EURODENDRO 2015

International Scientific Conference on Dendrochronology

Climate and Human History in the Mediterranean Basin

Book of Abstracts

Edited by
Ünal Akkemik

18 - 23 October 2015
Antalya - Turkey

Pinus brutia (Photo: Ü.Akkemik)

Preface

EuroDendro meetings, started by Dr. Dieter Eckstein, is one of the most powerful dendro-platforms having the recent advances of tree-ring research and related subjects. Each of the EuroDendro meetings had a leitmotif in any subject of dendro works. The leitmotif of EuroDendro 2015 is "Dendrochronology for the Study of Climate and Human History in the Mediterranean Basin". Together with these subjects, papers of all fields of tree-ring studies, anatomy and physiology of tree rings are included.

In this eighteenth Eurodendro meeting, 77 participants from 21 countries were attended, and performed a total of 34 oral presentations, and 51 posters. The presentations were grouped as dendrochronology, dendroclimatology, wood anatomy, dendroecology, model-based methodology and dendrogeomorphology. With these presentations we w shared new results and techniques during the scientific sessions.

We, organzing committee also invited keynote speakers to this conference. Four keynote speakers shared valuable information with us. Dr. Eckstein told about history of eurodendro meetings, Dr. Kuniholm shared the results of 42 years in dendroarchaeology, Dr. Dalfes provided a summary of dendroclimatology in the Eastern Mediterranean Basin and Dr. Guiot told us about model-based methodologies. These presentations provided a scientific framework for the conference, which was enriched with all oral and poster presentations.

During conference the hotel provided a comfortable environment for work and fun with its all-inclusive concept.

We, organizing committee, would like to thank all of participants, our sponsors, namely, Forestry Association of Turkey, Rinntech, Regent Instruments, IML Instruments, and Baytekin for their sponsorships, and our students for their kind help.

Ünal Akkemik

Juniperus excelsa from central Anatolia (Photo: Ü. Akkemik)

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1857

An old inn (Balkapanı Inn) from central Anatolia dated to 1488 AD (Ü. Akkemik)

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An oak wood dated to 1892 AD (Ü. Akkemik)

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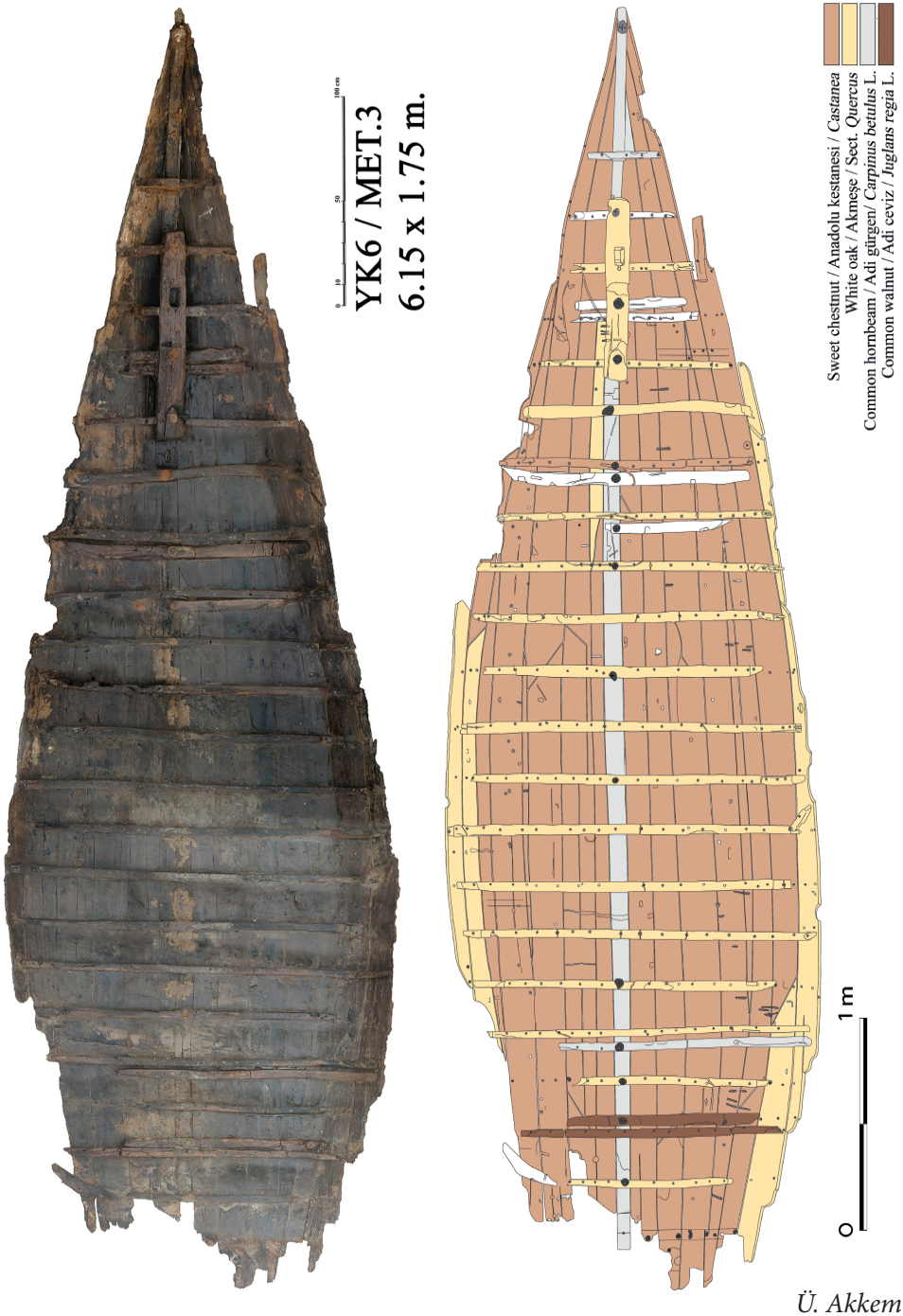
Dendroecology



Ü. Akkemik

A Byzantine merchantman from 10-11th centuries of Istanbul (Yenikapı 6)

EuroDendro 2015 Program

October 18th, 2015		
9.00-22.30	Arriving to the Hotel	
14.00-23.00	Registration	
22.00-22.30	Welcome cocktail	
October 19th, 2015		
9.00-9.10	**Ünal Akkemik**	Opening of the Conference
9.10-10.10	**Dieter Eckstein**	EuroDendro Conference – its origin and spirit
10.10-11.10	**Peter I. Kuniholm**	Aegean Dendrochronology Project: Results of 40-year study
11.10-11.30	**Coffee break**	
Session 1: Dendrochronology *(Chair: Peter I. Kuniholm)*		
11.30-11.50	Tomasz Wazny, Peter I. Kuniholm, Charlotte Pearson	Can dendrochronology solve the Santorini/Thera question?
11.50-12.10	Charlotte Pearson, Tomasz Wazny, Peter I. Kuniholm	Tree-Rings and the Lost Harbor of Constantinople
12.10-12.30	Otto Cichocki, Bernhard Knibbe, Isabella Tillich	SCIEM 2000 - Cedar dendrochronology in the Near East
12.30-14.30	**Lunch**	
Session 2: Dendrochronology - Dendroclimatology *(Chair: Dieter Eckstein)*		
14.30-14.50	**Katarina Čufar**, Michael Grabner, Willy Tegel, Tomasz Wazny, Maks Merela, Anton Velušček, Dieter Eckstein	Dendrochronology in SE Europe – filling the gaps in oak tree-ring network
14.50-15.10	**Insa Alice Lorenz**, Oliver Nelle, Joachim Schultze, Sigrid Wrobel, Vincent Mom, André Billamboz	Medieval woodland and its use in the Schleswig isthmus, Northern Germany
15.10-15.30	**Coffee break**	

Session 3: Poster presentations

(The list of the posters, which will be presented in this session, are given in the Table of Content)

(Chair: Tomasz Wazny)

15.30-17.30	Poster presentations	
17.30-18.30	Poster session	
19.30-21.00	**Dinner**	

October 20th, 2015

Session 4: Dendroclimatology

(Chair: Otto Cichocki)

9.20-10.00	**H. Nüzhet Dalfes**	Climate and dendroclimatology in the eastern Mediterranean Basin
10.00-10.20	Kirill N. Dyakonov, **Alexey Ju. Retejum**	Dendroindication of the Planets-Induced Climate Anomalies
10.20-10.40	**Malgorzata Danek**, Monika Chuchro, Adam Walanus	Climatic signal in larch (*Larix decidua* Mill.) from low and medium altitudes of Carpathian and Sudetes Mountains
10.40-11.00	**Coffee break**	

Session 5: Dendroclimatology

(Chair: Kambiz Portahmasi)

11.00-11.20	**Václav Treml**, Tereza Ponocná, Barbara Czajka, Ryszard Kaczka, Ulf Büntgen	Growth trends and climate responses of Norway spruce along elevational gradients in East-Central Europe
11.20-11.40	**Dario Martin-Benito**, Caroline Ummenhofer, Nesibe Köse, Tuncay Güner, Neil Pederson	May-June precipitation variability in the Caucasus for the last 250 years reconstructed from tree rings
12.00-14.00	**Lunch**	

Session 6: Model-based methodology

(Chair: H. Nüzhet Dalfes)

14.00-14.40	**Joël Guiot**, G. GeaIzquierdo, E. Boucher, A. Nicault	Modeling climate impacts on tree-growth in dendrochronology
14.40-15.00	**Guillermo Gea-Izquierdo**, Joël Guiot	Process-based modelling of forest performance under climate change and rising CO2: a process-based approach using multiproxy data
15.00-15.20	Ivan Tychkov, Margarita Popkova, **Vladimir Shishov**	VS-oscilloscope: New tool of dendrochronological modeling.
15.20-15.40	**Coffee break**	

Session 7: Wood anatomy and tree rings (*Chair: Holger Gärtner)*		
15.40-16.00	**Ana Stritih**, Georg von Arx, Patrik Fonti, Christof Bigler, Dario Martin-Benito	Inter- and intra-annual xylem variability of Fagus orientalis from Northeastern Turkey
16.00-16.20	**Margarita Popkova**, Marina Bryukhanova, Ivan Tychkov, Vladimir Shishov	Modified approach of cambial activity simulation in tree rings
16.20-16.40	**Kambiz Pourtahmasi**, Elham Elzami, Sirous Nasiri, Reza Oladi, Achim Bräuning, Mehdi Nadi	The effect of intra-annual changes in rainfall pattern on Wood formation of Beech and Oak in Caspian forests, Iran
16.40-17.00	**Bilgin İçel,** Gürcan Güler, Abdullah Sütçü	Can resistograph be used as a practical tool for the annual ring measurement of pines?
17.20-17.20	**Coffee break**	
Session 8: Poster presentations **(The list of the posters, which will be presented in this session, are given in the Table of Content)** *(Chair: Nesibe Köse)*		
17.20-18.40	Poster presentations	
18.40-19.30	Poster session	
19.30-22.00	**Dinner**	
October 21th, 2015		
8.30-15.00	Elmalı Cedar Forest	
15.00-18.00	Arykanda Antique City	
19.30-22.00	**Dinner**	
October 22th, 2015		
Session 9: Wood anatomy, wood formation *(Chair: Katarina Čufar)*		
9.00-9.20	**Holger Gärtner**, Alexander Bast	Maximum Latewood Density - X-ray densitometry vs Cell based density
9.20-9.40	**Patrick Fonti** and,~ 30 data cont.	Collecting tracheid anatomical data:
9.40-10.00	**Sofia Leal**, Joana Vieira, José Cerca de Oliveira, Jožica Gričar, Inês Chaves, Célia Miguel	A proteomic approach to the study of the phenology of cambial activity in *Larix decidua*
10.00-10.20	**Dominika Wrońska-Wałach**, Sobucki Mateusz, Gorczyca Elżbieta , Buchwał Agata, Korpak Joanna, Wałdykowski Piotr	Experimental exposure of spruce (Pice abies L. Karst.) roots
10.20-10.40	**Coffee break**	

Session 10: Wood anatomy - Dendroecology *(Chair: Patrick Fonti)*		
10.40-11.00	**Daniela Diaconu**, Hans-Peter Kahle, Heinrich Spiecker	Plasticity of European beech vessels in response to thinning and climate
11.00-11.20	**Marina Bryukhanova**, Valentina Fakhrutdinova, Georg von Arx, Patrick Fonti	Species plasticity to extreme weather conditions in permafrost zone of Central Siberia
11.20-11.40	**Negar Rezaei**, Ettore D'Andrea, Jozica Gricar, Giorgio Matteucci	Factors controlling wood formation dynamics in a Mediterranean beech forest
11.40-12.00	**Joana Vieira**, Filipe Campelo, Segio Rossi, Ana Carvalho, Helena Freitas3, Cristina Nabais	Adjustment capacity of maritime pine cambial activity in drought-prone environments
12.00-14.00	**Lunch**	
Session 11: Dendroecology *(Chair: Kurt Nicolussi)*		
14.00-14.20	**Alexander V. Kirdyanov,** Vladimir S. Myglan, Alexey I. Fertikov, Anna V. Taynik, Vladimir V. Shishov	Mortality dynamics of conifers in the north of Central Siberia (Russia) under the impact of pollutants emitted by metallurgic enterprises
14.20-14.40	**Maxime Cailleret,** Jordi Martínez-Vilalta, Christof Bigler, Steven Jansen, Elisabeth MR Robert, Harald Bugmann, and members of Topic Group 7 of the EU COST Action STReESS	Is there any universal growth-mortality relationship? Insights from a new international tree-ring database
14.40-15.00	**Marco Vanoni**, Harald Bugmann, Christof Bigler	Relating drought effects to abrupt growth decreases of major tree species in Switzerland
15.00-15.20	**Momchil Panayotov,** Nickolay Tsvetanov, Pepa Vasileva, Neno Alexandrov, Peter Bebi, Stefan Yurukov	An overview of tree-ring studies of forest disturbance histories in Bulgaria
15.20-15.40	**Coffee break**	
Session 12: Dendroecology *(Chair: Joel Guiot)*		
15.40-16.00	Sandro Morganti, Paolo Cherubini, Sylvie Beutel, Monica Fantin, Markus Egli, **Holger Gärtner**	The recent history of slope-instability at the Vajont slide site
16.00-16.20	**Anna Cedro**, Artur Zieliński	Floating forest

16.20-16.40	**Nesibe Köse**, H. Tuncay Güner, Abdurrahim Aydın	Identifying snow avalanche frequency using dendrochronological methods and vegetative indicators in Ayıkaya, Bolu (Turkey)
October 23th, 2015		
9.00-13.00	Departure	

An old Pinus nigra tree from Antalya

Oral Presentations

A Cedrus libani forest from Antalya (Photo: A. Kaya)

Keynote Speach

EuroDendro Conference – its origin and spirit

Dieter Eckstein[1]

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Germany
E-mail: dieter.eckstein@uni-hamburg.de

Abstract

EuroDendro came into existence unintentionally on the 4th of May, 1989 in Lourmarin/South France where roughly a dozen of graduate and PhD students from the surrounding region came together to discuss about "signature years" with four middle-aged dendrochronologists, namely Lucien Tessiers, acting as local host, and Françoise Serre-Bachet, both from the University of d'Aix-Marseille, France, Fritz Schweingruber, WSL, Switzerland and myself. There was no agenda to be followed but instead there was a non-moderated lively and intensely discussion and at the end of the day there remained the general but distinct wish of the students that some of the "teachers" should summarize the outcome of the day in written form and to submit it to the young journal "Dendrochronologia" which, at that time, did not yet practice a rigorous review process (see Dendrochronologia 27, 2009, 7 - 23). This paper on "Identification, presentation and interpretation of event and pointer years in dendrochronology" is published in Dendrochronologia 8, 1990, 9 - 38.

Was that all then? No, it wasn't. Fritz and I spent the rest of this day outdoor sitting on a bench and enjoying the Mediterranean mild air and discussing this and that. Incidentally, we ascertained each other that we should somehow continue with this kind of informal coming together. One year later, we met again in Liège, Belgium – again a one-day event with some 25-30 participants but this time from a larger 'catchment area' and for the first time with a few hours of art-historical sight-seeing through the roofs of the old city of Liège, guided by our host Patrick Hoffsummer. It took until 1996 in Moudon, Switzerland that the local organizers called their meeting EuroDendro. At present, 18 such EuroDendro Conferences have taken place within 26 years (see the map of Europe for the locations and years of these events; in the table, the names of the towns together with the years of the events are given). It was generally and silently agreed that the Hamburg group should feel responsible to contact and encourage potential organizers and offer them the know-how for doing this

job. Meanwhile, EuroDendro found several successors, e.g. in Asia (ADA) and North America (AmeriDendro). Which are the specific characteristics of EuroDendro? EuroDendro is working without any written or oral agreements between any persons; there are no by-laws to be followed and no membership fees to be paid to any society whatsoever. There is no secretary's office. EuroDendro is a self-organizing entity with the purpose to provide the dendrochronological community, particularly the younger generation, a forum as uncomplicated as possible to present themselves and their accomplishments and achievements. The auditorium is international and represents all age classes and all sub-disciplines of tree-ring research. It was one of the leading ideas just from the beginning that newcomers in the field should get the chance to present a topic for discussion which is still immature for being printed. Hopefully, the dendrochronological community will keep EuroDendro alive.

Map of 18 EuroDendro Conferences taken place within 26 years

The names of the towns and the countries together with the years of EuroDendros

Location	Country	Year of event
Lourmarin	France	1989
Liège	Belgium	1990
Lecce	Italy	1992
Nottingham	England	1993
Travemünde	Germany	1994
Moudon	Switzerland	1996
Savonlinna	Finland	1997
Kaunas	Lithuania	1998
Malborg	Poland	1999
Gozd Martuljek	Slovenia	2001
Obergurgl	Austria	2003
Rendsburg	Germany	2004
Viterbo	Italy	2005
Hallstatt	Austria	2008
Mallorca	Spain	2009
Engelberg	Switzerland	2011
Lugo	Spain	2014
Antalya	Turkey	2015

Keynote Speach

Forty-two years of Dendrochronological Research in Anatolia and Environs

Peter Ian Kuniholm[1]

[1)] *Laboratory of Tree-Ring Research and School of Anthropology University of Arizona, E-mail: pik@ltrr.arizona.edu*

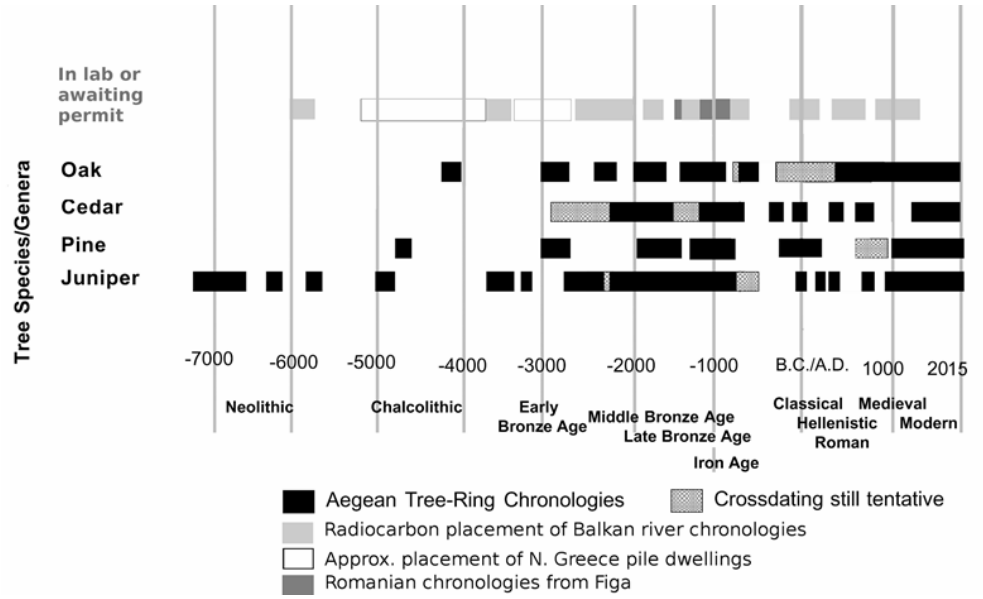
Abstract

When I started studying tree-rings in Turkey as a Ph.D. project in 1973, my goal was to try to build a juniper chronology from the present back to the first millennium BC and thereby date the Midas Mound Tumulus at Gordion (now ca. 740 BC). At the outset, I was told that "dendrochronology in Turkey will not work." When I asked why, the answer was that "nobody has tried it" (not correct, since Gassner and Christiansen-Weniger had studied Pinus nigra northeast of Ankara in the 1930s). Since then the Cornell laboratory and now the Arizona laboratory have built some 7500 years of chronologies (see table below) thanks to the help of some 600 students, a large number of whom later became research assistants.

If you had asked me, in those early years, whether I would get crossdating outside the Central Anatolian Plateau or interspecies crossdating, I would have said no. Since that time we have have been able to crossdate in the northwest almost up to the Alps, in the southwest to the tip of the Italian boot (Sicily seems to belong to a different climate regime and Mt. Etna does not even crossdate with Mt. Pollino in Calabria, only 200 kms away). To the north and east we can crossdate across the Black Sea (Crimea) and into Georgia. The political situation since the 1970s has prevented serious investigation in Iran and Azerbaijan. To the south and southeast Cyprus and North Lebanon are our present limits.

Crossdating works best on an west-east line and at higher altitudes. For example, for living trees along the 40th parallel from Mt. Pollino (Pinus heldreichii or leukodermis) in Calabria, Italy, to Grevena (Pinus heldreichii or leukodermis) in north Greece, to Çatacık/Eskişehir (Pinus nigra) in Turkey, to Batsara (Taxus baccata) in Georgia, the visual fits and accompanying statistics with minimum overlaps between 886 and 455 years are excellent in a step-wise fashion, although (not surprisingly) the extremes of east and west—more than 2500 kms. apart—do not match each other well.

The longest continuous chronology (2367 years from 2007 back to 357 BC) is oak



NOTE: Very short sequences ~100-200 years are not shown in this graph

from the present back through Ottoman and Byzantine times into Roman and Hellenistic. The wood of choice for both Ottoman and Byzantine builders was oak, and the Romans seem to have liked it, too. Some two hundred+ dated buildings (mosques, schools, churches, monasteries, fortresses, and other religious or civic buildings) from Turkey, Greece, and the former Yugoslavia form the backbone of this chronology (Kuniholm, Pearson, Wazny, and Griggs, 2015). When wood like pine or juniper or poplar is encountered, either the building is very poor, or the repair is late.

Carol Griggs has been exploiting this information for climate reconstruction.

The second-longest chronology, (1979 years from approximately 673 BC to 2651 BC), mostly juniper (much of it carbonized), and pinned in place to within a year or two by multiple wiggle- matched radiocarbon determinations covers the entire second millennium BC. This work helped redate both Tumulus MM and the Citadel Mound at Gordion (Newton and Kuniholm in Rose and Darbyshire, eds., 2011) and more recently has been used in a redating of the Old Assyrian period at Kültepe/Kanesh (Barjamovic, Hertel, and Larsen, 2012). Other significant chronologies are from a variety of *Juniperus* sp., *Buxus sempirvirens* (513 years), *Cedrus libani, Quercus* spp., *Taxus baccata*, and now and then *Picea* and *Abies alba.*

The biggest single problem has been what I have called for convenience the "Roman Gap" or the centuries on either side of the AD/BC transition. Although hundreds of Roman buildings and thousands of beam-holes exist, the wood is almost always gone. This "gap" has now been pretty much filled, thanks to the 1441 years of oak

chronologies from the recent excavations of the Marmaray Project in Istanbul (especially Yenikapı and Sirkeci), about which Charlotte Pearson will tell you.

A second problem has been the relative lack of correspondence with tree-ring chronologies to the north, specifically the Balkans and further north, which Tomasz Wazny has now been addressing with interesting results about which he will speak.

A third problem (well, not so much a problem as an interesting finding) is the extent and magnitude of the timber trade. The Yenikapı excavations have shown that oaks found in the Theodosian harbor of Istanbul come from as far away as the north Adriatic, the Black Sea, and up the Danube River, possibly as far north as Hungary. Tomasz is re-examining all our 70+ coastal chronologies as part of his efforts to dendroprovenance their constituent parts. If Brita Lorentzen can come to this meeting, she will be able to show you how Taurus cedar (among other things) was exported to the Levant. And in the second millennium BC we now have evidence for the appearance of imported Cedrus libani in Egypt.

Keywords: *dendrochronology, Anatolia, Dating, Aegean Dendrochronology Project*

Can dendrochronology solve the Santorini/Thera question?

Tomasz Ważny[1,2], Peter Ian Kuniholm[1], Charlotte Pearson[1]

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[2)]Nicolaus Copernicus University, Institute for the Study, Conservation and Restoration of Cultural Heritage, 87-100 Torun, Poland
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Abstract

Somewhere near the middle of the second millennium BCE - a violent volcanic eruption blew up the Aegean island of Santorini. The shock wave, earthquakes and following tsunami have been argued to have destroyed part of Aegean leaving traces as far as the coast of Egypt. Estimated tephra volume of 9.9 x 1010 m^3 may have influence the climate of northern hemisphere including the White Mountains in California where bristlecone pines - silent witnesses of climatic anomalies caused by this catastrophic event - are still living. Flourishing Minoan civilization collapsed, the Old World civilization changed its course.

When exactly did it happen? Pottery, Egyptian inscriptions and other documents place this event at c. 1550-1500 BCE. Interpretation of radiocarbon dates for archaeologically stratified materials 'supported' by proxy correlations with ice core acidity have been argued to place the Thera eruption ca 100-150 years earlier. If this last dating is confirmed, traditional chronologies of the Old World based on e.g. Egyptian king lists, astronomic observations, archaeological seriation and documentation will lose their validity. For decades thrilling debates have raged over the Santorini question illustrating divergence between scientific and humanistic evidence. Who is right? Which chronology is correct: "high" or "low"? The validity of radiocarbon dating during this period has been called into question. In the case of methods offering annual precision - dendrochronology and ice-core analysis - Wiener (2009) concluded that they do not provide any direct evidence for the Thera eruption; however,he stated "perhaps one day we may have good evidence from ice-core analysis or dendrochronology". Indeed

– both methods can provide year-by-year sequences beginning in the present, but the continuity of ice-core series remains questionable, and while annual resolution may be approached this is far less reliable than the certainty of annual growth in tree rings.

Tree-ring chronologies are verified by interregional as well as by interspecies cross-dating, and therefore are absolutely reliable.

How might we fulfill these expectations and where are we now, in 2015? There are three major requirements:

(a)Continuous and absolute dated chronologies going back to the Bronze Age. Peter Kuniholm presented an overview of east Mediterranean chronologies. All BCE-chronologies there are still floating and there are centuries on either side of the CE/BCE transition which are only partly filled by tree-ring sequences representing different wood species and different geographical regions. The 2nd Millennium BCE is covered entirely only by the Anatolian chronology placed on the time-scale by radiocarbon wiggle-matching. The key to bridging the gaps is to be found in the Balkans. The East-Balkans tree-ring growth patterns match both Mediterranean and Central European trees, at least for recent centuries (Ważny et al. 2014). Successful dating of Eneolithic settlements in Slovenia (Cufar et al. 2015) confirms the existence of far-distant correlations between the West-Balkans and Western Europe for particular periods. In addition Kuniholm proved the existence of significant interspecies correlations in the East Mediterranean.

(b)Chronologies ought to contain the "Thera" signal. The main impact of the eruption was oriented to the East. However, tephra of Thera-origin was found also in the Black Sea and we could expect to find traces in the Balkans. The wandering volcanic cloud after the eruption of the Icelandic volcano of Eyjafjallajökull which caused disruption of air traffic over Europe in 2010 is thought-provoking, with tephra layers recently identified in Ohrid and Prespa Lakes where we are collecting tree-ring samples.

(c)We should be able to detect this signal. Advances of dendrochemistry and wood anatomy make it possible.

The answer to the question posed in the title is from today's perspective: yes References:

Čufar, K., Tegel, W., Merela, M., Kromer, B., Velušček, A. 2015. Eneolithic pile dwellings south of the Alps precisely dated with tree-ring chronologies from the north. Dendrochronologia (in print).

Ważny , T., Lorentzen, B.E. , Köse, N. , Akkemik, Ü., Boltryk, y., Güner, T., Kyncl, J. , Kyncl, T., Nechita, C., Sagaydak, S., Vasileva, J.K., 2014. Bridging the gaps in tree-ring records - creating a high-resolution dendrochronological network for Southeastern Europe. Radiocarbon 56.

Wiener, M.H., 2009. Cold fusion: The uneasy alliance of history and science. In: Manning, S.W. & Bruce, M.J. (eds.), Tree-rings, Kings, and Old World Archaeology and Environment: Papers Presented in Honor of Peter I. Kuniholm. Oxford: Oxbow Books, 277-292.

Keywords: *dendrochronology, East Mediterranean, Thera*

Tree-Rings and the Lost Harbor of Constantinople

Charlotte Pearson[1], Tomasz Ważny[1,2], Peter Ian Kuniholm[1]
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[2)]Nicolaus Copernicus University, Gagarina 11, 87-100 Torun, Poland
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Abstract

Archaeological investigation of the "Theodosian Harbour in Yenikapı, Istanbul, underway since 2004, has recently come to a close. Over a decade of work by the Istanbul Archaeological Museum at this extraordinary site has produced a remarkable picture of life at the heart of the Byzantine Empire during the 1st millennium AD. Here we consider the contribution of dendrochronological analysis of c. oak 4000 timbers from the wooden structures of the harbor (mostly docks) for providing a

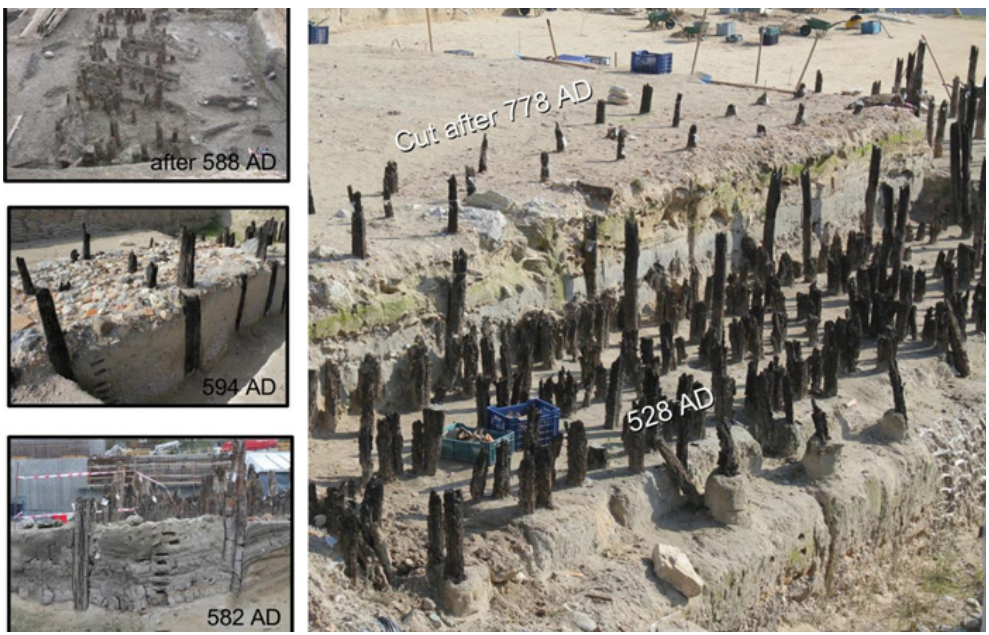

Figure 1 shows four examples of docks at the site with cutting dates or termini post quos for the whole structures or multiple phases.

precise framework for dating phases of activity at the site.

The earliest tree-ring dates derived from material from a pit and early harbor wall date after 281 AD and 382 AD respectively. These dates work well with what is known historically, with some activity in the natural harbor prior to the inauguration of Constantinople as the capital of the Byzantine Empire in 330 AD, followed by a rapid period of expansion. The vast majority of dates for the wooden docks (figure 1) fall within the period 400–800 AD which agrees well with coin and other archaeological evidence. A reduction in dates after 797 AD corresponds with other evidence for silting up and disuse of the harbor in the 9th century AD.

In addition to applying standard dendrochronological procedure to date structures at the site we also worked with geological colleagues to attempt to provide temporal constraints for some sedimentary features. Figure 2 shows the type of criteria used.

Finally we show how the timbers from the Yenikapı harbor match with material excavated from other Marmarary constructions and contemporary buildings in Istanbul and the contribution this has made to filling a long-standing chronological gap in Mediterranean tree-ring sequences.

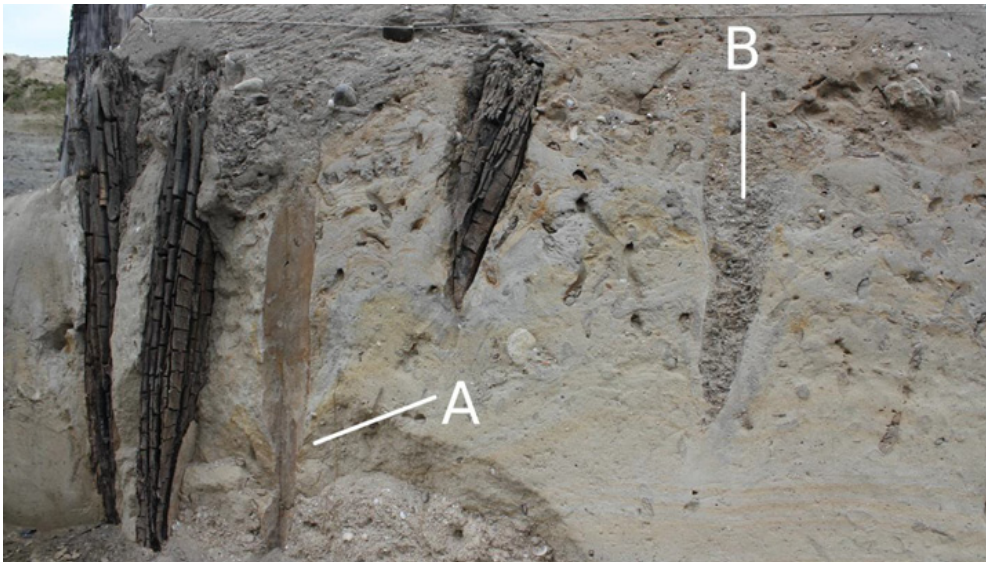

Figure 2 shows an example of sedimentary criteria used to assign tree-ring dates to stratigraphic layers. A shows deformation of the sediment as the post was originally put in place. The layer associated with 'A' was clearly laid down before the post was inserted. The layer associated with 'B' was laid down after the series of posts shown were put in place as can be seen from the infill of the post hole.

Keywords: *Dendroarchaeology, Turkey, First Millennium AD*

SCIEM 2000 - Cedar dendrochronology in the Near East

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Abstract

In the SFB SCIEM 2000 ("Synchronization of Civilizations in the Eastern Mediterranean in the 2nd Millennium BC)" the main attempt was to analyze and to contribute to solutions of dating problems in this time period. Those problems arose from divergences between dating results of historical chronologies and C_{14} measurements.

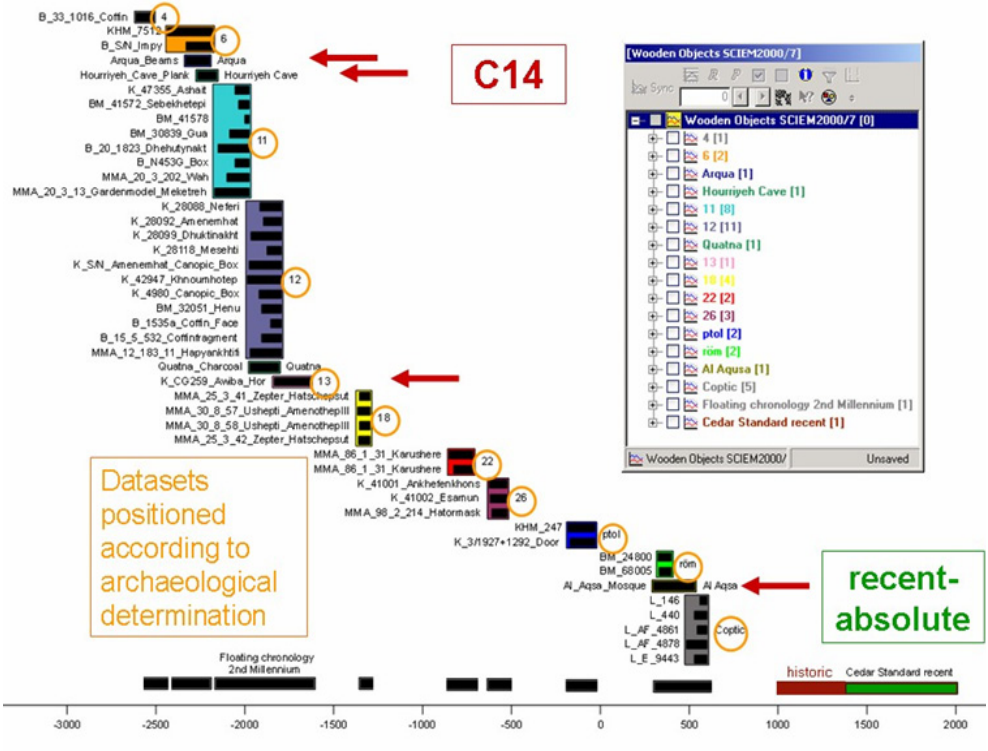
To establish another dating method dendrochronology of wooden artefacts made of Cedrus libani was our exploratory focus. In the Eastern Mediterranean Cedar is growing in Lebanon, Syria, Southern Anatolia and Cyprus. Between 2000 and 2012 we have collected all Cedar ring width data available, starting with living trees and construction wood from historical buildings and building remains in Lebanon, museum objects from Egyptian collections all over the world and wood samples from excavations in Egypt (Wadi Gawasis, Ain Soukhna), Lebanon (Tell Arqa, El Hourriye cave, Kamid el-Loz) and Syria (Qatna, Ebla, Tell Brak). To work on museum objects it was necessary to develop measuring instruments for non-invasive ring width measurements.

