STSM Report

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Host: Forest Research Institute - Sofia, Bulgarian Academy of Sciences

Topic: ***The effect of coppice management on the tree growth***

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Background

Coppicing is one of the oldest forestry systems which is known from many countries worldwide (FUJIMORI 2001). Coppices were usually used as a source of firewood until the second half of the 19th century (BUCKLEY 1992; PETERKEN 1993). Since then, conversion of coppices to high forests was the principal trend especially in central and north-western Europe (MATTHEWS 1991; PETERKEN 1992), particularly due to a demand for higher-quality timber (HÉDL et al., 2010). Today coppicing remains a common forest management in countries of south-eastern Europe (VELICHKOV et al. 2009; VACIK et al. 2009; MADĚRA et al. 2014), to provide firewood on the local scale. The importance of coppices increases in a field of nature protection (MASON and MACDONALD 2002), and also a natural habitat for the reproduction and life of birds (FULLER 1992), small mammals (GURNELL et al. 1992) and invertebrates (GREATOREX-DAVIS and MARRS 1992; SPITZER et al. 2008). Nowadays, with the growing interest in biomass as energy alternative there is a growing interest about coppicing. The potential renewal of coppicing can be seen in the countries of central and western Europe (MATULA et al. 2012; ŠPLÍCHALOVÁ et al. 2012).

This study is focused on the effect of active coppicing on individual tree growth in Bulgaria where many forests have been managed as active coppices for centuries. There was also survey of forest structure and analyse of soil quality done by measuring of the content of macroelements in both active and abandoned coppices. By using the data on soil properties and tree growth from active and long-time abandoned coppices from the same site, were tested the hypothesis: (1) active coppicing affects soil chemistry as well as (2) boosts individual tree growth.

Problem outline

The knowledge about growth dynamics of active coppices in respect to the high forest or a abandoned coppices has the same importance as e.g. information about the effect of coppicing on sites, especially when we are thinking about coppicing as an alternative of short-rotation coppices and as a renewable energy source. BÜHLER (1922) mentions the differences in mean annual growth are indistinctive between high and low forests (i.e. coppice), although the quality of the site plays an important role. In contrast to this finding VYSKOT (1978) reported much faster growth of coppice in comparison to generative forest.

Focus of the study

The goals of study were testing of two fundamental hypotheses: *i*) active coppicing affects boosts of individual tree growth, *ii*) soil nutrients, DBH and exposure are the main variables of coppices growth dynamic.

To test these hypotheses there was necessary to answer two issues:

1) What is the difference in the tree growth between active coppice and abandoned coppice/high forest?

2) Which variables affect the growth dynamic depending on the forest management?

Methods and material

Studied locality

The study was conducted in the forest stands close the villages Gorna Malina nad Baylovo, cadastre Sofia (Fig. 1). The research forest stands are localized between 23°41'49'' - 23°43'04''E and 42°40'59'' - 42°40'35''N (Gorna Malina), 41°09'15'' and 23°48'22'' - 23°51'41''E and 42°40'14'' - 42°39'21''N (Fig. 2) with the altitude ranging between 400 – 700 m ASL.

Fig 1. Localization of the studied area

The average annual rainfall is 700mm; the average annual air temperature is 9.5 °C. Geological subsoil is composed of shale siltstone. The main type of soils is cambisol.

Predominant species in the forest are Turkey oak (*Quercus cerris* L.), Italian oak (*Quercus frainetto* Ten.), Sessile oak (*Quercus petraea* Matusch.), European hornbeam (*Carpinus betulus* L.).

