neisse and the Dübener Heide. Here, Natura2000 targets, EU Water Framework Directive and the up-coming EU Soil Protection Directive are posing border-crossing challenges and provoke multiple management target conflicts between various stakeholder groups.

End-user needs oriented development approach

For ensuring an end-user needs oriented development of P.Y.L., an iterative development approach (Fig. 1) was chosen, including manifold feed-back loops with a number of 32 end-users from forestry, water and environmental management, nature protection and regional planning.

(1) A Delphi study revealed the corner stones "easy usability", "open web-access", "support of visualization and monetary evaluation of planning effects". Most relevant land-use types based on CORINE LANDCOVER (CLC) 2000, resolution 100*100 m² and functions (economy, ecology, tourism and water quality) for evaluating planning effects were defined. Changes in the forest or land-use type are made by clicking the raster cells in the maps and assigning a new type. The impact of each change is displayed as diagram in comparison to the starting situation. To evaluate land use planning effects, a value table was developed. Existing indicator sets were bundled and the effects of each land use type and forest type on the functions were referred to a relative evaluation scale from 0 (worst) to 100 (best). (2) A paper version ("paper computer") was used to refine planning support needs of different stakeholder groups in the context of a role play. (3) + (4) Following the end-user requests, two modi were developed: an expert mode supporting the integration of expert knowledge and research results into the evaluation of land use management effects and a game mode as interface to participatory planning processes. The "expert" modus allows introducing iteratively constraints for assigning types to the raster cells, which result e.g. from EU or national directives or regional management targets. Furthermore, the ranking of the forest and land-use type impacts can be modified to allow for an optimal regional referencing. The "game" modus uses a standardized ranking of the forest and land-use type impacts and allows "playing" any change for each cell. Fig. 2 shows the actual surface of P.Y.L. (game mode).



see: www.letsmap.de

Fig. 1: Iterative development approach of P.Y.L

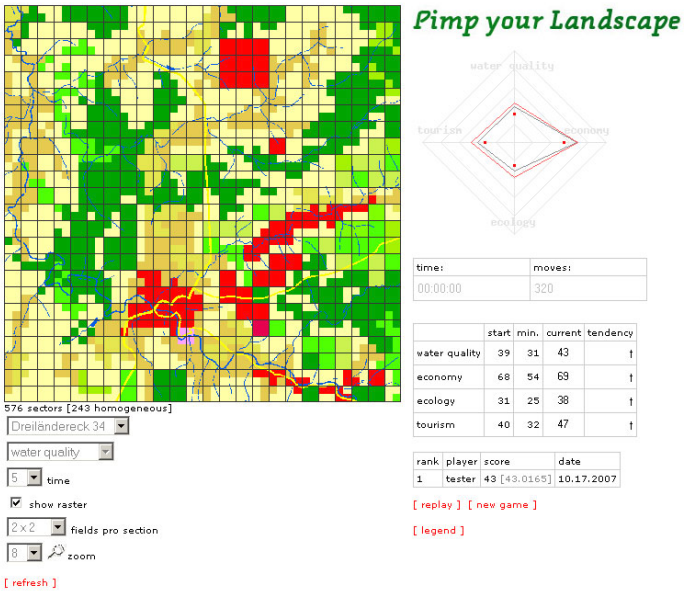


Fig. 2: Surface of Pimp your landscape (game mode). The map displays the actual distribution of land-use and forest types (CLC 2000). Effects of changes compared to the start situation are displayed in a star diagram and a trend table. Several users can play at the same time, at the end- a score list is displayed.

Application areas

P.Y.L. is actually available for three regions, the woodland region Dübener Heide, the urban region Leipzig and the agricultural and post-mining Euro-Region Neisse, further regions are in preparation. P.Y.L. is applied for conflict solution, management planning training and participatory approaches in regional planning, such as open cast mining restoration in the vicinity of Leipzig. In the vicinity of Dresden, P.Y.L. is used to test different land-use pattern with regard to their effects on regional climate change mitigation. In the context of "Education for sustainable development", P.Y.L. is adapted for environmental pedagogic in the Euro-Region Neisse. Furthermore, P.Y.L. is used for stand level management planning in a field trial of climate sensitive, participatory forest development in the Dübener Heide.

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Spatio-temporal dynamics of *Ips typographus* (l.) in declinig spruce stands in the north-western Slovakia

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Bark beetles are a serious problem in spruce forests in Central Europe. Increasing frequency and severity of abiotic stressors in recent years has enabled unprecedentedly large outbreaks. We present the spatio-temporal dynamics of bark beetles in declining spruce monocultures analysed using data on sanitary felling during the period 2000-2004 in the north-western part of Slovakia. Geostatistical analysis proved that data are spatially autocorrelated up to the distance ranging from 12 to 27 km. Conspicuous anisotropy was present during all investigated period, with prolonged axis in direction ranging between 20-50°. The anisotropy ratio increases in time (2.00 in 2002, 2.15 in 2003, 3.4 in 2004). Approximately 50% portion of nugget effect suggests high rate of local variation of infestation. The maps of infestation for the period 2000-2004 were produced using ordinary kriging. The area with the highest amount of infested trees forms remarkable radial structure, with axis parallel to the main valley in the region. The underlying processes forming this pattern can only be deduced. The obtained results are discussed.

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Economical aspects of Scots pine (*Pinus sylvestris* L.) stands conversion in the Polish Lowland.

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Aim of the paper is to assess the economic consequences of different dates of starting Scots pine stands conversion. The analyses are based on a forest inventory databases of over 35 000 stands growing on the area of about 130 500 hectares in the Wielkopolska Region (the Polish Lowland), including 3 500 ha of pine stands which need urgent conversion. Additionally, wood value and costs of timber harvested in each stand were taken into consideration.

Firstly, an empirical growth model of the pine stands requiring conversion was prepared. Then, optimal dates of starting conversion process were defined with respect to:

(1) wood increment,

(2) stands value, and

(3) expected income from the sale of the wood.

Finally, the economic consequences of taking decision about different dates of starting the conversion were analyzed.

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Species composition in European beech (*Fagus sylvatica* L.) mountain stands in the aspect of global climate changes.

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The characteristic of Bieszczady National Park is that its forest area mostly comprises beech stands in good condition (Przybylska, Kucharzyk 1999). From among the 16 categories of stand compositions, beech stands (with amount of *Fagus silvatica* over 80%) cover the area of about 14,729.75 ha which amounts to 65.8% of all the forest area (BULiGL O/Przemyśl 1996, Przybylska, Kucharzyk 1999). In the lower forest zone (500-1000 m over sea level) this advantage is even more significant.

As to tree species composition in mature stands, our research determined definitive domination of beech - 88.7% of the total tree count, 84.9% of the total stands' volume. Admixture species include: fir (*Abies alba)* – 5.7% in the tree count and 9.5% in stands' total volume, sycamore (*Acer pseudoplatanus*) – 3.85% and 3.5% respectively. The share of other tree species (Norway spruce, Goat willow, Aspen poplar, Mountain elm, Rowan, Ash and Hazel) was lower than 2%.

According to Jaworski's group, the primal stands in lower forest zone in plant association *Dentario glandulosae-Fagetum* in Eastern Carpathians (Bieszczady Mts.) are mostly composed of three tree species: beech, fir and ash (Jaworski i in. 1991, 1995, 2000), and in Western Carpathians (Babia Góra, Gorce): beech, fir and Norway spruce (Jaworski, Karczmarski 1990, Jaworski, Skrzyszewski 1995). The domination of beech in Bieszczady Mts. is much higher than in Beskidy Mts. Following the comparison made by Skrzydłowski (1998) we know than mean share of beech in Karpaty Wschodnie amounts to 74.4%, while 54.5% in Karpaty Zachodnie.

In comparison to the 1993 data, the tree species structure of beech stands did not change: beech share in the total tree count was about 87.4% and in the total stands' volume – 84.2%, fir – 6% and 10% and sycamore – 4.1 % and 3.5% respectively.

Upon the analysis of most primal lower forest zone stands Jaworski found that the diversity of species is decreasing because beech has been expelling fir (Jaworski, Karczmarski 1990, 1991, Jaworski, Skrzyszewski 1995, Jaworski i in. 1994). Korpel (1989) added that fir's lowering share within its natural range has been clearly seen especially for the last 15-25 years; however the share of beech has been on the rise, which has become typical of all the Carpathians.

The cause might be probably traced back to the global warming resulting from the increase in the volume of carbon dioxide in the atmosphere, particularly over the last decades (Fabijanowski, Jaworski 1996). Following the climate analysis in West Carpathians, Obrębska-Starklowa (1994) assessed that the total rise in temperature near the Carpathians and Tatras in the course of the current warming is typical of Central Europe. Between 1881 and 1990 the rise amounted to 0.9-1.3ºC, which is similar to the results of Jones's (1986) research involving the analysis of the changes in air temperature starting from 1851. Also Primault (1995), who analyzed the data of five Swiss weather stations starting beginning in 1863, revealed a clear trend resulting in a 1.3-centigrade increase.

Dobrowolska (1998) contends that the climate warming contributes to a dramatic dying process of spruce and pine, while other tree species, such as fir and beech, have managed to develop successfully despite the changing environmental conditions. This view may be supported by an absence, in a 10-year period (1993-2003), of significant changes in the species composition of Bieszczady mature beech stands. There was also no significant indication of fir's removal in the neighbouring stands in Ukraine's Carpathian Natural Park (Karczmarski, Loryś 1993). On the other hand, the analysis of natural seed tree restocking indicates some trends that may contribute to the future development of mature beech stands in Bieszczady. Both in undergrowth and in natural seedlings a significant increase in the number of beech (2.0 and 14.5% respectively) can be observed,

while the share of fir has decreased by 1.0% and 4.6% respectively. However, one may assume that the 10-year period is too short to link the results with the climate change. Such doubts can be found in a paper by Fabijanowski and Jaworski (1996). Moreover, as Trepińska (1993) observed, mountain climate have relatively low susceptibility to temperature changes. Thus, although general trends are similar, the fluctuations are weak and may even show a reverse trend.

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Analysis of conversion potential of pure stands in mixed stands as function of site

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The analysis of the forest areas comprises both the identification and the adequacy of the species, regarding their ecological-cultural characteristics and of the site, regarding their edafo-climatic characteristics and of the productions to be attained.

The analysis of the conversion potential was carried out in two phases; in the first one the species were identified and in the second one the potential for conversion was evaluated as function of the species aptitude to the site. In the first phase the land use map was used to determine the areas occupied by the species and in the second phase the site potential was evaluated using aptitude maps for each species.

The results obtained by the overlay analysis, in a GIS environment, of the two maps enabled an evaluation of the site conversion potential for the species and the net present value analysis a first approach of the alternatives at the regional forest planning level.

The analysis was carried out in Alentejo Litoral where forest occupies about 52% of the total area and is mainly composed by five species; cork oak (*Quercus suber* L.), holm oak (*Quercus rotundifolia* Lam.), umbrella pine (*Pinus pinea* L.), maritime pine (*Pinus pinaster* Ait.) and eucalyptus (*Eucaliptus globulus* Labill.). In the forest area cork oak, holm oak, umbrella pine, maritime pine and eucalyptus represent 43.9%, 4.6%, 7.6%, 8.9% and 15.8%, respectively. As to the aptitude of the area for these species 40.3%, 4.2%, 6.5%, 8.5% and 15.2%, respectively.

The comparison between the areas occupied by each species and the potentiality of the site, that is its aptitude, revealed that the most of the areas of maritime pine and eucalyptus have aptitude for cork oak, umbrella pine and in a smaller extent for Portuguese oak and holm oak. As the species have different incomes, being higher for umbrella pine and for cork oak, when the site has similar potentialities the option can be guided by economical factors or by a protection or conservation concerns.

Key words: conversion; species; aptitude; soil characteristics; NPV

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Evaluation of the forest growth simulator SILVA on mature mixed Silver fir - Norway spruce stands in South-West Germany with special respect to the dbh growth response to release during conversion

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Increasing abiotic and biotic risks have shifted renewed attention towards multi-layered mixed forest concepts as a more stable silvicultural alternative to the single-layered, single-species forestry practice. However, the growth constellations in such stands are far more complex. Thus, growth models on individual tree basis are needed in order to predict the dynamics of such forests for management purposes.

One decisive factor for the stand stability and cost-benefit relation of forest conversion towards multi-layered mixed conditions is the dbh growth enhancement of the upper canopy trees through a reduced stand density (in terms of basal area).

In this study, we evaluate the single-tree based growth simulator SILVA (version 2.3) on a data set of 55 long-term experimental plots of mature mixed Silver fir - Norway spruce stands on a wide range of site conditions in South-West Germany (Baden-Württemberg). The analysis was restricted to the surveys between 1989 and 2004 where the stands had reached heights of 25-40 m (h100) and diameters of 35-65 (d100). Special attention was paid to the correct reproduction of the dbh growth in response to the stand density.

In a first step, the true height and dbh growth was compared to the results from the SILVA simulation. The simulation runs were carried out with a rough site definition as site specific data were missing. For the evaluation period (1989-2004), height growth was on average overestimated by +50 % (Norway spruce) and +10 % (Silver fir), dbh-growth underestimated by -20 % (spruce) and -70 % (fir). The resulting volume growth was over/ underestimated by +5 % and -60 % for spruce and fir, respectively. The height growth error possesses a height

trend: height growth of taller stands was increasingly overestimated.