One main finding is evidence for much more differing local climatic units as assumed before (even in Lebanon more than one Cedar standard might be necessary).

Results for now are one absolute standard for Lebanon (based on living trees from Bsharre) back to 1060 A.D., several floating chronologies for Middle Ages, Antiquity, for the Ptolemeic period and contemporary to Egyptian dynasties 26, 22, 18, 13/12/11, 6 and 4. These data can be used for relative dating within the groups.

To close the gaps between these floating sequences for constructing a standard for absolute dating back to Bronze Age more samples/ring data will be necessary. As it is unknown for now, whether the main source area for antique Cedar imports to Egypt was Lebanon, it will be necessary to find out with the help of new data about whether the existing and the new data sets (floating sequences) are fitting together. As even now a lot of existing data do not fit to other obviously contemporary ones, most likely more than on standard will be necessary in the end.

Cichocki, O. 2003. Dendrochronological Investigations on Cedar Objects of Ancient egypt.). In: Bietak, M. (Hrsg.): The Synchronization of Civilizations in the Eastern Mediterranean in the



Second Millennium B.C. II. Denkschriften der Österreichischen Akademie der Wissenschaften 29:43-46, Wien.

Cichocki, O. 2004. The wooden plank from al-Hourriyeh cave. In: Beayno, F., Mattar, Ch., Abdul-Nour, H.(Authors). Mgharet al-Hourriyé (Karm Saddé, Caza de Zgharta). Bulletin d´Archéologie et d´Architecture Libanaises BAAL 6 (2002) : 135 – 178, Beyrouth.

Cichocki, O. 2006. Libanesische Zedern als Datierungswerkzeug in der ägyptischen Archäologie. Bd. 3, 293-299. In: Czerny, E., Hein, I., Hunger, H., Melman, D., Schwab,

A. (eds.) Timelines. Studies in honour of Manfred Bietak, OLA 149. Bd.1-3.

Cichocki, O. 2007/08. Analysis of charcoal samples from Early Bronze Age strata at Tell Arqa, Lebanon. AHL - Archaeology and History in the Lebanon 26-27, p. 99 –109.

Cichocki, O. (in print). Die Holzreste aus dem Korridor zur Königsgruft des bronzezeitlichen Palastes in Qatna, Syrien. In: Lange, S., Wissing, A., , Schmid, J., Paoletti, V., Ahrens, A. und Rossberger, E. Der Königsgruftkomplex von Qatna I: Befunde und Fundverteilung des Korridors und der Vorkammer, mit Beiträgen von Otto Cichocki, Ahmad al-Rawi, Stephanie Döpper, Ivana Puljiz und Simone Riehl, Qatna Studien 6/1, Harrassowitz, Wiesbaden.

Keywords: *dendrochronology, Cedrus libani, Near East*

Dendrochronology in SE Europe – filling the gaps in oak tree-ring network

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Abstract

Dendrochronological research in West and North-Central Europe has produced a network of long regional oak (Quercus sp.) reference chronologies which could be teleconnected and successfully used for dating, provenancing, and various paleoclimate research applications. Recently we recorded also vast progress of oak dendrochronology in South-Eastern Europe and Eastern Mediterranean, however there are still many spatio-temporal gaps in the emerging network and the knowledge on its links with the nearby and remote sites is still insufficient.

The aim of this study is to overview the recent development of oak dendrochronology in South-Eastern Europe and to discuss how the existing tree-ring chronologies could be combined to improve the density and length of tree-ring network in the area.

Recent study of 41 local 71-433 years long oak tree-ring chronologies in Austria, Hungary, Slovenia, Croatia and Serbia has shown good teleconnection among them. The agreement among the chronologies could mainly be ascribed to a common positive response to precipitation and a negative response to temperature in spring and early summer (Čufar et al., 2014). The knowledge on teleconnection could be vastly improved if these chronologies would be compared with the ones from the north-south transect between Poland and northwestern Turkey (Wazny et al., 2014). This study included forests and historical/archaeological sites in Slovakia, Moldo-

va, Ukraine, Romania, Bulgaria and Turkey and showed that the chronologies from South-Eastern Europ could provide a solid bridge between both major European dendrochronological networks.

Furthermore, a regional oak chronology from Austria (currently exceeding 1000 years) and Slovenia (currently exceeding 850 years) presented a significant link with more distant chronologies in the northeast, i.e. in Czech Republic and Germany. They could also be successfully applied for dating of historical / archaeological wood in the southeastern areas, i.e. in Croatia and Bosnia.

In Slovenia and Austria there have also been established chronologies based on prehistoric material. After two decades of systematic work, the first group of the Ljubljansko barje pile dwelling chronologies, has been absolutely dated by means of dendrochronology and correlation between remote tree-ring series. They span the period of 3771-3330 BC. However, most of the chronologies from the distant past are still floating (e.g. the Roman Period chronologies and subfossil oak stems from Slovenia), or dated by radiocarbon (e.g. chronologies from the Ljubljansko barje spanning the periods of 3160-3071 cal BC and 2659-2417 cal BC). Since there is apparently not enough wood preserved to fill the gaps and produce multimillennial chronologies in Slovenia and Austria, the wider region could probably benefit from chronologies of subfossil trees from Croatia, and Bosnia and Herzegovina. Recent work of Pearson et. al. (2014) presenting 3456 years of floating radiocarbon dated tree- ring chronologies spread through the last ca. 8000 years probably could at least partly help to bridge the gaps. The area could be particularly interesting, because oaks grew in South-Eastern Europe before they recolonized the areas north of the Alps after the last ice age.

Literature

Čufar, K., Kromer, B., Tolar, T., Velušček, A., 2010. Dating of 4th millennium BC pile- dwellings on Ljubljansko barje, Slovenia, Journal of Archaeological Science 37, 2031-2039. doi:10.1016/j.jas.2010.03.008

Čufar, K., Grabner, M., Morgos, A., Martinez Del Castillo, E., Merela, M., De Luis, M. 2014. Common climatic signals affecting oak tree-ring growth in SE Central Europe. Trees 28, 1267–1277. doi: 10.1007/s00468-013-0972-z

Pearson, C.L., Ważny, T., Kuniholm, P.I., Botić, K., Durman, A., Seufer, K., 2014. Potential for a new multimillennial tree-ring chronology from subfossil Balkan river oaks. Radiocarbon 56 (4) and Tree-Ring Research, 70 (3), 51-59. doi: http://dx.doi.org/10.3959/1536-1098-70.3.51

Ważny, T., Lorentzen, B., Köse, N., Akkemik, Ü., Boltryk, Y., Güner, T., Kyncl, J., Kyncl, T., Nechita, C., Sagaydak, S., Kamenova Vasileva, J., 2014. Bridging the gaps in tree-ring records: creating a high-resolution dendrochronological network for southeastern Europe. Radiocarbon 56 (4) and Tree-Ring Research, 70 (3): 39-50. doi: http://dx.doi.org/10.3959/1536-1098-70.3.39

Keywords: *oak, Quercus sp., tree-ring network, teleconnection*

Medieval woodland and its use in the Schleswig isthmus, Northern Germany

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Abstract

A current German Research Foundation (DFG)-funded project is dealing with the evaluation of a large dendrochronological data set from Haithabu and Schleswig from a dendroarchaeological perspective and by means of dendrotypology. The Viking Age international trading place Haithabu, situated in the southern part of the Jutland penin- sula, existed from the second half of the 8th till the 11th century. In the later part of the 11th century, the settlement transferred to the nearby town of Schleswig. Both sites exhibit a well preserved wooden legacy with a period covered by tree-ring series from 436 until 1278 AD, i.e. from the Migration Period through the early and high Medieval Period. In the past, more than 4000 oak timbers were dendrochronologically dated: Haithabu harbour (244 dated), Haithabu settlement (2673 dated), Danewerk (69 dated) and Schleswig Plessenstraße (868 dated). Especially for Schleswig the construction of the data set is in progress and will be extended to the 14th century.

During the long time of settlement, a huge amount of wood was used for construction, tools, commodities, domestic objects and energy supply. This resulted in a change of woodland composition and forest structure. Therefore, dendrotypology is used to cate- gorise the timbers, with respect to growth trend, size and age of the trees, in order to reconstruct their historic growing conditions and to develop an understanding for woodland transformation and for the potential impact on this renewable resource (Billamboz, 2008). The tree-ring series are clustered in homogeneous groups both by visual matching and correlation calculations. The latter takes euclidean distance of yearly variations into account. One special aim of this grouping is to identify wood samples that were cleft from the same tree. From the shape of the

wood samples we know that trees were often splitted radially (Mom et al. 2011). Another fact is that oak was predominantly sampled for dendrochronology. Therefore, more than 3000 wood charcoal taxonomic analyses from excavated houses, artefacts, harbour and graveyard in Haithabu complement this data set, including minimum diameter measurements (Nelle 2003). An idea of the medieval landscape is given by other wood, macro as well as pollen analyses.

In the 9th century, Haithabu, being the predecessor of Schleswig, had trees that were more than 200 years older. The average age of used trees decreases from the Viking Age to the high Medieval times. A significant regrowth of the forest stands is also observed (Eckstein & Wrobel 1982, Schultze 2008). Before Haithabu was established as a settlement, the growth rings indicate a dense forest during the Migration Period.

Based on Pollen diagrams the afforestation is exhibited during this time in this area. Additionally, the establishment of Schleswig shows a decrease of old oak trees. But this construction wood had a higher increment than the ones from Haithabu. Hence, these forest stands, where the construction timber of Schleswig was taken from, were more open than the ones of Haithabu.

Billiamboz, A. 2008. Dealing with heteroconnections and short tree-ring series at different levels. Dendrochronologia, 26, 145-155.

Eckstein, D., Wrobel, S. 1982. Dendrochronology in Europe – with special reference to Northern Germany and Southern Scandinavia. Second Nordic conference on the application of scientific methods in archaeology, 11-25.

Mom, V., Schultze, J., Wrobel, S., Eckstein, D. 2011. Which timbers were cleft from the same tree? Proc. of the 15th International Conference on Cultural Heritage and New Technologies, 582-591.

Nelle, O. 2003: Woodland history of the last 500 years revealed by anthracological studies of charcoal kiln sites in the Bavarian Forest, Germany. Phytocoenologia, 33, 667-682.

Schultze, J. 2008. Haithabu – Die Siedlungsgrabungen. 1. Methoden und Möglichkeiten der Auswertung (Hedeby – The settlement excavation. 1. Methods and possibilities of evaluations). Die Ausgrabungen in Haithabu, 13, Wachholtz Verlag Neumünster, 432 p.

Keywords: *dendrotypology, dendroarchaeology, palaeoecology, Middle Ages, Viking*

Keynote Speach

Climate and dendroclimatology in the eastern Mediterranean Basin

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Abstract

There is no doubt that the lands surrounding the eastern Mediterranean Basin (EMB) have been focal regions for the human cultural development over the 10,000 years. Therefore, reconstructions of the climate and related environmental variables do provide the basic framework on which any socioeconomic historical 'explanations' have been (and will be) built.

Although the instrumental record for Europe can be extended back to more than 350 years, this is not the case for our region of interest. So for any climatic information older than ~150 years, one has to rely on climate proxies. Innovations made in the last 50 years in analytical techniques provide us with a rich panoply of proxy information sources. Dendroclimatology, which relies structural growth patterns of woody plants, is particularly powerful due to the fact that it provides high (annual) temporal resolution; although seasonal character of the hydroclimatic information that can be retrieved is often quite constrained.

Unlike in dendrochronology, where floating tree-ring width (TRW) chronologies can be built, and therefore can be extended back in time, dendroclimatological reconstructions rely upon the existence of living (or recently dead) tree stands, for the chronologies need to overlap with instrumental records to allow for calibration. This requirement limits the time depth of climatic information retrievable through dendroclimatological approaches in the EMB. The region's environment in general, and its forests in particular have been heavily impacted by the long human presence (and therefore disturbance). Up to now, most chronologies built in the region are limited to 500-600 years.

Seasonality of the climate information retrievable from TRW chronologies may vary with tree species and, to some extent, with microclimatic conditions at the stand level. It has been observed that most chronologies developed in the EMB are quite

insensitive to temperatures (irrespective of the season), but are significantly correlated with late spring and summer precipitations (see Fig. 1) in general and May-June precipitation in particular (Touchan et al., 2003, 2005, 2007; Köse et al., 2011)

Lastly, the impact of data analysis procedure on the spectral content of the dendroclimatological information should be underlined. TRW measurements follow a long path involving many mathematical transformations until a proxy hydroclimatic time series is obtained. These transformations modify the spectral content of the information. In most cases, the climatic signal ends up being 'high-pass' filtered. Therefore, 'low-frequency' components, i.e. longer-term temporal trends of importance from a climate-theoretical point-of-view, may get lost.

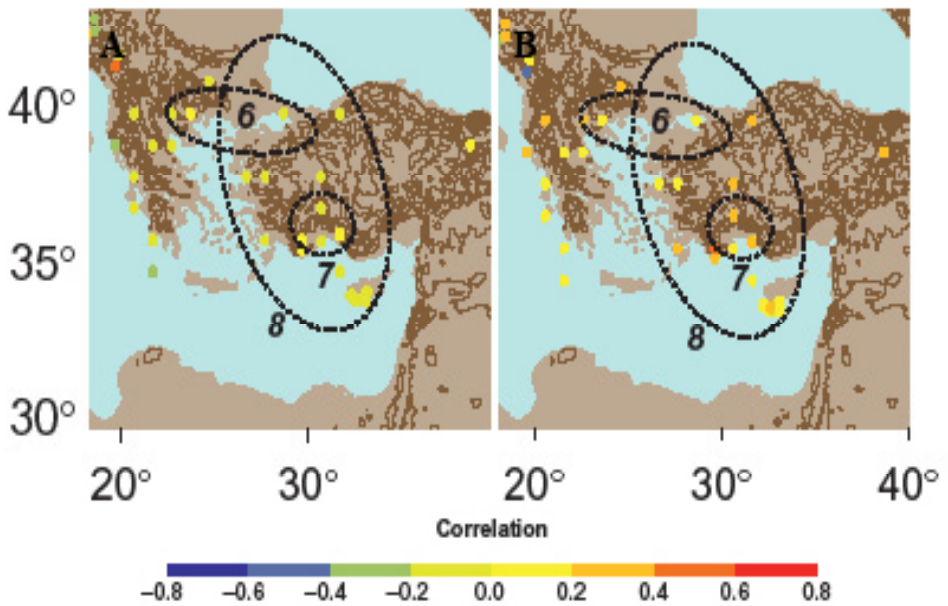

Figure 1 Location and climate sensitivity of TRW chronologies within the eastern Mediterranean Region. Pearson's correlation coefficients are computed against gridded JJA: (A) temperature and (B) precipitation indices. Black circles refer to climate reconstructions >600 years. (Modified from Luterbacher et al., 2012)

References

Köse, N., Akkemik, Ü., Dalfes, H.N., Özeren, M.S., 2011. Tree-ring reconstructions of May–June precipitation for western Anatolia. Quat. Res. 75, 438–450.

Luterbacher, J. et al., 2012. A Review of 2000 Years of Paleoclimatic Evidence in the Mediterranean. In: Lionello, P. et al. The Climate of the Mediterranean Region: From the Past to the Future. Elsevier, Amsterdam, pp. 87-186.

Touchan, R., Garfin, G.M., Meko, D.M., Funkhouser, G., Erkan, N., Hughes, M.K., et al., 2003. Preliminary reconstructions of spring precipitation in southwestern Turkey from tree-ring width. Int. J. Climatol. 23, 157–171.

Touchan, R., Xoplaki, E., Funkhouser, G., Luterbacher, J., Hughes, M.K., Erkan, N., et al., 2005. Reconstructions of spring/summer precipitation for the Eastern Mediterranean from tree- ring widths and its connection to large-scale atmospheric circulation. Clim. Dyn. 25, 75–98.

Touchan, R., Akkemik, Ü., Hughes, M.K., Erkan, N., 2007. May–June precipitation recon- struction of southwestern Anatolia, Turkey during the last 900 years from tree rings. Quat. Res. 68, 196–202.

Keywords: *East Mediterranean, dendroclimatology, tree ring, climate, Turkey*

Dendroindication of the Planets-Induced Climate Anomalies

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Abstract

The super-task of knowledge discovery is to ascertain the time of influential events of the past and of the future. Existing scientific basis of dendroclimatology includes multi- year analysis. This method allows to identify cycles of wet and dry periods with a duration varying from 3-4 to 30-40 and more years. One should admit that implementation of the cycles concept in practice is rather difficult as the exact cause of the climate fluctuations remains unknown and there is uncertainty about next period outcome. From a strategic viewpoint it is important to foresee the cases of very low tree growth. That's why our methodology focuses on the study of anomalous phenomena.

We performed the dendrochronology analysis for 15 the Mediterranean basin countries (Spain, Algeria, France, Morocco, Italy, Slovenia, Croatia, Bosnia and Herzegovina, Montenegro, Greece, Tunisia, Bulgaria, Romania, Russia, Turkey, Georgia). Major tree ring anomalies were considered along with the fluctuations of climate, river runoff and crop yield. One of the lowest tree growth occurred in early 1920s (Fig.1a).

It was time of the large-scale drought when the historic runoff minimum has been observed on the Eurasian rivers from the Thames and the Tejo in the West to the Lena and the Huang He in the East. A crop failure over Ukraine, Russia, Kazakhstan and China at this moment caused great famine and 7-8 million deaths.

Such unique event reflects the Earth body perturbation which should have an external origin. The corresponding source of energy is the motion of the planets. The 1920s anomaly was connected with a rare position of four outer planets (Fig. 1b).

The precipitation distribution study shows that the years around 1990 was a very dry period in the middle latitudes over the whole Northern Hemisphere (Fig. 2a). The consequence of this drought was extraordinary simultaneous reduction in tree growth.

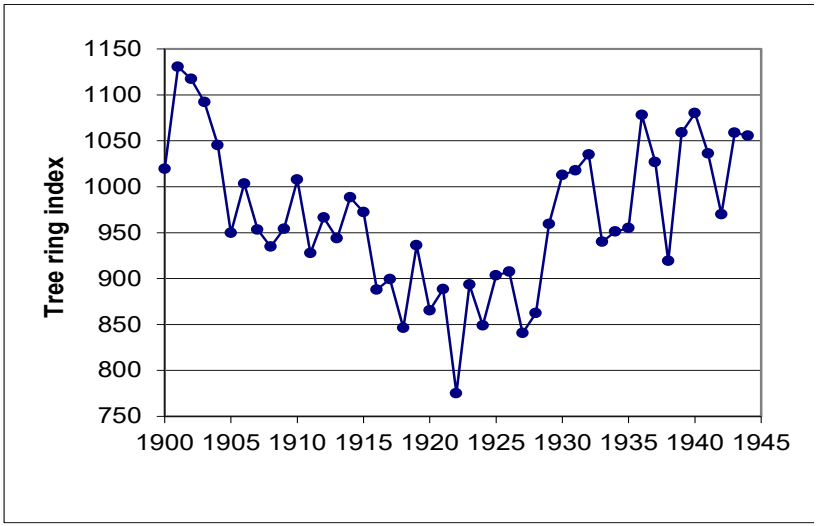

Figure 1a

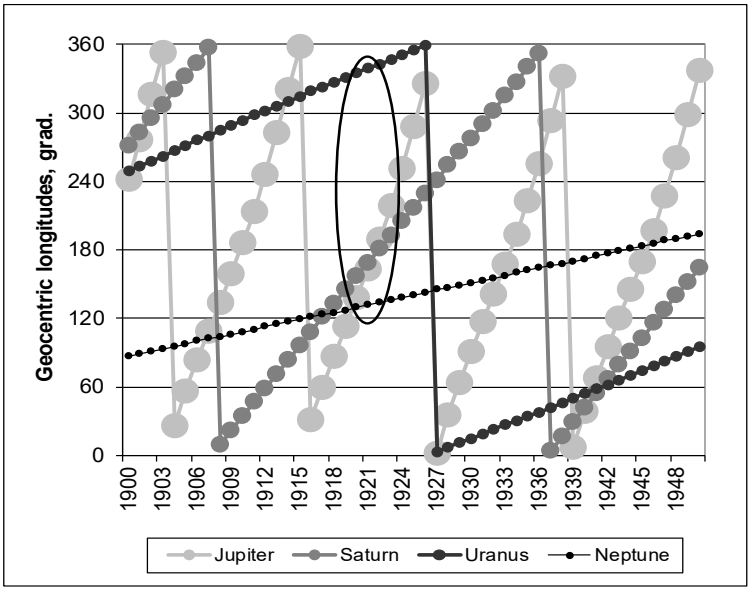

Figure 1b

Figure 1. The beginning of the 1920s event.
(a)The integrated Mediterranean dendrochronology. Source: calculation based on the Tree-Ring Data Bank
(b)The outer planets configuration. Note 0° and 180° differences in the planets location. Source: astronomical ephemeris calculation

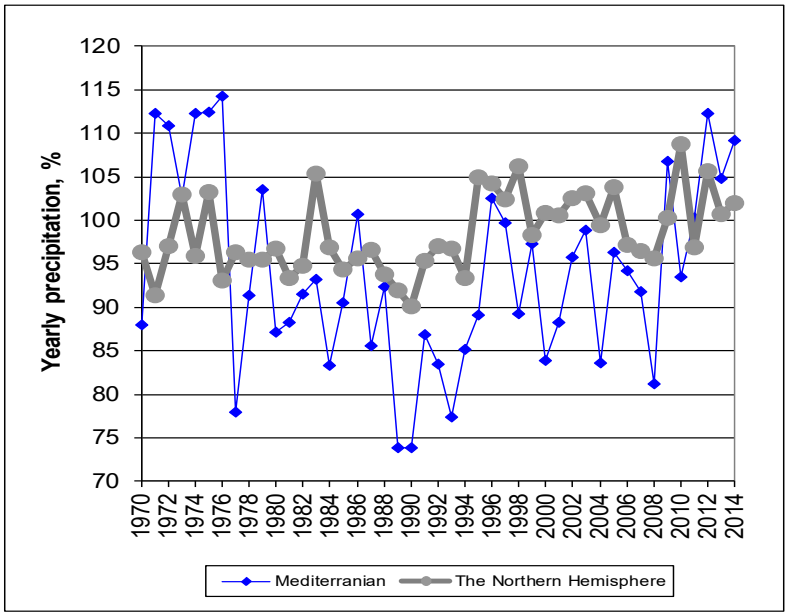

Figure 2a

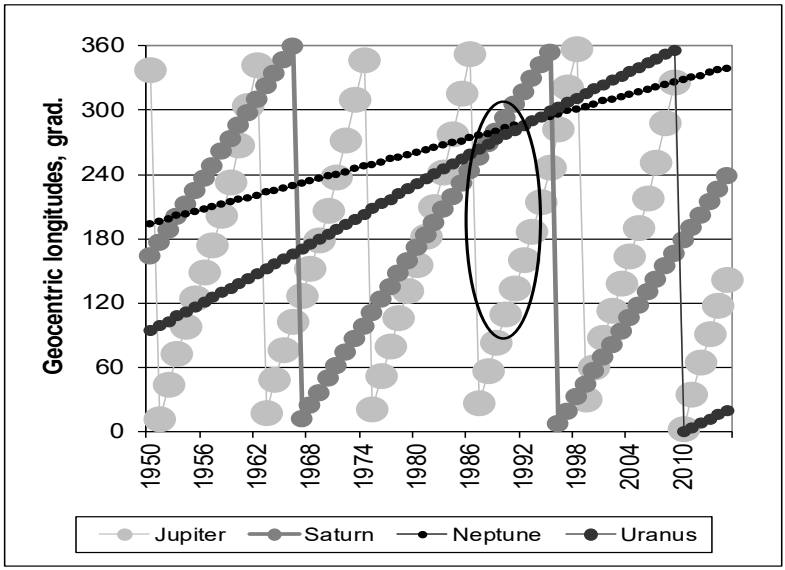

Figure 2b

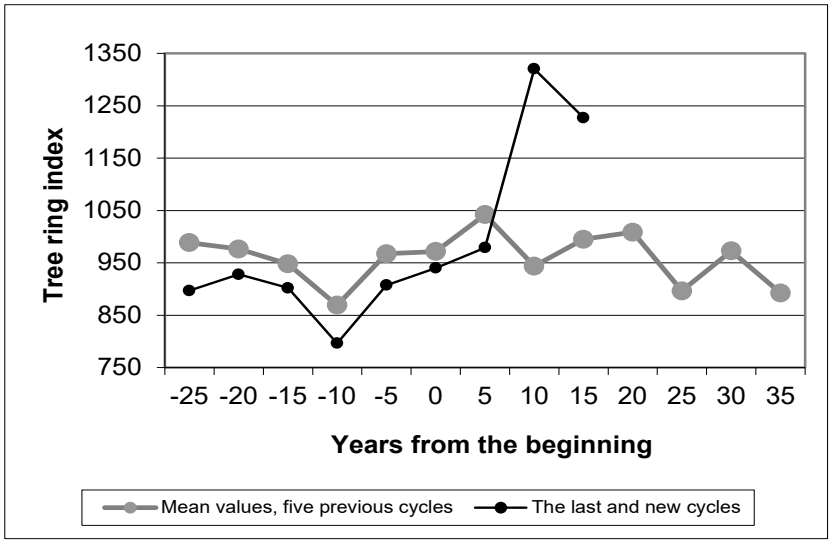

Figure 2c

Figure 2. The 179-year cycle.

(a) Yearly precipitation in the Mediterranean and the Northern Hemisphere (between 30° N and 40° N) during the end of old and the beginning of new cycles. Source: calculation based on data of the Earth Systems Research Laboratory

(b) The outer planets configuration. Note again 0° and 180° differences in the planets location. Source: astronomical ephemeris calculation

(c) 5-Year average tree ring growth in Anatolia during a transition period of 179-year cycles. Source: calculation based on the dendrochronology created by R.Touchan and M.Hughes

The Earth responded to the Sun acceleration relatively the barycenter of the Solar system in 1990. The planets configuration in 1990 (Fig. 1b) was quite unusual, it happens only once every 179 years reflecting the start of a new cycle.

Using the superposed epoch approach we have seen a certain similarity in the 179-year cycles of tree growth. A good example shows Grecian juniperus from Anatolia, Turkey (Fig. 2c).

These findings can be applied to the long-term prediction (or rather risk assessment because the appearance of a deviation in last years).

Acknowledgment: This study is being supported by the Russian Geographical Society. We appreciate the use of the International Tree-Ring Data Bank information and express our gratitude to R.Touchan and M.Hughes for the juniper data.

Keywords: *dendroindication, climate anomalies, droughts, planets impact*

Climatic signal in larch (*Larix decidua* Mill.) from low and medium altitudes of Carpathian and Sudetes Mountains

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Abstract

We present the first results of the more extended study, which aim is to determine the effect of climatic and site related factors on tree-ring widths of larch (*Larix decidua* Mill.) in the area of the Carpathian and the Sudetes mountains (Central Europe). In our research we use the larch stands located at different altitudes and various slope aspects, located in the mentioned mountains ranges, from their foothills to their higher parts. Study will lead to determination of the spatial/geographical variability of the signal observed in the tree-ring sequences of larch and identification regions with uniform dendrochronological signal. Our study is also focused on determination of climatic factors that are of particular importance for the growth of larch at different altitudes and whether, and to what extent, other site-related factors (e.g. slopes aspect) affects sensitivity of trees to climatic factors. Here we present some results of the study that is still in progress, concerning stands from lower and medium altitudes. Cluster analysis of residual chronologies that were already constructed shows that differences between chronologies from Sudetes and Carpathian Mountains exist, and most of them can be classified to one of the two main clusters. Results of PCA analysis of chronologies showed that first principal component (1PC) explains about 45% of variance in examined series. Results of the climate-growth relationship determination showed that the main factor responsible for it in both regions is the same: spring climatic conditions, with positive effect of May temperatures in particular. The second PC explain about 10% of the data variance. The other components are less important. The possible explanations of this fact, including influence of site- related factors, are discussed. We showed that in some sites the climatic signal is

stronger that in others and more complex, as expected at those altitudes. We tried to analyze this phenomenon. To do so, we performed the intra-site cluster analysis. Results showed that usually samples separate into two groups: one showing significantly stronger correlation with aforementioned climatic factors, and second in which this correlation is significantly weaker. This separation allow us to select data better suited for more robust, future climate reconstruction studies.

The study was supported by the National Science Centre, Poland, project no: 2014/13/B/ST10/02529.

Keywords: *climate-growth relationship, spatial differences, site related factors, Larix decidua Mill., Carpathian and Sudetes Mountains*

Growth trends and climate responses of Norway spruce along elevational gradients in East-Central Europe

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Abstract

Species-specific growth trends and responses to climate along elevational gradients are still not fully understood. Beside of elevation or regional provenance, reported different sample depths, uneven representation of sample ages and varying site characteristics often unintentionally drive growth variability captured in tree-ring chronologies. Furthermore, there is only a limited number of studies dealing with elevational gradients and applying standardization methods sensitive to trend preservation. Here we present 12 novel tree-ring chronologies of Picea abies from four elevational belts and three mountain regions in East-Central Europe between 15° and 19°E. Datasets of sufficient sample replication and comparable age structure were developed at sites between 900 m asl and local timberline, with the resulting chronologies covering the 1906-2012 period. Trees in the zone adjacent to timberline displayed substantial medium-frequency variability in tree rings and increasing growth rates since the 1980s. In contrast, medium-frequency growth variability of trees from the lower montane zone was relatively small, and growth rates over the last decade were either stable or even decreased. During the last four decades, P. abies exhibited a reduced response to temperatures of the autumn preceding ring formation in high elevations and increased sensitivity to drought in the lower-montane zone. Identified substantial differences in growth trends and climate responses of trees along altitudinal gradients should be considered in predictions of forest productivity and in forest management strategies.

Keywords: *Picea abies; radial growth; climate change; tree rings; montane forest*

May-June precipitation variability in the Caucasus for the last 250 years reconstructed from tree rings

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Abstract

Despite the high mean annual precipitation in the region, the Caucasus experiences recurrent droughts and floods that not only affect natural vegetation but also the agriculture-based economies of several countries. Instrumental meteorological records that could provide information on hydroclimate variability are scarce across the region and few extend before 1930's; thus little is known about the magnitude and frequency of past droughts and pluvials.

In recent decades, there has been an increased number of tree-ring based climate reconstructions for several parts of the Mediterranean and the Near East. Recent studies in Turkey and the Middle East have mostly focused in the western part of the country. No studies to date, however, have focused on the Caucasus region.

Using a multispecies network of tree-ring width chronologies from the Lesser Caucasus, we have developed the first precipitation reconstruction back to the early 1750's CE. We used a nested approach with principal component regression and split sample calibration and verification. Our reconstruction accounted for over 50% of May-June precipitation from 1930 to 2001. Results for the split-sample validation over two equal-length periods between 1930-2001 indicate temporal stability of the model for our precipitation reconstruction.

We observed a decrease in precipitation variability in the last 70 years compared to previous periods. While our reconstruction shows many similarities with previous reconstructions from the eastern Mediterranean and Northern Turkey, it depicts

distinct drought periods that were not apparent in other records. The effects of large scale-atmospheric circulation on spring precipitation suggest a complex teleconnection pattern of climatic variability in the Caucasus. North Atlantic Oscillation (NAO) is likely a key driver of May-June precipitation in the Caucasus and Anatolia, although its effects appear to be superimposed onto those of the East Atlantic/West Russia (EA/WR) atmospheric system. Our analysis also suggest an important role of sea surface temperatures in the Black Sea that, linked to the NAO, may be responsible for the large precipitation variability observed in the area.

Keywords: *Black Sea, Caucasus, drought, tree-ring network*

Keynote Speach

Modeling climate impacts on tree-growth in dendrochronology

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Abstract

Tree rings represent high-resolution archives of past climates. After a fruitful period where most sophisticated statistical techniques have dominated the analysis of relationships between climate and tree growth (Cook and Kairiukstis, 1990), ecophysiological modeling can now be used not only to understand and predict tree growth (dendroecology) but also to reconstruct past climates (dendroclimatology). Process models have been used for several decades in dendroclimatology (Fritts et al, 1991), but recently developed model-data fusion approaches have generated significant progress in modeling tree-growth as a function of climate and in reconstructing past climates (Guiot et al, 2014). Model-data fusion (MDF) approaches, mainly based on the Bayesian paradigm, have been shown to be powerful for both model calibration and model inversion. After a rapid survey of tree-growth modeling, we illustrate MDF with examples based on series of Southern France Aleppo pines and Central France oaks (Boucher et al, 2014). These examples confirm that CO2 fertilization of tree growth during the industrial era could bias climate reconstructions inferred from tree rings proxies. This bias could be extended to other environmenta,l non-climatic factors directly or indirectly affecting annual ring formation and not taken into account in classical empirical models, which supports the use of more complex process-based models.

Cited references:

Boucher, E., Guiot, J., Hatte, C., Daux, V., Danis, P., and Dussouillez, P. (2014). An inverse modeling approach for tree-ring-based climate reconstructions under chang-

ing atmospheric co2 concentrations. Biogeosciences 11, 3245–3258. doi:10.5194/bg-11-3245-2014

Cook, E., and Kairiukstis, L. (1990). Methods of Dendrochronology. Applications in the Environmental Sciences. Dordrecht: Kluwer Academic Publishers. doi:10.1007/978-94-015- 7879-0

Fritts, H., Vaganov, E., Scviderskaya, I., and Shashkin, A. (1991). Climate varia- tion and tree- ring structure in conifers. empirical and mechanistic models of tree-ring width, number of cells, cell size, cell-wall thickness and wood density. Climate Res. 1, 97–116. doi: 10.3354/cr001097

Guiot J, Boucher E and Gea-Izquierdo G (2014) Process models and model- data fusion in dendroecology. Front. Ecol. Evol. 2:52. doi: 10.3389/fevo.2014.00052

Keywords: *dendrochronology, tree-growth, process model, carbon fertilization, inversion*

Process-based modelling of forest performance under climate change and rising CO_2: a process-based approach using multi-proxy data

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Abstract

Climatic variability limits gross primary productivity (GPP) and carbon allocation differently in relation to environmental forcing. This relationship can be complex, therefore its variability can only be addressed by process-based forest models. Generally, empirical models have been preferentially used in dendrochronological studies. However, it is necessary to better address the interaction between climate and other factors such as CO_2 to properly assess the instability in the climate-growth response expressed by trees and increase the accuracy of the modelled relationships both in forward and inverse models. In this study we developed an existing mechanistic model MAIDEN (Misson 2004) originally implemented with dendrochronological data. To obtain unbiased estimates of forest productivity, the model was first calibrated to fit a combination of eddy covariance CO_2 flux data, dendrochronological time series of secondary growth and forest inventory data at two Mediterranean evergreen forests (Gea-Izquierdo et al. 2015). Among other differences with the original formulation, the model is now climate explicit in the key processes addressing acclimation of photosynthesis and the pattern of carbon allocation. It succeeded to fit both the high- and the low-frequency response of stand GPP and carbon allocation to the stem as calculated from tree-ring chronologies. Simulations suggest a decrease in mean stomatal conductance in response to environmental changes and an increase in mean annual intrinsic water use efficiency in both species during the last 50 years. However, this was not translated on a parallel increase in simulated ecosystem water use efficiency. A long-term decrease in annual GPP matched the local trend in precipitation since the 1970s observed in one site. In contrast, GPP did not show a negative trend and the trees buffered the climatic variability observed at the site where long-term precipitation remained stable. Long-term trends in GPP did not match those in growth, in agreement with the C-sink hypothesis. This model has a great

potential to be used with abundant dendrochronological data to analyse future forest performance under climate change, rising CO2 and also in dendroclimatic reconstructions. In this sense, on a second step in this study the model is validated using a network of chronologies in the Western Mediterranean Region. This kind of modelling could help to understand how different interfering factors produce divergence in the climatic signal expressed in tree-rings.

Gea-Izquierdo G et al. (2015) Modelling the climatic drivers determining photosynthesis and carbon allocation in evergreen Mediterranean forests using multiproxy long time series. Biogeosciences 12, 3695-3712.

Misson L (2004) MAIDEN: a model for analyzing ecosystem processes in dendroecology. Canadian Journal of Forest Research 34, 874-887.

Keywords: *process-based model, vulnerability, water use efficiency, Mediterranean*

VS-oscilloscope: New tool of dendrochronological modeling

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Abstract

Growth of tree-ring and wood formation strongly affected by climatic variations. The process- based tree-ring VS-model for standardized tree ring width variations is a nonlinear function of daily climatic variables which allows to estimate a climatic signal in tree rings (Vaganov et al., 2006). We developed a new visual approach of process-based tree-ring model parameterization (so-called VS-Oscilloscope), which allows to simulate a tree-ring growth and cell formations.