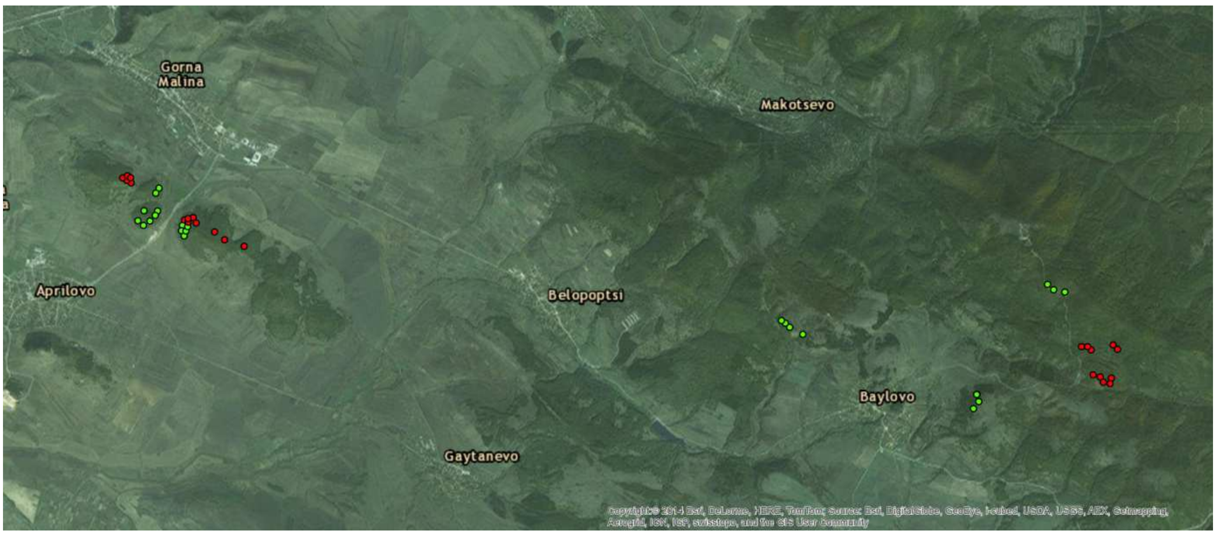

Fig. 2 Research plots. Green points – active coppice, red points – abandoned coppices/high forest

Clear-felling management with rotation time between 20 – 40 years has been used on the studied active coppices during last 100 years. The abandoned coppices were managed in the same way but have not been affected by any kind of management activities for approx. 80 years.

Research plots

The design of the research plots was projected by stratified sampling. In total 46 research plots were selected and measured by Field-Map technology (www.fieldmap.cz) in the past (Tab. 1). Distance between research plots was at least 60m. Unbalanced numbers of selected plots were caused by small number of suitable forest stands within the same site.

Tab. 1Table of research plots by the prevailing exposure.

Type of coppice	Exposure	
	South	North
Active coppice	14	10
Abandoned coppice	10	12

Data collection in the research area

The stand structure was studied in circular plots with radius 9 m by using the Field-Map technology (laser distance meter, compass, resistant tablet, monopod, and Field-Map Data Collector software) (IFER, Ltd., Jílové u Prahy, Czech Republic).

Samples of cores were collected for *Quercus* species. On each plot, cores were collected from three selected polycormons (cores were taken from biggest, middle and smaller sprout of the each polycormon). Cores were collected from abandoned coppices/high forest of the three trees with the greatest DBH on the each plot too. The wood cores were taken in the perpendicular direction to the slope in order to eliminate any bias of the results due to potential presence of reaction wood using Pressler's increment borer.

Soil samples were collected at 3 places of each plot from the A horizont – organic and mineral horizon (approx. 10cm layer under the litter) and averaged. Total of the 138 samples of soil were taken. Essential soil macroelements (Ca, K, Mg, P, Na, N total, oxidized carbon – Cox) and the soil reaction (pH_{KCl}) were analysed according to the methodology of Melich II (Zbíral 2002).

Data evaluation

The wood samples will be measured by using a VIAS TimeTable measuring system. The measurement and synchronization of the tree-ring series will be performed in PAST4 (Knibbe, 2004). Annual increments were measured with an accuracy of 0.01 mm.