This suggests that the local site conditions could not be covered by the rough definition we applied. For such cases, SILVA allows a manual adjustment based e.g. on local inventory data. The dbh growth of fir which was parameterised on the basis of only a few dense stands must be re-calibrated SILVA-internally. With respect to stand density (in terms of basal area), SILVA correctly reproduced the basal area dependency of dbh growth for spruce while the reaction of fir was underestimated. As in single-tree simluators the dbh growth reaction to stand density is derived from the individual-tree competition, the performance of the competition index KKL as a determinant of the competition-dependent dbh growth component was compared on single tree level. While for Norway spruce, real and simulated data well matched each other, the competition sensitivity of White fir was underestimated. However, the relation between competition and dbh growth was clear and did not saturate which approves the CCI as a highly suitable competition measure.

The individual tree basis and position dependence of SILVA are crucial elements for modeling conversion scenarios. The simulation of the evaluated scenarios required a (manually possible) adjustment of height growth, while in terms of dbh growth Norway spruce performed well, but for White fir a recalibration from a larger data base was recommended.

If this is assured, SILVA will prove a helpful and accurate tool in strategic forest planning of conversion and multilayered mixed forest management.

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Incorporation of impacts indication in target tree species composition planning

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The poster presents preliminary results of a trial aimed at optimizing tree species composition of future forests established after conversion by analyzing ecological, economic and social impacts of this phase of strategic forest management decision making. An innovative method of indicative decision making on target tree species composition based on an assessment of suggested tree species combinations by three independent impact indicators, namely naturalness index, yield index, and safety index, is presented.

Naturalness index (I_N) expresses how well actual tree species composition approximates to natural composition pre-defined for units of forest typology according to existing knowledge. It is calculated as a sum of deviations of actual tree species proportions from their proportions in natural composition.

Yield index (I_Y) expresses the ratio of actual forest yield to maximum possible yield in given spatial-temporal conditions. It is based on an economic parameter "value of cutting yield in rotation age" according to current forest evaluation models in Slovakia, and represents the commercial value of standing timber in rotation age.

Safety index (I_S) expresses the probability to achieve full functional efficiency of a forest simulated by logistic models according to the last development of current forests. Subsequently, computation based on transition matrices is used. From a methodological point of view, this is the most complicated indicator requiring next research. The values of all indexes range from 0 to 1, while 1 indicates the most favorable conditions.

Example simulations of the impacts for various stand mixtures and most common site conditions were performed for model territory of Kysuce (north-western part of Slovakia). This region is characterized by absolute predominance of unnatural spruce forests strongly affected by forest decline in last years. In addition to present climate, the effect of predicted climate conditions, resulting from climate change, on future forest generations was taken into consideration. For this purpose, instead of actual tree species composition, natural tree species composition and absolute site index values of individual tree species were taken from the nearest lower vegetation belt of the same site quality ranking (Table 1). This presumed change of site conditions is in approximated accordance with the predictions of climate in the middle mountains of Slovakia around the year 2075.

The presented results indicate, that the suggested approach is able to account for all main aspects of future forest composition planning, and could bring objectivity to this process and serve as a decision making support in forest management in general. Especially in the forests under conversion, this issue needs to be solved.

Table 1: *Examples of impacts indication for various types of target forests and most frequent site-related planning units in model territory of Kysuce (north-western Slovakia). Simulations I – IV are adjusted for conditions of predicted climate in the year 2075.*

Planning unit (MGFT)	Type of the target forest	Tree species proportion									Naturalness index (I_N)	Yield index (I_Y)	Safety index (I_S)
		Norway Spruce	Silver Fir	Scotch Pine	European Larch	Douglas Fir	European Beech	Sessile Oak	Sycamore Maple	Other broadleaved			
411	Natural forest in current climate	0,02	0,15	–	–	–	0,67	0,01	0,13	0,02	1,00	0,60	0,86
	Simulation I – natural forest	–	0,01	–	–	–	0,56	0,25	0,12	0,06	1,00	0,61	0,86
	Simulation II – close-to-nature forest	0,15	0,10	–	0,10	–	0,45	0,10	0,10	–	0,66	0,71	0,78
	Simulation III – seminatural yield oriented forest	0,30	–	–	–	0,30	0,10	0,20	0,10	–	0,40	0,84	0,74
	Simulation IV – forest with maximum yield	1,00	–	–	–	–	–	–	–	–	0,00	1,00	0,00
505	Natural forest in current climate	0,15	0,39	0,01	0,01	–	0,37	–	0,04	0,03	1,00	0,67	0,90
	Simulation I – natural forest	0,02	0,21	–	–	–	0,52	0,19	0,02	0,04	1,00	0,55	0,93
	Simulation II – close-to-nature forest	0,25	0,20	–	0,10	–	0,35	0,10	–	–	0,67	0,72	0,88
	Simulation III – seminatural yield oriented forest	0,50	–	–	0,10	0,10	0,10	0,20	–	–	0,31	0,83	0,82
	Simulation IV – forest with maximum yield	1,00	–	–	–	–	–	–	–	–	0,02	1,00	0,51
511	Natural forest in current climate	0,03	0,40	–	–	–	0,46	–	0,10	0,01	1,00	0,69	0,85
	Simulation I – natural forest	0,02	0,16	–	–	–	0,66	0,01	0,13	0,02	1,00	0,61	0,85
	Simulation II – close-to-nature forest	0,20	0,20	–	0,10	–	0,35	0,05	0,10	–	0,64	0,75	0,77
	Simulation III – seminatural yield oriented forest	0,40	–	–	–	0,30	0,10	0,10	0,10	–	0,23	0,86	0,65
	Simulation IV – forest with maximum yield	1,00	–	–	–	–	–	–	–	–	0,02	1,00	0,00

MGFT (management group of forest types):

411 – eutrophic beech forests
505 – oligotrophic silver fir-beech forests
511 – eutrophic silver fir-beech forests

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Humus conditions and stand characteristics of artificially established young stands in the process of the transformation of spruce monocultures

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Problems of spruce monocultures refer seriously to more European countries, particularly with respect to the new orientation of management and using forest ecosystems. In the Central-European region, there is a large number of spruce monocultures, which are not adaptable to the given site. On a long-term basis, only mixed stands (SPIECKER et al., 2004) are economically reliable whereas in a commercial forest spruce can be a dominant species even in the future (TESAŘ, KLIMO, 2004). The main reason to transform spruce monocultures on sites of mixed broadleaved forests is to create a natural relationship between the species composition of stands and soil processes. A mixed stand can be created by the combination of natural and artificial regeneration during the time distribution of the spruce stand transformation. The growth of a stand, stand environment and growing up to the rotation age are much more affected by the form of a mixture, in principle individual, row/belt and group (BURSCHEL, HUSS, 2003, OTTO, 1994). In the modern conception of forest ecology and forest soil science, surface humus and humus horizons are an important component of a forest ecosystem from the point of view of the element cycle preservation in forest ecosystems and maintaining their ecological stability. Humus represents a place of the main accumulation of carbon in the majority of terrestrial ecosystems and because it remains there unoxidated for centuries it becomes an important long-term reservoir of carbon in an an ecosystem (WARING, RUNNING, 1998). Forest floor is very important for forest soils affecting a number of their properties. It is important particularly in the forest soil hydrology, controls temperature conditions in such a way that by the increase of the air content functions as an insulator reducing temperature fluctuations in soils between day and night and in particular seasons (PELÍŠEK, 1964). Last but not least, it serves as the source of energy for soil organisms (KUŽEL et al., 2001).

The study compares humus conditions and basic growth characteristics of two mixed stands established by planting at a constant spacing of 2 × 2 m (spruce with beech in the row ratio spruce1:beech1, beech proportion 30% and larch with beech in the row ratio larch1: beech2, beech proportion 40%) at an age of 25 years with an unmixed beech stand (40 years) established by seeding and spruce (30 years) established by planting. The study is carried out on a long-term field research station on an identical site, ie acid modal ologotrophic Cambisol (KAmd´) in a fir/beech forest vegetation zone. The field research station is situated about 3 km west of the village of Němčice (co-ordinates: 49º29´31´´ N and 16º43´30´´ E), the Drahanská vrchovina Upland, its subunit Adamovská vrchovina Upland and the Škatulec district at an altitude of 600-660 m. Mean annual air temperature was interpolated to 6.5°C and mean annual precipitation to 717 mm (HADAŠ, 2000). Potential growth conditions were characterized by the Institute for Forest Management Planning as oligo-mesotrophic *Abieto/Fagetum*, type *Oxalis acetosella* (5S1). However, we suppose that the locality is situated on the upper limit of the beech forest vegetation zone.

The study evaluates the stands from the point of view of the condition of soil or surface humus (forest floor form, total humus accumulation, soil reaction, base-exchange complex, the content and reserves of carbon, nitrogen, C/N ratio, DOC (dissolved organic carbon), and stand characteristics (diameter at breast height /dbh/, height, basal area). Statistical analyses were carried out using Statistics program - ANOVA and SHD test (Stat-Soft Inc., Tulsa USA).

On the basis of our research work it is possible to formulate these conclusions from the point of view of stand (mensurational) characteristics: beech in a mixture with spruce and larch proves sufficient vitality, particularly in those individuals, which were not damaged by game in juvenile stages. At

present, beech in the mixture with spruce and larch reaches poorer growth parameters and, therefore, falls behind spruce and larch. In spite of different growth parameters beech is able to assert itself in the competition of other species under the fully closed stand of larch and spruce, which are the existence limits even of those most disadvantaged individuals. Beech in a mixture with larch reaches a little higher mean stand height and higher mean dbh than in a mixture with spruce. A pure beech stand shows a very wide diameter range. For the creation of a future quality stand trees with the largest dbh have to be removed. It is also demonstrated by the high value of basal area.

Conclusions from the aspect of forest floor and soil: forest floor form - moder in a pure spruce stand and mixed stands, mull-moder in a pure beech stand. Statistically significant differences in the forest floor reserves between a pure spruce and a pure beech monoculture as against mixed stands with the 30 to 40% proportion of beech at an age of 25 years. Statistically significant differences in active and exchangeable pH between an unmixed spruce and beech monoculture as against mixed stands with the 30 to 40% proportion of beech at an age of 25 years. Statistically significant differences in carbon and nitrogen reserves in forest floor between an unmixed spruce and beech monoculture as against mixed stands with the 30 to 40% proportion of beech at an age of 25 years. C/N ratio - statistically significant differences in forest floor and soil between spruce and beech monocultures and mixed stands under given conditions were not found. The adsorption complex in all stands is unsaturated under given conditions (V = 24 - 43%). The content of dissolved organic carbon (DOC) shows the trend of gradual decrease with layers of the surface humus towards depth. Significant differences in the content of DOC in the forest floor and soil between spruce and beech monocultures and mixed stands were not found. The higher content of DOC means the higher amount of energy fast available for soil organisms as well as more favourable decomposition of organic matter, but also higher risk for soil acidification (LESNÁ, KULHAVÝ, 2003).

Results obtained can be used for the transformation of spruce monocultures to forests close to the potential natural composition.

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The character of humus conditions at different ways of forest management

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In the modern conception of forest ecology and forest soil science, surface humus and humus horizons are the important component of a forest ecosystem from the aspect of maintaining the element cycle in forest ecosystems and preserving their ecological stability. Under conifers, accumulation of raw humus occurs in consequence of the effect of resins and waxes, which are included in needles and due to the anatomical structure of needles. The creation of raw humus is related to acidity and, therefore, under coniferous stands, we can find humus of increased acidity. Under mixed stands, forest litter is more aerated, which affects the creation of sound quality humus. The amount of dissolved organic matter in soil can be estimated on the basis of the determination of DOC in soil leaches and lysimetric waters. Dissolved forms of carbon become accepted for their importance in cycling forest nutrients. DOC is a primary form of carbon, which is transported from forest floor to mineral soil. The forest floor plays an important role in the dynamics of carbon and nitrogen of a forest ecosystem. It is considered to be the source of carbon and nitrogen for plants and soil microorganisms as well as the reservoir of carbon and nitrogen, which enters the forest floor. The study deals with the evaluation of the concentration of DOC in lysimetric waters sampled from forest stands of the various species composition in the Drahanska vrchovina Upland. At the same time, the input of DOC to soils in the form of precipitation is evaluated. Sampling soil waters by means of lysimeters is probably the most suitable method to obtain information on the content of DOC in the soil solution under natural conditions of a forest site.

Description of the experiment - characteristics of site conditions

Research plots occur on the reserach area of the Institute of Forest Ecology, MUAF in Brno in the natural forest region of the Drahanská vrchovina Upland, about 3 km west of the village of Němčice (co-ordinates: 49º29´31´´ N and 16º43´30´´ E). The plots are situated on the eastern slope of a watershed at an altitude of 625 to 640 m. Mean annual air temperature is 6.5°C, mean annual precipitation is 717 mm. On the area of the field research station, there is the slope soil cover including boulders of a size of about 1 m. The depth of the slope soils fluctuates and in an outcrop, rather deep weathering of granodiorite without the structure disturbance is evident. On the whole area of the research plots there is Cambisol. It refers to acid soil, which is partly conditioned by the character of parent rock and partly by the character of forest litter. From the point of view of physical conditions, the profile character is not optimal for the production of forest trees. It shows rather limited physiological depth, the impermeable layer of granodiorite weathering residues, which rises sporadically up to 50 cm profile depth. It means that the space of rhizosphere is limited to the layer of slope soils, which is rather gravelly. From the climatic aspects, the research station area can be ranked among the slightly warm and slightly humid zone. The research plots are ranked among the forest type group 5S - oligo-mesotrophic *Abieto/Fagetum* and forest type 5S1 - oligo-mesotrophic *Abieto/Fagetum* with *Oxalis acetosella*. *Fagus sylvatica* is considered to be an autochthonous species as an absolute dominating factor, the occurrence of *Abies alba* is sporadic, admixture of *Quercus petraea,* in places with gleying also *Quercus robur.* The description of plots selected for the purpose of research is given in Tab. 1.

