Identification of extreme events with the examination of Intra-Annual Density Fluctuation

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Purpose of the STSM

The main purpose of my STSM was to analyze the Scots pine (*Pinus sylvestris*) samples I have taken earlier in Hungary to examine the relationship between the climatic conditions and the tree ring growth. Parallel to this, I wanted to acquire a good basic knowledge of the methods of IADF investigations to ideintify the extreme events in my samples. I also wanted to get new ideas on wood anatomy and dendrochronology to improve the quality of my PhD work.

My work in Slovenia was supervised by Prof. Dr. Katarina Čufar and by the members of her team, Dr. Maks Merela and Luka Krze in the Dendrochronological Laboratory at the Department of Wood Science and Technology, Biotechnical Faculty, University of Ljubljana.

Description of the work carried out during the STSM

The samples I brought to Ljubljana were taken from the breast height of Scots pine (*Pinus sylvestris*) trees in the Bakony Mts, Hungary, during two sampling periods (1st: in 2010, 29 trees, 1 sample/tree; 2nd: in 2013, 18 trees, 2 samples/tree). In Ljubljana we sanded the 65 *Pinus sylvestris* cores with 8 different sandpapers to make the tree-ring boundaries as visible as it was possible. The measurements of the tree-ring widths were done with LINTAB

5 Measurement Station in 0,01 mm precision, from the pitch to the bark in two phases: in the first one I measured the whole tree-ring widths (TRW) and later, in the second phase I measured the earlywood (EW) and the latewood (LW) widths separately (Fig. 1).

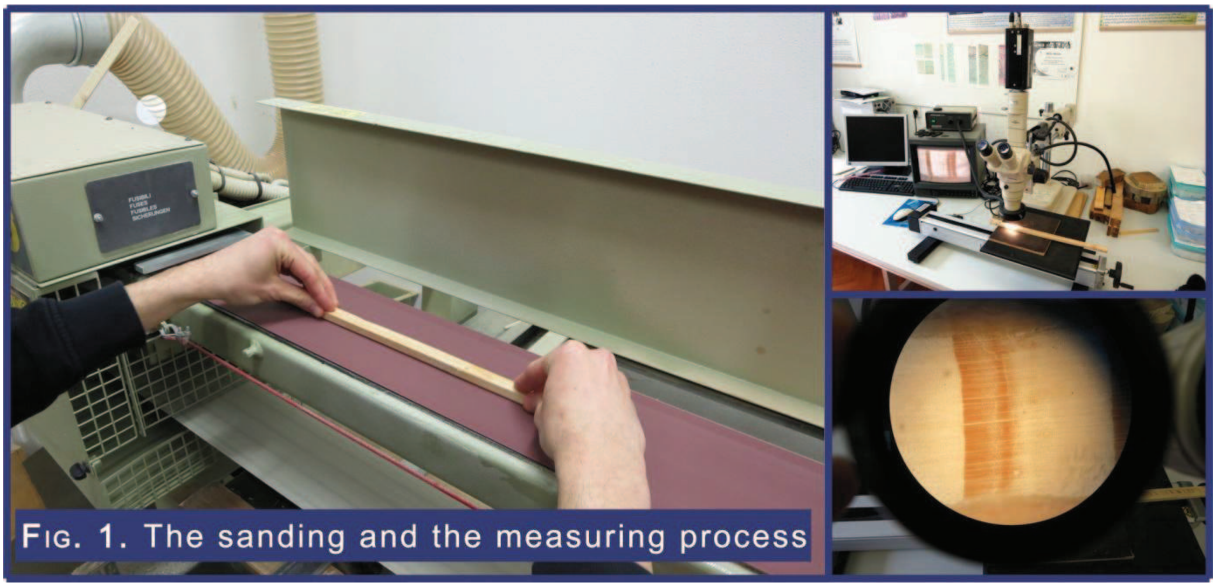

FIG. 1. The sanding and the measuring process

In total 4281 rings were measured to build a 179 years long chronology. The visual cross-dating was done by TSAPX, the series intercorrelation, the missing ring identification and the detection of possible dating errors were also checked by COFECHA. To remove the non-climatic trend from the tree-ring series I calculated different versions of the standardized chronologies by using program ARSTAN.

In the second part of my stay, IADF (Intra Annual Density Fluctuation) investigations were done. To this purpose, every dated tree-ring was inspected and arranged into one of three groups according to the cell structure: (a) *normal rings* with gradual transition from earlywood to latewood, (b) *L-rings* with earlywood-like cells in latewood and (c) *E-rings* with latewood-like cells in earlywood (CAMPELO ET AL, 2006) (Fig. 2). To calculate the frequency of IADFs per year I used the following formula:

$$F = \frac{N}{n}$$

where N is the number of tree-rings that present the same type of IADF in a given year and n is the number of observed tree-rings. To avoid the bias in the frequency variance what is generated by the changing sample depth (n) over the time I used the adjustment proposed by OSBORN ET AL. (1997) to improve the stability:

$$f = Fn^{0.5}$$

where *f* is the stabilized IADF frequency. All the observed results were evaluated in a data table.