Soil analysis were evaluated by the Manual of methods for soil and land evaluation (Constatini 2009), and calculated the C:N ratio. Potentially exchangeable soil reaction (pH_{KCL}) was primarily used to evaluate the soil pH value which is more stable compare to active soil reaction (pH_{H2O}) that shows considerable variability, for example, due to weather conditions.

The effect of growth dynamics and differences in soil chemistry will be analysed by using general linear models (OLS).

The data of soil will be used as dependent variables for testing the effect of the forest structure (active / abandoned coppice) on soil chemistry: pH_{KCL}, Ca, K, Mg, P, Na, N – total, Cox, C:N.

To test the connection between soil characteristic and forest structure there will be calculation of mean radial growth (using last 10 tree rings). Mean growth rate will be used as the dependent variable in OLS, while following ones as an independent variables: (1) For plots: The content of N, P, Na, K, Ca, Mg, pH, forest type, BA, aspect; (2) For the tree individuals: Stem age. Those variables will be analysed separately including also an interaction effect with bedrock type (limestone bedrock, neutral bedrock). There will be used usual level of significance α = 0.05. All analyses will be carried out in the R environment (R Core Team, 2013).

Results

In total 248 samples of wood core were taken. Samples of wood core will be processed at the appropriate time due to the time consuming of processing. Results will be written in an article after that. The results of the studies will be used for a conference paper or an article in an international peer-review journal. The idea is to add this data to the data from Eastern Europe countries which were studied in the past. In this context we can also answer two issues: 1) What is the difference in the tree growth between active coppice and abandoned coppice/high forest? 2) Which variables have effect on the growth dynamic depending on the forest management? Partial results of study on the stand structure and soils chemistry are below.

Stand structure

The age of trees in abandoned coppices is ranged between 70 and 90 years while the oldest stems within active coppice of plots on slopes were 15–50 years old (preliminary data). Characteristics of the coppice structure in the studied area are shown in the Table 2. Differences between the active and abandoned coppices are evident in all characteristics, e.g. basal area (BA) in active coppice reaches 86% of BA of abandoned coppices. Mean BA per polycormon was 0.04 m2. Mean DBH of the active coppice was 23% of the mean DBH for abandoned coppice. Mean height of active coppice stands was 34% of the mean height of abandoned coppices.

Tab. 2 Forest structure characteristics

Forest form of coppice	Age (yr)	Ø DBH (cm)	Mean height (m)	BA ($m^2.ha^{-1}$)	Number of stems Σ ($stems.ha^{-1}$)	Number of stems generative ($stems.ha^{-1}$)	Number of stems vegetative ($stems.ha^{-1}$)	Average of stems per 1 polycormon (indd)
Abandoned	70-90	23.9±11.1	13.0±4.0	24.04	1729	880	849	1.3±0.9
Active	15-50	5.5±0.9	4.5±0.9	20.7	3350	823	2527	2.7±0.7

DBH – diameter at breast height; BA – basal area; ± SD – standard deviation

Soil chemistry

The analysis of the effect of forest form of coppices on the nutrient contents in soils showed significant differences in average values of all studied nutrients in the Baylovo area (Fig. 3) except sodium content. These elements showed higher values in the active coppice forests in the Baylovo area compared abandoned coppice. There was not found similar trend in the Gorna Malina area (Fig 4).