Major difference and advantage of VS-Oscilloscope, in comparison with earlier versions of the model, is an ability to select certain parameter values that allow to get a best fit of simulated tree-ring growth curve to observed tree-ring width (Tychkov et al., 2015). VS-Oscilloscope is a computer software with graphical interface, based on Lazarus - free cross-platform integrated development environment using the Free Pascal compiler. VS-Oscilloscope contains 2 different window sheets: 1) Open Data, where users should upload the files of initial parameters values, climatic data, tree-ring chronology, etc.; 2) The Model Parameterization contains scroll-bars for most parameters of the model, such as minimum temperature for tree growth, critical growth rate and etc.. Values of the parameters can be changed manually in the Model Parameterization. Any changes in the scroll-bars positions will lead to a recalculation of the simulated curve with new settings of the data. In this case, the visual display automatically redraws the new simulated growth curve. (Tychkov et al., 2012).

VS-Oscilloscope was successfully tested on dendrochronological data from different regions of Siberia, Central Asia and Mediterranean. The model outputs have shown differences in seasonal tree-ring growth between species that was well supported by the field observations.. To better understand the seasonal tree-ring growth and to verify the VS-model findings, a multi- year natural field study is needed, including seasonal observation of thermo-hydrological regime of soil, duration and rate of tracheid development, as well as measurements of their anatomical features.

The work was supported by the RScF project # 14-14-00219 References

Tychkov, I.I., Koyupchenko, I.N., Ilyin, V.A., Shishov, V.V., 2015. Visual simulation V-S model parameterization and its application in dendroecology. SFU Journal. Biological series (accepted to print)

Tychkov, I.I., Leontyev, A.S., Shishov, V.V., 2012. New algorithm of tree-ring growth model parameterization – VS-oscilloscope and its application in dendroecology. Systems. Methods. Technologies 4(16), 45-51. (in Russian)

Vaganov, E.A., Hughes, M.K., Shashkin, A.V., 2006. Growth Dynamics of Conifer Tree Rings: Images of Past and Future Environments. Springer. Berlin - Heidelberg, 358 pp.

Keywords: *VS-oscilloscope, parameterization, process-based VS-model, tree-ring chronology*

Inter- and intra-annual xylem variability of Fagus orientalis from Northeastern Turkey

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Abstract

The xylem in trees performs multiple functions such as water transport, storage, and stability, and its structure may reflect a trade-off between these functions. These trade- offs are partly visible in the variability of the xylem structure, which makes the xylem a natural archive for past environmental conditions.

In this study, we explored the wood anatomy of mature *Fagus orientalis* trees from an old-growth temperate rainforest site in Northeastern Turkey. Image analysis with ROXAS was used to measure tree-ring widths and wood anatomical traits on microscopic images of the outmost 60 rings. Additionally, the rings were divided into four sectors to analyze their properties at an intra-annual resolution. For the rings and sectors, chronologies of several anatomical parameters, including mean vessel area, theoretical hydraulic conductivity, and vessel grouping were produced. We examined the wood-anatomical responses to climate and compared the intra-annual xylem structure between wide and narrow rings.

Compared to ring width, wood anatomical traits were more complacent and had lower common variability between trees. Radial growth was positively influenced by temperatures in May and June. Vessel size was positively correlated with ring width. In narrow rings, the sizes of vessels in sectors formed during different parts of the growing season were strongly correlated to each other, indicating a shorter growing season and/or a lower responsiveness to environmental variability during the season. In wider rings, the vessel sizes in different sectors were more independent from each other, suggesting a higher capacity of the xylem structure to adjust to changing conditions during the growing season. This also indicates a strong potential for intra- annual analyses of climate responses. Indeed, the size of vessels formed early in theseason was mainly influenced by conditions of the previous year, while the vessel size in sectors formed later in the season contained a relatively strong midsummer precipitation signal.

Our results demonstrate the potential of wood-anatomical analyses at the intra-annual time scale to yield information on the process of xylem formation and its responses to climate. Although very narrow tree rings can yield valuable information on inter-annual variability in climate, trees show more plasticity in intra-annual wood formation during good years. Wider rings could therefore be more useful for analysis of climate responses at a high temporal resolution.

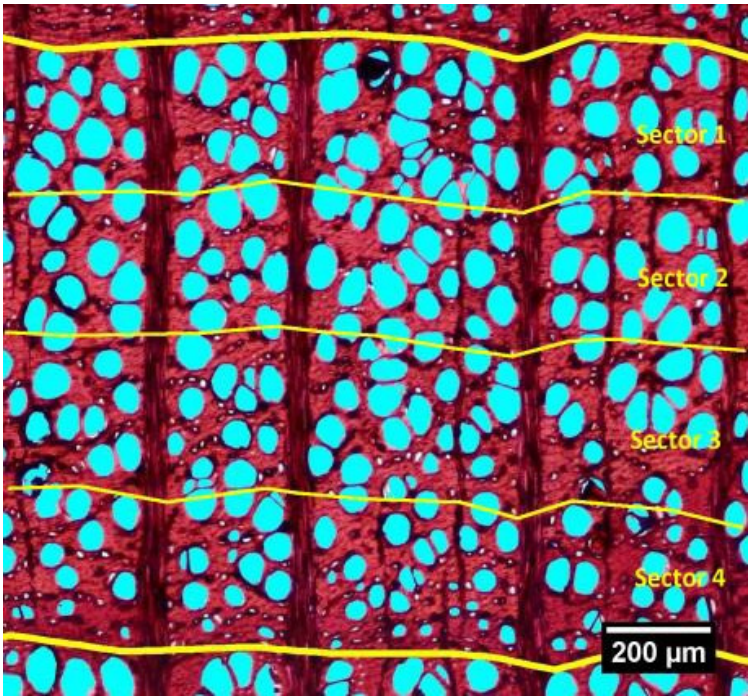

Figure 1. Part of a thin section of a F. orientalis core with measured vessels colored blue, and tree-ring boundaries and division into sectors shown in yellow.

Keywords: *wood anatomy, vessel size, intra-annual, climate response, Fagus orientalis, Colchic forest*

Modified approach of cambial activity simulation in tree rings

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Abstract

Climatic factors such as daily temperature, precipitation and solar irradiance have a significant impact on the seasonal tree growth and tree rings formation. Their reconstruction based on variation of tree-ring growth and cell profiles allows to estimate a variability of environment conditions and to restore climate changes in the past. Using the new parameterization approach of the process- based tree-ring VS-model - VS-oscilloscope (Tychkov et al., 2015), daily tree- ring growth rates can be obtained and then transformed to cell growth rates and simulated cell sizes based on a modified algorithm of cambial activity simulation. The approach was tested on tree-ring samples and cell measurements obtained for Scots pine trees (Pinus sylvestris) from two different regions of Siberia: the central part of the Republic of Yakutia (Russia) and the Khakassian region (Russia) (Popkova et al., 2015). Cambial activity and seasonal cell production were estimated based on the new modeling approach. Moreover the approach allowed to decode a tree-ring growth signal into climatic and non-climatic components. The work was supported by the RScF project # 14-14-00219

References

Tychkov I.I., Koyupchenko I.N., Ilyin V.A., Shishov V.V. 2015 Visual simulation V-S model parameterization and its application in dendroecology. SFU Journal. Biological series (accepted to print)

Popkova M.I., Tychkov I.I., Babushkina E.A., Shishov V.V. 2015 A modified algorithm for estimating the radial cell size in the Vaganov-Shashkin simulation model. SFU Journal. Biological series (accepted to print)

Keywords: *tree ring, process-based model, growth rate, cambial activity, cell size*

The effect of intra-annual changes in rainfall pattern on Wood formation of Beech and Oak in Caspian forests, Iran

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Abstract

Beech (*Fagus orientalis*) and oak (*Quercus castaneifolia*) are the ecologically and economically most important tree species in the Caspian forests of Iran. It is therefore important to know how these two different hardwoods will react to climate change scenarios. To investigate this, wood formation of two species was monitored during the years 2011 and 2012 by micro-coring technique. Four dominant trees with similar diameters were selected of each species in a natural mixed forest in Koliak area inside the central part of Caspian forests at ca. 1500 m a.s.l. The sampling was done bi- weekly from April to October and micro-cores were further processed for light microscopic studies using conventional methods. High resolution local climate data were logged by an automated weather station located about 1 km from the study site at the same altitude.

Results showed that the pattern and timing of wood formation was the same in two consecutive years and the major part of the tree-rings has been formed in May-July for both species: (ca. 80% for beech and ca. 78% for oak). However, the total radial growth in 2012 was significantly higher than in 2011 in both species. Beech trees formed considerably wider rings in 2012 (98% wider) while the corresponding increase was moderate for oak (27%). Since the sum of precipitation and mean air/soil temperature from previous October to current September showed extremely low variations in two years (only 55 mm more rainfall and 0.2 °C higher temperature in 2012), the intra-annual distribution of climatic parameters and not their total/mean values was attributed to cause the higher growth in 2012. The year 2011 experienced a pronouncedly hotter and drier July, while climate was more favorable in other months of the 2011 growing season. Beech, a diffuse-porous species, reacted sensitively to this change in seasonal climate while the radial growth in ring-porous oak was more steady and indifferent in two years. Thus, we expect that under scenarios of more frequent summer droughts, beech may suffer stronger increment reductions than oak.

Keywords: *Climate change, ring-porous species, diffuse-porous species, rainfall pattern, Wood formation*

Can resistograph be used as a practical tool for the annual ring measurement of pines?

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Abstract

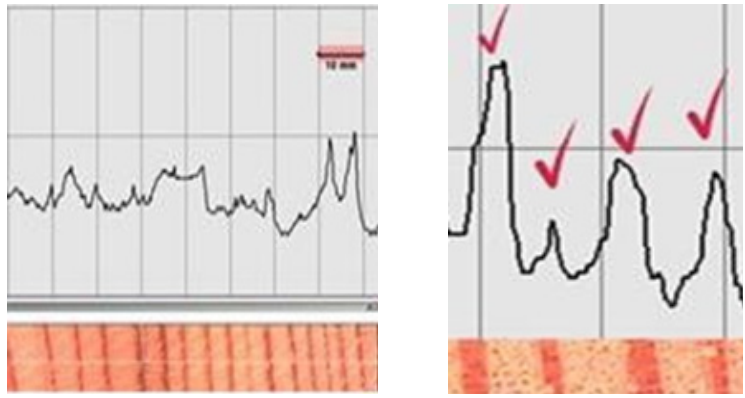
In forestry, increment coring is the common way which used for annual ring measurement in all around the World. Although this is considered a non-destructive method, in fact it is semi-destructive sampling method. Indeed, depending on the core diameter (increasing the diameter) this can be considerably destructive for living trees.

Resistograph is an instrument that penetration resistance of a fine drill needle is measured and recorded. In recent years the use of Resistograph has been widening for the purpose of non-destructive evaluation of some properties of standing trees. In fact this method is quasi non-destructive, since the diameter of the needle is very small that the weakening effect caused by the whole is negligible. Because of this negligible destruction many researcher mentioned it as a non-destructive instrument.

Resistograph provides a graphic representation (resistogram) of the energy which is consumed by the electric engine in penetrating the sample. Thus, given the internal constitution of the wood, a series of variables can be determined relating the characteristics of the material. The total energy consumed in penetrating the sample is closely related to the material density. Due to anatomical nature of pines, early wood and late wood are separable depending on density. Denser wood (late wood) formed at the end of the growth ring. Thus, the resistogram appears as a succession of peaks and valleys, corresponding to the varying difficulty in penetrating early and latewood part of annual rings (Figure 1a and b).

The study was mainly carried out to investigate the applicability of the Resistograph (IML RESI F500-S), as an efficient and a practical tool, for the determination of annual ring widths. For this purpose increment core samples and Resistograph data were collected from different age and type of Pinus brutia stands from Mediterranean region of Turkey for a project (TUBİTAK 110-O-560). Field works were carried

out at five experimental areas (Gölhisar, Pamucak, Karadağ, Melli and Kepez) which are remaining in the borders of Isparta, Burdur and Antalya cities. Ring properties measured on increment cores via image analysis method and compared to ring data obtained from resistograms. Normally an additional software module (including export option) must be purchased to obtain each amplitude values. But, in this study a free and easy way which allows exporting data without any additional purchased module developed and used.



a b

Figure 1. Match between resistogram peaks and late wood part

Results showed that Resistograph can be used for determining the width of the annual rings of pines, only if some specific circumstances are met. For example; drilling direction must be perpendicular to the direction of annual rings and passed through the pith. Working with relatively small-diameter trees would be better than larger ones. For successful results, annual ring widths should be higher than 1 mm. Intra annual density fluctuations can cause to determine more rings. Unexperienced people working with this instrument and software can cause errors etc. In this case for 50 trees, which consist of %14 of total trees, most of requirements were met and Pearson correlation coefficient found as 0.97. It means that this instrument is very promising to determine individual ring with in Pinus brutia and other pine species which have similar annual ring structure if all requirements fulfilled. However, we determined mostly (%78) more rings and lower ring width than increment cores, and less rings (larger ring widths) for the rest of sample trees (8% of total sample trees) using Resistograph data. These results clearly showed that the device or/this technique should be improved to meet most of these requirements in particular correct drilling direction for successful individual ring width measurement.

Keywords: *Pinus brutia, Resistograph, annual ring, NDE (Non-destructive evaluation)*

Maximum Latewood Density - X-ray densitometry vs Cell based density

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Abstract

Maximum latewood density (MXD) of coniferous tree rings is the most reliable measurement to reconstruct growing season temperatures. Especially late summer temperatures show high correlations to MXD values. Although technical advances resulted in alternative methodologies to determine density variations in annual rings of conifers as e.g., blue reflectance, x-ray tomography or high frequency densitometry, the procedure most commonly used still is x-ray densitometry. This technique is set as a standard for MXD determination and all new techniques are verified (or falsified) against values measured using this standard technique.

In recent years, wood anatomical analyses came more and more into play focusing on a more detailed analysis of environmental factors causing changes in the anatomical structure of annual rings. Analyzing the variations of cell characteristics in relation to e.g., mechanical impacts or temperature variations proved to be applicable for a highly resolved, intra-annual reconstruction of past environmental conditions.

Wood anatomical analyses require the preparation of micro sections. These sections are mostly restricted to small specimen of a few centimeters in length. Consequently, the adaption of wood anatomical parameters to an intense time-series analysis was extremely labor intensive. The most recent development of a sectioning technique to cut micro sections off entire increment cores (up to 40 cm in length) helped solving this problem. Using this technique, preparation time in wood anatomy is reduced to a minimum and micro images of entire increment cores can be taken within a few hours of time.

Against this background, an earlier approach to determine maximum latewood density of conifer rings based on cell measurements was tested in more detail against x-ray densitometry by using the same samples for both techniques. The cores taken

for this test (*Larix decidua* Mill.) were prepared following the standard procedure for x-ray densitometry. The resulting laths (thickness:1.25 mm) were used to produce the x-ray images and thereafter glued on wooden mounts to cut micro sections off for subsequent anatomical imaging and measurements.

Results presented in this presentation show, that specific formulas adapted to the values of cell parameters as cell wall thickness and lumen length allow for a detailed calculation of density values along each ring. The maximum density values extracted for each ring correspond to the values measured by x-ray densitometry. Consequently, this new technique combined with the new preparation techniques of entire cores will allow to establish a new technique at least having the potential to substitute x-ray densitometry in near future.

Keywords: *Wood anatomy; Dendroecology, time-series analyses, Densitometry*

Collecting tracheid anatomical data: State of the art and opportunities

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Abstract

In nature, structures and functions are always very closely inter-connected. This is also true for the xylem, which tissue needs to constantly and contemporaneously fulfill multiple functions. Being able to guarantee an efficient and safe sap transport and mechanical stability require enough plasticity to optimally regulate the numerous functional trade-offs.

The anatomy of cell conduits along series of dated tree-rings can be considered as a ecological archive of how the trees have adjusted their structure under changing environmental conditions. More and more studies are now making use of intra-annual tree-ring anatomy to explore how the environment affect the xylem structure and impact its functioning. There is now the opportunity to centralize and homogenize all these data in a collection to explore for global patterns of responses across species and environments.

Here we will present the state of the art of the current data collection and demonstrate with few examples how this data can be used for improving our mechanistic understanding of the processes linking environment, xylem structure, and tree performance.

Keywords: *lumen diameter, cell wall thickness, time-series, global patterns, intra- annual*

A proteomic approach to the study of the phenology of cambial activity in *Larix decidua*

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Abstract

The last decade has been prolific in studies on cambial activity dynamics and tree ring development based on the regular collection of cambial region and differentiating wood tissues during the growing season. These studies provide a detailed insight concerning the tree's response to changing climatic conditions reflected by the variability in its wood-anatomical characteristics and extent of the growth season across different years, species, and ecosystems. The intra-annual variability in wood formation was however, only observed at the anatomical level leaving out the aspects related to the complex gene expression programme lying at its origin. Proteins represent the ultimate result of the expression of protein-encoding genes. Proteomic studies in forest trees have shown that climatic stress, such as drought and extreme temperatures, induce differential protein expression patterns. Proteomics is a recent, flourishing field and a fundamental research area in the post genome era. However, very few studies have mapped the proteome of wood tissues in mature trees stems (e.g. Gion et al. 2005; Paiva et al. 2008).

The present work reports on the first attempt to apply proteomic analysis to the monitoring of tree ring development and introduces a novel dimension for dendrochronology: differential expression of stress-related proteins.

In order to achieve our goal we have been following the cambial activity and wood formation of *Larix decidua* Mill. during the 2015 growth season, at a high altitude forest stand in Slovenia. In each of the 10 selected trees we are performing, at weekly intervals, a double sampling of the stem, which started shortly before cambial reac-

tivation (day of year 140), in order to collect wood forming tissues by: a) extracting wood microcores for anatomical analysis; and b) collecting a wood block containing the cambial region, developing xylem and phloem increments as well as previous tree rings. This wood block is immediately placed in liquid nitrogen to prevent the degradation of proteins and later processed in the lab by scraping off the differentiating wood for proteome analysis. For the anatomical analysis of wood microcores we employ standard microtomy, microscopy, and image analysis techniques (e.g Gricar and Cufar 2008). For proteome analysis we are optimising existing protocols for protein extraction, followed by protein separation with electrophoresis, and characterization through mass spectrometry methods (Gion et al. 2005; Paiva et al. 2008) resorting to databases accessible online (e.g. PROTICdb for maritime pine wood proteome). Using bioinformatic tools, we will scan for similarities and dissimilarities among the collected proteomic snapshots, and the corresponding wood-anatomical features taken throughout the period of cambial activity. We expect to identify the proteins that are being under- or over-expressed throughout the growing season and to understand how it translates in the anatomy of the formed wood.

References

Gion JM, Lalanne C, Le Provost G, Ferry-Dumazet H, Paiva J, Chaumeil P, Frigerio JM, Brach J, Barré A, Daruvar A, Claverol S, Bonneu M, Sommerer N, Negroni L, Plomion C. 2005. The proteome of maritime pine wood forming tissue. Proteomics 5: 3731-3751.

Gricar J, Cufar K. 2008. Seasonal dynamics of phloem and xylem formation in silver fir and Norway spruce as affected by drought. Russian Journal of Plant Physiology 55: 597-603.

Paiva JA, Garcés M, Alves A, Garnier-Géré P, Rodrigues JC, Lalanne C, Porcon S, Le Provost G, Perez Dda S, Brach J, Frigerio JM, Claverol S, Barré A, Fevereiro P, Plomion C. 2008. Molecular and phenotypic profiling from the base to the crown in maritime pine wood-forming tissue. New Phytologist 178: 283-301.

Keywords: *lxylogenesis; stress; tree growth; protein expression; vascular cambium*

Experimental exposure of spruce (*Pice abies* L. Karst.) roots

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Abstract

In the last decade, wood anatomy changes within exposed roots have become a useful tool in the analysis of erosional processes (Gartner et al. 2001; Corona et al. 2011). The question that remains unanswered and affects the estimation of the amount of material removed from roots by erosional processes is the position (depth) of a root within the soil prior to exposure. Therefore, an analysis of anatomical changes within roots exposed from a different depth in the soil was the main objective of the study. The main question in the study concerned the reaction of roots to exposure in terms of different depth in the soil. Artificially-induced Anatomical Reactions (AiAR) of roots such as commonly used earlywood (EW) and latewood (LW) changes (Gartner et al. 2001) were taken into account. The experiment was set initiated in 2010 (May and August) by exposing spruce roots at ten plots located on a slope without signs of strong erosion. Between 5 and 10 spruce roots growing at a different depth from 1 cm below ground to more than 22 cm were exposed on each plot. The thickness of soil cover (mineral and organic, measured separately) was measured every 10 cm along the entire length of the root. Additionally, geodetic measurements were performed to ensure correct location of roots within the soil. In 2013 ten roots obtained from the study area were taken for further analysis. Parts of roots growing at less than 3, 5, 10, 15 and more than 20 cm below ground were taken into consideration and serial-sectioned. Additionally, parts of roots still found in the soil were taken as a reference for

exposed parts of roots. AiAR were not the same for all the analyzed roots. Substantial variability of AiAR was observed within small distances (1.5-

2.5 cm) in the longitudinal profile of the studied roots. AiAR either did not occur or was marginal in the majority of roots exposed at five or less cm below ground. Changes in wood anatomy had occurred before the manmade exposure of roots growing at less than three cm below ground. Cross-sectional and longitudinal variability in AiAR was noted for the majority of roots exposed at more than 15 cm of depth. Changes in wood anatomy were observed for 10% of parts obtained from the analyzed roots in the year of exposure.

The remaining roots exhibited the first EW and LW changes in 2011 or one year after exposure.

References:

Corona C., Saez J.L., Rovera G., Stoffel M., Astrade L., Berger F., 2011, High resolution, quantitative 334 reconstruction of erosion rates based on anatomical changes in exposed roots at Draix, Alpes 335 de Haute-Provence — critical review of existing approaches and independent quality control 336 of results. Geomorphology, 125, 433– 444.

Gärtner, H., Schweingruber, F.H., Dikau, R., 2001. Determination of erosion rates by analyzing structural changes in the growth pattern of exposed roots. Dendrochronologia 19(1), 81-91.

Keywords: *spruce, root, wood anatomy, experimental exposure*

Plasticity of European beech vessels in response to thinning and climate

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Abstract

European beech (*Fagus sylvatica* L.) is the most abundant broad-leaved forest tree species in Central Europe, and because of its high ecological and economic value it is one of the most important hardwood tree species for forest management in this region. This demands for profound research to examine the adaptive capacity of beech forests to changing environmental conditions.

Analysis of wood anatomical structures has developed into a valuable dendroecological tool for studying environment-growth relations of trees. However, due to the laborious methodology for quantitative wood anatomy of broadleaves not many studies have been conducted on those jet.

The aim of our research was to investigate the wood anatomical structures of European beech trees growing on two opposite expositions, and under different thinning regimes.

Increment cores of 24 sample trees were collected from both expositions across a valley in southwestern Germany. Thin sections were prepared with a sledge microtome, stained with safranin astrablue, embedded in Canada balsam, oven dried and scanned under a transmitted light microscope at 20X magnifications. Images were processed with Image Pro Plus and Roxas software.

The treatment had a significant effect not only on tree-ring width but as well on all analysed cell structure and derived parameters (vessel density, mean vessel size, total vessel area and hydraulic conductivity). With increasing tree-ring width the total vessel area per tree-ring is reduced but the accumulated potential hydraulic conductivity is considerably increased. The difference between expositions was noticeable for vessel size but very strong for vessel grouping index, trees on the southwestern slope having more and larger groups of vessels. Our results provide a better understanding of beech xylem plasticity as well as its adjustment to climate warming and contribute new arguments in the actual discussion on the safety-efficiency trade-off in the xylem of broadleaves.

Keywords: *Fagus sylvatica, xylem plasticity, wood anatomy*

Species plasticity to extreme weather conditions in permafrost zone of Central Siberia

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Abstract

Global warming is most pronounced in high-latitude regions by altering habitat conditions and significantly influencing tree productivity and vegetation changes. Within this study we aimed at determining which limiting factors control tree-growth and estimating which tree species (deciduous, conifer deciduous or conifer evergreen) is more plastic under possible climate changes in permafrost zone. A tree-ring parameters of mature *Larix gmelinii* (Rupr.) Rupr., *Betula pubescens* Ehrh. and *Picea obovata* Ledeb. from Siberia (Russia, 64°N, 100°E) were used to identify the physiological principle of responses related to the structural-functional changes of wood. Multiparametric tree-ring chronologies were analyzed and correlated with climatic parameters over the last 77 years. Variability of tree-ring width and xylem structural characteristic under climatic conditions of particular years indicated that an increased spring temperature will initially lead to increase of tree growth. However, due to an increased use of water through transpiration, the tree growth could progressively shift from a temperature to a moisture limited.

Keywords: *boreal forest, tree-ring width, xylem anatomical parameters*

Factors controlling wood formation dynamic in a Mediterranean beech forest

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Abstract

The onset and the rate of wood formation during growing season is controlled by internal and external factors. Hence, a better knowledge of the factors controlling wood formation and consequently intra annual growth is essential for a reliable understanding of the impact of anthropogenic, such as forest management, and environmental changes on ecosystem functioning.

The aims of this study were: (1) defining wood formation dynamic in a Mediterranean beech forest, (2) evaluating the physiology and climate effect on wood formation, (3) assessing competition effect on intra-annual radial growth.

The experiment was carried out from April till November 2014, in a beech stand of Central Italy. The study site is equipped with an eddy-covariance tower measuring the exchange of CO_2 and a meteorological station. Using a trephor tool, micro-cores were extracted from 5 trees to assess wood formation dynamics. The carbon isotope composition (δ13C) of leaves, collected in May and August, was used as a proxy to detect differences in tree physiological responses. Intra-annual radial growth (phloem and xylem) was monitored on 10 trees using permanent girth measurer (UMS). The formation of xylem and radial growth were analysed with the Gompertz function. Competition index was calculated in two steps: in the first step, for each tree, the neighbouring trees that compete with the target tree for resources were determined. In second step, the strength of competition from each of the neighbours identified on that tree was calculated.

Observation of cambium and newly formed xylem showed that the dormant cambium contained 3–5 cell layers. Divisional activity in the cambium started in the period between 14 and 28 May when the number of cambial cells increased to approximately

eight till ten cell layers. Divisions in the cambium stopped from the end of August till mid September.

A connection among trees physiology and wood formation was very evident. There was a positive relationship between the isotope composition and xylem formation at the beginning of the growing season (Fig. 1) and when the cambium activities were decreasing. Trees with more positive δ13C using the reserves and the resources more efficiently showed higher growth rate.

At stand scale, was found a correlation between Carbon fluxes and wood formation (Fig. 2). Carbon allocation in xylem, represented by the ratio between tree ring increment and carbon uptake, wasn't constant during the growing season. It was possible to observe three phases, the first one where the ratio increased till the end of July, the second phase, was characterised by a slow decline till mid september and at the end of the growing season was observed a small increment. The C fixed by the forest from late May to the end of July was largely utilised for plant growth, as indicated by the fast increase of the new xylem. During this period the higher number of cell production was observed. During August and September, the growth decreased, this can be explained with suspension of divisions in the cambium and continuing only the development of the latest formed xylem cells.

Among the climatic parameters only the vapour pressure deficit (VPD) had a significant effect on wood formation. This climatic parameter is related to stomata transpiration, if trees can supply to atmosphere request, an higher photosynthesis rate can increases the carbon uptake and rate of xylem formation. In the study site the request of water from atmosphere was satisfied during the period of Maximum wood formation.

All Gompertz parameters describing intra-annual growth were affected by competition(Fig. 3). These results demonstrated that competition and forest structure plays a crucial role in trees growth.

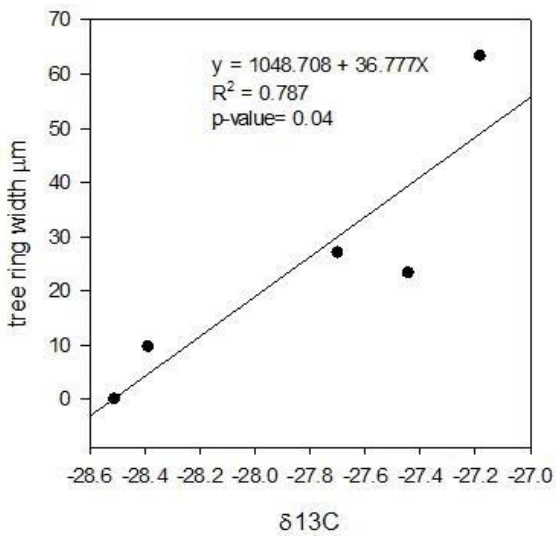

Figure 1. Correlation between $\delta^{13}C$ and tree ring width µm

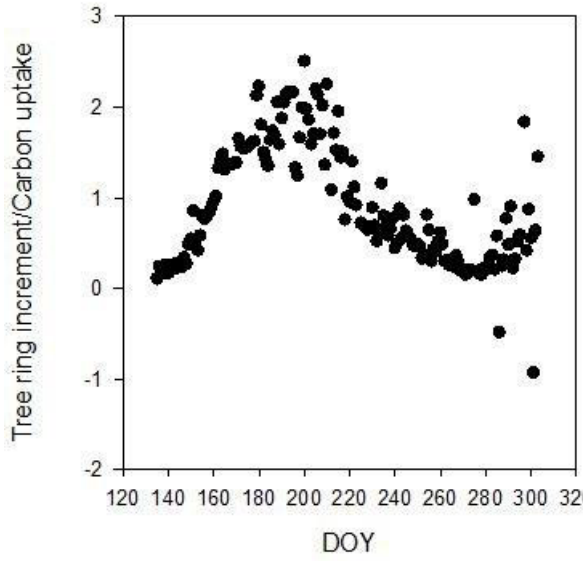

Figure 2. Ratio between tree ring increment and carbon uptake

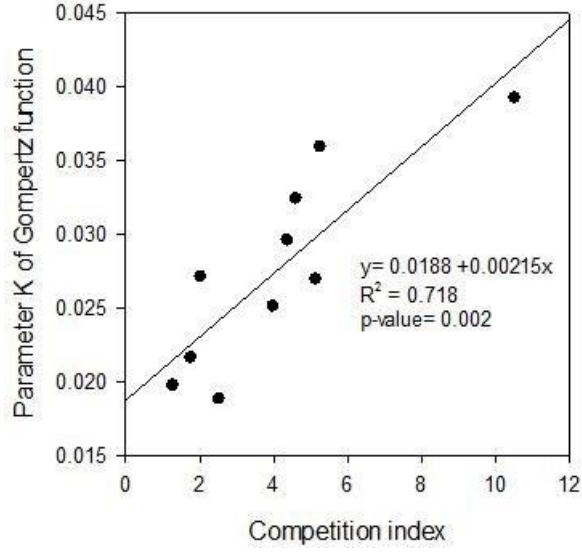

Figure 3. Effect of competition on parameter K of Gompertz function

Keywords: *European beech= Fagus sylvatica, wood formation, carbon isotope, competition, allocation*

Adjustment capacity of maritime pine cambial activity in drought-prone environments

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Abstract

Intra-annual density fluctuations (IADFs) are anatomical features formed in response to changes in the environmental conditions within the growing season. These anatomical features are commonly observed in Mediterranean pines, being more frequent in younger and wider tree rings. However, the process behind IADF formation is still unknown. Weekly monitoring of cambial activity and wood formation would fill this void. Although studies describing cambial activity and wood formation have become frequent, this knowledge is still fragmentary in the Mediterranean region. Here we present data from the monitoring of cambial activity and wood formation in two diameter classes of maritime pine (*Pinus pinaster* Ait.) over two years in order to test: (i) whether the differences in stem diameter in an even-aged stand were due to timings and/or rates of xylogenesis; (ii) if IADFs were more common in large trees; and (iii) if their formation is triggered by cambial resumption after the summer drought. Larger trees showed higher rates of cell production and longer growing seasons, due to an earlier start and later end of xylogenesis. When a drier winter occurs, larger trees were more affected, probably limiting xylogenesis in the summer months. In both diameter classes a latewood IADF was formed in response to late-September precipitation, confirming that the timing of the precipitation event after the summer drought is crucial in determining the resumption of cambial activity and whether or not an IADF is formed. It was the first time that the formation of a latewood IADF was

monitored at a weekly time scale in maritime pine. The capacity of maritime pine to adjust cambial activity to the current environmental conditions represents a valuable strategy under the future climate change conditions.

Keywords: *Cambial activity, Anatomy, Intra-annual density fluctuations, Drought, Mediterranean*

Mortality dynamics of conifers in the north of Central Siberia (Russia) under the impact of pollutants emitted by metallurgic enterprises

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Abstract

Forest-tundra ecosystems in northern Eurasia form a unique natural complex extremely sensitive to both natural and anthropogenic influences. In the north of Central Siberia (Russia) terrestrial and aquatic ecosystems for more than 70 years have been suffering from the strong impact of technogenic pollutants emitted by the Norilsk industry (metallurgical production). This anthropogenic pressure resulted in decrease of species diversity, transformations of species composition and degradation of forest vegetation on the territory of more than 1500000 ha around Norilsk. Here we analyze tree-ring data obtained for Siberian larch (*Larix sibirica* Ledeb) and Siberian spruce (Picea obovata Ledeb) impacted by the pollutants emitted by enterprises of Norilsk to reconstruct the mortality dynamics of larch and spruce-larch stands. Cross-dating of tree-ring width chronologies was performed to detect the year of dying off of over 500 trees at sites located from 6 to 85 km from Norilsk. The death of individual trees at the locations closest to Norilsk was recorded immediately after the first enterprises started to operate in the early 1940s. The mass mortality of the trees started in the 1960s due to the establishment of new smelters and the consequent increase in pollutant emissions. The complete destruction of the stands (100% die off of larch trees) at sites located along the main directions of pollutant air transport at the distance of up to 65 km from Norilsk occurred in the 1970s. At the most distant site (85 km), the highest rate of larch death was observed between 1975 and 1980, and in 2004 only 23% of larch trees were alive. Spruce trees are characterized by higher resistance to airborne pollution in the region. Thus, over 50% of spruce is still alive at the most distant studied site.

A comparative analysis of the tree-ring width data testified to the decrease in tree

radial growth at the period before the complete degradation of stands. Unfavorable climatic conditions became an additional factor that enhanced the rate of tree mortality due to the impact of pollutants. Although the increase in tree radial growth at the sites with surviving trees has been found in late 1990-2000s, the current status of studied trees indicated that the area of completely degraded forest ecosystems might become larger under increased pollutant emissions.

The work was supported by Russian Science Foundation (project 14-14-00295).

Keywords: *environmental pollution, conifers, tree mortality, forest-tundra, Siberia*

Is there any universal growth-mortality relationship? Insights from a new international tree-ring database

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Abstract

Most of statistical tree mortality functions implemented in dynamic vegetation models assume species- and site-independent tree mortality processes, i.e., the shape of the growth-mortality curve only changes with the stress-induced growth reduction (Bigler and Bugmann 2004; Bircher et al. 2015). However, some studies have reported that growth patterns prior to death may differ among species (e.g., Kane and Kolb 2014) and between sites with contrasted environmental conditions (e.g., Wunder et al. 2008). To assess if growth-mortality relationships are common or vary between species and between factors that trigger mortality, we compiled a unique international tree ring- width dataset consisting in 3195 dead and 4831 living trees from 34 species located in 160 sites.

Based on a logistic mixed-effects model approach, we determined which multivariate model was best at discriminating 'alive' from 'death' observations (paired sampling; Cailleret et al. submitted). This best model included 4 explanatory growth variables (Gx in eq. 1) calculated over optimized time windows (nx: number of years prior to the alive/death observation):

-mean RWnx: average ring-width of the last n years.

-slope RWnx: slope of the linear regression fitted to RW data over the last n years.

-SDnx and A1nx: standard deviation and lag-1 autocorrelation of the rings calculated using an autoregressive model fitted to the detrended RW chronology of length n.

$$log\left[\frac{Pr(Y_{i,t}=1)}{(1-Pr(Y_{i,t}=1))}\right]=\alpha_0+\sum_{x=1}^{x=4}(\beta_{0x}+\beta_{sx})*Gx_{i,t,nx}$$

where Pr(Yi,t) follows a binomial distribution with Yi,t = 0 indicating that tree i is dead at time t, while Yi,t = 1 indicates that the tree is alive. α0 is the intercept. The "common" growth-mortality relationship was provided by the fixed effects of the model (β0x). To consider that growth-mortality relationships may change among sites, random effects were estimated for the growth variable (i.e., the slope), with study site as the grouping variable (βsx ~ N(0,σ2)). The model was built using differential evolution optimizati on βsx algorithms in order to maximize its AUC (Area Under the receiving operator characteristics Curve).

The performance of the multi-site mortality model was correct (AUC = 0.749; AIC = 7809.4) and higher than a model without random effects (AUC = 0.684; AIC = 8020.7) indicating that growth-mortality relationships changed among sites. However, there was a high variability among species in terms of model performance (AUC ranged between 0.5 and 1), that was not dependent on species type (Genus; evergreen vs. deciduous…; Fig. 1). On average, the best predictor in tree status was mean RW of the last 3 years, which was positively related to survival (Table 1). The coefficient of this relationship showed a high variability among sites that did not seem species-specific or related to the main factor that triggered mortality (Fig. 2; similar result with the other variables).