Tab. 1 – Characteristics of research plots

	Pure beech stand	Mixed stand	Pure spruce stand
Age	40	125	103
Species composition	beech 100	beech 55, spruce 40, fir 5, larch, pine	spruce 100
Soil type	modal ologotrophic Cambisol (KAmd´)		
Forest type	5S1 - oligo-mesotrophic *Abieto/Fagetum* with *Oxalis acetosella*		

Methods

Vacuum lysimeters of a German company UMS GmbH as well as gravitation lysimeters of our production were used. In vacuum lysimeters, water intake happens through vacuum into special draw off vessels (suction pressure in draw off vessels is evacuated at the beginning of each of the take-off periods – a system with decreasing vacuum – "falling tension" system). In gravitational lysimeters ("zero tension" lysimeters), water intake happens only by the gravitational passage of water through the soil profile. In each of the plots, three measuring places were installed and in each of the measuring places, three lysimeters were used (two vacuum and one gravitational lysimeter). In precipitation waters and waters intercepted in underground lysimeters, the amount and chemical composition of water was determined in every sampling - the amount of water (volumetrically), pH (using potentiometers), conductivity (using conductometers), the content of cations (through atomic absorption spectrophotometry) and the content of anions (through gradient ion chromatography). DOC was determined by means of a SHIMADZU TOC VCSH/CSN analyser according to the CSN EN 1484 (1998) standard. In the filtrate, we determine the content of total carbon (TC) and anorganic carbon (IC) by means of an automatic analyser. From data obtained the content of dissolved organic carbon is calculated. Samples were taken in the winter season once a month, in other seasons in 14-day intervals. In winter months, lysimetric waters were not sampled.

Results and Conclusions

The aim of the paper was to compare data on the content of dissolved organic carbon in forest soils on variously managed areas of different species composition. Preliminary results show that dissolved organic carbon can be a suitable characteristic to evaluate the transformation of spruce monocultures. With the increasing soil depth the content of DOC decreases. Dissolved organic carbon concentrations were highest in a soil solution recorded by gravitation lysimeters, which shows evidence of the sufficient amount of substrate available for soil microorganisms in a fast decomposition process, however, it also represents the greater risk of soil acidification. Dissolved organic carbon concentrations in lysimetric waters under spruce stands were higher than concentrations under beech stands.

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The impact of light condition during cultivation of beech seedlings to morphological parameters and chlorophyll a fluorescence

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Increase of proportion of beech in artificial reforestation has many problems. Protection of plants against the game is very important, boost of rapid growth after transplanting and the reduction of losses are important too. The light conditions during cultivation of seedlings in nursery are important for growth after transplanting. Seedlings cultivated in the sun or in the shadow differ in morphological, anatomic and physiological parameters. The light conditions very often change during transplanting seedlings cultivated in shadow beds to clear cuts or conversely when seedlings from sunny nursery are used for transplanting in the gaps and underplantings.

The experiment with cultivation of containerized beech seedlings in different light conditions was founded in 2007. The aim of the experiment is detection of seedlings reaction to change of light conditions after transplanting to clear cut or to shadow under stand. The paper shows the results from the first year of seedlings cultivation.

Material and methods

Beech nuts originated from 4th and 7th vegetation zone were seeded into trays HIKO V-265 in greenhouse. Half of greenhouse was shaded in order to transmit about 25 percent of full light. We assessed the state of assimilation apparatus by repeated measurement of chlorophyll a fluorescence (in June, August, September and at the beginning of October). At the end of vegetation season morphological features of one-year-old seedlings ready for outplanting were assessed. Next year the experiments with these seedlings will continue on a research plot.

Chlorophyll a fluorescence was measured with pulse-amplitude modulated fluorimeter Imaging-PAM 2000 (Walz, Effeltrich, Germany). At least ten seedlings per treatment were assessed in every measurement (1 leaf per seedling). Maximal quantum yield of PS II (photosystem II) photochemistry was calculated as F_v/F_m, where $F_v = F_m - F_0$ is variable fluorescence, F_m - maximum fluorescence yield, F_0 minimum fluorescence yield in samples adapted to dark. Measure light 3 μmol $m^{-2}s^{-1}$ and saturation pulses 2400 μmol $m^{-2}s^{-1}$ lasting 800 ms were applied.

Light response curves were generated in the same leaves. The irradiance was increased up to 1580 μmol $m^{-2}s^{-1}$ in 20 steps lasting 10 s and saturation pulses were applied at the end of every step. Apparent rates of photosynthetic electron transport (ETR) were calculated according to Maxwell and Johnson (2000).

Morphological features of seedlings (height, diameter, shoot and root volume etc.), were measured at Nursery control laboratory according to standard methods.

Results

Comparison of chlorophyll a fluorescence of seedlings grown in shaded and unshaded greenhouse showed higher values of maximal quantum yield (F_v/F_m) in beeches being grown in shade (fig 1). It suggests higher effectiveness of their photosystem. This pattern occurred during the whole season (from June to October) in beeches originated from both lower and higher altitudes (4th and 7th vegetation zone). Differences, however, were rather small and usually no significant.

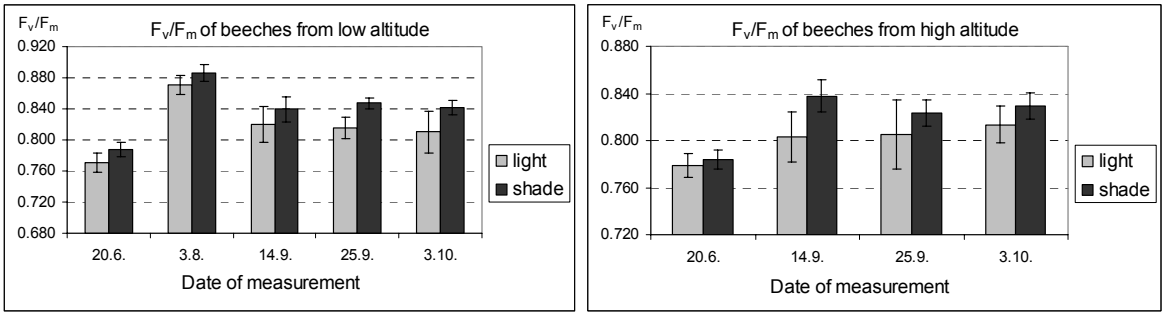

Fig. 1: Comparison of maximal quantum yield chlorophyll a fluorescence (F_v/F_m) of beech seedlings originated from 4th and 7th vegetation zone grown in various light conditions. Perpendicular bars drawn from the columns and in the columns show confidence intervals of sampling

Significant differences between shaded and sunny seedlings occurred in light response patterns (fig. 2). Sunny seedlings reached noticeably higher ETR. Electron transport of shaded seedlings increased more slowly with increasing radiation and showed lower saturation rate. The same pattern of ETR occurred in seedlings originated from both altitude zone and in all terms during growth season.

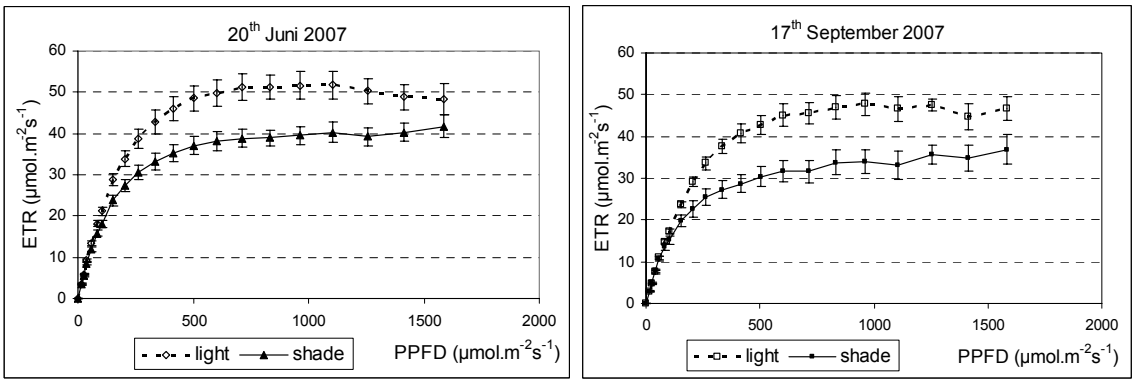

Fig. 2: Comparison of ETR pattern of beech seedlings originated from low altitude (4th vegetation zone) grown in various light conditions (June and September)

The morphological features of seedlings were compared at the end of the first vegetation period. The seedlings from greenhouse without shading were significantly higher and had greater root collar diameter and volume of roots and shoots. The differences in root/shoot ratio were not perspicuous.

The results suggest that the light conditions during cultivation of seedlings in nursery have strong impact on morphological and physiological quality of seedlings. The subsequent monitoring will be focused to reaction of seedlings to change light conditions after transplanting.

Acknowledgement

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Comparison of the impact of blue spruce, Norway spruce and reed *Calamagrostis villosa* on forest soil chemical properties

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Nutrient content as well as other chemical and physical properties of soils is the consequence of bedrock, abiotical soil forming factors and impact of organisms – plants and animals. The inner ecosystem nutrient exchange has following sub-processes: production, conversion, mineralization, recycling (Otto 1994). Plants use nutrients included in atmosphere and soil liquids to build phytobiomass. One part of the biomass is through litterfall directly transported to soil and transformed by bio-chemical processes. Direct impact of the plant species on soil characteristics differs.

After the air pollution induced decay of forest stands in the mountain regions of the Czech Republic in 1970's to 1990's, there was a problem of autochthonous tree species planting failure on the climatically extreme localities. Norway spruce and European beech were main autochthonous species there. The problem was temporary solved by alochthonous – introduced tree species plantings (Šindelář 1982).

Blue spruce (B. s.) of North America was the most extended substitute tree species used in the higher mountain localities (Mauer et al. 2005). Nowadays, air pollution load decreased and blue spruce forest stands are being converted with the autochthonous tree species (mostly Norway spruce).

Production potential of the blue spruce is lower than of Norway spruce (Šika 1976), negative impact of blue spruce on the forest soils is mentioned in the literature (Kantor 1989, Podrázský 1997, Remeš et al. 2002, Podrázský et al. 2005). It does not cover the soil surface enough, it does not protect soil from desiccation and worse chemical properties. According to Remeš (et al. 2002) has blue spruce similarly unfavourable litterfall like Norway spruce, but in lower amounts, which leads to farther soil degradation comparable with the long-term clear-cuts.

This study aims to compare impact of 20 year lasting cover of blue spruce, Norway spruce and clear-cut reed *Calamagrostis villosa* to the soil quality.

Materials and methods

Our research was done on the locality of Plochý in the upper part of the Jizerské hory Mts., Czech Republic, altitude 880 m, NW slope to 5°, acidic spruce forest site type (8K). On the locality, blue spruce forest stand as well as Norway spruce groups were planted in 1985 to 1990 (beating up), after the forest decay due to air pollution disaster. Thanks to the planting failure are strips of the locality without forest cover. In 2006, mean height of the blue spruce stand was ca 4.5 m, Norway spruce was higher (5.5 m). The stand canopies are closing.

In autumn 2006, transects of seven soil pits in blue spruce (variant PP), Norway spruce (PA) and grass *Calamagrostis villosa* (CV) were settled. Horizons of L, F, H and Ah were taken on every pit in an iron frame 20 x 20 cm. These parameters were analyzed: total dry weight, active and exchangeable acidity, nutrient contents by Mehlich III. (P, K, Ca, Mg), characteristics of adsorption complex (by Kappen: S – content of exchangeable bases, T – cation exchangeable capacity, H – hydrolytical acidity and V – saturation of the adsorption complex with bases), total C and N content (Springer-Klee method) and exchangeable titration acidity.

Due to the character of the data, following statistical methods were used (alpha = 0.05): one-way ANOVA with Tuckey test for multiple comparisons of proportions, Kruskal-Wallis test, Welsh test and Games-Howell test of multiple comparisons. In some cases were the data normalised by logarithmic or square root transformation.

Results

There was significantly higher thickness of litter (horizon L) in PP variant and of humification horizon (H) in variant CV comparing to other variants. The thickness of all humus layers was significantly higher in *Calamagrostis*.

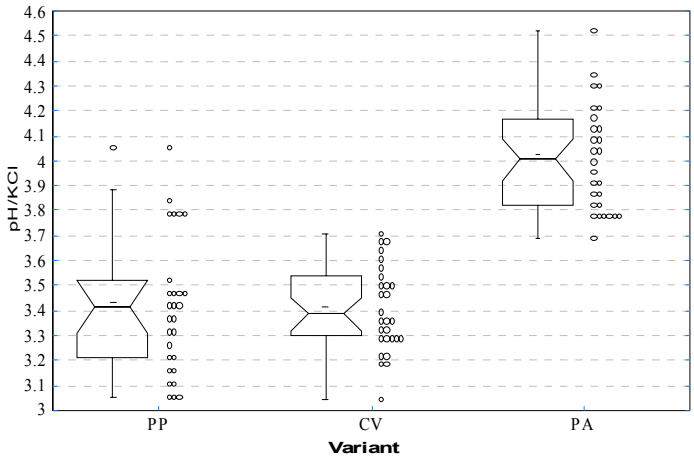

Fig.: Box plots of exchangeable acidity. PP – Soil pits under Picea pungens, CV – Soil pits under Calamagrostis villosa, PA – Soil pits under Picea abies.