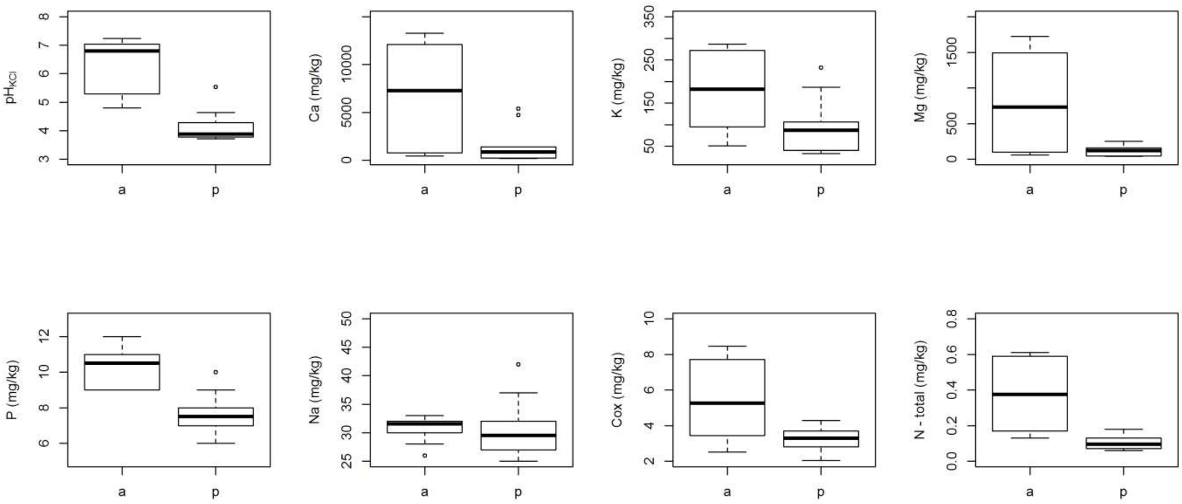

Fig. 3 Box plots of differences in soil chemistry for the forest form of coppice in the Baylovo area. (a) active coppice, (p) abandoned coppice

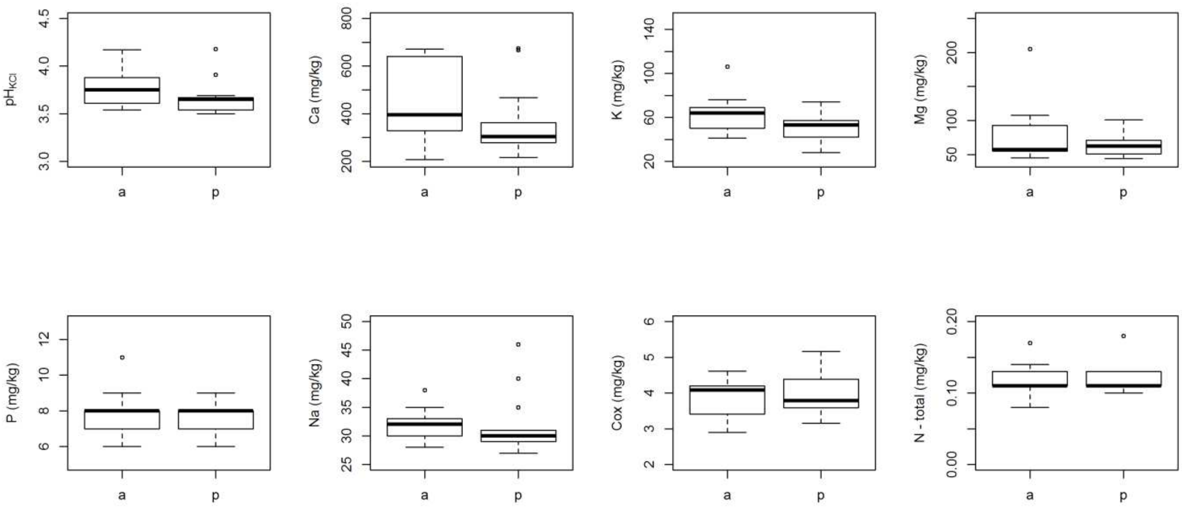

Fig. 4 Box plots of differences in soil chemistry for the forest form of coppice in the Gorna Malina area. (a) active coppice, (p) abandoned coppice

Future collaboration with the host institution

This STSM improved already existing partnership between Forest Research Institute in Sofia and Mendel University in Brno, therefore other collaborations can be expected for a study and publishing of the coppice topics in the next future.

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