Although various aspects of tree growth can be powerful predictors of tree mortality, growth-mortality relationships seem to be neither universal nor species-specific, but rather site-dependent. They may be dependent on the factors that triggered mortality, but this was not observed on our dataset, probably due to the interactions between them and the difficulty to attribute the causes of mortality on the field.

Table 1: Characteristics and summary statistics of the best logistic model. In the present study time windows were tested between 1 and 20 years. The effect size of the fixed effects indicates the proportion of the total variance in predicted survival probability explained by the variation in each explanatory variable and was calculated using variance analysis techniques.

	Best time window (n)	Estimate	p-value	Effect size (%)
Intercept		-0.54	p<0.001	
mean RW	3	1.88	p<0.001	75.7
slope RW	3	0.85	p<0.001	8.0
SD	12	-1.30	p<0.01	3.5
A1	19	-0.57	p<0.001	12.8

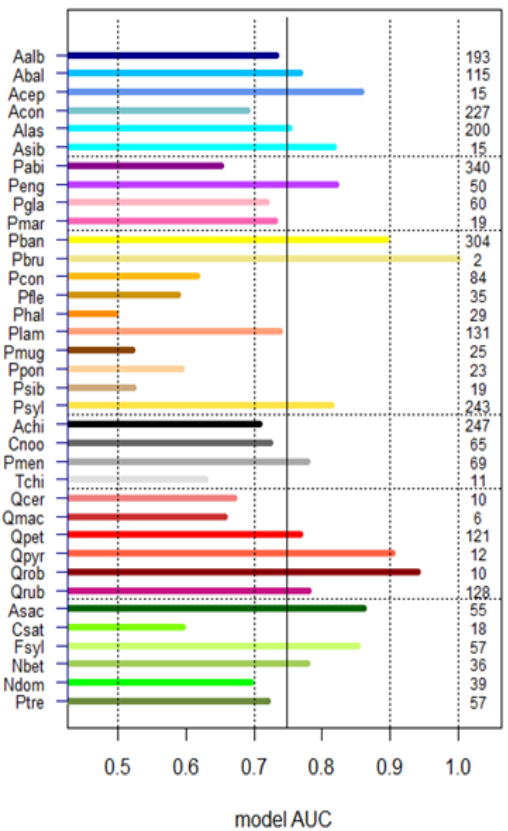

Figure 1. AUC of the best logistic model calculated for every species included in the database. The number of pairs sampled for each species is indicated in the rightmost part of the figure. Aalb: Abies alba; Abla: Abies balsamea; Acep: Abies cephalonica; Acon: Abies concolor; Alas: Abies lasiocarpa; Asib: Abies sibirica; Pabi: Picea abies; Peng: Picea engelmannii; Pgla: Picea glauca; Pmar: Picea mariana; Pban: Pinus banksiana; Pbru: Pinus brutia; Pcon: Pinus contorta; Pfle: Pinus flexilis; Phal: Pinus halepensis; Plam: Pinus lambertiana; Pmug: Pinus mugo; Ppon: Pinus ponderosa; Psib: Pinus sibirica; Psyl: Pinus sylvestris; Achi: Austrocedrus chilensis; Cnoo: Callitropsis nootkatensis; Pmen: Pseudotsuga menziesii; Tchi: Tamarix chinensis; Qcer: Quercus cerris; Qmac: Quercus macrocarpa; Qpet: Quercus petraea; Qpyr: Quercus pyrenaica; Qrob: Quercus robur; Qrub: Quercus rubra; Asac: Acer saccharum; Csat: Castanea sativa; Fsyl: Fagus sylvatica; Nbet: Nothofaugs betuloïdes; Ndom: Nothofagus dombeyii; Ptre: Populus tremuloïdes.

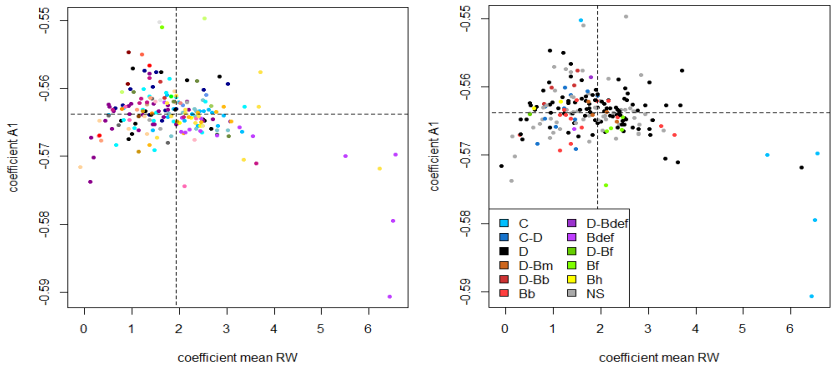

Figure 2. Site-specific coefficients of the effect of mean RW (x-axis) and A1 (y-axis) on tree survival probability. These coefficients were calculated by adding the estimates of the fixed effects (Table 1) with the conditional means of the random effects for both growth variables. The different colors of the dots symbolize the species studied (Left; same color code than Fig. 1) and the main factor that triggered mortality (Right; according to data providers) on each site. C: Competition; D: Drought; B: Biotic; Bm: mistletoe; Bb: Bark beetle; Bdef: insect defoliator; Bf: fungi; Bh: herbivory. NS: Not specified

References

Bigler and Bugmann (2004) Predicting the time of tree death using dendrochronological data. Ecological Applications 14:902-914.

Bircher et al. (2015) The agony of choice: different empirical models lead to sharply different future forest dynamics. Ecological Applications 25:1303–1318.

Cailleret et al. (submitted) Towards a common methodology for developing logistic tree mortality models based on ring-width data. Ecological Applications

Kane and Kolb (2014) Short- and long-term growth characteristics associated with tree mortality in southwestern mixed-conifer forests. Canadian Journal of Forest Research 44:1227-1235.

Wunder et al. (2008) Growth-mortality relationships as indicators of life-history strategies: a comparison of nine tree species in unmanaged European forests. Oikos 117:815-828.

Keywords: *Tree mortality, growth, tree-ring, model*

Relating drought effects to abrupt growth decreases of major tree species in Switzerland

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Abstract

Drought may have important effects on tree growth, which is generally reflected as short- to long-term growth decreases. While a majority of studies has focussed on the annual drought-induced growth variability, relatively little is known about sustained growth decreases following drought years (Zang et al. 2014). In our study, we combine two statistical methods to facilitate the identification of climatic factors inducing abrupt growth decreases, which may eventually result in tree mortality. We collected 1200 increment cores from standing dead trees in eight plots of the Swiss natural forest reserve network, ranging from suppressed to dominant trees. Five of the most important Central European tree species were considered including *Abies alba, Picea abies, Fagus sylvatica, Quercus robur* and *Quercus petraea*. The standardized precipitation evapotranspiration index (SPEI) was calculated to provide information about plot-specific drought conditions from 1931 to 2011. In a first step, we applied linear regression models to detect structural growth changes for each sampled tree (Zeileis et al. 2002). This allowed identifying the years of abrupt growth decreases followed by long-term suppression periods. In a second step, we applied distributed lag non-linear models (DLNMs), which take both delayed effects and the non-linear relationship of the predictor (SPEI) on the response (occurrence of abrupt growth decreases) into account (Gasparrini et al. 2010). On the basis of this modelling framework, the influence of drought periods on negative changes in annual growth rates was quantified.

Results of the DLNMs revealed species-specific growth reactions to drought: In the oak species, abrupt growth decreases were more likely to occur following drought years. In contrast, this lagged effect was not observed in the other species. In spruce, f ir and beech, abrupt growth decreases occurred frequently already in the drought year. We conclude that our proposed framework allows us to relate drought intensity to the probability of abrupt growth decreases. While species-specific growth responses to drought

were identified, other environmental influences need to be considered to increase our understanding when abrupt growth decreases are to be expected.

Gasparrini, A., B. Armstrong, and M. G. Kenward. 2010. Distributed lag non-linear models. Statistics in Medicine 29:2224-2234.

Zang, C., C. Hartl-Meier, C. Dittmar, A. Rothe, and A. Menzel. 2014. Patterns of drought tolerance in major European temperate forest trees: climatic drivers and levels of variability. Global Change Biology 20:3767-3779.

Zeileis, A., F. Leisch, K. Hornik, and C. Kleiber. 2002. strucchange: An R Package for Testing for Structural Change in Linear Regression Models. Journal of Statistical Software 7:1-38.

Keywords: *abrupt growth decrease, drought, lag effects*

An overview of tree-ring studies of forest disturbance histories in Bulgaria

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Abstract

Disturbances are among the key factors shaping forest ecosystems dynamics.

A frequent problem in understanding disturbance histories is the lack of reliable historical data. In such cases tree-rings may provide a way to date disturbance events with annual or even seasonal accuracy.

We present an overview of tree ring studies on disturbances carried out in Bulgaria, Southeastern Europe. The most intensively studied forests were Norway spruce (Picea abies Karst.). Three forest landscapes in natural reserves, namely Parangalitsa, Bistrishko branishte and Beglika were analyzed. Initially the study areas were mapped based on historical aerial images and newer satellite data with the aim to distinguish forest patches. Within the patches we collected increment cores from 10 to 15 from the largest trees, live and dead standing trees at visible borders with neighboring forest patches and trees from younger cohorts. In total 2324 trees were analyzed. Data showed that at least 20% of the territory of the old-growth forest Parangalitsa was shaped by small, medium and large-scale windthrows in the last 150 years (Panayotov et al., 2011). The subalpine forest Beglika was characterized mostly by gaps which covered approximately 10% of the studied area in the last 50 years, whereas the spruce forests in Bistrishko branishte reserve were affected by large-scale windthrows, bark beetles and fires (Panayotov et al., 2015). Our data indicated that large-scale disturbances were most numerous in forests that were between 120 and 160 years old, unimodal DBH distributions, and especially those located in vulnerable topographic settings.

In the last decade studies were carried out in old-growth Pinus heldreichii and Pinus peuce forests in Pirin Mountains. Fires were dated on the basis of more than 150 increment cores collected from fire-scarred trees and intact trees in vicinity (Vasileva et al.,

submitted). Fire scars were dated as produced in 1509, 1724, 1800, 1803, 1830,

1855, 1885 and 1946. The fire year 1724 was found in trees from 3 different valleys, while 1855 and 1946 were found in two valleys. Our data provides evidence that fires are integral part of the natural dynamics of Pinus heldreichii forests. Although numerous avalanche tracks exist in these forests, to date there has been only one study carried out by Panayotov (2007) for an avalanche couloir in Pinus peuce forest on the Northwestern slope of Todorka peak. Increment cores intersectioning the whole stem were collected from 38 trees. Avalanche events were dated based on the onset of reaction wood formation, wound scars, numerous missing rings, sharp growth suppressions and traumatic resin ducts. Bigger avalanches were dated in 1818, 1837, 1887, 1899, 1906, 1916, 1931, 1937, 1944, 1955, 1958, 1963, 1965, 1969, 1973, 1982,

1987 and 1996. The 1837 and 1906 avalanches went deeper into the neighboring forest and caused subsequent formation of younger forest patches. Our data demonstrated that bigger avalanches are relatively frequent in the studied region and should be taken in consideration during the processes of land-use planning.

Acknowledgement: The data is based on projects IZEBZO143109 of SNSF, Velux Foundation Nr. 414 and DMU 02/22/2009

References

Panayotov, M., Bebi, P., Tsvetanov, N., Alexandrov, N., Laranjeiro, L., Kulakowski, D., 2015. The disturbance regime of Norway spruce forests in Bulgaria, Canadian Journal of Forest Research, in press, DOI: 10.1139/cjfr-2014-0505

Panayotov, M., Kulakowski, D., Laranjeiro, D.S. and Bebi, P. 2011. Wind disturbances shape old Norway spruce-dominated forest in Bulgaria. Forest Ecology and Management, 262 (1): 470–481, ,doi:10.1016/j.foreco.2011.04.013

Panayotov, M. (2007) Determination of avalanche events by analysis of tree rings of Pinus peuce. Econological Engineering and Environmental Protection, No.1: 75-82

Vasileva, P. and Panayotov, M. Dating fire events in Pinus heldreichii forests by analysis of tree ring cores. Submitted to Dendrochronologia

Keywords: *tree rings, forest disturbances, Bulgaria, windthrows, fires*

The recent history of slope-instability at the Vajont slide site

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Abstract

During the night of October 9th, 1963, about 270-300 million m3 of rock slid from Monte Toc into the newly built Vajont dam reservoir in North-Eastern Italy. The sudden displacement generated a giant floodwave (50 million m3) that caused heavy devastations up- and downstream the river Vajont, destroying the city of Longarone and causing 1910 victims. Despite its role as a milestone in the progression of civil engineering, key aspects of the rockslide remain unsolved to date, amongst others the dynamics of the sliding process and the remaining geological risk.

An initial dendrogeomorphic field campaign in 2009 and information handed down by residents raised concerns about past and recent stability conditions of the upper slope areas not involved in the 1963 catastrophic event. This study aims at reconstructing slope movement episodes before and after the major 1963 slope failure with a particular focus on the recent development.

A total of 33 *Larix decidua* Mill. and *Picea abies* (L.) Karst. trees were cored along two transects situated above the sliding scar of the 1963 event. To build reference chronologies of each species and elevation, additional sampling was performed at two control sites apparently not interested by slope movements.

All cores were processed following standard procedures, but additionally analysis of wood anatomical variations along an entire radius of a tree was carried out using micro sections of entire cores. Hence, an unambiguous detection of compression wood occurrences as a reaction to tree tilting was possible. Disturbance dating using compression wood was complemented by visual analysis of eccentric growth, and additional features, such as abrupt growth reduction.

The slope movement history of the upper part of the northern slope since the 1930s was reconstructed. The persistence of disturbance responses across the entire observation period characterizes Mount Toc as a geomorphological highly active area. Disturbances detected for the years 1950, 1951 and 1955 are evidence of episodic movement already a decade before the dam construction. A first detachment of the future catastrophic rock mass in 1960 is well displayed within our data. Further major displacements along the whole flank seem to occur with a recurrence interval of ten years. Beyond the identification of 16 major episodes, the analysis indicates different dynamics for the two sampled sites. Analysis of climatic records revealed abundant monthly precipitations in spring or previous-year November as possible triggering factors for 50% of the events. The single influence of seismic activity can be hypothesized as being dependent on pre-shaking precipitation amounts, without significant slope movements when earthquakes occur during dry periods.

Our results complement the extensive research available on the Vajont slide by adding a new annually resolved dimension across time. The growth reactions of trees on Monte Toc outline the chronical instability of its northern slope already prior to the construction of the Vajont reservoir. Ongoing movements despite a fundamentally changed morphology as a result of the catastrophic rockslide in 1963 advises the need for more detailed analyses of recent slope movements.

Keywords: *Compression wood, eccentricity, micro sections, episodic movements*

Floating forest

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Abstract

The research was focused on trees growing on floating peat islands, situated within small karstic lakes in the Połaniecka Basin (S Poland). The islands present a peculiar habitat, on account of their origin, unusual geological background, as well as shifting positions. Hence, a question arises, whether tree stands growing on such islands could be considered as forests.

The first forest area analysed is located on a floating peat island of the surface of 0.08 ha in the lake Donica, of the surface of 0.59 ha and the maximum depth of 6.1

m. The trees growing in the island represent the species: Pinus sylvestris, Picea abies, and Betula pendula Roth. There have been also encountered several Quercus spp trunks. The trees reach maximum height of 12-13 m, with relatively small trunk diameters, usually up to 12-15 cm. In the summer, when leaves are fully developed, the island often dynamically changes its location, depending on the predominating wind direction, because the island trees act as a boat sail.

The second forest area investigated is located on a floating peat island of even smaller surface of 0.06 ha. It is situated in the lake Fifth Pond, of the surface of only

0.18 ha and the maximum depth of 4.2 m. The trees growing in the island represent similar species, as these presented above. The position of this island is essentially fixed, stabilized by felled trees, earlier grown on the lake shores and blown over the island.

The island trees display so-called 'starvation' forms, marked by low dimensions (height and trunk thickness), miniaturization of the assimilatory apparatus, and also very narrow annual growths.

Altogether 58 trees; pine, spruce, birch and alder, were sampled from both islands. The habitat type is characteristic for the boggy forest as well as the mineral-soil forest, growing around the lakes. On account of the amount of trees from the islands and the lake shores, Scots pine was the main subject of the dendrochronological studies. Samples were taken with a Pressler increment borer, additionally 10 trunks of pine trees were collected. Measurements of the annual growth width, with 0.01 mm accuracy, followed by classical dating methods, resulted in the island chronology spanning 104 years (1908-2011). The average annual growth width of the trees examined amounts to 0.49 mm, more than twice less than at the trees of the same species growing on the lake shores. Their 74-year chronology covers the years 1938- 2011, at the average annual growth width of 1.07 mm. Anatomical analysis of the island wood revealed 42 frost rings (2% of all measured), at simultaneous lack of them at the mineral-soil grown trees. Analysis of the signature years, correlation, and the response function pointed at different weather conditions affecting the cambial activity at both populations. The dendrochronological method was also attempted for reconstruction of the accumulation rate the of peat-moss layers in the islands. The average accumulation rate was estimated to 7 cm/year; in the range from 2.2 cm/year up to 11 cm/year.

Keywords: *tree-ring width, Pinus sylvestris L., floating peat islands, S Poland*

Identifying snow avalanche frequency using dendrochronological methods and vegetative indicators in Ayıkaya, Bolu (Turkey)

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Abstract

The snow avalanches have been occurred frequently in Eastern Anatolian, Southeastern Anatolian, and Western Black Sea regions of Turkey. The avalanches are recorded when they injured or killed people. Therefore, there are many unknown snow avalanches, which are very far from settlements and / or which do not cause injures or dead. Dendrochronological methods and vegetative indicators can be used to identify the snow avalanches tracks and frequencies.

The study area, Ayıkaya, located in the main road of Yedigöller National Park which is heavily used by visitors. The aims of the present research are to determine the boundaries and frequencies of the avalanche area using dendrochronological methods and vegetative indicators, and to reconstruct snow avalanches history using tree-ring analysis. For dendrochronological analysis, increment cores were taken from 60 living trees in the avalanche area and ten more trees from unaffected area. For each effected tree, the years observing the formation of reaction wood, callus tissue, traumatic resin ducts, and abrupt growth changes on the rings were determined as event years. To identify the boundaries and frequencies of avalanches using vegetative indicators, plant composition, the structure of plant populations, and age distribution were determined.

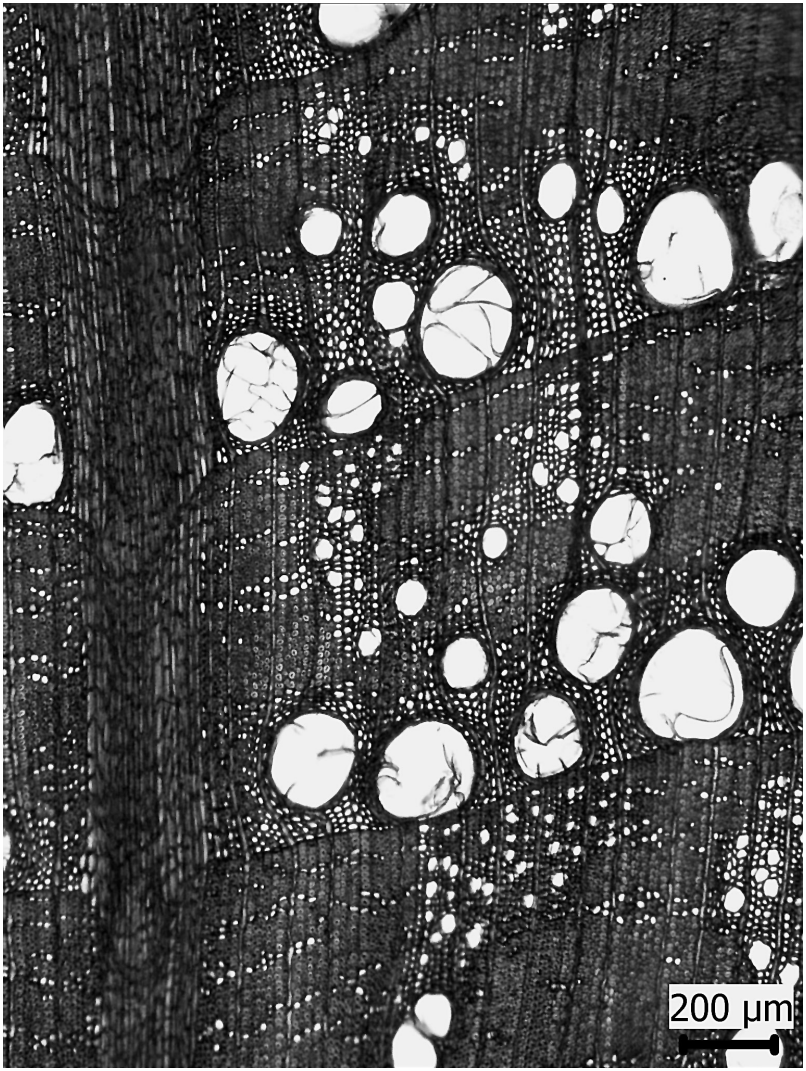
We identified 24 avalanche events, 15% of the trees responding in the same year, for the period of 1900-2008. The major avalanche events, affecting the widest area and having maximum damage on the trees, were occurred in 2000-2001 and 1935-1936 winters. Based on the tree-ring analysis, the frequency of the avalanche is about five years. Similarly, vegetation analysis showed that the frequency is between 1 and 10 years.

Acknowledgement: This research was supported by Republic of Turkey Ministry of Forestry, Project number: 08.5101.

Keywords: *Dendrogeomorphology, tree ring, snow avalanche, vegetative indicators*

An old tree of Cedrus libani from Antalya

Poster Presentations



Cross-section of Quercus petraea (Ü. Akkemik)

Testing the dating of wooden artifact using FT-IR spectroscopy through dendrochronology: preliminary considerations

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Abstract

The aim of the present research is the determination of the possibility of dating wood materials from FT-IR spectra analysis. This work1 was based on a method of absolute dating of wood, such as dendrochronology, as a basis for an experimental phase to verify the method itself. FT-IR spectroscopy is a useful technique to study the chemistry of wood ageing, because a minimal manipulation of samples is required, and very small quantities can be analyzed to provide detailed information. FT-IR has been extensively used to characterize the chemistry of wood and to obtain quantitative data, mainly in the determination of lignin. Moreover, it has been used also to analyze the chemical changes in wood that occur during weathering, decay and chemical treatments, and biodegradation processes.

The samples analyzed in the present study were taken from 26 larch (*Larix decidua* Mill.) beams. All beams belonged to wooden roof structures in Venice, and were dated by means of dendrochronological analysis2 (Table 1). The use of samples already dated using dendrochronology is a prerequisite to this research: having reliable data allows an accurate comparison with the data generated by FT-IR.

About 70 wood meal samples taken from the investigated beams. The samples had to be in the form of meal (instead of flakes) in order to obtain reproducible results.

*1This work was carried out during a degree research at the University of Verona.This research was carried out in collaboration with the laboratories of Dendrodata, CNR- IVALSA and CNR-IFAC.

*2 Dendrochronological dating was carried out by Dendrodata sas Verona on behalf of Soprintendenza per i Beni Architettonici e Paesaggistici di Venezia e Laguna.

Although extracting meal was slightly invasive, it might be considered low-destructive due to the amount of powder needed for the analysis (3 mg), and the integrity of the artefacts was preserved. The data were acquired by using the Attenuated Total Reflectance (ATR) accessory. This methodology was chosen after a methodological study were two FT-IR modes of working, such as transmission mode (carried out on pellets of wood meal mixed with KBr) and ATR mode (carried out directly on wood meal), were compared.

The first phase of the research involved qualitative analysis of spectra. The samples were first analyzed without extraction process. Subsequently, the samples were extracted with organic solvents, to obtain fatty acids, resin acids, waxes, tannins and coloring substances. The quantitative analysis was carried out only on spectra obtained from wood meal already extracted.

At the end of this first phase of the study it was possible to draw the following considerations:

1.The analysis of samples coming from the same beam showed a good uniformity of value; this allowed establishing that a possible dating would correspond to the year of the tree death.

2.The analysis of samples from the same year but from different beam did not however show any correlation with the time value.

3.The relationship between the values of the IR spectra and the time, it showed a single unique trend: the absorption band near 1735 cm-1 declines following the wood ageing, but the absorption decline is asintotic, thus not related only to the time. This decline is in terms of wood mass loss and not of variation of nature of the component.

Table 1. The samples analyzed were taken from 26 larch (Larix decidua Mill.) beams. All beams belonged to wooden roof structures in Venice, and were dated by means of dendrochronological analysis.

roof structure	sample	time extension AD
G1	n. 2	1274-1556
	n.3	1519-1614
	n. 5	1357-1570
	V1	923-1295
	V3	1244-1553
	V5	1272-1555
	V6	913-1215
G2	n. 1	1295-1525
	n. 3	1293-1557
	n. 7	1048-1143
	n. 8	1058-1231
	n. 10	947-1188
	n. 14	1361-1727
	n. 15	1098-1258
TA	n. 1	1306-1564
	n. 2	1439-1554
	n. 3	1340-1552
	n. 4	1385-1564
	n. 5	1395-1562
	n. 8	1236-1522
	n. 9	1355-1548
PG	n. 4	1394-1477
	n. 7	1337-1464
PNN	n. A	965-1281
	n. B	1586-1838
	n. C	1149-1368

As a final conclusion, based on these evaluations, although limited to a small number of samples and to one specie only, it cannot be deemed that the FT-IR spectroscopy allows to reach the dating of wooden artefacts.

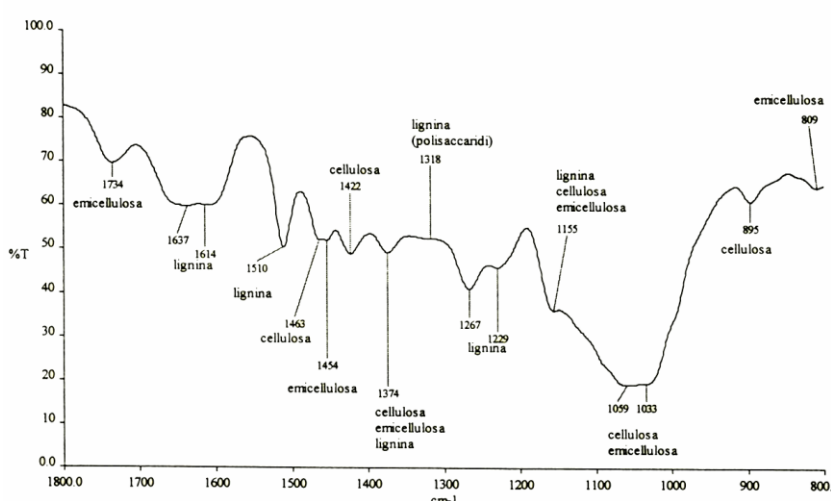

Figure 1. The diagram shows the main absorption band in a spectra of larch wood (Apollonia, Bertone 2002).

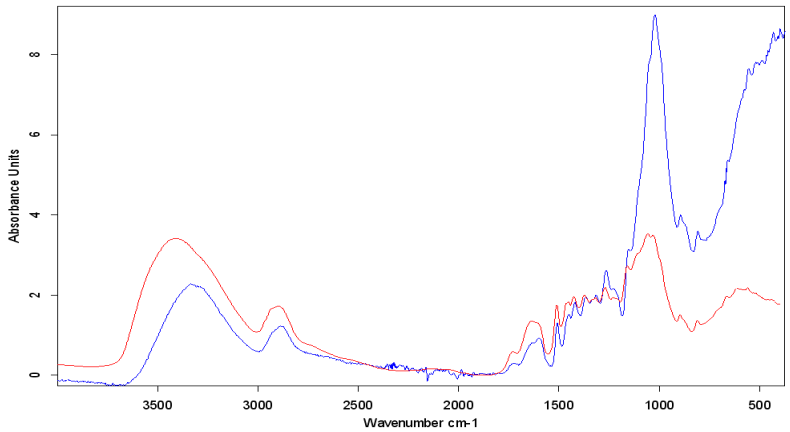

Figure 2. Comparison between normalised (Min_Max 1900-1300 cm-1) ATR (blue curve) and transmission-mode on KBr pellet (red curve) spectra.

Bibliography

Appolonia, L., Bertone, A.ç 2002. Studio di legni valdostani con spettroscopia FTIR, in Il legno nella storia e nell'arte, atti del convegno Le giornate del ChiBec (Pisa 30 settembre- 1 ottobre 2002), Pisa pp. 20- 24

Derrick, M.R., Landry, J.M., Stulik, D.C. 1999. Infrared spectroscopy in conservation science. Scientific tools for conservation, The Getty Conservation Institute

Klein, P., Peterson, I., Faix, O. 1998. Infrarot-Spektroskopie fuer die Datierung von Holz. Moeglichkeiten und Grenzen, Restauro, 46-51.

Matthaes, G. 1998. The scientific dating of wooden art objects, Sci. Am. 44-50.

Picollo, M. , Cavallo, E., Macchioni, M., Pignatelli, O., Pizzo, B., Santoni, I. 2010. Spectral characterisation of ancient wooden artefact with the use of traditional IR techniques and ATR device: a methodological approach, 9th international conference of the Infrared and Raman Users' Group (IRUG) in Buenos Aires, Argentina, 3-6 March. "e- PRESERVATIONScience" IR spectroscopy of ancient wood, e-PS, 8, 23-28

Keywords: *wood dating, FT-IR, dendrochronology, investigation of artworks, ATR mode*

Holocene driftwood localities in Hungary – status report of an on-going dendrochronological research

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Abstract

Subfossil driftwood logs are frequently found in Holocene alluvial sediments of the Hungarian rivers. A large set of sample has been compiled during the last decade owing to systematic or occasional sample collection expeditions.

Altogether ~180 samples have been collected at 7 sites along three rivers (Table 1). Driftwood occurs typically in gravel material.

Table 1. Major Holocene dritwood localities in Hungary

River	site	number of samples
Sajó/Slána	Arnót	25
	Ónod	8
	Nyékládháza	83
Hernád/Hornád	Hidasnémeti	8
	Zsujta	15
	Garadna	14
Mura/Mur	Muraszemenye	27

The most frequent species are oak (*Quercus* sp) and elm (*Ulmus* sp.). Similar species dominance have been reported for Moldova and Siret rivers (Nechita et al. 2014). Pine (*Pinus* sp.) logs have been found occasionally only at the upper course of Hernád river. The average number of measureable rings is ~60 with very few samples consisting more than 150 rings. Obviously, the relatively few ring counts and the usual complacent structure cause rather low crossdating success. In addition, driftwood might derived from various locations, or accumulated through a long time which further challenge dendrochronological synchronization. Regarding the crossdating experience at the species level oak performed better synchronicity and resulted a few floating chronologies.

The limited number of available radiocarbon data and the similar findings from the surrounding region (Krapiec 2001, Kolár et al. 2012, Nechita et al. 2014, Pearson et al. 2014) suggest an even distribution of these driftwood material throughout the past couple of millennia which is a great motivation for the continuation of the work and construction of long oak chronology. These records have the potential to bridge the Eastern Central European (e.g. Krapiec 2001), and Mediterranean (e.g. Pearson et al. 2015) oak dendro zones which was recently assigned as a crucial task for future European dendrochronology (Wazny et al. 2015).

Figure 1. Subfossil driftwood deposits from some major Hungarian localities.

Supported by OTKA K67.583 and LP2012-27/2012.

References

Kolar, T., Kyncl, T. & Rybnicek, M. 2012. Oak chronology development in the Czech Republic and its teleconnection on a European scale. Dendrochronologia 30: 243–248.

Krapiec M. 2001. Holocene dendrochronological standards for subfossil oaks from the area of Southern Poland. Studia Quaternaria 18, 47–63.

Nechita C., Radoane, M. Chiriloaei, F., Radoane, N., Popa, I., Roibu, C., Robu, D. 2014. Subfossil oaks from alluvial deposits and their role in past fluvial activities analysis: case study East Carpathian rivers, Romania. In: Mindrescu M. (Ed.) Late Pleistocene and Holocene climatic variability in the Carpathian-Balkan Region 2014, Georeview Abstracts volume, Stefan cel Mare University Press, Suceava, pp.107-110.

Pearson, C. L., Wazny, T., Kuniholm, P. I., Botic, K., Durman0 A., Seufer, K. 2014. Potential for a New Multimillennial Tree-Ring Chronology from Subfossil Balkan River Oaks. Radiocarbon, 56(4): S51-S59.

Wazny, T., Lorentzen, B., Köse, N., Akkemik, Ü., Boltryk, Y., Güner, T., Kyncl, J., Kyncl, T., Nchita, C., Sagaydak, S. Vasileva, J. K. 2014. Bridging the Gaps in Tree-Ring Records: Creating a High-Resolution Dendrochronological Network for Southeastern Europe. Radiocarbon, 56(4): S39-S50.

Keywords: *subfossil wood, black oak, Pannonian Basin, gravel terrace*

Wooden structures from the Ottoman-period Eger

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Abstract

The city of Eger has a symbolic importance in the Hungarian history. This was namely the place where in 1552 the Ottoman expansion could be stopped for the first time in Medieval Hungary. The castle and the city could be occupied by the Ottoman Empire as late as in 1596 when the Ottoman rule had been already well established in the Carpathian Basin. Christians recaptured Eger on 17th December 1687. In the last few years large-scale reconstruction works were carried out in the centre of the city during which the archaeological remains of an industrial quarter – dated to the 91-year period of Ottoman rule – could be unearthed under the main square of the settlement.

Several wooden structures (wells, tan-pit and cesspit) were discovered, with well preserved wooden material allowing dendrochronological analysis.

Oak was consequently used for preparing the boards, the blocks fissured in half or the dimensioned trunks of the objects. Very young and old samples were used alike. Fir wood was applied only for shingles.

The dating of the eight objects was fairly diverse: from the time before the Ottoman rule through its middle till the end of the period.

A speciality of the use of the material was that the sapwood was not removed from the wood. Due to the remains of bark we could even detect that the wood-cutting happened not exclusively in the winter months, but in several cases they were cut after the beginning of the vegetation period. This feature, together with the great variety of age, means that the then inhabitants of the city practiced timber mining in the woods of the area around the settlement

Keywords: *Hungary, industrial quarter, period of Ot¬toman rule, oak, archaeology*

New subfossil oak trunks from the Labe river basin in the Czech Republic

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Abstract

Absolutely dated tree-ring width chronologies from subfossil material are important palaeoclimate proxy records. Subfossil oak trunks, usually found in the basin of large rivers, may provide new knowledge about the floodplain forest in the period when oaks grew. Here, we present new centennial long TRW chronologies representing the Labe river basin in Central Bohemia. A set of very well preserved 53 subfossil oaks (*Quercus* spp.) and 2 subfossil elms (*Ulmus* spp.) was processed using standard dendro-methods. Two absolutely dated oak TRW chronologies were developed for the periods 3650–3291 BC and 82 BC–115 AD, respectively. One elm sample was dated to 66 AD and the other material is going to be dated by C14 dating. With respect to the still active mining in the gravel pit where the subfossil trunks were found, a large subfossil oak dataset is expected in the near future. The detailed analyses of the subfossil material may bring new information about the structure and dynamics of the former forest.

Acknowledgments: The study was prepared within funding from the Czech Republic Grant Agency through the grant numbered 13-04291S; the Ministry of Education, Youth and Sports of CR within the National Sustainability Program I (NPU I), grant number LO1415; projects no. IGA 28/2014 and no. LDF_VP_2015004. The authors would like to thank Willy Tegel for verification of the dating.

Keywords: *subfossil trunk, oak, Labe river, Czech Republic*

Oak coppice crop from the year 3203 BC: snapshot on the timber supply of a Neolithic short-term shore settlement at Lake Constance

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Abstract

Within the framework of a co-project (Landesamt für Denkmalpflege Baden-Württemberg and Kantonalarchäologie Thurgau), unterwater archaeology is dealing with the exploration of pile-dwellings on a peninsular situation at the Western end of Lake Constance (bank of Orkopf near Öhningen). There, short term occupations of a strongly stream-exposed bank position are evidence for the strategy of settlers to control the outlet part of the lake and its natural water gate. For the building of one of these pile-dwellings, a 50-year old oak coppice has been systematically harvested within the one and same year at 3203 BC. The dating of the short chronology was supported by radiocarbon wiggle matching. The homogenous set of timber along with its tree-ring series represent a unique collection for the assessment of oak coppice during the Neolithic period. Within this scope, reference is made to recent dendroecological investigations of abandoned oak coppice in the French Jura Mountains.

Keywords: *oak coppice, Neolithic pile dwellings, short tree ring series, French Jura Mountain*

Radiocarbon dated late-glacial Scots pine (*Pinus sylvestris* L.) chronology from Central Poland

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Abstract

Dendrochronologically dated wood of subfossil trunks of trees presents the basic material used at construction of the calibration curve. In the last years numerous studies are aimed at construction of chronologies covering the late-glacial period (Kaiser et al. 2012).

At present, Koźmin and Kwiatków (Kolska Basin, Central Poland) proved to be very perspective sites, in which wood from the end of Allerød and Younger Dryas was recognized. A level of organic deposits with so-called 'fossil forest' was encountered within the late-Vistulian terrace of the low valley of the Warta river. This wood may be of crucial importance for connecting two well defined parts of the curve; the pattern based on the absolute oak chronology extended with the pine chronology (to 12594 cal BP), and the late-glacial pine chronology SWILM.