Tab. 1: Mean values of the selected pedochemical characteristics. Homogeneous groups are designated by letters of the alphabet (the same letter in the same vertical position means the same group of statistical homogeneity).

Variant	Horizon	Dry matter (g)	pH/KCl	S (mval.kg^{-1})	V (%)	Exchangeable acidity (mval.kg^{-1})	H^+ (mval.kg^{-1})	Al^{3+} (mval.kg^{-1})
Picea pungens	L	45,10	3,75 a	10,2	27,8	38,1 a	10,16 a	27,99
	F	263,40 a	3,40 a	19,2	28,9	83,6	9,30 a	74,30
	H	739,84 a	3,37 a	12,3 a	20,5	119,4	3,89 a	115,48 ab
	Ah	895,83	3,22 a	8,3 a	22,4 a	100,1 a	3,07 a	97,06 a
Picea abies	L	58,38	4,29 b	14,6	34,6	47,2 ab	1,43 b	45,80
	F	356,37 b	4,07 b	21,2	36,8	108,1	0,57 b	107,57
	H	320,15 b	3,90 b	16,9 b	24,4	128,5	0,77 b	127,71 a
	Ah	760,24	3,82 b	14,5 b	34,9 b	150,1 b	0,94 b	149,19 b
Calamagrostis villosa	L	48,98	3,63 ab	17,4	34,7	49,6 b	12,71 a	36,91
	F	317,70 ab	3,47 a	17,6	26,8	87,6	8,99 a	78,59
	H	695,20 a	3,32 a	12,7 a	21,1	113,2	4,98 c	108,18 b
	Ah	676,71	3,24 a	7,2 a	21,0 a	89,8 a	2,95 a	86,83 a

In F horizon in PA soil, there was significantly higher weight of dry matter compared with PP, and on the contrary significantly lower weight of dry matter in H horizon compared to the other varians (Tab. 1). Soil acidity (pH/KCl) in PA was significantly higher in all horizons compared with PP as well as compared with CV in horizons F, L and Ah (Tab. 1, Fig. 1). In correspondence to these outcomes, concentration of H^+ in PA was significantly lower. However, concentration of aluminium (Al^{3+}) was in all horizons under PA stand higher, in horizon H and Ah significantly. The lowest nutrient content in upper horizons L and F was in PA, significantly by K and Mg in L horizon comparing with CV. Differences in base saturation with exception of Ah were not significant (Tab. 1). Soils under PP and CV showed very little statistically significant differences, it corresponded with preceding works. Total nutrient and N and C supply of variants did not significantly differ.

Conclusion

We can conclude that most favourable soil acidity was found under the *Picea abies* stand. In spite of lower nutrient content, PA variant has higher base saturation. Thanks to high variability, soils under PP and CA showed very similar conditions, this corresponds with preceding outcomes. In total nutrient, nitrogen and carbon supply the variants did not differ. Differences can be found in phytobiomass.

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Growth reaction of maturing spruce stand on different shelterwood cutting

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Transformation of spruce monocultures can be realised by various methods; shelterwood system of management offers good growing conditions for next regeneration of most species and possibility of additional volume increment of released trees. Information about the selection of suitable trees varies according to site and stand conditions, species, age and methods of release. Trees of mean diameter are generally considered as suitable trees for release. Spruce with dominant position in stand can not react adequately on further release, acclimatisation of originally suppressed trees with high growing potential on release can take long time and result is uncertain.

Site conditions and methods

Two different shelterwood fellings by removal of ca 50% of the stand volume were realised in maturing Norway spruce stand (age 68 years) on research plot Zelivka in 1971. Initial stand characteristics corresponded to table characteristics for spruce stand with density 0.9 of given age and site conditions (altitude 400 m, mild slope on the gleyic soil, acidic Oak – Fir stand is natural species composition on this site). The shelterwood plots were selectively released from above (starting from the largest trees with respect to stand stability – 2 plots) or from below (starting from smallest trees – 3 plots), 4 control plots were without release. Two principally different stands with comparable stand volumes were created – Release from above formed relatively dense stand formed from initially intermediate trees; Release from below created single layered stand formed by permanently dominant trees.

Repeated measurements (tree diameter, height, length of crown) of numbered trees were done annually in period from 1971 to 1988, measurement of water regime and microclimatic conditions in growing seasons were realised on some plots. Development of basic stand characteristics was counted in 5 years intervals (7 years for the last interval 1981 – 1988).

Results

Initial stand conditions on plots were comparable. By removal 50 % of stand volume was on plots with Release from below removed 72% of trees, 28% of trees on plots Release from above. Sanitary cuttings in period 1972 – 1988 removed 12% of trees on Control, 31% on Release from above and 23% on Release from below. Development of basal area and stand volume was comparable on both released plots, final differences did not exceed 5%. Final diameter distribution on Release from above and Control was comparable; diameter distribution on Release from below moved to the thicker dimensions. Originally suppressed trees reacted on release by larger diameter increment than released dominant trees, differences increased with time after release. On Release from below all trees moved to the next diameter class (4 cm), movement of thin trees on Release from above was higher for 40% than on the control. Released thin trees had higher height increment than trees on other plots.

Conclusion

Growing reaction of spruce with various social status on heavy release was measured on plot Zelivka for 18 years. Removing 50% of stand volume by two methods of selection changed growing conditions of released trees. Heavy release of originally suppressed thin spruces increased their diameter and height increment, growing reaction of released dominant and co-dominant trees was significantly lower. Development of basal area and stand volume was comparable on both variants of release.

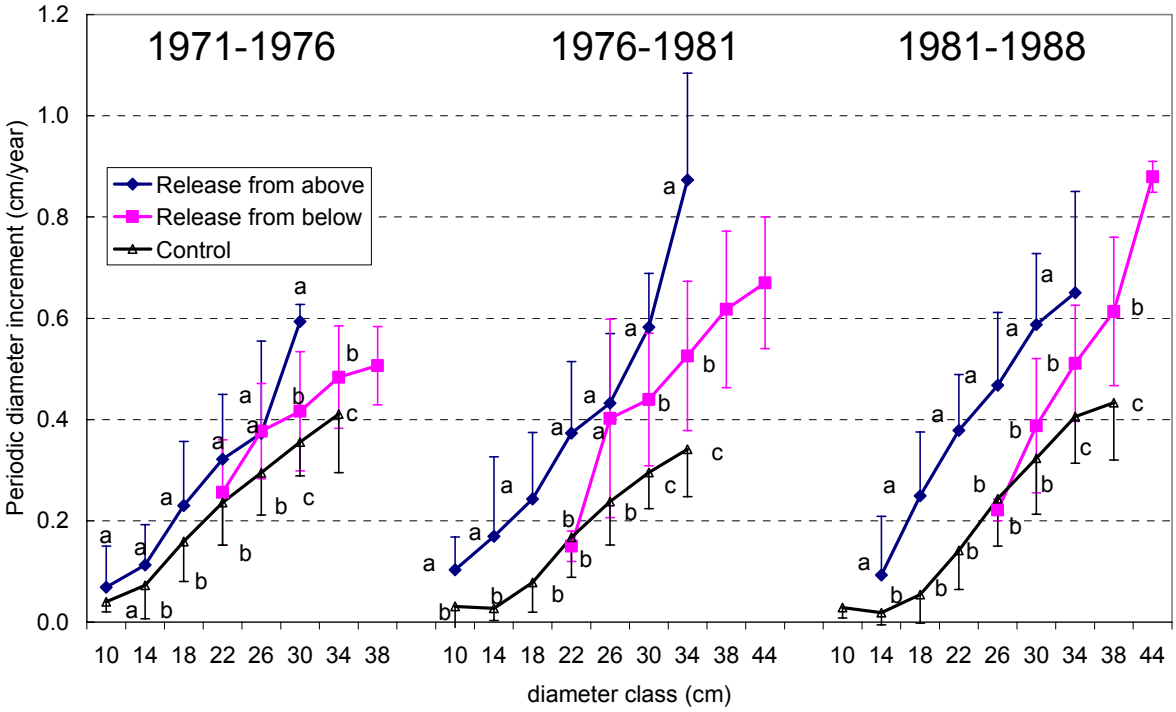

Figure: Periodic diameter increments. Significant differences (P<0.05) are indicated by letters (ANOVA,Tukey-Kramer)

Acknowledgments

This study was supported by the long-term Research Project of the Czech Ministry of Agriculture (MZE0002070201 - Stabilization of the forest functions in biotopes disturbed by anthropogenic activity under changing ecological conditions).

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Height growth of fir and beech underplantings in spruce stand

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Snow disaster in October 1930 and subsequent bark beetle outbreak caused vast calamite clearcuts in conifer stands on locality Cikháj (Czech-Bohemia Upland). More than 0.5 mill. m3 of wood was removed in the next years. Artificial plantation on clearcuts was mainly by spruce, broadleaves species with pioneer strategy of growth were also used. Share of other species decreased by thinings in next years. Spruce monocultures at the age 60 – 70 years dominate at present time. Stability of stands is endangered by high water table with danger of waterlogging and occurrence of decay due to repeated game damages.

Present stands have been gradually stabilised by system of shelterwood cuttings and gaps since 1996. Height of dominant trees is over 33 m, basal area varies from 27 to 45 m^2/ha according to the site conditions and the degree of release (density 0.6-0.9). Beech and fir were underplanted on released places in time and space advance before natural regeneration of spruce. Next broadening and connection of regeneration should divide present large areas of conifer monocultures and ensure appropriate portion of all species including spruce.

Methods

Total height, height increments, length of lateral branches and health status of fir and beech were evaluated in year 2007. Fir and beech were measured 4 – 11 years after plantations. Height increments of fir were measured retrospectively for 4 – 6 years, only last height increment was measured for beech. Height and retrospective height increments were also measured on spruces from natural regeneration. Measurements were realised on 20 localities, 150 plantations on each site. Gaps with various site characteristics (soil conditions, water table level, area of gap, age, dimensions of upper stand, light conditions) were selected for measurements. Fir was planted in various soil conditions (acidic, gleyic, moderate nutrient rich and wet soil category), beech on dominant acidic sites only.

Results

Loss after plantations did not exceed 10%, greater damage by rodents were recorded in 1998, 1999 and 2005. Height growth of fir differed according to site conditions, growth of beech was comparable with fir on same soil conditions. Fir growing on appropriate sites (fresh or gleyic soils with medium nutrient content) had rising tendency of height growth from the second year after planting; height growth on acidic or wet sites stagnated for first 3-4 years and then increased. Most of fir did not show unfavourable apical dominance ratio, quality of fir was good. Beech had also good height growth and quality. Spruces with comparable age as plantations had in the same conditions lower increment than plantations of both species, older regeneration positively reacted on stand release and increased their growth. Older regeneration of spruce is spatially separated from plantations. Next openings of the stands will change growing conditions and species differentiations of height growth.

Conclusion

Shelterwood cuttings partly stabilise spruce stands on locality Cikhaj, next damages by snow and wind were only local. Shelter of mature trees secures good growing conditions for regeneration. Height growth of fir and beech plantations vary according to site conditions. Spatial and time advance of plantations before natural regeneration of spruce secure their future growth and corresponding share in the future stand.