DESCRIPTION OF THE MAIN RESULTS OBTAINED

First I tested the standardized tree-ring values against the climatic data. Unfortunately we did not dispose with a long enough climatic instrumental dataset for the sampling area so I used the data from the CRU TS 1.2 database (MITCHELL ET AL. 2004) with monthly total precipitation and monthly mean temperature values. According to the results the July precipitation has the biggest effect on TRW but the June precipitation has significant affect as well. The temperature seems to have a secondary role with a maximal correlation value for August. Using LW data helped me to observe even better correlation between the LW series and climate than in the case of TRW. Summer (especially July) precipitaiton has a big effect on latewood variation and correspondingly to the TRW results, whereas the temperature has less impact. Due to lack of symilaritry the EW series could not be adequately cross-dated and the EW values did not prove to be suitable to reconstruct the climatic effect on their variation: although their correlation to the precipitation and the temperature data was significant, it was much lower than in the case of the earlier indices.

TABLE 1. Statistical values of the three chronologies

	r	EPS	Rbar
TRW	0.651	0.92	0.45
LW	0.679	0.95	0.51
EW	0.617	0.9	0.36

These reasults are giving reason to concern about the future of the pines in the investigated area, because in the most significant period for tree-ring variation (summer) the precipitation has constantly decreased in the last 50 years. In addition to reduced precipitation the trees are under stress beacuse they grow on sandy soil where ground water level is low.

The 16% of the total amount of the tree-rings contained IADFs. The frequency of L-rings was considerably higher than the frequency of E-rings. Since the distribution of the IADFs did not always seem to be clearly connected to the climatic conditions of the given years the reasons of their formation should be investigated. It is supposed that the high temperature in the last month of spring and in the first month of summer as well as the low precipitation in the mid summer are related to the formation of IADFs. But the story can be even more complicated: from 1980 through about 20 years there was an active bauxite mining in the area with a huge effect on the tree growth due to pollution. It is clearly visible in my results that during the mining period the correlation between the tree-ring indices and the July precipitation (as I mentioned before, this is the main factor in the normal tree-ring formation) considerably decreased from r=~0.6-0.7 to zero or even to negative range what means that in this period another stress (probably connected to the bauxite mining) had bigger influence on tree-ring growth than the climatic conditions.

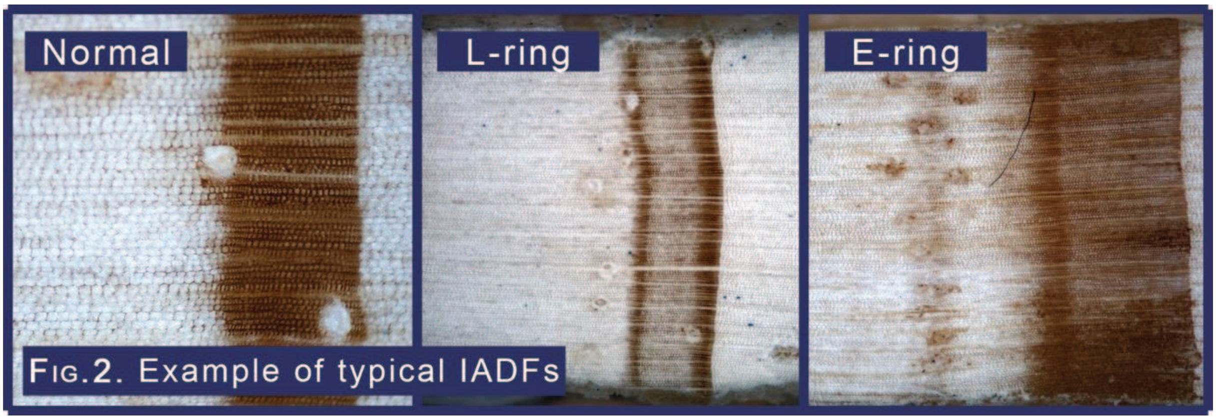

FIG.2. Example of typical IADFs

To sum up I can say that I successfully analyzed the relationship between the main climatic factors and the tree-ring growth but because of the complexity of the area's background I have to continue the IADF investigations with a special emphasis on factors which could affect their formation.

DESCRIPTION ABOUT HOW THE RESULTS CONTRIBUTE TO THE ACTION AIMS

When all the further investigations will be done the results of the STSM will be contributed to the main aims of COST action FP1106 STREeSS, Working groups (I) to establish a platform to survey and integrate information about stress response to extreme events on tree growth, wood anatomy, and ecophysiology and laboratory experiments, and (III) to help identifying the existing knowledge gaps on tree response to environmental stress. Because of the special conditions of the study area and the relatively small amount of tree-ring investigations in Hungary the IADF results will provide new data to the topic group TG 5 - Intra-annual density fluctuations.

The collected data and eventual publications will contribute to progress of COST FP1106 STReESS.

ACKNOWLEDGEMENT

I want to thank to the STReESS COST Action for giving me the opportunity to work in Ljubljana for three months. During this time I have learned a lot and I had the chance to use equipment which is not availably at my home university. I am very glad that I could meet with Prof. Dr. Katarina Čufar and her team. With their help I could learn a lot and I can use the new knowledge at home institution where I am preparing a PhD thesis..

AUTHORIZATION TO POST THE REPORT AT THE ACTION WEBSITE

I authorize to post this report at the Action website.

CONFIRMATION BY THE HOST INSTITUTION OF THE SUCCESSFUL EXECUTION OF THE STSM

The confirmaton letter by the host institution has been attached to the end of this report.

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