In Koźmin over 300 pieces of wood were documented. Abundant trunks and short stumps of trees have been very well preserved in a series of organic sediments, up to

1.5 m in thickness. Felled trunks are up to 4 m in length and up to 20 cm in diameter. Dendrochronological analysis of over 100 samples complying to the requirements of the method allowed to construct a 130-year chronology. Radiocarbon analyses point out that the Koźmin wood, dated to ca. 12700-12500 cal BP (10700-10600 BP), represent the Younger Dryas.

Dzieduszyńska D., Kittel, P., Petera-Zganiacz, J., Brooks, SJ., Korzeń, K., Krąpiec, M., Pawłowski, D., Płaza, DK., Płóciennik, M., Stachowicz-Rybka, R., Twardy, J., 2014. Environmental influence on forest development and decline in the Warta River valley (Central Poland) during the Late Weichselian. Quaternary International 324, 99-114.

Kaiser, KF., Friedrich, M., Miramont, C., Kromer, B., Sgier, M., Schaub, M., Boeren, I., Remmele, S., Talamo, S., Guibal, F., Sivan, O., 2012. Challenging process to make the Lateglacial tree-ring chronologies from Europe absolute – an inventory. Quaternary Science Reviews 36, 78-90.

Keywords: *subfossil wood, Scots pine, dendrochronology, radiocarbon dating*

Wells are telling history. Dendroarchaeological investigations in the Munich Gravel Plane

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Abstract

The attractiveness of the modern day metropolitan region of Munich led to the expansion of the city into the smaller surrounding settlements. This was accompanied by large-area excavations. Many excavations exposed wooden remains, mostly wells, but also pile dwellings, post constructions, waste pits, etc. Because of drainage in the 1920s wooden remains are becoming less frequent and the leftover samples show a very bad level of preservation. It is liable that the residual wood in the ground will decompose in the next few decades.

The investigation is based on the analysis of approx. 900 wood samples from seven Early Medieval settlements in the Munich Gravel Plane. A total of 50 Early Medieval wells were examined. The timescale ranges from the 6th to the 9th century.

Connecting archaeological and dendrochronological methods in a multidisciplinary approach (Billamboz, 2009; Bleicher, 2014) allows for a higher information potential of wooden remains to be tapped on a high percentage level. To determine whether wood transport has taken place a non-linear regression model will be used (Eissing, 2011; with the support of T. Eissing). With this model it is possible to estimate the elevation of the growing site, so that imported timber can be filtered (Gravel Plane: 400-700m a.s.l.).

Aside from investigations on resource management and construction techniques new insights into the history of vegetation and wood-economy are to be expected. Currently the laboratory work on the samples is finished and the results are being analysed.

Initial results show that Early Medieval settlers felled mature oak trees, up to 400 years of age, for building purposes. Oak wood was used for nearly everything. Meaning, that from the early third to the sixth century AD great and old oak forests must have covered a considerable share of the research area. Well-linings were adapted to the available resources - simple multilayered wood-framed wells ensured the water supply. A

drastic change happened in the early ninth century. Harvesting leapt exponentially. In a few decades the old oak forests vanished completely. The preserved wood samples include fast grown oak as well as other species like beech, elm and spruce. Due to this fact building techniques evolved. Well-linings were henceforth assembled in different layers so that they could be repaired or replaced. The conifers used originate most likely from higher elevation sites. In response to the incurred lack of material, sub montane to montane levels were subdued.

Along with the benefit of developing chronologies for provenancing, the historical material can be used for dendroclimatic reconstruction. Likewise, the impact of settlement history and land use on long-term growth changes can be investigated.

Reference

Billamboz, A., 2014. Regional patterns of settlement and woodland developments: Dendroarchaeology in the Neolithic pile-dwellings on Lake Constance (Germany). The Holocene 24, 1278-1287.

Bleicher, N., 2014. Four levels of patterns in tree-rings: an archaeological approach to dendroecology. Vegetation History and Archaeobotany 23/5, 615-627.

Eissing, T., 2011. Timber transport and dendro-provenancing in Thuringia and Bavaria. Scientia Artis, 7, 137-149.

Keywords: *Land use-reconstruction, Early Medieval Ages. Wells, Southern Germany*

Dating of a violin from Turkey

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Abstract

The history of violin, its origin is Italy, goes back to 16th century in Europe. From 18th to mid of 20th centuries, violins imported from Europe were used by Turkish musicians. After 1950's violin production started in Turkey.

In the first half of 20th century, violin training in Turkey started in Çapa Science College (formerly called Darülmuallimin-i Ali) with Osman Zeki Üngör who is the first violin virtuoso of Turkey, and also the tunesmith of the Turkish national anthem. After him, Ekrem Zeki Ün, who is his son, worked in this college as music trainer.

The college has two old violins, bought from Germany, in its exhibition cupboard. The production dates of these two violins are unknown, and it is unclear that they belong to Osman Zeki Üngör and/or his son. A dendrochronological study was performed on the spruce woods of the violins to throw light on the discussion.

Tree-ring series obtained from the first violin (Figure 1) was compared with European spruce chronologies from ITRDB. The highest correlation was found with SWIT181 chronology from Swiss Alps (Figure 2), with 0.67 ($p \leq 0.001$) value of percentage of parallel variation. T value and Cross Dating Index were calculated as 5.1 and 30, respectively. The outer ring dated to 1917. Because of lacking the outermost ring we could not give an exact date. On the other hand, our results support the idea the violin belongs to this family's time.

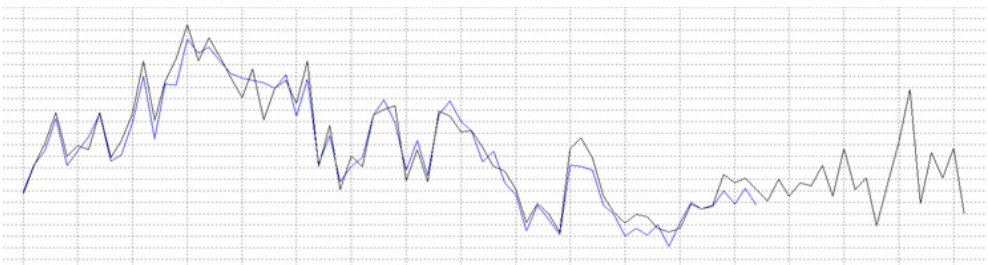

Figure 1. Dating of two spruce woods on the first violin

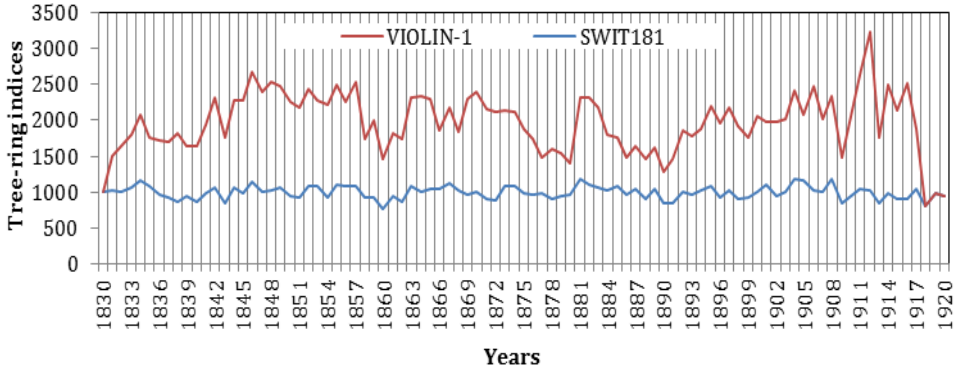

Figure 2. The best crossdating of the first violin with the spruce chronology (SWIT181) from Swiss Alps

Figure 3. The best crossdatings were indicated with green home and good ones with green circle, and non-significant ones with brown circles

Second violin has only 51 rings. We could not give any exact time interval due to the shortness of the chronology. After a C^{14} dating it will be possible to give a date for this violin.

Keywords: *Violin, dating, tree-ring, dating, Osman Zeki Üngör, Ekrem Zeki Ün*

An Early Bronze Age floating pine chronology from Küllüoba excavation

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Abstract

The Early Bronze Age Settlement of Küllüoba is located in the western extremity of the upper Sakarya Plains, 15 kilometers north-east of the modern town of Seyitgazi and 35 kilometers south-east of Eskişehir. The site, which we can consider as an urban-like settlement is on the crossroads of the main communication routes from all directions.

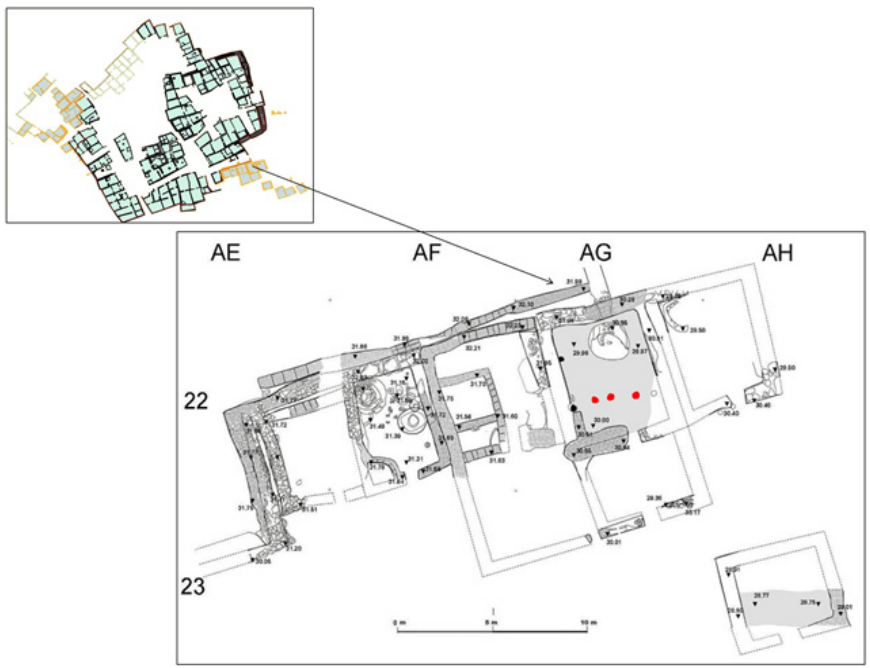

Figure 1. The plan of the settlement of Küllüoba. Red dots indicate the wood and charcoals

The excavations under the direction of Turan Efe have been carrying out uninterrupted since 1996. The settlement is comprised of upper and lower settlements in the Early Bronze Age I and II periods.

The wood and charcoals are found in one of the houses of the lower settlement located within the grids of AG 22, in the southeast of the mound. The house in question is severely burnt, many pots and various find groups are found together (Figure 1).

Dendrochronology methods can serve to find exact dates of the archaeological sites. For this purpose we collected 14 pieces from charcoals indicated in Figure 1, which are probably belonging to two different wood pieces. In the first stage we identified the woods as Black pine (Pinus nigra Arnold). After measuring tree-ring widths and building individual chronologies, we produce a mean chronology from 11 individual pieces (Figure 2). The rest 3 of them could not be used.

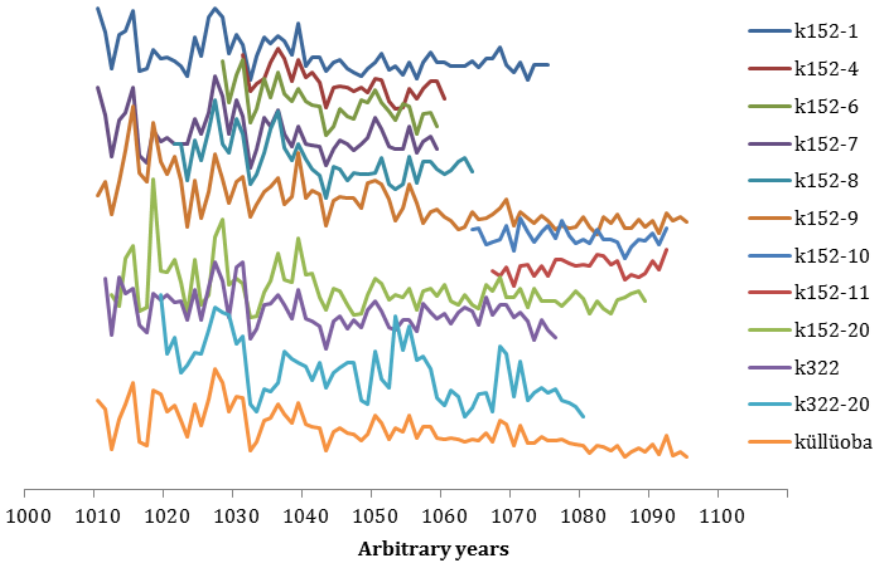

Figure 2. The individual chronologies and their mean floating chronology (küllüoba)

Because the occupation date of Küllüoba is about the similar to Demircihöyük, where is near to here, the mean pine chronology was compared to Demircihöyük chronologies built by Peter Kuniholm (Kuniholm, 1987) and we could not find any significant date. As a preliminary result, the mean chronology is a floating pine chronology and we need C14 dating to find the place of it.

Reference

Kuniholm, P. I. 1987. Demircihüyük – Dendrochronological Analysis. In: Korfmann, M. Demircihüyük II: 1-4. Von Zabern

Keywords: *Küllüoba, dating, floating chronology, dendrochronology*

Historical value and ecoturism potential of wooden houses in Meydancık, Artvin, Turkey: Preliminary results

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Abstract

Traditional wooden houses in rural areas are an important cultural heritage in terms of ecotourism potential. It's possible to see some examples of this wooden architecture in Turkey, especially in Black Sea Region. Meydancık, located in this region, with wooden architecture and natural resources, is being seen as an important ecotourism destination.

In order to assess the current ecotourism situation of the region, we performed SWOT analysis with stakeholders. As a result of SWOT Analysis; it was determined that the region is rich in natural resources and cultural values but ecotourism infrastructure in the region is inadequate. One of the most important cultural values was wooden houses. When we focus on the wooden houses following problems were founded out: 1) protection and sustainability of these houses 2) unknown historical value 3) no awareness about their usage for ecotourism activities.

From this point of view, we think that determining of historical value and protection of traditional wooden houses are the tools to improve ecotourism potential in that region. In this research, we present the preliminary results obtained from one wooden house, which was described by villagers as quite old.

Our preliminary results showed that it is the house longhorn beetle Hylotrupes bajulus that represents the most serious biotic factors in the areas. This is a large beetle which leaves a characteristic oval flight hole about 9 mm across. Because of the seriousness

of the damage caused by this beetle the building conservation politics now require all structural wood in the areas where this pest is established.

In order to find out construction year of the wooden house, and its hayloft we took ten cross-sections. Using standard dendrochronological techniques, we built two separate historic tree-ring chronologies for the house (from six samples) and the hayloft (from four samples). The house and hayloft chronologies dated to 1858 and 1863, respectively. The samples from the house did not have few rings from the outer part, while most of the samples from the hayloft had. Our results showed that both constructions could be built in the same year, in 1863.

As a result, protection of traditional wooden houses or architecture and determination of their historical values mean protection of culture (design, lifestyle, customs, gastronomy, language) which have been experienced more than a century in that area.

Keywords: *Wooden houses, tree ring, dating, wood protection, ecotourism*

d^{13}C of earlywood and latewood cellulose as short- and long term stress indicator of local weather extremes and regional climate change

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Abstract

As a results of three decades cooperative scientific work, the IPCC (IPCC, 2013) reported the acceleration of weather extremes over the last century. Forests as cross sections of biosphere, atmosphere and geosphere are exceptional sensitive to atmospheric CO2 increase, temperature anomalies and moisture availability among others. The carbohydrate remobilization via heterotrophic metabolism for initiating annual tree growth is well investigated through field and chamber experiments (Brüggemann et al., 2011), but not for its relation to weather extremes. Here we focus on this subject by studying carbon isotope variations during the last two and a half centuries. Since, deciduous species provide tree ring sections built either by a mixture of heterotrophic- and autotrophic metabolism (earlywood) or exclusively autotrophic metabolism (latewood) (Hayes, 2001), the intra-annual comparison of early- and latewood reveals useful information about the degree of remobilized carbohydrates and consequently about the weather extremes limiting autotrophic metabolism in the past.

A managed oak forest in Switzerland, assumed to be a well-watered study site, was investigated. After tree ring width measurements, alpha-cellulose of separated early- and latewood sections were extracted by a modified Jayme-Wise method (Boettger et al., 2007) and subsequently stable isotopic composition was measured using a new, recently developed triple isotope approach (C-H-O) (Loader et al., 2014) to provide high resolution early- and latewood time series from 1750 to 2013. The iWUE simulation based on measured d^{13}C time series represents an increasing trend reflecting the adaptation of long term change of atmospheric CO2 concentration. In order to investigate the short term variability of carbon remobilization we calculated the autocorrelation for EW and LW isotopic records shifted in time by -1 to -15 years representing carbon

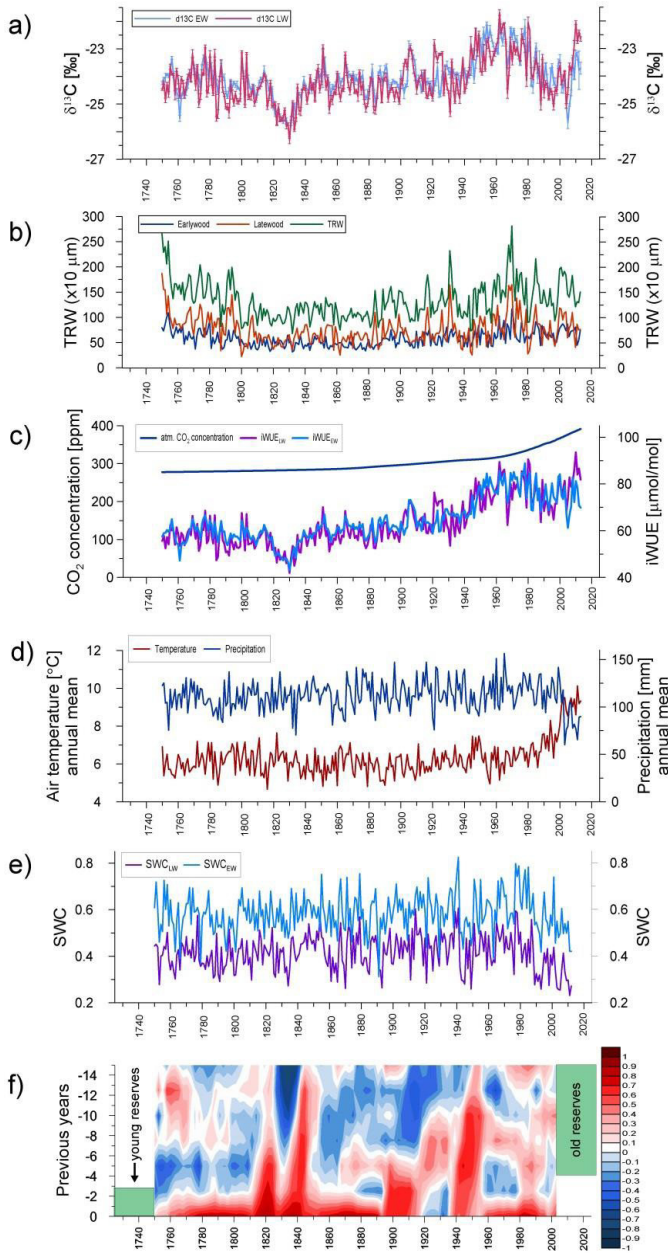

Figure: Results of tree ring (Quercus robur) analysis including stable carbon isotopic ratio (a) tree ring width (b), intrinsic water use efficiency simulation (c), temperature and precipitation (d), modeled soil water content (e) and autocorrelation values (EW vs previous years' LWs) (f) from 1750 to 2013.

reserves from different age classes. We assume that young reserves are represented by the age class (-1 to -3) and old reserves by (-10 to -13).

These correlations can be used as indicators of severe stress situations under which the tree has to recycle already allocated carbon. Therefore, they most probably are representing weather extremes to which the tree. In model simulations one can try to distinguish different limitations, namely originating from temperature, light, precipitation or soil water content (SWC). SWC simulations (Fig. panel e) show variations in the range of 0.35 to 0.65 units, the only strong agreement between low SWC and high usage of old reserves, indicated by high positive correlations between EW and LW (Fig. panel e) is observed during 1940 to 1950. Assuming that modelled SWC are correct indicates that the other periods with strong old reserve usage such as 1810 to 1845 might not be due to SWC deficit and requires another explanation.

References:

Boettger T, Haupt M, Knöller K, Weise SM, Waterhouse JS, Rinne KT, Loader NJ, Sonninen E, Jungner H, Masson-Delmotte V, et al. 2007. Wood Cellulose Preparation Methods and Mass Spectrometric Analyses of δ13C, δ18O, and Nonexchangeable δ2H Values in Cellulose, Sugar, and Starch: An Interlaboratory Comparison. Analytical Chemistry 79(12): 4603-4612.

Brüggemann N, Gessler A, Kayler Z, Keel SG, Badeck F, Barthel M, Boeckx P, Buchmann N, Brugnoli E, Esperschütz J, et al. 2011. Carbon allocation and carbon isotope fluxes in the plant-soil-atmosphere continuum: a review. Biogeosciences 8(11): 3457-3489.

Hayes JM. 2001. Fractionation of Carbon and Hydrogen Isotopes in Biosynthetic Processes. Reviews in Mineralogy and Geochemistry 43(1): 225-277.

IPCC. 2013. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

Loader NJ, Street-Perrott FA, Daley TJ, Hughes PDM, Kimak A, Levanič T, Mallon G, Mauquoy D, Robertson I, Roland TP, et al. 2014. Simultaneous Determination of Stable Carbon, Oxygen, and Hydrogen Isotopes in Cellulose. Analytical Chemistry 87(1): 376-380

Keywords: *carbon, reserves, earlywood, latewood, heterotrophic, stress*

The carbon isotopic composition of Atlas Cedar from North-Western Morocco: a record of aridity

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Abstract

Since the 1970s, several periods of below average precipitation have occurred in North Africa. The Middle Atlas area (North Morocco) is the most important water reservoir in Morocco, whose moisture history has to be retraced for planning the future. Over the last 40 years, the temperature (T) of the growing season has increased (dTApril-June= ~+0.3°C/decade) and the precipitation decreased (~ -18 mm/decade in November and in December when soil aquifer is recharged). Reflecting these concomitant variations, the monthly Palmer Drought Severity Index (1870-2000, Dai et al., 2004) has decreased.

We examined two datasets of carbon isotopic ratios of the tree-rings cellulose (d13C-cell) of *Cedrus atlantica* from the Middle Atlas area in order to assess the potential of this proxy for reconstructing past variations of moisture. The unusual autocorrelation of the carbon isotopic data is corrected using an autoregressive model. This large autocorrelation is likely due to the utilisation of reserve sugars by trees during the driest days of the growing season. The low-frequency components of the $d^{13}C$ chronologies are strongly linked to PDSI and consistent with other dendro-isotopic records from Southern Europe. The residuals (after application of the autoregressive model) are correlated with various climate parameters (in particular temperature) at the wettest site. A reconstruction of PDSI variations in North-Western Morocco over the last two centuries is proposed and compared with other ones based on tree-ring width.

Keywords: Morocco, $d^{13}C$, tree-ring, autocorrelation, aridity

Climate sensitivity of *Pinus nigra* tree ring chronologies from Bulgaria and a reconstruction of early summer precipitation since 1645 AD

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Abstract

The Mediterranean region is vulnerable to climatic changes. Most projection climate models predict increase of the frequency of heat waves and dry spells over the region. Such events can have strong environmental and socioeconomic impact. Better knowledge on past climate can help understand drought events and mitigate their negative effects on forest ecosystems. Reconstructions of summer temperatures and precipitation were made for several locations around the Mediterranean like Turkey (Köse et al., 2011), Greece (Klesse et al., 2014) and Albania (Levanič et al., 2015). Yet, such studies are scarce for the interior part of the Peninsula. Black pine (*Pinus nigra* Arn.) is one of the long-lived tree species in the region that can be sensitive to climate conditions and has been used to produce reliable tree-ring based reconstructions. The high conservation value of old-growth Pinus nigra forests makes improving our knowledge on their reaction to climatic stresses even more important.

We studied three different populations of black pine in South Bulgaria. The aim of our study was to investigate the reaction of the trees to climatic conditions and evaluate their yearly ring widths as possible proxy for reconstruction of past climate.

We collected samples from one location in Slavyanka Mountain (Panayotov et al., 2013) and two locations in Rhodope Mountains – Dobrostan (Shishkova et al., 2013) and Trigrad, in South Bulgaria. All samples were processed, following classic methodology and tree ring widths and latewood widths were measured. To remove age-trend from the series we detrended them with 100 year smoothing splines, using signal free standardization in order to retain low frequency variation, which can be caused by climate. We built separate chronologies for the tree individual locations and calculated correlation coefficients between each of them and gridded (0.25°x0.25°) temperatures and precipitation. There were statistically significant positive correlations between tree ring width and summer precipitation (r>0.45) as well as negative correlations with summer tem-

peratures for all three chronologies. We also found high mean series intercorrelations in each of the chronologies (0.592, 0.645, 0.469) as well as common climate signals in the three chronologies.

We used the longest chronology (the one for Trigrad - 420 years), which had strong and stable through time correlation with June-July precipitation (r=0.55) as a proxy for early summer precipitation reconstruction. Using linear regression we estimated June-July precipitation for the period with EPS above 0.85 (after 1645). Comparisons of our reconstruction with other reconstructions in the region showed common dry periods and similar year to year variability. In the calibration period the driest years of the reconstruction were matching those from the gridded precipitation series (1965, 1996, 2000, 2007), with the decadal trends also being well represented. In the pre-instrumental part the relatively dry periods were 1830-1835, 1792-1797, 1725-1730 and 1680-1687. Spatial correlations to gridded precipitation data showed that the reconstruction is representative for Central and South Bulgaria as well as parts of Greece, Turkey and Macedonia.

Acknowledgement: The data is based on project IZEBZO143109 of SNSF and project DTK 02/02/2010 of the National Science Fund of Bulgaria.

References:

Klesse, S., Ziehmer, M., Rousakis, G., Trouet, V., Frank, D., et al., 2014. Synoptic drivers of 400 years of summer temperature and precipitation variability on Mt. Olympus, Greece. Climate Dynamics, 1-18.

Köse, N., Akkemik, Ü.,Dalfes, H.N., Özeren M.S., 2011. Tree-ring reconstructions of May–June precipitation for western Anatolia. Quaternary Research 75, 438–450.

Levanič, T., Poljanšek, S., Toromani, E., 2015. Early summer temperatures reconstructed from black pine (Pinus nigra Arnold) tree-ring widths from Albania. The Holocene 25(3), 469-481.

Panayotov, M., Shishkova, V., 2013. Pinus nigra Arn. tree ring chronology from Slavyanka Mts. in Bulgaria is strongly related to regional drought events Forestry Ideas, 2013, vol. 19, No 1 (45): 79–90

Shishkova, V., Panayotov, M., 2013. Climate-growth relationship of Pinus nigra tree-ring width chronology from the Rhodope Mountains, Bulgaria. Bulg. J. Agric. Sci., Supplement 2, 19: 225–228

Keywords: *tree ring, Pinus nigra, summer precipitation reconstruction, Bulgaria*

Local climate reconstruction from *Pinus nigra* and *Juniperus excelsa* populations in the Taurus mountains, Southwest Turkey

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Abstract

The ancient city of Sagalassos, situated in the Taurus Mountains in southwest Anatolia, has been the subject of archaeological research for the last two decades, with a focus on nature-society interactions through interdisciplinary research (www.sagalassos.be). (Figure 1). The study period runs from classical times until the present and into the future.

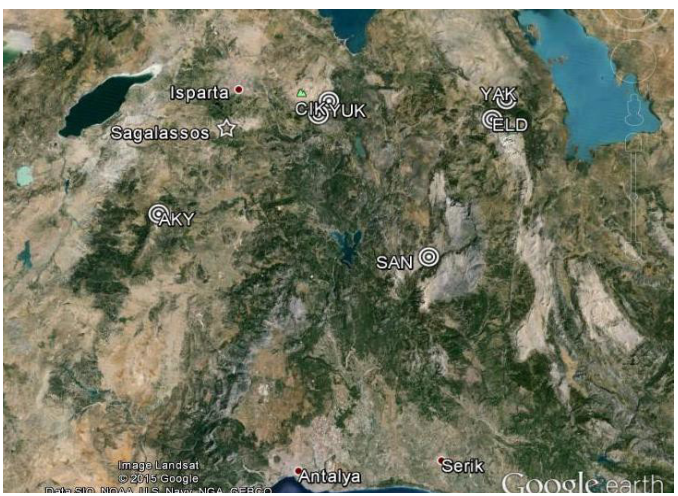

Fig. 1 Location of the ancient city of Sagalassos and the sampling sites of Pinus nigra and Juniperus excelsa in the Taurus mountains, Southwest Turkey

One of the points of interest of the Sagalassos archaeological research project is the study of climate in the region. Palaeoecological records show a number of climate-driven vegetation shifts occurred in the area since late Roman times (Bakker et al., 2012). Local climate records of high resolution retrieved from tree rings can provide additional insight and help to disentangle climatic and anthropogenic influences on vegetation reflected in pollen records.

In this project the aim is to reconstruct the local climate based on tree ring data from

162 *Pinus nigra* and 200 *Juniperus excelsa* trees sampled from 7 sites in the surroundings of the ancient city. Tree ring width as well as maximum latewood density are used as climate proxies.

First results on a subset of samples considering only tree ring width (TRW) for the site Sanli (SAN, Fig. 1) show a correlation between TRW on the one hand and spring precipitation and winter temperature on the other.

Bakker, J., Kaniewski, D., Verstraeten, G., De Laet, V., Waelkens, M., 2012. Numerically derived evidence for late-Holocene climate change and its impact on human presence in the southwest Taurus Mountains, Turkey. The Holocene 22, 425- 438.

Keywords: *Sagalassos, Temperature, Precipitation, Maximum latewood density, Tree ring width*

Oxygen isotope composition of tree-rings and climate variability in Eastern Carpathians, Romania

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Abstract

The pristine forests in Romania offers the possibility to create long tree ring chronologies with annual resolution to be used in paleoclimatic studies. Until recently, all dendroclimate reconstructions in Romania were based on tree-ring width, while the stable isotope composition of tree-rings was not studied.

Our motivation is to build the first multicentennial palaeoclimate reconstruction based on oxygen stable isotope in tree ring cellulose in Eastern Carpathians, Romania .

For this study we analyzed wood samples of Swiss stone pine (Pinus cembra L.) from living and dead trees from Călimani Mts., NE Romania. The isotopic composition of δ18O from the cellulose was analyzed at the Institute for Geological and Geochemical Research, Budapest, Hungary, using a high-temperature pyrolysis sistem (Thermo Quest TC-EA) coupled to an isotope ration mass spectrometer (Thermo Finningan Delta V) following a ring by ring (i.e., non-pooled) approach.

The average δ18O level of cellulose for the period 1622-2012 is 29 ‰. The preliminary raw data show low δ18O values between 1650-1690, 1700-1850 and 1950-1980, with minimum values in 1675 and 1837 (26.4 ‰), and high ones between 1690-1700, 1850-1900 and since 1980 until present, with maximum values in the 21st century (Fig. 1). The highest values were found over the last hundred years with pronounced positive peaks in 1928, 1946, 2000, and 2007.

The isotopic composition of δ18O is strongly positively correlated with maximum air temperature and sunshine duration and negatively correlatated with precipitation amount and relative humidity during the summer months (June, July and August).

By Romania's position in Est - Central Europe, where Atlantic, Mediterranean and Scandinavina climatic influeces converge, paleoclimate studies in this region could shed light on our understanding of climate variability of the entire continent. As at present our data extneds back only through the Little Ice Age, we intend to continue this study back in time to cover last millennium.

Thanks for the support to LP2012-27/2012 and CLIMFOR 18SEE

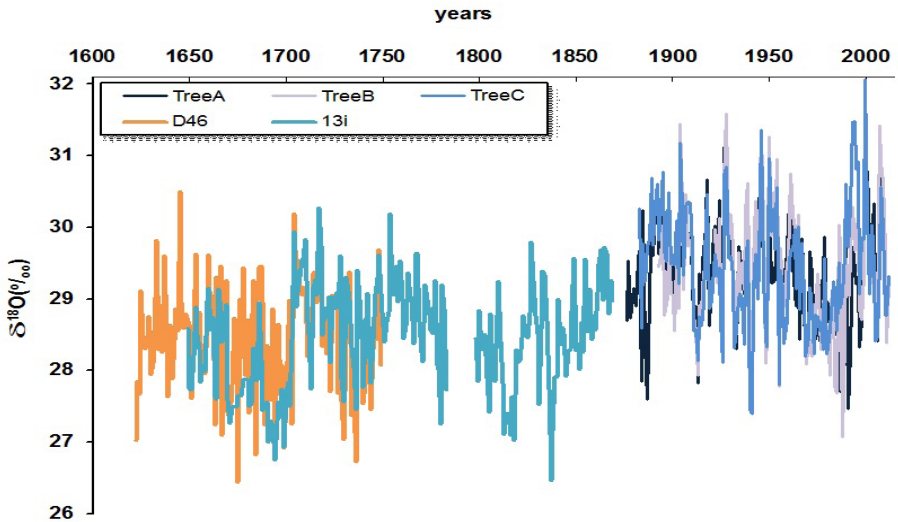

Figure 1. Stable oxygen isotope composition of alpha-cellulose from stone pine tree rings from Călimani Mts., Romania

Keywords: *δ18O, Pinus cembra L. paleoclimatology, Romania, paleoclimate reconstruction*

Assessing the climatic sensitivity of *Pinus brutia* on the eastern coast of the Black Sea

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Abstract

Pinus brutia var. pityusa is considered vulnerable because of population size reduction linked to habitat decline. Global warming and its collateral modification of rainfall regimes may dramatically modify their distribution ranges. To understand response to future climatic variability, we studied climate-growth relationships in this rare variety of Brutia pine on the eastern coast of the Black Sea, in the northernmost refugiums of the species. Four 55-150 year length ring-width chronologies were developed at sites with different growth conditions:

(1) site with relatively low amount of precipitation where trees grow on steep slopes;

(2) similar site but under high amount of precipitation;

(3) flat sites under high amount of precipitation.

Tree growth in sites on slopes is limited by precipitation during preceding winter, current spring and summer. The strength of limitation is higher in site with low precipitation. On the flat sites ring-width sensitivity is low, responses of tree growth to climate is insignificant. False and light rings were found to be common anomalies in the wood of Brutia pine. The occurrence of these anomalies was positively related to low precipitation and high temperature during vegetation season. Our results demonstrate the potential of P. brutia var. pityusa ring-width and tree-ring anomalies for reconstruction of moisture availability.

Keywords: *Pinus brutia, Russia , ring-width chronologies, tree-ring anomalies*

Tree ring chronologies from coniferous species in Bulgaria – current status and potential

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Abstract

Tree ring chronologies are one of the important sources of information for studying the relationships between trees and different components of natural ecosystems, including climate. In the last decade there were serious efforts to continue the initiated in the past tree ring studies and construct new robust chronologies. Here we present the current status of studies of the coniferous tree species in Bulgaria.

The longest chronologies (> 750 years) are from Bosnian pine (Pinus heldreichii Christ) (PIHE), which in Bulgaria is found in isolated subalpine locations in Pirin and Slavyanka Mountains. The tree ring width (TRW) chronologies are positively correlated with summer precipitation and negatively with summer temperatures, but are also positively correlated with winter temperatures (Panayotov et al., 2010). This mixed climate signal hinders direct climate reconstructions, but nonetheless the longest chronology is used in a larger study of proxy climate variation in the European region for the last 2 millennia lead by Ed Cook. A Maximum latewood density (MXD) chronology was prepared from PIHE and served as a source for reconstruction of summer temperature variability for a period of more than 200 years, which was then used to reveal that the sNAO pattern is a main driver of the teleconnection between opposing summer temperatures in southeastern versus northwestern Europe (Trouet et al., 2012). In an attempt to further understand the effects of climate on tree growth of this species there are studies in progress of xylogenesis (Ivanova et al., 2013) and anatomical structures.

Another subalpine species with high longevity in Bulgaria is Pinus peuce Griseb. (PIPE). TRW chronologies were developed by Mirchev and Vakarelov and Panayotov et al. (2010). They are with length of up to 350 years, but the potential is about 600 years (Panayotov et al., 2010). The chronologies are positively correlated with summer temperatures, but similarly to PIHE the climate signal is mixed. MXD studies were initiated by Albena Ivanva, but results are not yet published.

Pinus nigra in Bulgaria also provides potential for long chronologies (Panayotov and Shishkova, 2013). Work in progress in analysis of TRW chronologies by Shishkova demonstrates strong and stable over time correlation with summer drought and is used for the first June-July precipitation reconstruction with length of more than 400 years for Bulgaria.

The developed up to the moment Pinus sylvestris chronologies are with shorter length (up to 200 years). Yet, there is a dense network for Western Bulgaria developed by Nickolay Zafirov. Several chronologies from locations at different altitudes were used to study anatomical tree ring features and the related with them climate extremes (Panayotov et al., 2013).

In Bulgaria there is also one more species from Pinus genus (Pinus mugo Turra), several Junipers, of which the highest potential has Juniperus excelsa and locations of Taxus baccata. There are initial studies of tree ring widths carried out mostly by the team from the University of Forestry, but up to the moment robust chronologies have not been published. There are also serious efforts in studying forest dynamics with the help of tree rings.