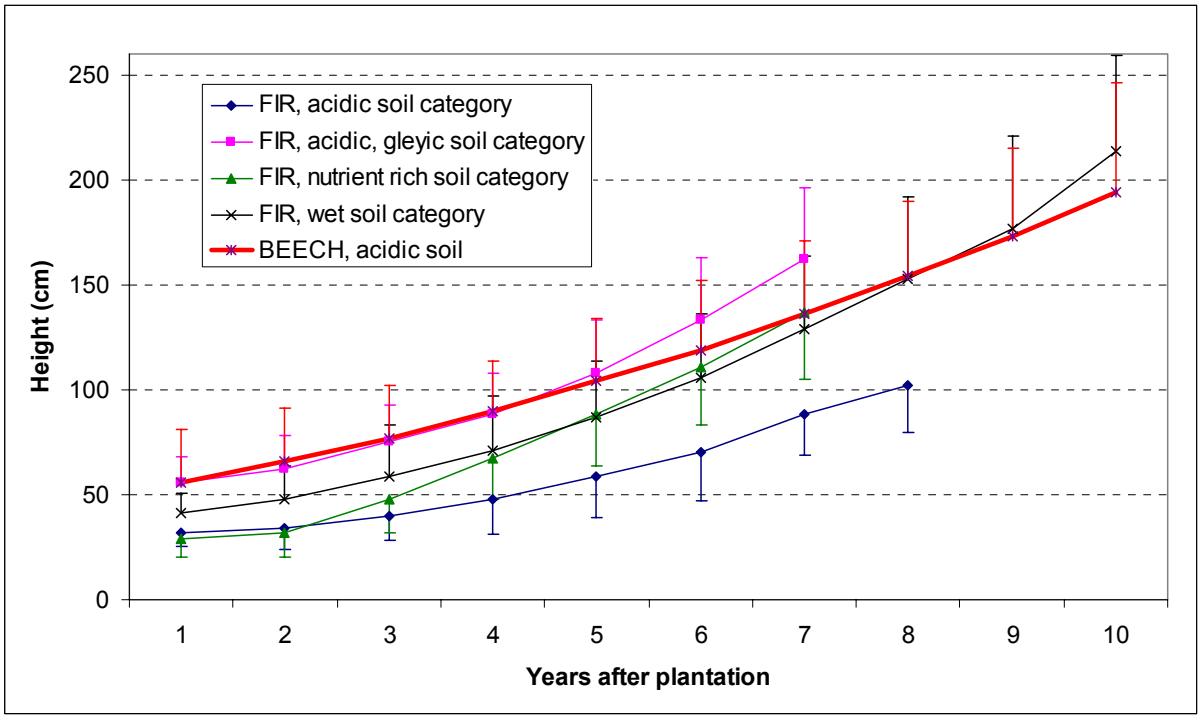

Fig. 1 Height growth of fir and beech in underplantings in various soil categories

Acknowledgments

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Evaluation of afforested soils' properties using multivariate analysis

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Our study focuses on some properties of soil samples taken from mineral (A, B) horizons of soils that underwent different land use in the last decades. The point is that the soil develops depending not only on inherited properties related to bedrock, topography and climate which result in formation of particular type of soil, but biota influences also site-specific soil conditions. In addition to these natural processes, human activities are perhaps the most important soil-forming and even soil-creating factors of soil genesis. An agricultural cultivation is likely to be the oldest human-induced alteration of soil properties. Even rather extensive thousands years lasting amendment including a primitive tillage lead to formation of extraordinarily thick A horizons high in soil organic matter and phosphorus which are key factors to classify profiles as formerly cultivated (Singer and Munns 1996). There were large shifts in land use in the past; the forests were converted into fields, meadows and pastures which become forest land again due to both succession and artificial afforestation. Large area was afforested mainly in 50ties when roughly 200,000 ha of less-productive areas have been afforested in the Czech Republic (Míchal et al. 1992). Despite new stands often grow very well; we suppose there are still different soil properties typical of cultivated soils that endured for a long time. Therefore the study deals with alteration of soil properties due to land-use changes, especially in terms of change from agricultural to at least semi-forest soil addressing two research questions:

(1) Does recently afforested agricultural land differ from long-term-afforested ones?

(2) Do afforested agricultural-land plots differ from continuous forest soils?

Materials and Methods

The soil samples were collected from forest soils of different land-use history. Among native tree species, Norway spruce grows on former agricultural land as the most frequent one in the Czech Republic being considered as the best productive though it is often threaten by game and fungi. Therefore we focused on comparative analysis of neighboring sites; there were sampled soils from recently afforested localities (planted 3 – 7 years ago) including adjacent spruce stands covering the former agricultural land for decades. Also samples of long-term forest land origin were taken if available. The soil was sampled beneath spruce stands because the spruce was reported as the most acidifying species (Binkley and Valentine 1991, Podrázský and Štěpáník 2002, Hagen-Thorn et al. 2004). A total of 118 samples from 8 sites were studied. The sites represented soils derived from metamorphic and sedimentary rocks. The most frequent soil type was classified as cambisol (FAO) altered due to cultivation. The samples from 0 – 10 and 11 – 30 cm were analyzed for pH value (both pH H_2O an pH KCl), plant-available nutrient element (P, K, Ca, Mg) concentrations using Mehlich III method, base saturation capacity, cation exchange capacity and hydrolisis acidity according to Kappen method. To process the data, a cluster analysis using NCSS software was applied. Group average – unweighted pair-group method calculates cophenetic correlation coefficient; values above 0.75 are felt to be good (Meloun et al. 2005); this is the correlation between the original distances (Euclidean distance) and those that result from the cluster configuration. Second measure of goodness of fit is called delta (degree of distortion); values close to zero are desirable.

Discussion and conclusion

Even though the agricultural practices have altered soil properties, Bedrna (2002) considers such process as logical continuation of natural development. Soil properties of mineral-top-soil horizons alter according to different tree-species cover (Podrázský and Štěpáník 2002). Also Binkley and Valentine (1991) found substantially more acidic top-five-cm soil layer under spruce in comparison with white pine and green ash. The most acidic top soil under spruce in comparison with broadleaves reported also Hagen-Thorn et al. (2004). We did not confirm differences among continuously-

forested sites and afforested agricultural land as found Wall and Hytönen (2005). On the other hand, our results also show a trend of an increased nutrient (especially Ca) concentration in recently afforested soils **(1)** which is being considered as a legacy of former artificial fertilization compared to both continuous forest and afforested land sites. Of course this status seems to be typical of former-intensively fertilized soils only. Long-term-afforested agricultural soils do not differ **(2)** from continuous-forested ones.

A technology of afforestation seems to be "well-managed" measure to establish forests within abandoned fields; both the soil fertility and terrain accessibility support soil preparation, planting, fencing, care of young plantation and growth of new stands. Consequently, extensive, nearly even-aged and species-homogeneous stands have been established. In spite of experienced success in establishing forest under agricultural-soil conditions, new stands have to be regarded as a "transitive" stage of forest development because of pioneer character of such first-generation forest stands. Even though the legacy of agricultural practices may have endured in soils even for centuries after abandonment and afforestation, we found altered fertilization-induced calcium concentrations only under conditions of formerly tilled and fertilized sites which were afforested a couple of years ago.

Acknowledgements

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Runoff from forest catchment influenced by hydromeliorative treatment and growth and development of forest stand

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Analysis of the situation showed how the hydrographical network, its condition and regulation are important for the genesis of runoff from regeneration felling in mountain locations. At the same time it was discovered that the precipitation-runoff process is very variable and extremely dependent on concrete natural and economic-technical conditions. We cannot apply directly the results from abroad, which had been achieved under different natural and technical conditions. For our practical application of measures we must acquire results based on our own conditions. In the Czech Republic the combined water-reclamation intervention (technical and biological measures) is a combination of regulation (in many places reconstruction) of the hydrographical network and regulation of the water regime by drainage. It is performed as a hydrological measure to regulate the erosion-induced runoff conditions of waterlogged disaster areas and as a silvicultural measure supporting the growth of forest woody species.

Localisation and characteristics of the experimental watershed

The effect of the combined water-reclamation intervention on runoff was explored in a small experimental watershed "U Dvou louček" on the mountaintops of the Orlické hory Mts. established in 1991. The southwest exposure of the fan-shaped watershed lies at an altitude of 880 to 950 m on an area of 32.6 ha. The gradient is variable, in the lower part 7.5°, in the central part 8.5° and in the upper part 4.3°. The watercourse draining the watershed forms two branches 340 and 300 m long respectively. One sixth of the watershed is periodically even permanently affected by a high water table. The area of the mature beech-spruce stand (average age 80 years) is 5.7 ha (17.5 %). The rest of the area is a former pollution-induced clear felling with a spruce culture of different age up to 15 years. The density of the road network in the watershed is 62 $m.ha^{-1}$. In terms of hydrogeology the watershed belongs to the crystalline complex of the Orlické hory Mts. The rock consists namely of gneiss and mica schist; gneiss in the hydrogeology structure of the watershed plays the role of a collector and the mica schist acts as a hydrogeology insulator. Due to the good permeability of gneiss and gradient of the terrain the water continually flows off via the underground. In contrast, the area of the mica schist in the lower and middle parts of the watershed prevents the water to flow via the underground and it swells to the surface causing its waterlogging. Cambisols and partly also humus podzols developed from the gneiss; while humus podzols, gleyic peat podzol and peat soils developed from the mica schist. The soil is loamy-sand, in some horizons clayey, extremely stony (20 to 50 %) and non-homogeneous. We proposed a water-reclamation intervention using open ditches within an area of 5 ha to restore the function of the existing drainage system, to retain runoff from the spring areas and the blind drainage areas, to cut off the artificial fall lines of the machinery-formed water courses and to regulate the disrupted original water courses. The planned length of the drainage ditches was 500 m. In 1996 the water-reclamation intervention was carried out manually.

Evaluation of changes in the runoff process after renewal of the hydrographical network

Evaluation of the existing course of the experiment in terms of changes in the runoff by means of the double-mass curve divided the time series into three periods. The first period was calibration, from the establishment of the experiment until the water-reclamation intervention (hydrological years 1992 to 1995); the second was the post-intervention period (hydrological years 1996 to 2001); and the third was the hydrological forest stabilisation period (hydrological years 2002 to 2005) when the young forest plantations (80 % of the area) canopy closed passing into the small pole stage. The gradient slope of the period of hydrological forest stabilisation was identical with the slope of the calibration period indicating stabilisation (recurrence) of the precipitation-runoff conditions (runoff coefficient) to the original before-intervention level. The average runoff coefficient for the calibration, post-intervention and hydrological forest stabilisation periods was 0.55, 0.77 and 0.65, respectively. Separation of the runoff components revealed the differences in these components not

only in the between-investigation periods, but also in the periods based on the particular discharge waves (runoff volume and height of culmination). Since the height of culmination in the analysed hydrographs was closely connected with the runoff volume, based on the culmination it was possible to divide the discharge waves into three markedly different sets with limits of less than 20 $l.s^{-1}$, from 20 to 60 $l.s^{-1}$ and more than 60 $l.s^{-1}$; the highest frequency was seen around the mean value of the set. With the increasing volume of precipitation, size of source areas and duration of rundown the share of accelerated hypodermic runoff (lateral infiltration through the soil) increased. The extent of the slow and accelerated hypodermic soil runoff (89.5 % to 99.4 %) compared to the rapid overland flow (0.6 % to 10.5 %) caused the absence of overland flow in the forest environment. Even the water-reclamation intervention did not disturb this favourable ratio. On the contrary, with the smallest discharge waves it completely eliminated rapid runoff (0.6 %) and during higher discharge it reduced it by 2.2 % to 4.2 %. In the period of hydrological stand stabilisation the accelerated and rapid runoff ratio again increased, by 10 % and 4 %, respectively. However, rapid runoff did not reach its initial volume of the calibration period. We can deduce that the increase in runoff was connected with the higher number of preferential routes appearing as a result of the proliferation of the root systems of the trees.

Conclusions

- An increased water content of low water and increased culmination discharges of low discharge waves after the intervention was confirmed,
- the reduction of discharges due to renewal of the poor hydrologic suction function of forest stands was confirmed,
- increased infiltration and acceleration of the hypodermic subsurface runoff probably due to the forming of preferential routes along the tree roots was proved,
- prevailing absence of overland flow in the forest environment based on the correlation between slow and accelerated soil runoff and the rapid runoff (90% / 10%) out of the total runoff from the forest watershed was proved,
- reduction of the share of rapid runoff by as much as 4% by increased soil retention after the water-amelioration intervention,
- the water-reclamation intervention and regulation of the hydrographical network and sporadic ditch drainage on 16% of the watershed is friendly to the water component of the watershed and does not damage it.

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Evapotranspiration and soil surface evaporation in a young Norway spruce stand after snowbreakage disaster in 2005/2006

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Impulse to bring the study, extreme disturbance of forest environment in the young experimental spruce stand after snow breakage disaster in winter 2005/2006 became. Content and aim of the study are clear from title of the paper. Investigation was grounded on two methodical procedures:

- assessing evapotranspiration of forest stands based on continuous measuring water content in root zone of soil profile,
- intermittent measuring evaporation from soil surface inclusive ground vegetation.

Comparative investigation was simultaneously done in the young experimental beech stand.

Material and methods

The Destenska stran experimental area in the Orlicke hory Mts. (50°19´20´´ N.Lat.; 16°21´45´´ E.Long.) - was established for studying the water balance of Norway spruce and European beech ecosystems as the representatives of two most important tree species of middle-altitude mountain locations in the Czech Republic. It consists of a pair of balance plots.

- Both of these balance plots (each sized 40 x 30 m) are ca 50 m apart from each other being situated on a slope with WSW aspect and mean gradient 16 degrees at an altitude of 890 m.

- Mean annual daily air temperature is 4.9 °C and mean annual sum of precipitation is 1 200 mm.

- Soils of both stands can be considered typical acid Cambisols of higher altitudes, sandy loam to loamy sand with the 50% mean volume admixture of skeleton, the proportion of which reaches 90 – 98 % at a depth of 0.7 – 1.0 m (weathered parent rock being mica schist).

- The spruce and beech stand belong to the most widespread forest type of the spruce/beech forest vegetation zone, to the forest type of a spruce/beech stand on acid sites with *Deschampsia* (6K1).

Description of forest stand development and present feature of the spruce and beech stands on experimental balance plots

1976-1981 observation of water balance components run in the mature spruce and beech large-diameter stands

1982 forest regeneration by clear felling method and hole planting spruce and beech

1983-2005 following observation of water balance components during growth, progress and tending both stands from plantation to small pole stage and pole stage stand

2005/06 in winter 25 years old spruce stand was severely damaged by crown and stem snow breaks, the young beech stand was afflicted with snow breaks only minimally;

98% spruce trees were affected by snow breakage, the stand density decreased from 1550 to 950 trees per ha, the needle foliation of the stand was reduced to about 40% and the stand canopy was markedly disturbed

2006 following observation of water balance components in remedying spruce and beech stands after snow disaster

2007 stand gaps began to be infested by forest weeds of which cover reached even 80% in summer and autumn

Total evapotranspiration of the young spruce and beech stands

- During growing season from May 1 to October 31 in 2005, 2006 and 2007 was determined by calculation from continuous measurement of volumetric moisture changes in soil profile (ŠACH et al. 2006, 2007).
- By rooting through depth we induced for calculating ET the thickness of root zone equal to 500 mm.
- The volumetric soil moisture is measured by the transducers VIRRIB.

