STSM Report

Detecting drought traces in the wood structure of contrasting European beech provenances

COST Action: FP1106
COST STSM Reference Number: COST-STSM-FP1106-12371
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Period: 3/2/2013 – 9/3/2013

❖ Purpose of the STSM

The expected climatic changes with increasing in the frequency and duration of intense summer droughts (IPCC, 2007), will negatively affect beech, which is known to be sensitive to drought (Rose et al., 2009). Thus, the future survival and sustainability of European beech ecosystems in Europe has become of great concern. Therefor, knowledge on the capability of trees to cope with and adapt to stress is of crucial importance to predict future performance of beech trees and forests.

Summer drought influences several growth features of plant species such as xylem anatomy and radial growth (Villar-Salvador et al., 1997). For instance, a decrease in the mean diameter of the vessels has been associated with a reduction of water availability in the soil (Zhang et al. 1992). In that sense, the main objective of STSM was to investigate variability of wood anatomical structure in relation to drought stress in different European beech provenances. Visiting of DendroLab at Wageningen University provided me opportunity to learn techniques regarding wood anatomical and dendrochronological measurements (i.e. measurement and analyses of tree-ring width, vessel size and vessel density, etc.) and applied it to beech trees originating from Serbian provenance trials to study climate-growth relationships and assess sensitivity of drought in selected provenances.

❖ **Description of the work carried out during the STSM**

Activities carried out during the STSM could be separated into several phases:

- Collecting of samples on the field,
- Preparation of samples and measurements of tree ring width,
- Additional preparation of samples for anatomical measurements,
- Measurements of anatomical structure within tree rings,
- Processing of obtained data.

Collecting of samples was carried out in the European beech provenance trial located at the Fruška Gora Mountain, in the Northern part of Serbia (Figure 1). Provenance trial was established in the spring of 2007 in the framework of COST Action E52: "Evaluation of Beech Genetic Resources for Sustainable Forestry".

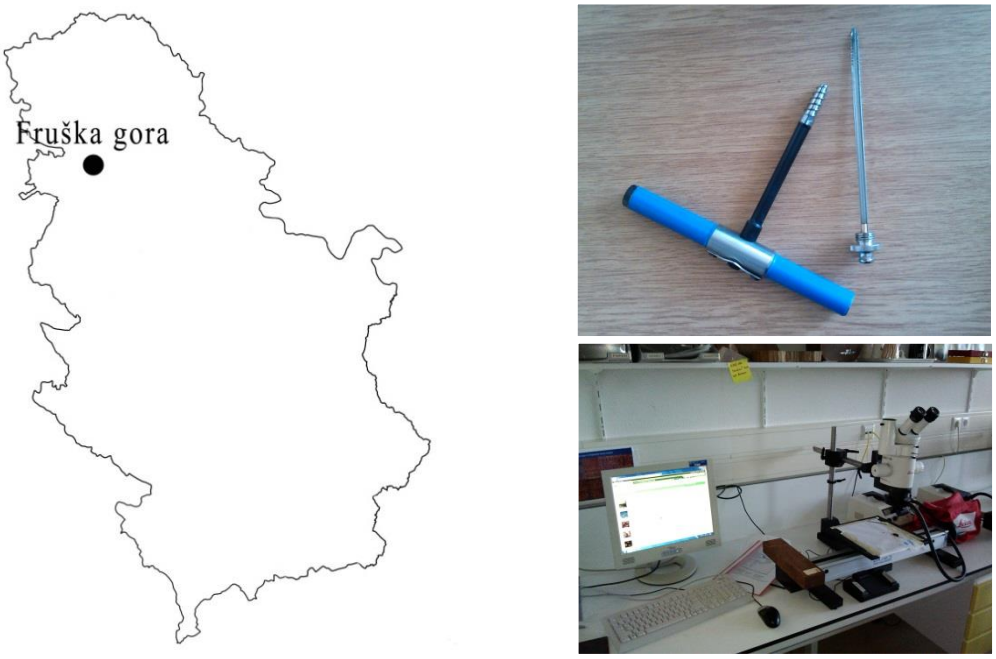

Figure 1. Locality of European beech provenance trial and equipment used for sampling of cores and measurement of tree ring width.

Study involved four different provenances (one from Croatia and Serbia, and two from Germany), covering gradient of climate and stand conditions from the north to the south of Europe (Figure 2). Cores were taken from five genotypes within each of provenance, from the zone of root collar.

Preparation of samples for tree rings analysis was done in the Dendro Lab of Wageningen University, using a core microtome (WSL, Switzerland). Analysis of tree ring width was performed using a combination of a Lintab digital positioning table and the software TSAP-Win (both Rinntech, Germany).