References:

Panayotov, M., Zafirov, N., Cherubini, P. 2013. Fingerprints of extreme climate events in Pinus sylvestris tree rings from Bulgaria. Trees-Structure and Function. 27(1):211-227, doi: 10.1007/s00468-012-0789-1

Panayotov, M. and V. Shishkova, 2013. Pinus nigra Arn. tree ring chronology from Slavyanka Mts. in Bulgaria is strongly related to regional drought events Forestry Ideas, 2013, vol. 19, No 1 (45): 79–90

Ivanova, A., Y. Todorova, P. Rangelova, M. Panayotov, 2013. Xylogenesis of Pinus heldreichii and Pinus peuce in Pirin Mts. Bulg. J. Agric. Sci., Supplement 2, 19 Trouet, V., Panayotov, M., Ivanova, A., Frank, D. (2012) A pan-European summer teleconnection mode recorded by a new temperature reconstruction from the northeastern Mediterranean (ad 1768–2008). The Holocene 22:887-898. doi:10.1177/0959683611434225

Panayotov, M., Bebi, P., Trouet, V., Yurukov, S. 2010. Climate signal in tree-ring chronologies of Pinus peuce and Pinus heldreichii from the Pirin Mountains in Bulgaria. Trees - Structure and Function, 24: 479-490, 24: 479-490DOI: 10.1007/s00468-010-0416-y

Keywords: *tree ring chronologies, Bulgaria, climate reconstructions*

Dendrochronology of wild service trees (*Sorbus torminalis* L.) in Poland - preliminary results

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Abstract

The study concerns dendrochronology and dendroclimatology of the wild service tree growing in Poland. Wild service tree (*Sorbus torminalis* L.) is non-dominant sub-canopy and rare tree species in Polish forests, occurring in deciduous and mixed forests. The study area covers north-western part of Poland, representing the eastern distribution limit of the species. Actually, Sorbus torminalis is a protected species in the whole area of Poland, but still it is found in small fragmented populations consisting of 3-few hundred individuals. The samples were taken from 611 trees (from 31 localities). In the case of the wild service tree, on account of very weak visibility of borders between the annual growth rings, the measurements were carried out using the aqueous filter. Measurements of the annual growth widths were made with the accuracy of 0.01 mm, using a stereoscopic binocular microscope. Then, using classic methods of dating (cross-dating), correlation coefficients r, values t of the Student's test, local chronologies were constructed. Statistical cross-dating was performed with the Cofecha program. The computer program Arstan was applied to detrend cross- dated tree-ring sequences using a negative exponential curve and to average the tree- ring width sequences detrended into the residual (RES) chronologies for each plot. The chronologies constructed were used as a base for dendroclimatological studies: analyses of correlation, response function and pointer years, for which data were taken from the nearest meteorological station. Preliminary analysis show that negative pointer years for wild service trees were related to deficiency of precipitations in the growth season, particularly in the summer months, cambium activity could be additionally weakened by high summer temperatures combined with droughts. Positive pointer years were years with humid summer periods. For the air temperatures negative values of correlation and regression could be generally noted, above all for the current and previous growth seasons, whereas for the precipitations these values could be positive (December, April and July) or negative (January and February).

The project was financed from means of the National Centre of Science, granted on the basis of the decision DEC-2011/03/B/ST10/06157

Keywords: *tree-ring, dendroclimatology, wild service trees, Sorbus torminalis, Poland*

Searching for precipitation signal in the Western Carpathians

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Abstract

The temperature of the growing season is the main climate factor limiting the tree growth in mountainous regions. The strength and stability of this relationship is high enough to allow the development of the millennium–long temperature reconstructions based on tree-rings (e.g. Esper et al. 2002; Büntgen et al. 2005). In mountain environment of temperate zone the tree-ring record of precipitation signal is less frequent and the reconstruction of precipitation poses a challenge. Büntgen et al. (2012) reported a possibility of finding moisture sensitive Scot pine sites in the Western Carpathians, although the signal is not constant over larger area. This motivated the further investigations covering bigger range and wider variety of coniferous species. Here we present the results of analyses focusing on precipitation signal of 7 coniferous species growing in the Western Carpathians (cold, temperate zone). The sites are spread over 130 km and 1000 m of elevation difference (from timberline at 1600 m a.s.l. down to 600 m a.s.l.). In total 30 study sites and almost 2400 trees were analyzed. After proper sample preparation, the measurements were performed using CooRecorder 8.0 software (Cybis Elektronik & Data AB). For each species and each site the TRW chronologies were built and signal strength was checked by EPS and Rbar. Gridded climate data were used: annual sum of precipitation, Palmer Drought Severity Index (PDSI), cloud cover and vapor pressure for the years 1901-2004. The results show the positive growth-response for winter precipitation (January – March) and negative signal for summer precipitation for all species of subalpine zone (Norway spruce, Stone pine, European larch, and Dwarf mountain pine). However, the signal does not dominate over temperature. For most of the species the low elevation sites exhibit rather weak response to precipitation. These results contradict the previous findings concerning the increase of precipitation strength with decrease of elevation. Scots pines growing on the cliff sites seem to be the best precipitation indicator.

All these sites reveal significant correlation with Palmer index and vapor pressure.

References:

Büntgen U., Esper J., Frank D.C., Nicolussi K., Schmidhalter M. 2005. A 1052-year tree-ring proxy for Alpine summer temperatures. Climate Dynamics, 25(2-3), 141-153.

Büntgen U., Kaczka R.J., Trnka M., Rigling A. 2012. Ensemble estimates reveal a complex hydroclimatic sensitivity of pine growth at Carpathian cliff sites. Agricultural and forest meteorology, 160, 100-109.

Esper J., Cook E.R., Schweingruber F.H. 2002. Low-frequency signals in long tree-ring chronologies for reconstructing past temperature variability. Science, 295 (5563), 2250-2253.

Keywords: *precipitation record, coniferous species, Scots pine, cliff sites*

Climatic signals in tree-ring width of European larch in Latvia

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Abstract

Plantation of exotic species is aimed to maximize productivity of stands due to faster growth and/or lower susceptibility against pests. In Baltic countries, European larch (*Larix decidua*) has been considered as potential species and, during the 20th century, it has been planted in experimental plantations scattered over the territory of country. European larch in Latvia has high productivity especially in the initial stage of development; however, its climatic demands have not been studied. Therefore, the aim of this study was to assess the signatures of climatic factors in high-frequency variation of tree-ring width of European larch growing in different parts of Latvia. Ten stands of larch with age bout 100 years located across the territory of Latvia were selected. In each stand, ten dominant trees were sampled. Two increment cores per tree were taken. Tree-ring width was measured. The quality of measurements was checked and time series were crossdated. Residual chronologies for each site were produced and climatic signals were determined by bootstrapped correlation analysis.

High-frequency variation of tree-ring width of larch showed common tendencies between all sites; however, regional differences were also present in the chronologies. In general, tree-ring width was affected by temperature in summer preceding growth that might be explained by occasion of water deficit. Such effect can be explained via production of nutrient reserves that influence growth of deciduous trees in the next season. In some sites, positive effect of precipitation in current summer was also observed, approving the negative effect of water deficit. Similar effect of temperature has been previously observed for species in the mid-parts of their distribution area. Considering that European larch in Baltic countries occurs north of its natural distribution area, the observed climate-growth relationships suggest that winter conditions in Latvia are suitable for growth of the species. Still, some differences in climate-growth relationships were observed between the western and eastern parts of Latvia. In the eastern part of Latvia, where climate is harsher, the effect of summer temperature was stronger; in the western part of Latvia, additionally some positive signatures of temperature were observed is a few sites.

Keywords: *Larix decidua, exotic species, Baltic region, regional signatures, weather conditions*

Growth-climate relationship investigated from Slovakian oak recent TRW chronology

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Abstract

The missing independent oak tree-ring-width chronology for Slovakia represented a significant gap in the network of Central European TRW chronologies. Here, we present a newly established well replicated oak recent TRW chronology for this area. This composite record, representing most of Slovakia, was used to test oak climate sensitivity in the region. The modern wood was randomly sampled at numerous sawmills and living trees all over the country. Slovakian oak chronology consists of disc and core samples from 1028 oaks (820 from the west and 208 from the east) spanning the period from 1717 to 2013 AD. The results confirm that the resemblance of TRW chronologies decreases with an increasing distance of the plots. High similarity was revealed between the eastern and the western TRW chronologies despite a huge difference in the replication and the mountainous regions in between them. This trend is also obvious when the chronology is compared with the oak chronologies of the neighbouring countries. Tree growth is driven particularly by spring and early summer precipitation and PDSI. Therefore, drought spells were most likely the main reason of the most negative pointer years. The newly established recent TRW chronology forms a basis for a potential long oak chronology creation from historical material in the region, which can be then used for climatic reconstructions.

Acknowledgments: This study was conducted with funding from the Czech Republic Grant Agency through the grant numbered 13-04291S, "Establishment of an International Scientific Team Focused on Drought Research" (no. OP VK CZ.1.07/2.3.00/20.0248), the Ministry of Education, Youth and Sports of CR within the National Sustainability Program I (NPU I), grant number LO1415 and projects no. IGA 28/2014 and no. LDF_VP_2015004.

Keywords: *dendrochronology, climate-growth relationships, oak, Slovakia, PDSI*

On the paleoclimatic potential of a new millennium-long oak composite chronology from Slovakia

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Abstract

The area of Slovakia was the only one in Central Europe for which oak (*Quercus* spp.) tree-ring width chronology had not been created. Therefore, the main objective was to collect the available oak dendrochronological data and to use the chronology to test oak climate sensitivity in the region. The historical material was taken mostly from historical wooden building constructions and the recent samples were randomly taken at numerous sawmills and from living trees from all over the country. We collected 276 samples from oak historical constructions and 1028 samples from recent oak from 61 stands in Slovakia. The oak chronology range is from 967 to 2013. The growth-climate relationship reveals significant late spring and summer precipitation and especially summer PDSI. Concurrently, the impact climatic signal in the tree ring decreased in the last thirty years. Due to unstable replication and temporal instability of the climatic signal, the dataset remains unprepared for reliable climatic reconstructions.

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Keywords: *oak, Slovakia, precipitation, PDSI*

High-frequency variation of tree-ring width of several tree species in Latvia

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Abstract

Climate is one of the main factors affecting distribution of tree species, therefore sensitivity of trees to weather conditions is a useful parameter for the evaluation of possible changes in their growth and distribution under shifting climatic conditions. Species (provenance) specific and regional and/or local variability of climate-growth responses should be considered for reasonable projections. The aim of this study was to assess similarity of high-frequency variation of tree-ring width of four native (Scots pine, Norway spruce, silver birch and black alder) and three exotic (European beech, red oak and European larch) tree species in hemiboreal conditions in Latvia. Increment cores form mature dominant trees of native species and larch were collected in ten sites located across Latvia. Cores from beech and red oak were collected in one and three sites. Tree-ring widths were measured, measurements were crossdated for each species and site residual chronologies were developed. The same standardization methods: double detrending (negative exponential curve and cubic spline with wavelength of 64 years and 50 % cut-off level) with autoregressive modelling was applied for all datasets. The similarity of tree-ring variation was assessed by Principal Component Analysis based on residual chronologies for sites for period 1950–2010; annual indices were used as variables. Climate-growth relationships were determined by bootstrapped correlation analysis.

The ordination of chronologies showed that tree-ring width of native trees had species- specific variation, as suggested by distinct grouping of sites. Such results were expected as the studied species had sensitivity to different climatic factors. Pine, spruce and alder were mainly affected by temperature in winter/spring, summer precipitation and temperature in early summer, respectively. Amongst the studied native species, climatic signals in birch were the weakest and site specific as expectable for pioneer species growing in mid part of its distribution area. Variation of tree-ring

width of the studied exotic species, which in Latvia occur at higher northern latitudes than their natural distribution area, was quite similar to native conifers. This suggested that climatic conditions in Latvia have not been drastic for their radial growth. Nevertheless, despite similarity of tree-ring width patterns with spruce and pine, the studied exotic species commonly showed correlations with climatic factors referable to water deficit in summer as observed in mid-parts of their distribution. Apparently, the studied exotic trees have been well adapted to winter conditions in Latvia. The study was supported by Forest Competence Centre (ERAF) project "Methods and technologies for increasing forest capital value" (No. L-KC-11-0004).

Keywords: *principal component analysis, local variation, climate-growth relationships, species comparison, exotic species*

How Blue reflectance data enhance the climatic signal of coniferous

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Abstract

In the dendrochronological analysis the various proxies related to annual tree growth is used. The most commonly used and the earliest source of information is the width of annual tree-rings (TRW). Along the science development the measurments of anatomical features came into widespread use: wood density (X-ray methods, electrofusion etc.), chemical composition and stable isotope composition. All of them are used for several decades, proving its usefulness in various branches of dendrochronology. One of the most recent inventions is the use of the image analyses of blue spectrum reflected from the wood (Blue Reflectance, BR). A preview studies have shown it is a good temperature indicator (McCarroll et al. 2002) as good as the maximum latewood density data (Schweingruber et al. 1978). We aimed at testing the potential of BR as climate proxy comparing to tree-ring width. Here we present the results of the analyses of the blue reflectance for seven coniferous species growing in the Carpathian Mountains region: four within subalpine zone [*Larix decidua* Mill., *Pinus mugo* Turra, *Picea abies* (L.) Karst., *Pinus cembra* (L.)] and three in montane zone [*Abies alba* (L.) Karst., *Pinus sylvestris* (L.), *Taxus baccata* (L.)]. The samples were scanned and blue reflectance and TRW were measured using the CooRecorder 8.0 software (Cybis Elektronik & Data AB). The standard techniques of verification (visual crossdating and Cofecha program) and chronology computing (Arstan) were employed. The BR and the TRW chronologies for each species were built. The signal strength of both, the BR and TRW chronologies was compared by the inter-series correlation (Rbar), and the Expressed Population Signal (EPS). Correlation analysis between the BR, TRW chronologies and climate data was undertaken over the 1901– 2006 period, using an 18-month window from May of the year prior, to tree growth until the current-year October. Growth response to climate analysis of the BR and TRW chronologies shows respectively rather consistent response to current-year spring-summer (April - August) and high summer (June - August) temperature. The Yew

tree shown the different response and sensitivity on winter temperatures (prior December, January – March). The BR chronologies of all species show the higher and for longer period response to climate than TRW (except the Yew tree) and in case of spruce, larch and stone pine comparable with MXD. The presented results lead to the conclusion that the BR proxy has high potential as the climate proxy for all the coniferous species in mountain regions of temporal climate.

The study was supported by the National Science Centre, project no: 2013 /11 /B / ST10/04764 NN 306070540

References:

McCarroll D., Pettigrew E., Luckman A., Guibal F., Edouard J.L. 2002. Blue Reflectance provides a surrogate for latewood density of high-latitude Pine tree rings. Arctic, Antarctic and Alpine Research, 34 (4): 450–453.

Schweingruber F.H., Fritts H.C., Bräker O.U. et al. 1978. The x-ray technique as applied to dendrochronology. Tree-Ring Bulletin, 38: 61–91

Keywords: *Coniferous species, Mountain regions, Blue reflectance, temperature response*

Blue intensity analyses on spruce, larch and cembran pine cores of living trees from the Alps

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Abstract

Maximum density (MXD) data of conifer tree rings is well known as a strong proxy for summer temperatures. However, the classical approach to establish such data, i.e. radiodensitometric analyses, is relatively expensive and time consuming. Blue intensity (BI) / blue reflectance has been recognised as a proxy to acquire wood density of conifers, but in a maybe easier way than with radiodensitometric analyses (McCaroll et al. 2002).

Most BI studies published so far are based on scots pine (*Pinus sylvestris*) samples (e.g. Björklund et al., 2014). Here we investigate the potential of BI analyses for three other conifer species: spruce (*Picea abies*), larch (*Larix decidua*) and cembran pine (*Pinus cembra*). These species and close relatives are widespread in Europe and Asia. The investigated samples were taken from living trees at treeline or near-treeline sites in the Alps. BI analyses of the samples were carried out after i) resin extraction (acetone), ii) preparing the surfaces utilising a WSL core-microtome (Gärtner and Nievergelt 2010), iii) filling the tracheid lumens of the conifer samples with chalk, iv) producing high-resolution pictures of the samples by microscope photography, v) stitching these pictures together and vi) establishing BI data for earlywood as well as latewood by using the software LignoVision (Österreicher et al., 2015). Moreover, δBI series were established by subtracting earlywood BI (EWBI) from maximum BI (MXBI) data. This preparation procedure is different to the usually applied preparation approach of BI samples, i.e. sanding and scanning. Our approach aims at an improvement of the BI analysis of samples with small latewood sections. For a subset of the spruce samples, radiodensitometrically established MXD data is available from cores of the same trees (Esper et al 2007). It is to notice, that both larch and cembran pine show a more or less marked difference between heartwood and sapwood. To investigate possible effects of these properties on the BI data, we applied the Super-

posed Epoch Analysis (SEA) on the series of these two species. Response function analyses were carried out utilizing regional instrumental temperature and precipitation data of the last ca. 150 years.

The usage of chalk results in a clear differentiation of the EWBI from the corresponding MXBI values. EWBI, MXBI and δBI data show nearly normal distributions and the different BI data groups are clearly separated. For the subset of spruce trees for which also MXD data is available the shape of the value distributions of density and BI data are very similar. Moreover, the established MXD and MXBI / BI chronologies show high similarities (Österreicher et al., 2015). For cembran pine, the SEA results do not indicate any effect at the heartwood / sapwood transition on MXBI data. For larch, however, the SEA results show a lower level of the MXBI values in the sapwood than in the heartwood. Response function analyses with the MXBI chronologies prove similar results as they are known for comparable MXD chronologies (e.g. Esper et al. 2007), i.e. best correlations with July to September average temperature data.

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References

Björklund JA, Gunnarson BE, Seftigen K, Esper J, Linderholm HW, 2014. Blue intensity and density from Northern Fennoscandian tree rings: using earlywood information to improve reconstructions of summer temperature. Climate of the Past 10, 877–885.

Esper J, Büntgen U, Frank D, Pichler T, Nicolussi K, 2007. Updating the Tyrol tree-ring data set. In: Haneca, K. et al. (eds.), TRACE - Tree Rings in Archaeology, Climatology and Ecology 5, 80-84.

Gärtner H, Nievergelt D, 2010. The core-microtome. A new tool for surface preparation on cores and time series analysis of varying cell parameters. Dendrochronologia 28, 85-92.

McCarroll D, Pettigrew E, Luckman A, Guibal F, Edouard JL, 2002. Blue reflectance provides a surrogate for latewood density of high-latitude pine tree-rings. Arctic, Antarctic and Alpine Research 34, 450-453.

Österreicher A, Weber G, Leuenberger M, Nicolussi K, 2015. Exploring blue intensity - comparison of blue intensity and MXD data from Alpine spruce trees. In: Wilson R, Helle G., Gärtner H. (eds.), TRACE – Tree Rings in Archaeology, Climatology and Ecology 13, 56-61. Scientific Technical Report 15/06, GFZ German Research Centre for Geosciences

Keywords: *Blue intensity, Picea abies, Larix decidua, Pinus cembra, Alps*

Climatic signal in tree-ring width of hybrid poplar (*Populus balsamifera x P. laurifolia*) in Latvia

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Abstract

In Nordic countries, economic significance of hybrid poplar as a source of renewable energy and timber is increasing due to its rapid growth and short rotation. In Latvia, poplar hybrids appear especially promising for use on the abandoned agricultural lands. Still, there is poor knowledge about the role of climatic factors on its radial increment, likely due to limited age of the stands. Therefore, the aim of this study was to evaluate the effect of monthly mean temperature and precipitation sums on tree-ring width of 60-year-old hybrid poplar (*Populus balsamifera x P. laurifolia*) growing in two experimental plantations in the western part of Latvia (56°31'N 22°56'E and 57°15'N 22°42'E). In each site, 12 dominant trees were felled and stem disks from 1.3 m height were taken. In laboratory, the surface of disks was grinded with sandpaper of four roughness grits (80, 120, 240 and 400) using belt and vibration sanding machines. For each disk, tree-ring widths were measured along two opposite radii avoiding reaction wood. The quality of measurements was checked and time series crossdated by graphical inspection and using COFECHA. Based on the crossdated time series of trees, residual chronologies were produced. The effect of climatic factors was assessed by bootstrapped Pearson correlation analysis. The tested climatic window extended from January of the year preceding growth to September of current year.

The time series of tree-ring width showed good agreement among trees within and between sites, suggesting reaction to large-scale factors. A few time series were rejected during the quality checking and a few missing rings in a few most recent years were detected during the crossdating. The established chronologies had similar range of index values and correlation between them was 0.78. Nevertheless, the sets of the significant climatic factors differed between sites. Correlation coefficients calculated between the chronologies and climatic factors did not exceed 0.35, suggesting intermediate effect of weather conditions on radial increment of hybrid poplar. Precipitation in January of the previous year was the only factor significant in both sites. The

effect of this factor might be explained by the insulating properties of snow layer that decreases amplitude of soil temperature and freeze depth, thus reducing root mortality. In the first site, negative effect of temperature in previous September was observed. In the second site, negative effect of temperature in current June and August was observed. The negative effect of increased temperature might be explained by facilitation of water deficit in warmer conditions or by impeding of assimilation by high temperature. The observed negative effect of temperature in current March might be explained by premature cessation of dormancy, when nutrient reserves are being depleted. Considering the observed climate-growth relationships, warming of climate might burden radial growth of poplar.

Keywords: *temperature, precipitation, hybrid poplar clones, agroforestry*

Tree-ring forward modelling for improving growth response to drought for simulating long-term forest dynamics

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Abstract

Understanding and simulating the species- and site-specific variability in tree growth responses to droughts is a complex issue. Cell growth and formation are among the first processes impacted by drought stress (Palacio et al., 2014). In consequence, the dynamics of intra-annual cambial activity strongly vary between sites with contrasted water conditions, and among species that use different strategies to face drought in terms of water use, water uptake and phenology (Zweifel et al., 2009). In regions characterized by summer drought, wood formation mainly occurs in spring, when temperatures are high enough to allow photosynthesis and soil moisture is relatively high. During the summer months, growth is usually inhibited and carbon assimilation is reduced; while during fall, evergreen species may exhibit a second peak of photosynthetic activity thanks to increased water availability. This inter-seasonal and inter-site variability in growth responses to drought is not implemented in most forest succession models although it may impact their projections of forest dynamics, especially under climate change. The main objective of our study was to consider this variability in simulating growth with a forest succession model (ForClim, cf. Bugmann, 1996) while maintaining its parsimony regarding its structural complexity.

We used a forward modeling approach of tree-ring growth (VS-Lite model; cf. Tolwinski-Ward et al., 2011) to quantify the intra-annual growth responses to drought of Scots pine (*Pinus sylvestris* L.) in sixteen sites located along a gradient that covers most of the environmental conditions of the species. We included these new functions in ForClim, and tested the accuracy of the new model versions in two dry Scots pine forests (Valsaín in Central Spain and Pfynwald in the Valais, a dry-inner alpine valley in Switzerland) by comparing simulated with observed temporal changes in stand basal area. Simulations were performed with three different ForClim versions: (1) the original ForClim (Bugmann and Cramer, 1998), and modified versions of ForClim including (2) site-specific or (3) averaged monthly growth functions. This allowed us to investigate if site-specific growth strategies should be included in models that aim to forecast forest succession at continental scale.

The VS-Lite model was able to capture a large part of the inter-annual variability in ring-width based on monthly meteorological data (Fig.1). We observed that Scots pine growth could be split into two periods – late spring/early summer and beginning of fall (Fig.1). At both sites, the overall growth response in late spring/early summer is maximal, while a second minor peak of growth is simulated in fall. The stand basal area simulated by ForClim that included site-specific intra-annual growth response was the closest to the measured one, followed by simulations with ForClim with averaged monthly growth functions and finally with the original approach that performed the less (Fig. 2, Table 1).

Our results suggest that forest succession models should take into consideration the intra-annual differences in drought-growth relationships when simulating forest dynamics in water stressed environments. In addition, we demonstrate the opportunity

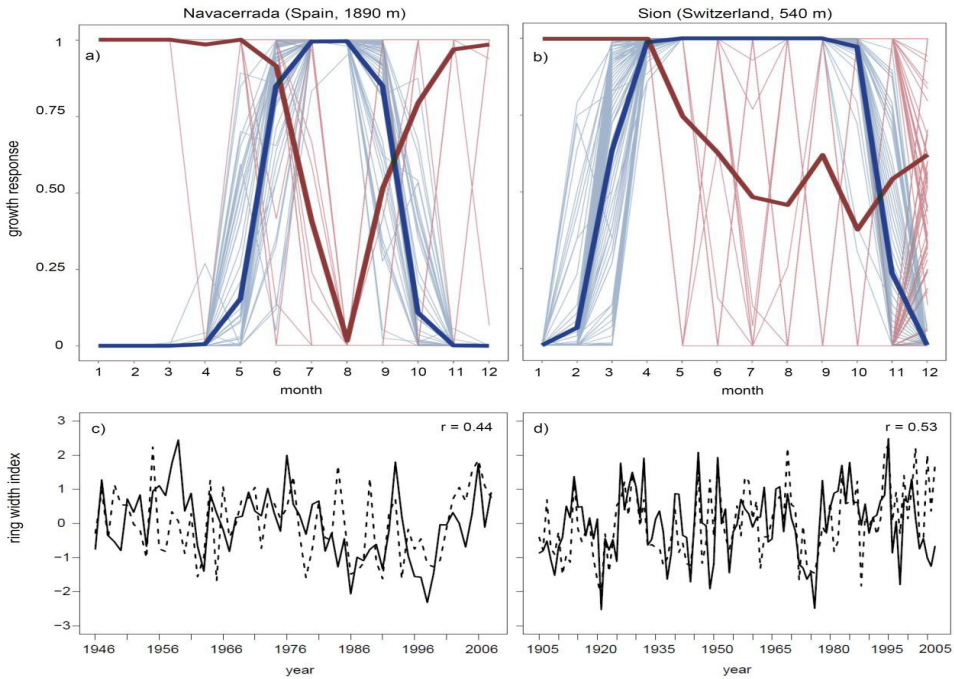

Figure 1: Upper panels: monthly growth response curves for temperature (blue lines) and soil moisture (red lines) simulated with VS-Lite in Valsain (data from weather station Navacerrada) and Pfynwald (Sion weather station). A value of 1 means that there are no limitations to growth, while a value of 0 means no growth. The overall growth response is modeled as a monthly minimum of either temperature or soil moisture. The thin lines represent the curves obtained for each year included in theobtained metereological time series while the thick lines show the long-term means. Lower panels: observed (solid) and simulated (dashed) ring-width indices for Navacerrada ($r = 0.44$, $p<0.01$) and Sion ($r = 0.53$, $p<0.01$).

of using a tree-ring based forward-modelling approach to re-calibrate ecological processes in forest dynamic models.

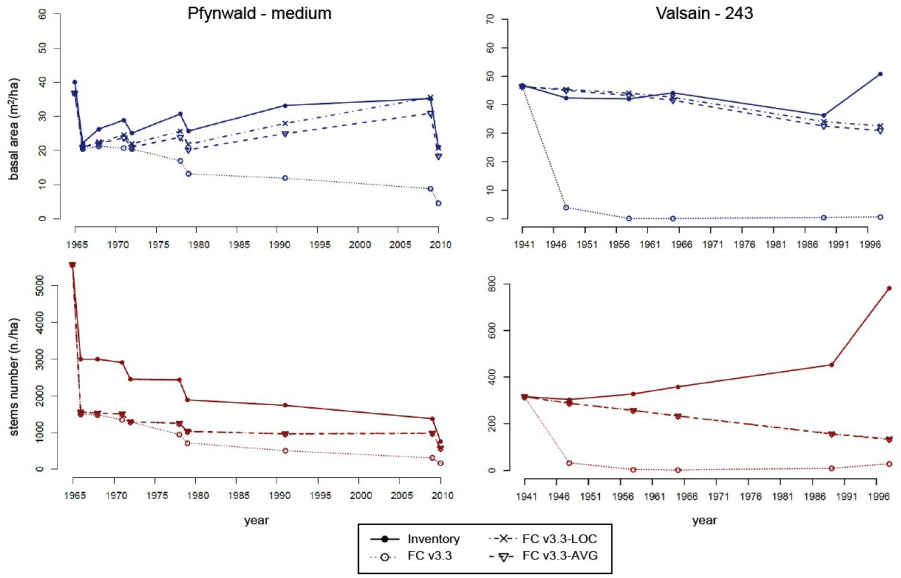

Figure 2: Stand basal area (m2/ha) and stem numbers (per ha) measured (solid lines) and simulated by ForClim (dashed lines) in the medium thinning experiment of Pfynwald (Left) and in the stand 243 from Valsaín (Right). FC v3.3 = version using the original approach for simulating drought; FC v3.3-LOC = ForClim modified version using site-specific optimized sets of drought parameters obtained optimized with local tree-ring chronologies; FC v3.3-AVG = ForClim using drought parameters averaged over the entire precipitation gradient.

Table 1: Percentage bias (Bias; in %) and relative root mean square error (RMSE; in %) of basal area and stem numbers simulated with the current ForClim version (FC v3.3), the ForClim version using local and averaged M1-M2 parameters (FC v3.3-LOC and FC v3.3-AVG, respectively)) compared with measured values from forest inventories. The column Stand indicates the thinning treatment in Pfynwald (1=light thinning treatment; 2=medium thinning; 3=heavy thinning) or the forest compartment in Valsaín.

		Basal area						**Stem Numbers**					
		FC v3.3		FC v3.3-LOC		FC v3.3-AVG		FC v3.3		FC v3.3-LOC		FC v3.3-AVG	
Location	Stand	Bias	RMSE	Bias	RMSE	Bias	RMSE	Bias	RMSE	Bias	RMSE	Bias	RMSE
Pfynwald	1	-25.9	28.8	5.8	6.5	-0.4	0.5	-21.2	23.5	-8.6	9.5	-8.4	9.3
Pfynwald	2	-39.3	43.6	-10.4	11.5	-15.8	17.6	-45.1	50.1	-35.4	39.3	-35.3	39.3
Pfynwald	3	-45.8	50.9	-11.4	12.7	-18.3	20.3	-11.4	12.6	14.1	15.6	13.6	15.1
Valsaín	134	-88.1	105.7	-44.4	53.3	-46	55.2	-83.4	100.1	-43	51.6	-42.9	51.4
Valsaín	143	-42.3	50.8	-21.5	25.7	-23.1	27.7	-33.6	40.3	-23	27.6	-22.7	27.3
Valsaín	243	-80.2	96.3	-6.6	8	-8.7	10.4	-84.5	101.4	-45.4	54.5	-45.5	54.6

References

Bugmann, H. and Cramer, W., 1998. Improving the behaviour of forest gap models along drought gradients. Forest Ecology and Management, 103(2-3): 247-263.

Bugmann, H.K.M., 1996. A Simplified Forest Model to Study Species Composition Along Climate Gradients. Ecology, 77(7): 2055-2074.

Palacio, S., Hoch G., Sala A., Körner C.,and Millard P., 2014. Does carbon storage limit tree growth? New Phytologist 201:1096-1100.

Tolwinski-Ward, S.E., Evans, M.N., Hughes, M.K. and Anchukaitis, K.J., 2011. An efficient forward model of the climate controls on interannual variation in tree- ring width. Climate Dynamics, 36(11-12): 2419-2439.

Zweifel, R., Rigling, A. and Dobbertin, M., 2009. Species-specific stomatal response of trees to drought - a link to vegetation dynamics? Journal of Vegetation Science, 20(3): 442-454.

Keywords: *drought, tree-ring width, Scots pine, forest succession model, VS-Lite model*

Forty centimeter long transverse micro-sections cut from fresh increment cores

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Abstract

The analysis of anatomical variations within annual rings of trees has great potential for reconstructing past environmental conditions. However detailed wood anatomical analysis have rarely been applied to long-term reconstructions mostly because of methodological constrains and time-consuming procedures of data collection.

We proposed a cutting technique which allows analyzing 15-20 μm thick micro- sections of entire increment cores with length of up to 40 cm. Gärtner and Nievergelt (2010) have presented the new advanced WSL core-microtome for the wood surface preparation of entire 40 cm increment cores. By using this device we were able to successfully make micro-sections of entire tree ring cores.

Our aim was to prepare for building multi-centennial anatomical chronologies from two endemic species for Balkan Peninsula (Pinus heldreichii Christ. and Pinus peuce Griseb.) and additionally test the cutting technique on other species (Ivanova et. al; submitted). Previous studies on tree ring width series of Pinus heldreichii Christ. (Panaytov et al., 2010) and Pinus peuce Griseb. have shown strong inter-series correlation, but mixed climatic signal. Tree ring growth was found to be strongly dependent both from summer precipitation and temperature, but also from winter temperatures (P. heldreichii). We therefore chose to study the climatic signal in maximum latewood density (MXD) of Pinus heldreichii which may contain a much stronger climatic signal than tree ring width. Our initial results show that there is significantly positive correlation with summer temperatures (Jun-Sep) and negative correlation with summer precipitation (Trouet et. al., 2012). This researches outlined the potential for constructing long tree ring chronologies which may be used for studying the climatic variation in the past. A difficulty is the mixed climate signal. We therefore decided to study in more detail the anatomy of tree rings and with our ongoing study

on xylogenesis of those two species we are looking for better understanding on climate influence on tree rings formation. We collected 40 cores from 20 trees from bought species and performed up to 40 cm long micro-sections. We did the image analysis by the ROXAS package, which automatically produces data of sufficient accuracy for most research questions (von Arx and Carrer, 2014). We were able to create a 100 years old anatomical chronology based on ring width, tracheid size, cell wall thickness and thickness-to-span ratio or Mork's index for all cells.

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Gärtner H & Nievergelt D. 2010. The core-microtome: A new tool for surface preparation on cores and time series analysis of varying cell parameters. Dendrochronologia 28: 85--92.

Ivanova A., Dolezal J., Gärtner H., and Schweingruber F., (2015) Forty centimeter long transverse and radial micro-sections cut from fresh increment cores; IAWA Journal, (submitted)

Panayotov, M. P., Bebi, P., Trouet, V. and Yurukov, S. 2010. Climate signal in tree-ring chronologies of Pinus peuce and Pinus heldreichii from the Pirin Mountains in Bulgaria. Trees - Structure and Function 24, 479-490.

Trouet V., Panayotov M., Ivanova A., Frank D, 2012: A pan-European summer teleconnection mode recorded by a new temperature reconstruction from the northeastern Mediterranean (AD 1768–2008). The Holocene, Vol. 22, No. 8, pp. 887-

898.

von Arx G, Carrer M. 2014. ROXAS - a new tool to build centuries-long tracheid-lumen chronologies in conifers. Dendrochronologia 32: 290--293

Keywords: *wood anatomy; multi-centennial anatomical chronologies; entire increment cores*

Plasticity in variation of xylem and phloem cell characteristics of Norway spruce under different local conditions

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Abstract

Norway spruce (*Picea abies* (L.) H. Karst.) is considered to have high adaptive potential. Despite many hazards it remains one of the most important European forest tree species. Due to its major economic importance and vulnerability to climate change, numerous tree-ring studies have been carried out in recent decades. Whereas investigating intra- and inter-annual variability of xylem anatomy has already been demonstrated to be a promising approach in tree-ring studies, phloem structure and its relation to environment is still relatively unexplained.

To upgrade current knowledge on the plasticity of secondary growth which allows trees to adjust their growth to specific environmental regimes, we examined radial growth of spruce from three contrasting locations in the temperate climatic zone by analysing tree-ring widths and cell characteristics in xylem and phloem increments formed in the years 2009–2011. This joint approach of dendrochronological and quantitative-anatomical methods allowed us to define climate-growth relationships from cell parameters and tree-ring widths more precisely. For analyses, two locations were selected in Slovenia and one in the Czech Republic. The sites differed in altitude and latitude. Micro-cores, which were collected at the end of the growing season of each year (i.e. October), were fixed, embedded in paraffin, cut on a rotary microtome, and stained with safranine / astra blue water mixture. The cross-sections were examined with light microscope and image analysis system.

Variation in the structure of annual xylem and phloem increments in Norway spruce clearly showed that plasticity in seasonal dynamics of cambial cell production and

cell differentiation exists on both xylem and phloem sides. Anatomical variables of xylem and phloem cells seem to be predominantly site-specific characteristics in Norway spruce, because they varied among sites but were fairly uniform among years in trees from the same site. We found no link among the variations of radial lumen size of initial and terminal cells in xylem and phloem increments at individual locations. In addition, xylem and phloem tissues formed in the first part of the growing season seemed to be more stable in structure, indicating their priority over latewood and late phloem for tree performance.

Keywords: *cambium, tracheidogram, phloemogram, radial growth, growth/climate relation*

Fibre length of Black locust - how to understand the variability between early- and latewood

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Abstract

Diversification of sizes of tracheal elements, the length of fibres in particular, in various zones of the annual ring seems to depend on variable environmental conditions. The understanding of the role of climatic conditions determining the activity of vascular cambium, necessitates identification of interactions within the phloem-cambium-xylem internal system. One of the theories describing the mechanisms of radial growth in a tree trunk, is the hypothesis of the mechano-osmotically driven plastic adaptation to mechanical stress generated by swelling phloem [Kjos 2012]. Our studies were carried out as one of the phases of testing the selected elements of this hypothesis.