- The transducers have been placed into deductive root zone in depths of 50 mm, 200 mm and 500 mm with 3 repetitions. Repeating follows forest stand variability.
- In 3 depths with 3 repetitions total 9 transducers was placed into each forest stand.

Procedure of calculating evapotranspiration of a forest stand

Calculating evapotranspiration in mm for a particular soil layer per month was done by a formula:

$$ET_{LM} = \sum W_V * D_{SL} * (1 - S_{VP})$$

ET_{LM}	evapotranspiration for a soil layer (mm per month)
$\sum W_V$	sum of volumetric soil moisture decrements as decimal number
D_{SL}	soil layer thickness in mm
S_{VP}	skeleton volumetric proportion as decimal number

Sum of ET_{LM} for three observed soil layers of root zone represents evapotranspiration of forest stand at month in question. By newly devised method we can calculate also daily values of ET (Šach et al. 2006).

Criteria for calculating evapotranspiration of a forest stand

- Into calculation we included the changes of volumetric soil moisture (mean of 3 repetitions in the same depth) if volumetric soil moisture of next record was lower than that of antecedent record.

- In consideration of six hour intervals (0, 6, 12, 18, 0, 6 hour, … of Central European Time – CET=UTC+1) Into calculation we did not usually include small decreases in volumetric soil moisture at night.

- Decreases in volumetric soil moisture during 12 hours after rain are considered vertical flow and especially at low air temperature and high air humidity (usually 100%) we do not take them in calculation (similarly Chang (1987) from comparable conditions).

- During rain, when volumetric soil moisture usually increases, we do not take ET into consideration.

Evaporation from soil surface inclusive ground vegetation in the young spruce and beech stands

- were determined by intermittent accurate weighing sets of Popov´s evaporimeters in summer hydrologic halfyear 2005, 2006 and 2007.

- The evaporimeter with evaporative circle cross-section equal to 160 square centimetres gave evaporation from the soil layer 0-20 cm.

- The evaporimeter set (more than 10) represented soil cover proportionally in spruce and beech stands and newly for comparison also on a clearcut.

- Observations were realised during characteristic rainless periods on the beginning, in the middle and in the end of growing season; they gave results about morning, afternoon and night evaporation (in detail KANTOR, KARL 2006, Kantor et al. 2007).

Results an conclusions

– Primarily, extremely high increase of the soil surface evaporation was proved in a gappy spruce stand disturbed by snow breakage. Immediately after the disaster, maximum daily totals of evaporation ranged from 1.5 to 2.0 mm in spring and summer 2006 while in beech, they reached half values. In the following year 2007, with gradual weed infestation of stand gaps, the values of evaporation in the spruce stand reached even 3 mm per day (exceptionally even more), in warm summer days being on the level of weed-infested clear felled area. In the same days, evaporation in a fully closed beech stand was usually 3 to 4 times lower.

– Total evapotranspiration ET (evaporation from the soil surface and ground vegetation + transpiration of trees) is comparable in both stands (200 to 235 mm for the growing season). Until 2006, ET was ± 10% higher in the spruce stand, whereas in 2007, ET was 10% higher in the beech stand.

– Thus, it follows that the actual transpiration of spruce itself markedly decreased after the snow disaster. The main reason consists in the marked reduction of the tree needle foliation (qualified estimate - in 2006, about 40% original values remained).

– In next years, it is possible to anticipate the gradual stabilization of the spruce stand (of course, at the worse quality of individual trees - bayonet-shaped trees), closing canopy, increasing transpiration and, on the other hand, decreasing evaporation from the soil surface. In the course of next years, it will be possible to assess if this scenario has expected course or, vice versa, if other destruction of the spruce stand could occur.

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European Beech (*Fagus sylvatica*) and Sycamore Maple (*Acer pseudoplatanus*) Interplantings into Birch (*Betula*) and Rowan (*Sorbus aucuparia*) Young Stands

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European beech (Fagus sylvatica L.) and sycamore maple (Acer pseudoplatanus L.) are considered as the important target tree species for the mountain forest sites. Besides wood production, they fulfil stand stabilizing and soil improving function as well. In the mountains, these species are recommended to be planted (as admixed species to forest stands) up to the spruce vegetation zone (altitude 1,050 - 1,250 m a.s.l., Vacek, Balcar 2000). For the problems concerning with their sensitivity – young plantations are sensitive to climatic stresses - some tests to optimise planting techniques by interplantings into the young stands of pionner species are tested.

Materials and Methods

Experimental series are situated in the Jizerské hory Mts. at an altitude of about 960 m a.s.l. According to the climatological monitoring, mean air temperature of the site is nearly 5.1 oC (measured 1996 – 2007) and precipitation 1,088 mm (measured 1994 – 2007, Balcar, Kacálek, Bartoš 2007). The soil type was classified as a Ferro-humic podzol to Histo-humic podzol (FAO classification, Hraško et al. 1987) originating from weathered granite parent material. According to air-pollution stress, the site belongs to Pollution Threat Zone B (the second most polluted areas in four-grade scale).

In 1990 - 1991, experimental area located in air-pollution clearing (area extend of 120m by 80 m) was reforested using various tree species in order to test their tolerance to environmental stresses (Balcar, Podrázský 1994). Individuals were planted within subplots 10m by 10 in size (4 replicates) at the spacing of 2m by 1. Therefore initial number of 50 trees per subplot was planted (5,000 trees per ha). Among species, two birches (Betula pendula Roth and Betula sp.), mountain ash (Sorbus aucuparia L.), European beech (Fagus sylvatica L.) and sycamore maple (Acer pseudoplatanus L.) were planted. Because of high mortality caused by environmental stresses at the beginning of the experiment, the gaps were replanted in 1992.

Seven years after establishment of experiment (1997), average mortality of the mentioned species was as follows: European birch 55%, birch sp. 54%, mountain ash 42%, European beech 90%, and sycamore maple 90 % (Balcar 1998). For the unsufficient state of beech and maple experimental plantations, interplantings of the two species into birch and mountain ash subplots (covered with young trees) were performed. Beech and maple transplants were planted regularly between former plantation rows ca at spacing 2m by 1, it means about 50 plants per subplot (some points were omitted for technical reasons, e.g. big stones). As control plantations, beeches and maples of the same planting stock origin were also planted within the subplots where nearly all beech and maple individuals died during 1990 – 1997. Because of higher replicate numbers in control plantations (4 replicates) than in interplantings (2 replicates), the control plantation was divided into two groups where both mortality and height increments were counted separately (cont. 1 and cont. 2 resp.).

Health condition of tested plantations (injury symptoms and mortality appearance) is observed every year in spring. The second regular health condition observations are performed in the beginning of autumn, when the trees are measured (measurement of height annually, measurement of trunk diameter and crown projection in several-year terms).

As a integral part of the planting experiment, growing conditions (climate, air pollution) are monitored (Balcar 2004, Slodičák a kol. 2005).

Results and Discussion

According to the results (Tab. 1) both species showed high mortality degree. Average total plantation mortality after 11-years period (1997 – 2007) of European beech was 91%, and of sycamore maple 88%. Majority of losses occurred during the first six years after planting (beech 84%, maple 60%), in spite of protection measures, the mortality was attributed chiefly to damage due to voles (Microtus agrestis L.),

and injury due to climatic stresses (spring frosts etc.). It was obvious, that beech and maple are tested near the upper limit of their natural range, and the plantation stage was the critical one.

Tab. 1: Tested species and their eleven-year mortality and average height increment (1997 – 2007)

Both species were more successful when planted into the young birch (average survival of beech was 18%, maple 22%), than they were planted into young mountain ash (survival of beech 9%, maple 13%),

Tested species	Plantation area	Planted (pcs)	Mortality from 1997 up to (%)		Height increment 1997 – 2007 (cm)
			2002	2007	
Fagus sylvatica	*Betula pendula*	82	77	79	82
Fagus sylvatica	*Betula sp.*	95	75	85	57
Fagus sylvatica	*Sorbus aucuparia*	93	82	91	32
Fagus sylvatica	Clear area - cont. 1	87	93	100	
Fagus sylvatica	Clear area - cont. 2	81	95	98	22
Acer pseudoplatanus	*Betula pendula*	97	45	78	10
Acer pseudoplatanus	*Betula sp.*	91	42	79	21
Acer pseudoplatanus	*Sorbus aucuparia*	91	35	87	19
Acer pseudoplatanus	Clear area - cont. 1	91	84	98	5
Acer pseudoplatanus	Clear area - cont. 2	89	94	99	27

and plantation on clear cut area (survival of beech 1%, survival of maple 2%). Height increment of beech plantations during eleven years after planting (1997 – 2007) shows better growing vitality in the tested young birch stands (average increment was 70 cm), slower growth was observed in mountain ash stands (32 cm) and in clear cut (22 cm). Sycamore maple grew much slower, and the differences were not so ambiguous. Average increments in birch and mountain ash stands and on clear cur were 16 cm, 19 cm, and 16 cm respectively.

Results of the experiment confirm previous experimental investigation performed at higher elevation with European beech in the Jizerské hory Mts. (Balcar, Kacálek 2003 and 2008). European beech plantations are very sensitive to late frosts (Kubelka at al. 1992, Lokvenc 1992) and young stands can provide effective ecological shelter against them (Hobza et al. 2008). As concerns sycamore maple, its sensitivity to late frost stresses is also obvious, but it is regarded as less sensitive than beech (Kubelka et al 1992, Balcar, Špulák 2006). Because of less attention devoted to this species, especially in terms of plantation and interplantation establishment at higher mountain elevations, there is not such experience of the optimal silvicultural planting methods for substitute species stands conversion yet as it is reported for European beech.

It is proposed, that research observation of the European beech and sycamore maple planted in the ridge part of the Jizerské hory Mts. in spring 1997 will be lasted for about 20 years, and we consider the results as presumise. However positive effect of young birch stand upon beech plantation and sycamore maple is obvious. Similar but less positive effect has been observed in young mountain ash stands. To confirm these results next investigation is needed.

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Thinning experiment in the spruce and beech mixed stands on the locality naturally dominated by beech – growth, litter-fall and humus

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Experimental base for forest tending research, historically oriented on pure stands (Novák, Slodičák 2003), is being extended to stands with typical mixtures according to the new State Forest Policy in the Czech Republic. In the frame of the new research activities, thinning experimental series Všeteč was established. This new experiment is focused on structure, growth and development of spruce and beech mixed stands with different thinning regimes. Additionally, effect of thinning on litter-fall and humus forms is studied. The aim of this paper is to show the preliminary results from ten-year investigation of this experiment.

Material and methods

Thinning experiment Všeteč was established in young 19-years-old stands with the mixture of European beech and Norway spruce in the Southern Bohemia (49°13´48´´ N, 14°16´25´´ E) in 1997. The experiment lies on 7% west slope on elevation of 440 m on cambisol of 4th Beech forest vegetation zone (acid category - *Fagetum acidophilum – Avenella flexuosa*). Mean annual temperature is 8°C and mean sum of precipitation represents ca 500 mm.

The thinning experiment consists of the variant stands (0.1 ha) with different thinning regimes: 1 - regime without thinning, 2 - regime with thinning from above and 3 - regime with thinning from below. Diameters of stems in breast height of all individuals and the height on representative sets of trees (n = 30) are measured annually.

In 1999 (age of 21 years), density of the stand on comparative plot 2 was decreased by thinning with positive selection from above - removed 19% N (21% G) of spruces and 10% N (26% G) of beeches. In the same year, density of the stand on comparative plot 3 was decreased by thinning with negative selection from below - removed 39% N (20% G) of spruces and 44% N (19% G) of beeches. Tending of other interspersed species (larch, oak, aspen, rowan, and birch) is conformed to thinning regimes of main tree species (beech and spruce).

In the frame of the presented research, two variants were selected to investigate litter-fall and humus conditions: 1 (as Control - unthinned) and 3 (as Thinned – first thinning by negative selection from below). In October 2003 (stand age of 25 years), forest-floor-humus horizons (L, F and H) were investigated quantitatively and qualitatively on identical comparative plots (1- Control, 3- Thinned). In 2005, litter-fall collectors (five per variant) were installed in plots 1- Control, 3- Thinned. The litter-fall samples were collected yearly and total amount of annual litter-fall was calculated. All samples (humus horizons and litter-fall) were dried at 80°C, and weighed and total nutrient content was detected using standard laboratory methods. All statistical analyses were performed in statistical software package UNISTAT® (one-way ANOVA, Tukey test, levels of $p < 0.05$).

Results - Growth

The most pronounced effect of thinning consisted in decreased amount of basal area, which had to be removed as salvage cut (dead, broken and uprooted trees, mainly spruces). While the salvage cut on thinned plots varied in the period of investigation from 7% (plot 2 with thinning from above) to 18% (plot 2 with thinning from below), the salvage cut on control plots 1 without thinning represented 38% of period basal area increment (Tab. 1).

Eight years after the first thinning (which was done at the age of 21 years), beech portion has been increasing and spruce portion decreasing continually according to number of trees on all variants (only exception first three years period characterized by nearly balanced portions of both species in variant 3). On the other hand, analysis of basal area shown that beech:spruce ratio was almost constant on plot 2, whilst on plots 1 and 3, beech portion has been increasing and spruce portion decreasing continually. Growth and stability of dominant spruces and beeches (200 thickest trees per hectare) is important.