After the analysis of tree ring width was completed thin sections were made for the measurement of anatomical structures. Thin sections with a thickness of 20 μm were prepared using a sliding microtome (WSL, Switzerland). To increase the contrast between the cell walls and the cell lumina thin sections were stained using an alloy of safranine O and astra-blue.

Subsequently the sections were dehydrated in an alcohol concentration gradient (50%, 95% and absolute ethanol), then in Roticlear and permanently fixed with Roti-Mount. Air bubbles were removed placing an additional weight on each slide and left for 2-3 days.

Figure 2. Provenances involved in study.

Taking of photos of thin sections was done using light microscope „Leica“ and the software „LAS V3.8 (Leica Application Suite)“. In order to stitched singe photos altogether I used the software „Autostitch“.

Analysis and measurements of samples were performed with the software „ImageJ“ (http://rsb.info.nih.gov/ij/). Measurements were going through the three stages (Figure 3):

1. definition of region of interest within the each of tree ring,
2. transformation of color photo into binary photo,
3. measurement of vessel area, number of vessel per area and percentage of potentialy water conducted area.

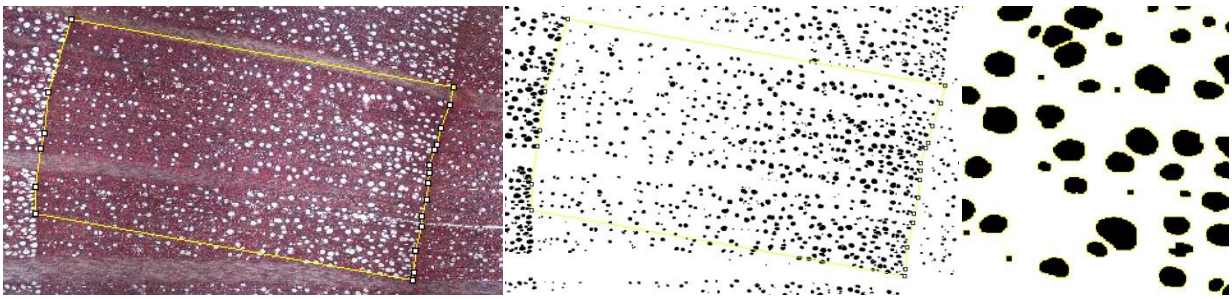

Figure 3. Stages in the analysis of wood anatomy, using „ImageJ“ program.

In order to process raw date of measurements, Excel 2010 and Statistica 12 were used.

❖ Description of the main results obtained

Provenance trial is established in spring of 2007, as it is mentioned already. Within the referent period (2007-2012), climate occurences were quiet contrasting in different years. For defining of dry years we have adopted the definition of De Martonne. Based on the index values, climate during observed period varied between „semiarid“ (yr 2008, yr 2011 and yr 2012) and „humid“ (yr 2010). 2007 and 2009 were „moderately humid“ years.

Regarding measurement of tree ring width it should be highlighted that before the provenance trial was established, beech seedlings were cultivated in nursery. From that reason, plants were suffering of transplanting shock in the first years after re-planting. Short tree ring chronology due to plant age and pronaunced transplanting shock, made it difficult to found relationship between growth and climate variables.

Generally, at this early stage, the diameter increment does not reflect full growth potential of genotype and the effect of the local environment on the genotype. According to von Wuehlisch (2004), the main effects on plant growth in this stage has how the plants took root and how they overcame the planting shock. Therefore it is too early to reach a conclusion regarding provenance potential.

In regards of wood anatomical structure, during the STSM we investigated next parameters: vessels area, number of vessel per area and percentage of potentialy water conducted area. All measurement were carried out within each of tree ring. Correlation analysis revealed statisticaly significant ($p<0.05$) relationship between tree ring width, on one side, and mean vessels area and number of vessel per area, on the other, in all provenances.

❖ Future collaboration with the host institution

During the STSM it was expressed mutual interest in continuing of cooperation. Because the researches in the field of dendrochronology and wood anatomy are not developed in the Institute of Lowland Forestry and Environment, we recognized Wageningen University as the partner which could help us to improve these fields of researche. Thus we could conduct mutual researches in the climate conditions of Netherlands and Serbia. Also, we are interested in sharing of plant material in order to establish trials in which we could investigate plant respons to climate conditions different of those on the place of origin.

❖ Projected publications to result from the STSM

At the moment we are preparing a manuscript based on the the results of this STSM which will be submitted to the IAWA Journal.

❖ Confirmation by the host institution of the successful execution of the STSM

The confirmation letter by the host institution of successful execution of the STSM is enclosed in the separate file.

❖ References

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