The research covered two Black locust stands (MIE and WOL) in the western part of Poland out of which 5 sample trees were selected. The analyses covered three annual rings representing the years 1981, 1991 and 2011. Each annual ring was analysed in terms of fibre length and the results were separated into two categories – early- and latewood. The results of fibre length measurements were assigned to three length classes: short (78-555 μm), medium (556-1,032 μm) and long (1,033-1,508 μm) fibres. For each fibre length class independent statistical analyses were carried out. Linear model was applied, taking into account the following variables: location, annual ring zone, year of measurement and the interaction between those elements. For both stands the basic weather characteristics were determined, along with mean temperature and the sum of precipitation for periods associated with the formation of early- and latewood (APR – JUN and JUL - SEP respectively).

For the short fibres significant differences between early- and latewood were confirmed only in case of the MIE stand. Fibres of 1981 were also considerably longer than those of 1991. The most abundant class of fibres in terms of their length was the medium class - fibres from the WOL stand were longer than those of MIE stand, but only in case of fibres of 1991 and 2011. In the third class - long fibres – the only fibres which significantly differed

in early- and latewood were those of 2011. For the WOL stand the fibres formed in 1991 differed from those of 1981 and 2011.

Statistical analysis of results was supplemented with morphological analysis, which showed non-intuitive and complex dependencies determining the fibre length in early- and latewood. In extreme cases, when the nature of growth was determined by a factor in its minimum (seasonal precipitation), the entire system was behaving as expected. In intermediate cases, compensating mechanisms were activated. Hence, for the explanation of particular processes leading to fibre, vessel elements and entire annual ring formation the wider environmental context of analysed occurrences had to be taken into account. Fibre length in earlywood is smaller than in latewood. It is most evident, if the conditions for the growth of vessel elements are favourable. Fibres in earlywood are longer, if growth conditions for vessel elements are worse. Fibre length, however, depends on the speed and size of radial growth and that depends on weather conditions - the longer the early spring, the greater the spring growth (in aphyllous condition). Substantial spring growth provides conditions for the formation of numerous, medium-sized vessel elements and an increased percentage amount of small fibres with dominating medium-sized ones. If, however, the growth of spring wood is rapid and short-term (rapid increase of temperature and/or low spring precipitation), then a lower number of vessel elements occurs with high diversification of fibre length.

Latewood fibres formed in summer are also affected not only by the temperature and precipitation, but also by earlywood to a certain extent (precipitation and temperature in spring). For instance, if the summer growth occurred in unfavourable conditions, then the subsequent growth reactions even in favourable conditions will still be atypical and the formed fibres resulting from intrusive growth will have different length than expected.

The above described analyses lead to a conclusion that the explanation of distribution of different fibre length classes in annual rings requires more precise data on lowest and highest day and night temperatures in particular seasons. Moreover more detailed data are required on the availability of water in particular growth and development phases of vascular cambium. In addition, for the latewood formation the following conditions are also crucial: length of a day, air humidity, precipitation, cloud cover, wind speed, number of days/nights with temperature lower than threshold value, higher auxin availability, higher supply of CO_2, etc. - which were not taken into account in this study.

Because of an inconsistent interpretation of growth mechanism and diversification of fibres lengths in early- and latewood, based on the auxin hypothesis, we applied the mechano-osmotical qualitative hypothesis of radial growth of broadleaved trees to discuss the results of our research. Due to its precise anticipation of the influence of a specified set of external and internal environmental conditions on radial growth, the mentioned hypothesis seemed a relevant interpretation tool. In the course of works it occurred, however, that for the simple cause and effect inference, it requires more precise empirical data, in particular those referring to external environmental conditions. On the other hand, it allowed for the preparation of initial morphological tables, identification of deviations from the hypothetical anticipations and later on for the determination of causes of those deviations.

Keywords: *fibre length, black locust, mechano-osmotically driven growth hypothesis, earlywood, latewood*

History of life encoded in wood of ash (*Fraxinus excelsior* L.) with dieback symptoms

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Abstract

Since the 1990s, a large-scale ash dieback has been observed in countries around the Baltic Sea and recently spreading to other regions of Europe. The fungi which occur most frequently within the sick and dead tissues taken from declining ashes are considered to fulfill important role in the disease process. The fungus referred as Chalara fraxinea is believed to be a causal agent of ash dieback. However, it seems that climate changes enhance the phenomenon of dying ash trees as well.

The aim of our survey was to verify the hypothesis that observed in recent years the weather anomalies combined with the activity of biotic factors trigger the vitality of ash trees which is reflected in the weakening of their health and frequently lead to death not only single individuals but whole stands.

Disc samples of wood were collected in July 2010, at breast height (bh = 1.3 m) from the stem of 13 European ash trees (Fraxinus excelsior L.) growing in the Srokowo Forest District (21°36'20"E, 54°20'48"N). Based on the degree of defoliation, three groups of health were established for the ash trees. The first represented dead trees (group 1), the second encompassed weakened trees with dieback symptoms (group 2), and the third consisted of healthy trees (control, group 3). The first group was represented by 5 trees, the two latter by 4 each. The breast age of ashes was from 54 to 88 years.

Having cross sections and macerated wood the hypothesis was upheld based on the measurement of: (i) tree-ring widths, (ii) vessel diameter in earlywood, (iii) vessels element length in earylwood, (iv) fibre length, (v) fibre width (vi) fibre lumina width, and

(vii) fibre wall thickness. Anatomical parameters of wood deposited in years 1999-2000 were compared with that formed in years 2008-2009. Moreover, tree-ring measurement series in each group were standardized by fitting a linear or negative exponential regres-

sion equation. Bi-weight robust mean were used to build mean chronologies for each group separately.

We noted the growth ring suppression after 1999, however the highest reduction was observed in group 1 comparing with group 3. Also, the variability of the analyzed anatomical parameters in group 1 deposited in 1999-2000 was apparent comparing with that formed during the period 2008-2009.

We postulate that both tree-ring widths and anatomical traits of wood, especially vessel diameter, are good indicators when complex phenomenon of ash dieback is surveyed because of the among others environmental factors, the climate signal is encoded in their structure.

Keywords: *Ash dieback, annual tree-ring, fibres, Fraxinus excelsior, vessels*

Differences in wood anatomical traits of larch growing under contrasting conditions within the forest-tundra ecotone (Taimyr, Russia)

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Abstract

The study of tree-ring cell structure changes as the result of tree adaptation to varying environmental conditions becomes increasingly important to predict future vegetation shifts under projected climate changes. Xylem determines the functioning of conductive and storage systems (Baas, 1986; Bryukhanova, Fonti, 2013). The link of tree physiological processes (e.g. photosynthesis, transpiration, storage and use of photoassimilates) with hydrothermal soil conditions is realized through xylem (tracheids). The aim of this study was to examine the differences between xylem anatomical traits of larch (*Larix gmelinii* Rupr.) trees, growing under contrasting hydrothermal soil conditions within a forest-tundra ecotone in Siberia (Russia).

The monodominant larch stands in the forest-tundra ecotone in the valley of the Kotuy river (Taymyr, Russia, 70o52' N, 102o55' E) were studied: the OF site at the open larch forest treeline and the CF site at the boundary of closed and open larch forest. The distance between OF and CF sites was 1700 m with the difference in elevation being 232 m. Morphometric indicators of the larch stands as well as tree-ring widths of model trees were measured. From each study site, 5 trees were chosen for xylem analyses. To reveal and analyze wood anatomic traits, several xylem traits, including radial lumen width (LUM), the cell wall thickness (CWT) were measured for the rings formed between 1964 and 2008 (45 rings). The comparative analysis of these tree-ring cell structure parameters and their sensitivity to environmental conditions was carried out. The boundary between earlywood and latewood was placed according to Mork's formula (Denne, 1988).

To characterize the hydrothermal regime of the soils, temperature and moisture of soil at different depths was measured at each of the sites. Soil hydrothermal conditions in the

open forest were found to be better then those in the closed forest site as the root zone temperature and melting soil depth were higher, while soil moisture was lower at OF site in comparison with the CF site.

The trees from the forest-tundra boundary (OF) had greater radial growth rate, formed bigger conductive zone in tree-rings with wider mean lumen area in comparison with the trees at the closed forest site (CF). This result can be explained by the adaptive features and high ecological plasticity of the Gmelin's larch xylem. In addition, the tree rings of the larch were characterized by strong variability of structure from year to year.

Moving correlations between tree-ring parameters and mean daily temperature and precipitation for 20 days window shifted by 5 days identified periods of significant influence (at the 95% confidence level) of climatic factors on tree-ring structure parameters. The negative temperature in May significantly affected the xylem traits of trees at both the sites. The highest correlation coefficients were found for the trees growing under less favorable soil conditions at CF site. High temperature in May led to the formation of small earlywood and latewood tracheids with thin cell walls in the trees from the closed forest site, while narrow earlywood formed in the rings of trees from the open forest. All the tree-ring structure parameters were positively influenced by the temperature during the active radial growth period (June), but a stronger correlation was obtained for the OF trees. The larger tracheids in latewood with thicker cell walls as well as earlywood tracheids with bigger lumen were developed in trees from OF under higher June temperatures. Warmer June also led to formation tree-rings with large number of earlywood tracheids at CF. Low precipitation in the first half of July resulted in bigger tracheids at OF (larger lumen in earlywood tracheids and thicker cell wall in latewood cells).

Conclusion. The trees growing under contrasting hydrothermal soils conditions in the north of Central Siberia (open forest vs closed forest) differed in xylem cell parameters as well as the duration and extent of the period with climatic factors primarily defining tree-ring structure. The results obtained may have implications to understanding the changes in forest ecosystem functioning under the projected climate changes and permafrost degradation.

The study was partly financed by the Russian Science Foundation (project 14-14-00295)

Baas, P. (1986) Ecological patterns in xylem anatomy. On the Economy of Plant Form and Function. (ed. T.J. Givnish), pp 327-349. Cambridge University Press, Cambridge.

Bryukhanova, M.V. Fonti, P. (2013) Xylem plasticity allows rapid hydraulic adjustment to annual climatic variability. Trees 27, 485–496.

Denne, M.P. (1988) Definition of latewood according to Mork (1928). IAWA Bulletin n.s. 10 (1), 59-62.

Keywords: *tree-ring structure; xylem anatomy; Larix gmelini; climatic influence*

Environmental signals in wood-anatomical characteristics of oak (*Quercus robur*) and ash (*Fraxinus excelsior*) from lowland forests

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Abstract

Due to excessive urbanization as well as intensive and unplanned silvicultural and agricultural exploitation, the lowland forest area in Slovenia and Croatia has been shrinking. In addition, environmental conditions, such as decreasing ground water levels as a result of changes in climatic conditions and unsuitable artificial melioration of land for agricultural purposes, affected health condition of lowland forest stands. This is reflected in reduced wood increment, which is closely related to the wood quality and thus its properties, causing a lower value of wood products and financial losses. Therefore, economic and ecological consequences associated with decreasing vitality of European oak (*Quercus robur* L.) and European ash (*Fraxinus excelsior* L.), two commercially very important Slovenian and Croatian tree species cannot be neglected.

It is has been known that timing and dynamics of earlywood vessel formation in ring-porous Q. robur and F. excelsior differ, as well as the relation between leaf phenology and vessel formation. We compared the environmental sensitivity of tree- ring patterns in Q. robur and F. excelsior from two lowland forests; one in Slovenia and one in Croatia. We hypothesized that due to well-known differences in seasonal dynamics of radial growth in relation to leaf phenology the hydrologic and climatic signals in wood-anatomical characteristics of the selected two species would differ. To these purpose, stem disks of six dominant / co-dominant mature trees of each tree species were taken on each plot and wood structure was analysed on a cellular level with special focus on initial ring of earlywood vessels. Climatic and hydrologic signals in wood-anatomical patterns of ash and oak will be compared and discussed.

The response of two ring-porous species to environmental variables, the potential

signal and the relevance of information stored in anatomical structure of earlywood and latewood will be checked. We will outline important differences in response to environmental factors between the two tree species. Finally, the stability of the environmental information stored in tree-ring features among the samples trees and different locations will be discussed.

Keywords: *European oak, European ash, earlywood vessels, tree-ring, River flow*

Xylem sap flow and radial growth in *Quercus pubescens* Willd. from abandoned grasslands in Slovenian Karst region

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Abstract

Karst region, which is located in the sub-Mediterranean area in SW part of Slovenia, has been significantly changed during the last decades due to the abandonment of marginal agricultural lands, mostly dry calcareous grasslands. Consequently, heterogeneous karst landscape is nowadays in several successional stages; from grasslands to shrublands to secondary oak forests. In sub-Mediterranean climate, characterized by rather harsh winter and dry and hot summer drought periods frequently occur leading to a great impact on plant and ecosystem functioning.

Pubescent oak (*Quercus pubescens* Willd.), hophornbeam (Ostrya carpinifolia Scop.) and manna ash (Fraxinus ornus) are the dominant native tree species of the Slovenian Karst region. For this area, particularly the pubescent oak is ecologically important as it is growing in forests that prevent degradation of vulnerable, shallow and erosion-prone soil. To survive in such environment, pubescent oak has developed various mechanisms and adaptations, such as conservative water use, tolerance of plant water potential drop, deep and extensive root system, narrow xylem increment etc.

Research was conducted in abandoned karst grassland that is being overgrown with different tree species among which pubescent oak dominates. In the current study we evaluated intra-annual regulation of water of pubescent oak with eco-physiological and wood-anatomical analysis. We investigated relations between leaf phenology, xylem sap flow, radial growth patterns and weather conditions. In the growing season of 2014 (i.e., in the period April–October), we performed the following measurements and analyses: 1) xylem sap flow measurements according to the Heat Ratio Method, 2) micro-core sampling at weekly intervals using Trephor to study the timing of xylem and phloem formation, and the widths and structure of completed xylem and

phloem increments, 3) leaf phenological observations, 4) collection of weather data.

Preliminary results show that xylem sap flow is closely related to the climate factors (particularly to precipitation and vapour pressure deficit), and to internal tree factors (vessel enlargement in early and latewood). With the development of new shoots and with leaf unfolding at the beginning of May xylem sap flow increased. Cambial cell production and, consequently, xylem and phloem formation started in the third week of March 2014. By the second half of April, the first ring of the earlywood vessels was fully developed and thus ready for water transport. In mid-May the second ring of earlywood vessels was forming in wider xylem growth rings, while latewood formation began in the third week of May. The transition between early and late phloem occurred at the end of May. Weekly measured xylem and phloem increments revealed that phloem production was faster in the first part of the growing season (i.e., in the period April–May), but thereafter xylem production accelerated. Production of cells in the cambium stopped at the beginning of August on xylem and phloem sides.

In order to get a better insight into tree water relations and radial growth of Quercus pubescens, we have to extend measurement period over several years, which will include dry and wet periods.

Keywords: *pubescent oak, karst, xylem sap flow, radial growth, phenology*

Animating tree colonization and growth

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Abstract

Analyzing spatial patterns in plant communities can provide an understanding of competition between species and of the dynamics between vegetation and its surrounding environment. Cartographic animation can facilitate an exploration of the dynamic processes resulting from complex spatial interactions across plant communities. Focused on a small study area (less than 5000 m^2), this inter-active poster demonstrates an animation of tree colonization over more than a century using a micro GIS method, which includes geo-referencing, tree circumference growth modelling, measuring spatial competition and cartographic mapping. The spatial and temporal patterns / interactions of four species, Ash (*Fraxinus excelsior*), Oak (*Quercus robur*), Yew (*Taxus baccata*), Small-leaved Lime (*Tilia cordata*) are animated and analysed using ESRI ArcGIS 10.1 in order to gain an understanding of woodland dynamics. This case study highlights the potential for applying micro GIS to woodland communities where more traditional large-scale GIS analyses would be found wanting.

Keywords: *Tilia Cordata, GIS, competition, conservation management, UK*

Tree-ring growth of *Larix sibirica* in the Russian Altai-Sayan Mountains

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Abstract

Tree-ring research in the Altai-Sayan Mountains so far only considered a limited number of well-replicated site chronologies. The dendroecological and palaeoclimatological potential and limitations of large parts of south-central Russia therefore remain rather unexplored. Here, we present a newly updated network of 13 larch (*Larix sibirica* Ldb) tree-ring width (TRW) chronologies from mid to higher elevations along a nearly1000 km west-to-east transect across the greater Altai-Sayan region. All data were sampled between 2009 and 2014. The corresponding site chronologies cover periods from 440-860 years . The highest TRW agreement is found between chronologies ≥2200 m asl, whereas the material from lower elevations reveals overall less synchronized interannual to longer-term growth variability. While fluctuations in average June-July temperature predominantly contribute to the growth at higher elevations, arid air masses from Mongolia mainly affect TRW formation at lower elevations. Our results are indicative for the dendroclimatological potential of the Altai- Sayan Mountains, where both, variation in summer temperature and hydroclimate can be robustly reconstructed back in time. These findings are valid for a huge region in central Asia where reliable meteorological observations are spatially scarce and temporally restricted to the second half of the 20th century. The development of new high-resolution climate reconstruction over several centuries to millennia will further appear beneficial for timely endeavors at the interface of archaeology, climatology and history.

The work was supported by Russian Science Foundation (project 15-14-30011).

Keywords: *Siberia Altai-Sayan Mountains, central Asia, climate reconstruction, growth-climate sensitivity, hydroclimate, network analyses, south-central Russia, summer temperature, tree-ring width, upper treeline*

Climate and grazing impact on a radial increment of oak (*Quercus robur* L.)

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Abstract

The main goal of our research is estimation of climate and grazing impact on increment of oak in the Neman river valley in the western part of Belarus.

The objects of our research were oaks trees in two near situated plots. One of them is floodplain area; forest type is Quercetum graminoso-fluvialis (chronology LPCH02o). This area traditionally used by local people for grazing. Another one is a little bit raised area inside floodplain; forest type is Quercetum oxalidosum (chronology LPCH01o). Dynamic of livestock were obtained in the nearest village for the period 1973-2014. Meteorological data came from the Volkovyssk station is situated at the distance about 30 km from the research area.

Two cores were taken from more than 20 oak trees in each plot. Age of trees is from 170 to 250 years. Tree rings width was measured to the nearest 0.01 mm. For this purpose, scanned images of the cores and the ArcGIS program adapted for tree ring measured, were used. The tree-ring series were cross-dated by using the COFECHA 6.06P program and standardization was done using the ARSTAN40C program.

Both tree ring chronologies have a high intercorrelation (0.71 in LPCH01o and

0.63 in LPCH02o), that confirms existence of well-expressed external factors which are specify a similar dynamics of all trees inside plot. In addition high correlation noted between both chronologies, t-value is 8.3.

Tree ring chronology LPCH01o has a high autocorrelation of first order (0.62), but chronology LPCH02 has a lower (0.47). That is, trees growing in dense stand form its own microclimate, which smoothed external impacts, unlike pasture oaks, where the distance between trees up to several dozen meters.

The response function only explains 33.5 % of variation in residual tree ring chronology LPCH01o (Quercetum oxalidosum) and 44.1 % in chronology LPCH02o.

There is significant positive response function coefficients between indexes of LPCH01o chronology and precipitation in September last year, in April, June, July of the current year and with average temperatures of December of the previous year. The negative coefficients are noted for temperature in September last year and January, and also February precipitation.

A little bit differences are observed in response function of LPCH02o chronology. There is significant positive coefficients with precipitation in January, March, April, July and September and with average temperatures of November of the previous year and August of the current year. The negative coefficients are noted for temperature in September and January last year, and also February precipitation.

The response function shows that growing season in pasture oaks is wider than in the dense stand. Thus its annual increment should be higher. However, despite the same age, the absolute increment values have been the same in both chronologies until 1980. After that, the increment in the flood plain oak forests began to increase. Sharp decrease in the number of cattle and reduce grazing pressure on the ecosystem start in the same period (Fig.1). In this case the herd of cows in 200 heads constantly grazing or forced through sparce flood plain oak forests leads a declined a radial increment of trees by 20-30%.

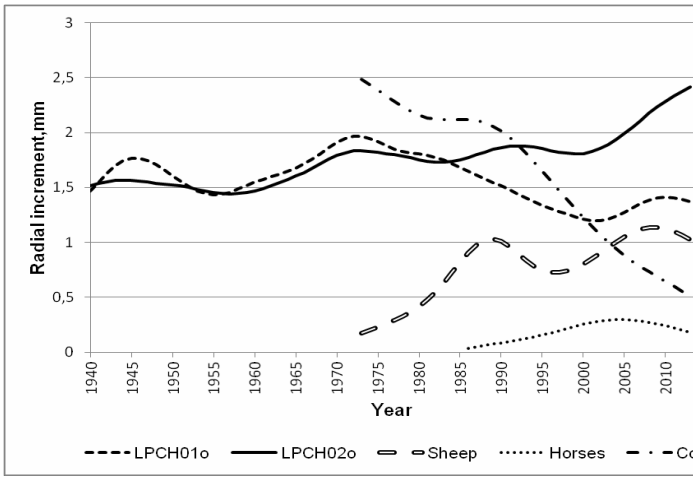

Figure 1. Radial increment and livestock dynamic, smoothing 20-year moving average

Keywords: *oak, tree ring chronology, air temperature, precipitation, grazing*

Difference in climate responses of trees (*Larix gmelinii*) growing in contrast permafrost conditions of north-and south- facing slopes (Central Siberia)

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Abstract

The numerous dendrochronological studies shown, that the annual rings formed in the same years at various heights in the stems, similar respond to the influence of climatic factors (Schweingruber et al., 1996). However, in highly sensitive trees growing in extreme conditions of permafrost climatic signal may be modified.

The aim of this paper is to study radial growth dynamics at various heights (1/4, 3/4) in the stems including a top part (in 20-30 cm beneath apex) of larch trees (Larix gmelinii), growing in permafrost contrast conditions of the north and south facing slopes (Central Siberia, 64°19'23" N, 100°13'28" E) under the influence of the same climate factors.

In two sampling sites 10 dominant trees were selected. Disks from the stems were treated, using standard dendrochronological methods. We estimated climate- growth relationships by means of more sensitive method of "sliding time-window correlations" (Fonti et al, 2007; Simanko et al., 2013). Correlations were calculated between mean indexed chronologies for each tree height in the stem and daily averaged air temperature and precipitation recorded at "Tura" weather station (1974- 2009). A 20-day moving window technique whereby the climate variables were shifted across time in 5-day steps from April to October was used.

The response of tree growth on temperature showed two periods within a growth season (Fig. 1). The first period was revealed from April 20 to May 5 in 3/4 of mean tree height on the north-facing slope and from 20 to 30 April in 1/4 and 3/4 of tree heights on the southern-facing slope; the correlation is negative. It could be resumed, that the trees on the southern-facing slope are more sensitive to the negative influence of temperature in early spring, when the formation of tree ring is not yet started. The second period was revealed from 25 May to 14 July in 1/4, 3/4 and 4/4 of mean tree heights on the north-facing slope, and from 19 June to 4 July in 1/4 of tree height on the southern-

facing slope. So that, the trees on the southern-facing slope are less sensitive to positive influence of air temperature. Tree growth positive correlates with precipitation from 25 May to 10 June i.e. in the beginning radial growth season at both slopes, but in the period of intensive growth in 3/4 and 4/4 of mean tree heights on the north-facing slope and in height 3/4 on the southern-facing slope.

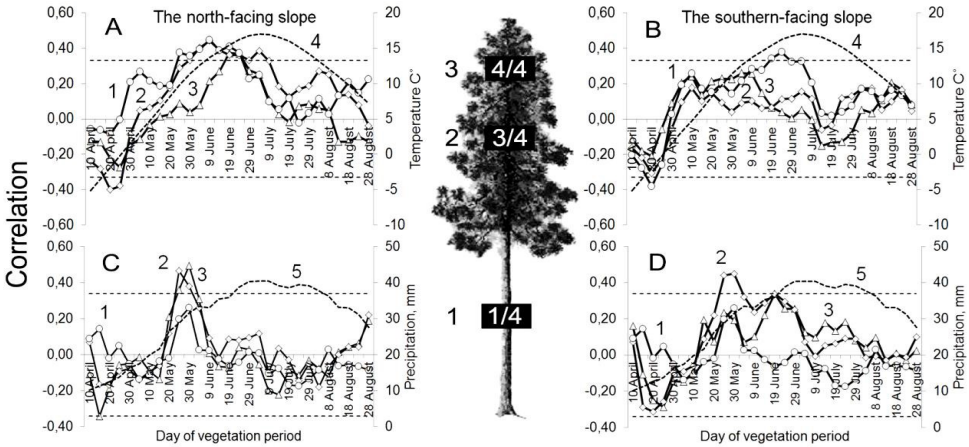

Figure 1. Variation of the correlation coefficient between tree ring width chronology and climatic factors: temperature (A, B) and precipitations (C, D). The heights in the stem: 1/4 (1), 3/4 (2) and top part (3); 4, 5 – average data of temperature and precipitation recorded at "Tura" weather station (1974-2009) (R>0.33 significant for P>0.95).

Therefore, according to our results, tree ring variation at the tree tops shows high sensitivity to precipitation in the beginning of vegetation season on the north- facing slope, which is not typical for trees on the south facing slopes. Along with this, we could assume that at dry seasons the trees may suffer from water deficiency. It would affect top-drying – the phenomenon wide-spread in the northern forests of Central Siberia.

1.Fonti P., Solomonoff N., García-González I. Earlywood vessels of Castanea sativa record temperature before their formation // New Phytologist, 2007, 173 (3), P. 562-570.

2.Schweingruber, F. H., 1996: Tree Rings and Environment. Dendroecology. Birmensdorf, Swiss Federal Institute for Forest, Snow and Landscape Research. Berne, Stuttgart, Vienna, Haupt. 609 pp.

3.Simanko V.V., Benkova A.V., Shashkin A.V. The application of «sliding respond function» method for revealing climatic factor influence on tree radial growth // The Bulletin of KrasGAU. 2013. №7. P. 188-194

Keywords: *dendroecology, larch, permafrost, climate response*

Pedunculate oak longevity and growth-to-climate relation in city forest at the Western Steppe

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Abstract

The longevity of *Quercus robur* in the old oak-stand in the Donetsk city and a chronology relations with climate variations were the main aim of this investigation. We also assessed the periodical structure of tree-ring signal and main climatic predictors' in the region, and the values of favorable for oaks growth temperatures and precipitations.

The study was performed in Putilovsky forest in Donetsk (48°03'53", 37°47'34"), which is the industrial center in Ukraine. The city is at the Western part of Eurasian Steppes, but up to the end of 19th century the large number of small forest grown hear at the ravine and along rivers coast. At our days, the only Putilovsky forest steel exist at the border of the city.

The 80 ha forest area is dominated with pedunculate oaks, common ashes (*Fraxinus excelsior* L.), field maples (*Acer campestre* L.). The oldest trees present the core of the forest and number about 150–200 large-sized pedunculate oaks and common ashes.

We sampled the cores of the 20 oaks with widest stems with no or small-sized external damages. One or two cores per tree at the breast height (1.3 m above ground) were extracted with Pressler's borer. Prepared samples were scanned at a resolution of 3200 dpi using an Epson V33 scanner. Rings width was measured using AxioVisionLE tools (Carl Zeiss Imaging Solution GmbH) with 0.01 mm precision. Data were cross- dated and combined into master-series. The individual series chronologies were checked, standardized, and detrended using COFECHA program (Grissino-Mayer, 2001) and dplR package (Bunn, 2008). Monthly precipitations and mean temperatures, from 1886 to 2013, were used in order to test trees growth response to climate. We calculated Pearson's correlation coefficient by standard method and using progressive year-to-year sliding calculation with 35 years' base length. We also applied Fast Fourier Transform algorithm to estimate periods of growth index I and climate changes. The value of optimal meteorological conditions for oak growth in the steppe zone was calculated.

Mean ring width (MRW) of the oaks was 2.14±0.49 mm and varied from 1.41 to 3.26 mm. The tree rings number in the sampled cores was 57–173, and the age of trees with safe wood was 103–162 years. The estimated age of hollowed-stem oak was 97– 254 years. Thus, the oldest oaks in the ravine forest represent two age cohorts: 100– 150 years old and 150–200 y. o. with age-to-diameter ratio 2.22±0.54 years per cm. The stand show linear relation with climate variation especially to May and June precipitation and March, April, and June average temperature. The dominant period of tree growth variation corresponds to the thirty–five–year climatic cycle, which expressed in annual, March and September values of precipitations and annual, autumn and February average temperature variations. These results show the exceptional importance of the temperatures and precipitations during oak secondary growth time from March to June. Considering continental climate and recreation, the establishment of old trees in Donetsk must be to prevent soil compaction and to maintain forest canopy.

Keywords: *Quercus robur, chronology, Eastern Europe*

Long and short-term natural regeneration after windthrow disturbances in Norway spruce forest in Bulgaria

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Abstract

Norway spruce forests are among the most affected by natural disturbances mountain ecosystems in Europe. In cases of disturbances one of the key questions is the possibility of forests to quickly recover, which is highly dependent on regeneration. We studied the natural regeneration after two windthrows which occurred more than 30 (1983) and 50 years ago (1962) in old-growth forest with age of more than 150 years in the Parangalitsa reserve and in a windthrow 14 years ago (2001) in 130-year old uniform forest in the Bistrishko branishte reserve in Bulgaria. Our specific objectives were to study (1) the durationof the regeneration process in the blowdown areas; (2) the temporal changes in the species composition and (3) the regeneration substrates. .

The windthrow areas were identified and mapped on the basis of forest maps and orthorectified aerial photographs in GIS software (Panayotov et al., 2011; Panayotov et al., 2015). Along altitudinal gradients in each windthrow we designed transects along which we set sample plots of 100 m2 (10 x 10 m) at every 50 m. In total we established 21 transects with 85 sample plots. In each sample plot we recorded the species composition, density, diameter at breast height, and height of the regeneration. The age structure was analysed by extracting tree ring cores (n = 475). In addition we examined the distribution of saplings per microsite type (pit, mound, coarse woody debris and intact forest floor). The coverage of the main microsites types was also estimated.

Our data indicated that there were two discrete peaks of post-disturbance regeneration. The first one started immediately after the windthrows and was dominated by Norway spruce and Rowan, while the second started about 30 years later and was dominated by spruce (Fig. 1). Pioneer species played less than expected role. Initially the most important regeneration substrate was intact forest floor hosting between 69 and 80 % of the regeneration. In the second regeneration wave the importance of coarse woody debris (CWD) rose significantly. CWD proved to be particularly important substrate for the recruitment of Picea abies and *Abies alba* (Fig. 2).

Our data confirmed previous findings that forest recovery after medium and large-scale wind disturbances may be a long-lasting and dynamic process. As a result, 30-50 years after the disturbances the forest canopy was still not closed and the regeneration processes were still going on. In both study areas the windthrows lead to reestablishment of Picea abies and other species, which were dominant in the studied forests before the disturbances. The occurrence of pioneer species was limited to the very first stages of the regeneration process. The most important regeneration substrates were intact forest floor in the first decade after the disturbances and coarse woody debris 3 to 4 decades later.

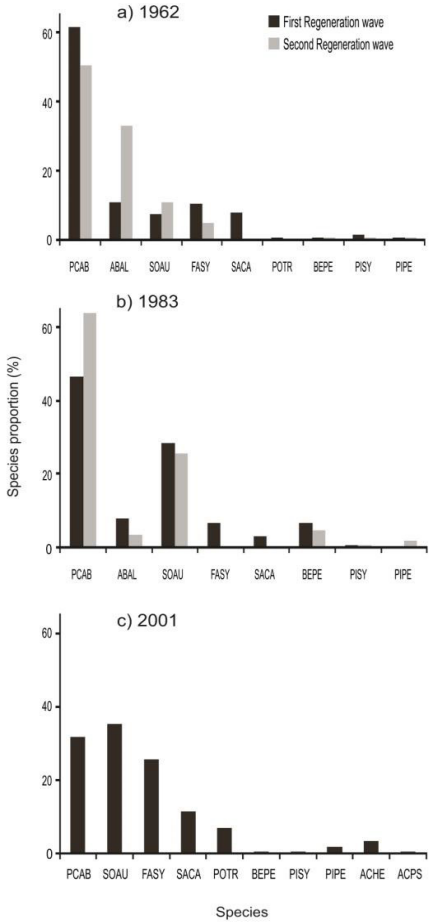

Figure 1. Species proportion in the First and Second regeneration waves: a) 1962 windthrow; b) 1983 windthrow; and c) 2001 windthrow. Species abbreviations: PCAB – Picea abies (L.) Karst.; ABAL – Abies alba Mill.; SOAU - Sorbus aucuparia L.; FASY - Fagus sylvatica L.; PISY – Pinus sylvestris L.; PIPE - Pinus peuce Griseb.; SACA - Salix caprea L.; BEPE - Betula pendula Roth; POTR - Populus tremula L.; ACHE - Acer heldreichii Orph. ex Boiss; ACPS - Acer pseudoplatanus L

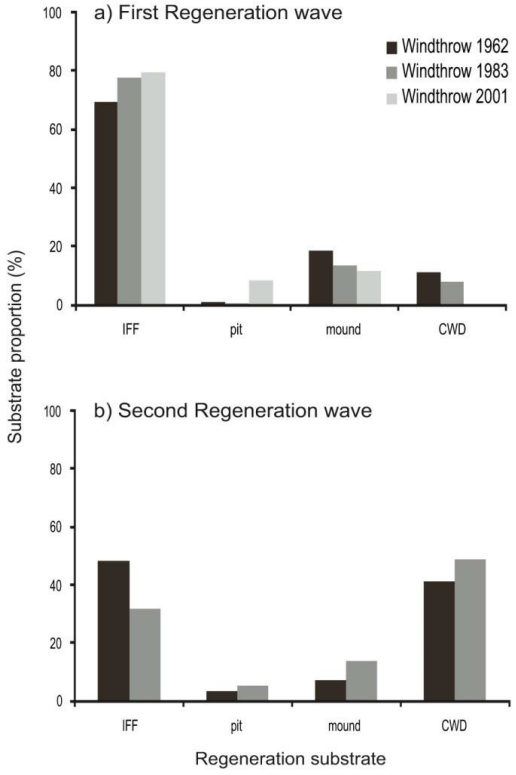

Figure 2. Substrate proportion in the First and Second regeneration waves: a) 1962 windthrow; b) 1983 windthrow; and c) 2001 windthrow. Used abbreviations: IFF - Intact forest floor; CWD - Coarse woody debris.

References:

Panayotov, M., D. Kulakowski, L. Larnjeiro Dos Santos, B. and Bebi P., 2011. Wind disturbances shape old Norway spruce-dominated forest in Bulgaria. Forest Ecol. Manag., 262: 470-481.

Panayotov, M., Bebi, P., Tsvetanov,N., Alexandrov, N., Laranjeiro, L., Kulakowski, D., 2015. The disturbance regime of Norway spruce forests in Bulgaria. Can. J. For. Res., in press, doi: 10.1139/cjfr-2014-0505

Keywords: *Picea abies, natural regeneration, windthrows, South-Eastern Europe*

Age vs. reproductive capacity in the oldest known black pine growth stand in Spain

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Abstract

Black pine (*Pinus nigra*) is a long living Mediterranean species, with trees reaching a thousand years of age in an old growth stand located in the Cazorla Mountain Range, SE Spain, at almost 2,000 m a.s.l.. A total of 80 trees which age had been previously determined by dendrochronology (from 25 to 889 years), were selected within the stand in order to harvest cones (December 2013), for studying the reproductive capacity in relation to their age. When possible, at least 60 cones were picked per tree. The cones were later taken to the lab where weight, length and diameter were measured. Cones were oven dried for seed extraction; and the number of seeds per cone was counted.

At the end of April 200 seeds per tree were placed to germinate in laboratory dishes (4 dishes with 50 seeds each one) at air temperature (22ºC).The number of germinated seeds were counted in a daily basis. Germination power, germination energy, average time for germination and germination value according to Czabator (1962) and Diavanshir and Pourbeik (1976) were calculated per tree according to the daily values of germination. The first 80 seeds germinated per tree were sowed in containers (59) filled with a mixture of peat and perlite (3:1) with an statistical design consisting in 4 blocks including 20 plants per block (80 plants per tree and a total amount of 2400 plants) randomly located within the tray. Emergence was assessed in a weekly basis. Percentage of final emergence and average time of emergence were calculated.

Seedling survival was also assessed in a monthly basis up to October.

Every parameter mentioned above was also statistically analyzed in relation to the age of the trees.

We found an average of 21±0.59 seeds per cone, and average dry mass per seed of 17.7±0.2 mg. Viable seeds constitute 75.2±3 % of the total amount of seeds and viability is not correlated with age of the tree. Germination capacity showed significant differences among trees but not with the age of the trees; the size of the seeds also influenced this parameter.

The emergence of the seedlings one month after plantation reached 83.8 % ± 5.8 %, being significantly different among trees, but without significant differences or correlation with age ($r = 0.08$, $N = 531$). The mortality of plants after emergency and up to October wasn't correlated with age, but diferences among trees weren't found either.

Keywords: *Pinus nigra, cones, germination, old growth stands*

Extreme events in tree rings of Scotch Pine on the North of Pechora Plain: microclimatic aspects

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Abstract

We collected cores of *Pinus sylvestris* L., growing on dry and wet sites at the northern range of distribution on Pechora Plain (65°05´- 65°59´N 57°20´ - 57°39´E, 50-60 m a.s.l.) to reveal differences in abnormal structures formation and their spatio-temporal distribution in different ecological growth condition. We have built 270 year tree-ring chronologies using Lintab 5 and TSAP software and revealed missing rings by cross- dated by COFECHA software. Additionally, we developed tree ring density chronologies based on the same sample, measured by ITRAX and WinDendro to reveal rings with extreme low and high late wood density and earlywood/latewood ratio. Finally we described anatomical abnormal structures as frost rings, light rings and pathological resin channels. Based on these three sources we analyzed differences between dry and wet grow conditions during last 270 years. This work is supported by RFBR No 14-04-91356.