During the period of investigation (age of 19 – 29 years), the h_{200}/d_{200} ratio of dominant spruces increased continually. On the other hand, h_{200}/d_{200} ratio for spruce showed decreasing trend on both plots with thinning (variants 2 and 3) at the last revision.

Tab. 1: Basic data of thinning experiment Všeteč

Variant	Tree species	1997 (19 years)			1999 (21 years)									SC 1997-2007 (19 – 29 years)		2007 (29 years) After thinning			I 1997-2007 (19 – 29 years)				I - SC 1997-2007	
					Before thinning			Thinning			After thinning														
		N	G (m^2)	d (cm)	N	G (m^2)	d (cm)	N	G (m^2)	d (cm)	N	G (m^2)	d (cm)	N	G (m^2)	N	G (m^2)	d (cm)	G (m^2)	%	d (cm)	%	G (m^2)	%
1	spruce	2,060	11.4	8.9	2,040	12.6	9.5	*	*	*	2,040	12.6	9.5	1100	4.0	960	12.0	13.4	4.6	40	4.5	51	0.6	5
	beech	2,970	8.9	6.6	2,970	10.2	7.0	*	*	*	2,970	10.2	7.0	260	0.3	2,710	15.2	8.8	6.6	74	2.2	33	6.3	71
2	spruce	2,610	11.2	7.7	2,550	13.3	8.4	490	2.8	7.4	2,060	10.5	8.4	410	0.9	1,710	17.9	11.7	10.4	93	4.0	52	9.5	85
	beech	2,620	6.0	4.9	2,600	6.8	5.3	260	1.7	6.0	2,340	5.1	4.9	50	0.1	2,310	8.8	6.7	4.6	77	1.8	37	4.5	75
3	spruce	2,510	13.7	8.3	2,450	15.2	8.8	960	3.1	6.4	1,490	12.1	10.1	430	2.4	1,120	15.0	13.0	6.8	50	4.7	57	4.4	32
	beech	2,900	8.4	6.1	2,890	9.6	6.6	1,280	1.8	4.3	1,610	7.8	7.9	10	0.0	1,610	13.3	10.4	6.7	80	4.3	70	6.7	80

N – number of trees per 1 hectare, G – basal area per 1 hectare, d – diameter at breast height, SC – salvage cutting, I – increment including SC, I – SC – increment without salvage cutting, 1 – control plot without thinning, 2 – comparative plot with thinning from above, 3 – comparative plot with thinning from below

Litter-fall

The total weight of annual litter-fall in studied young spruce and beech mixed stands at the age of 27 – 28 years varied from 4,930 to 5,050 kg.ha^{-1}. This amount (about 5,000 kg.ha^{-1}.year^{-1}) is comparable with our results from the pure spruce (Novák, Slodičák 2004) and beech monocultures (Novák, Slodičák 2008). An analysis of the nutrient content found ca 48 - 49 kg.ha^{-1} of Nitrogen in annual litter fall. Furthermore, the biomass of litter fall can contribute about 4 – 5 kg of Phosphorus, 11 - 12 kg of Potassium, 60 – 70 kg of Calcium and about 7 - 8 kg of and Magnesium per hectare annually to the nutrient budget of the stand. Differences between the comparative variants were statistically insignificant, probably due to the similar amount of dry biomass in litter fall.

Humus horizons

In horizon L (Litter), amount of dry biomass varied from 5,500 to 6,700 kg.ha^{-1}. Second horizon F (Fermentation) accumulated from 17,900 to 19,300 kg.ha^{-1} of dry biomass. The highest value was found in horizon H (Humus) – from 65,000 to 104,600 kg.ha^{-1}. Altogether, horizons L, F and H accumulated approximately 91,000 – 128,000 kg.ha^{-1} of dry biomass. On Thinned plot, dry biomass content was higher in layers L and F. On the other hand we observed higher value of dry biomass in horizon H on Control plot. Although presented values varied between variants (Control, Thinning), differences were insignificant for all horizons. The results of investigation showed that first and second horizons L and F (litter + fermentation) accumulated per one hectare 23 – 26 thousand kg.ha^{-1} of dry biomass. These values are comparable with the results from the 33-year-old spruce monoculture in the mountains condition – L+F 25 – 26 thousand kg.ha^{-1} (Podrázský et al. 2006).

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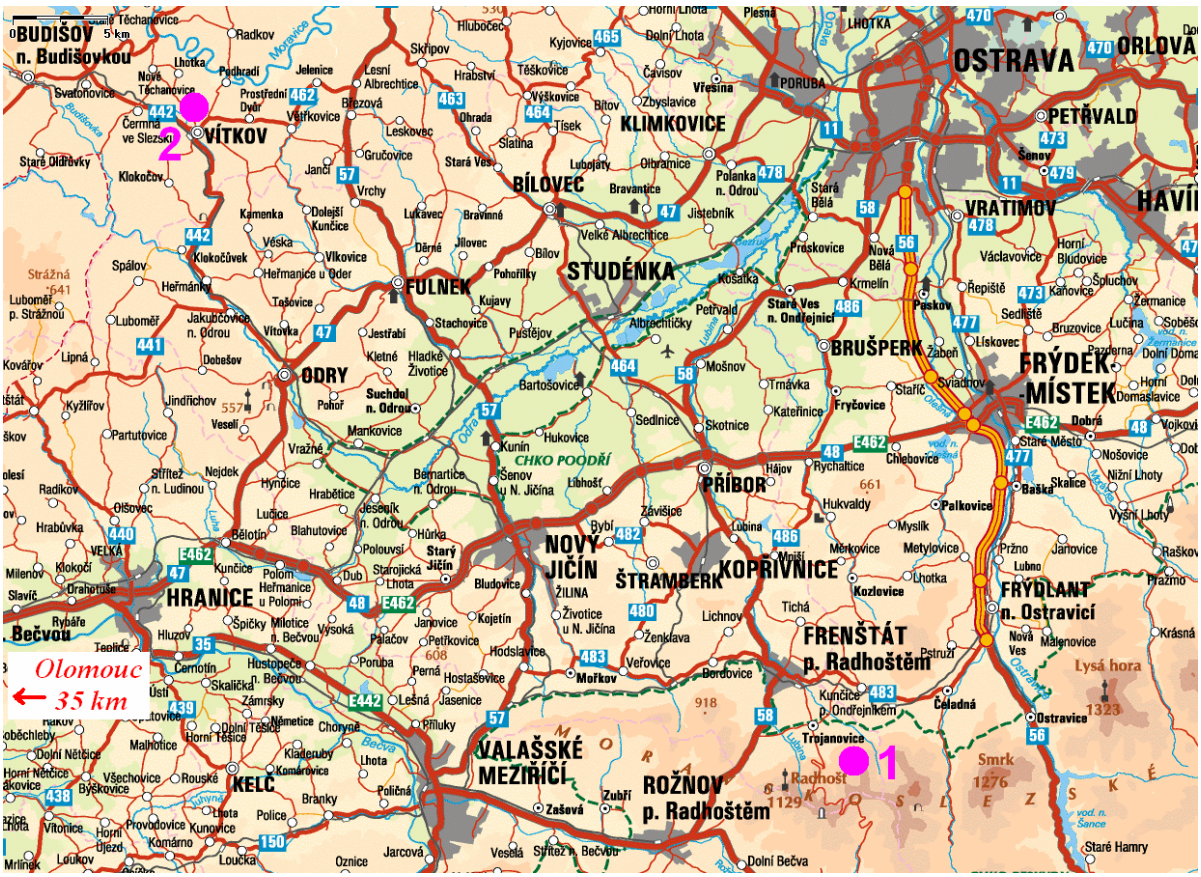
Excursion Guide



Fundamental informations about Forests of the Czech Republic s.e., Head Regional Office in Frýdek – Místek

JAROSLAV ZÁTOPEK

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Forests of the Czech Republik state enterprise (FCR s.e.) plans and carries out silvicultural activities in order to create optimal relation between the fulfillment of all functions of the forests managed by FCR and the market economic environment. For these purposes the enterprise uses the principles of sustainable forests managed by FCR and the market economic environment. For these purposes the enterprise uses the principles of sustainable forest management, which is the ground for a sustained production of quality timber while respecting and developing all other, especially non-wood-producing functions of the forest.

Planning and realization of forestry activities is oriented on securing sustained harmony between the need, the creation and the use of own financial resources and aims at the most economical use of special purpose contributions from the state budget and other resources. The actual business activities of FCR and its organizational structure are constantly being adjusted in accordance with these fundamental principles.

The Regional Head Office of FCR is divided into 11 Forest Districts which manage 77.4 % of the total area of forests in this region. The area of the state forests is 149,450 ha. The highest forest cover is in the mountains of the Hrubý Jeseník Mts. and the Moravian – Silesia Beskydy Mts. The species composition is shifted in favour of conifers (70 – 80%), while broadleaved represents 20 – 30%.

The annual cutting plan represents 1.210 tis. m^3, the annual task of the forest regeneration is about 1,600 ha and the stand tending is about 5500 ha in one year.

The present problem of Northern Moravia forests is high level of salvage cut, especially in Norway spruce stands. The damage is coused mainly by low rainfall and high temperatures in last years. This situation was the main reason for a decision to change the species composition in favour of broadleaves.

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1.

Experimental watershed Malá Ráztoka

Long-term research of water regime in the small, fully forested mountain watersheds. Changes in species composition and way of management

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Experimental watershed Malá **Ráztoka (MR)** is one of the two research objects of the Forestry and Game Management Research Institute, in the region of Moravskoslezské Beskydy. Same as in the other watershed, **Červík (CE),** forestry-hydrological research is ongoing since November 1, 1954, focused on changes of water balance in the small, fully forested basins, connected to the changes of species composition and way of management. Such a long, not interrupted research is unique not only in CR, but also in European scale. Original intention, to influence the hydrological regime by vast and demanding forestry measures was obsolete; today the research is focused on the impact of climatic and anthropogenic changes on forest ecosystems and its elements in mountain conditions. Mainly the existence of long-term time series of measuring data, not interrupted in spite of the political and social changes, is the base, on which the changes and development of all elements of the water balance can be described, and misleading simplifying can be avoided.

During today excursion we will go through the Malá Ráztoka watershed. Excursion will start in an attractive tourist place Pustevny, favourite destination of winter and summer sport activities, and starting point of tours in surrounding mountains. Well known are the tourist bases Maměnka and Libušín, projected by famous architect Dušane Jurkovič, and declared to be the state cultural monument in 1996. Radhošť (1129 m) hill is nearby, with the sculpture and a chapel to St. Cyril and Method in the top. Radhošť is a frequent destination not only for the tourists, but also for Christian pilgrims. On the road to Radhošť there is also well known statue of a pagan good, Radegast, patron of the region. For many he is known also thanks to famous beer of the same name from the nearby brewery in Nošovice.

Experimental watershed **MR (2.07 km^2)** is situated in the north-western slopes of the Beskydy mountains, at the altitude of 602 - 1084 m over the sea level. In 1953 – 1965 the watershed was calibrated, before stand changes, since 1966 the stands were regenerated in strips and a cableway was used for skidding the wood to horizontal forest roads of the density of 41.1 km/ha. Before 1993 about 70% of the area of the watershed was regenerated. During regeneration the species composition in MR was changed – beech was replaced by spruce – to study possible changes in water run-off. Today spruce represents more than a half of trees.

Experimental watershed **CE (1,85 km^2)** is situated in so called Back Mountains of Moravskoslezské Beskydy, over the water dam Šance, at the altitude 640 – 960 m. Watershed is 100% forested, in the calibrating period conifers represented 85 % of the tree species. The watershed CE is naturally divided in two parts, CA (0,88 km^2) and CB (0.84 km^2). For the research purpose the method of the pair basins was selected. Part A was fast regenerated in strips, after 1965, part B was left as a control, with no intentional logging and natural regeneration. In natural species composition spruce was dominating, today beech represents about 1/3 in the stand.

In Malá Ráztoka basin, mature stands of beech were prevailing. Model intention of the research was to change the species composition and to replace beech by spruce. Original goal was to study the changes in water run-off. Stand regeneration realised is to be understand as an experiment, not a practical recommendation. Period of vast clearcuts and prevailing regeneration with spruce, typical in the second half of the last century, is over fortunately, not only in Beskydy, but also in other mountains in CR.

Evaluation of precipitation-runoff relations in the fifty year time series shows, surprisingly, much less significant reaction to regeneration measures, than supposed. Variability of the natural conditions (climatic, soil) is so big that changes caused by regeneration and management measures can be hardly proved statistically. Changes in run-off water during stand regeneration depend mainly on the logging and skidding technologies used. Measures, disturbing significantly the soil surface and causing or speeding up the erosion process are of negative effect. When the favourable physical and chemical characteristics of soil are preserved, also its retention capacity is preserved even during the forest regeneration. In euthropic sites, soon after logging of original stand, herb layer starts to develop, its rooting helps water to infiltrate into the soil and prevents erosion, until this function is again ensured by the young forest stand. In more sensitive way of management (selective, shelterwood) this process can be even more favourable, humus layer is not mineralised and depleted. Representation of beech is important not only for mechanical stability of the stand, but also for the soil state. Beech, thanks to the depth of its root system, is able to bring better the nutrients of the deeper soil horizons back to the element circulation. Beech litterfall, due to calcium amount, effects positively acidification of the upper soil horizon and preserves its favourable state. Thus the impact of the species composition on water balance in the watershed is mostly secondary, through the soil conditions.