Keywords: *abnormal structures, tree ring width, wood density, Pinus sylvestris, Pechora Plain*

Growth analysis of larch trees in Järvselja Forest Research Station (Estonia)

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Abstract

Different larch species have been cultivated in Estonia since 19 centuries. Larch is well growing and resistant to disturbances. Tree rings of larch trees are good indicators to detect growth changes during the time. The aim of this study was to detect growth changes on five larch species in Järvselja Forest Research Station.

Increment core data are collected from 24 larch stands and divided according to species into five groups: Russian, Japanese, European, Kuril and Hybrid larch. Totally 233 trees were cored. Correlation and redundancy analysis were done to describe relationships between radial increment and weather factors (daily mean temperature °C and sum of precipitation mm). Pointer year analyze was used to detect extreme positive and negative event years.

Results of analysis revealed that temperature is main growth promoting or limiting factor of radial growth of larch trees. Early- and latewood growth was also influenced by temperature. The temperature in March, before vegetation period, influenced negatively tree growth of European, Kuril, Russian and Hybrid larches. Redundancy analysis showed similar variability between species detected radial growth pattern of loading. The first principal component explains between high-frequency chronologies 69.4 % of the total variation.

According to pointer year analyses 1964 and 1995 were detected as the most significant negative years among different species, while low amount of precipitation during the year caused poor growth of trees. Positive pointer years were detected 2001 and 2004, while this was caused by previous year warm autumn.

Also mean annual increment differ statistically significantly among species, except mean growth between Hybrid and Japanese, also between European and Russian larch species. Hybrid and Japanese larch tee-ring widths were wider, they grow faster

than other species. Larch increment depends from start of growing season and with earlier growth is Japanese larch.

The relationship between climate conditions and tree growth, also with site characteristics are very complex and the factors that affect tree growth may even change from year to year. Daily data are more advanced data set for detailed analysis and finding out the exact length of frost or heat period, also length of the growing season and other variables which significantly influence tree increment.

Keywords: *climate, early- and latewood, ring-width, increment, Larix sp.*

European ash (*Fraxinus excelsior* L.) dieback reflected in tree rings of trees from SE Poland – signal detection and data processing methods comparison

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Abstract

European ash (*Fraxinus excelsior* L.) dieback has been increasingly observed in eastern, northern and central Europe since 1990s. In Poland firstly it was observed in 1992 in NE part and during last decades spread all over the country. The reason of ash decline is still unclear, however the contribution of fungus *Chalara fraxinea* sp. nov. in this process is emphasized. Phenomenon is observed in all age classes, in natural stands and nurseries. Disease leads to top and shoot dieback. Cankers on shoots, branches and steam are also an observed symptoms. The study that is conducted in SE Poland focuses on the relation between observed dieback and tree-ring widths, and their time dependency. The 100-years old stands, at various stage of dieback are examined. In this study we compare different methods of data standardization and preprocessing. When useful signal is hidden in the last part of the tree-ring time series, applied method of detrending is critical for its proper recognition and determination. In the case of standard detrending methods (e.g. negative exponential function) the last part of data can be highly distorted. In this study we compared different standardization methods of tree-ring data from tree stands at various stage of dieback (also on dead trees) with statistical and data-mining methods. Results for analyzed methods are presented and discussed. We showed that in this particular case the best results can be obtained for C-method (based on constant annual basal area increment).

The study was supported by the statutory grants of the AGH University of Science and Technology, Krakow, Poland, no 11.11.140.613 and 11.11.140.626.

Keywords: *ash dieback, detrending methods, data-mining methods*

Medieval floating spruce chronologies from a peat bog, Maramures Mts, Romania

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Abstract

This paper presents the result of investigations carried out on subfossil trunks collected between 2010 and 2014 from a peat bog located on the Vinderel Plateau, Farcău massif, Maramureș Mts. (Romania), in the vicinity of the Ukrainian border. The peat bog lies (N47°54'11", E24°26'37", 1530 m) below of Rugașu ridge (approx. 1820 m) and the locality serves as a conservation area for the fallen down coniferous trees.

During the past 4 years, 56 wood samples have been collected. The majority of wood-remains are Norway spruce (*Picea abies*). The samples have been subjected to dendrochronological analysis. Six floating chronologies have been developed so far. The longest floating chronology contains 259 years and the shortest spans 56 years. Neither of them cross-dated with the regional spruce master chronologies, reach back to 1588 A.D.

Six samples were selected and AMS radiocarbon analysis were performed. Calibration of 14C dates to calendar years was performed by the OxCal v.4.2 (Bronk Ramsey, 2009) program in conjunction with the Northern Hemisphere IntCal13 (Reimer et al., 2013) dataset.

The radiocarbon age of the oldest analysed wood-sample (MAR 025) is 1717 ± 19 yr BP, whereas the youngest one (MAR 003) is 1039 ± 16 yr BP. Calibrated age obtained for the above mentioned oldest and youngest samples are 255 – 388 cal AD, and 985 – 1023 cal AD, respectively. The floating chronologies all together provide and incomplete coverage over the 200 to 1200 AD period. These floating chronologies –

supported with 14C dates – serve as reference samples will provide important material to extent the East Carpathian spruce chronology back to the Medieval Times.

The lack of samples following the 13th century probably caused by anthropogenic deforestation at the elevation of the lake basin, and the spread of pastures around the site. This corresponds to the increased of grazing indicators detected in the regional pollen record.

Keywords: *subfossil, bog wood, Picea abies, Carpathians, peat bog*

The effect of climate on the radial growth of Black pine at the different altitudes of Sandıras Mountain, Turkey

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Abstract

In this study, we identified the most important climate factors affecting radial growth of black pine at the different altitudes of Sandıras Mountain (Mugla/Turkey). We used four black pine tree-ring chronologies built by Doğan and Köse (2015), which represent upper and lower distribution limits of black pine forest in south and north slopes of Sandıras Mountain. The relationships between tree-ring width and climate were identified using response function analysis (Fritts 1976). Mean temperature and total precipitation values were arranged from previous October to current October (duration of the biological year). Response function coefficients were calculated for each site and each meteorological station separately using DENDROCLIM2002 software (Biondi and Waikul 2004). We performed hierarchical cluster analysis to classify the response functions into meaningful groups (Fritts 1976, Köse et al. 2012).

The effect of precipitation on the lower limit of black pine forest on the Sandıras was positive from May to July. This positive effect was significant for May and June. Higher temperatures from February to April had a positive effect and from May to July had a negative effect on radial growth on the lower limit of black pine forest. On North Slope the positive effect of temperatures was significant for February. Besides, the effect of mean temperature was significantly positive in February and March, and significantly negative in June on South Slope.

According to the results of response function, the effect of precipitation on the upper limit of black pine forest on the Sandıras was positive in May for North Slope and in May to June for South Slope. Different from the other sites, higher February precipitation had a negative effect on radial growth of black pine in South Slope. The effect of temperature was appeared to be negative in previous October and current June,

with significant coefficients on the upper limit of black pine forest. Besides, the effect of temperature was negative for South Slope.

Hierarchical cluster analysis was used to sort climate responses of black pine trees from different altitudes and from different aspects. Group 1 was composed of the chronologies located in upper forest limits of the mountain, while the site chronologies from lower forest limits were combined into group 2. It's clear that elevation differences rather than aspect, is the main factor responsible for the formation of the clusters.

Keywords: *Black pine, tree-ring, radial growth, Sandıras Mountain, Turkey*

The variability of radial growth of Gmelin larch growing along the altitudinal transects in the north of Central Siberia, Russia

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Abstract

In the frame of global climate changes, it is important to understand plant adaptation strategies to new environments. The impact of climate change on survival and primary production of trees is more noticed at the sites, where the growth conditions are more limited (Fritts, 1976).

The aim of the study was to identify and evaluate the tree-ring growth variability and climatic response of Gmelin larch (*Larix gmelinii* (Rupr.) Rupr.) growing under different conditions in the north of Central Siberia (65° 25'N, 97° 35'E). In the studied area, the woody plant secondary growth is supposed to be strongly controlled by environmental conditions and very sensitive to even small changes. We studied trees growing at different elevations along the N- and S-facing slopes from the closed forest at the Tembichi-river valley (250 m a.s.l.) to upper treeline (900 m a.s.l.). Gmelin larch, a conifer species with an extremely wide distribution range in Asia (from the Yenisei in the west to the Far East regions in the east), is well adapted to extreme growing conditions. The set of conditions, observed along the studied transects, covered a wide range of possible conditions typical for the region, representing the maximum of adaptive variability of larch in the area.

Our preliminary results show that there is a sufficient effect of the site conditions on radial growth of L. gmelinii, indicating that climate conditions along the gradient modulate the response of individuals. These results are crucial to improvements of the forecast of tree survival under the climate changes pressure.

Fritts H.C. Tree rings and climate. / Fritts H.C.- Acad. Press: London – New York – San Francisco, 1976.-576 pp.

The work was suported by Russian Science Foundation № 14-14-00295.

Keywords: *local conditions, permafrost, transect, Gmelin larch, Siberia*

Comparative study on radial growth of *F. sylvatica* and *F. orientalis* planted in north Germany

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Abstract

Future climate change scenarios predict temperature increase for Central Europe, especially a higher frequency of summer heat waves and related droughts. Thus, forest management envisages to increase the resilience of European forest to extreme climatic events by replacing important central European timber species by more drought resistant species of provenances. In case of European beech (*Fagus sylvatica*), Oriental beech (*F. orientalis*) which occurs in warmer climates of the Middle East, might be an interesting alternative. This study aimed to compare the adaptability to dry climate of 4 different provenances of each beech species. All studied trees were planted at the end of 1986 in a provenance trial in northern Germany and were cut at the end of 2014. The planted trees were from 4 different provenances originating Turkey (TR) and 4 provenances from Germany (GE). For each provenance, we compared ring-width series and drought response reactions of three trees.

There were no significant differences between DBH and height of trees coming from different origins. However, trees from TR-Akkus had higher diameter and height compared to the other provenances. From German origins, trees of Dierdorf had highest diameters and trees from Farchau had biggest height. Between species there were no significant differences in DBH and height. However, the DBH of F. orientalis (13.7 cm) was slightly higher than F. sylvatica (13.1 cm), whereas the height was wise versa (16.17 m compared to 16.32 m). R-bar for all ring width series of European Beech was 0.31 and for Oriental Beech 0.30. The correlation of mean ring width of the two species was 0.84 which is showing very similar behavior of radial growth for provenances growing under identical climate conditions.

According to our preliminary results we conclude that the radial growth amount and variation was similar between both species and also between different provenances. We can expect due to climate change scenario which is facing increasing of temperature the F. orientalis can adapt to this changes. Further studies on wood anatomy and density are continued to understand better the different response of these two species to climate factors.

Keywords: *ash dieback, detrending methods, data-mining methods*

Dendroecology of a *Fagus orientalis* old-growth forest in Northeastern Turkey

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Abstract

The Colchic region is considered one of the most important biodiversity hotspots in the world. Because of its proximity to the Black Sea and its complex topography, it contains a high diversity of microclimates and some of the highest spatiotemporal variance in summer precipitation in Eurasia. Some areas receive up to 4000 mm of precipitation annually, which allows the development of luxurious temperate rainforest vegetation in the midst of an otherwise semi-arid region. These forests are dominated by either broadleaved trees or conifers and are characterized by an evergreen understory. Some of these forests have remained unmanaged for centuries, mainly in the most inaccessible areas. These old-growth forests offer the possibility to study natural forest dynamics and potential drivers of their dynamics.

For this study, we set up several circular plots in a high-elevation old-growth forest dominated by *Fagus orientalis* Lipsky. Within each plot, trees were mapped; diameter and tree height measured and one or two cores were sampled per tree. Using different release detection methods (RDM) from time-series of tree-ring widths, we analyzed stand disturbance dynamics, tree recruitment, and the canopy accession strategies for overstory trees. Several trees dated back to the mid to late 1500s CE and many were >300 years old. Although the RDM showed differences in frequency and timing of the releases detected, we identified periods with a high occurrence of releases that were also spatially defined suggesting the formation of important gaps in the stands.

Keywords: *Oriental beech, Colchic forest, temperate rainforest*

Spatial M/F analysis of landslide activity by using dendrochronological methods

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Abstract

The main aim of the study was to estimate a long-term magnitude/frequency (M/F) of mass movement dynamic on the area of the whole landslide. A middle-sized, active landslide has been selected. It was located at the concave slope of the Kamień Mtn (714 m a.s.l.) in the Beskid Niski Mountains (Poland). The landslide was compound, with high diversity of relief, which is typical in the Polish Outer Carpathians. The road traversing a middle part of the landslide, was built in the 1960s and severely damaged in 2001 as a result of mass movements activity. Studied landslide was covered with Dentario glandulosae-fagetum dominated by beech (Fagus sylvatica) and silver fir (*Abies alba*) semi-natural forest.

Dendrogeomorphological analysis of past landslide dynamics was performed. A total of 144 silver firs were sampled and 288 increment cores were obtained from upslope (c) and downslope (d) side of trees. From 32 trees affected by mass movements from different directions, samples were taken from additional two sides (perpendicularly to the slope, a and b). The most significant issue which was taken into account during selection of trees was distribution of trees providing further data interpolation. For the reference, 20 firs located in two neighboring slopes, which were not affected by landslide were also taken. First group was located at the upper part of the slope developed in sandstones. Second group was located at the lower part of slope developed in shales and mudstones. The samples were prepared following standard procedure and tree-ring widths measurements were performed using LINTAB with TSAP-Win system. From the obtained data values of eccentricity index (ei) were calculated following procedure developed by Wistuba et al. (2013). Subsequently, for the purpose of M/F analysis two thresholds of ei were calculated from reference trees for both sites separately. First threshold was understood as a value above 5% of calculated ei, second – above 1% of calculated ei. Gathered data were transformed into decadal resolution. Spatiotemporal pattern of previous landslide activity was interpolated in

ESRI ArcGIS by using two methods: spline and spline with barriers tool. Barriers - edges of inter-landslide landforms like packets, tongues were double-checked - localized at the LIDAR model of terrain and during the fieldworks. The area of individual part of landslide was from 0.08 to 6 ha.

The analysis covered a period from 1870 to 2014. During this period 2010 growth disturbances occurred in total, providing about 14 events in average per tree. The signal of landslide activity obtained from dendrochronological analysis was spatially and temporally diversified. Return interval of landslide activation was in average 13.5 ranging from 1.6 to 55 years for particular trees. The largest part of landslide was active during two periods: 1971-1980 (39%) and 1991-2000 (44%). In terms of different interpolation methods used – 62% (spline) to 72% (spline with barriers) of landslide was at least once activated since 1910. Dendrogemorphological analysis gives essential information about the past landslide activity and thereby we conclude that it should be applied in hazard assessments for local spatial plans.

References:

Wistuba M., Malik I., Gärtner H., Kojs P., Owczarek P., 2013. Application of eccentric growth of trees as a tool for landslide analyses: the example of Picea abies Karst. in the Carpathian and Sudeten Mountains (Central Europe). Catena 111: 41-55

Keywords: *landslide, magnitude, frequency, interpolation, Polish Flysch Carpathians*

The frequency and magnitude of erosion in upper course of Akçay valley, SW Turkey: Preliminary results

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Abstract

The research area is located in the southwest of Turkey. Most of the precipitation fall in winter, and it is mostly torrential. Aridity in summer is prominent. Therefore, the study area, Akçay valley, is devoid of flow during almost half of the year, and huge amount of water flows abruptly during rainy season. Subsequently, the material transported by stream flow causes erosion in river channel and slopes.

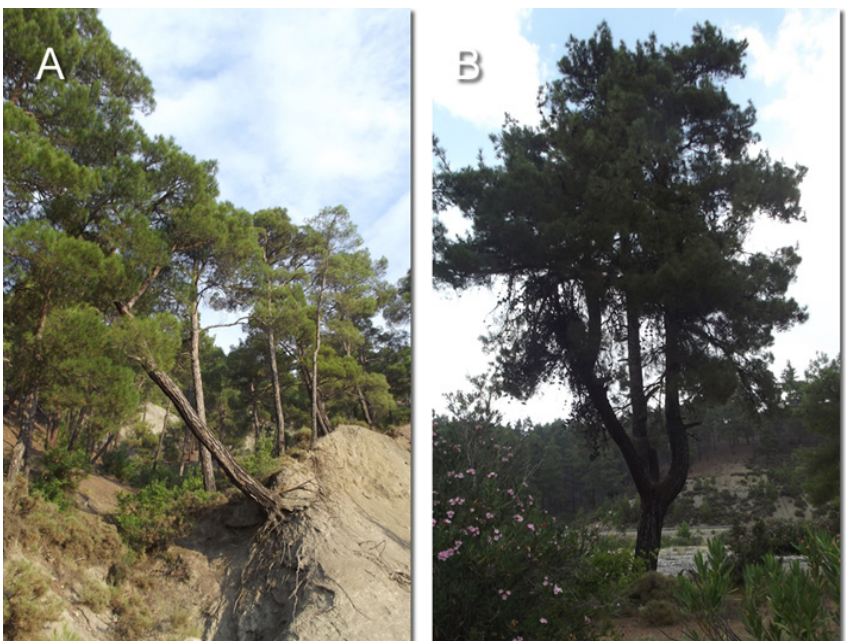

Fig. 1 (A) tilting of trunks. (B) candelabra growth.

We used dendrogeomorphological methods to identify the frequency and the magnitude of the erosion occurred as well as to identify the variations of river channel. The vegetation of research area is formed mostly by red pine (*Pinus brutia* Ten.). 60 red pine trees were sampled in three different areas using increment borer: (a) 14 the islands in the river bed, (b) 36 the southern slopes of the valley, (c) 10 from unaffected area. In the fieldwork, we observed some impacts on the affected trees caused by the natural processes such as tilting of trunks, candelabra growth (Fig 1), scar formation, root exposure and tree death(Fig 2).

We built a mean chronology using the samples from unaffected trees to compare with affected trees. Laboratory analyses on the cores from affected trees are ongoing. As preliminary results, we observed traumatic resin ducts, scars, callus tissue and abrupt growth change on the samples. Our aim of this research is to establish the relationship between geomorphological events and the affected trees.

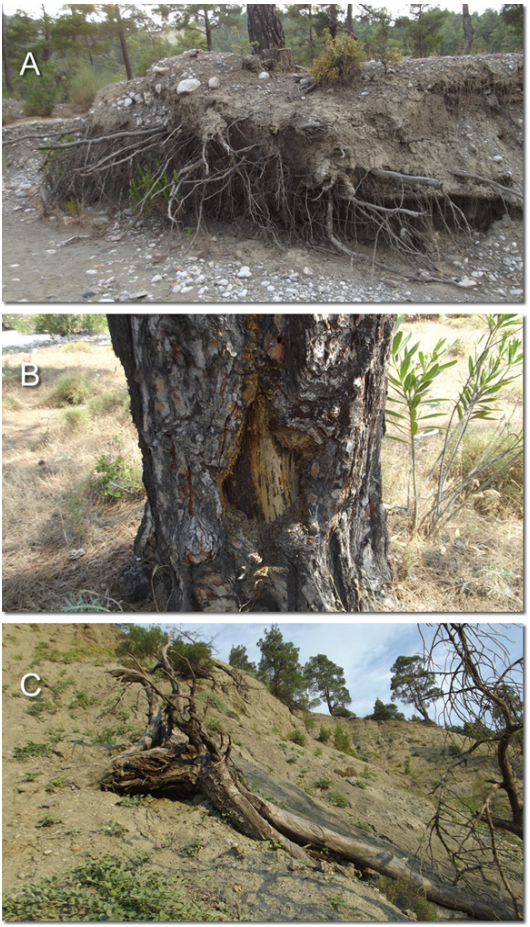

Fig. 2 (A) Root exposure. (B) Scar formation. (C) Tree death.

Keywords: *Tree rings, Anatolia, dendrogeomorphology, river valley*

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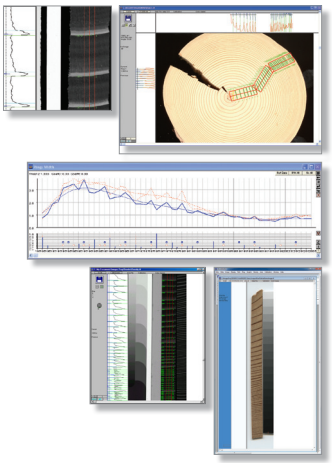

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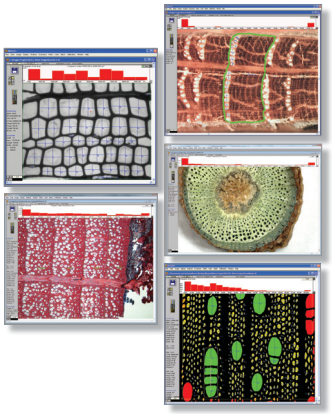

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Trockenholzbohrer

Bohrkerne aus Trockenholz / Balken:

- aus (historischen) Gebäuden und Konstruktionen, auch Brücken, Masten und Pfosten
- Vollholz, Brettschichtträger/Leimbinder
- für normale (Akku-) Bohrmaschinen geeignet (13mm Bohrfutter)
- kann nachgeschärft werden (auch bei uns ☺)

Anwendung in Dendrochronologie, Holzforschung, Holzinspektion: zur Datierung, zu Analyse von Jahrringen, Holzdichte, Holz/Leim-Zustand, Zellstrukturen, ...

2 Längenvarianten>	[mm]	[mm]	*< 2 different length versions*
Gesamtlänge	150	250	Total length
Maximale Bohrkernlänge	110	210	Maximum core length
Außendurchmesser	16	16	Outer diameter
Bohrkerndurchmesser	7	7	Core diameter

Drywood borer

increment cores from dry timber / beams:

- beams in (historical) buildings or structures, timber bridges, poles/piles
- full-size timber, glue-lam beams
- can be used with conventional battery driven drill (13mm clutch)
- can be re-sharpened (even by us ☺)

Application in dendrochronology and wood science as well as in timber inspection: for analysis of tree rings, wood density, wood/glue condition, cellular structures, ...

Zuwachsbohrer

Zur Bohrkernentnahme aus Bäumen und (intakten) Hölzern (~5mm Bohrkerne)

- 2 schneidig (2N) für Harthölzer, sonst 3N
- bedingt tauglich in geschädigtem Bauholz
- Manueller Antrieb oder per Bohrmaschine
- kann nachgeschliffen werden

MORA-CORETAX
(=HAGLÖF)
DJOS
SUUNTO
10, 15, 20, ... 100cm
2N, 3N

MORA-CORETAX
(=HAGLÖF)
DJOS
SUUNTO
5", 7", 12", 16", ... 40"
2N, 3N

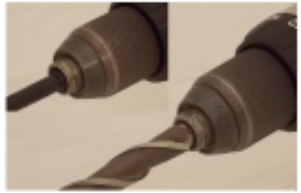
Increment borer

For taking 5mm (~1/5") increment cores from trees and (intact) timber

- 2-threaded (2N) for hardwoods, others 3N
- limited usability in deteriorated timber
- driven manually or by portable drill
- can be re-sharpened

Zubehör

- Bohrkernausstoßer (für 5 / 7 mm Kerne)
- Schärf-Set und Reinigungs-Set
- Verfügbar für 5 und 7 mm Bohrer
- Akkuschrauber mit hohem Drehmoment (FEIN, BOSCH, MAKITA): Trockenholz- und Zuwachsbohrer passen also direkt und ohne Adapter in das Bohrfutter.



Accessories

- Core ejector (for 5 / 7 mm cores)
- Sharpening set and cleansing set
- Available for 5 and 7 mm borer
- High-torque battery driven electric drill (FEIN, BOSCH, or MAKITA): dry-wood and increment borers directly fit into the drill chuck without need of any adaptor.

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Bohrkern-Ausstoßer

C o r e J e c t o r ™

Increment core ejector

Eine einfache, sichere und zuverlässige Lösung für eine häufige Aufgabe bei der Probenahme in der Forst- und Jahrring-Wissenschaft, Baum- und Holz-Untersuchung: festsitzende Bohrkerne aus einem Zuwachsbohrer holen, ohne Bohrkern und Schneide zu beschädigen.

- Transparentes Acryl-Glas.
- Kunststoff-Stift zum kontrollierten Herausdrücken des festsitzenden Bohrkerns.
- Material, Form und Position des Stiftes vermeiden eine Beschädigung der Schneiden.
- Äußere Bohrschneide geführt und geschützt.
- Robust und ohne beweglichen Teile.
- Erhältlich für die markt-gängigen Zuwachsbohrer verschiedener Hersteller.
- Kann zwecks Aufbewahrung auf Ersatz-Bohrern zum dauerhaften Schutz des Bohrkopfes verbleiben.
- In bislang leicht veränderter Form auch für 7mm-Trockenholzbohrer erhältlich.

A simple, safe, and reliable solution for a common challenge of increment core sampling in forestry and tree-ring sciences as well as practical tree- and timber inspection: remove stuck cores from increment borer without destroying the core and without harming cutting edges.

- Transparent acrylic glass.
- Plastic pin for controlled pushing of stuck increment core out to the back.
- Material, size, geometry, and orientation of pin guarantee application without harming front cutting edges.
- Outer thread guided and protected, too.
- No moving parts, robust design.
- Available for common increment borers from different manufacturers.
- Can be used in addition to permanently protect cutting edges of replacement bits, for storage purposes, too.
- Available for 7mm dry-wood borers, too, yet in slightly different design.

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TECHNIK & WISSEN ZUR UNTERSUCHUNG VON BÄUMEN & WÄLDERN, BALKEN & KONSTRUKTIONEN, HOLZ & JAHRRINGEN

RINNTECH

TECHNOLOGY AND KNOW-HOW FOR INSPECTING TREES AND FORESTS, TIMBER AND STRUCTURES, WOOD AND TREE-RINGS

Linearer Jahrringmesstisch

LINTAB™ Series 6

Linear tree-ring measuring stage

- Stammscheiben, Sektionen oder Bohrkerne
- Robustes, spritz-wasser- und staubfestes Spindel-Lineargehäuse
- Messung von Jahrringbreite, Frühholz- und Spätholzbreite
- Standardversion: 560mm Messlänge, 5mm Vorschub pro Umdrehung, 100 Messwerte/mm (=Auflösung 1/100mm=2540dpi), Messwerte als Zeitreihen im Heidelberger ASCII-Format (.FH)
- Unterschiedliche Messlängen, Sensitivitäten (Spindelsteigung, Handkurbeldurchmesser) und Auflösungen sind erhältlich, auch mit Motorantrieb für sehr große Proben.

- Stem disks, sections or increment cores
- Robust, splash-water and dust proved spindle slide casing
- Measuring tree-ring width, earlywood-, and latewood-width
- Standard version: 560mm measuring length, 5mm feed per revolution, 100 points per mm (=resolution 1/100mm=2540dpi, saving of values as time series in Heidelberg ASCII-format (.FH)
- Different measuring lengths, sensitivities (spindle-slope, hand-crank diameter) and resolutions (points per mm) available, even with motorized spindle for very large samples.

Die Standardmesslänge kann um jeweils 10cm verlängert werden. Bei 660 und 760 ist ein Winkelgetriebe erforderlich, ab 860mm ein Motorantrieb, um sinnvoll damit arbeiten zu können.

L = 560, 660, 760, 860, 960, ... [mm]

Standard measuring length can be extended by each +10cm (+4") up to more than 1meter. 660 and 760 require a 90° miter-wheel gear box, lengths of 860mm and more require a motorized stage version.

Wer meist sehr eng-ringige Proben hat, nimmt 2.5mm Steigung (=Vorschub pro Umdrehung) und höhere Auflösung: 500p/mm oder 1000-p/mm ≙ 1 Micron).

mm/r	points/mm			
5.0	100	200	400	
2.5	100	500	1000	

For people mostly measuring samples with narrow rings, 2.5mm/r is better plus higher resolution (=measured points per mm: 500 or 1000p/mm ≙ 1/1000mm ≙ 1 Micron (µ)).

Optional kann die Handkurbel über ein Winkelgetriebe angeschlossen werden. Dies ist sinnvoll bei sehr vielen Messungen oder sehr großen Proben (Stammscheiben).

Optionally, the hand crank can be mounted to the front by using a 90° miter-wheel gear box. This makes handling more comfortable with big samples (stem disks) or if many measurements have to be carried out.

LEICA S4E
6.3x - 30x
compact
BINO

LEICA S8 APO
10x - 80x
compact
TRINO
optional:
+ CCD CAM
+ LED RING

LEICA M80
7.5x - 60x
modular
optional:
+ CCD CAM
+ LED RING
+ TRINO
+ ...

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Kompakter kleiner Jahrringmesstisch

Für Studienseminare / Schulklassen

- Stammscheiben, Sektionen oder Bohrkerne.
- Messung von Jahrringbreite, Frühholz- und Spätholzbreite.
- Abgedeckter Spindelantrieb, robuste Ausführung.
- LED-Lampe.
- Software: TSAP-Mess-Modul.
- Messwerte als Zeitreihen im Heidelberger ASCII-Format (.FH).
- Optional inklusive Binokular- oder Trinokular-Stereo-Mikroskop und Stativ. Mikroskopauswahl je nach Kundenwunsch/Anforderung und verfügbarem Budget. Vorhandene Mikroskope können befestigt werden.

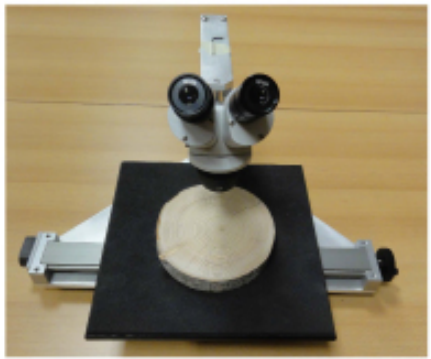
LINTAB™ Series 6m

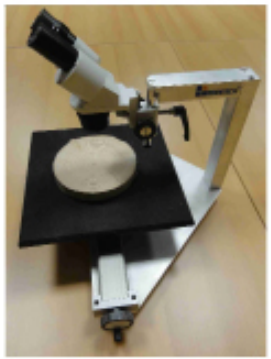
Messlänge	400mm	measure length
Auflösung	1/100mm	resolution
	≙2540dpi	
Vorschub pro Umdrehung	4mm/r	Thrust / feed per revolution
Software	TSAP	Software
PC-Anschluss	USB	PC connector

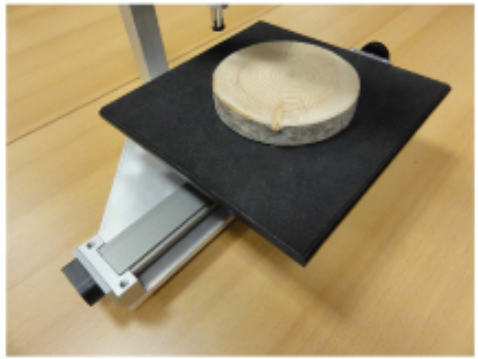
Compact small tree-ring measuring stage

For student seminars / school classes

- Stem disks, sections or increment cores.
- Measuring tree-ring width, earlywood-, and latewood-width.
- Covered spindle, robust structure.
- LED spot light.
- Software: TSAP measure module.
- Saving of values as time series in Heidelberg ASCII-format (.FH).
- Optionally including binocular or trinocular stereo microscope and stand. Microscope selection depending on application requirements and available funds. Existing microscopes can be attached.







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RINNTECH

TECHNOLOGY AND KNOW-HOW FOR INSPECTING TREES AND FORESTS, TIMBER AND STRUCTURES, WOOD AND TREE-RINGS

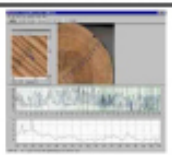
Jahrringanalyse auf Holzoberflächen

LignoVision™

Tree-ring analysis on wood surfaces

Computerprogramm zur Jahrringanalyse auf Holzoberflächen

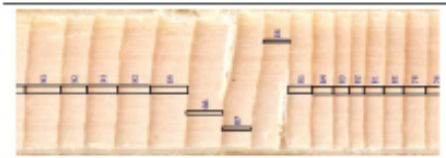
- Stammscheiben, Sektionen oder Bohrkerne
- Optische Bilder von Scannern oder Kameras, Röntgenbilder
- Speichern der Jahrringbreiten- und Jahrringdichteparameter-Zeitreihen sowie Grauwert-, Dichte- und Farb-Profile im Heidelberger ASCII-Format (.FH)



Computer program for analysing tree-rings on wood-surfaces

- Stem disks, sections, or increment cores
- Images from scanners, cameras, X-ray images
- Saving of ring-width and tree-ring density parameter time-series as well as grey-scale, density and colour-channel-profiles in readable Heidelberg ASCII-format (.FH)

Verschiedene Versionen für unterschiedlichen Anforderungen =	Pro	Exp	Sci	*= Different versions covering features for different needs*
Jahrringgrenzen manuell setzen, Speichern der Breitenkurve/Reihe.	X	X	X	Manuel setting of tree ring borders and saving of ring-width curve.
Automatische Jahrringerkennung im Grauwertprofil. Speichern des Grauwertprofils sowie der Jahrringdichteparameter.		X	X	Automatic tree-ring detection in grey-scale profile. Saving of grey-scale profile and tree-ring density parameters.
Dichtekalibration des Grauwertprofils (z.B. für Röntgenfilme) + Anzeige, Auswertung und Ausgabe der Dichte- sowie Farbkanal-Profile ROT-GRÜN-BLAU mit Jahrring-Dichteprofil-Parametern.			X	Density calibration of grey-scale profile (for example from x-ray scans) + Display, analysis, saving of density + colour-channel profiles (RED-GREEN-BLUE) with tree-ring density profile parameters.



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Visueller Schnelltest der Wirkung verschiedener mathematischer Funktionen auf Zeitreihen

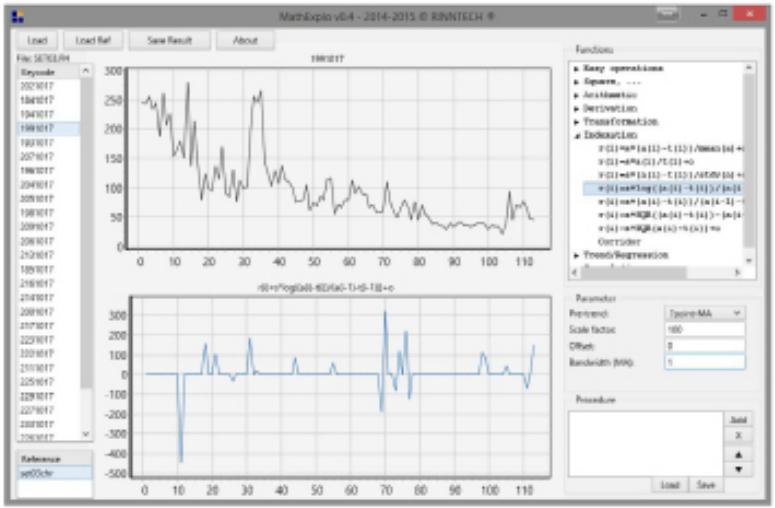
MathExplo™

MAC-OS + WIN-PC

Quick visual test of the result of various different mathematical functions applied on times series

Zur Analyse von Jahrring- oder auch Klima-Daten werden verschiedene mathematische Funktionen benötigt. Dabei gibt es z.B. für die Trendelimination oder Indexberechnung unterschiedliche Methoden mit zum Teil sehr verschiedenen Ergebnissen. MathExplo ermöglicht es, eine nahezu unbegrenzte Anzahl an Zeitreihen einzuladen und die Wirkung verschiedener mathematischer Funktionen direkt visuell zu vergleichen. Der obere Graph zeigt die Originaldaten, des links per KeyCode ausgewählten Datensatzes. Der untere Graph zeigt sofort das Ergebnis der rechts ausgewählten Funktion bzw. Methode mit den dort eingestellten Parametern. Ein Durchlaufen der KeyCode-Liste ermöglicht es, die Wirkung der Operation auf die verschiedenen Zeitreihen zu vergleichen. Auch nach Methodenwahl und Parameteränderung wird das Ergebnis sofort angezeigt.

- Zeitreihen im FH-Format.
- Eingabe: KeyCode, Methode, Parameter
- Ausgabe: (Transformierte) Zeitreihen
- RINNTECH®-Kunden, Studierende, Forschungs- und Lehr-Institutionen erhalten Rabatt.



APPLE-MAC-OS-X (Version ≥10.8)
MS-WINDOWS® (WIN XP,7,8)

For analysis of tree-ring or climatic time series, various mathematical functions are commonly used. For trend elimination or indexation, in addition, several different kinds of methods and parameter settings lead to correspondingly different results. MathExplo enables the user to instantly visually check the results of various mathematical methods and parameter settings on hundreds of time series. The left window shows the stack of input data (selection by KeyCode). The top graph displays the original series, the right window lists the mathematical functions and parameter. The bottom graph shows the resulting series (that can be saved) instantly after selecting KeyCode (left), method and parameters (right).

- Time series in FH-format (ASCII).
- Input: KeyCode, method, parameter
- Output: (transformed) series.
- RINNTECH®-clients, students, research and education institutions get a discount.

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