The research had proved more significant impact of the species composition on run-off condition, than that of the way of management, experimentally applied within the Červík watershed, where, both before and after the stand regeneration spruce is dominating.

Measuring of the elements of water balance

Precipitation measuring is the base; it is done precisely, using different methods to record the inputs in precipitation-runoff process. In our mountain conditions precipitations often are of very local character, mainly in summer storms the differences can be high even within one small watershed. That is why in each watershed four totalizers are placed permanently, three of them in watershed divide, one down in the valley, in the middle of the watershed. Total precipitation is measured by the Horton polygon method and recalculated for the whole watershed area. Precipitations in time, during the whole warm period, are recorded by pluviographs of week maintenance, which give important information for the analysis of the flood waves. Reliability of measuring is verified by the station precipitation gages. In winter, the height of new snow is measured, total snow cover and its water value.

Since 1998, the two experimental watersheds are equipped with digital data measuring. The measuring device is the sixteen channel registration unit M4016, which is the base, making possible the connection to all current measuring sensors. Communication with the unit is through the communication and evaluating programme MOST, and the newest MOST 32, respective. These programmes make possible to transfer the data to notebook, to state the parameters of measuring and to store the data and their processing in table and graph outputs. The newest type of the unit, in CE, enables also long-distance communication and data reading with use of GSM modem.

In the meteo-stations, rain gages SR02 are used, measuring precisely precipitation intensity even in a short period.

Measuring gutters in the closing profiles of the watersheds

Run-off waters of the watershed are measured in open measuring gutters with limn graph shaft. They are equipped with OTT limn graphs of week interval. The observer records daily, in given time, water level on the scale and water temperature, as a control. In run-off water measuring also digital equipment is used – intelligent ultrasonic probe US 3000, measuring water level in the gutters. Main advantage of this way of measuring is that a short interval of data storing can be fixed, so precise start of the flow gage recorded. Run-off water is evaluated on the base of consumption curves, repeatedly verified. Minimal flow is measured in 50 litre calibrated vessel, placed under the gutters.

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Fig. 1: Air view to MR watershed (Photo: Jan Vondra)

Fig. 2: Winter air view to MR watershed (Photo: Jan Vondra)

Fig. 3: Stand regeneration and change of species composition – beech replaced by spruce

Fig. 4: Tourist bases Maměnka and Libušín, Pustevny.

Fig. 5: Statue of a pagan god Radegast (left) and chappel and statue of St. Cyril and Method in the top of Radhošť (right).

2.

Basic information about Forest District Vítkov

MIROSLAV DUŠEK

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Description of the terrain including some interesting spot heights

The whole area of Forest District (FD) Vítkov is a part of orographic whole called Nízký Jeseník Mts. and of its piece "Vítkov hilly area". The area is a plateau disturbed by brooks and small river streams that have often carved into the terrain forming a canyon shape relief. Typical of this region is above all the Moravice river valley and Odra river valley with its tributary of Budišovka rivulet. The highest elevation point is "Červená hora" (Red Hill), 749 m – meteorological station "Červená u Libavé", the lowest elevation point is "Husí potok" (Goose brook) near Hladké Životice, 244 m.

Administration

The whole area of FDVítkov lies in Moravia-Silesian region, on the territory of three former districts – Opava, Nový Jičín, and Bruntál. According to new organization, the Forest Control comes under the authority of seven districts of administration with extended activity, i. e. Opava, Vítkov, Bílovec, Nový Jičín, Odry, Bruntál, and Ostrava.

Territory extent

The total extent of FD Vítkov is 70,000 ha. The area of "Forest land use territory" that comes directly under the management of Forests of the Czech Republic state enterprise is 11,273 ha. The FD performs the function of Forest Manager Expert (for small private owners) on the territory of 1 769 ha.

Protected areas, genetic bases

FD Vítkov marginally reaches "Poodří" Protected Landscape Area. Within the frame of forests that comes directly under the management of "Forest of the Czech Republic" there are three nature parks, three nature preserves, and genetic base "Suchá Dora" for these tree species: European beech, small-leaved linden, and sycamore maple.

Staff

24 technical-economic workers and 6 manual workers have a permanent employment in Forest District Vítkov.

Tree species composition

There was the following species composition on the FD Vítkov at the beginning of this decennium (2003):

Tree species	**%**	**Tree species**	**%**
Norway spruce	63	European beech	8
European larch	7	Sycamore maple	4
Scots pine	3.5	Small-leaved linden	4
Silver fir	2.2	Sessile oak	2.5
		European hornbeam	2
		European ash	2
		Common alder	1
		others	1
Coniferous total	**76**	**Broadleaved total**	**24**

Artificial regeneration in this decennium according to tree species:

Tree species	**%**	**Tree species**	**%**
Norway spruce	22	European beech	35
European larch	1.6	Sycamore maple	1.8
Scots pine	10.4	Small-leaved linden	1.4
Silver fir	14	Sessile oak	9.4
Douglas fir	0.8	European ash	1.8
		Common alder	1.8
Coniferous total	**48.8**	**Broadleaved total**	**51.2**

Logging operations since the beginning of this decennium

Maximum total cut per decennium (2003 – 2012) according to Forest Management Plan – 915,000 m^3, i. e. 91,500 m3 per year.

Actual state in 2003 - 2007 reached the amount of 710,251 m^3 (95% of whose were salvage cut). There have been annually 40,950 m^3 of planned cut (according to Forest Management Plan) for next five years. However, supposed cut for 2008 is 170,000 m^3, all as salvage cut.

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Decline and consequent dieback of spruce stands in Moravian-Silesian region

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In Moravian-Silesian region the total forest area is 196,894 ha. From that amount 152,521 ha comes under the state ownership and management of the Forest of the Czech Republic (state enterprise) – Administration Frýdek Místek and the rest is in the municipal as well as other subjects' ownership. There are 76% of coniferous and 24% of broadleaved trees in the whole area.

The undermentioned overview shows present area of declining stands. However, it must be mentioned that forest decline is a dynamic and deteriorating process that has been observing here several last years.

- total forest area managed by Forests of the Czech Republic 152,521 ha,
- declining spruce stands 19,020 ha,
- breaking and dying spruce stands 12,649 ha.

From the given numbers it follows that present percentage of affected stands is about 20% from the total area. The property of other owners is affected by the same problems. **Declination and consequent dieback of spruce stands is occurring massively in the areas of 3rd (oak dominated) and 4th (beech dominated) vegetation zone, where spruce is allochthonous tree species.** Affected trees change the colour of needles (from yelow to even brown). Only one or two needle year-classes instead of four or five remain. Trees gradually decline and consequently die.

According to forest research results, spruce stands disintegration is caused by a combination of two main influences: gradual change of climatic conditions, and massive occurrence of *Armillaria ostoyae*. Climatic studies support changes of precipitation amounts and its pattern as well as changes of temperature and sunshine in the period 1961 – 2006 in comparison with long-term average values in 1901 – 1950 and with calculated standard of 1961 – 1990.

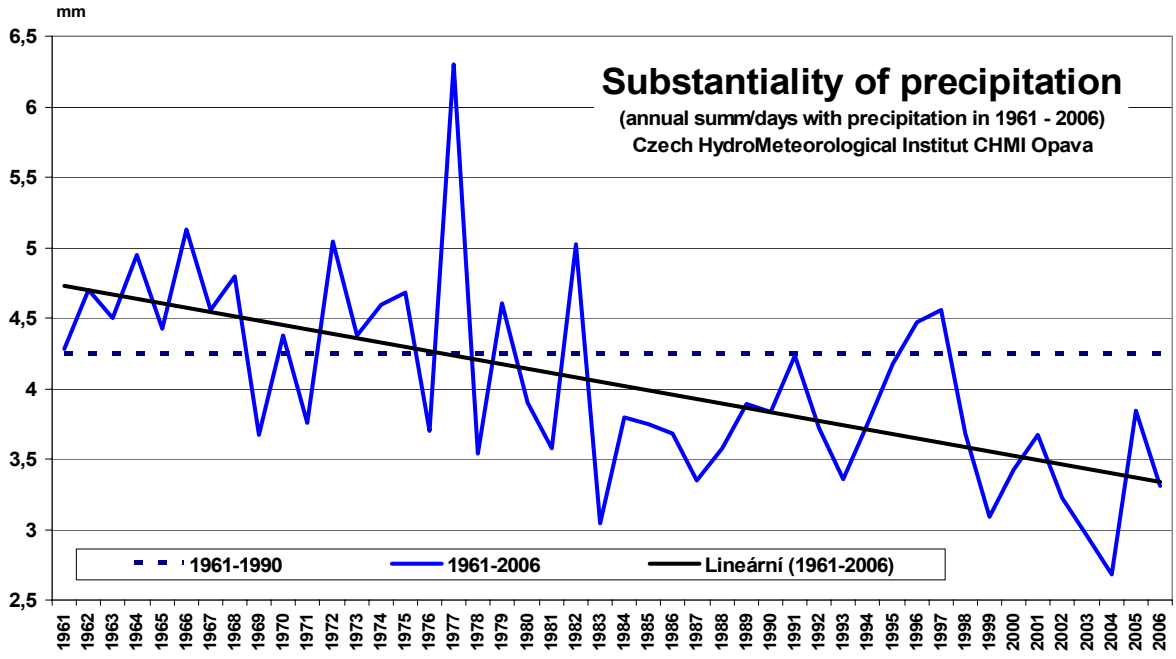
Conclusions of the climate study are:

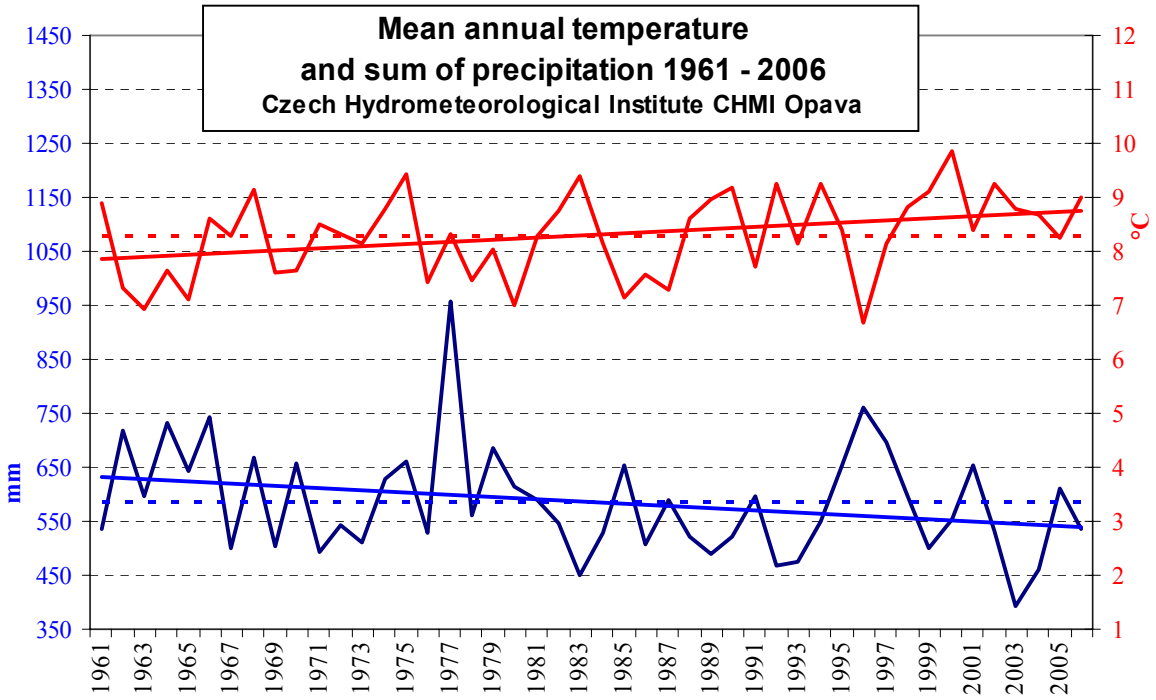
- Growth of average annual temperatures as well as the temperature in the period IV. – IX. (April – September), and especially V. – VIII. (May – August).
- Decreasing of annual precipitation amounts as well as the precipitations in the period IV. – IX. (April – September).
- Changes of precipitation patterns and increasing number of torrential rains with lesser influence on total water balance.
- Significant growth of sunshine in the period IV. – IX. (April – September), and especially in V. and VIII. (May and August).
- Growth (significant) of absolute annual day frequencies with average daily temperature +0°C, +5°C, +8°C, +10°C.
- Growth (significant) of potential evapotranspiration of annual values also in the period IV. – IX. (April – September) and in individual months.
- Occurrence of humidity deficit in all monitored periods.
- Decreasing of humidity balance (a downward tendency) in 1984 – 2006.

In the light of the mentioned facts it is evident that water regime has been gradually changing into the evaporation regime during last 15 years in these areas, which means that atmospheric precipitation value is smaller than evaporation.

The spruce stands vitality has been significantly weakened due to abiotic factors and at the same time biotic agents have widely spread; it is evident that *Armillaria ostoyae* has gained a dominant influence as a primary factor of massive damage occurring across all age classes within a stand as well as in young spruce outplantings and naturally regenerated spruce stands.

Declination and gradual dieback of spruce stands is caused by constant increase and spread of bark beetle population which speeds up the process of decline. Unfortunately, there is no possibility to avert this phenomenon at present time. We can call this situation "ecological disaster with subsequent bark beetle calamity".





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